

433 N. Virginia Street Prescott, Arizona 86301 (928) 777-1130

ADDENDUM NUMBER TWO

FOR THE

YAVAPAI HILLS #1 LIFT STATION REHABILITATION PROJECT

DATE OF ADDENDUM: April 26, 2024

TO ALL BIDDERS BIDDING ON THE ABOVE PROJECT:

The following addendum shall be made part of the Project Specifications and Contract Documents. All other provisions of the Contract Documents remain unchanged. <u>The Bidder shall</u> acknowledge receipt of this Addendum on page 10 of the Bid Proposal form, in addition to signing below and returning this form with the bid package. The contents of this Addendum shall be given full consideration in the preparation of the Bid.

On Page 5 DELIVERY OF SUBMITTALS change:

Sealed bids will be received **before 2:00 PM Thursday May 16, 2024, at the City Clerks Office, 201 N. Montezuma Street, Suite 302, Prescott, Arizona 86301,** at which time all submittals will be publicly opened.

Also on Page 5 change:

The outside of the submittal envelope shall indicate the name and address of the Respondent; shall be addressed to the City Clerk, City of Prescott, at the above address; and shall be clearly marked:

Notice of Inviting Bids: Yavapai Hills #1 Lift Station Rehabilitation DUE BEFORE 2:00 PM ON MAY 16, 2024

Also, on Page 5 Requests for Information change:

Requests for information must be received by 5:00 PM on Tuesday May 7, 2024. Responses or addenda will be issued no later than 12:00 May 13, 2024.

On Page 13 Proposed Staging Locations change:

Bid Date: May 16, 2024

REMOVE the Construction Drawings, Construction Standard Details, and Technical Specifications and **REPLACE** them with Construction Drawings Addendum 2, Construction Standard Specifications Addendum 2, Technical Details Addendum 2, Technical Memorandum Addendum 2 and Geotech Report Appendix A.

Addendum No. Two: Yavapai Hills #1 Lift Station Rehabilitation 4/26/2024

Requests for Information

Question: Sheet C - 101 mentions two areas that are to receive 8' Masonry Block Wall at both site entrance gates. There is no bid item for 8' Masonry Block Wall, should it be assumed that the 8' block wall will be paid under the fabricated steel gate and operator bid item?

Response: Yes, the block wall will be paid as part of the steel gate item.

Question: Can a measurement and payment specification be provided for this project? There are multiple items of work that do not currently have an associated bid item.

Response: Refer to section 102.5.1 and section 109 of the City of Prescott Supplement to MAG uniform Standard Specifications and Details for Public Works Construction.

Question: Specification section 01110 - Summary of Work Paragraph 1.1 Subpart C mentions a contract document listed as "Volume 4 - Technical Memorandum". That document does not currently appear to be included in the initial Invitation to Bid documents. Please provide "Volume 4 - Technical Memorandum".

Response: Technical Memorandum addendum 2 is attached.

Question: "Sheet M-201 calls out detail 15040 for the pipe supports within the lift station. This detail was not provided. Please provide detail 15040."

Response: Standard Details for Construction Addendum 2 is attached.

Question: Sheet M-101, call outs 13 and 14 reference detail 15145. This detail was not provided. Please provide detail 15145.

Response: Standard Details for Construction Addendum 2 is attached.

Question: Are there any specifications or special requirements for instrumentation such as flow meters, pressure indicators, level transmitters, pressure transmitters, and floats?

Response: Technical Memorandum Addendum 2 is attached.

Question: Bid Item for Misc. Shelving – Please Clarify, item is not referenced in the Plans or Specifications.

Response: Misc. Shelving will be called out in the attached revised drawings. Shelves will be aluminum and will abide by specification section 5500.

Question: Specification section 16050 1.9 B. The only corrosive location that is listed is the Chlorination room. This project does not have a Chlorination room. Please confirm the corrosive locations.

Response: The only corrosive environment will be within the wet well, manholes and SS piping. Reference to the chlorination room has been removed.

Addendum No. Two: Yavapai Hills #1 Lift Station Rehabilitation 4/26/2024

Question: What is the intent of LCP 601 and LCP 602 if the existing wet well that it serves is going to be demolished?

Response: Existing wet well shall be protected in place. Pumps 601 and 602 are to replace existing pumps within the wet well and act as overflow pumps.

Question: If the vendor supplied LCP 601 and LCP 602 come with a disconnecting means for PMP-601 B and 02 B can the 2 separate disconnects shown on the single line diagram for the pumps be removed from the project?

Response: The proposed change would need to be provided in the form of a submittal for review and approval.

Question: Aggregate Roadway- No depth is specified for the aggregate roadway. Please clarify what depth is required?

Response: Construction Drawings Addendum 2 are attached.

Question: Manhole Details – No details have been provided for the 3 polymer manholes. The only information provided is the rim elevation on sheet C-102, which is not enough information for vendors to price these structures. Please provide a detail showing the bottom of manhole elevations in order to decipher the actual size of the manholes required at the site.

Response: Construction Drawings Addendum 2 are attached.

Question: Please provide the existing flow rates of the site for bypass purposes.

Response: Single pump capacity of existing pumps is 825 gpm 150ft. Provide bypass pumping that matches this performance.

Question: Disconnect Switches- Ates the disconnect switches located outdoors at the wet wells to be rated NEMA 3R of NEMA 4X?

Response: Provide NEMA 4X enclosures.

Question: Exposed Electrical Conduit – Is above ground outdoor electrical conduit to be galvanized rigid steel of PVC coated rigid, including at the wet wells?

Response: Provide PVC coated rigid steel conduit.

Question: Please indicate the required NEMA rating for the VFD panels at the building and local control panels at the wet wells, 4X or 12X?

Response: Provide NEMA 4X Enclosures.

Question: Conduit and Cable Requirements – Please clarify any seal off or air gap requirements for the conduits and cables entering the wet wells.

Response: Provide sealed conduits within 10 ft. of the barrier per NFPA 820, preferred on the outside. Barrier is the is the interior of the wet well. Addendum No. Two: Yavapai Hills #1 Lift Station Rehabilitation 4/26/2024 page 3 of 4 **Question:** Please clarify the location of Item 25 15812 SP 4" FRP Duct, 200 LF, not shown of Plans.

Response: FRP ducts/yard piping shall be utilized for the passive odor control system and the vent piping of the structures. This shall be further clarified within Construction Drawings Addendum 2, attached.

- End –

City of Prescott Public Works Department

Randy Perham

04/29/2024

Date

Gwen Rowitsch, Public Works Director Randy Perham, City Engineer, on behalf of

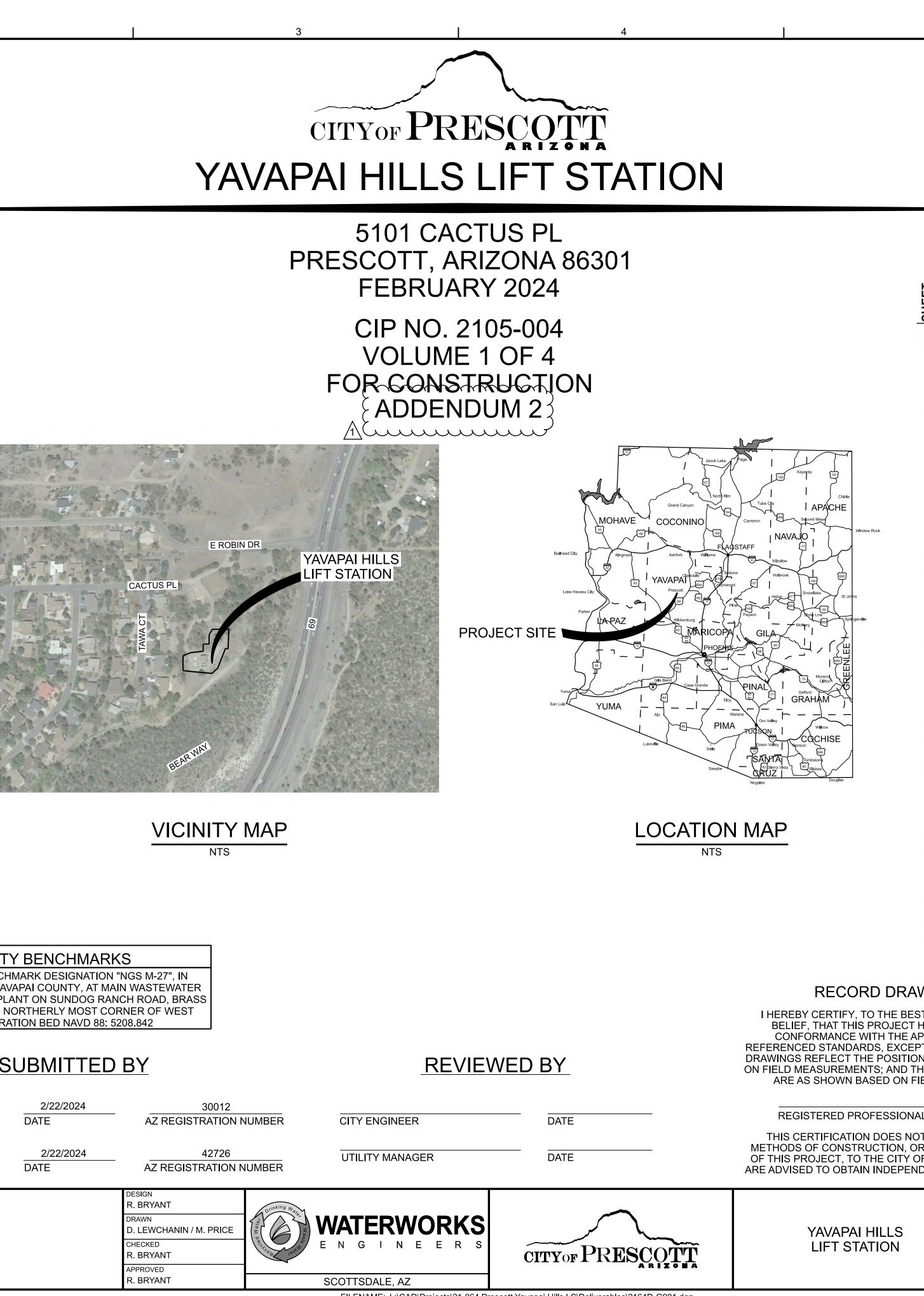
Acknowledgement: (must be signed and turned in with the bid documents)

Company Name

Signature of Company Official

Date

	UTI	LITY INFORMATION	
	COMPANY	CONTACT	TELEPHONE
	ARIZONA PUBLIC SERVICE CO. 6672 CORSAIR AVENUE PRESCOTT, ARIZONA 86301	MONIQUE HOLLIDAY	(928) 445-6612
	CENTURY LINK 1445 MASONRY WAY PRESCOTT, ARIZONA 86301	DELL HOWARD	(520) 838-3050
	UNISOURCE ENERGY SERVICES 6405 WILKINSON DRIVE PRESCOTT, ARIZONA 86301	MALI ROSS	(928) 771-7227
	SPARKLIGHT 3201 TOWER ROAD PRESCOTT, ARIZONA 86305	DOUG HAMILTON	(928) 713-8382
	CITY OF PRESCOTT WATER & SEWER P.O. BOX 2059 PRESCOTT, ARIZONA 86301	STEVE OLFERS	928-777-1130
	NOTES: YCESD APPROVAL TO CONSTRUCT AN PERMIT REQUIRED PRIOR TO CONSTR CONTRACTOR IS TO USE EXTREME CA VOLTAGE OVERHEAD POWER LINES A CONTRACTOR TO LOCATE AND DELIN	RUCTION AUTION WHEN WORKING ND HIGH PRESSURE GAS	
	CONSTRUCTION EASEMENTS. NO ACTIVITY SHALL OCCUR OUTSIDE ALL EASEMENTS CALLED OUT IN THES DEDICATED BY A RECORDED LEGAL D AS "EXISTING" WITH BOOK & PAGE LO PROJECT IS FUNDED VIA WIFA. PROV WAGES PER LATEST WAGE DETERMIN ALL OTHER APPLICABLE WIFA REQUIR	SE CONSTRUCTION DRAY DESCRIPTION UNLESS OT CATION OF RECORDING. VIDE WIFA COMPLIANT SIGNATION, AMERICAN IRON	WINGS SHALL BE THERWISE NOTED GN, DAVIS-BACON
	REFER TO THE FOLLOWING QU DETAIL FOR PROJECT NOTES W FROM THE CITY OF PRESO HTTP://WWW.PRESCO 101P GENERAL N 103P WATER PLAN GEN 104P WASTEWATER PLAN GEN 104P WASTEWATER PLAN O 105P-1 GRADING AND DR 105P-2 EROSION AND SEDIMENTA 106P-1 SIGNING AND STF 106P-2 TRAFFIC SIGN	HICH ARE AVAILABLE COTT WEBSITE: TT-AZ.GOV/ NOTES IERAL NOTES GENERAL NOTES AINAGE NOTES TION CONTROL NOTES RIPING NOTES	COP BM "M-27" COP BM "M-27" COP BM TREATMENT PL CAP AT THE M AER
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ER MOC		THEY LOIS	JOHN H. MATTA TED PRINCIPAL MBOGI
			ROB D. BRYANT PROJECT MANAGER
VER	RIFY SCALE		Biofessional English
ORIG 0	S ONE INCH ON INAL DRAWING 1"		42726 ROB D. BRYANT
THIS S	T ONE INCH ON 4/17/24 SHEET, ADJUST 1 4/17/24 ADDENDUM 2 S ACCORDINGLY NO DATE REVISION		MR RDB



FILENAME: L:\CAD\Projects\21-064 Prescott Yavapai Hills LS\Deliverables\2164D-G001.dgn

DRAWING INDEX

DRAWING NUMBER	
Diatine itelibert	TITLE
GENERAL	
G-001	COVER SHEET
G-002	ABBREVIATIONS
G-003	STANDARD DESIGNATIONS
G-004	OVERALL SITE PLAN
G-005	TEMPORARY BYPASS LINE PHASING PLAN - PHASE 1 & 2
G-006	TEMPORARY BYPASS LINE PHASING PLAN - PHASE 3 & 4
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D-302	DETAILS 2
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C-001	SYMBOLS & LEGEND
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E-030	SCHEMATICS - 1
E-040	SCHEDULES - 1
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E 102	LIFT STATION ENLARGED POWER AND LIGHTING PLAN
E-301	DETAILS-1
INSTRUMENTATION	
	SYMBOLS AND LEGENDS
	SYMBOLS AND ABBREVIATIONS
	PRESCOTT YAVAPAI HILLS LIFT STATION P&ID
N-602	PRESCOTT YAVAPAI HILLS LIFT STATION P&ID
	G-003 G-004 G-005 G-006 DEMOLITION D-301 D-302 ED-001 ED-002 CIVIL C-001 C-101 C-102 MECHANICAL M-001 M-001 M-101 M-201 ELECTRICAL E-001 E-002 E-003 E-010 E-020 E-030 E-030 E-040 E-101 E-102 E-103 E-103 E-103 E-301

METHODS OF CONSTRUCTION, OR OTHER ITEMS AFFECTING THE WARRANTY OF THIS PROJECT, TO THE CITY OF PRESCOTT. USERS OF THIS INFORMATION ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF ACTUAL CONDITIONS. Call 811 or click Arizona811.com

DATE **FEBRUARY 2024** PROJECT NO. 21-064 DRAWING NO. G-001 SHEET NO. 1

PLOT DATE: 2/14/2024

GENERAL

COVER SHEET

PLOT TIME: 2:48:44 PM

@)	AT	E	EAST
AE		ANCHOR BOLT, AGGREGATE BASE ASPHALTIC CONCRETE, ASBESTOS CEMENT	EA EC	EACH END CURVE
AC	CI	AMERICAN CONCRETE INSTITUTE	ECC	ECCENTRIC
	CU DD	AIR CONDITIONING UNIT ADDITIONAL	EF EG	EACH FACE EXISTING GRADE
A	DH AB	ADHESIVE ANCHOR BOLT	EL	ELEVATION
	DJ E	ADJACENT, ADJUSTABLE ANALYZER ELEMENT	ELC ELEC	ELECTRIC LOAD CENTER ELECTRIC, ELECTRICAL
AF	FF	ABOVE FINISH FLOOR	EM	EMISSION MEASUREMENT
	FG ISC	ABOVE FINISH GRADE AMERICAN INSTITUTE OF STEEL	EMR ENGR	EMERGENCY ENGINEER
		CONSTRUCTION	EP	EDGE OF PAVEMENT
A	IT L, ALUM	ANALYZER INDICATOR/TRANSMITTER ALUMINUM	EQL SP EQPT	EQUALLY SPACED EQUIPMENT
	L, ALOM LTN	ATERNATE	ESC	EROSION SEDIMENT CONTROL
	NSI PPROX	AMERICAN NATIONAL STANDARDS INSTITUTE APPROXIMATE	ESA EVC	ENVIRONMENTALLY SENSITIVE ARE
	PVD	APPROVED	EW	END OF VERTICAL CURVE EACH WAY
	PWA RCH, A	AMERICAN PUBLIC WORKS ASSOCIATION ARCHITECTURAL	EWEF EXC	EACH WAY, EACH FACE
	STM	AMERICAN SOCIETY FOR TESTING AND	EXP	EXCAVATE EXPOSED, EXPANSION
	UTO	MATERIALS	EXP JT EXST	EXPANSION JOINT
	UX	AUTOMATIC AUXILIARY	EXST	EXISTING
	VE	AVENUE		
	WG WWA	AMERICAN WIRE GAGE AMERICAN WATER WORKS ASSOCIATION	FB FBE	FLAT BAR FUSION BOND EPOXY
			FCO	FLOOR CLEAN OUT
В		BORING	FD FDA	FLOOR DRAIN FLOOR DRAIN W/ INTEGRAL TRAP
BC	С	BEGIN CURVE, BOTTOM OF CURVE	FDN	FOUNDATION
	LDG LK	BUILDING BLACK	FEXT FF	FIRE EXTINGUISHER FINISH FLOOR
BL	LM	BUREAU OF LAND MANAGEMENT	FG	FINISH GRADE, FUEL GAS
BN BC	M OC	BENCH MARK, BEAM BACK OF CURB	FHY FL	FIRE HYDRANT FLOOR, FLOW LINE
BC	OG	BACK OF GUTTER	FLG	FLANGE
	00 0T	BOTTOM OF OPENING BOTTOM	FLH FLL	
BF	RG	BRG	FM	FLOW LINE FORCE MAIN
B∖	VC	BEGINNING OF VERTICAL CURVE	FNSH	
			FOC FOE	FACE OF CONCRETE FLANGED ONE END
C C	to C, CC	CENTER TO CENTER CHANNEL (BEAM)	FRP	FIBERGLASS REINFORCED PLASTIC
CA	ATH	CATHODIC PROTECTION	FS FT	FINISHED SURFACE FOOT OR FEET
C/ CE	ATV B	CABLE TELEVISION CATCH BASIN	FWD	FORWARD
	CS	CENTRAL CONTROL SYSTEM	°F	DEGREE FAHRENHEIT
CE		CONDENSATE CUBIC FEET	GAL	GALLON
	FM	CUBIC FEET PER MINUTE	GALV	GALVANIZED
	FS	CUBIC FEET PER SECOND	GB GCO	GRADE BREAK GRADE CLEAN OUT
	HE HEM	CHEMICAL TUBING CHEMICAL	GD	GENERAL DRAINAGE
CJ		CONSTRUCTION JOINT, CONTRACTION JOINT	GL GPD	GLASS GALLONS PER DAY
CL	L LG	CENTERLINE CEILING	GPH	ALLONS PER HOUR
CL	LR		GPM GRTG	GALLONS PER MINUTE GRATING
	LSM MU	CONTROLLED LOW STRENGTH MATERIAL CONCRETE MASONRY UNIT	GVL	GRAVEL
CC	0	CLEANOUT	GW	GROUND WATER
	OL OM	COLUMN COMMUNICATION	HD	HUB DRAIN
CC	OMB	COMBINED	HDR	HEADER
	ONC ONN	CONCRETE CONNECTION	HDW HGL	HARDWARE HYDRAULIC GRADE LINE
CC	ONT	CONTINUOUS, CONTINUATION	HGT	HEIGHT
	OORD OP	COORDINATE COPPER	HM HORIZ	HOLLOW METAL HORIZONTAL
CF	PLG	COUPLING	HORIZ	HORSEPOWER
	PVC TRD, CTD	CPVC CENTERED	HPT HR	HIGH POINT HANDRAIL
CT	TR	CENTER	HSS	HOLLOW STRUCTURE STEEL
CL	U U FT	COPPER CUBIC FOOT		
CL	U IN	CUBIC INCH	HWY HYD	HIGHWAY HYDRANT
CL	U YD	CUBIC YARD		
CL °C	ULV C	CULVERT CELSIUS	I & C	INSTRUMENTATION & CONTROL
Ĭ			ID	INSIDE DIAMETER
d		PENNY	IF ID	INSIDE FACE INSIDE DIAMETER
DE	BA	DEFORMED BAR ANCHOR	IN	INCH
	BL ET	DOUBLE DETAIL	INSTM INSUL	INSTRUMENTATION INSULATE, INSULATION
	F	DOUGLAS FIR/LARCH	INV	INVERT
DF		DROP INLET DIAMETER	IR	IRON ROD
DI		DIAGONAL		
DI DI DI	AG	DIMENSION	JT	JOINT
DI DI, DI, DI	IM	DIRECTION		
DI DI, DI, DI DI DI	IM IR IST	DIRECTION DISTANCE		
DI DI, DI, DI DI DI DI	IM IR IST N	DISTANCE DOWN	KIP	THOUSAND POUNDS
DI DI DI DI DI DI do	IM IR IST N	DISTANCE	KIP KW	THOUSAND POUNDS KILOWATT
DI DI DI DI DI DI DI DI DI DI DI DI DI D	IM IR IST N PT R	DISTANCE DOWN DITTO DIFFERENTIAL PRESSURE TRANSMITTER DRAIN		
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MR RDB

BY APVD

IF NOT ONE INCH ON THIS SHEET, ADJUST 1 4/17/24 ADDENDUM 2 SCALES ACCORDINGLY NO DATE REVISION

R. BRYANT DRAWN D. LEWCHANIN CHECKED R. BRYANT APPROVED R. BRYANT

DESIGN

GENERAL ABBREVIATIONS

L	LEFT, ANGLE, LENGTH	RT	RIGHT
LAB	LABORATORY	RV	ROOF VENT
LAT'L		R/W	RIGHT-OF-WAY
LB LB/CU FT	POUNDS POUNDS PER CUBIC FOOT		
LF	LINEAR FEET	C	LEEAM SOUTH SLODE
LG	LONG	S S =	I-BEAM, SOUTH, SLOPE SLOPE EQUALS
LONG	LONGITUDINAL	SAT	SUSPENDED ACOUSTIC TILE
LP	LOW POINT	SCFH	STANDARD CUBIC FEET PER HOUR
LR	LONG RADIUS	SCFM	STANDARD CUBIC FEET PER MINUTE
		SCH	SCHEDULE
		SD SE	STORM DRAIN SOUTHEAST
MAX MCC	MAXIMUM MOTOR CONTROL CENTER	SEC	SECONDARY
MCJ	MASONRY CONTROL JOINT	SECT	SECTION
MECH	MECHANICAL	SH	SHEET
MFR	MANUFACTURER	SIM	SIMILAR
MGD	MILLION GALLONS PER DAY	SLP	SLOPE
MH MIN	MANHOLE MINIMUM, MINUTE	SMP SOLN	SAMPLE SOLUTION
MISC	MISCELLANEOUS	SOU	SLIP ON WELD
MJ	MECHANICAL JOINT	SP	SPACE OR SPACES
MPH	MILES PER HOUR	SPEC	SPECIFICATIONS
MSNRY	MASONRY	SPLY	SUPPLY
MSP	MILL STEEL PIPE, MANUAL OF STANDARD PRACTICE	SQ SQ FT	SQUARE SQUARE FOOT
MTL	MATERIAL	SQ IN	SQUARE INCH
		SS	SANITARY SEWER
		SSMH	SANITARY SEWER MANHOLE
N	NORTH	STA	STATION
NC NE	NORMALLY CLOSED NORTHEAST	STD	STANDARD
	NORTHEAST NOT IN CONTACT	STIF STL	STIFFENER STEEL
NO	NUMBER, NUMBERING	STR	STRAIGHT
NPT	NATIONAL PIPE THREAD	STRL	STRUCTURAL
NTS	NOT TO SCALE	SUBFL	SUBFLOOR
		SUP	SUPPLY
OC	ON CENTER	SUSP SW	SUSPEND SOUTHWEST
OD		SYMM	SYMMETRICAL
OF		o mini	
OG OHE	ORIGINAL GROUND OVERHEAD ELECTRIC		
OMRF	ORDINARY MOMENT RESISITING	Т	TANGENT, TELEPHONE LINE, TOP
O TO	FRAME	T&B	TOP AND BOTTOM
0	OUT TO OUT	T&G t, T	TONGUE AND GROOVE THICKNESS
OPNG	OPENING	TBG	TUBING
OPP OVF	OPPOSITE OVERFLOW	TCE	TEMPORARY CONST EASEMENT
OVF OZ	OUNCE	TDH	TOTAL DYNAMIC HEAD
02	001102	TECH	TECHNICAL
		TEL TEMP	
PENT	PENETRATION	TEMP	TEMPORARY, TEMPERATURE TOP FACE
PI PJF	POINT OF INTERSECTION PREMOLDED JOINT FILLER	THD	THREAD
PL	PLATE, PROPERTY LINE	ТНК	THICK
PLYWD	PLYWOOD	TNK	TANK
POB	POINT OF BEGINNING	TOC TOW	TOP OF CURB, TOP OF CONCRETE TOP OF WALL
POC	POINT OF CONNECTION	TOF	TOP OF FOOTING
POE PP, P&P	POINT OF ENDING, PLAIN ONE END PLAN AND PROFILE, POWER POLE	TP	TURNING POINT, TEST PIT
PPM	PARTS PER MILLION	TRANS	TRANSITION
PRC	POINT OF REVERSE CURVE	TRANSV	TRANSVERSE
PRCST	PRECAST	TST	TOP OF STEEL
PREFAB	PREFABRICATED	TT TWS	THRUST TIE TRACER WIRE STATION
PRESS	PRESSURE	TYP	TYPICAL
PRI PROP	PRIMARY PROPERTY		
PS	PUMP STATION		
PSF	POUNDS PER SQUARE FOOT	UBC	
PSI	POUNDS PER SQUARE INCH	UD UG	UNDERDRAIN UNDERGROUND
PSIG	POUNDS PER SQUARE INCH, GAUGE	UH	UNIT HEATER
PT P.U.E.	POINT OF TANGENCY PUBLIC UTILITY EASEMENT	UNK	UNKNOWN
PVC	POBLIC UTILITY EASEMENT POINT OF VERTICAL CURVE	UNO	UNLESS NOTED OTHERWISE
PVCGS	POLYVINYL CHLORIDE PLASTIC-		
	GRAVITY SEWER TYPE	V	VOLT
PVCW	POLYVINYL CHLORIDE PLASTIC-	VC	VERTICAL CURVE
PVI	WATER DISTRIBUTION SERVICE TYPE POINT OF VERTICAL INTERSECTION	VERT	VERTICAL
PVT	POINT OF VERTICAL INTERSECTION POINT OF VERTICAL TANGENCY,	VPI	VERTICAL POINT OF INTERSECTION
	PRIVATE	VPS	
		VTR	VENT THRU ROOF
R, RAD RC	RADIUS REINFORCED CONCRETE	W/	WITH
RD	ROAD, ROOF DRAIN	W	WIDE FLANGE (BEAM), WEST, WATER
REF	REFER, REFERENCE	WC	WATER CLOSET
REINF	REINFORCED, REINFORCING, REINFORCE	WD WH	WOOD WATER HEATER
REQD		WM	WATER METER
RLS RM	RUBBER LINED STEEL ROOM	WR	WATER RESISTANT
RM RO	ROOM ROUGH OPENING	WS	WATER SURFACE, WATER STOP
RP	RADIUS POINT	W SH ST	WEATHERING SHEET STEEL
R/R	REMOVE AND REPLACE	WSE WT	WATER SURFACE ELEVATION WATER TIGHT
RST	REINFORCING STEEL	WTR	WATER
		WW	WASTEWATER

YAVAPAI HILLS LIFT STATION

WW WWF

XFMR

Y

WASTEWATER WELDED WIRE FABRIC

CITY OF PRESCOTT

TRANSFORMER

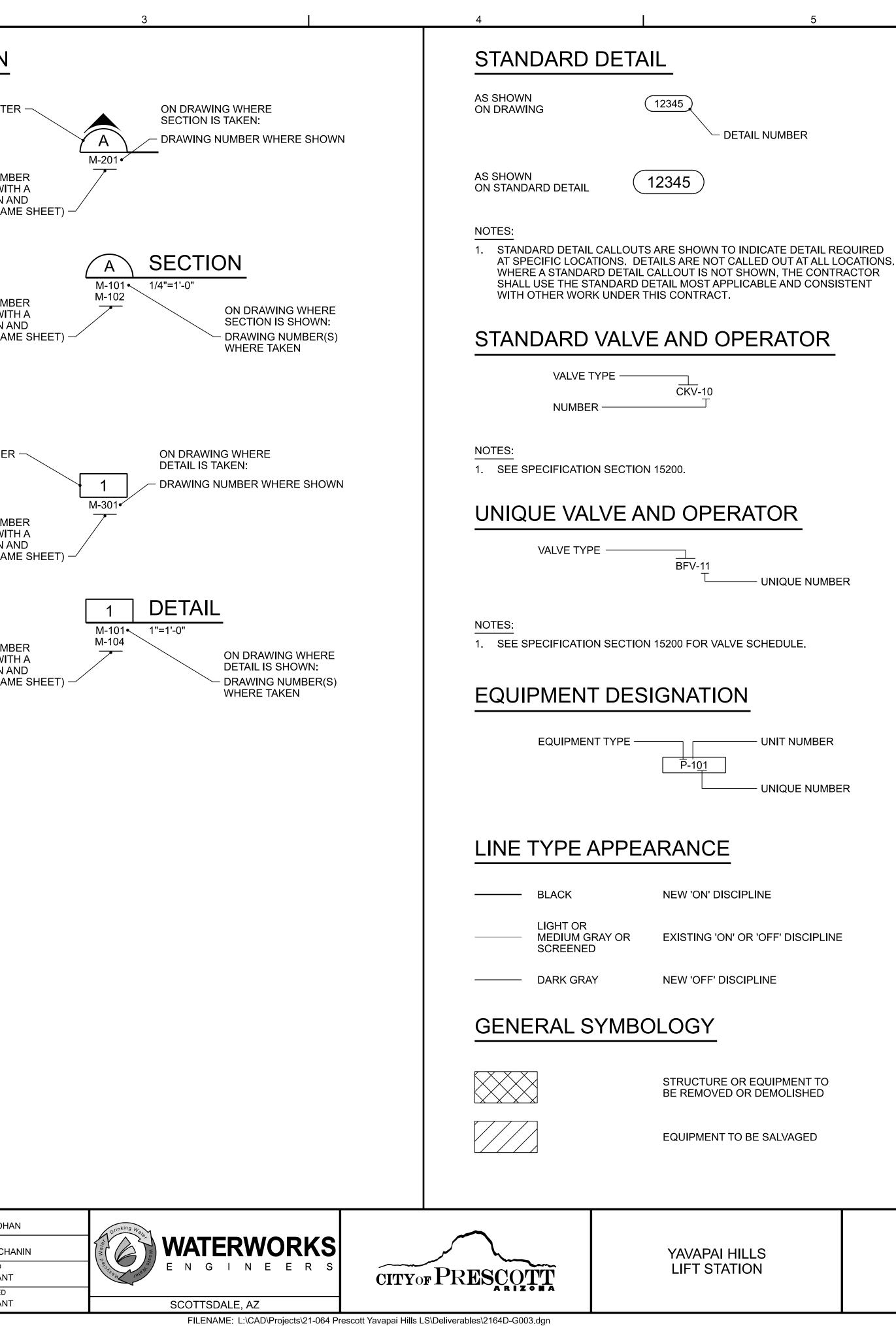
YARD

Volter Park

WATERWORKS E N G I N E E R S

GENERAL DATE FEBRUARY 2024 PROJECT NO. 21-064 ABBREVIATIONS drawing no. SHEET NO. 2 PLOT DATE: 2/14/2024 PLOT TIME: 3:11:25 PM

	1		2	
		ER		SECTION
	DISCIPLINE	 M-101		SECTION LETTER
			NUMBER	DRAWING NUMB
A	DISCIPLINE			(REPLACED WITH LINE IF TAKEN AN SHOWN ON SAMI
	LETTER G D C A S M H P	DISCIPLINE GENERAL DEMOLITION CIVIL YARD ARCHITECTURAL STRUCTURAL MECHANICAL HEATING, VENTILATION A PLUMBING	ND COOLING	DRAWING NUMBI (REPLACED WITH LINE IF TAKEN AN SHOWN ON SAMI
	E N	ELECTRICAL INSTRUMENTATION		DETAIL
	DRAWING SERIES	5		DETAIL NUMBER
В	NUMBER SERIES	DRAWING TYPE		
	000 100 200 300 400 500 600 700	GENERAL PLANS SECTIONS DETAILS ELEVATIONS/ ISOMETRIC SCHEMATICS SCHEDULES NOT USED	S	DRAWING NUMBI (REPLACED WITH LINE IF TAKEN AN SHOWN ON SAMI
	800 900	NOT USED DEMOLITION		DRAWING NUMBI (REPLACED WITH LINE IF TAKEN AN
				SHOWN ON SAM
С				
D				
	VERIFY SCALE		arotessional English	DESIGN A. PRADHAN
	BAR IS ONE INCH ON ORIGINAL DRAWING			DRAWN D. LEWCHAI
	0 IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII		R RDB	CHECKED R. BRYANT
	THIS SHEET, ADJUST14/17/24ADDENDUM 2SCALES ACCORDINGLYNODATEREVISION	M		APPROVED R. BRYANT

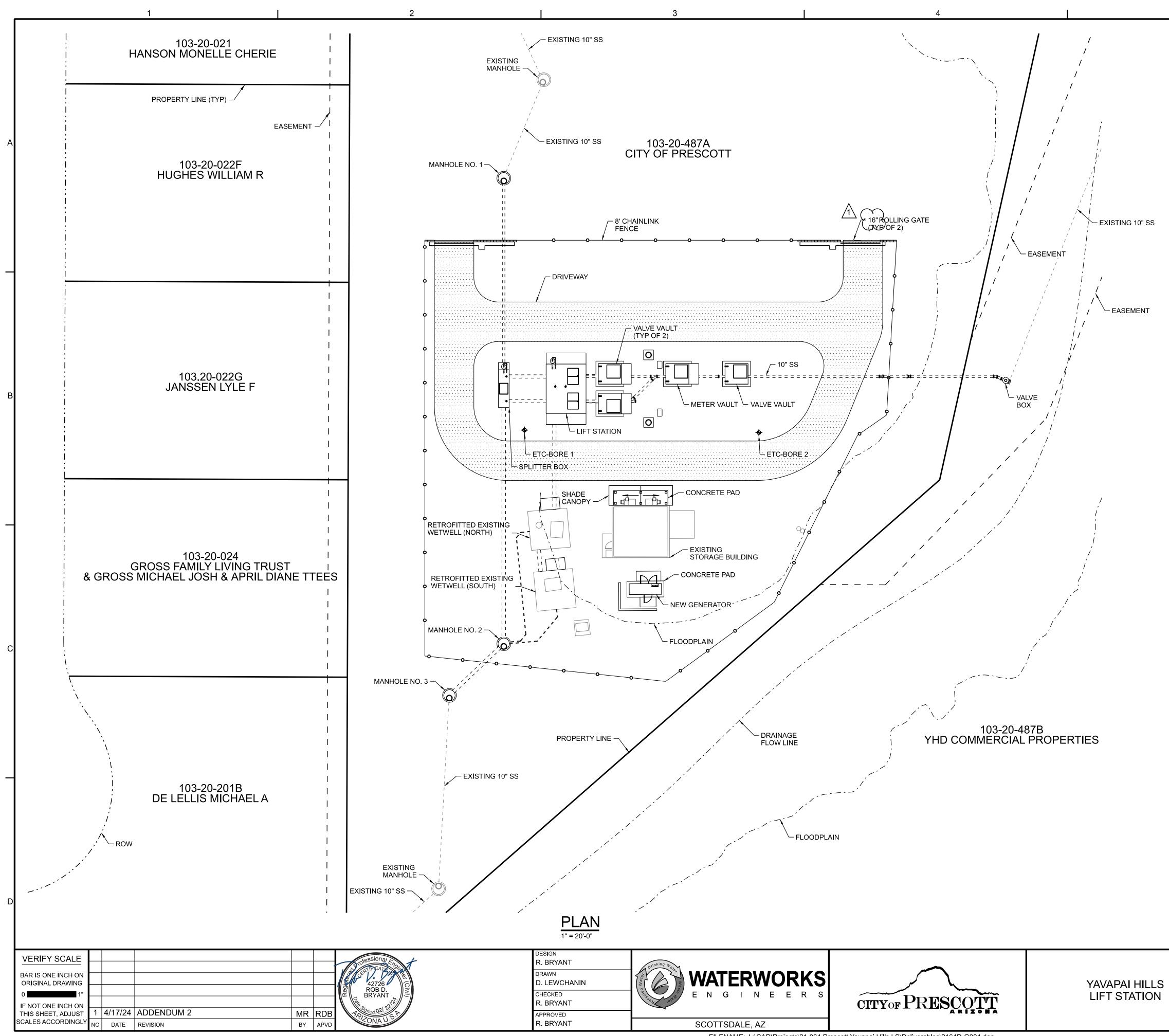


– UNIQUE NUMBER

- UNIT NUMBER

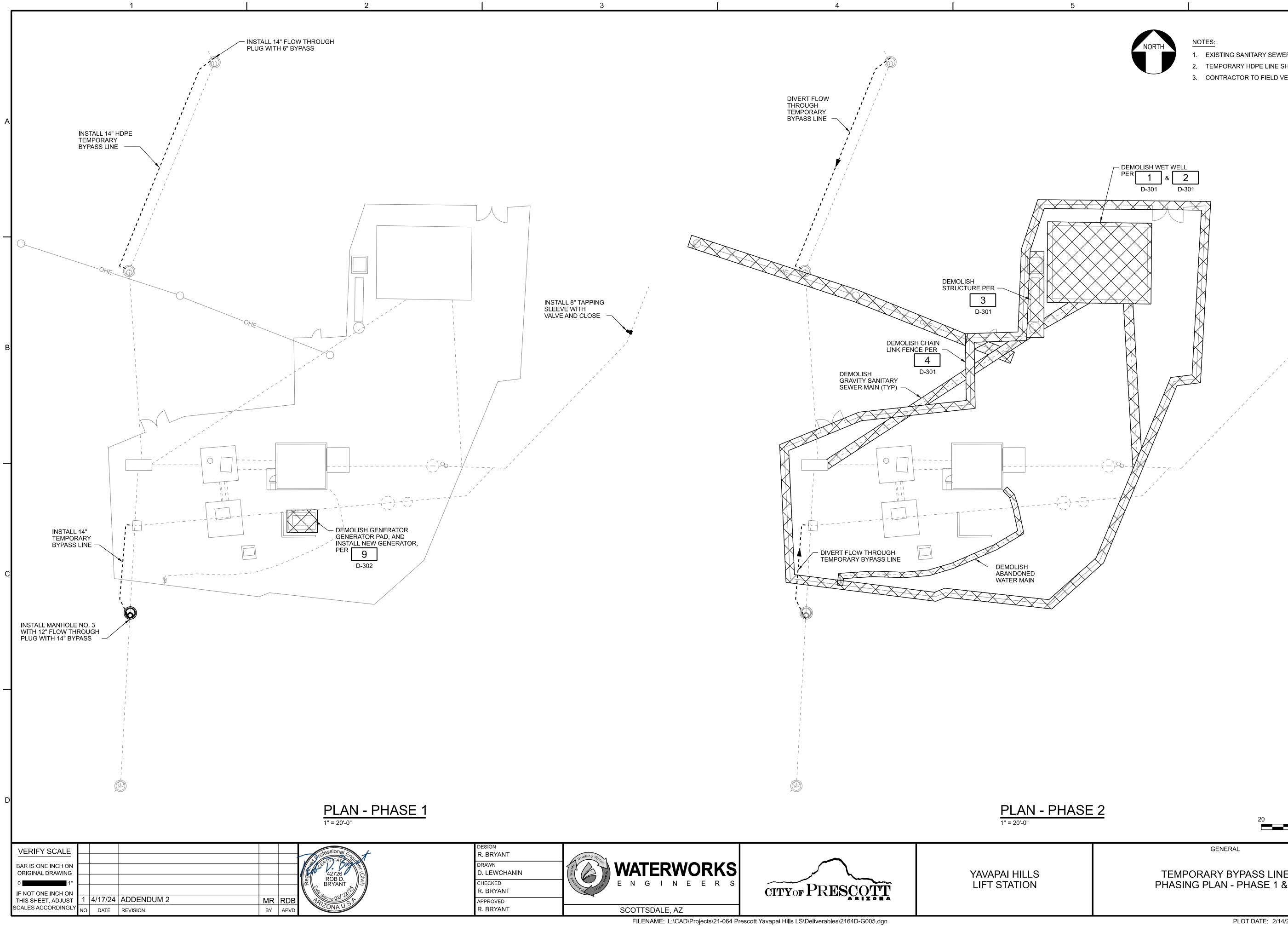
– UNIQUE NUMBER

DATE GENERAL FEBRUARY 2024 PROJECT NO. 21-064 STANDARD DESIGNATIONS DRAWING NO. G-003 SHEET NO. 3 PLOT DATE: 2/14/2024 PLOT TIME: 3:25:13 PM





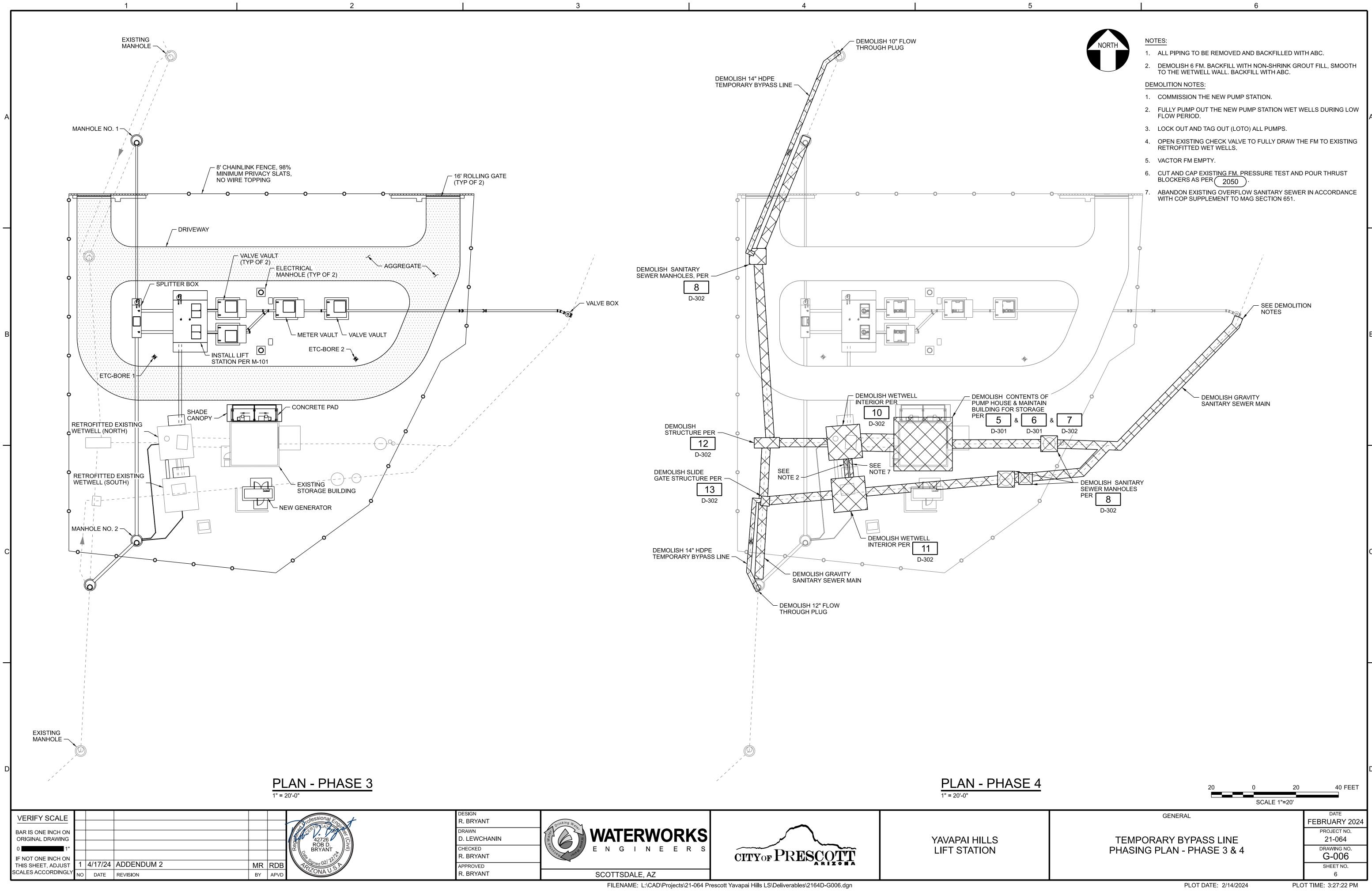
20 0 20 SCALE 1"=20'	40 FEET
	DATE FEBRUARY 2024 PROJECT NO. 21-064
OVERALL SITE PLAN	DRAWING NO. G-004 SHEET NO. 4
PLOT DATE: 2/14/2024 PLC	T TIME: 3:26:10 PM

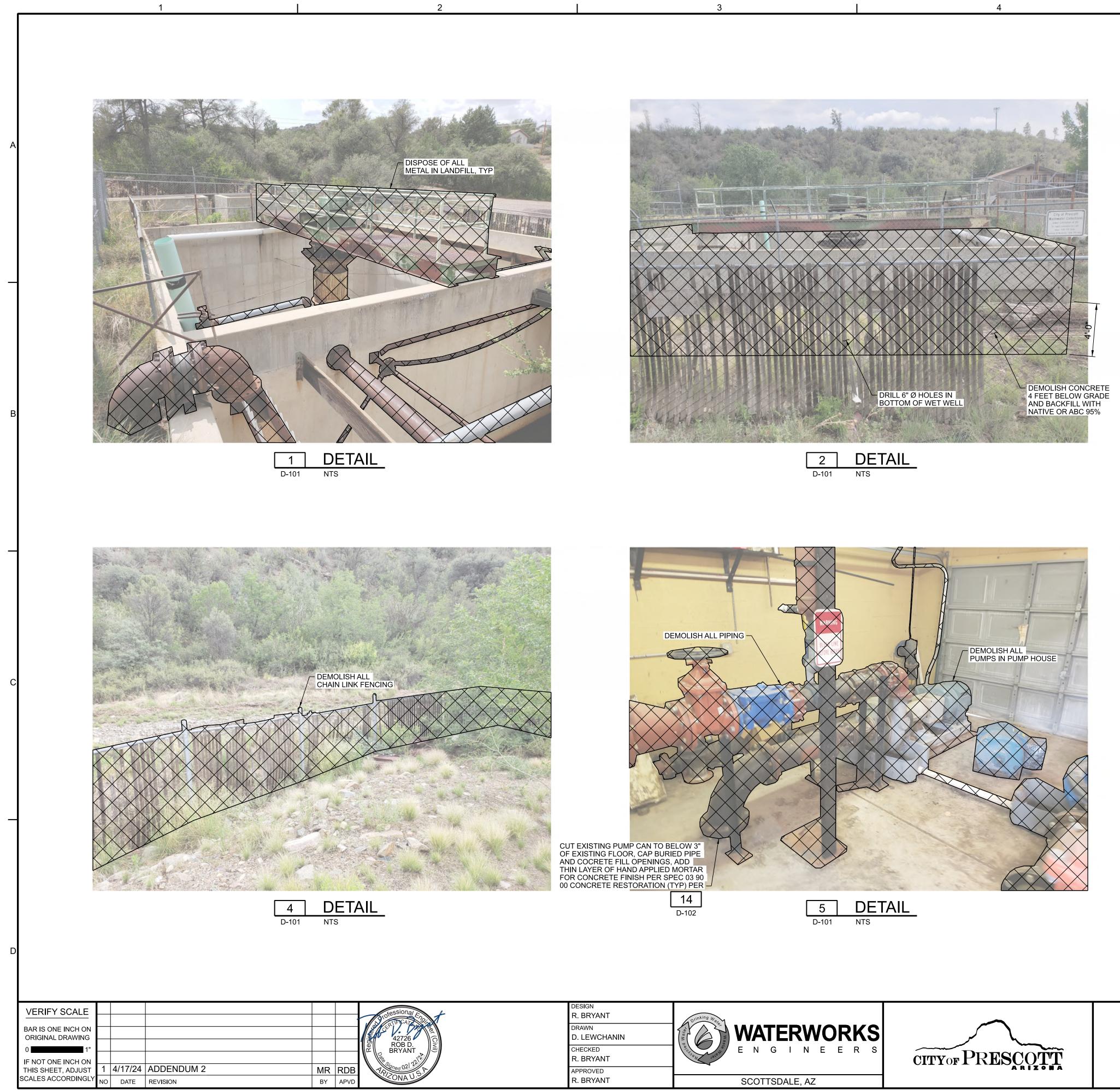


	H	C
HASE	20 0 20 SCALE 1"=20'	40 FEET
	GENERAL TEMPORARY BYPASS LINE PHASING PLAN - PHASE 1 & 2	DATE FEBRUARY 2024 PROJECT NO. 21-064 DRAWING NO. G-005 SHEET NO. 5
	PLOT DATE: 2/14/2024 PLO	T TIME: 3:26:44 PM

- 2. TEMPORARY HDPE LINE SHALL BE 14-INCH DR 21 (100 PSI) PIPE. 3. CONTRACTOR TO FIELD VERIFY OD OF EXISTING FORCEMAIN.

- 1. EXISTING SANITARY SEWER AND PUMPS SHALL REMAIN ONLINE.







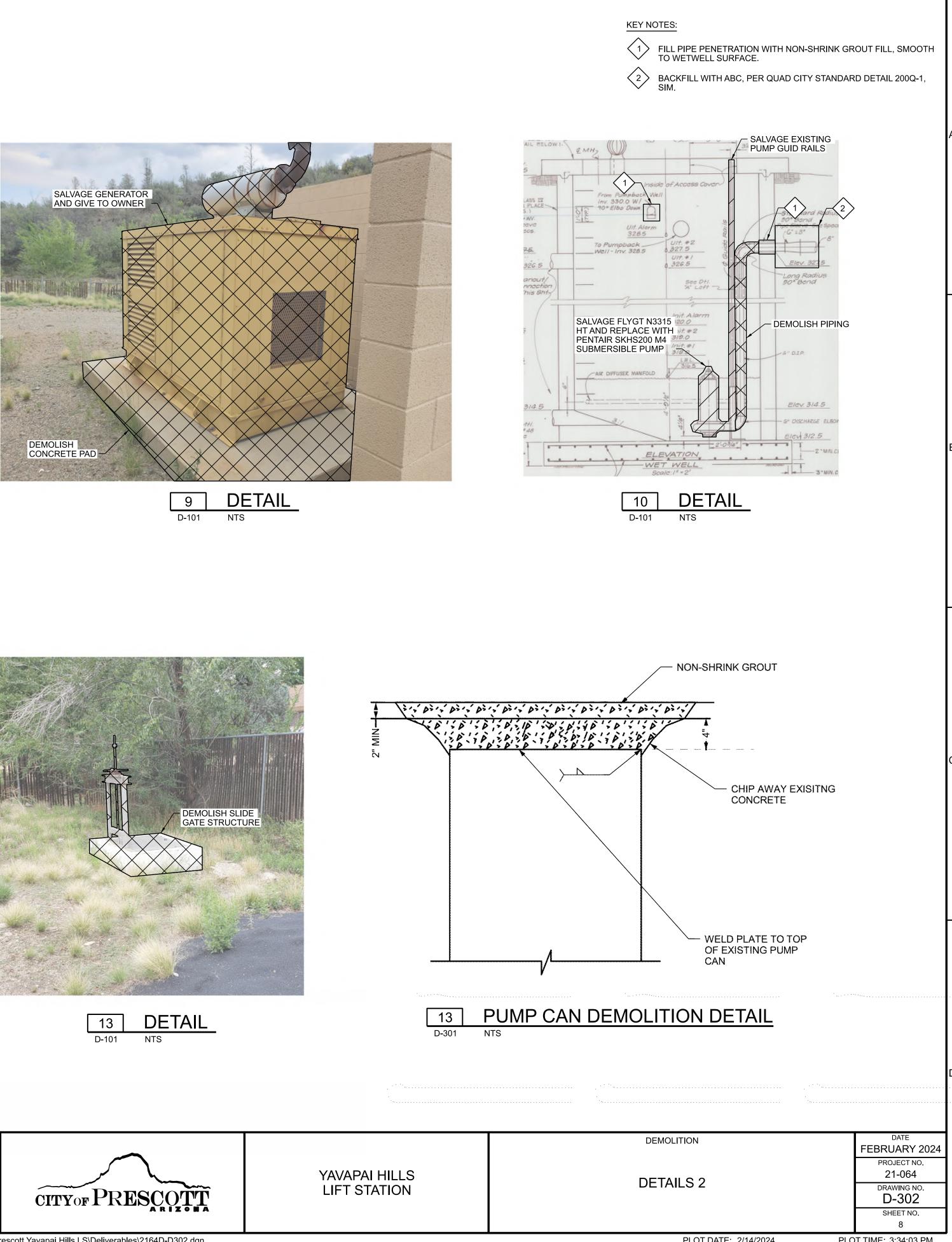


YAVAPAI HILLS LIFT STATION

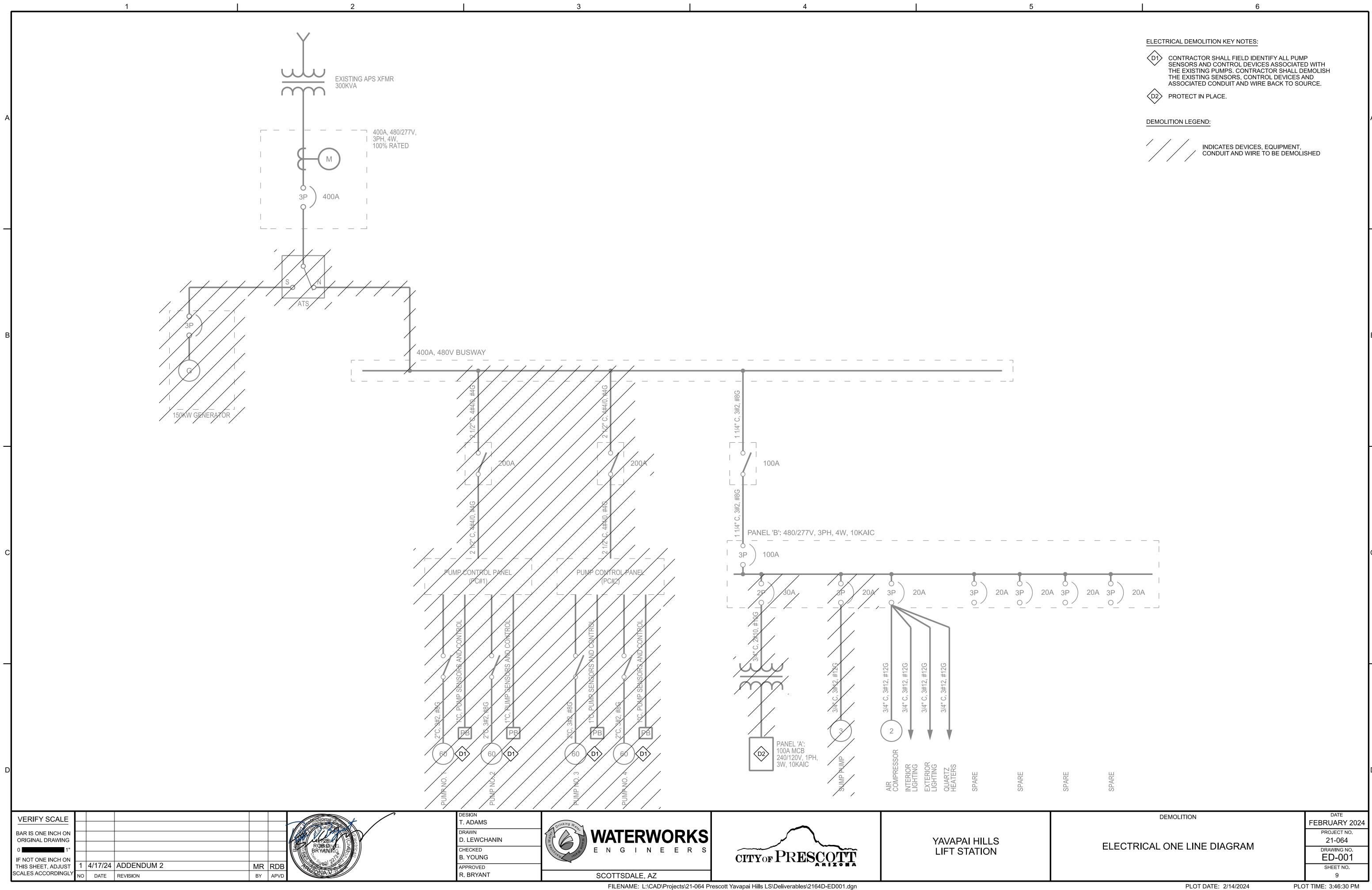
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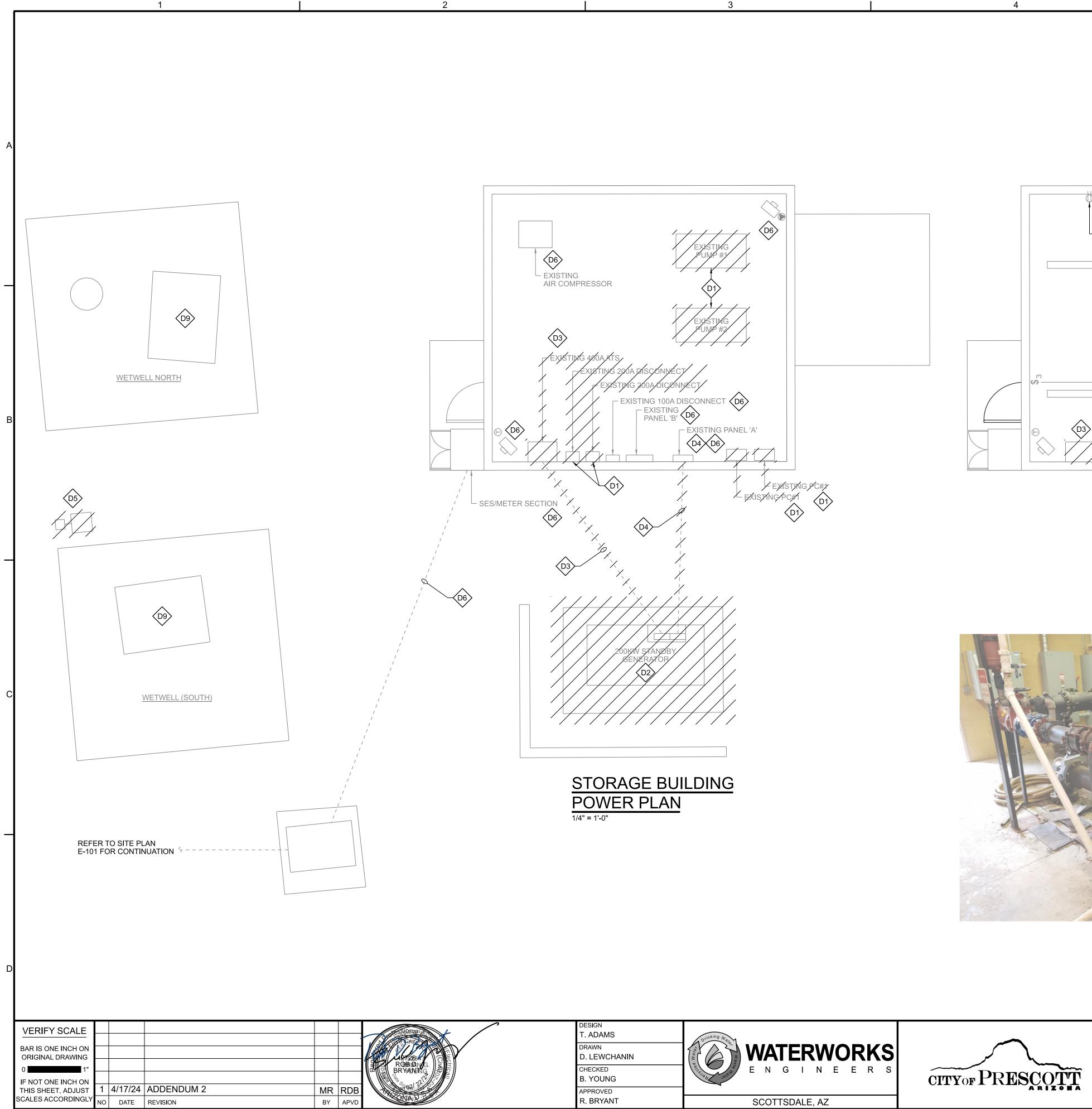


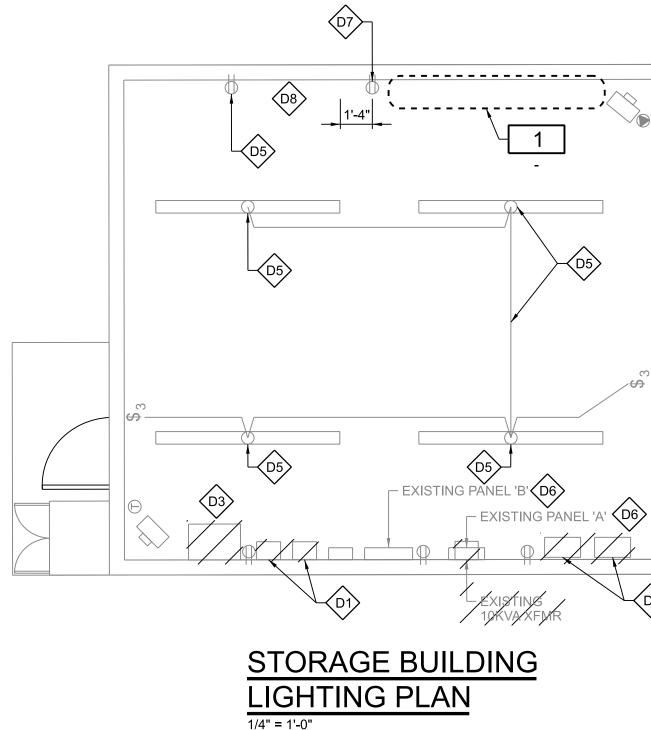


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- NTS

YAVAPAI HILLS LIFT STATION



ELECTRICAL DEMOLITION KEY NOTES:

- D1 CONTRACTOR SHALL FIELD IDENTIFY ALL PUMP SENSORS AND CONTROL DEVICES ASSOCIATED WITH THE EXISTING PUMPS. CONTRACTOR SHALL DEMOLISH THE EXISTING SENSORS, CONTROL DEVICES AND ASSOCIATED CONDUIT AND WIRE BACK TO SOURCE.
- D2 SEE DEMOLITION REQUIREMENTS OF EXISTING GENERATOR AND PAD ON DRAWINGS D-101 AND D-302 PRIOR TO BEGINNING NEW CONSTRUCTION.
- SEE DEMOLITION REQUIREMENTS OF EXISTING ATS ON DRAWINGS D-302 PRIOR TO BEGINNING NEW CONSTRUCTION. DEMOLISH EXISTING CONDUIT AND WIRE BETWEEN ATS AND EXITING GENERATOR PRIOR TO NEW CONSTRUCTION.
- DEMOLISH EXISTING CONDUIT AND WIRE BETWEEN EXISTING PANEL 'A', CKT# 1,3 AND EXISTING GENERATOR ACCESSORY PANEL PRIOR TO NEW CONSTRUCTION. PROTECT EXISTING 30A, 2-POLE BREAKER IN PLACE.
- D5 PROTECT IN PLACE EXISTING LIGHTS AND RECEPTACLES.
- D6 PROTECT IN PLACE EXISTING PANEL 'B' AND 'A'.
- CD7 RELOCATE EXISTING RECEPTACLE 1'-4" WEST IN PREPARATION FOR NEW WORK. PROVIDE NEW WIRE AND CONDUIT TO MATCH EXISTING AS REQUIRED.
- DEMOLISH EXISTING CONDUIT/PIPE STORAGE RACK LOCATED ON NORTH WALL IN PREPARATION FOR NEW WORK. FOR ADDITIONAL CLARIFICATION SEE
- D9 DEMOLISH EXISTING SUMP PUMP, PUMP CABLE. LEVEL SWITCHES, DISCONNECT AND ASSOCIATED CONDUIT AND WIRE BACK TO SOURCE.
- DEMOLITION LEGEND:



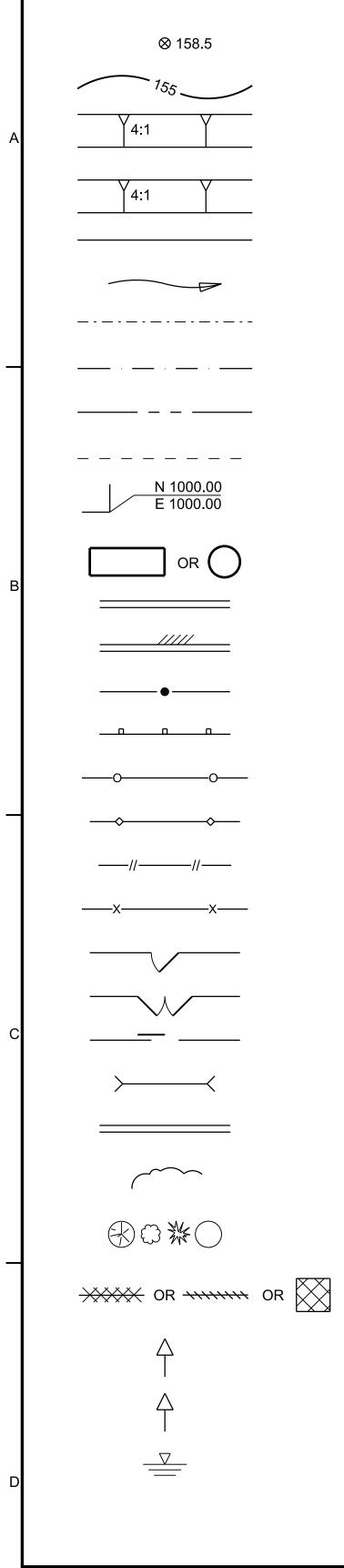
INDICATES DEVICES, EQUIPMENT, CONDUIT AND WIRE TO BE DEMOLISHED

4 0 4 SCALE 1/4"=1'-0"	8 FEET
DEMOLITION ENLARGED STORAGE BUILDING PLANS	DATE FEBRUARY 2024 PROJECT NO. 21-064 DRAWING NO. ED-002 SHEET NO. 10
PLOT DATE: 2/14/2024 PLC	T TIME: 3:47:05 PM

CIVIL LEGEND

SPOT ELEVATION

1



CONTOUR LINE	
CUT SLOPE (HORIZ:VERT)	
EMBANKMENT - FILL SLOPE (HORIZ:VERT)	
DRAINAGEWAY OR DITCH	
DIRECTION OF FLOW	
CENTER LINE, BUILDING, ROAD	
PROPERTY LINE	
RIGHT OF WAY, EASEMENT OR SETBACK	
STAGING OR WORK AREA LIMITS	
STRUCTURE, BUILDING OR FACILITY LOCATION POINT COORDINATES	
STRUCTURE, BUILDING OR FACILITY	
RETAINING WALL	
CONCRETE CURB	
ARCHITECTURAL FENCE	
GUARD RAIL / BARRICADE	
CHAIN LINK FENCE WITH 3 STRAND BARBED WIRE TOPPING	
ARCHITECTURAL FENCE	
WIRE FENCE	
BARBED WIRE	
SINGLE SWING GATE	
DOUBLE SWING GATE	
SLIDING GATE	
CULVERT	
WALL	
BRUSH / TREE LINE	
TREE	
DEMOLITION	
AUTOMATIC AIR RELEASE VALVE	
MANUAL AIR RELEASE VALVE	
WATER SURFACE	

VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING ROB [BRYAN IF NOT ONE INCH ON
THIS SHEET, ADJUST14/17/24ADDENDI
ADDENDI
NOSCALES ACCORDINGLY
NONODATEREVISION 1 4/17/24 ADDENDUM 2 MR RDE BY APVD

CIVIL PATTE

<u>=Y//11=Y//11=Y//11</u>

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APPROVED R. BRYANT

2

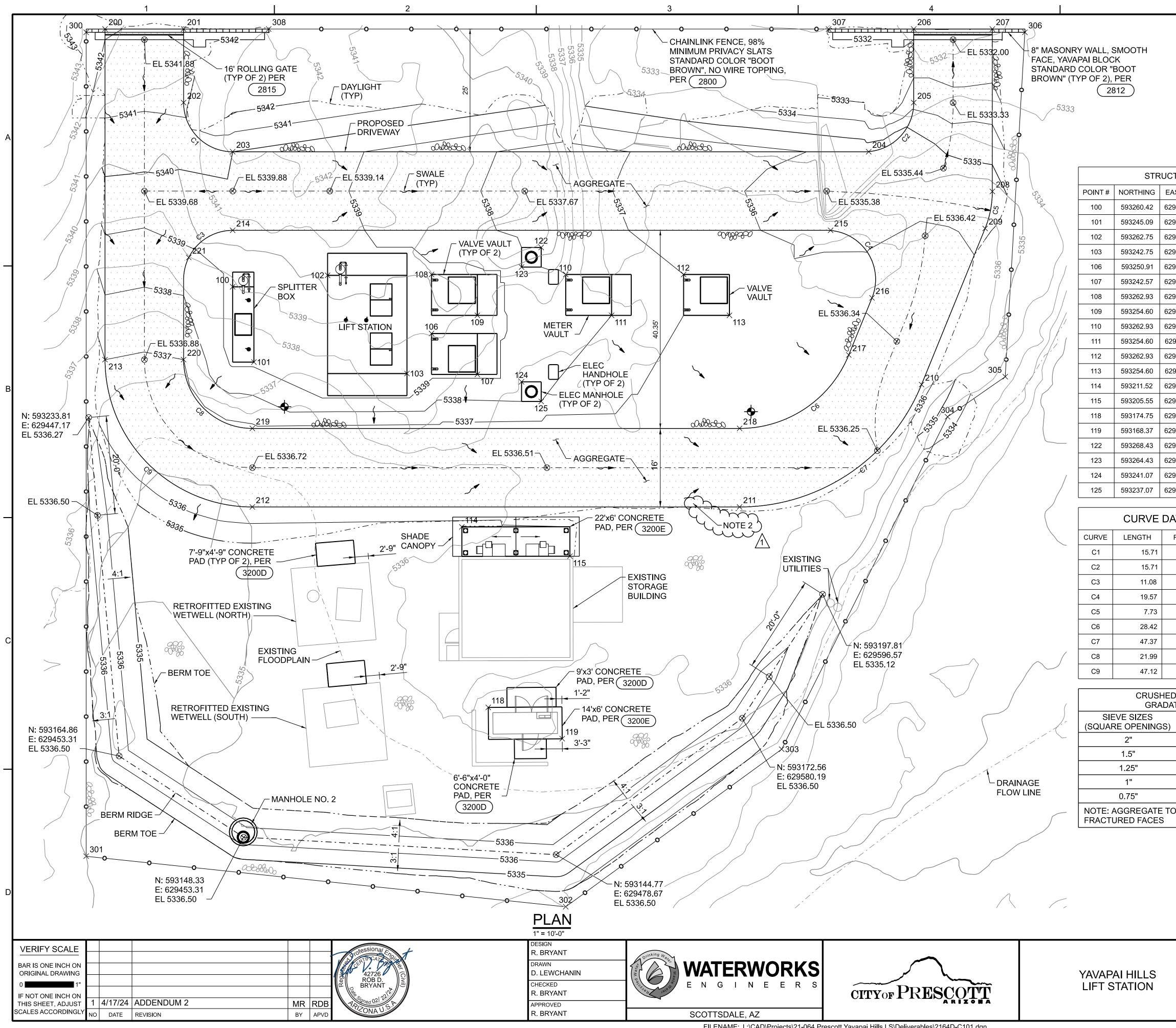
I	3			4	
	LEGEND				
	BEDROCK				
	ROCKS OR RIPRAP				
	SAND				
	AGGREGATE BASE				
	NATURAL SOIL				
	COMPACTED SOIL				
	CONCRETE				
	GROUT CONTROLLED LOW STRENGTH MATERIAL (CLSM)				
	PAVEMENT				
	GRATING				
DESIGN R. BRYANT DRAWN	Drinking Ware			$\overline{1}$	
D. LEWCHANIN CHECKED R. BRYANT	E N G I N E	KKS ERS	CITYOF PR	ESCOTT	YAVAPAI HILLS LIFT STATION

FILENAME: L:\CAD\Projects\21-064 Prescott Yavapai Hills LS\Deliverables\2164D-C001.dgn

SCOTTSDALE, AZ

5		6
<u>NOT</u>	TES:	
1.	SCREENED AND/OR LIGHT-L	NT AND TOPOGRAPHY ARE SHOWN INED. NEW PIPING, EQUIPMENT, O GRADE ARE SHOWN HEAVY-LINED.
2.		D SHEET. SOME SYMBOLS MAY T MAY NOT BE USED ON THE PLANS.

	CIVIL	DATE FEBRUARY 2024
SYMBOLS & LEG		PROJECT NO. 21-064
	SYMBOLS & LEGEND	drawing no. C-001
		SHEET NO. 11
	PLOT DATE: 2/14/2024 PLO	T TIME: 3:27:56 PM







NOTES:

COLOR OF FENCE AND CMU BLOCK WALL SHALL BE 2. AGGREGATE GRADING SHALL BE PER DETAIL 2505

CTURES POINT TABLE						
ASTING	ELEVATION	DESCRIPTION				
29476.45	5339.17	SPLITTER BOX FG				
29480.78	5339.17	SPLITTER BOX FG				
29495.78	5339.17	LIFT STATION				
29511.95	5339.17	LIFT STATION				
29516.95	5339.17	VALVE VAULT FG				
29526.28	5339.17	VALVE VAULT FG				
29516.95	5339.17	VALVE VAULT FG				
29526.28	5339.17	VALVE VAULT FG				
29544.28	5338.00	VALVE VAULT FG				
29553.61	5338.00	VALVE VAULT FG				
29568.28	5337.00	METER VAULT FG				
29577.61	5337.00	METER VAULT FG				
29523.12	5336.00	CONC PAD FG				
29545.13	5336.00	CONC PAD FG				
29528.50	5336.00	CONC PAD FG				
29543.55	5336.00	CONC PAD FG				
29539.28	5338.00	ELEC MANHOLE FG				
29535.28	5338.00	ELEC MANHOLE FG				
29535.28	5338.00	ELEC MANHOLE FG				
29539.28	5338.00	ELEC MANHOLE FG				

9535.28		5338.00	ELEC	: MANH
9535.28		5338.00	ELEC	: MANH
9539.28		5338.00	ELEC	: MANH
ΑΤΑ ΤΑ	BI	_E		
RADIUS		DELTA		
10.00		90°00'00"		
10.00		90°00'00"		
10.00		63°27'29"		
10.00		112°08'36"		
20.00		22°08'36"		
24.00		67°5	51'24"	

67°51'24"

90°00'00"

90°00'00"

D	AGG	REG	SATE

40.00

14.00

30.00

٩T	ION TABLE
	PERCENTAGE BY
	WEIGHT PASSING SIEVE
	100
	50-90
	25-50
	10-25
	0-10
0	HAVE A MINIMUM OF 3

	PAVING POINT TABLE					
POINT # NORTHING EASTING ELEVATION		ELEVATION	DESCRIPTION			
200	593312.93	629450.45	5342.00	DRIVEWAY FG		
201	593312.93	629466.46	5342.00	DRIVEWAY FG		
202	593297.93	629466.45	5341.25	DRIVEWAY FG		
203	593287.93	629476.45	5340.00	DRIVEWAY FG		
204	593287.93	629605.98	5335.67	DRIVEWAY FG		
205	593297.93	629615.14	5333.65	DRIVEWAY FG		
206	593312.93	629615.14	5332.00	DRIVEWAY FG		
207	593312.93	629631.14	5332.00	DRIVEWAY FG		
208	593279.84	629631.14	5335.67	DRIVEWAY FG		
209	593272.30	629629.67	5335.67	DRIVEWAY FG		
210	593240.50	629616.73	5336.50	DRIVEWAY FG		
211	593215.58	629579.68	5336.50	DRIVEWAY FG		
212	593215.58	629480.45	5336.84	DRIVEWAY FG		
213	593245.58	629450.45	5337.00	DRIVEWAY FG		
214	593271.93	629476.45	5340.00	DRIVEWAY FG		
215	593271.93	629598.21	5335.50	DRIVEWAY FG		
216	593258.16	629606.64	5336.50	DRIVEWAY FG		
217	593246.53	629601.91	5336.50	DRIVEWAY FG		
218	593231.58	629579.68	5336.50	DRIVEWAY FG		
219	593231.58	629480.45	5336.84	DRIVEWAY FG		
220	593245.58	629466.45	5337.00	DRIVEWAY FG		
221	593266.40	629467.51	5338.25	DRIVEWAY FG		

	FENCING POINT TABLE					
POINT #	NORTHING	EASTING	DESCRIPTION			
300	593312.26	629446.61	CORNER OF FENCE			
301	593144.45	629446.61	CORNER OF FENCE			
302	593134.15	629544.27	CORNER OF FENCE			
303	593166.24	629588.24	CORNER OF FENCE			
304	593233.94	629622.02	CORNER OF FENCE			
305	593242.11	629633.78	CORNER OF FENCE			
306	593312.26	629637.77	CORNER OF FENCE			
307	593312.93	629597.81	CORNER OF FENCE			
308	593312.93	629483.79	CORNER OF FENCE			

<u>LEGEND</u>

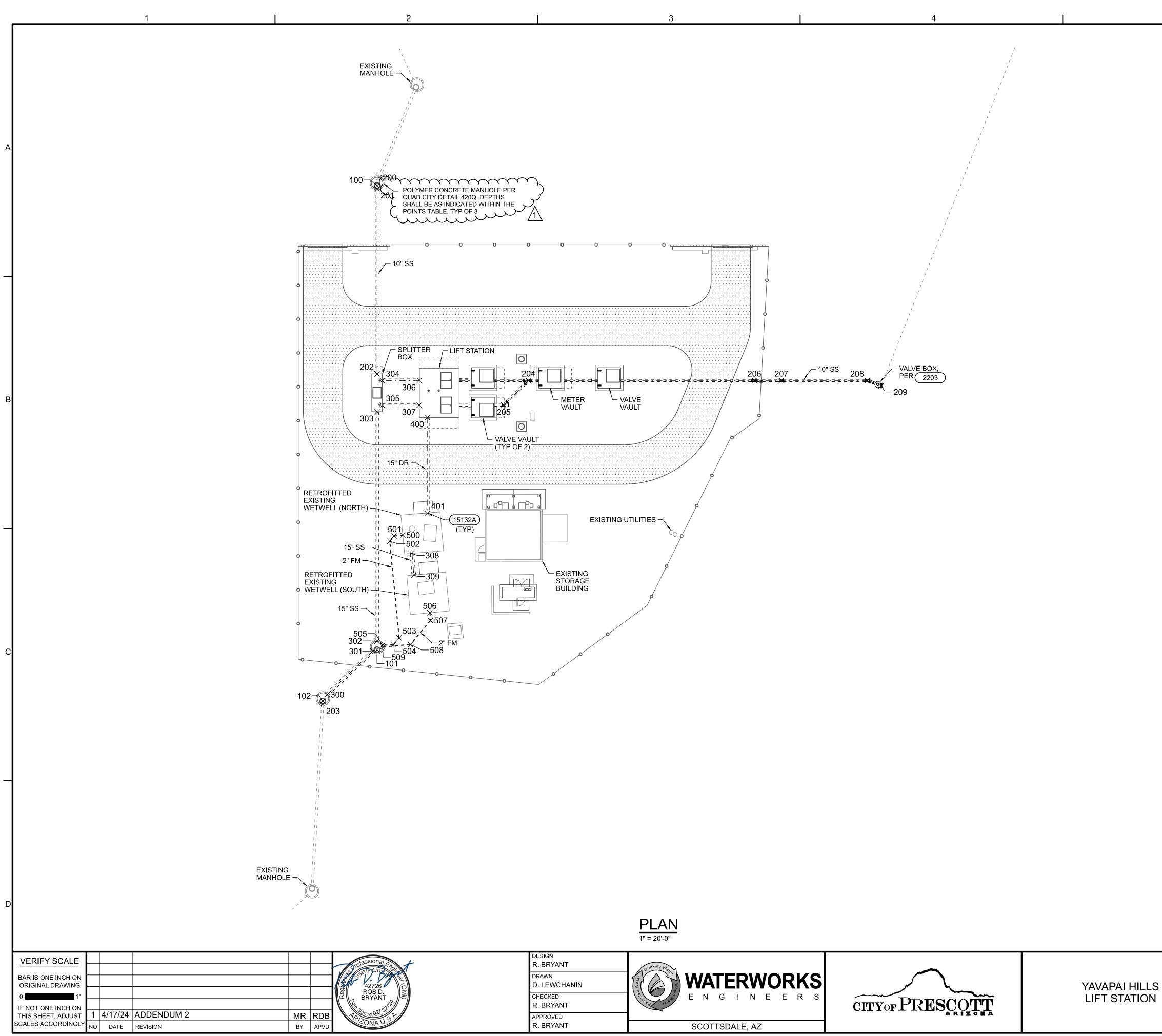


SANG GRAVEL



20 FEET SCALE 1"-10' CIVIL DATE FEBRUARY 2024 PROJECT NO. PAVING, GRADING AND DRAINAGE PLAN 21-064 DRAWING NO. C-101 SHEET NO. 12

PLOT TIME: 3:28:29 PM



593203.85	629499.12	5327.76	15" IN INV				
2" FM YARD PIPING POINT TABLE							
NORTHING	EASTING	ELEVATION	DESCRIPTION				
593194.87	629489.06	5330.80	2" OUT INV				
593194.51	629485.50	5330.78	2" 45° BEND INV				
593192.40	629483.76	5330.77	2" 45° BEND INV				
593153.16	629487.55	5330.57	2" 45° BEND INV				
593150.52	629485.37	5330.54	2" 45° BEND INV				
593150.07	629480.85	5330.49	2" IN INV				
593163.33	629500.05	5330.80	2" OUT INV				

5330.77 2" 45° BEND INV

5330.64 2" 45° BEND INV

5330.53 2" IN INV

5328.71 | 15" OUT INV

15" IN INV

15" IN INV

15" SS IN INV

5328.67

5328.67

5328.17

593178.67 629493.54 5328.08 15" SS OUT INV

593242.75 629499.12 5328.18 15" OUT INV

15" DR YARD PIPING POINT TABLE

POINT # NORTHING EASTING ELEVATION DESCRIPTION

200	593340.19	629479.50	5336.54	10" IN INV	
201	593335.70	629478.61	5336.50	10" OUT INV	
202	593260.42	629478.61	5328.71	10" IN INV	
203	593126.17	629456.48	5330.55	10" IN INV	
204	593257.74	629540.11	5330.97	10" WYE CL	
205	593247.70	629530.07	5330.97	10" WYE CL	
206	593257.74	629631.91	5330.97	10" 45° BEND DOWN CL	
207	593257.74	629642.91	5319.90	10" 45° BEND UP CL	
208	593257.72	629677.87	5319.90	10" 22.5° BEND CL	
209	593255.58	629683.43	5319.90	10"X8" TAPPING SLEEVE CL	
	15" SS YA	ARD PIPING	G POINT TAB	BLE	
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION	
300	593130.09	629458.32	5329.08	15" OUT INV	
301	593147.82	629476.91	5328.90	15" IN INV	
302	593151.75	629478.61	5329.00	15" OUT INV	
303	593245.09	629478.61	5328.77	15" IN INV	
304	593257.71	629480.78	5328.71	15" OUT INV	

	М	ANHOLE P	OINT TABLE	
POINT #	NORTHING	EASTING	ELEVATION	DESCRIPTION
100	593336.95	629478.61	5341.00	MANHOLE NO. 1 RIM
101	593148.33	629478.61	5336.50	MANHOLE NO. 2 RIM
102	593127.42	629456.55	5335.00	MANHOLE NO. 3 RIM

10" SS YARD PIPING POINT TABLE

DESCRIPTION

POINT # NORTHING EASTING ELEVATION

593247.67 629480.78

593257.73 629495.78

593247.71 629495.78

593187.47 629492.80

305

306

307

308

309

400

401

500

501

502

503

504

505

506

507

508

509

POINT # NORTHING

593160.22 629500.33

593150.47 629492.20

593149.44 629480.95

CIVIL

YARD PIPING PLAN



NOTES

1. TAPPING SLEEVE AND VALVE PER MAG STD DTL 340.

PLOT DATE: 2/14/2024

PLOT TIME: 3:29:08 PM

20

SCALE 1"=20'

40 FEET

DATE

FEBRUARY 2024

PROJECT NO.

21-064

drawing no.

SHEET NO.

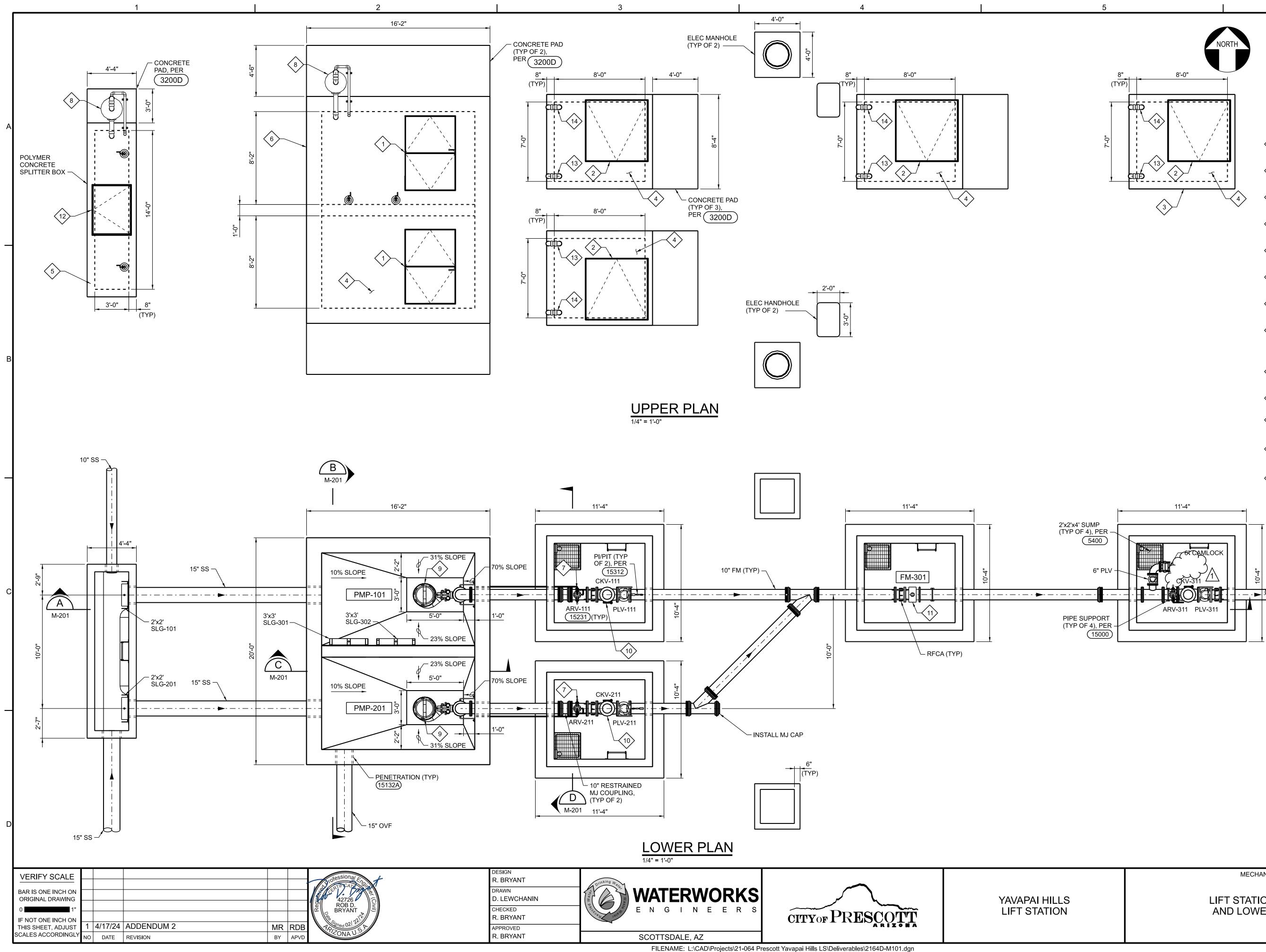
13

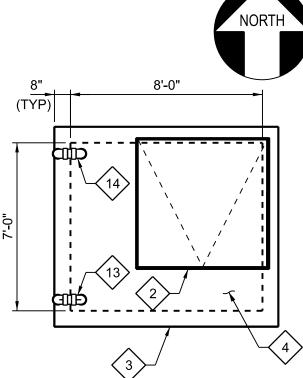
1		2		3		4	5		6
PIPING SYMBOLS	PUMPS		ACTUAT	ORS	MISC FIT	TING SYMBOLS	PIPING DESIGNATIONS		
<u>SYMBOL</u> <u>SINGLE LINE</u> <u>DESCR</u>	IPTION SYMBOL	PUMP TYPE	SYMBOL	ACTUATOR TYPE	SYMBOL	EQUIPMENT TYPE	DOUBLE LINE PIPES		
	PE (SCREENED)		М		I ∖_ I			PTIONAL FLOW STREAM IDENTIFICATION ER PIPE SCHEDULE	
		CENTRIFUGAL PUMP		MOTOR ACTUATOR	'	Y STRAINER		OW DIRECTION	
					\Leftrightarrow	PULSATION DAMPER		EL XXXX.X (PRESSURE PIPES)	
EXISTING PIF		SUBMERSIBLE PUMP	Р	PNEUMATIC ACTUATOR	$\langle \rangle$	GAUGE		V EL XXXX.X (GRAVITY PIPES)	
	PE TO BE DEMOLISHED	VERTICAL TURBINE PUMP			\uparrow		<u>12" RW</u>		
OR REMOVE	D AND SALVAGED	(PLAN)	S	SOLENOID ACTUATOR		DIAPHRAGM SEAL	PE	OW STREAM IDENTIFICATION ER PIPE SCHEDULE	ŕ
VALVES			CATES			RUPTURE DISK (PRESSURE)		OMINAL PROCESS PIPE DIAMETER	
SYMBOL VALVE TYPE		VERTICAL TURBINE PUMP	<u>GATES /</u> <u>SYMBOL</u>	GATE / WEIR TYPE		RUPTURE DISK (VACUUM)	<u>SINGLE LINE PIPES</u>	OW DIRECTION	
		(SECTION)					, <u>12" RW</u> → ,		
BALL VALVE				SLIDE GATE	l¦l	ORIFICE		NGLE-LINE FLOW STREAM IDENTIFICATION ER PIPE SCHEDULE	
		DIAPHRAGM METERING PUMP			-11	BLIND FLANGE OR TANK NOZZLE	VALVE DESIGNATIONS		
_ IDI CORPORATION STOP VALVE				STOP LOG		EXPANSION COUPLING		XX XX XX XX VALVE EQUIPMENT NUMBER, MOTORIZED VALVES ONLY. SEE	
		PERISTALIC PUMP			b l			XX I&C LEGEND	
Image: Second state BUTTERFLY VALVE				WEIR	\sim	FLEXIBLE COUPLING	ACTUATOR SYMBOL	BAV-10 VALVE TYPE	
DIAPHRAGM VALVE		PROGRESSIVE CAVITY PUMP			I I	UNION		ALL VALVES, SEE SPEC SECTION 15200	
GATE VALVE			MISC EC	QUIPMENT	D	CONCENTRIC REDUCER			
KNIFE GATE	M-8	AXIAL FLOW PUMP	<u>SYMBOL</u>	TYPE		ECENTRICE REDUCER	VALVE SYMBOL —	FLOW DIRECTION	
				WATER METER	Ъ	ECENTRICE REDUCER	NOTES:		
B GLOBE VALVE	BLOWE	RS			נ	CAP	1. MOTORIZED VALVE SHOWN, MANU	JAL VALVE SIMILAR.	E
MUD VALVE	SYMBOL	BLOWER TYPE		AIR DIFFUSER	Ę	FEMALE QUICK CONNECT	NOTES:		
		CENTRIFUGAL BLOWER			L		1. ONLY FLANGED END CONNECTION	NS ARE SHOWN HERE FOR DOUBLE LINE	
		CENTRI UGAL BLOWER		SPRAY BAR OR DIFFUSER		MALE QUICK CONNECT	THE CONSTRUCTION DRAWINGS.	END PATTERNS ARE SHOWN SIMILARLY ON ALSO SEE PIPING SPECIFICATIONS AND THE	
		BLOWER FAN			(QUICK CONNECT WITH CAP	PIPING SCHEDULE.		
PINCH VALVE					ŕ□	QUICK CONNECT	TO PIPING SPECIFICATIONS FOR S	GLE LINE FITTINGS ARE GENERIC ONLY. REFER SPECIFIC END CONNECTIONS FOR SINGLE LINE	
	FLOWM	<u>ETERS</u>	P q	EMERGENCY	Ę⊔ ▼	COUPLING	PIPE AND FITTINGS.		
- PLUG VALVE	SYMBOL	FLOWMETER TYPE	<u>ب</u>	EYEWASH AND SHOWER	Ý	DRAIN	GENERAL PIPING NOTES:		-
PLUG VALVE (ECCENTRIC)					ſ	DRAIN		TWEEN INDICATED ELEVATION POINTS. HES UNLESS OTHERWISE SHOWN.	
BALL CHECK VALVE		MAGNETIC FLOWMETER			ሻ	SIGHT GLASS		WINGS SHALL CORRESPOND TO ADJACENT	
					M	SIGITI GLASS	STRAIGHT RUN OF PIPE, UNLESS	OTHERWISE INDICATED. TYPE OF JOINT AND SAME AS SHOWN FOR ADJACENT STRAIGHT	
CHECK VALV		PROPELLER FLOWMETER				CALIBRATION COLUMN	RUN OF PIPE.		
		SAND STRAINERS			단		ONLY APPROXIMATE. FINAL SUPPO	HANGERS AND PIPE SUPPORTS SHOWN IS ORT REQUIREMENTS SHALL BE DETERMINED	
	<u>SYMBOL</u>	FILTER TYPE			FI	ROTAMETER	IN THE FIELD AND APPROVED BY 1 MAXIMUM SPACING SHALL BE AS S	THE ENGINEER PRIOR TO INSTALLATION. SPECIFIED.	
C					FI	ROTAMETER WITH NEEDLE VALVE		IPE DETAIL SHALL BE USED WHEREVER	
SWING CHECK VALVE	ן " <i>ך</i> ל"	FILTER			\smile				
	 ۱۹ <u></u> ۲۰۱				MISC SY	MBOLS	PROVIDED WITH THRUST TIES, BL	LANGED COUPLING ADAPTERS SHALL BE OCKS, OR ANCHORS, UNLESS OTHERWISE	
		CARTRIDGE FILTER (SMALL)			SYMBOL	DESCRIPTION	SPECIFIED.	ALL BE ADEQUATE FOR TEST PRESSURES	
					S	SAMPLE	6. SYMBOLS, LEGENDS, AND PIPE US	SE IDENTIFICATIONS SHOWN SHALL BE RAWINGS, WHEREVER APPLICABLE. ALL OF	
		CARTRIDGE FILTER (LARGE)			$\langle \cdot \rangle$			NOT NECESSARILY USED IN THE PROJECT.	
COMBINATION AIR RELIEF						WATER SURFACE		SSURE TESTED, EXCEPT FLANGED. WELDED, VING, SHALL BE PROVIDED WITH TRUST	
PRESSURE REGULATING VALVE		BASKET STRAINER			—			HANGES, UNLESS OTHERWISE NOTED. SEE	ľ
*	MIXERS					EQUIPMENT TAG	8. NUMBER AND LOCATION OF UNION	NS SHOWN ON DRAWINGS ARE ONLY	
PRESSURE RELIEF VALVE	<u>SYMBOL</u>	MIXER TYPE						ONS NECESSARY TO FACILITATE CONVENIENT	
HOSE BIBB OR FLUSHING CONNEC	CTION							JECT IS RESPONSIBLE FOR COORDINATING	
BACKFLOW PREVENTER VALVE	M-S	MIXER					APPURTENANCES INSTALLED UND	ION OF THE PIPING AND ASSOCIATED DER THIS CONTRACT TO BOTH THE EXISTING	
							PIPING AND FACILITIES.		
D		STATIC MIXER						FING PIPE OR STRUCTURE, THE CONTRACTOR	
	— — — — — — — — — — — — — — — — — — —						SHALL EXPOSE THE EXISTING PIP LOCATION, SIZE, MATERIALS, AND	E OR STRUCTURE TO VERIFY ITS EXACT INVERT ELEVATIONS.	ľ
		WAFER STATIC MIXER					11. COMPONENTS SHOWN WITH A DO A PACKAGE SYSTEM. SEE EQUIPM	UBLE ASTERISK (**) ARE PART OF	
VERIFY SCALE		DESIGN						MECHANICAL	DATE
BAR IS ONE INCH ON		R. BRY		WATERWORK		\frown			FEBRUARY 2024 PROJECT NO.
ORIGINAL DRAWING	42726 ROB D. BRYANT	D. LEW CHECKE	CHANIN	E N G I N E E R			YAVAPAI HILLS LIFT STATION	MECHANICAL LEGEND	21-064 DRAWING NO.
IF NOT ONE INCH ON THIS SHEET, ADJUST 1 4/17/24 ADDENDUM 2	MR RDB	R. BRY	ANT	19/01 19/01		TYOF PRESCOTT			M-001 SHEET NO.
SCALES ACCORDINGLY NO DATE REVISION	BY APVD	XX-XX-XX R. BRY		SCOTTSDALE, AZ					5HEET NO. 14

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PLOT DATE: 2/14/2024

PLOT TIME: 3:47:33 PM





NOTES:

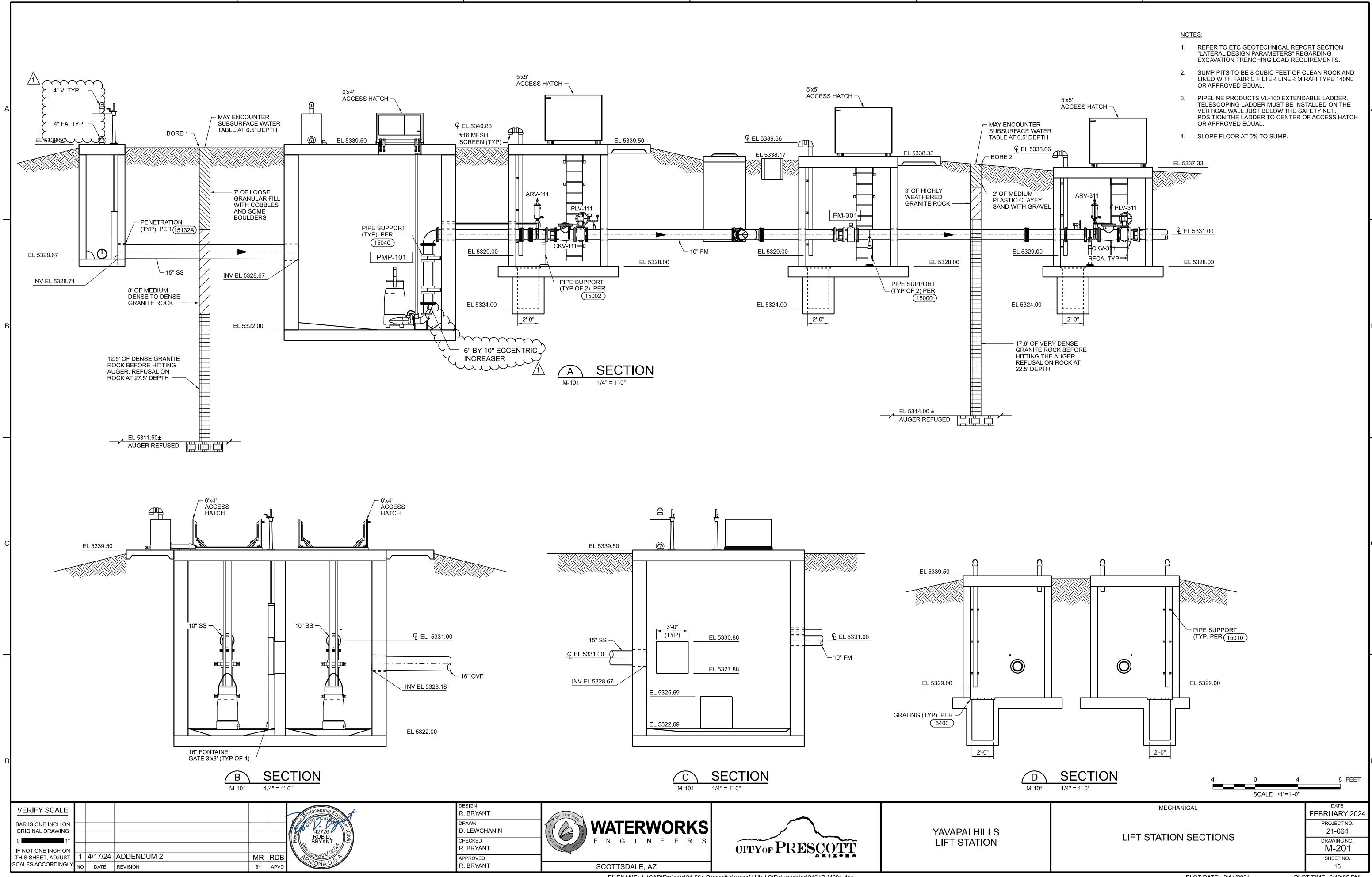
- ALL PIPING WITHIN THE LIMITS OF THE PROJECT SHALL BE FULLY RESTRAINED.
- SLIDE GATES SLG-101, SLG-201, AND SLG-302 SHALL BE 2. FLUSH BOTTOM SEALED.
- ALL LADDERS SHALL BE INSTALLED WITH SAFETY 3. GRATING AND TELESCOPING SAFETY POST.

KEY NOTES:

- 1 6'x4' ALUMINUM HATCH, 300 PSF RATED, DUAL-LEAF WITH FALL PROTECTION GRATING, LIFT ASSIST, SLAM-LOCK, HOLD-OPEN.
- 2 5'x5' ALUMINUM HATCH, 300 PSF RATED, SINGLE-LEAF WITH FALL PROTECTION GRATING, LIFT ASSIST, SLAM-LOCK, HOLD-OPEN.
- (3) PRECAST CONCRETE VAULT, 300 PSF RATED.
- $\langle 4 \rangle$ 3" PAINTED LETTERING "300 PSF LIMIT".
- 6 PRECAST POLYMER CONCRETE WETWELL.
- 7 2" SEWAGE AIR/VACUUM VALVE, ARI D-025. ROUTE VENT TO WET WELL.
- 8 PASSIVE ODOR CONTROL, CALGON CARBON VENTSORB PE OR APPROVED EQUAL.
- 9 FLYGT N3315 HT WITH COOLING JACKET 160 HP, VFD RATED WITH LIFT EYE, BASE ELBOW, GUIDE RAILS AND ALL MOUNTING HARDWARE, NO APPROVED EQUAL, PUMP FROM EXISTING WET WELL TO BE REMOVED AND STORED AS A BACKUP.
- 10 10" SWING CHECK VALVE, EPOXY LINED AND COATED, EXTERNAL LEVER AND AIR CUSHIONED CLOSURE, 316 STAINLESS STEEL HARDWARE.
- $\langle 11 \rangle$ 10" MAG METER, PTFE LINED WITH REMOTE DISPLAY (ELECTRIC RACK).
- 3'x4' ALUMINUM HATCH, 300 PSF RATED, SINGLE-LEAF WITH FALL PROTECTION GRATING, LIFT ASSIST, SLAM-LOCK, HOLD-OPEN.
- 4" CPVC GOOSENECK VENT ENDS 6" BELOW TOP OF CONCRETE, PER (15145).

4" CPVC GOOSENECK VENT ENDS 1'-0" ABOVE BOTTOM OF SLAB, PER 15145

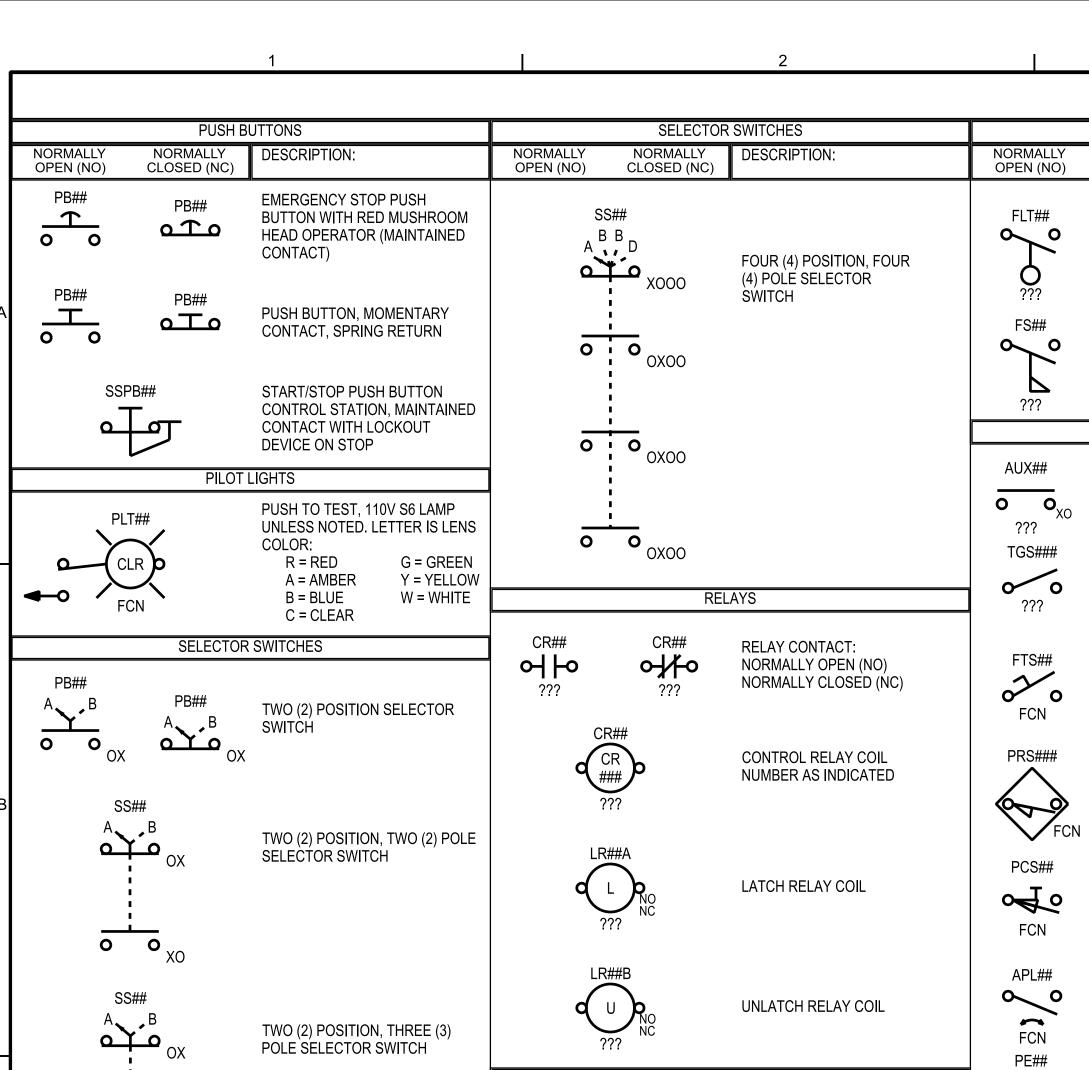
4 0 4 SCALE 1/4"=1'-0"	8 FEET
MECHANICAL	DATE FEBRUARY 2024 PROJECT NO. 21-064
AND LOWER PLANS	DRAWING NO. M-101 SHEET NO. 15
PLOT DATE: 2/14/2024 PLO	T TIME: 3:48:32 PM



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PLOT DATE: 2/14/2024

PLOT TIME: 3:49:05 PM



		LIMIT S	SWITCHES
o o xo	FCN LS##	LS## FCN	POSITION (LIMIT) SWITCH
SS##	LS## ???	LS## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	POSITION (LIMIT) SWITCH NO: HELD CLOSED NC: HELD OPEN
A B C SS## A B C A B C THREE (3) POSITION SELECTOR SWITCH OOX	TS## ???	TS## 7??	TORQUE SWITCH NO: CLOSES ON HIGH TORQUE NC: OPENS ON HIGH TORQUE
SS##	Р	RESSURE & TEM	PERATURE SWITCHES
SS## A B C THREE (3) POSITION, THREE (3) POLE SELECTOR SWITCH	PS## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	PS## 2???	PRESSURE SWITCH NO: CLOSES ON RISING PRESSURE NC: OPENS ON DROPPING PRESSURE
SS## SS## A B B D B B D FOUR (4) POSITION SELECTOR	PSV## ~ ??? DPS##	PSV## V ??? DPS##	VACUUM SWITCH NO: CLOSES ON RISING PRESSURE NC: OPENS ON DROPPING PRESSURE DIFFERENTIAL PRESSURE SWITCH NO: CLOSES ON RISING DIFFERENTIAL PRESSURE NC: OPENS ON DROPPING
		2 ??? TS## 6 6 7??	DIFFERENTIAL PRESSURE TEMPERATURE SWITCH NO: CLOSES ON RISING TEMPERATURE NC: OPENS ON RISING TEMPERATURE
VERIFY SCALE		- Base	THEAD IN THE AND IN THE ADDRESS OF T

BAR IS ONE INCH ON ORIGINAL DRAWING

IF NOT ONE INCH ON

THIS SHEET, ADJUST

SCALES ACCORDINGLY

1 4/17/24 ADDENDUM 2

DATE REVISION

5284

BRIAN G.

YOUNG

MR RDE

BY APVC

FILENAME: L:\CAD\Projects\21-064 Prescott Yavapai Hills LS\Deliverables\2164D-E001.dgn

D. LEWCH/ CHECKED B. YOUNG APPROVED R. BRYANT			NEERS	CITYOF PRESCOT		APAI HILLS T STATION
T. ADAMS DRAWN	A N I N I		WORKS	\sim		
DESIGN			- + or - V	III BATTERY V		EARTH GROUND
				T##B	0	FIELD CONDUCTO TWISTED PAIR
			FCN AM##	AMP METER		FIELD CONDUCTO
	0			VOLT METER		TWISTED PAIR
SPD1 O	Ŷ	SINGLE POLE DOUBLE THROW (SPDT) RETURN FROM BOTH	FCN	HORN		CONDUCTOR SHIE
SPD1 0	r##C 0	SINGLE POLE DOUBLE THROW (SPDT) RETURN FROM UP	ABU## FCN AH##	BUZZER		CONDUCTORS CO
o—	。 プ	SINGLE POLE DOUBLE THROW (SPDT) RETURN FROM DOWN	ABE## FCN	BELL		CONDUCTORS NO
SPDT			MIS	SCELLANEOUS DEVICES	CONDUI	TS & CONDUCTORS
0	0	(SPDT) MAINTAIN) ОИТ ВОТН ТОР	E	GROUND CHASSIS
FCN SPD1	FCN O	SINGLE POLE DOUBLE THROW		OUT RIGHT TOP		
어ト	<u>~}/{~</u>				LT##	ENCLOSURE LIGH
PE##	PE##	PHOTO EYE		IN LEFT TOP	??? ??? ???	
FCN	FCN	A-PLUG	✓ PJ##			RECEPTACLES
FCN APL##	FCN APL##		✓ PJ## ∧ PJ##		RCPT## RCPT##	
PCS##	PCS##	PULL CORD	▲ PJ##		- -	GROUND
FCN	FCN	PROXY SWITCH			TVS## TVS ???	SUPPRESSOR
FCN PRS###	FCN PRS###		$\nabla \nabla_{\#} \nabla^{?} \nabla^{?}_{\#}$	TRIANGLE	1 (???	on non or
FTS##	FTS##	FOOT SWITCH	$\diamondsuit \diamondsuit_{\#}^{\#} \diamondsuit_{\#}^{?} \diamondsuit_{\#}^{?}$	DIAMOND	C##	CAPACITOR
???	???		$\circ \circ \circ_{\#} \circ \circ \circ_{\#} \circ \circ \circ_{\#}$			ZENER DIODE
TGS###	TGS##	TOGGLE SWITCH		SQUARE		
???	???		??			

	Ú.
SINGLE LINE & CONTROL DIAGRAM SYMBO	LS

DESCRIPTION:

FLOW

LIQUID LEVEL (FLOAT)

NO: CLOSES ON RISING LEVEL

NC: OPENS ON RISING LEVEL

FLOW SWITCH (AIR, WATER, ETC.)

NC: OPENS ON INCREASED FLOW

NO: CLOSES ON INCREASED

AUXILIARY SWITCH CONTACT

FLOW & LEVEL SWITCHES

OTHER SWITCHES

NORMALLY

CLOSED (NC)

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AUX##

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DESCRIPTION:

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NOTO: NORMALLY OPEN, TIMED

OPENING WHEN

DEENERGIZED

DEENERGIZED

TIMED CLOSING WHEN

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CLOSING, WHEN

TIMED OPENING, WHEN

ON DELAY

OFF DELAY

TIMERS

NORMALLY CLOSED (NC)

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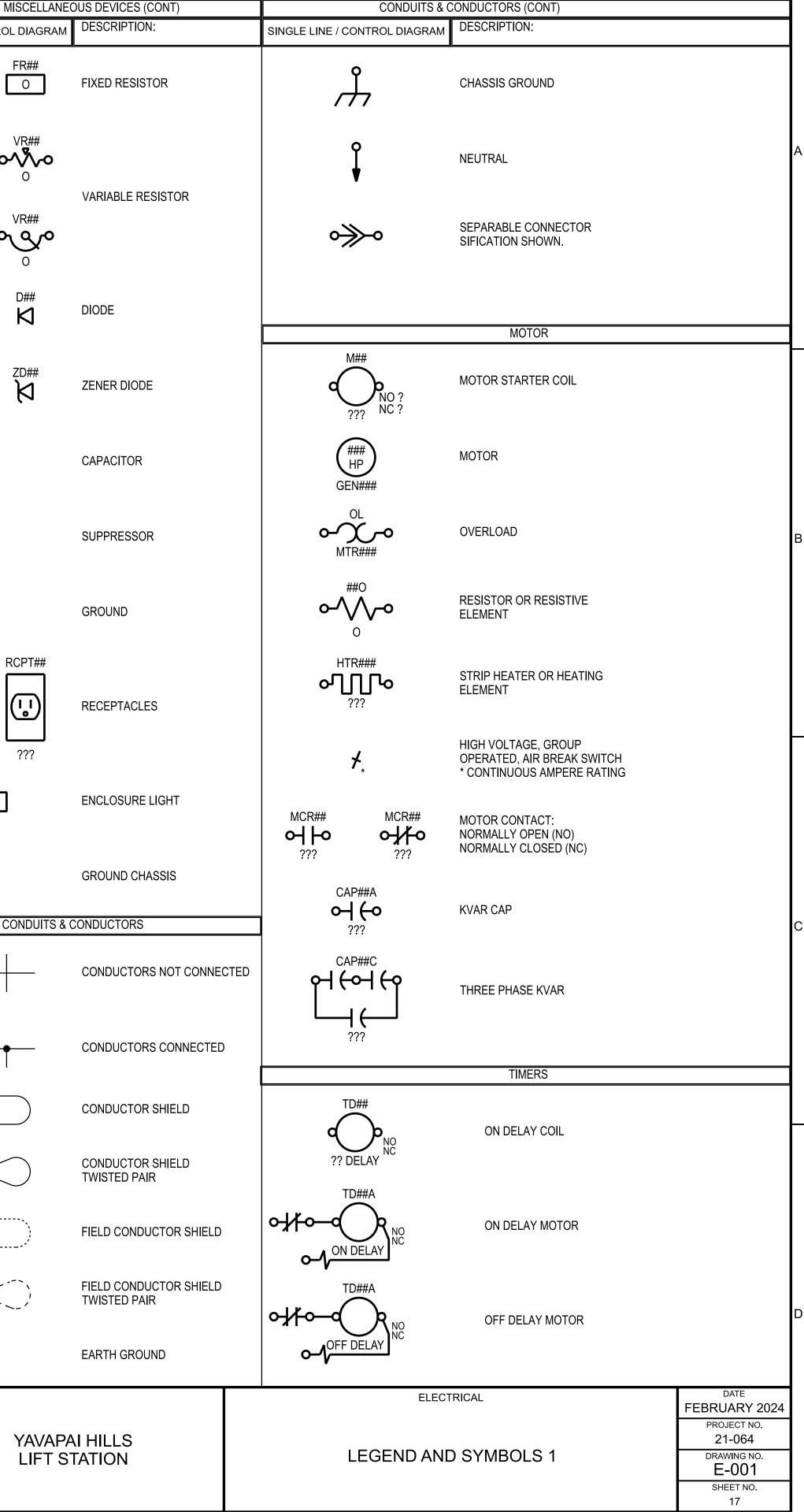
0-10

FCN

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TERMINALS & CONNECTORS

DOT



SINGLE LINE / CONTROL DIAGRAM

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					SINGLE LI	NE, CONTROL	DIAGRAM & PLAN SYMBOL	S			
				MENT & DEVICES			IT & DEVICES (CONT)				LIGHTING FIXT
SINGLE LINE / CONTROL DIAGRAM	DESCRIPTION:	SINGLE LINE OR CONTROL DIAGRAM	PLAN VIEW	DESCRIPTION:	SINGLE LINE OR CONTROL DIAGRAM	PLAN VIEW	DESCRIPTION:	SINGLE LINE OR CONTROL DIAGRAM	PLAN VIEW	DESCRIPTION:	
DI DI## FCN	DISCRETE INPUT	DISC# ###AT ###AF	DISC#	NON-FUSIBLE DISCONNECT SWITCH, 600 VOLT, 3 POLE, (##A) AMPERE RATING	CR##	N/A	NON-FUSIBLE DISCONNECT SWITCH, 600 VOLT, 3 POLE, (##A) AMPERE RATING	N/A	ESA	EMERGENCY SHOWER ALARM STATION	ALCP-#### OR
FCN A	DISCRETE OUTPUT NALOG I/O	•##A FU## • • • • • • • • • • • • • • • • • • •	FJ	FUSIBLE DISCONNECT SWITCH, 600 VOLT, 3 POLE, AMPERE RATING AND FUSE SIZE AS NOTED (##A) AMPERE RATING	TVSS	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR (POWER DISTRIBUTION TYPE)	OR	N/A	JUMPER	LP-#### OR
AI## FCN AO##	ANALOG INPUT		• E CLR MMS#	(FU#) FUSE RATING MANUAL MOTOR STARTER WITH THERMAL OVERLOAD PROTECTION "CLR" INDICATES WITH PILOT LIGHT	PLT## CLR FNC	N/A	PUSH TO TEST, 110V S6 LAMP UNLESS NOTED, LETTER IS LENS COLOR: R = RED $G = GREEN$ C CLEAR A = AMBER $Y = YELLOWB = BLUE$ $W = WHITE$		N/A	MOTOR SWITCH	PP-#### OR
FCN	ANALOG OUTPUT	₩₩ MTR###	N/A	"#P" INDICATES NUMBER OF POLES DRAWOUT TYPE EQUIPMENT OR DEVICE	SOL## FCN	SOV	SOLENOID OPERATED VALVE	N/A	U	JUNCTION BOX	NL a
FUSES & C SINGLE LINE OR PLAN VIEW ONTROL DIAGRAM	IRCUIT BREAKERS DESCRIPTION: THERMAL MAGNETIC CIRCUIT BREAKER	\triangleright	N/A	MEDIUM VOLTAGE CABLE TERMINATION	ETM	N/A	ELAPSED TIME METER	N/A	PB OR PB	PULL BOX	$\mathbf{X} \mathbf{X} \mathbf{X} \mathbf{X} \mathbf{X} \mathbf{Y} \mathbf{X} \mathbf{Y} \mathbf{A} \mathbf{X}$
	TRIP RATING ABOVE; FRAME RATING BELOW. TYPICAL FOR OTHER TYPES OF BREAKERS. BREAKER TO BE 3 POLE UNLESS NOTED OTHERWISE AS 1P OR 2P DRAWOUT MEDIUM VOLTAGE POWER	TGS### FCN	N/A	MEDIUM VOLTAGE AIR INTERRUPTER SWITCH	UH### ##kW	UH###	UNIT HEATER		GROL	FIELD MOUNTED INSTRUMENT: XXX= DESIGNATION TO BE OBTAINED FROM INSTRUMENTATION DRAWINGS JNDING	
•€B### •//A •//A •//A •//A	BREAKER UPPER NUMBER INDICATES LONG TIME TRIP SETTING LOWER NUMBER INDICATES BREAKER CONTINUOUS CURRENT RATING COMBINATION MOTOR STARTER WITH	₩AT ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★	N/A	MEDIUM VOLTAGE FUSED MOTOR CONTROLLER #AT = AUTOTRANSFORMER TYPE	WH### ##kW	WH###	WATER HEATER) -	GROUND ROD	X <u>?? </u>
	MOTOR CIRCUIT PROTECTOR, MAGNETIC CONTACTOR AND OVERLOAD PROTECTION X= AMPERE SIZE Z= NEMA SIZE MOTOR STARTER WITH MAGNETIC	M## WM T##	N/A	METER (M##) WM - WATT METER WHM - WATT HOUR METER WHDM - WATT HOUR DEMAND METER WHDR - WATT HOUR DEMAND RECORDER PF - POWER FACTOR METER	DM- #####	DM- #####	DAMPER MOTOR) -	GROUND ROD IN GROUNDING WELL	X ?? Y
FU##	CONTACTOR AND OVERLOAD PROTECTION Z= NEMA SIZE	(###	\frown	TRANSDUCER (T##) AX - CURRENT TRANSDUCER WX - WATT TRANSDUCER GENERATOR WITH GENERATION NUMBER,	##KW MOV ####	MOV	MOTOR OPERATED VALVE "XXXX" DENOTES LOOP NUMBER TO B OBTAINED FROM INSTRUMENTATION DRAWINGS) -	GROUND ROD IN TEST WELL	
FU##	FUSE	HP GEN###	G	RATINGS AND CONNECTIONS AS NOTED IN CALL OUT ON DRAWING	N/A	•	CONTROL STATION	<u>آ</u>		GROUND GRID CABLE CONNECTION, WELDED	##-??-###
N/A ##A	FUSED SWITCH	HP MTR### FCN	MTR	MOTOR, NUMERAL INDICATES HORSEPOWER AUTOMATIC TRANSFER SWITCH (ATS)	ITP	ITP	INTERMEDIATE TERMINAL PANEL	\$	a	ICHES SINGLE POLE SWITCH "a" INDICATES SWITCH LEG SHALL CONTROL LUMINARIES WITH "a" DESIGNATION	CLR
C XFMR### ##kVA ###A / ###A ##Ø	TRANSFORMER, RATINGS AND CONNECTIONS AS NOTED. UNLESS OTHERWISE NOTED ON THE ONE LINE DIAGRAMS ALL DRY TYPE TRANSFORMERS SERVICING ADMINISTRATIVE AND	SON ATS##	ATS-###	"N" INDICATES NORMAL SOURCE "S" INDICATES STANDBY SOURCE #RATE = INDICATES CONTINUOUS CURRENT RATING	ITP#### FCN	N/A	KEY INTERLOCK	\$	2 b	DOUBLE POLE SWITCH "b" INDICATES SWITCH LEG SHALL CONTROL LUMINARIES WITH "b" DESIGNATION	E1 X Y E2
-	LABORATORY SPACES SHALL HAVE A K FACTOR OF 13. ALL OTHER DRY TYPE TRANSFORMERS SHALL HAVE A K-4 RATING. ISOLATION TRANSFORMERS SHALL HAVE A K-20 RATING	VFD###	VFD-###	# = INDICATES ATS NAME AC MOTOR SPEED CONTROLLER (VARIABLE FREQUENCY DRIVE)	κĒ	N/A	ELECTRONIC KEY INTERLOCK	\$	3 c	THREE WAY SWITCH "c" INDICATES SWITCH LEG SHALL CONTROL LUMINARIES WITH "c" DESIGNATION	REM Y
	DUAL TRANSFORMER	SCR###	SCR-###	DC MOTOR SPEED CONTROLLER (SILICON CONTROLLED RECTIFIER)				\$	4 d	FOUR WAY SWITCH "d" INDICATES SWITCH LEG SHALL CONTROL LUMINARIES "d" DESIGNATION	XXX XY SP
			N/A	VOLTMETER WITH SWITCH, 3 PHASE (*) = SCALE	-Œ	-⁄‹/-ር፡	CORD AND PLUG CONNECTION	\$	M	SINGLE POLE, DOUBLE THROW MOMENTARY CONTACT SWITCH, CENTER OFF	XX
N/A ************************************	CURRENT TRANSFORMER *QUANTITY XXXX = PRIMARY AMPERE RATING	(*) AM###	N/A	AMMETER WITH SWITCH, 3 PHASE	N/A	Ţ	THERMOSTAT	\$)'	SINGLE POLE SWITCH AND PILOT LIGHT	X Y SP
B C (*)	POTENTIAL TRANSFORMER (PT) OR CONTROL POWER TRANSFORMER (CPT) * QUANTITY XXXX = PRIMARY VOLTAGE RATING	(*) LA##		(*) = SCALE	N/A		OCCUPANCY SENSOR	Ca	a	LIGHTING CONTACTOR WITH NUMBER OF POLES AS INDICATED a-CONTACTOR NUMBER (C1, C2, ETC.)	
o N/A	INDUCTOR	۰۰ ۱۰	N/A	LIGHTNING ARRESTOR	N/A	PC	PHOTOCELL	ТМ	Л	TIME SWITCH	
RIFY SCALE Image: Constraint of the second seco	NDUM 2 MR RI	DB	Electrical	DESIGN T. ADAMS DRAWN D. LEWCHANIN CHECKED B. YOUNG APPROVED R. BRYANT	Drinking Walds	NATERN ENGIN		PRESCOT	Ĩ	YAVAPAI HILLS LIFT STATION	LEGEN

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LIGHTING FIXTURES	& EQUIPMENT (CONT) DESCRIPTION:	
ALCP-### OR	AREA LIGHTING CONTACTOR PANEL ### = PANEL NAME	
LP-#### OR	LIGHTING PANEL BOARD NO. # (240/120V OR 208/120V) ### = PANEL NAME	
PP-#### OR PP-###	POWER DISTRIBUTION PANEL BOARD NO. # (480V OR 480/277V) ### = PANEL NAME	
$ \begin{array}{c} $	TYPICAL LUMINARIES SEE SCHEDULE FOR SPECIFICS "XX"-FIXTURE TYPE X= PANEL BOARD NAME "b"-CONTROLLED BY SWITCH "b" Y= CIRCUIT NUMBER NL= NIGHT LIGHT (UN-SWITCHED)	
$ \begin{array}{c} $	WALL MOUNTED LUMINARIE.REFER TO SCHEDULE FOR SPECIFICS. (NOTATIONS SAME AS ABOVE)	
Y A	DIRECTIONAL FLOOD LIGHT TYPE LUMINARIES. SEE SCHEDULE FOR SPECIFICS. (NOTATIONS SAME AS ABOVE)	
?? X Y NL a	FLUORESCENT TYPE LUMINARIES. SEE SCHEDULE FOR SPECIFICS. (NOTATIONS SAME AS ABOVE)	
X ?? Y NL a	FLUORESCENT TYPE LUMINARIES. SEE SCHEDULE FOR SPECIFICS. (NOTATIONS SAME AS ABOVE)	
##-??-###	INDICATES ALL LUMINARIES WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE TYPE "A" UNLESS OTHERWISE NOTED. SEE LIGHTING FIXTURE SCHEDULE FOR TYPES	
CLR	ALARM BEACON. COLOR AS NOTED. REFER TO SPECIFICATIONS FOR REQUIREMENTS.	
E1 X Y	EMERGENCY LUMINARIES WITH BATTERY PACK "E1" FIXTURE TYPE. REFER TO SCHEDULE FOR SPECIFICS. X= PANEL BOARD NAME Y= CIRCUIT NUMBER	
E2 REM Y	REMOTE EMERGENCY LUMINARIES "E2"-FIXTURE TYPE. REFER TO SCHEDULE FOR SPECIFICS	
XX XX SP	CEILING MOUNTED EXIT SIGN "X1" LUMINAIRE TYPE. REFER TO SCHEDULE FOR SPECIFICS LP-##= PANEL BOARD NAME Y= CIRCUIT NUMBER SP= SELF POWERED	
XX Y SP	WALL OUTLET EXIT SIGN. ARROW INDICATES DIRECTION OF EXCESS "X2" LUMINAIRE TYPE. REFER TO SCHEDULE FOR SPECIFICS. LP-## = PANEL BOARD NAME Y= CIRCUIT NUMBER SP= SELF POWERED	
		DATE FEBRUARY 2024 PROJECT NO. 21-064 DRAWING NO. E-002
	PLAN VIEW ALCP-#### ALCP-#### $RLP#### RPP#### RIP#### RIP#### RIP#### RIP#### RIP#### RIP#### RIP#### RIP#### RIP#### RIP####RIP####RIP####RIP####RIP####RIP####RIP####RIP####RIP####RIP####RIP####RIP####RRRRRRRR$	ALCP-###ALCP-###NLCP-###QRALCP-###LP-###QRUGHTNO PANEL BOARD NO. # (240/120V QR 200/20V) ## = PANEL NAMELP-###QRPP-###UP-###QRPP-###UP-###QRPP-###PP-###QRPP-###PP-###QRPP-###PP-###QRPP-###PP-###QRPOWER DISTRIBUTION PANEL BOARD NO. # (240/120V QR 200/20V) ## = PANEL NAMEVIC-INTURE TYPE NLPANEL NAMEVIC-INTURE TYPE NLNAMEVIC-INTURE TYPE NLNAMEVIC-INTU

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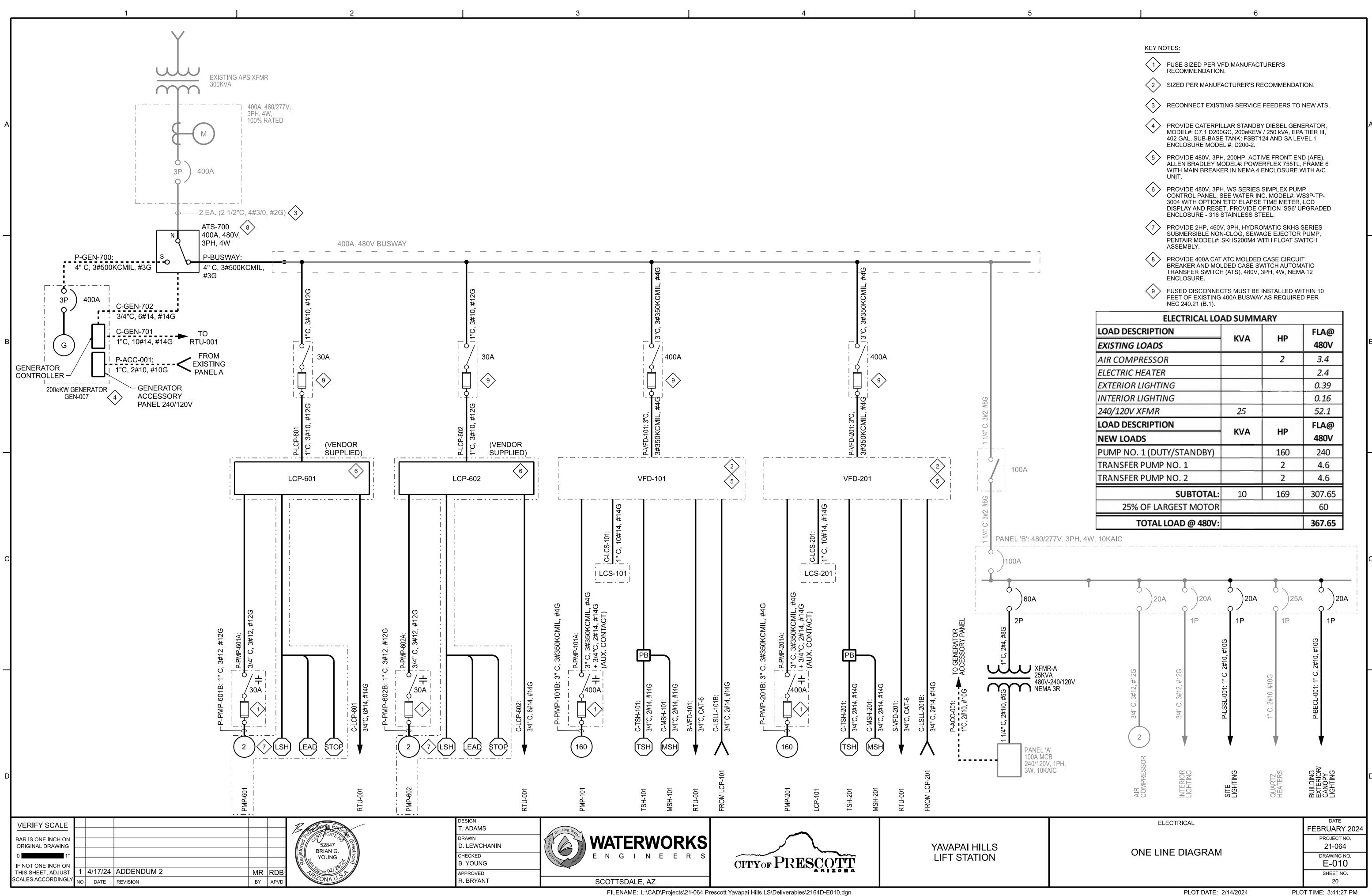
	PLAN VIEW	DNDUIT DESCRIPTION:		POWER	RECEPTACLES DESCRIPTION:
		EXPOSED CONDUIT		##A LP-### Y	208V, 3P, 4W, RECEPTACLE ##A = AMPERE RATING AS NOTEL LP-##= PANEL BOARD NUMBER
А		HIDDEN / CONCEALED CONDUIT		##A LP-### Y	Y= CIRCUIT NUMBER 240V, 20, 3W, RECEPTACLE ##A = AMPERE RATING AS NOTEL LP-##= PANEL BOARD NUMBER Y= CIRCUIT NUMBER
		UNDERGROUND CONDUIT		##A LP-### Y	FLOOR OUTLET BOX WITH TYPE
		OVERHEAD POWER LINES		##A LP-### Y	480V, 3P, 4W RECEPTACLE AND DISCONNECT SWITCH ##A = AMPERE RATING AS NOTEL X = PANEL BOARD NUMBER
_		GROUNDING CONDUCTOR			Y = CIRCUIT NUMBER DUPLEX RECEPTACLE, 20A, 120V
		CONDUITS IDENTIFIED BY A NUMBER SHALL BE LISTED IN THE CONDUIT BLOC DIAGRAM	к	GFCI X WP Y	UNLESS OTHERWISE NOTED * =C - MOUNTED ABOVE COUNTE GF - GROUND FAULT INTERRUPT WP - WEATHERPROOF T - TRANSIENT VOLTAGE SURGE
	AA	CONDUITS IDENTIFIED BY LETTERS SHALL CONFORM TO THE TABLES IN THE LEGEND			SUPPRESSER X= PANEL BOARD NUMBER Y= CIRCUIT NUMBER
В		CONDUIT STUBBED OUT AND CAPPED		₩#A LP-### Y	QUAD RECEPTACLE, 20A, 120V, 2 UNLESS OTHERWISE NOTED NOTATION SAME AS ABOVE
		FLEXIBLE CONDUIT OR MANUFACTURER'S CABLE(S)		SECUI	RITY SYSTEM
		CONDUIT TURNED DOWN		KP	SECURITY SYSTEM KEY PAD
	\bigcirc	CONDUIT TURNED UP		CR	SECURITY SYSTEM CARD ACCES READER
		INDICATES LIMITS OF EQUIPMENT OR WIRING ENCLOSURE		MD	SECURITY ALARM MOTION DETEN
	► XXXX	CONDUIT HOME RUN, XXX DENOTES DESTINATION CONTRACTOR SHALL FIELI ROUTE FROM EQUIPMENT TO DESIGNATED LOCATION	D	ССТУ	CLOSED CIRCUIT TV CAMERA
С	(2)-3"C, 3-#3/0, 1-#2G	DENOTES A QUANTITY OF TWO (2) 3-INCH CONDUITS EACH CONTAINING THREE NC 3/0 AWG CONDUCTORS AND 1 NO. 2 AWG GROUND CONDUCTOR).		
	2 PR #16 TWSH	DENOTES A QUANTITY OF TWO INSTRUMENT CABLES. EACH CABLE TO CONSIST OF TWO NO. 16 AWG CONDUCTORS TWISTED TOGETHER AND COVERED WITH A METALLIC SHIELD AND AN OVERALL PROTECTIVE JACKET. REFER TO THE SPECIFICATIONS FOR THI EXACT CABLE TO BE PROVIDED.			
_	2 TR #16 TWSH	SAME AS ABOVE EXCEPT CABLE TO CONSIST OF THREE NO. 16 AWG CONDUCTORS TWISTED, SHIELDED AND COVERED WITH AN OVERALL PROTECTIVE JACKET. REFER TO THE SPECIFICATIONS FOR THE EXACT CABLE TO BE PROVIDED.			
	2 PR #16 TW	DENOTES A QUANTITY OF TWO INSTRUMENT CABLES. EACH CABLE TO CONSIST OF TWO NO. 16 AWG CONDUCTORS TWISTED TOGETHER AND AN OVERALL PROTECTIVE JACKET. REFER TO THE SPECIFICATIONS FOR THI EXACT CABLE TO BE PROVIDED.			
D	(3)-4"C	THREE 4-INCH CONDUITS			
				17 Farth 5	DESIGN
	VERIFY SCALE BAR IS ONE INCH ON				T. ADAMS DRAWN
	ORIGINAL DRAWING			S2847 BRIAN G. YOUNG	D. LEWCHA
	IF NOT ONE INCH ON THIS SHEET, ADJUST 1 4/17/24 ADDE	NDUM 2 MF		Respired 02/26	B. YOUNG
	SCALES ACCORDINGLY NO DATE REVISIO	N BY	APVD		R. BRYANT

				PLAI	N VIEW SYMBOLS					
C	ONDUIT	POW	ER RECEPTACLES	TELECOMM	UNICATION SYSTEM (CONT)	FIRE ALA	RM / LIFE SAFETY (CONT)	ARE	A CLASSIFICATION	
/IEW	DESCRIPTION:	PLAN VIEW	DESCRIPTION:	PLAN VIEW	DESCRIPTION:	PLAN VIEW	DESCRIPTION:	PLAN VIEW	DESCRIPTION:	
	EXPOSED CONDUIT	##A LP-### Y	208V, 3P, 4W, RECEPTACLE ##A = AMPERE RATING AS NOTED LP-##= PANEL BOARD NUMBER Y= CIRCUIT NUMBER	© ^{C2}	PAGING SPEAKER, FLUSH MOUNTED CEILING TYPE	STB ???	WEATHERPROOF HIGH DENSITY FIRE ALARM STROBE LIGHT	DAMP	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF	
	HIDDEN / CONCEALED CONDUIT	##A LP-### Y	240V, 20, 3W, RECEPTACLE ##A = AMPERE RATING AS NOTED LP-##= PANEL BOARD NUMBER Y= CIRCUIT NUMBER	S	PAGING STATION, SURFACE MOUNTED		SPRINKLER FLOW ALARM SWITCH		NEMA 12 CONSTRUCTION (OR GASKETED AND SUITABLE FOR USE IS A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.	
	UNDERGROUND CONDUIT DUCT BANK	##A LP-### Y	FLOOR OUTLET BOX WITH TYPE OUTLET	VC	REMOTE WALL MOUNTED VOLUME CONTROL. FOR CEILING SPEAKER (MOUNT UP 5'-0" AFF UNO)	СМ	ADDRESSABLE CONTROL MODULE	WET	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF NEMA 4X CONSTRUCTION (OR GASKETED	
	OVERHEAD POWER LINES	##A LP-###	480V, 3P, 4W RECEPTACLE AND DISCONNECT SWITCH ##A = AMPERE RATING AS NOTED	EIRE	PAGING SPEAKER AMPLIFIER ASSEMBLY	ММ	ADDRESSABLE MONITOR MODULE		AND SUITABLE FOR USE IN A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.	
	GROUNDING CONDUCTOR	Y	X = PANEL BOARD NUMBER Y = CIRCUIT NUMBER DUPLEX RECEPTACLE, 20A, 120V, 2P, 3W		FIRE ALARM HEAT DETECTOR 135Y FIXED TEMPERATURE UNLESS OTHER- WISE NOTED.			CORROSIVE	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF	
- 100	CONDUITS IDENTIFIED BY A NUMBER SHALL BE LISTED IN THE CONDUIT BLOCK DIAGRAM	GFCI X WP Y	UNLESS OTHERWISE NOTED * =C - MOUNTED ABOVE COUNTERTOP GF - GROUND FAULT INTERRUPTER TYPE WP - WEATHERPROOF T - TRANSIENT VOLTAGE SURGE	R	"200" DENOTES 200YF TYPE "R" DENOTES FIXED TEMPERATURE RATE-OF-RISE TYPE. FIRE ALARM DUCT SMOKE DETECTOR	SD	SMOKE DETECTOR		NEMA 4X CONSTRUCTION (OR GASKETED AND SUITABLE FOR USE IN A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.	
– AA	CONDUITS IDENTIFIED BY LETTERS SHALL CONFORM TO THE TABLES IN THE LEGEND		SUPPRESSER X= PANEL BOARD NUMBER Y= CIRCUIT NUMBER	DSD	PHOTOCELL TYPE UNLESS OTHERWISE NOTED. "I" DENOTES IONIZATION TYPE.	TELECO	DMMUNICATION SYSTEM	CLASS 1, DIV. 1	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH	
]	CONDUIT STUBBED OUT AND CAPPED	##A LP-### Y	QUAD RECEPTACLE, 20A, 120V, 2P, 3W UNLESS OTHERWISE NOTED NOTATION SAME AS ABOVE	DSD ²	FIRE ALARM DUCT SMOKE DETECTOR	ТТВ	TELEPHONE TERMINAL BOARD 4FT X 8FT X 3/4 INCH UNLESS NOTED OTHERWISE	GROUP D	THIS NOTATION APPEARS SHALL CONFORM TO N.E.C. REQUIREMENTS FOR THE HAZARDOUS AREA CLASSIFICATION SHOWN.	
\sim	FLEXIBLE CONDUIT OR MANUFACTURER'S CABLE(S)		CURITY SYSTEM	FACP-####	FIRE ALARM CONTROL PANEL	\bigtriangledown	TELEPHONE OUTLET, WALL TYPE (MOUNT 1'-6" AFF UNO)			
	CONDUIT TURNED DOWN	(KP)	SECURITY SYSTEM CARD ACCESS	FAVP-####	FIRE ALARM VENTILATION PANEL (WITH GRAPHIC PANEL)		TELEPHONE OUTLET AND FLOOR BOX			
	INDICATES LIMITS OF EQUIPMENT OR	CR	READER	FARAP-####	FIRE ALARM REMOTE ANNUNCIATOR	V	TELEPHONE/DATA OUTLET, WALL TYPE (MOUNT 1'-6" AFF UNO)			
.;	WIRING ENCLOSURE CONDUIT HOME RUN, XXX DENOTES DESTINATION CONTRACTOR SHALL FIELD	MD	SECURITY ALARM MOTION DETECTOR		FIRE ALARM MANUAL PULL STATION,		TELEPHONE/DATA OUTLET AND FLOOR			
XX	ROUTE FROM EQUIPMENT TO DESIGNATED LOCATION	CCTV	CLOSED CIRCUIT TV CAMERA	MWP	MOUNT UP 4'-0" WP DENOTES WEATHERPROOF COVER	C1	BOX PAGING SPEAKER, WALL MOUNTED			
3/0, 1-#2G	DENOTES A QUANTITY OF TWO (2) 3-INCH CONDUITS EACH CONTAINING THREE NO. 3/0 AWG CONDUCTORS AND 1 NO. 2 AWG GROUND CONDUCTOR			F	OUTDOOR WEATHERPROOF FIRE ALARM MASTER BOX		"H1" AND "C1" DENOTES TYPE. H=HORNC=CONE			
VSH	DENOTES A QUANTITY OF TWO INSTRUMENT CABLES. EACH CABLE TO CONSIST OF TWO NO. 16 AWG CONDUCTORS TWISTED TOGETHER AND COVERED WITH A METALLIC SHIELD AND AN OVERALL PROTECTIVE JACKET.			F	WP FIRE ALARM SPEAKER, MOUNT UP 7'-8"		PAGING SPEAKER, WALL MOUNTED, BIDIRECTIONAL NOTATIONS SAME AS ABOVE			
	REFER TO THE SPECIFICATIONS FOR THE EXACT CABLE TO BE PROVIDED. SAME AS ABOVE EXCEPT CABLE TO CONSIST OF THREE NO. 16 AWG			S	FIRE ALARM STROBE, WALL MOUNT UP 6'-8" OR AT CEILING					
/SH	CONDUCTORS TWISTED, SHIELDED AND COVERED WITH AN OVERALL PROTECTIVE JACKET. REFER TO THE SPECIFICATIONS FOR THE EXACT CABLE TO BE PROVIDED.			F	FIRE ALARM HORN AND STROBE LIGHT COMBINATION, MOUNT UP 6'-8"					
V	DENOTES A QUANTITY OF TWO INSTRUMENT CABLES. EACH CABLE TO CONSIST OF TWO NO. 16 AWG CONDUCTORS TWISTED TOGETHER AND AN OVERALL PROTECTIVE JACKET.			F	FIRE ALARM HORN AND STROBE LIGHT COMBINATION, CEILING MOUNT					
	REFER TO THE SPECIFICATIONS FOR THE EXACT CABLE TO BE PROVIDED.			× N	SPRINKLER VALVE SUPERVISORY SWITCH					
	THREE 4-INCH CONDUITS			FO	FIRE ALARM BELL					
		S2847 BRIAN G. YOUNG	DESIGN T. ADAMS DRAWN D. LEWCHANIN CHECKED	Portinking Water Barris Water Barris	ERWORKS		YAVAPAI HILLS LIFT STATION	LEGEN	ELECTRICAL	DA FEBRUA PROJE 21- DRAWI

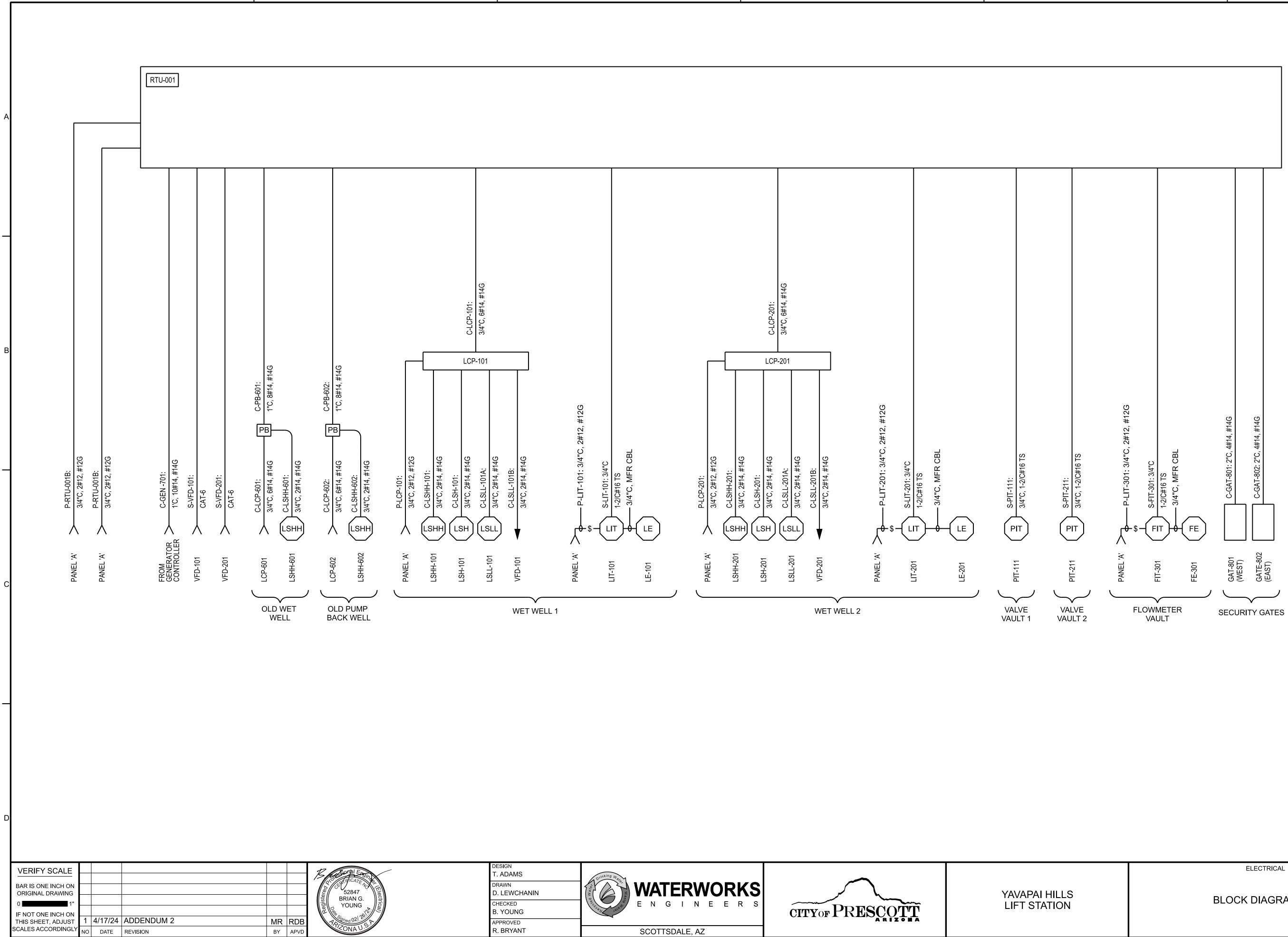
SCOTTSDALE, AZ FILENAME: L:\CAD\Projects\21-064 Prescott Yavapai Hills LS\Deliverables\2164D-E003.dgn

Ì	AREA	CLASSIFICATION		
	PLAN VIEW	DESCRIPTION:		
E	DAMP	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF NEMA 12 CONSTRUCTION (OR GASKETED AND SUITABLE FOR USE IS A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.		А
	WET	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF NEMA 4X CONSTRUCTION (OR GASKETED AND SUITABLE FOR USE IN A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.		
	CORROSIVE	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL BE OF NEMA 4X CONSTRUCTION (OR GASKETED AND SUITABLE FOR USE IN A WET LOCATION WHERE NEMA STANDARDS DO NOT APPLY) UNLESS OTHERWISE NOTED.		
(8FT ISE	CLASS 1, DIV. 1 GROUP D	INDICATES THAT ALL ELECTRICAL EQUIPMENT AND MATERIALS INSTALLED WITHIN THE ROOM OR AREA IN WHICH THIS NOTATION APPEARS SHALL CONFORM TO N.E.C. REQUIREMENTS FOR THE HAZARDOUS AREA CLASSIFICATION SHOWN.		В
X				
PE				
OR				
				С
5				
				D
		ELECTRICAL	DATE FEBRUARY 2024	
	LEGEND	DAND SYMBOLS 3	PROJECT NO. 21-064 DRAWING NO. E-003	

19



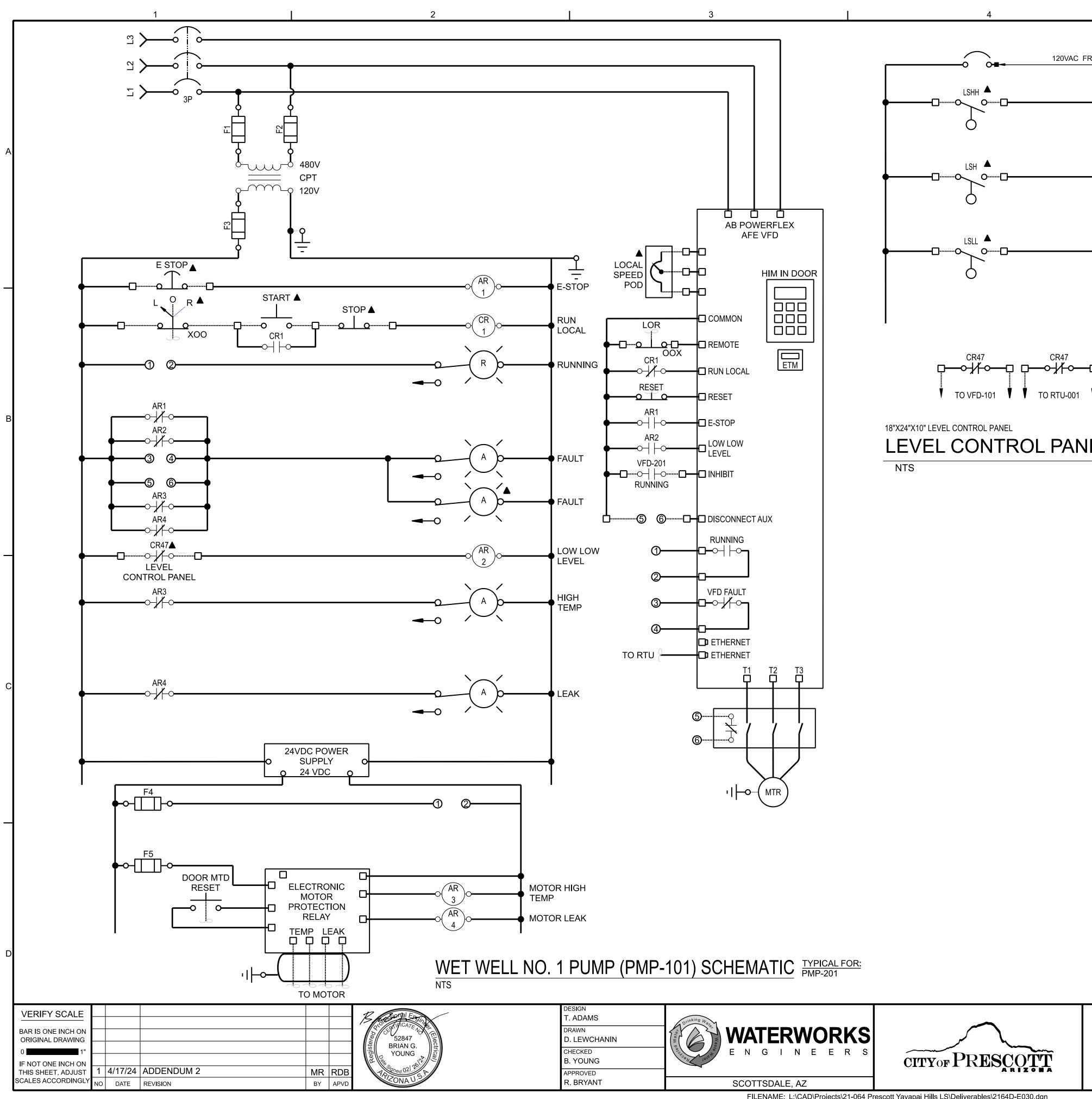
ELECTRICAL LOA	D SUMM	ARY	
LOAD DESCRIPTION	1010	UD	FLA@
EXISTING LOADS	KVA	HP	480V
AIR COMPRESSOR		2	3.4
ELECTRIC HEATER			2.4
EXTERIOR LIGHTING			0.39
INTERIOR LIGHTING			0.16
240/120V XFMR	25		52.1
LOAD DESCRIPTION	1010	ЦБ	FLA@
NEW LOADS	KVA	HP	40014
INEW LUADS			480V
PUMP NO. 1 (DUTY/STANDBY)		160	480V 240
		160 2	
PUMP NO. 1 (DUTY/STANDBY)			240
PUMP NO. 1 (DUTY/STANDBY) TRANSFER PUMP NO. 1	10	2	240 4.6
PUMP NO. 1 (DUTY/STANDBY) TRANSFER PUMP NO. 1 TRANSFER PUMP NO. 2	10	2 2	240 4.6 4.6

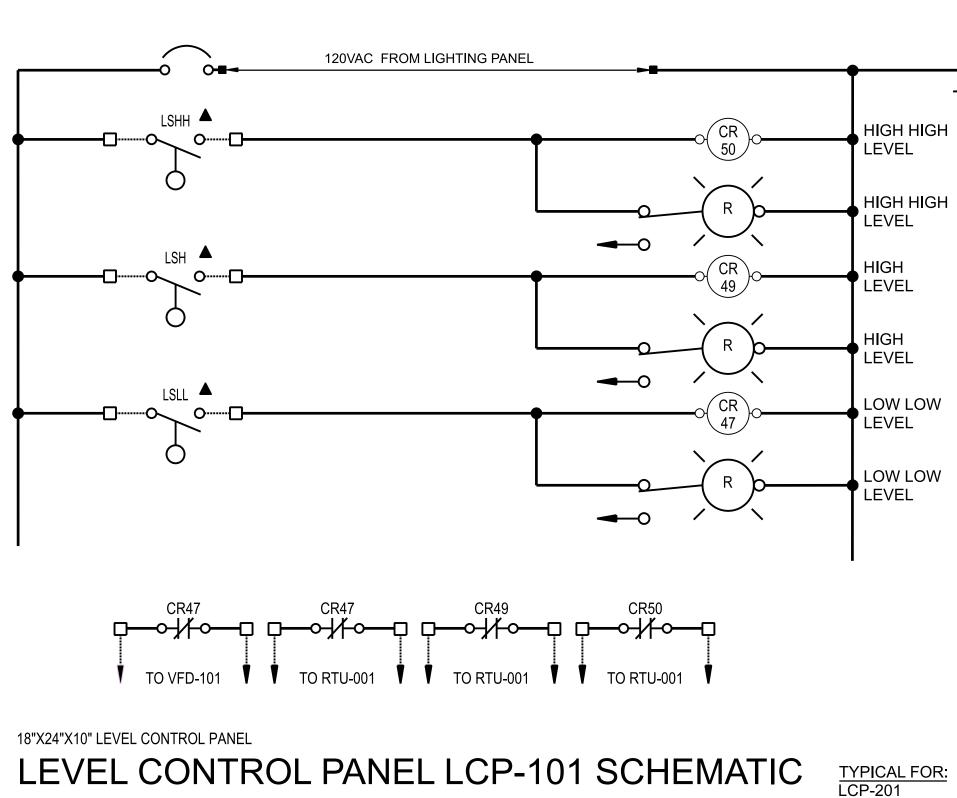


FILENAME: L:\CAD\Projects\21-064 Prescott Yavapai Hills LS\Deliverables\2164D-E020.dgn

ELECTRICAL	DATE FEBRUARY 2024
	PROJECT NO. 21-064
BLOCK DIAGRAMS - 1	DRAWING NO. E-020
	SHEET NO. 21

PLOT TIME: 3:41:59 PM





YAVAPAI HILLS LIFT STATION



HIGH HIGH

HIGH HIGH

LEVEL

LEVEL

HIGH

LEVEL

HIGH

LEVEL

LOW LOW

LOW LOW

LEVEL





THE CONTRACTOR SHALL BE ALLOWED TO COMBINE LIKE CIRCUITS WHERE APPROPRIATE WITH ENGINEERS APPROVAL.

2. REFER TO ONE LINE DIAGRAMS.

<u>SYMBOLS</u>

- ON VFD
- LOCATED AT MOTOR
- ♦ LOCAL TO PLC
- O DEVICE TERMINAL
- ▲ LOCATED AT LOCAL CONTROL STATION (LCS)

ELECTRICAL	DATE FEBRUARY 2024
	PROJECT NO. 21-064
SCHEMATICS - 1	DRAWING NO. E-030
	SHEET NO. 22

							PAN	EL B	
100	AMP MAIN CIRCUIT BREAKER RATING				/		22	KA SHOR	T CIRCUIT RATING
100	AMP BUS RATING	20	POLES			ELE	CTRON	C GRADE:	NO
480/277	VOLTS	3	PHASE	4	WIRE	60	HZ		
		L	OAD KV	A					
CIRCUIT		PHASE	PHASE	PHASE		BREAKER		CIRCUIT	
NO.	DESCRIPTION	А	В	С	TYPE	AMPS	NOTES	NO.	DESCRIPTION
1	PANELA - TRANSFORMER (10kVA)	5.04			CONT	30/2		2	
3			5.04		CONT			4	SPARE
5				1.18	MOTOR			6	
7	AIR COMPRESSOR	1.18			MOTOR	20/3		8	INTERIOR LIGHTIN
9			1.18		MOTOR			10	SITE LIGHTING
11	QUARTZ HEATERS			2.00	NON-CONT	25/1		12	BUILDING EXTERI
13	SPACE							14	SPACE
15	SPACE							16	SPACE
17	SPACE							18	SPACE
19	SPACE							20	SPACE
	SUM OF KVA (ODD):	6.220	6.220	3.180	TRANSFOR	MER KVA:	17	MIN	
	FEEDER KVA (ODD):	7.480	7.480	3.180			2		
NOTES:								NOTES:	
1	PROVIDE LOCKING HARDWARE							2	PROVIDE LOCKIN
3 EQUIPMENT PROTECTION 30ma GFI							4	PERSONEL PROTE	
5	BRANCH CIRCUIT WIRING: 3/4"C, 2#12,#	#12G			· ····			6	BRANCH CIRCUIT
7	BRANCH CIRCUIT WIRING: 3/4"C, 3#12,#	‡12G						8	BRANCH CIRCUIT
9	BRANCH CIRCUIT WIRING: 1 1/2"C, 3#6,	#10G						10	
11								12	

1

						PAN	IEL A						
100	AMP MAIN CIRCUIT BREAKER RATING	22 KA SHO			RT CIRCUIT RATING		ON:	STORAGE BUILDING					
100	AMP BUS RATING	12	POLES	ELECTRONI		CTRONI	NIC GRADE: NO			SURE:			
240/120	VOLTS	1	PHASE	3 WIRE 60		60	HZ		MOUN	TING:			
		LOAD	KVA						LOAD) KVA			
CIRCUIT		PHASE	PHASE		BREAKER		CIRCUIT	Barrier and a state	PHASE PHAS			BREAKER	
NO.	DESCRIPTION	А	В	TYPE	AMPS	NOTES	NO.	DESCRIPTION	А	В	TYPE	AMPS	NOT
1	STBY GENERATOR	2.88		CONT	30/2		2	RECEPTACLES	0.90		CONT	20/1	
3	ACCESSORY PANEL		2.88	CONT			4	SPARE			CONT CONT MOTOR	20/1	
5	RTU-001(A)	1.20		CONT	20/1		6	SPARE				20/1 20/1 20/1 20/1 20/2 20/2	
7	RTU-001(B)		1.92	CONT	20/1		8	P-LIT-101		0.25			
9	SPARE			CONT	30/2		10 12 14 16 18	P-LIT-201 P-FIT-301 EAST SECURITY GATE	0.25 0.18 0.20	0.15			
11				CONT									
13	WEST SECURITY GATE	0.18		MOTOR MOTOR	20/2								
15			0.18										
17	LCP-101	0.20		CONT	20/1			LCP-201					
19	SPACE			CONT	/1		20	SPACE			CONT	/1	
21	SPACE			CONT	/1		22	SPACE			CONT	/1	
23	SPACE			CONT	/1		24	SPACE			CONT	/1	
	SUM OF KVA (ODD):	4.460	4.980	TRANSFOR	RMER KVA:	12	MIN	SUM OF KVA (EVEN)	1.530	0.580	25% OF LAR	GEST MOTO	DR:
	FEEDER KVA (ODD)	5.530	6.180					FEEDER KVA (EVEN)	1.868	0.680	KVA=		0.0
								TOTAL FEEDER KVA	14.	303	TOTAL AMPS	5	3
NOTES:							NOTES:						
1	1 PROVIDE LOCKING HARDWARE							PROVIDE LOCKING RED HARDWARE					
3	3 EQUIPMENT PROTECTION 30ma GFI							PERSONEL PROTECTION 5ma GFI					
5	BRANCH CIRCUIT WIRING: 3/4"C, 2#12,	#12G					6	BRANCH CIRCUIT WIRING: 3/4"C, 2#10,	#12G				
7	BRANCH CIRCUIT WIRING: 3/4"C, 3#12,	#12G					8	BRANCH CIRCUIT WIRING: 3/4"C, 2#10,	#10G				
9							10						
11							12						

2

 \cap

VERIFY SCALE					B ASSESSION	ESIGN . ADAMS
BAR IS ONE INCH ON ORIGINAL DRAWING					S2847	RAWN D. LEWCH
0 1" IF NOT ONE INCH ON					BRIAN G. YOUNG	HECKED
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY		ADDENDUM 2 REVISION	MI BY	RDB APVD	A A A A A A A A A A A A A A A A A A A	PPROVED R. BRYAN

	LOCATI	ON:	STORAGE BUILDING						
	ENCLOS	SURE:	NEMA 1						
	MOUN	TING:	SURFA	CE					
	L	OAD KV	A						
	PHASE	PHASE	PHASE		BREAKER				
	А	В	С	TYPE	AMPS	NOTES			
				CONT					
				CONT	20/3				
				CONT					
NG	0.86			CONT	20/1				
		0.10		CONT	20/1				
IOR/CANOPY LIGHTING			0.07	CONT	20/1				
SUM OF KVA (EVEN):	0.860	0.100	0.070	25% OF LARG	EST MOTO	R:			
FEEDER KVA (EVEN):	1.075	0.125	0.088	KVA=		0.295			
TOTAL FEEDER KVA:		19.723		TOTAL AMPS		24			
IG RED HARDWARE									
ECTION 5ma GFI				_					
WIRING: 3/4"C, 2#10,#	10G					· ·			
WIRING: 3/4"C, 3#10,#									

3

LIGHTING FIXTURE SCHEDULE								
TYPE	WATT	DESCRIPTION	MFR (OR APPROVED EQUAL)					
C1	30	15" SQUARE, SEMI-RECESSED, LED CANOPY FIXTURE, 4,564 LUMEN, TYPE 5 DISTRIBUTION, DIE-CAST ALUMINUM, POWDER-COATED FINISH, ACRYLIC LENS, 277V, 0-10V DIMMING, 40K, 70 CRI, 10KV SURGE PROTECTION, IP65 LISTED.	HUBBELL OUTDOOR LIGHTING: VHS-30-4K7-UNV.					
WE	18	WALL-MOUNTED LED, FULLY CUT-OFF WITH BACK BOX, 3000 LUMEN, 40K, 277V (MVOLT), EMERGENCY BATTERY BACKUP (CEC COMPLIANT), BUTTON TYPE PHOTOCELL FOR DUSK-TO-DAWN OPERATION, 6KV SURGE PROTECTION, BLACK FINISH, IP65 RATED, DARK-SKY COMPLIANT.	LITHONIA LIGHTING: ARC1 LED P3 40K MVOLT E4WH/PE/SPD6KV/DBLXD/WS BBW DBLXD.					
L1	2x18	TWIN LED, FULLY CUT-OFF, POLE MOUNTED AREA LIGHT, 2x2212 LUMEN, T4 DISTRIBUTION, 277V (UNV), UL LISTED. IP 65 RATED. TYPE: P1 POLE.	VISIONAIRE LIGHTING: VSX-II T4 16LC 3 5K UNV SAM GY					
P1	-	16 FOOT, SOFT SQUARE, NON-TAPERED ALUMINUM, HINGED BASE POLE. ARM CONFIGURATION: 180°	VALMONT STRUCTURES: S-160040406YH-D2-DCG					

5

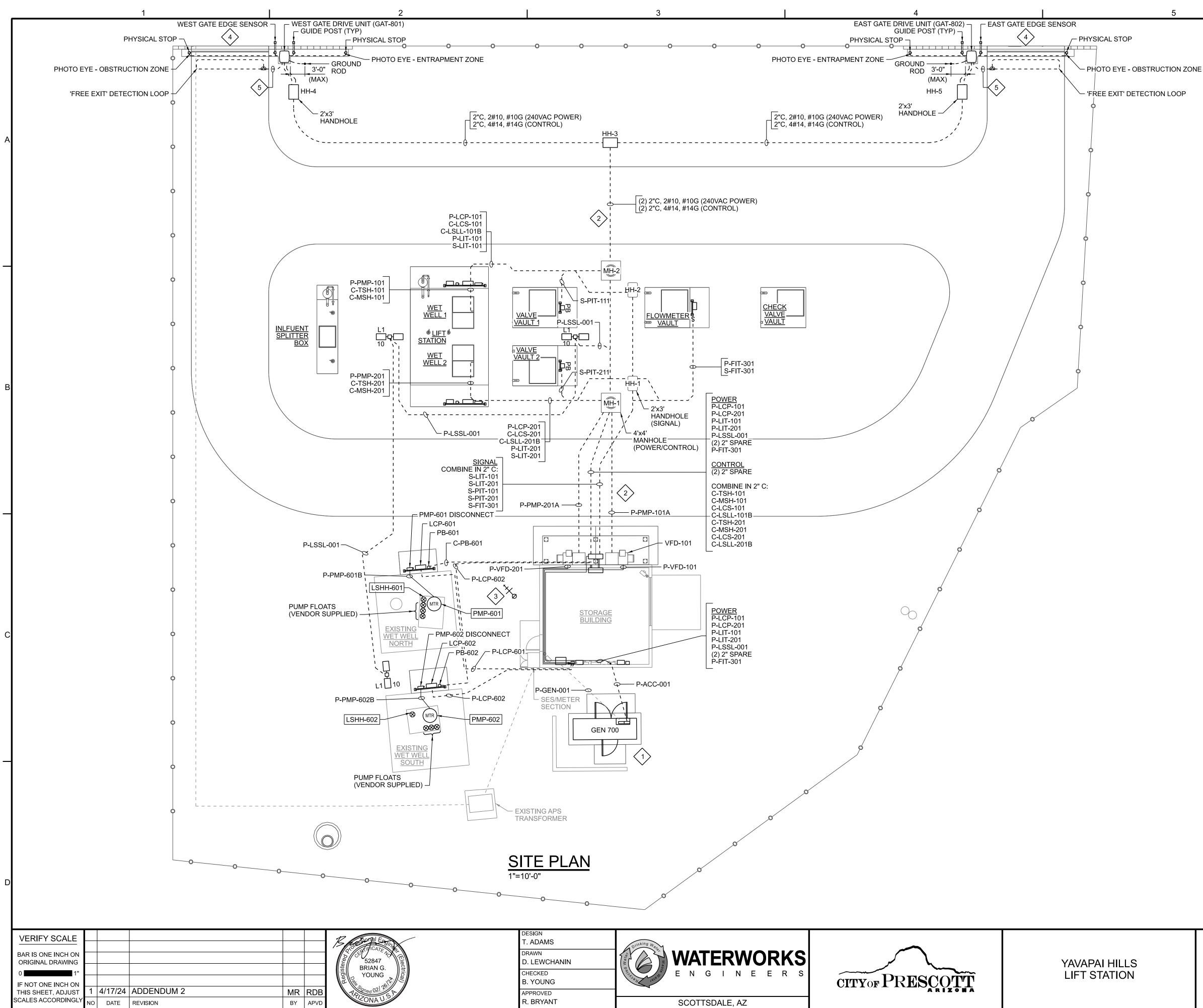


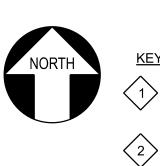


4

YAVAPAI HILLS LIFT STATION

ELECTRICAL	DATE FEBRUARY 2024
SCHEDULES - 1	PROJECT NO. 21-064 DRAWING NO. E-040
	SHEET NO. 23
PLOT DATE: 2/14/2024 PL	OT TIME: 3:42:39 PM





KEY NOTES:

 $\widehat{1}$

< 3 >

SEE DEMOLITION REQUIREMENTS OF EXISTING GENERATOR AND PAD ON DRAWINGS D-101 AND D-302 PRIOR TO BEGINNING NEW CONSTRUCTION.

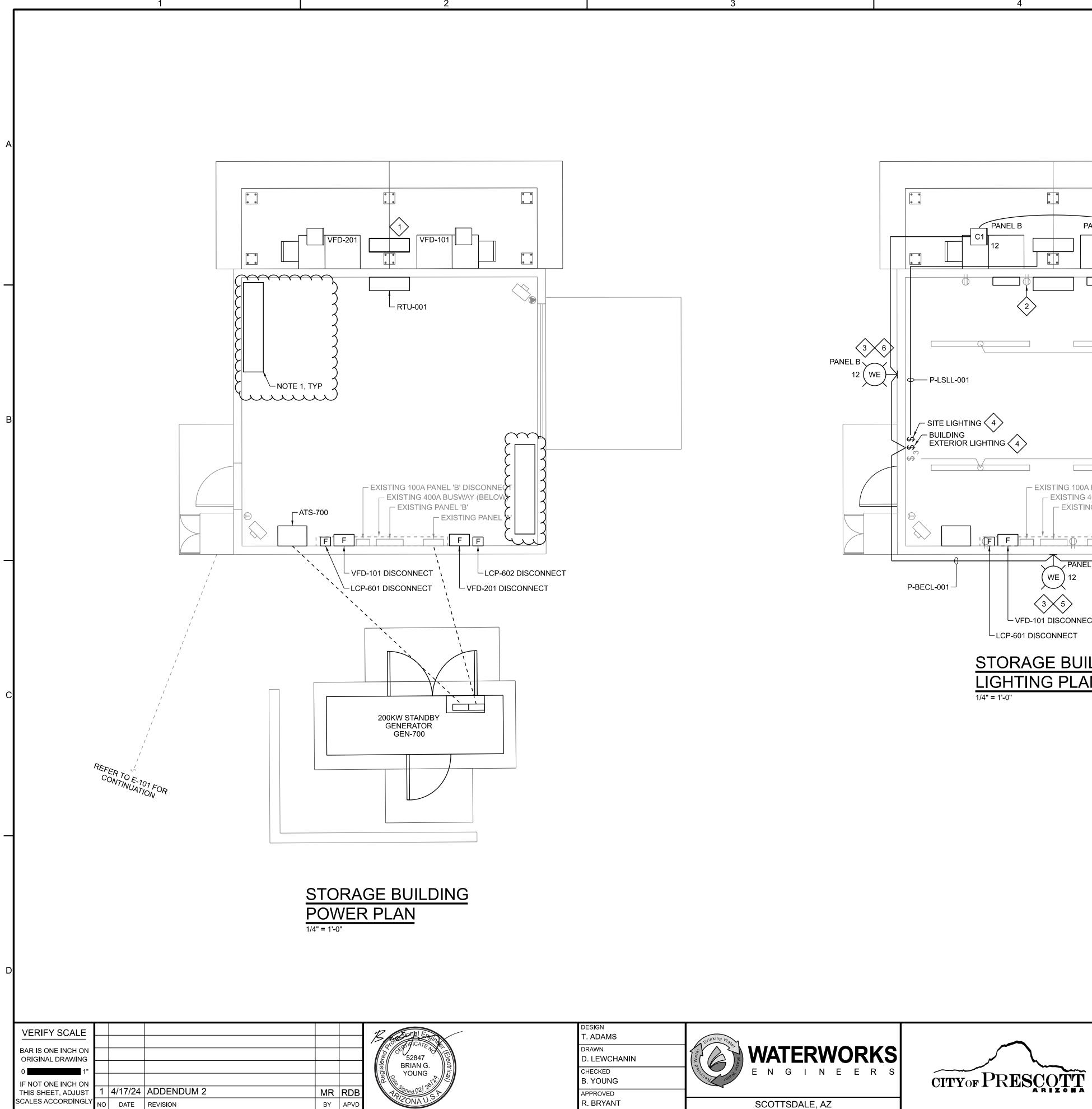
PROVIDE CONCRETE CAP OVER DIRECT BURIED CONDUIT AT ROADWAY CROSSINGS.

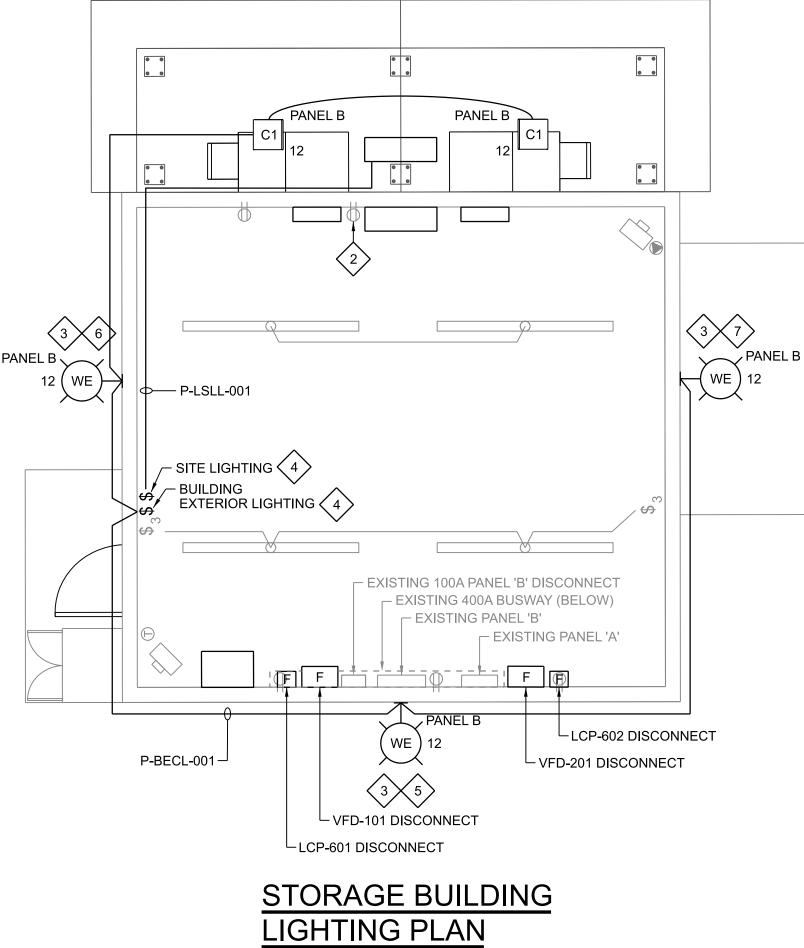
CONTRACTOR SHALL PROVIDE AND INSTALL NEW 20 FT. RADIO ANTENNA POLE. REFER TO DETAIL 16500P FOR ADDITIONAL REQUIREMENTS. MOUNTING OF YAGI ANTENNA, ROUTING AND TERMINATION OF ANTENNA WIRE AND AIMING OF THE YAGI ANTENNA WILL BE THE RESPONSIBILITY OF RIPPLE INDUSTRIES.

REFER TO E-301 DETAILS FOR ADDITIONAL REQUIREMENTS. (4)

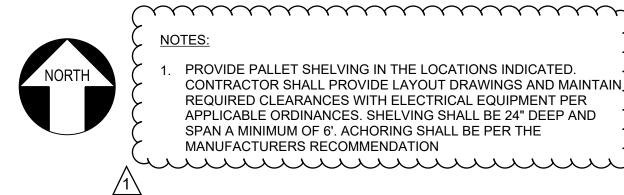
 $\langle 5 \rangle$ 'FREE EXIT' DETECTION LOOP, LEAD-IN CABLE. CONTRACTOR SHALL INSTALL LEAD-IN CABLE CONDUCTORS WITH A MINIMUM OF 10 TWISTS PER FOOT OF RUN LENGTH BETWEEN SPLICE BOX AND DRIVE UNIT CONTROLLER TERMINATION.

10 0 10 SCALE 1"-10'	20 FEET
ELECTRICAL	DATE FEBRUARY 2024
SITE PLAN	PROJECT NO. 21-064 DRAWING NO. E-101
	SHEET NO. 24
PLOT DATE: 2/14/2024 PLC	DT TIME: 3:43:30 PM





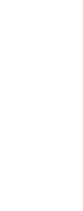
YAVAPAI HILLS LIFT STATION

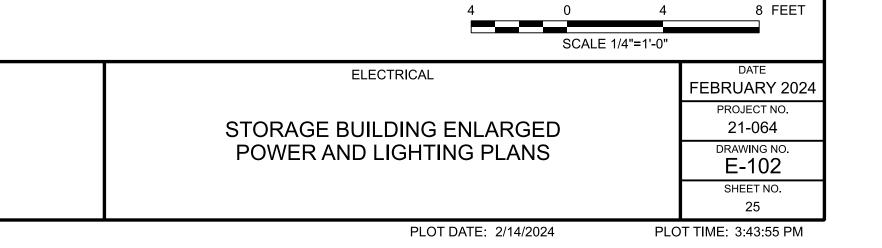


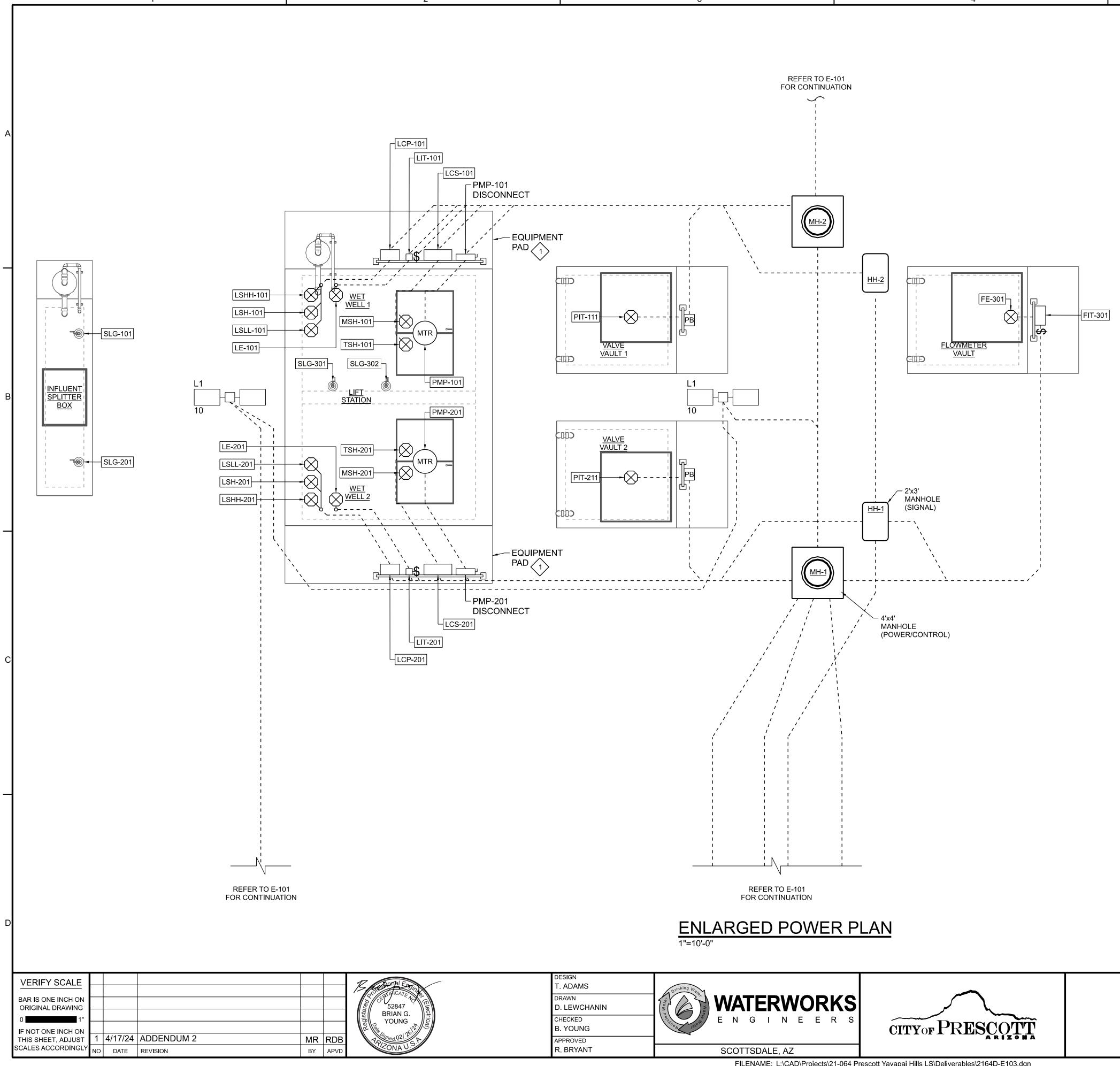
NOTES:									
	1								
1. PROVIDE PALLET SHELVING IN THE LOCATIONS INDICATED.	3								
CONTRACTOR SHALL PROVIDE LAYOUT DRAWINGS AND MAINTAIN	え								
REQUIRED CLEARANCES WITH ELECTRICAL EQUIPMENT PER	2								
APPLICABLE ORDINANCES. SHELVING SHALL BE 24" DEEP AND)								
SPAN A MINIMUM OF 6'. ACHORING SHALL BE PER THE)								
MANUFACTURERS RECOMMENDATION	1								
	\mathcal{I}								

KEY NOTES:

- PROVIDE NEMA 3R WIREWAY MOUNTED ABOVE VFD ENCLOSURES FOR ROUTING OF POWER, CONTROL AND SIGNAL $\langle 1 \rangle$ CABLE AND WIRES (P/C & S).
- 2 RELOCATED EXISTING RECEPTACLE. REFER TO DEMOLITION NOTE D7 ON DRAWING ED-002 FOR REQUIREMENTS PRIOR TO BEGINNING NEW WORK IN THIS AREA. SEE ALSO DEMOLITION NOTE D8.
- PROVIDE UN-SWITCHED HOT LEG BACK TO SOURCE FOR FIXTURE'S EMERGENCY DRIVER.
- (4) PROVIDE HEAVY-DUTY, 120/277V SWITCH.
- 5 MOUNT FIXTURE CENTERED ON WALL @ 9'-8 1/2" A.F.F..
- 6 MOUNT FIXTURE CENTERED ON WALL @ 7'-4 1/2" A.F.G.
- MOUNT FIXTURE CENTERED @ 4 1/2" OVER GARAGE DOOR ROUGH OPENING.





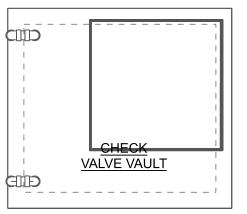


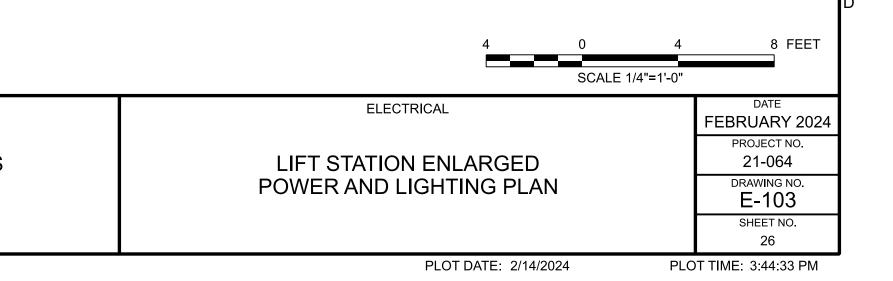


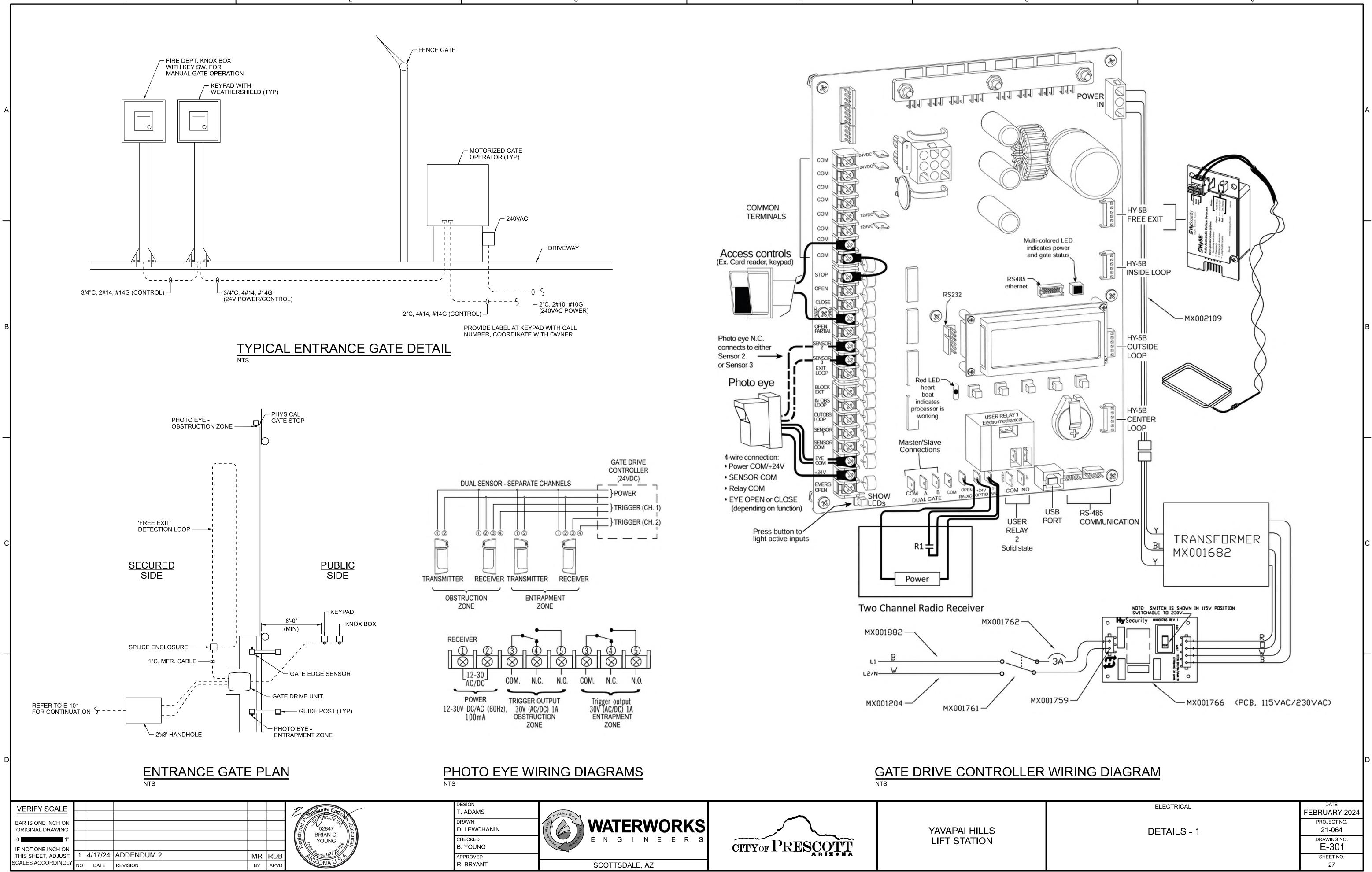
YAVAPAI HILLS LIFT STATION

KEY NOTES:

(1) PROVIDE A SUN SHADE OVER EQUIPMENT PANELS.







PLOT TIME: 3:45:04 PM

		1		2	
	PROCESS	<u>S LINES</u>		PROCESS S	SYMBOLS
	LINE WEIGHT, COLOR & LINE TYPE	DESCRIPTION:		SYMBOL	DESCRIPTION:
		PRIMARY PROCESS LINE		ζ	SIGNAL LINE BREAK
		PRIMARY PROCESS LINE (DEMO)		8	PROCESS LINE BREAK
A		PRIMARY PROCESS LINE (FUTURI	Ξ)	()	
		PRIMARY PROCESS LINE (VENDO	R SUPPLIED)		SECONDARILY CONTAINE
		PRIMARY PROCESS LINE (EXIST)			BOX INDICATING FUNCTION OR EQUIPMENT THAT REP
		SECONDARY PROCESS LINE			ARROW INDICATES DIREC
		SECONDARY PROCESS LINE (DEM	<i>1</i> O)	>	ARROW INDICATES DIREC
		SECONDARY PROCESS LINE (FUT	URE)		SIGNAL CONNECTION PO
		SECONDARY PROCESS LINE (VEN SUPPLIED)	IDOR		PROCESS LINES CROSSI
		SECONDARY PROCESS LINE (EXI	ST)	─	(NOT CONNECTED)
		AUXILIARY / TERTIARY PROCESS	LINE		PROCESS LINES CROSSI
		AUXILIARY / TERTIARY PROCESS			(CONNECTED)
В		AUXILIARY / TERTIARY PROCESS (FUTURE)		— ##-??-### A	PROCESS GOING TO ANO LETTERS)
U		AUXILIARY / TERTIARY PROCESS (VENDOR SUPPLIED)	LINE	В ##-??-###	PROCESS LINE FROM ANG (MATCH LETTERS)
		AUXILIARY / TERTIARY PROCESS	LINE (EXIST)		SIGNAL GOING TO ANOTH
	+	HEAT TRACE		###-??-### <u>1</u>	(MATCH NUMBERS) SIGNAL LINE FROM ANOT
				2 ##-??-###	(MATCH NUMBERS)
		INSTRUMENT SUPPLY / CONNECT PROCESS	ION TO		PROCESS LINE CONTINUI OUTSIDE SCOPE OF DRA
	— X — X —	CAPILLARY SIGNAL			ANALOG SIGNAL IN
		ELECTRICAL SIGNAL		▼	ANALOG SIGNAL OUT
		CAT 5E ETHERNET SIGNAL		•	
				\bigtriangleup	DISCRETE SIGNAL IN
С		FIBER OPTIC SIGNAL		\bigtriangledown	DISCRETE SIGNAL OUT
U	- L L L L L L	HYDRAULIC SIGNAL			PULSED SIGNAL IN
	<u> </u>	MECHANICAL LINK SIGNAL			FLOAT SWITCH
	- 	PNEUMATIC SIGNAL			LIQUID LEVEL / SURFACE
	00	SOFTWARE SIGNAL		(SPEC) (SPEC)	
					PIPE SPEC CHANGE
				###V \succ OR \prec ###V	INSTRUMENT POWER SU
					RADIO ANTENNA
D					
					DESIGN
	VERIFY SCALE BAR IS ONE INCH ON ORIGINAL DRAWING			Souther States and Sta	T. ADAM DRAWN D. LEWC
		- 1			

		BRIAN G. YOUNG
MR	RDB	70 gned 02 20 F
BY	APVD	CONA U.S

1 4/17/24 ADDENDUM 2

NO DATE REVISION

IF NOT ONE INCH ON THIS SHEET, ADJUST

SCALES ACCORDINGLY

UPPLY INSTRUMENT IDENTIFICATION SUCCEEDING LETTER(S) -(REFER TO TABLE FIRST LETTER(S) SYSTEM I/O INTERFACE. ABOVE RIGHT) DIRECTION OF FLOW / FIT ΗÓΑ INDICATES WHETHER 08101B FIT ZS IT IS INPUT OR OUTPUT 40220 '08201B' INSTRUMENT ID DUPLICATE LETTERS, TAG NUMBERS, (ISA STANDARD) - INSTRUMENT -ABBREVIATIONS & OTHER ANNOTATIONS ARE SIMILAR TO THE ABOVE INSTRUMENT FIT 80 101 R IDENTIFICATION. PROCESS AREA IDENTIFIER WATERWORKS YAVAPAI HILLS CHANIN ENGINEERS CITYOF PRESCOTT CHECKED LIFT STATION B. YOUNG APPROVED R. BRYANT SCOTTSDALE, AZ

3	4

		ISA INSTRUMENT SYMBOLS & IDENTIFICATION					
		FIRST	LETTERS	SUCCEEDING LETTERS			
		MEASURE / INITIATING VARIABLE	VARIABLE MODIFIER	READOUT / PASSIVE FUNCTION	OUTPUT / ACTIVE FUNCTION	FUNCTION MODIFIER	
	A	ANALYSIS		ALARM			
	В	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE	
	С	USER'S CHOICE			CONTROL	CLOSE	
	D	USER'S CHOICE	DIFFERENCE, DIFFERENTIAL			DEVIATION	
	E	VOLTAGE		SENSOR, PRIMARY ELEMENT			
	F	FLOW, FLOW RATE	RATIO				
S	G	USER'S CHOICE		GLASS, GAUGE, VIEWING DEVICE			
	н	HAND				HIGH	
	1	CURRENT		INDICATE			
	J	POWER		SCAN			
	к	TIME, SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION		
	L	LEVEL		LIGHT		LOW	
	M	USER'S CHOICE				MIDDLE, INTERMEDIATE	
	N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE	
	0	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN	
	Р	PRESSURE		POINT (TEST CONNECTION)			
	Q	QUANTITY	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE			
	R	RADIATION		RECORD		RUN	
	S	SPEED, FREQUENCY	SAFETY		SWITCH	STOP	
	т	TEMPERATURE			TRANSMIT		
	U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION		
МАТСН	v	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER		
	w	WEIGHT, FORCE		WELL, PROBE			
Т	x	UNCLASSIFIED	X-AXIS	ACCESSORY DEVICE, UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	
	Y	EVENT, STATE, PRESENCE	Y-AXIS		AUXILIARY DEVICES		
	z	POSITION, DIMENSION	Z-AXIS, SAFETY INSTRUMENTED SYSTEM		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT		

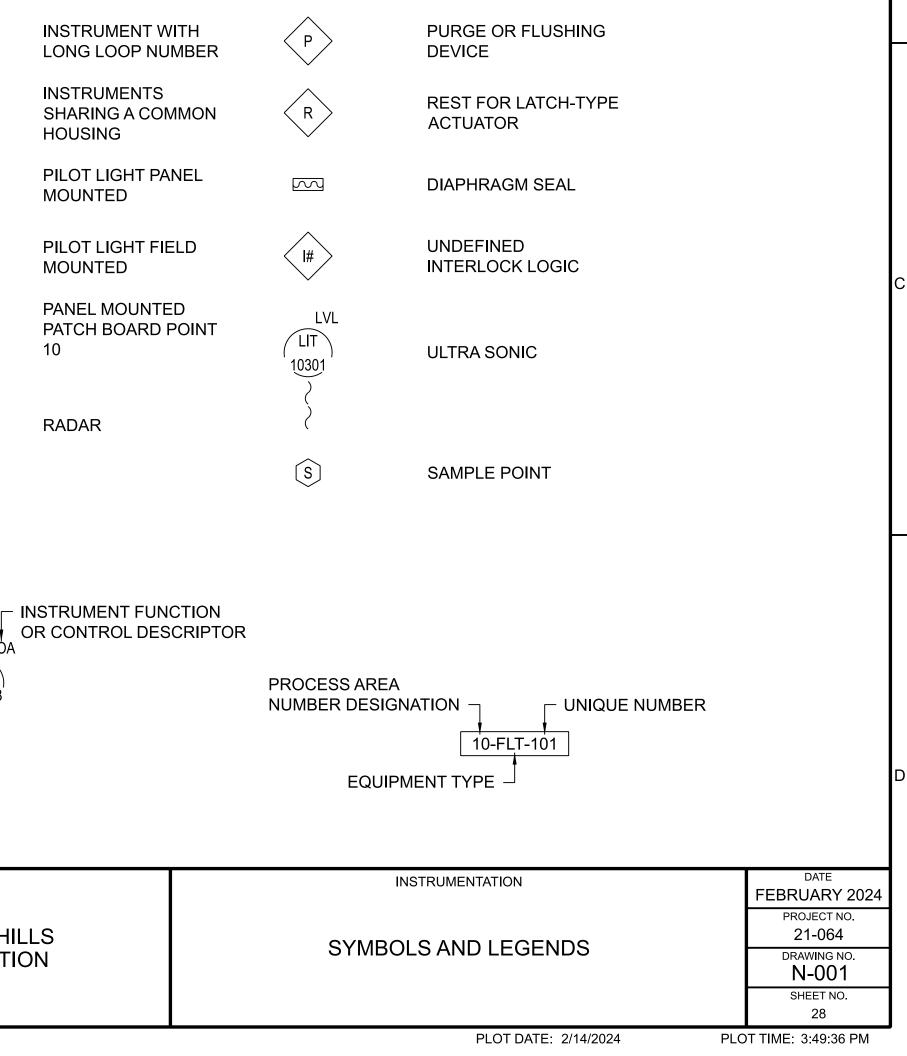
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JED AWINGS

GENERAL INSTRUMENT & DIGITAL INTERFACE SYMBOLS

GENERAL INS	INUMENTA		ERFACE ST	IVIDULS	S/S	
	FIELD MOUNTED INSTRUMENT	PANEL MOUNTED INSTRUMENT	MCC MOUNTED INSTRUMENT	INACCESSIBLE INSTRUMENT	(PIT) 40101	INSTRU LONG
DISCRETE INSTRUMENTS	(XXX) ###	XXX ###	XXX ###	XXX ###	PI PIT 38101 38101 ALM YL	INSTRU SHARII HOUSII PILOT I
SHARED DISPLAY SHARED CONTROL	XXX ###	XXX ###	XXX ###	XXX ###	,10101 ALM (YL) ,10101	PILOT I MOUN
COMPUTER FUNCTION	XXX ###	XXX ###	XXX ###	XXX ###	A 10	PANEL PATCH 10
PROGRAMMABLE LOGIC CONTROL	XXX ###	XXX ###	XXX ###	XXX ###	LVL (LIT) 510201	RADAR

INSTRUMENT TAG NUMBERING SYSTEM

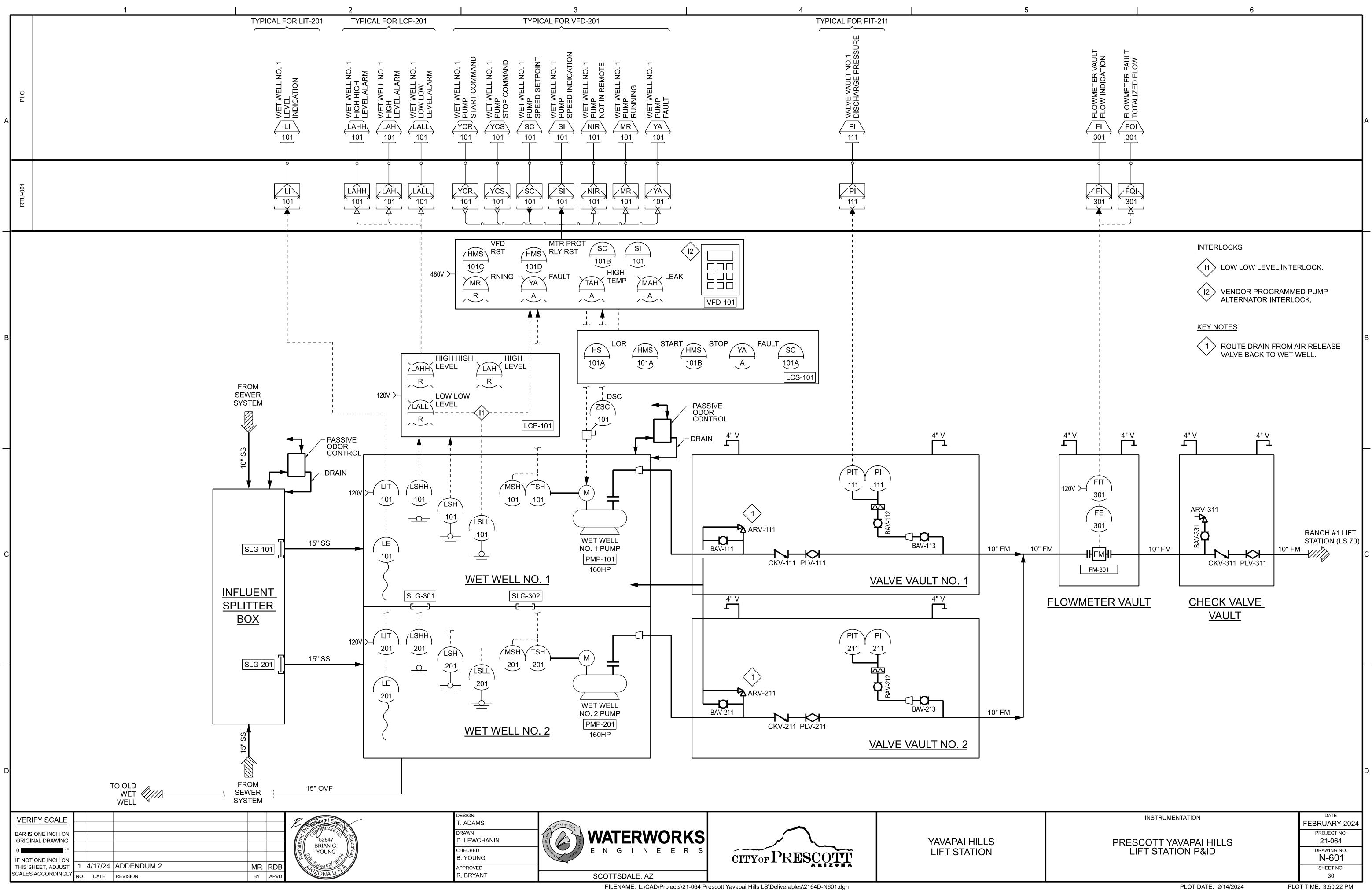


PROCES	S VALVES	PROCESS V	/ALVES (CONT.)	PROCESS FIT	TINGS & DEVICES	PROCESS EQU	IIPMENT (CONT.)	PROCESS EQUI	IPMENT (CONT.)	PROCESS	EQUIPMENT
SYMBOL	DESCRIPTION:	SYMBOL	DESCRIPTION:	SYMBOL	DESCRIPTION:	SYMBOL	DESCRIPTION:	SYMBOL	DESCRIPTION:	SYMBOL	DESCRIPTION:
ARV-###	AIR RELIEF VALVE		SILENT CHECK VALVE		BLIND FLANGE		- M	(M)	EQUIPMENT MOTOR		AIR INTAKE FILTER
AVV-###		СНК-###]	PIPE CAP						,
Y	AIR VACUUM VALVE	Снк-###	CHECK VALVE	ЮH	EXPANSION COUPLING		FINE SCREEN		HEAT EXCHANGER		AUTO STRAINER
BFP-###	BACKFLOW PREVENTER VALVE	Т Ц тv-###	TELESCOPING VALVE		FLEXIBLE COUPLING						BASKET STRAINER
$\nabla \hat{\uparrow}$	BACK PRESSURE REDUCING		SLIDE GATE / KNIFE GATE		DIAPHRAGM SEAL						
BPRV-###	VALVE			Y	DRAIN				BOILER		FILTER
<0 BCV-###	BALL CHECK VALVE		STOP LOG	$\langle \cdot \rangle$	GAUGE					FM	FLOW METER (MAGNET
	BALL VALVE NO = NORMALLY OPEN	$\left\langle \right\rangle$	WEIR		DOUBLE CONTAINMENT PIPE		DUMPSTER				
V-### BAV-### NO NC	NC = NORMALLY CLOSED	M			NOZZLE		BOWN STER		SAFETY SHOWER / EYEWASH STATION	(M)	MIXER
`•_ BFV-###	BUTTERFLY VALVE				DIFFUSER		EJECTOR			\frown	
⁄-### ∠	COMBINATION AIR RELIEF / AIR VACUUM VALVE	P			ORIFICE PLATE						AXIAL FLOW PUMP
ا ۲ ا	CORPORATION STOP VALVE	S		Г <u></u>	PILOT TUBE		CALIBRATION COLUMN			· · ·	
() CRP-###					PULSATION DAMPER	<u>f</u>			GRIT BASIN		BACK DRAFT DAMPER
DPB-###					QUICK CONNECTOR COUPLING WITH CAP						BAR RACK
<	DUAL DISK SWING CHECK		SS & DEVICES (CONT.)		QUICK CONNECTOR COUPLING		WASTE GAS BURNER				DATATION
СНК-###		SYMBOL	DESCRIPTION:		QUICK CONNECTOR COUPLING (FEMALE)						
СНК-###	DUCK BILL CHECK VALVE		SIGHT GLASS		QUICK CONNECTOR COUPLING (MALE)	一一一					COARSE SCREEN
✓ ► ✓ F ✓ GAV-###	GATE VALVE NO = NORMALLY OPEN NC = NORMALLY CLOSED		SILENCER		REDUCER, CONCENTRIC		INJECTION QUILL		GRIT CLASSIFIER WITH CONCENTRATOR		
NO NC		IH2XXX_HI	STATIC MIXER		REDUCER, ECCENTRIC						
	GLOBE VALVE NO = NORMALLY OPEN	\sim	SONIC FLOW ELEMENT	FI			PROGRESSIVE CAVITY PUMP		COARSE GRIT SCREEN		
/-### GLV-### NO NC	NC = NORMALLY CLOSED		SPRAY BAR	FI	ROTAMETER WITH NEEDLE VALVE	M =					
• MV-###	MUD VALVE	Б	TARGET TYPE FLOW				SUBMERSIBLE PUMP	<u> </u>			
, MPV-###			ELEMENT TOTALIZING ELEMENT:				CENTRIFUGAL PUMP		VERTICAL TURBINE PUMP		
	MULTI-PORT VALVE(S)	\bigcirc	POSITIVE DISPLACEMENT FLOW								
NV-###	NEEDLE VALVE	8	TURBINE / PROPELLER FLOW ELEMENT				METERING PUMP				
	PINCH VALVE		UNION				PERISTALTIC PUMP	邕			
PV-###	PLUG VALVE NO = NORMALLY OPEN	\bigvee	VENT								
→	NO = NORMALLY OPEN NC = NORMALLY CLOSED		VENTURI TUBE				CENTRIFUGAL BLOWER				
/-### \$	PRESSURE RELIEF VALVE										
× ×	PRESSURE REGULATING VALVE		Y-STRAINER			$\left(\circ \right)^{r}$	BLOWER FAN				
PRV-###	VALVE RUPTURE DISK (PRESSURE		CLEAN OUT			\bigcirc	COMPRESSOR POSITIVE DISPLACEMENT				
☑ RDV-###	RELEASE)										
∑RDV-###	RUPTURE DISK (VACUUM RELEASE)										
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_ DRAWING		မ်ိဳး BRIA	UNG II	D. LEWCHANIN CHECKED	E N G I N E E R			YAVAPAI HILLS LIFT STATION	SYMBOL	S AND ABBREVIATION	NS 21-0
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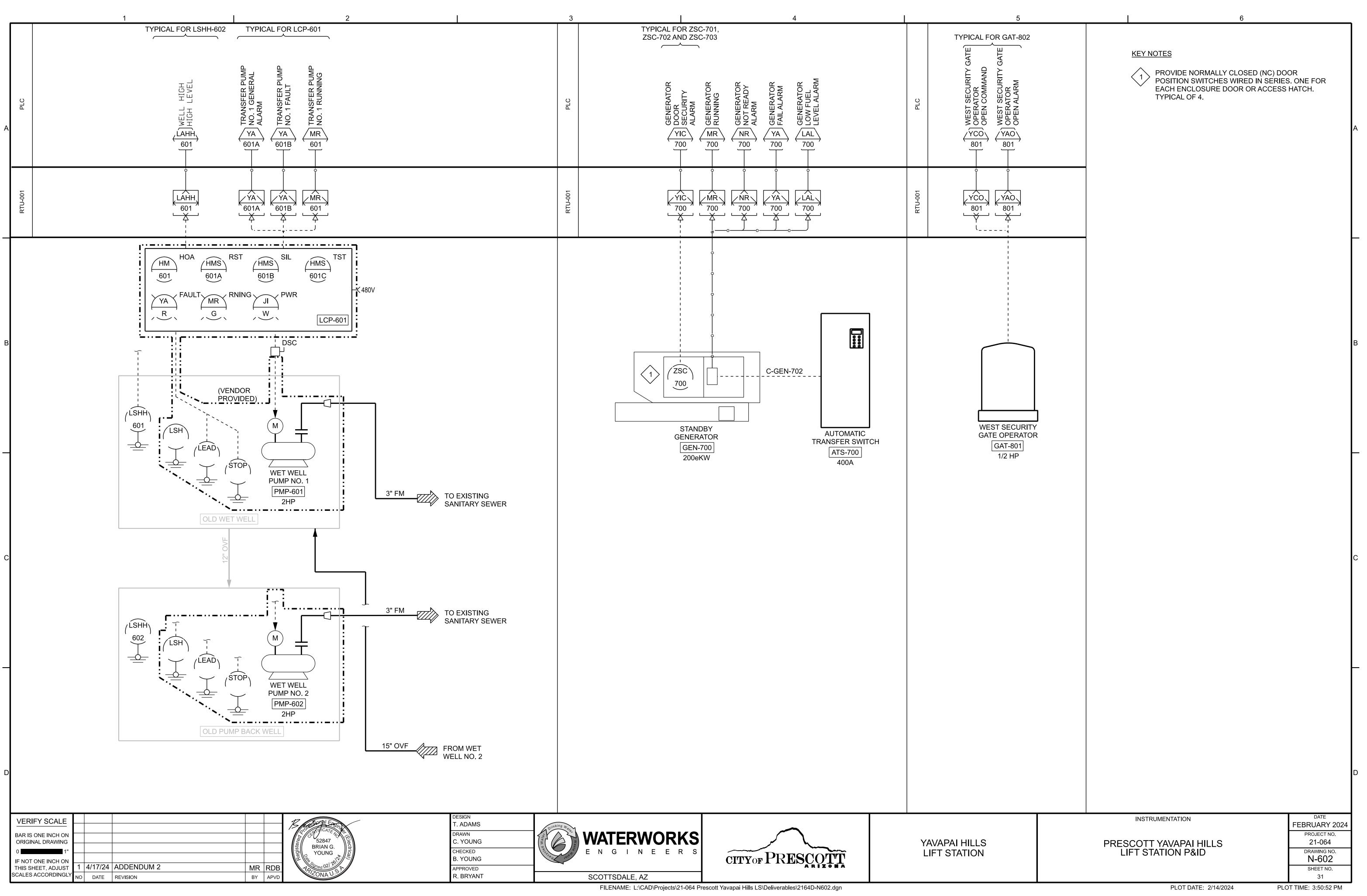


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CITY OF PRESCOTT, YAVAPAI HILLS LIFT STATION # 1 TECHNICAL SPECIFICATIONS

FOR CONSTRUCTION ADDENDUM 2 VOLUME 2 OF 4



April 2024

PREPARED BY: WATER WORKS ENGINEERS, LLC. 7500 N. Dobson Road #200 Scottsdale, AZ 85256 (480) 661-1742



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SUMMARY OF WORK

PART 1 - GENERAL

1.1 LOCATION AND DESCRIPTION OF WORK

- A. The Work covers the demolition, new construction and rehabilitation of portions of the Yavapai Hills Lift Station #1 and performing related required work, located as shown on these Drawings and Specifications.
- B. The Work is located at Yavapai Hills Lift Station, 5101 Cactus Place, Prescott, Arizona 86301.
- C. The Work will be constructed under one contract. The Contract Documents include the following:
 - 1. Volume 1 Drawings
 - 2. Volume 2 Technical Specifications
 - 3. Volume 3 Standard Details
 - 4. Volume 4 Technical Memorandum
- D. Interference with work on utilities:
 - 1. 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.
 - 2. The CONTRACTOR shall schedule the work so as to minimize interference with said relocation, altering, or other rearranging of facilities.
- E. Responsibility for Damage:
 - 1. The CONTRACTOR shall not be responsible for damage done by CONTRACTORs not under their jurisdiction.
 - 2. The CONTRACTOR will not be liable for any such loss or damage, unless it is through the negligence of the CONTRACTOR.

1.2 WORK BY OTHERS

- A. OWNER will perform the following work:
 - 1. Operation of all existing system valves and equipment, unless specified otherwise.

1.3 SITE CONDITIONS

- A. Site Investigation and Representation
 - 1. The CONTRACTOR acknowledges that it has satisfied itself as to the nature and location of the work, the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, tide stages, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during the

City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 01110-1

prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this Contract.

- 2. The CONTRACTOR further acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information derived from exploratory work that may have been done by the OWNER or included in these Contract Documents. Any failure by the CONTRACTOR to become acquainted with all the available information will not relieve the CONTRACTOR from responsibility for properly estimating the difficulty or cost of successfully performing the work.
- 3. Field Verification:
 - a. Before undertaking each part of the work, the CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements.
 - b. As the work proceeds, the CONTRACTOR shall field verify the depth and location of all buried utilities, and existing systems, and location of hazardous waste and contaminants.
 - c. The CONTRACTOR shall promptly report in writing to the ENGINEER any conflict, error, or discrepancy which the CONTRACTOR may discover and shall obtain a written interpretation or clarification from the ENGINEER before proceeding with any work affected thereby.
- B. Existing Utilities and Improvements
 - 1. Location of Underground Utilities:
 - a. Known existing underground conduits, pipelines and other utilities have been shown on the contract drawings in their approximate locations (within 3 feet of actual location). However, the accuracy or completeness of utilities indicated on the drawings is not guaranteed.
 - b. It shall be the responsibility of the CONTRACTOR to determine the exact location of all utilities and their service connections.
 - c. All potholing or other procedures for verifying utility location shall be performed by the CONTRACTOR as necessary to prepare for excavation at least 4 working days in advance of scheduled excavation.
 - d. The CONTRACTOR shall immediately notify the ENGINEER as to any utility located by him which has been incorrectly shown or omitted from the drawings.
 - e. If the CONTRACTOR cannot locate an underground utility whose presence is indicated on the Drawings, the ENGINEER shall be notified in writing.
 - f. The CONTRACTOR shall ascertain the exact locations of underground utilities whose presence is indicated on the Drawings, the locations of their service laterals work and of service laterals or appurtenances of any other underground utilities which can be inferred from the presence of visible facilities such as buildings, meters and junction boxes prior to doing work that may damage such utilities or interfere with their service.
 - g. Utilities Not Shown on Drawings:
 - 1) Attention is directed to the possible existence of underground utilities not indicated on the Drawings and to the possibility that underground utilities may be in a location different from that indicated on the Drawings.
 - 2) If the ENGINEER determines that the underground utility for which such notice has been given has not been depicted on the Drawings with reasonable accuracy (within 3 feet of actual location), the additional cost incurred in locating the utility will be paid for as extra work as provided in the General Conditions.

- 3) If the CONTRACTOR discovers underground an utility not indicated on the Drawings, the CONTRACTOR shall immediately give the ENGINEER and the Utility Company written notification of the existence of such utility.
- 4) Such utilities shall be located and protected from damages as directed by the ENGINEER and the cost of such work will be paid for as extra work as provided in the General Conditions.
- 2. Utility Coordination:
 - a. The CONTRACTOR shall notify Arizona 811 at least 2 working days prior to excavation, telephone (602) 659-7500.
 - b. The CONTRACTOR shall also contact all utility owners not registered with Arizona 811 but known to have utilities in the project area to field locate underground utilities at least 4 days prior to excavation.
 - c. The CONTRACTOR shall notify all owners of utilities when the Work is in progress and shall make arrangements as are necessary to make any emergency repairs.
 - d. Existing utilities that are shown or that are made known and located to the CONTRACTOR prior to excavation, and that are to be retained; and all utilities that are constructed during excavation operations shall be properly supported and protected from damage during the progress of the work.
- 3. Utility Protection and Damage:
 - a. Existing utilities that are shown or that are made known and located to the CONTRACTOR prior to excavation, and that are to be retained, and all utilities that are constructed during excavation operations shall be properly supported and protected from damage during the progress of the work.
 - b. Should any damage to a utility occur during the progress of the work, the CONTRACTOR shall notify the OWNER or the utility at once and render all assistance possible to repair the damage and restore the service.
 - c. No extra compensation will be made for the repair of any services or utility damaged by the CONTRACTOR nor for any damage incurred through neglect or failure to provide adequate protection to existing utilities.
 - d. The provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.
 - e. Damaged water pipelines will be repaired by the OWNER at the CONTRACTOR's expense. If the CONTRACTOR fails to pay the cost of repairs to water pipelines within thirty days of receipt of the invoice, the OWNER reserves the right to withhold the amount owed from the CONTRACTOR's Progress Payment.
 - f. Damage Report:
 - 1) In the event that the CONTRACTOR damages any underground utilities not shown on the Drawings or not depicted on the Drawings with reasonable accuracy (within 3 feet of actual location) or any lateral service the location of which could not be inferred by the CONTRACTOR, a written report thereof shall be made immediately to the ENGINEER.
 - 2) The CONTRACTOR's report shall also advise the ENGINEER of any schedule delays. Compensation for such delays will be determined in accordance with the General Conditions. The CONTRACTOR shall be entitled to no other compensation for any such damage.
- 4. All utilities encountered along the line of the work shall remain continuously in service during all work under the Contract, unless otherwise shown on the drawings, or unless other arrangements satisfactory to the ENGINEER are made with the owner of said utilities.
- C. CONTRACTOR's Responsibility for Utility Facilities and Service

- 1. Where the CONTRACTOR's operations could cause damage or inconvenience to railway, telephone, television, power, oil, gas, water, sewer, or irrigation systems, the CONTRACTOR shall make all arrangements necessary for the protection of these utilities and services.
- 2. The CONTRACTOR shall be solely and directly responsible to the owner and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage which may result from the construction operations under this Contract.
- 3. Neither the OWNER nor its officers or agents shall be responsible to the CONTRACTOR for damages as a result of the CONTRACTOR's failure to protect utilities encountered in the work.
- 4. In no event shall interruption of any utility service be allowed outside working hours unless granted by the owner of the utility.
- 5. No sand, mud, rocks or other construction debris shall be disposed of in the sanitary sewers or storm sewers.
- 6. Where bypassing of sewage is required to perform sewer repairs or service relocations and where temporary pumps are required to bypass any sewage across traffic lanes, the discharge lines crossing the traffic lanes shall be buried a minimum of 4 inches below the pavement surface and backfilled with temporary asphalt concrete surfacing. The CONTRACTOR shall take all necessary steps to assure continuous flow of sewage. Bypassing of untreated wastewater to surface waters or courses will not be permitted.
- 7. The CONTRACTOR shall replace, at its own expense, any and all existing utilities or structures removed or damaged during construction, to their existing condition unless otherwise provided for in these Contract Documents.
- 8. The CONTRACTOR shall repair or replace, at its own expense, all pavement damaged during the construction, to its existing condition unless otherwise provided for in these Contract Documents.
- D. Names of Known Utilities Serving the Area
 - 1. The following is a list of the known public utilities serving the area:
 - a. Sewer City of Prescott
 - b. Telecommunications Century Link, Sparklight
 - c. Electric Arizona Public Service
 - d. Gas UniSource Energy Solutions
- E. Railroads
 - 1. The CONTRACTOR shall not perform work or occupy any part of railroad property without a permit authorizing the same.
- F. Interfering Structures
 - 1. The CONTRACTOR shall take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Drawings. While the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid possible difficulties.
 - 2. The CONTRACTOR shall protect all existing structures, trees, shrubs, and other items on the project site that are to be preserved, by substantial barricades or other devices commensurate with the hazard, from injury or destruction by vehicles, equipment, workmen, or other agents.

- 3. Where existing fences, gates, buildings, or any other structure must be removed to properly carry out the work, or are damaged during the work, they shall be restored at the CONTRACTOR's expense to their original condition or better.
- 4. Without additional compensation, the CONTRACTOR may remove and replace in a condition as good as or better than original, any small structures such as fences, and signposts that interfere with the CONTRACTOR's operations.
- G. Field Relocation
 - 1. During the progress of construction, it is expected that minor relocations of the work will be necessary.
 - 2. Such relocations shall be made only by direction of the ENGINEER.
 - 3. If existing structures are encountered that will prevent construction as shown, notify the ENGINEER before continuing with the work in order that the ENGINEER may make such field revisions as necessary to avoid conflict with the existing structures.
 - 4. If the CONTRACTOR shall fail to notify the ENGINEER when an existing structure is encountered, and shall proceed with the work despite this interference, CONTACTOR shall do so at their own risk.
 - 5. Any CONTRACTOR request(s) for additional compensation or contract time resulting from necessary field relocations will be considered as set forth in the General Conditions.
 - 6. If the CONTRACTOR fails to notify the ENGINEER when a structure which interferes with construction is encountered, and proceeds with the work despite this obstruction, the CONTRACTOR shall do so at their own risk and at no additional cost to the OWNER.

1.4 REFERENCE POINTS AND SURVEYS

- A. Location and elevation of benchmarks are shown on Drawings.
- B. Dimensions for lines and elevations for grades of structures, appurtenances, and utilities are indicated on Drawings, together with other pertinent information required for laying out Work. If conditions vary from those indicated, notify OWNER immediately, who will make minor adjustments required.
- C. OWNER may perform checks to verify accuracy of CONTRACTOR's layout Work and that completed Work complies with Contract Documents.
- D. Any existing survey points or other control markers destroyed without proper authorization will be replaced by owner of the survey points or control markers at CONTRACTOR's expense.
- E. CONTRACTOR's Responsibilities:
 - 1. Provide all survey and layout required.
 - 2. Locate and protect reference points prior to starting site preparation.
 - 3. Notify OWNER at least 3 working days in advance of time when grade and line to be provided by others will be needed.
 - 4. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
 - 5. In event of discrepancy in data provided by OWNER, request clarification before proceeding with Work.
 - 6. Provide cut sheets for all staking.

- 7. Preserve and leave undisturbed control staking until ENGINEER has completed checks it deems necessary.
- 8. Re-establish reference points resulting from destruction by CONTRACTOR's operations.
- 9. Cooperate with ENGINEER so that checking and measuring may be accomplished with least interference to CONTRACTOR's operations.

1.5 SEQUENCE AND PROGRESS OF WORK

- A. The CONTRACTOR shall submit a Construction Schedule covering the entire Work in accordance with Section 01320, Progress Schedule.
- B. The CONTRACTOR shall incorporate the requirements of Section 01130, Special Project Constraints, into the Construction Schedule.
- C. Alternate Sequence:
 - 1. The CONTRACTOR's schedule may use a different sequence from that shown or specified, if techniques and methods known to the CONTRACTOR will result in cost and time savings to the OWNER, still achieve the required objective and maintain the same or greater level of treatment.
 - 2. The ENGINEER's determination on the acceptability of any alternative sequence from that shown or specified shall be final.

1.6 CONTRACTOR'S USE OF PREMISES

- A. Restriction of Work Area:
 - 1. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to the CONTRACTOR.
 - 2. The CONTRACTOR must operate entirely within the space allowed to the CONTRACTOR.
 - 3. The Drawings defines the area allocated to the CONTRACTOR.
- B. The CONTRACTOR shall be solely responsible for obtaining and paying all costs in connection with any additional work area, storage sites, access to the site or temporary right-of-way, which may be required for proper completion of the Work.
- C. Limitations on Use of Work Area:
 - 1. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of the CONTRACTOR and that no claim shall be made against the OWNER or their authorized representatives by reason of any act.
 - 2. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct the CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same.
 - 3. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, unless the ENGINEER has agreed to the location contemplated by the CONTRACTOR to be used for storage.
 - 4. All stored materials shall be labeled according to the appropriate contractor or Subcontractor with the manufacturer's label as well.
 - 5. Appropriate material safety data sheets (e.g., MSDS) shall be provided.

D. The CONTRACTOR shall be required to share use of the premises with other Contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

1.7 USE OF OWNER'S FACILITIES

- A. The CONTRACTOR may use existing facilities or equipment in the Work for construction purposes, only if the OWNER's written permission is obtained.
- B. Restore existing facilities and equipment used for temporary purposes to original condition in a manner satisfactory to OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

++ END OF SECTION ++

SPECIAL PROJECT CONSTRAINTS

PART 1 - GENERAL

1.1 LIMIT OF CONSTRUCTION ACTIVITIES ON WORK SITE

- A. Traffic Control:
 - 1. During non-work hours, the CONTRACTOR shall keep all lanes of traffic open and clear. All trenches shall be backfilled or covered with suitable steel plates and open to traffic.
 - 2. No equipment, construction material or excavated material that will interfere with traffic shall be stored on streets or roadways at any time.

1.2 SEQUENCE OF WORK

- A. General:
 - 1. The CONTRACTOR shall schedule and sequence their work in order to complete the Work by the specified completion date.
 - 2. The OWNER's wastewater collection system must remain operational at all times.
 - 3. Re-vegetation of graded areas shall take place as quickly as possible as weather permits.
- B. Delivery of OWNER-Furnished Equipment:
 - 1. The OWNER-furnished equipment is currently onsite within the South Wet Well. The CONTRACTOR shall be prepared to inspect, remove and store the equipment during that period, in accordance with the requirements of Section 01630, Owner-Furnished Equipment.
 - a. Existing Submersible Pump: Flygt NP 3315 HT 3 ~ 453

1.3 PROJECT CONSTRAINTS

- A. Maintenance of OWNER's Operations:
 - 1. Constraints listed herein involve limits on activities during construction. These limits relate to the critical nature of the existing water system.
 - Continuous operation of OWNER's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
 - 3. Work Plan:
 - a. The CONTRACTOR shall submit a detailed Work Plan and time schedule for all construction activities that will make it necessary to remove a tank, pipeline, electrical circuit, equipment, structure, road or other facilities from service, including the critical outages identified herein.
 - b. The Work Plan shall, at a minimum, identifying:
 - 1) the date and time when each activity will occur;
 - 2) what equipment will be present including standby equipment;
 - 3) what assistance will be required by OWNER's operating personnel;
 - 4) an emergency backup plan identifying what action will be taken if Work cannot be completed within the allotted time; and
 - 5) what individual will be in charge of the activity.

City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 01130-1

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- c. Submit Work Plan 10 days prior to the scheduled activity.
- 4. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of OWNER's operations.
- 5. Shutdowns:
 - a. Coordinate proposed Work with OWNER and facility operations personnel before affecting unit shutdowns. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.
 - b. Under no circumstances shall the CONTRACTOR cease Work at the end of a normal working day or at the end of a working week if such actions may inadvertently cause a cessation of any facility operating process, in which case, remain onsite until necessary repairs are complete.
- 6. Do not close lines, open valves or gates, shut down equipment, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after approval of OWNER.
- 7. Do not proceed with Work affecting a facility's operation without obtaining OWNER's advance approval of the need for and duration of such Work.
- B. Relocation of Existing Facilities:
 - 1. During construction, it is expected that minor relocations of Work will be necessary.
 - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
 - 3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
 - 4. Perform relocations to minimize downtime of existing facilities.
 - 5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by OWNER.
- C. Overtime:
 - 1. Conduct Work outside regular working hours on prior written consent of OWNER to meet Project schedule and avoid undesirable conditions.
 - 2. All overtime Work by the CONTRACTOR necessary to conform to the requirements of this Section and related Sections shall be performed by the CONTRACTOR, at no cost to the OWNER and shall be performed in accordance with the General Conditions. The CONTRACTOR shall make no claims for extra compensation as a result thereof.

1.4 SCHEDULED SHUTDOWNS AND CONSTRUCTION SEQUENCING CONSTRAINTS

- A. Scheduled Shutdowns:
 - 1. The scheduled shutdowns during the period of the CONTRACTOR'S Work will be as shown in Table 01130-A
 - 2. All Work requiring the OWNER's facilities to be out-of-service shall be performed during the scheduled shutdowns shown.
 - 3. The OWNER's staff will continue to perform administrative, operation and maintenance functions during shutdowns.
- B. Critical work sequencing constraints are described in this paragraph. Work not specifically covered in this Section may, in general, be done anytime during the contract period.
- C. Key work sequencing constraints are as follows:
 - 1. Flow cannot be stopped.

- 2. Electrical outages should be minimized as necessary and shall occur during low flows.
- 3. See Drawings for sequencing.

TABLE 01130-A SCHEDULED SHUTDOWNS			
AREA/IT EMS	SHUT- DOWN	FACILITY	SUBSTANTIAL/ FINAL COMPLETION & CONSTRAINTS
Existing Generator	0.5 hr max primary and backup power outage	Power outage is necessary to disconnect the existing generator and ATS,	Coordinate sequencing and outage with OWNER. Make provisions for temporary backup generator to run single 160HP Flygt pump if longer outage is needed.
New Generator and ATS	0.5 hr max primary and backup power outage	Power outage is necessary to complete new ATS connections and connect the new generator.	Coordinate sequencing and outage with OWNER. Make provisions for temporary backup generator to run single 160HP Flygt pump if longer outage is needed.
Existing WWTP Structures	None	Plug/Cap existing overflow piping.	No constraint anticipated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

O&M MANUAL REVIEW CHECKLIST

SUBMITTAL NO.	UBMITTAL NO DATED DATED PEC. SECTION REVIEW DATE REVIEWER REVIEWER REVIEWER					
SUBJECT			R			
EQUIP. ITEM	SUI	PPLIEF	ξ			
	MA	NUFAC	TURER			
ACCEPTABLE	PROJECT TITLE:					
UNACCEPTABLE	PR	ОЈЕСТ	NO.	CIP <u>No. 2105-004</u>		
		ACC	EPTABL			
DISPOSITION	-	YES	NO	 NA	COMMENTS	
		• = •				
HARD-COPY 0&M MANUALS						
Minimum five (5) copies						
Three-ring binder with hard-back cover						
 Cover Label and Title Page: 	_					
Project title and Project number						
Specification section						
System/Equipment names						
Facility						
Equipment number	–					
Typed table of contents						
 Heavy section dividers w/numbered plastic index tab 	os.					
 Sections parallel equipment specifications 						
 Pages punched for 3 ring binder (punching does not obliterate data). 						
 Info larger than 8-1/2"x11" folded showing title bloc or included in binder pockets 	ж,					
 Multiple volumes labeled "Vol. 1", "Vol. 2", etc 						
 Table of contents for entire set in each binder 						
ELECTRONIC O&M MANUALS						
 Minimum one (1) copy delivered by sharepoint 						
Full version of O&M manual in PDF format						
 Separate text and drawing files used to create PDF O&M manual. 		<u> </u>				
TECHNICAL CONTENT						
 Diagrams and illustrations, including pump curves Detailed description of function of principal components 						
components						
Performance and nameplate data Installation instructions	–					
Installation instructions						
Starting procedure						
 Proper adjustment procedure 	···· _					

DISPOSITION	ACCEPTABLE?			
	YES	NO	NA	COMMENTS
Test procedures				
Operating procedure				
Shutdown instructions				
• Emergency operating instructions & troubleshooting				
Safety instructions				
Maintenance and overhaul instructions				
Lubrication instructions				
List of electrical relay settings and control and alarm contact settings				
Electrical interconnection wiring diagrams, including control and lighting systems				
Recommended spare parts and special tools				
 Project specific warranty statement 				

QUALITY CONTROL

PART 1 - GENERAL

1.1 OBSERVATION AND SUPERVISION

- A. The ENGINEER or ENGINEER's appointed representative will review the Work and the CONTRACTOR shall provide facilities and access to the Work at all times as required to facilitate this review.
- B. Responsibility:
 - 1. The CONTRACTOR shall be solely responsible to supervise and direct the entire Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to complete the Work in accordance with the Contract Documents.
 - 2. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, quality control, and procedures of construction and safety precautions and programs incidental thereto.
 - 3. The foregoing includes work performed by the CONTRACTOR's Subcontractors.
 - 4. The CONTRACTOR shall be responsible to see that the finished Work complies accurately with the Contract Documents.
- C. Superintendent:
 - 1. The CONTRACTOR shall designate in writing and keep on the work site at all times during its progress a technically qualified, English-speaking superintendent, who shall not be replaced without written acceptance of the ENGINEER.
 - 2. The superintendent shall be the CONTRACTOR's representative at the job site and shall have authority to act on behalf of the CONTRACTOR.
 - 3. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR.
 - 4. The CONTRACTOR's superintendent shall be present at the site of the Work at all times while work is in progress. Failure to observe this requirement shall be considered as suspension of the Work by the CONTRACTOR until such time as such superintendent is again present at the site.

1.2 RESPONSIBILITY

- A. The CONTRACTOR is responsible for conducting all testing and inspection specifically required by the Specifications and otherwise necessary to ensure compliance with the Contract Documents.
 - 1. Approval of Testing Laboratories:
 - a. All laboratory work under this contract shall be performed by a laboratory approved by the ENGINEER, whether the laboratory is employed by the CONTRACTOR, or is owned and operated by the CONTRACTOR.
 - b. The basis of approval includes the following:
 - 1) Testing laboratories performing work in connection with concrete, steel, and bituminous materials shall comply with ASTM E 329 and ASTM D 3666, respectively.

- 2) Testing laboratories performing work not in connection with concrete, steel, bituminous materials, soils and non-destructive testing shall comply with ASTM E 548.
- B. The ENGINEER may conduct periodic independent testing and inspection to verify compliance with the Contract Documents.
- C. Retesting:
 - 1. The OWNER reserves the right to back-charge the CONTRACTOR for retesting of deficient or defective work or products upon written notification.
 - 2. Compensation for retesting on behalf of the OWNER will be made through deductions from the Progress Payments.
- D. The CONTRACTOR is responsible for correcting all defective work discovered prior to final acceptance of the Contract, despite the failure of the Inspector(s) to discover it.

1.3 TESTS AND INSPECTIONS

- A. The CONTRACTOR shall be responsible for scheduling all inspections and tests required.
 - 1. The ENGINEER shall be given a minimum 48 business hours notice prior to any inspections or tests.
- B. The CONTRACTOR shall pay for all tests including, but not limited to:
 - 1. Inspections and tests necessary to comply with laws, ordinances, rules, regulations and orders of public authorities pursuant to General Conditions.
 - 2. Mix designs, including tests of trial batches, on concrete mixes.
 - 3. Tests of materials, inspections, and certifications required by the Specifications.
 - 4. Testing, adjusting, and balancing of equipment and systems required by the Specifications.
 - 5. One tension and elongation test for each 5 tons of steel or fractional part thereof for each size will be required, unless the steel can be identified by heat or melt numbers and is accompanied by mill analysis and test reports. Commercial stock may be used, subject to approval of the ENGINEER.
 - 6. Any testing performed by the CONTRACTOR for their own quality control (e.g., compaction tests).
 - 7. Retests or re-inspections by the OWNER, if required, and tests or inspections required due to CONTRACTOR error or lack of required identifications of material.
 - 8. Any and all water used by the CONTRACTOR in any testing.
- C. Two copies of the agency or laboratory report of each test or inspection shall be provided to the ENGINEER. All tests of materials shall be made in accordance with the commonly recognized standards of national technical organizations, and such other special methods and tests as are prescribed in the Contract Documents.
- D. Purchase Orders:
 - 1. One copy of each of the CONTRACTOR's purchase orders for materials forming a portion of the work shall be furnished to the ENGINEER, if requested.
 - 2. Each such purchase order shall contain a statement that the materials included in the order are subject to inspection by the OWNER.
 - 3. Materials purchased locally will be inspected at the point of manufacture or supply, and materials supplied from points more than 50 miles from the job site will be

inspected upon arrival at the job, except when other inspection requirements are provided for specific materials in other Sections of this Specification.

- E. Samples:
 - 1. The CONTRACTOR shall furnish samples of materials as are required by the ENGINEER, without charge.
 - 2. No material shall be used until the ENGINEER has had the opportunity to test or examine such materials.
 - 3. Samples will be secured and tested whenever necessary to determine the quality of the material.
 - 4. Samples and test specimens prepared at the job site, such as concrete test cylinders, shall be taken or prepared by the ENGINEER in the presence and with the assistance of the CONTRACTOR.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

PART 1 - GENERAL

1.1 STORAGE - GENERAL

A. The CONTRACTOR shall provide any temporary storage required for the protection of equipment and materials as recommended by manufacturers of such materials.

1.2 STORAGE BUILDINGS

- A. The CONTRACTOR shall erect or provide temporary storage buildings of the various sizes as required for the protection of mechanical and electrical equipment and materials as recommended by manufacturers of such equipment and materials.
- B. The buildings shall be provided with such environmental control systems that meet recommendations of manufacturers of all equipment and materials stored in the buildings.
- C. The buildings shall be of sufficient size and so arranged or partitioned to provide security for their contents and provide ready access for inspection and inventory.
- D. At or near the completion of the work, and as directed by the ENGINEER, the temporary storage buildings shall be dismantled, removed from the site, and remain the property of the CONTRACTOR.
- E. Combustible materials (paints, solvents, fuels, etc.) shall be safely stored and separated in accordance with the manufacturer's requirements and in compliance with hazardous material storage requirements. CONTRACTOR shall be responsible for providing proper storage buildings for combustible materials.

1.3 STORAGE YARDS

- A. The CONTRACTOR shall provide temporary storage yards as required for the storage of materials that are not subject to damage by weather conditions.
- B. Materials such as pipe, reinforcing and structural steel, shall be stored on pallets or racks, off the ground, and stored in a manner to allow ready access for inspection and inventory.
- C. Temporary gravel surfacing of the storage yards shall meet with the approval of the ENGINEER.

1.4 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, OWNER's operations, or construction operations.

1.5 VEHICULAR TRAFFIC

- A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.
- B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

1.6 DELIVERY-STORAGE-HANDLING

- A. General:
 - 1. The CONTRACTOR shall deliver, handle, and store materials and equipment in accordance with supplier's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft.
 - 2. Delivery schedules shall be controlled to minimize long-term storage at the site and overcrowding of construction spaces.
 - 3. In particular, the CONTRACTOR shall provide delivery/ installation coordination to ensure minimum holding or storage for material or equipment recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss.
- B. Transportation and Handling:
 - 1. Materials and equipment shall be transported by methods to avoid damage and shall be delivered in dry, undamaged condition in supplier's unopened containers or packaging.
 - 2. The CONTRACTOR shall provide equipment and personnel to handle the materials, and equipment by methods that will prevent soiling and damage.
 - 3. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging packaging, and surrounding surfaces.

C. Storage and Protection:

- 1. Materials and equipment shall be stored in accordance with supplier's written instructions, with seals and labels intact and legible. Exposed metal surfaces of valves, fittings and similar materials shall be coated with grease in accordance with manufacturer's recommendations to prevent corrosion. Sensitive materials and equipment shall be stored in weather-tight enclosures and temperature and humidity ranges shall be maintained within tolerances required by supplier's written instructions.
- 2. For exterior storage of fabricated materials, they shall be placed on sloped support above ground. Materials or equipment subject to deterioration shall be covered with impervious sheet covering; ventilation shall be provided to avoid condensation.
- 3. Loose granular materials shall be stored on solid surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
- 4. Inspection:
 - a. Storage shall be arranged to provide access for inspection.

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- b. The CONTRACTOR shall periodically inspect to assure materials and equipment are undamaged and are maintained under required conditions.
- 5. Storage shall be arranged in a manner to provide access for maintenance of stored items.

1.7 PROJECT SECURITY

- A. The CONTRACTOR shall make adequate provision for the protection of the work area against fire, theft and vandalism, and for the protection of the public and OWNER personnel against exposure to injury, and for the security of any off-site storage areas.
- B. All costs for this protection shall be included within the CONTRACTOR's bid.

1.8 TEMPORARY UTILITIES

- A. The CONTRACTOR shall provide and pay for all necessary temporary telephones, fuel, power, potable water, sanitary, and proper toilet accommodations. CONTRACTOR shall not use OWNER-owned utilities.
- B. The temporary facilities to be provided by the CONTRACTOR as described above shall conform to all requirements in regard to operation, safety, and fire hazards of State and local authorities and of Underwriters.
- C. CONTRACTOR shall return the site and facilities to their original "as-found" condition, unless otherwise specified in the Contract Documents, at the completion of the project.

1.9 SOUND CONTROL

- A. The CONTRACTOR shall comply with all local sound control and noise level rules, regulations and ordinances which apply to any work performed pursuant to the contract.
- B. Each internal combustion engine, used for any purpose on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer, so as to produce a maximum noise level of 85 dBA at 5 feet.
- C. No internal combustion engine shall be operated on the project without said muffler.
- D. Special Precautions for Inhabited Areas:
 - 1. In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation.
 - 2. In residential areas, special measures shall be taken to suppress noise generated by repair and service activities during the night hours.

1.10 DUST/AIR POLLUTION CONTROL

A. The CONTRACTOR shall take whatever steps, procedures, or means as are required to prevent dust conditions being caused by operations in connection with the execution of the Work; and on any road which the CONTRACTOR or any of their Subcontractors are using, excavation or fill areas, demolition operations, or other activities.

- B. Control shall be by sprinkling, use of dust palliatives, modification of operations, or any other means acceptable to agencies having jurisdiction.
- C. Damage to personal property, etc., resulting from the CONTRACTOR's construction operations shall be borne by the CONTRACTOR at no cost to the OWNER.
- D. The CONTRACTOR shall keep the streets and work area clean at all times by means of mechanical sweepers or hand sweeping. Water will be used for dust control only, and not for cleaning streets.
- E. Burning of waste, rubbish, or other debris will not be permitted on or adjacent to site.

1.11 WASTE DISPOSAL

- A. The CONTRACTOR shall dispose of surplus materials, waste products, and debris and shall make necessary arrangements for such disposal. The CONTRACTOR shall obtain written permission from property owner prior to disposing surplus materials, waste products, or debris on private property.
- B. All waste disposal shall be done in accordance with applicable laws and regulations.
- C. Landfill Disposal:
 - 1. If the CONTRACTOR proposes to dispose of construction debris, trench spoils, excavation spoils, etc., at a landfill, the CONTRACTOR shall be responsible to provide and pay for all permits and analyses required by the landfill.
 - 2. If the analyses determine that the material is hazardous, then an equitable adjustment of the Contract for the cost of hazardous waste disposal will be made in accordance with the General Conditions, and the following:
 - a. Time extension or contract costs will not be granted for delays that could have been avoided by the CONTRACTOR redirecting their forces and equipment to perform other work on the contract.
- D. Ditches, washes, or drainageways shall not be filled.
- E. Disposal operations shall not create unsightly or unsanitary nuisances.
- F. The CONTRACTOR shall maintain the disposal site in a condition of good appearance and safety during the construction period.
- G. Prior to final acceptance of the work, the CONTRACTOR shall have completed the leveling and cleanup of the disposal site.

1.12 CLEAN UP

- A. Throughout the period of construction, the CONTRACTOR shall keep the work site free and clean of all rubbish and debris, and shall promptly remove from the site, or from property adjacent to the site of the work, all unused and rejected materials, surplus earth, concrete, plaster, and debris.
- B. Upon completion of the work, and prior to final acceptance, the CONTRACTOR shall remove from the vicinity of the work all plant, surplus material, and equipment belonging to the CONTRACTOR or used under their direction during construction.

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1.13 TEMPORARY ENCLOSURES

- A. When sandblasting, spray painting, spraying of insulation, or other activities inconveniencing or dangerous to property or the health of employees, the public or construction workers, are in progress, the area of activity shall be enclosed adequately to contain the dust, over spray, or other hazard.
- B. In the event there are no permanent enclosures of the area, or such enclosures are incomplete or inadequate, the CONTRACTOR shall provide suitable temporary enclosures as required by the ENGINEER to meet field conditions in accordance with the recommendations of the owner-furnished equipment supplier (if applicable) and the CONTRACTOR's equipment supplier requirements.
- C. Said temporary or permanent enclosures shall be adequately ventilated to ensure the safety of the workers.

1.14 DRAINAGE

- A. The CONTRACTOR shall take all necessary actions as required to meet discharge requirements of the Arizona Dept. of Environmental Quality and other pertinent local ordinances and regulations pertaining to dewatering and/or site drainage discharged into storm drains and creeks. This may include, but may not be limited to, the use of retention basins and silt basins to settle most of the solids prior to discharge.
- B. In excavation, fill, and grading operations, care shall be taken to disturb the pre-existing drainage pattern as little as possible.
- C. Particular care shall be taken not to direct drainage water onto private property or into streets or drainageways inadequate for the increased flow.
- D. Drainage means shall be provided to protect the work.

1.15 TEMPORARY LIGHTING

A. The CONTRACTOR shall provide temporary lighting in all work areas sufficient to maintain a lighting level during working hours not less than the lighting level required by OSHA standards.

1.16 CONSTRUCTION FACILITIES

- A. Construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities shall be of ample size and capacity to adequately support and move the loads to which they will be subjected. Railings, enclosures, safety devices, and controls required by law or for adequate protection of life and property shall be provided.
- B. Temporary supports shall be designed with an adequate safety factor to assure adequate load bearing capability. Whenever required by safety regulations, the CONTRACTOR shall submit design calculations for staging and shoring prior to application of loads.

1.17 REMOVAL OF TEMPORARY FACILITIES AND UTILITIES

- A. At such time or times as any temporary construction facilities and utilities are no longer required for the work, the CONTRACTOR shall notify the ENGINEER of their intent and schedule for removal of the temporary facilities and utilities, and obtain the ENGINEER's approval before removing the same.
- B. As approved, the CONTRACTOR shall remove the temporary facilities and utilities from the site as CONTRACTOR's property and leave the site in such condition as specified, as directed by the ENGINEER, and/or as shown on the Drawings.
- C. In unfinished areas, such as planted medians, the condition of the site shall be left in a condition that will restore original drainage, evenly graded, seeded or planted as necessary, and left with an appearance equal to, or better than original.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

GENERAL PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. All products furnished and installed under this contract shall conform to the general stipulations set forth in this Section except as otherwise specified in other Sections.

1.2 COORDINATION

A. The CONTRACTOR shall coordinate all details of the products and equipment with other related parts of the work, including verification that all structures, piping, wiring, and equipment components are compatible. The CONTRACTOR shall be responsible for all structural and other alterations in the work required to accommodate products or equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.3 DESIGN REQUIREMENTS

- A. Where CONTRACTOR design is specified, design and installation of systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of 2018 edition of the International Building Code (IBC).
 - 1. Basic Wind Speed: 115 mph, Exposure C.
 - 2. Snow: 30-psf, non-reducible.
 - 3. Seismic:
 - a. S_S (maximum short-term spectral response acceleration) = 0.343
 - b. S₁ (maximum 1-second spectral response acceleration) = 0.105
 - c. S_{DS} (design short-term spectral response acceleration) = 0.297
 - d. S_{D1} (design 1-second spectral response acceleration) = 0.105
 - e. I_e (Seismic Importance Factor) = 1.25
 - f. Risk Category = III
 - g. Seismic Design Category = B
 - 4. Maximum Rain Intensity: 3-inches/hour
- B. Proof of Compliance:
 - 1. Structural integrity and anchorage shall be certified by an approved calculation that demonstrates the adequacy of the anchorage system for seismic forces. This calculation may be based on principles of structural analysis and engineering mechanics, or based on similarity to approved shake-table tests.
 - 2. The CONTRACTOR shall submit for review and approval test data or calculations certified by a Civil or Structural Engineer registered in the State of Arizona to show compliance with the above requirements.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 5350 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of -10 degrees F to 110 degrees F.

1.5 WORKMANSHIP AND MATERIALS

- A. The CONTRACTOR shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
- B. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gages so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch thick.
- D. Except where otherwise specified, all metal which will be exposed to weather, submerged or otherwise exposed to moisture shall be either non-ferrous or stainless steel, as the application may require.

1.6 LUBRICATION

- A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.
- B. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by OWNER. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.
- C. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.7 ELECTRIC MOTORS

- A. Unless otherwise specified, motors furnished with equipment shall meet the following requirements:
 - 1. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
 - 2. Rated for continuous duty at 40oC ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

- 3. Insulated with Class F insulation and designed for a service factor of 1.15, or greater.
- 4. Three phase motors used in conjunction with variable speed drives shall have Class F insulation with a Class B temperature rise at rated nameplate horsepower, and 1.15 service factor.
- 5. When operating at service factor load, maximum observable temperature rise of insulation and motor parts, as determined by resistance or thermometer methods, shall not exceed the NEMA allowable limits for the type of motor, the type of enclosure, and the particular application with regard to continuous or intermittent duty.
- 6. To ensure long motor life, nameplate horsepower, regardless of service factor, shall be at least 115 percent of the maximum load imposed by the driven equipment.
- 7. Designed for full voltage starting.
- 8. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion per IEEE Standard 519.
- 9. Derated, if required, for the altitude at which the equipment is installed.
- 10. Clamp-type grounding terminal shall be inside motor conduit box.
- 11. External conduit boxes shall be oversized at least one size larger than NEMA standard.
- 12. Totally enclosed motors shall have a continuous moisture drain which also excludes insects.
- 13. Bearings shall be either oil or grease lubricated.
- 14. Manufacturer's standard motor may be supplied on integrally constructed, packaged assemblies such as appliances, tools, unit heaters, and similar equipment specified by model number, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.
- 15. Totally enclosed motors shall be furnished on:
 - a. Equipment for installation below grade.
 - b. Equipment operating in wet or dust-laden locations.
- 16. Drip-proof motors, or totally enclosed motors at the supplier's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.
- 17. Explosion-proof or submersible motors shall be furnished as required by applicable codes, as specified in other Sections, or at the supplier's option.
- 18. Motors shall be rated and constructed as follows:
 - a. Below 1/2 hp:
 - 1) 115 volts, 60 Hz, single phase.
 - 2) Built-in manual-reset thermal protector, or integrally mounted stainless steel enclosed manual motor starter.
 - b. 1/2 hp and above:
 - 1) 460 volts, 60 Hz, 3 phase.
 - 2) Where specified or required by the drawings, motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.

1.8 DRIVE UNITS

- A. The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hours continuous service.
- B. Unless otherwise specified, the use of gearmotors will not be acceptable.

- C. Gear reducers:
 - 1. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated antifriction, rolling element bearings throughout.
 - Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall bear an AGMA nameplate.
 - 3. The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F.
 - 4. Bearings:
 - a. Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing by means of a manually operated grease gun.
 - b. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent over greasing of the bearing.
 - c. The use of permanently sealed, grease lubricated bearings will not be acceptable.
 - d. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil lubricated bearings.
 - e. A dipstick or sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.
 - 5. Gear reducers that require the removal of parts or periodic disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.
 - 6. Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer and that the unit provided is fully compatible with the conditions of installation and service.
- D. V-belt drives:
 - 1. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower of the drive motor.

1.9 SAFETY GUARDS

- A. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard.
- B. Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum-clad sheet steel or 1/2-inch mesh galvanized expanded metal.
- C. Each guard shall be designed for easy installation and removal.
- D. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.
- E. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

1.10 ANCHOR BOLTS

- A. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment.
- B. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.
- C. Anchor bolts shall comply with Section 05051, Anchors, Inserts and Epoxy Dowels and, unless otherwise specified, shall have a minimum diameter of 1/2-inch.
- D. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

1.11 EQUIPMENT BASES

- A. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high.
- B. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment.
- C. Each unit and its drive assembly shall be supported on a single baseplate of neat design.
- D. Baseplates shall have pads for anchoring all components and adequate grout holes.
- E. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection.
- F. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in Section 03600, Grout.

1.12 SPECIAL TOOLS AND ACCESSORIES

A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

1.13 SHOP PAINTING

- A. Surface Protection:
 - 1. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop.
 - 2. Surfaces that will be inaccessible after assembly shall be protected for the life of the equipment.
 - 3. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting.
 - 4. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with a high-grade oil-resistant enamel suitable for coating in the field with an alkyd enamel.
 - 5. Coatings shall be suitable for the environment where the equipment is installed.

- B. Shop Primer:
 - 1. Surfaces to be painted after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.
 - 2. Unless otherwise specified, the shop primer for steel and iron surfaces shall be:
 - a. Cook "391-N-167 Barrier Coat",
 - b. Koppers "No. 10 Inhibitive Primer",
 - c. Tnemec "37H Chem-Prime HS",
 - d. Valspar "13-R-28 Chromox Primer",
 - e. Or equal.
- C. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, Houghton "Rust Veto 344", Rust-Oleum "R-9", or equal.

1.14 PREPARATION FOR SHIPMENT

- A. All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of ENGINEER.
- C. Grease and lubricating oil shall be applied to all bearings and similar items.
- D. Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

1.15 STORAGE

- A. Upon delivery, all equipment and material shall immediately be stored and protected until installed in the work.
- B. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60° F. Equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.
- C. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the work.

1.16 INSTALLATION AND OPERATION

A. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary for proper results. When so specified, or when employees of the CONTRACTOR or their subcontractors are not

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qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

- B. Qualified field representatives shall be provided by the equipment manufacturers as required by Section 01750, Testing, Training and Startup.
- C. All equipment installed under this Contract, including that furnished by OWNER shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activity shall be provided.
- D. Acceptance of work in connection with the installation of equipment furnished by others will be subject to approval of the field representative. The CONTRACTOR shall be responsible for planning, supervising, and executing the installation of work, and the approval or acceptance of ENGINEER or the field representative will not relieve the CONTRACTOR of responsibility for defective work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

OWNER-FURNISHED EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work specified in this Section includes the unloading, handling, installation, connection, and testing of OWNER-furnished equipment as indicated on the Plans and as specified herein.
- B. OWNER-furnished equipment:
 - 1. Existing Submersible Pump:
 - a. Equipment Manufacturer: Flygt
 - b. Contact Person:
 - c. Components: Submersible Pump, Cable and Base Elbow
- C. Definitions: As used in this Section, the following terms have the meaning indicated:
 - 1. Equipment Manufacturer:
 - a. The Company with whom the OWNER has a contract to procure the equipment items.
 - 2. Defective:
 - a. An adjective which when modifying the word "equipment" refers to OWNER-furnished equipment and indicates that such equipment is unsatisfactory, faulty or deficient; that such equipment does not conform to the provisions of the Equipment Specifications; that such equipment does not meet the requirements of any inspection, test, or approval referred to in the Equipment Specifications; or that such equipment is damaged.
 - 3. Equipment specifications:
 - a. The specifications and other Contract Documents covering the purchase and delivery of OWNER-furnished equipment are included in the separate agreement between the OWNER and the Equipment Manufacturer.
 - 4. Approved shop drawings:
 - a. The drawings and data supplied by the Equipment Manufacturer for OWNER-furnished equipment, as approved by the ENGINEER.

1.2 CONTRACTOR COORDINATION WITH EQUIPMENT MANUFACTURER

- A. CONTRACTOR shall be in close coordination with service representatives of the manufacturer of the OWNER-furnished equipment in every phase of installation.
- B. Both the CONTRACTOR and the Equipment Manufacturer have separate responsibilities, both of which must necessarily be interwoven as regards the installation, testing and acceptance of the equipment.
- C. The Agreement between the OWNER and the Equipment Manufacturer, plus approved Shop Drawings, are available for inspection at the Engineer's Office. All prospective Contractors shall review said Agreement and Shop Drawings.

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1.3 QUALITY ASSURANCE

- A. Equipment specifications and approved shop drawings:
 - 1. The CONTRACTOR will be presumed cognizant, prior to entering into the Contract, of the provisions of the Equipment Specifications and approved Shop Drawings.
 - 2. One copy of the approved Shop Drawings will be made available to the CONTRACTOR to whom the Contract is awarded.
- B. Installation:
 - 1. OWNER-furnished equipment shall be installed as specified in Article 3.1.
- C. Operation:
 - 1. OWNER-furnished equipment shall be operated in accordance with the written instructions furnished with the equipment, and with the instructions issued by representatives of equipment manufacturers.
- D. Testing:
 - 1. After installation, and following certification in writing by Equipment Manufacturer that the installation is ready for electrical testing, the CONTRACTOR shall make electrical tests on OWNER-furnished equipment.
 - 2. The tests shall prove that the equipment has been properly installed; that power, control, instrumentation, and alarms are properly connected and wired from the equipment to points of supply or receipt of signals and are properly calibrated; and that all other work performed by the CONTRACTOR renders the equipment operational as intended.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of OWNER-furnished equipment:
 - 1. Equipment will be delivered to the CONTRACTOR at the site of the work as specified in the Equipment Specifications and identified in Section 01100, Summary of Work.
 - 2. Changes to the delivery procedure and schedule may be made if mutually agreed between the CONTRACTOR and the OWNER, and if approved by the Equipment Manufacturer.
 - 3. Inspection and Acceptance:
 - a. Upon delivery, conduct with OWNER or ENGINEER a joint inspection for the purpose of identifying product, general verification of quantities, and observation of apparent condition.
 - b. Such inspection will not be construed as final or as receipt of any product that, as a result of subsequent inspections and tests, are determined to be nonconforming.
 - c. Damaged or incomplete products to be returned for replacement will not be unloaded, except as necessary to expedite return shipment.
 - d. OWNER will submit claims for transportation damage and expedite replacement of damaged, defective, or deficient items.
 - e. Indicate signed acceptance of delivery on a copy of the invoice.
 - f. Upon CONTRACTOR's acceptance of OWNER-furnished equipment, it shall be understood that the CONTRACTOR assumes the responsibilities assigned to him in these Specifications in relation to the installation, testing and operation of OWNER furnished equipment.
 - 4. Defective Equipment Notice:

- a. The CONTRACTOR shall verify the conditions of OWNER-furnished equipment and shall submit to the ENGINEER within 7 days after delivery date a statement listing all defective equipment items.
- b. The list shall include the cost and extension to the Contract Time that the CONTRACTOR estimates for the correction and repair of each defective equipment item and a statement of the CONTRACTOR's opinion as to the cause of the defective equipment items.
- c. If the CONTRACTOR makes no submittal within the time period specified, it shall be understood that the OWNER-furnished equipment is in satisfactory condition and that the CONTRACTOR's acceptance has occurred as of the date of delivery.
- d. If the CONTRACTOR makes a submittal listing defective equipment items within the time period specified, the ENGINEER will decide on the course of action to be taken. The possible courses of action by the ENGINEER include:
 - 1) Correction By Change Order:
 - a) To authorize the CONTRACTOR to proceed with the correction and repair of defective equipment items through the issuance of a Change Order.
 - b) The CONTRACTOR's consent to perform such repair and correction shall be construed as CONTRACTOR's acceptance for the items included in the Change Order.
 - 2) Correction By Force Account:
 - a) To direct the CONTRACTOR to proceed with the correction and repair of defective equipment items through the procedures specified for force account work.
 - b) It shall be understood that CONTRACTOR's acceptance has occurred for the items covered under force account work on the date of the issuance of the ENGINEER's directive.
 - 3) Correction By Others:
 - a) To have others perform the correction and repair of defective equipment items.
 - b) The CONTRACTOR shall observe the work done by others and notify the ENGINEER in writing of all irregularities, faulty workmanship, or unsatisfactory work done by others.
 - c) The CONTRACTOR observations shall be carried out without obstruction or interference to others performing work.
 - d) Upon completion of the correction and repair, the ENGINEER will notify the CONTRACTOR and it shall be understood that CONTRACTOR's acceptance has occurred for items repaired by others upon receipt of the ENGINEER's notification.
 - 4) Modify the Installation Contract:
 - a) To modify the Plans and Specifications in order to meet changing conditions.
 - b) It shall be understood that CONTRACTOR's acceptance has occurred upon receipt of the ENGINEER's modifications to Plans and Specifications.
 - 5) Reject the Characterization:
 - a) To state to the CONTRACTOR that an item listed by the CONTRACTOR is not a defective equipment item.
- e. Regarding such items, it shall be understood that CONTRACTOR's acceptance has occurred on the delivery date.
- 5. If CONTRACTOR is not prepared to accept delivery of OWNER-furnished equipment by either the specified Estimated Date of Arrival or such OWNER-confirmed delivery date, as specified herein, associated costs incurred by OWNER shall be borne by CONTRACTOR. Such costs may include, but not be limited to, demurrage, interest,

insurance costs, additional administrative and engineering costs, additional factory and field technical support, additional storage and reshipping costs, cost escalation, and extended warranty costs due.

- 6. The CONTRACTOR shall unload the equipment from the delivery vehicle within 24 hours after arrival of the vehicle transporting such equipment to the site. The equipment shall be unloaded in accordance with manufacturers' instructions, or as specified.
- 7. The CONTRACTOR shall assume responsibility for storage and handling of equipment after the delivery has been accepted.
- B. Protection of OWNER-furnished equipment:
 - 1. The CONTRACTOR shall protect the equipment in accordance with the Equipment Manufacturer's recommendations against weather conditions, including construction of a temporary cover, and periodic lubrication, if required.
 - 2. From the time of receipt until the equipment is energized for operations, unless such equipment is being worked on, equipment shall be considered in storage.
 - 3. While in storage, a 120V, 1 phase source of power shall be provided and connected to space heaters in all items of equipment so equipped. Equipment not provided with space heaters shall be provided with a light bulb or electric heater while in storage to prevent moisture condensation.

1.5 SCHEDULING:

A. It shall be understood that the CONTRACTOR's review of the Equipment Specifications has allowed the scheduling of their operations in accordance with the dates for the delivery of OWNER-furnished equipment anticipated in said Equipment Specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. The CONTRACTOR shall install OWNER-furnished equipment in accordance with the instructions and recommendations furnished with the equipment, approved shop drawings, instructions of the representatives of equipment manufacturers and installation manuals, and as indicated on the Plans.
- B. The CONTRACTOR shall be responsible to include in their bid all labor, materials, and equipment required to install the OWNER-furnished equipment and make the complete system operate satisfactorily.
- C. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results. Such personnel shall be field representatives of the Equipment Manufacturer.
- D. Factory Service Representatives:
 - 1. Qualified factory service representatives will be provided by the Equipment Manufacturer as required to perform all manufacturers' field services called for in these Specifications.

- 2. Equipment Manufacturer will submit resumes of the proposed factory service representatives to the ENGINEER for review and acceptance not less than 21 days prior to the factory services representative's first site visit.
- 3. Factory service representatives will observe, instruct, guide, and direct CONTRACTOR's erection or installation procedures, and perform an installation check, as required herein or as requested by the ENGINEER.
- 4. Each factory service representative will revisit the site as often as necessary to attain installation satisfactory to ENGINEER.
- E. The CONTRACTOR shall furnish and install all piping, electrical and instrumentation work, interconnections, finish painting and accessories as required to make the OWNER-furnished equipment and system complete and functional.
- F. Provide foundation pads for OWNER-furnished products as shown. Verify exact dimensions and configuration of all pads, including penetrations, with OWNER-furnished product shop drawings.
- G. Anchor Bolts:
 - 1. Where required, provide anchor bolts, fasteners, washers, and templates needed for installation of OWNER-furnished equipment.
 - 2. Size and locate anchor bolts in accordance with OWNER-furnished product shop drawings and installation instructions.
- H. Mechanical and electrical equipment shall be properly aligned, plumb and level, with no stresses on connecting piping or conduit.

3.2 FIELD FINISHING

- A. Products will be delivered with prime coat(s) applied.
- B. Finish coat as specified in Section 09900, PAINTING.
- C. Touch up or repair damage to coatings resulting from unloading, storage, installation, testing, and startup.
- D. If finish coats are damaged extensively after transfer, completely repaint.
- E. Touch up, repair, or complete repainting shall match color of original paint, and shall be fully compatible with applied primers and finish.

3.3 EQUIPMENT FIELD TESTING

- A. General:
 - 1. Field Testing shall consist of Functional Testing performed by the CONTRACTOR, and Performance Testing performed by the Equipment Manufacturer with OWNER assistance.
 - 2. Minimum Functional Testing requirements are specified in Section 01750, Testing, Training and Startup.
 - 3. The CONTRACTOR shall schedule, coordinate, and perform all Functional Tests required to prove that the equipment has been properly installed and is in satisfactory operating condition.

- 4. The Equipment Manufacturer will furnish a factory trained representative to provide technical guidance to assist the OWNER's CONTRACTOR during Functional Testing.
- 5. Addition Functional Testing requirements for the Owner-Supplied Equipment are listed in the Technical Specifications.
- B. The CONTRACTOR shall repair, replace or correct to the satisfaction of the ENGINEER all defective equipment items caused by the CONTRACTOR's improper placement and handling of OWNER-furnished equipment.
- C. After testing, the CONTRACTOR shall repair, replace, or correct faulty work.

3.4 SERVICES OF EQUIPMENT MANUFACTURER'S REPRESENTATIVES

- A. The Equipment Manufacturers (through the OWNER) will provide services of skilled representatives of equipment manufacturer's for inspecting the installation, adjustments, start-up and testing of OWNER-furnished equipment.
- B. The extent of services provided by manufacturer's representatives is specified in the Equipment Specifications.
- C. The services will be provided as requested by the ENGINEER.
- D. The CONTRACTOR and their employees shall fully cooperate with the manufacturer's representatives.
- E. The CONTRACTOR shall notify the ENGINEER in writing 15 calendar days before the equipment manufacturer's representative needs to be present at the site.

+ + END OF SECTION + +

SECTION 01750

TESTING, TRAINING AND STARTUP

PART 1 - GENERAL

1.1 GENERAL

- A. Scope:
 - 1. This Section covers general equipment and system testing and startup requirements, services of the manufacturer's representatives and special coordinating services required of the CONTRACTOR that shall apply during construction and training of the OWNER's personnel for facilities operation.
 - 2. Specific testing and tracking procedures and requirements found in the Technical Specifications shall also apply.
- B. The CONTRACTOR shall inform all Subcontractors and manufacturers of the requirements herein and include the required services in their costs for the work specified in these Contract Documents. Where a minimum amount of time is stated in the Technical Specifications for manufacturers' services, any additional time required to perform the specified services shall be provided at no additional cost to the OWNER.
- C. Scheduling:
 - 1. Equipment testing and plant startup are requisite to satisfactory completion of the Contract and, therefore, shall be completed within the contract time.
 - 2. All equipment testing and plant startup activities shall be realistically allowed for and shown on the CONTRACTOR's Construction Schedule, in accordance with Section 01320, Progress Schedule.
 - 3. All equipment testing and plant startup activities shall be scheduled in conformance with the restrictions specified in Section 01130, Special Project Constraints.
- D. Equipment testing shall be satisfactorily completed prior to commencing plant startup associated with the particular equipment item or equipment package. The equipment shall not be considered ready for testing until the following conditions are satisfied:
 - 1. Manufacturer's certification of equipment installation has been accepted by the ENGINEER.
 - 2. Electrical and/or instrumentation Subcontractor certification of motor control logic has been accepted by the ENGINEER.
 - 3. Related Technical Submittals, O&M Manual and Final Shop Drawings have been accepted by the ENGINEER.
 - 4. Operator training services have been furnished by the CONTRACTOR (operational testing only).
 - 5. Testing procedures have been submitted in writing and accepted by the ENGINEER in accordance with Section 01330, Submittal Procedures. All testing procedures and results shall be submitted in writing.
- E. The requirements of plant startup specified herein shall also apply to the startup of individual treatment plant processes and facilities.
- F. Startup Plan:

- 1. Not less than 3 months prior to initial equipment or system startup, the CONTRACTOR shall submit to the ENGINEER for review, a detailed Facilities Startup Plan for the associated items of equipment and/or systems.
- 2. The Startup Plan shall include:
 - a. A detailed sub-network of the CONTRACTOR's Construction Progress Schedule including the following activities:
 - 1) Manufacturer's Services;
 - 2) Installation Certifications;
 - 3) Operator Training;
 - 4) O&M Manual;
 - 5) Functional Testing;
 - 6) Performance Testing;
 - 7) Operational Testing;
 - 8) All other activities necessary to affect a coordinated and successful Testing, Training and Startup.
 - b. Written testing plan with proposed data logs for each item of equipment to be tested.
 - c. A discussion of any coordination required with the Owners staff and/or any system or equipment outage requirements.
 - d. The Plan shall be updated and/or revised as necessary prior to subsequent Construction Progress Meetings.
 - e. Testing shall not be scheduled earlier than 30 days after approval of the Plan.

1.2 SERVICES DURING CONSTRUCTION

- A. General:
 - 1. Manufacturer's Representative:
 - a. The CONTRACTOR shall provide the services of competent and experienced technical representatives of the manufacturers of all equipment and systems furnished under the contract, for as many days as may be necessary for assembly, installation, testing assistance and operator training.
 - b. Manufacturer's field representatives shall observe, instruct, guide, and direct CONTRACTOR's erection or installation procedures, or perform an installation check, as required.
 - c. In each case, the CONTRACTOR shall arrange to have the manufacturer's representative revisit the job site as often as necessary until operator training is complete and testing and startup problems have been resolved to the satisfaction of the ENGINEER.
 - d. This requirement applies to manufacturers of all equipment furnished (excluding manually operated valves smaller than 24 inches in size, and any other items of equipment specifically exempted by the ENGINEER in writing), whether or not specifically set forth in the Technical Specifications.
 - e. The CONTRACTOR shall maintain a service record on each item of equipment and shall deliver these service records to the ENGINEER prior to acceptance of operational testing.
- B. Fulfillment of Specified Minimum Services:
 - 1. The CONTRACTOR shall obtain prior written approval from the ENGINEER for providing manufacturers' services.
 - 2. All requests to the ENGINEER for prior approval shall (1) be in writing, (2) be submitted not less than 10 calendar days prior to the providing of the subject

services, (3) state the service to be provided, and (4) state the reason(s) why the timing of the service is appropriate.

- 3. Request made to the ENGINEER less than 10 calendar days prior to the manufacturers' services may not receive consideration and response prior to the times the services are provided.
- 4. Visits of manufacturers and their representatives to the jobsite or training classroom without prior approval as provided herein may not act to fulfill the specified minimum man-day requirements.
- C. Certificate of Proper Installation:
 - 1. Equipment requiring factory tests shall not be delivered to the jobsite until the CONTRACTOR submits acceptable certified test results to the ENGINEER.
 - 2. Equipment shall not be considered ready for functional testing until after the following certifications have been submitted and accepted by the ENGINEER.
 - a. Manufacturer Representatives:
 - The CONTRACTOR shall require that each manufacturer's representative furnish to the ENGINEER a written and signed report addressed to the OWNER certifying that the equipment has been properly installed, adjusted, lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts, has been operated satisfactorily under full-load conditions and is ready for full-time operation.
 - 2) For pumps, compressors, blowers, engines, motors, and other rotating or reciprocating equipment, the report shall certify that the equipment operates within the manufacturer's allowable limits for vibration.
 - 3) The report shall also certify that all controls, protective devices, \instrumentation, and control panels furnished as part of the manufacturer's equipment package are properly installed and calibrated; and that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
 - 4) The CONTRACTOR shall also sign said certification.
 - 5) The CONTRACTOR shall submit "Manufacturer's Certification of Proper Installation" on the OWNER form.
 - b. Electrical and Instrumentation Subcontractor:
 - The CONTRACTOR shall require that the electrical and/or instrumentation Subcontractor shall furnish a written and signed report to the ENGINEER certifying that the motor control logic for the equipment item that resides in motor control centers, control panels, control boards, microprocessors, distributed processing units, computers, and the like furnished by the electrical and/or instrumentation Subcontractor has been properly tested and calibrated.
 - The report shall certify that the control logic for equipment startup, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
 - 3) The CONTRACTOR shall also sign said certification.

1.3 STARTUP AND TESTING

- A. General:
 - 1. The CONTRACTOR shall provide the effective coordination of all parties necessary for the successful project startup.

- 2. The ENGINEER shall not be responsible to instruct the CONTRACTOR in the startup of the project, however, the ENGINEER will be available prior to and during startup to provide operational and technical support to the CONTRACTOR.
- 3. The CONTRACTOR shall furnish all labor, consumables (power, water, chemicals, air, etc.) tools, equipment, instruments, and services required and incidental to completing all functional, performance and operational testing of installed equipment.
- 4. The CONTRACTOR shall submit the proposed test procedures to the ENGINEER for review at least 30 days prior to testing.
- 5. The CONTRACTOR shall give the ENGINEER written notice confirming the date of testing at least five working days before the time the equipment is scheduled to be tested.
- 6. All testing shall be witnessed by the ENGINEER to be considered valid.
- 7. Test Reports:
 - a. CONTRACTOR shall submit written detailed results of all functional, performance and operational testing.
 - b. Upon successful completion of Operational testing all equipment installation, testing and maintenance records shall be submitted to the ENGINEER.
 - c. Said records shall be bound separately for each piece of equipment or system and shall be collected by type of record.
- 8. For factory tests, written test results shall be submitted to the ENGINEER at least 10 days prior to shipment.
- B. Functional testing:
 - 1. All items of mechanical and electrical equipment shall be functionally tested by the CONTRACTOR after installation for proper operation.
 - 2. A minimum of ten (10) days prior to the start of functional testing, the CONTRACTOR shall submit interconnection diagrams for the equipment and for the alarms, controls and instruments associated with the equipment. This requirement shall not relieve the CONTRACTOR of meeting any requirements in the technical specifications for earlier submittal of the interconnection diagrams.
 - 3. Minimum Test Requirements
 - a. The functional test of each piece of mechanical equipment shall continue for not less than eight (8) continuous hours without interruption.
 - b. The functional test shall include checking for proper rotation, alignment, speed, flows, pressure, vibration, sound level, etc. Initial equipment and system adjustment and calibrations shall be performed in the presence of and with the assistance of the manufacturer's representative.
 - c. The functional test shall include a demonstration of the proper performance of all alarms, local and remote controls, instrumentation, equipment functions, and all other electrical, mechanical and piping systems.
 - d. All parts shall operate satisfactorily in all respects, under continuous full load, and in accordance with the specified requirements, for the full duration of the eight-hour test period.
 - e. If any part of a unit shows evidence of unsatisfactory or improper operation during the eight-hour test period, correction or repairs shall be made and the full eight-hour test operation, as specified herein, shall be repeated after all parts operate satisfactorily.
- C. Performance testing:
 - 1. Where performance testing is required by the Technical Specifications, the testing shall be supervised by the manufacturer's representative. These services shall continue until such times as the applicable equipment or system has been

successfully tested for performance and has been accepted by the ENGINEER for operational testing.

- 2. Performance testing shall take place after functional testing is successfully completed in accordance with Article 1.3 B.
- 3. Performance testing shall demonstrate that the equipment meets all performance requirements specified.
- D. Startup/operational testing:
 - 1. Upon successful completion of operator training and the functional, performance and leakage testing, the CONTRACTOR shall startup the plant facilities and test the equipment operation and performance by conducting a seven (7) day, continuous operational test of the completed facilities as an operational process unit to demonstrate to the ENGINEER's satisfaction that all equipment and systems required by these specifications will operate in the manner in which they are intended to perform.
 - 2. The OWNER will provide CONTRACTOR-trained operating personnel for the duration of the operational test. Said operation shall be conducted and under the supervision and direction of the CONTRACTOR and/or manufacturer's representative.
 - 3. Operational Defects:
 - a. All defects in materials or workmanship which appear during the operational test shall be immediately corrected by the CONTRACTOR.
 - b. In the event of a malfunction or deficiency that results in shutdown or partial operation of a system or process unit or results in performance that is less than that specified, the startup duration shall be repeated for that corresponding system or process unit and any other affected equipment so its proper operation and performance as required by the Contract Documents is demonstrated for a minimum of seven (7) continuous and trouble free days.
 - 4. If the operational test is interrupted through no fault of the CONTRACTOR the test may resume at the earliest mutually agreeable time.
 - 5. No unit process or part thereof shall be placed in service until it has successfully completed operational testing.
 - 6. During plant startup, the CONTRACTOR shall provide the appropriate construction trades and the services of authorized Manufacturer's representatives for operational testing and as necessary, to correct faulty equipment operation.
 - 7. After completion of all startup/operational testing, the CONTRACTOR shall repaint, hose, scrub, clean up and otherwise return the work to a "like new" condition, prior to OWNER acceptance.

1.4 TRAINING OF OWNER PERSONNEL

- A. General:
 - 1. Operation and maintenance training of OWNER's personnel shall be provided for mechanical, electrical, instrumentation and control equipment as listed in this Section or elsewhere in the Specifications.
 - 2. For the purposes of this requirement, operations training is considered to be separate from maintenance training. Instructions are to be tailored to the needs of each group.
 - These training services shall be conducted by the manufacturer's representative and shall ensure measurable and observable means that OWNER personnel are qualified to perform equipment task requirements, including essential knowledge, skills and abilities.

- 4. Training shall be conducted by competent representatives who are certified by the manufacturer to be thoroughly familiar with the subject matter as well as instructional methods.
- 5. Training materials shall be submitted to the OWNER (see Paragraph 1.4 C below) for review. Acceptance of training materials is required prior to start of training.
- 6. All training shall be completed prior to beginning operational testing.
- 7. The OWNER shall have the right to videotape any or all training sessions, or may designate separate sessions or portions thereof for the sole purpose of videotaping.
- B. Training coordinator:
 - 1. The CONTRACTOR shall designate and provide one or more persons to be responsible for coordinating and expediting training duties.
 - 2. The person or persons so designated shall be present at all training coordination meetings with the OWNER.
- C. Training schedule:
 - 1. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER's personnel and manufacturer's representatives, and shall submit a training schedule and the training materials for each piece of equipment or system for which training is to be provided.
 - 2. The training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the then current Plan of Operation.
 - 3. Equipment and/or systems shall be deemed suitable for use in training upon satisfactory completion of functional testing.
 - 4. All training with regards to a unit process or part thereof shall be completed prior to the start of operational testing.
 - 5. As a minimum, training shall be provided on the following equipment and systems:
 - a. Submersible Pumps
 - b. All Valves
 - c. All Instrumentation
 - d. Control Panel
 - e. Generator and ATS
 - f. Odor Control
 - 6. The CONTRACTOR shall provide distinct and separate training sessions for both operations and maintenance personnel, meeting the following criteria:
 - a. Maintenance Training:
 - 1) Maintenance training shall be provided for all items in 1.4.C.5 above.
 - 2) The CONTRACTOR shall provide two (2) separate training sessions on a day agreed to by the ENGINEER.
 - 3) Training shall emphasize theory of operations, troubleshooting, and preventative maintenance and repair procedures.
 - 4) The discussion shall encompass issues relating to instrumentation, electrical, and mechanical systems.
 - b. Operations training:
 - 1) Operations training shall be provided for each piece of equipment listed in Paragraph 1.4.C.5 above.
 - 2) The CONTRACTOR shall provide two (2) separate training sessions for each three (3) operating shifts.
 - 3) Sessions are to be provided for each shift within the following time periods.a) Day Shift: 8:00 a.m. 2:00 p.m.
 - c. Training session schedules shall be approved by the ENGINEER.

- d. Training shall emphasize theory of operations, startup instructions, emergency and normal shutdown instructions, lockout procedures, troubleshooting, preventative maintenance, and alarm and control logic.
- 7. The CONTRACTOR shall confirm each training period a minimum of three working days prior to the schedule time.
- 8. If a manufacturer's representative fails to conduct a scheduled training class, the CONTRACTOR hereby agrees to compensate the OWNER for labor costs, including overhead, for all OWNER personnel in attendance for the entire scheduled training period.
- 9. If the CONTRACTOR or the manufacturer's representative fails to provide training that qualifies the OWNER personnel to perform equipment task requirements, the CONTRACTOR hereby agrees to provide remedial training to ensure OWNER personnel proficiency at no additional cost to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 RECORD KEEPING

- A. The CONTRACTOR shall maintain as a minimum, the following records:
 - 1. Equipment manufacturer's shop drawings.
 - 2. Daily logs indicating all equipment testing and startup activities.
 - 3. Log and time sheets of all manufacturer's representatives performing services on the jobsite.
 - 4. Updated equipment testing and startup schedules.
 - 5. Records of system cleaning.
 - 6. Hydrostatic and pressure test records.
 - 7. Equipment alignment and vibration measurements and corrective actions.
 - 8. Equipment lubrication records.
 - 9. Insulation resistance measurements.
 - 10. Electrical phase, voltage and amperage measurements.
 - 11. Electrical breaker inspection, test, and adjustment records.
 - 12. Logs of abnormal circuits and lifted wires.
 - 13. Testing and validation of all central and alarm functions.
 - 14. Data sheets of all testing and calibration of instrumentation devices and control loops including documentation of set points.
 - 15. Equipment and system release logs (from construction to startup).
 - 16. Daily work reports.

3.2 GENERAL PROCEDURES

- A. The general work procedures listed below outline the work to be performed by the CONTRACTOR. Additional procedures applicable to specific equipment items are specified elsewhere.
- B. Technical assistance and support:
 - 1. Obtain the assistance of the appropriate construction trades and the manufacturer or vendor, as required for technical assistance during equipment installation, testing,

and startup by the CONTRACTOR and for training of the OWNER's Operation and Maintenance personnel.

- 2. Furnish names and telephone numbers of manufacturer's and vendor's current technical service representatives for use by the ENGINEER.
- C. Instructions:
 - 1. Maintain an adequate manufacturer's instruction file so that the information will be readily available during equipment testing and startup.
 - 2. Prior to equipment testing, finalize, and transmit to the ENGINEER the applicable technical manuals as required under Section 01330, Submittal Procedures of the Contract Specifications.
- D. Removal of rust preventives:
 - 1. Prior to equipment testing, remove all rust preventives and oils used to protect the equipment during the construction period whenever these protective materials will be detrimental to operation or equipment maintenance.
- E. Lubricants:
 - 1. At least 60 days prior to startup, provide a list of the manufacturer's recommended lubricants for use in the plant. All equipment lubrication shall be listed with the lubricant types and quantities recommended and approved by the equipment manufacturers.
 - 2. Provide the necessary lubricants for startup and the initial 60 days of operation.
 - 3. Flush systems and install the initial charge of all lubricants. Dispose of flushing oil in accordance with applicable regulations.
 - 4. The CONTRACTOR shall lubricate the equipment in accordance with the manufacturer's recommendations until the equipment is accepted by the OWNER.
 - 5. Maintain a lubrication record for each item of equipment. The CONTRACTOR shall submit the lubrication records to the ENGINEER prior to equipment testing.
- F. Packing and seals:
 - 1. Install, adjust, and replace packing, mechanical seals, and accessories, as necessary, during the equipment testing and startup period.
 - 2. Adjust seal water and flushing water flow rates in accordance with the equipment manufacturer's recommendations.
- G. Removal of temporary bracing:
 - 1. Prior to equipment testing, remove all temporary supports, bracing, or other foreign objects that were installed in vessels, transformers, rotating machinery, or other equipment to prevent damage during shipping, storage, and erection, and repair any damage sustained.
- H. Rotation, alignment, and vibration:
 - 1. Prior to equipment testing, check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting the driver.
 - 2. Prior to equipment testing, perform the cold alignment and hot alignment to the manufacturer's tolerances.
 - 3. Prior to equipment testing, test equipment vibration and correct any vibration in excess of the manufacturer's recommendation.
- I. Tie-ins at the contract limits:

- 1. Provide proper notification, preparation, and coordination for safe tie-ins and minimal interference with the plant operation.
- 2. Obtain approval and make the necessary tie-ins at the unit limits as required by the Contract Documents and as approved by the ENGINEER.
- 3. Prior to startup, remove the temporary blind flanges, plugs, bulkheads, seals, etc.
- J. Leak and pressure tests:
 - 1. Provide the ENGINEER with 3-day advance notification in writing of the schedule for non-operating field leak tests or field pressure tests on piping and field fabricated equipment, unless otherwise directed by the ENGINEER.
 - 2. Provide the water, air and any special media required for the test purposes.
 - Prior to startup, conduct all leak and pressure tests in accordance with applicable codes, regulations, and the Contract Documents, and as approved by the ENGINEER. The CONTRACTOR is advised that the tests shall be witnessed by the ENGINEER, to be considered valid.
 - 4. Maintain a record of the leak and pressure test data and work completed.
 - 5. Dispose of the test media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
 - 6. Isolate in-line equipment as necessary for protection against test pressure.
- K. Pressure/vacuum safety relief devices:
 - 1. Prior to equipment testing, test and adjust all safety devices as recommended by the equipment manufacturer.
 - 2. Prior to plant startup, provide the ENGINEER with a list of all field or factory equipment settings.
- L. Flushing and chemical/mechanical cleaning:
 - 1. Prior to equipment operation, conduct all flushing, blowing, and chemical/mechanical cleaning operations without using the permanently installed equipment.
 - 2. Provide any special media needed for flushing and/or cleaning purposes.
 - 3. Dispose of all media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.
 - 4. All systems shall be free of trash and construction debris before initiating startup.
 - 5. Maintain a record of the work completed.
- M. Screens, strainers, and blind flanges:
 - 1. Provide and install temporary strainers, screens, and blind flanges as necessary to protect the equipment and to test the equipment and pipelines.
 - 2. Prior to startup, remove all of the temporary blinds and temporary appurtenances.
 - 3. Clean the screens and strainers as required during startup.
 - 4. At the end of startup, clean all of the permanently installed screens and strainers.
- N. Purging/inerting:
 - 1. Prior to startup, purge and/or passivate the facilities as specified.
 - 2. Install purge/inerting connections in accordance with the manufacturer's recommendations.
 - 3. Provide purge or inerting materials and conduct the necessary operations as recommended by the equipment manufacturer.
- O. Drying out:

- 1. Prior to startup, dry out the facilities as specified or recommended by the equipment manufacturer to prevent contamination of catalysts, operating materials, and/or product.
- 2. Dry out systems, protective coatings, refractories, and linings as specified or recommended by the equipment manufacturers.

3.3 SPECIFIC PROCEDURES

- A. In addition to the work responsibilities described in Subsection 3.2, the procedures outlined below further define the work responsibilities of the CONTRACTOR for specific systems and items of equipment.
- B. Mechanical equipment:
 - 1. Level baseplates and soleplates and grout under all load bearing surfaces.
 - 2. Install suitable supports and flexible connections to alleviate any piping stresses that may be imposed on pumps, compressors, and drivers.
 - 3. In accordance with the manufacturer's recommendations, chemically clean lube oil, seal oil, and cooling systems. Dispose of waste and cleaning media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
 - 4. In accordance with the manufacturer's recommendations, charge the lube oil, seal oil, and cooling systems with flushing media and circulate for cleaning purposes. Dispose of any flushing media in a manner that is acceptable to and approved by the OWNER and applicable regulatory agencies.
 - 5. Charge the lube oil systems, seal oil systems, and cooling systems with the amount and type of operating oil or coolant recommended by the manufacturer.
 - 6. Operate the equipment and check for excessive vibration, abnormal operating noises, overheating and lubricant leakage, etc., and test any safety shutdown/alarm devices for proper operation, and make any operating tests required by the ENGINEER. The adjustments required for proper operation shall be made prior to operational testing.
 - 7. Utilize manufacturer's representative for technical assistance during installation and startup.
 - 8. Prior to startup, all sidewalks, gratings, handrails, safety chains, safety shields, etc., shall be installed.
 - 9. Prior to startup, demonstrate to the ENGINEER's satisfaction that all chemical solution pipelines are connected to the intended tank(s), feeder(s), pump(s), and application points, and that the pipes, appurtenances contained therein and diffusers will operate at the intended flow rates.
 - 10. Prior to startup, the applicable safety equipment, emergency shower and eyewash units, fire extinguishers, fire suppression equipment, self-contained breathing apparatus, toxic and/or combustible gas detectors (including the respective personnel warning system), protective clothing, emergency repair kits, etc., shall be installed in an acceptable manner-subject to the ENGINEER's approval, and be fully ready for operation.
 - 11. All safety hazards, e.g., exposed drive shafts or rotating equipment members, exposed electrical circuitry, open electrical junction boxes and panels, improperly supported piping and conduits, missing safety devices, etc., shall be corrected prior to supplier training of the OWNER's personnel.
 - 12. The CONTRACTOR shall perform a comprehensive safety inspection and correct any safety deficiencies found before implementing plant startup.
 - 13. Roadways that are required for ambulance service, fire fighting access, delivery of treatment chemicals and supplies, and disposal of the treatment byproducts shall be completed prior to startup.

14. Prior to startup, install all warning and safety signs, labels, and devices.

C. Tanks:

- 1. Test all tanks and internals, as required to demonstrate conformance to the Contract Documents. Dispose of test media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.
- 2. Prior to startup, conduct chemical cleaning or flushing operations as specified. Dispose of wastes and cleaning media in a manner that is acceptable to and approved by the OWNER and the applicable regulatory agencies.
- 3. Prior to startup, install all chemical identification, warning, and safety signs and labels.
- D. Electrical power and lighting systems:
 - 1. Provide the ENGINEER with 3-day advance notification in writing of the test schedule. The CONTRACTOR is advised that the tests shall be witnessed by the ENGINEER.
 - 2. Perform insulation resistance tests on all wiring 120 volt and larger. Do not meggar instruments or solid-state devices.
 - 3. Perform insulation resistance tests on all motor and transformer windings from phase to phase and phase to ground.
 - 4. Perform grounding system tests to determine the continuity of connections and the value of resistance to ground.
 - 5. Fill electrical gear with oil and/or other media as recommended by the equipment manufacturer.
 - 6. Prior to substantial completion and startup, test and set switchgear and circuit breaker relays for proper coordination and operation.
 - 7. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to perform a thermographic survey on all switchgear buses, insulators and power connections when energized and under at least 20 percent load. Significant hot spots shall be further checked by infrared pyrometer for exact temperature rise. The CONTRACTOR shall troubleshoot and correct the thermographic hot spots. Correction shall be verified by repeating the thermographic survey at no additional cost to the OWNER.
 - 8. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electric Testing Association, to inspect and test the protective relays and the 800-ampere and larger drawout breakers for proper installation, adjustment, and operation in accordance with the manufacturer recommendations.
 - 9. The CONTRACTOR shall obtain the services of a qualified "independent testing service", member of the National Electrical Testing Association, to perform DC high potential tests on all cables that will operate at more than 2,000 volts to ground.
 - 10. Obtain local electrical inspector's approval where required.
 - 11. Energize all substations, with approval of the Utility Company and the ENGINEER after completion of all electrical testing.
 - 12. Prior to startup, perform tests and adjustments on all switchgear and motor control equipment to demonstrate proper operation and conformance to the Contract Documents and manufacturer's recommended settings.
 - 13. Prior to startup, test installation of emergency power and lighting systems for proper operation, including light intensity.
 - 14. Prior to startup, provide the ENGINEER with a record of all test data and the work completed.
 - 15. Vacuum clean all electrical equipment prior to startup and acceptance.

- E. Piping systems:
 - 1. Provide the ENGINEER with 3-day advance notification in writing of test schedule.
 - 2. Hydrostatically or pneumatically test all piping as required by the codes and contract documents.
 - 3. After successful testing of the piping, slowly drain the system and then flush the system. Orifice plates shall be installed after testing. If installed with the piping, they will be removed and replaced with spacers or pipe spools of equal length prior to the pressure test.
 - 4. Dewater the system, remove blind flanges, and perform tightness tests, as required by the ENGINEER.
 - 5. Insulate or paint piping, flanges, threaded joints, or field welds after the specified testing of each item has been completed unless instructed otherwise by the ENGINEER.
 - 6. Leave exposed all welded joints (longitudinal, girth, and nozzle) in underground piping that have not been shop tested until the specified testing has been completed. After final testing of these joints, cover the system.
 - 7. Prior to substantial completion and startup, check pipe hangers, supports, guides, and pipe specialties for the removal of all shipping and erection stops and for the correctness of the cold and hot settings for the design service, make adjustments as necessary to obtain proper installation. Provide the ENGINEER with instructions for the hot settings.
 - 8. As necessary during equipment testing and at the end of substantial completion and startup, clean or replace the screens and filter elements as appropriate for the filter type and service.
 - 9. Prior to startup, verify, to the extent required by the ENGINEER, that specified valve packing has been provided on valves installed in the plant.
 - 10. Prior to startup, install all of the valve and piping system identification labels.
 - 11. Prior to startup, check and record the position of all process system valves.
 - 12. Prior to startup, correct support, vibration, and thermal expansion problems detected during the preliminary equipment testing.
 - 13. Prior to the startup, retorque all hot and cold service bolting as required to ensure a permanent and proper installation.
 - 14. Prior to startup, demonstrate to the ENGINEER's satisfaction that each piping system (e.g., chemical, sample, utility, irrigation process, etc.) functions as designed and required by the Contract Documents.

+ + END OF SECTION + +

SECTION 01800

OPERATIONAL COMPLETION AND PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 GENERAL

- A. The Work will be considered operationally complete when all technical and administrative submittals, testing, training and startup are completed satisfactorily in accordance with the Contract Documents.
- B. Operational completion shall apply to the project in its entirety.

1.2 CERTIFICATION OF OPERATIONAL COMPLETION

- A. Prior to requesting the ENGINEER's inspection for certification of each phase as operationally complete, the CONTRACTOR shall certify in writing that each phase of the Work is operationally complete and shall submit a list of known items still to be completed or corrected (punchlist) prior to Contract Completion.
- B. The following items shall be completed:
 - 1. OWNER has been advised of any pending insurance changeover requirements.
 - 2. Specific warranties, maintenance agreements, final certifications and similar documents have been submitted.
 - 3. All tools, spare parts, extra stocks of materials, and similar physical items have been delivered to OWNER.
 - 4. Instruction of OWNER's operation/maintenance personnel, and start up testing has been completed.
 - 5. Submittal and acceptance of all O&M manuals.
 - 6. Changeover of locks to OWNER's cores/keys.
- C. Punchlist:
 - 1. When the CONTRACTOR considers that the Work, or a portion or phase thereof which the OWNER agrees to accept separately, is operationally complete, the CONTRACTOR shall certify in writing that the work is operationally complete and shall prepare and submit to the ENGINEER a comprehensive list of items to be completed or corrected prior to Contract Completion (punchlist).
 - 2. The ENGINEER may add additional work items to the punchlist.
 - 3. Failure to include an item on the punchlist does not alter the responsibility of the CONTRACTOR to complete all Work in accordance with the Contract Documents.
 - Upon receipt of the CONTRACTOR's punchlist, the ENGINEER will make an inspection to determine whether the Work or designated portion thereof is operationally complete.
 - 5. If the ENGINEER's inspection discloses any item, whether or not included on the CONTRACTOR's list, that is not in accordance with the requirements of the Contract Documents, the CONTRACTOR shall, upon notification by the ENGINEER and before an issuance of the Certificate of Operational Completion is provided, complete or correct such item.
 - 6. The CONTRACTOR shall then submit a request for another inspection by the ENGINEER.

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- 7. When the Work or designated portion thereof is accepted by the ENGINEER to be operationally complete, the ENGINEER will prepare a Certificate of Operational Completion.
- 8. The date of Operational Completion shall be the date of the ENGINEER's inspection and acceptance.

1.3 DESCRIPTION OF PROJECT CLOSEOUT

- A. Closeout is hereby defined to include general requirements near the end of the Contract Time, in preparation for Final Acceptance, Final Payment, normal termination of Contract, occupancy by OWNER and similar actions evidencing completion of the Work.
- B. Specific requirements for individual units of Work are specified in Sections of Divisions 2 through 16.

1.4 FINAL CLEANUP

- A. At completion, leave project clean and ready for use.
 - 1. Legally dispose of waste materials, debris and rubbish off the site.
 - 2. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from exposed and enclosed surfaces.
 - 3. Repair, patch and touch up all affected curbs, gutters, and sidewalks to match adjacent surfaces.
 - 4. Broom clean paved surfaces, rake clean other surfaces of grounds. Vacuum clean all interior surfaces, rake clean other surfaces of grounds.

1.5 RECORD DRAWINGS

- A. The CONTRACTOR shall prepare and submit Contract Record Drawings for the OWNER.
 - 1. The CONTRACTOR shall make a record of changes during construction on prints of the Drawings provided by the OWNER for this purpose (Contract Record Drawings) as described in Section 01330, Submittal Procedures.
 - 2. The reproducible drawings on which changed conditions are recorded shall be returned to the ENGINEER prior to project completion.

1.6 GUARANTEES

- A. The General Conditions cover the CONTRACTOR's responsibility to remedy defects due to faulty workmanship and materials which appear within one year from the date of Final Acceptance.
- B. Special guarantees are required by various Sections of the Specifications. Assemble written guarantees, label and submit to the ENGINEER.
 - 1. Provide the "Warranty Form" included in the General Conditions.
 - 2. Equipment guarantees shall be written in the manufacturer's standard form and shall be countersigned by the Subcontractor or supplier and the CONTRACTOR.
 - 3. All other guarantees shall be written on the Subcontractor's or supplier's letterhead and shall be countersigned by the CONTRACTOR.

1.7 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Spare parts and maintenance materials are required by various Sections of the Specifications.
 - 1. Parts and materials shall be packaged so as to preclude damage in normal handling and storage.
 - 2. Packages shall be labeled with full description of contents and project name and clearly identified as to which item of equipment they belong to. CONTRACTOR shall maintain a spare parts inventory list which shall be provided to the OWNER prior to Final Acceptance.
 - 3. Submit packaged parts and materials to ENGINEER.
 - 4. Submit the value of all spare parts.

1.8 FINAL INSPECTION

- A. Prior to requesting ENGINEER's final inspection for certification of Final Acceptance and Final Payment, complete the following and list known exceptions (if any):
 - 1. Submit Final Payment request with final releases and supporting documentation not previously submitted and accepted.
 - 2. Submit copy of final punchlist of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by ENGINEER.
 - 3. Submit Consent of Surety.
 - 4. Revise and submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Certify in writing that the work has been completed in accordance with the Contract Documents, and request ENGINEER's final inspection.
- C. Reinspection:
 - 1. Within seven (7) days after receipt of the CONTRACTOR's notice that the work has been completed, including punchlist items resulting from earlier inspections, and excepting incomplete items delayed because of acceptable circumstance, the ENGINEER will reinspect the work.
 - 2. Upon completion of reinspection, ENGINEER will either prepare a certificate of Final Acceptance or advise the CONTRACTOR of work not complete or obligations not fulfilled as required for Final Acceptance.
 - 3. If necessary, inspection procedure will be repeated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

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DIVISION 02

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SECTION 02220

DEMOLITION

PART 1 - GENERAL

1.1 DEFINITIONS

- A. "Demolish": CONTRACTOR shall remove from the site as property of CONTRACTOR. Demolition includes disconnecting, removal, loading, repairs, cleanup, transportation, unloading, disposal permits and fees, disposal, and all other items required to remove the material from the site.
- B. "Salvage": CONTRACTOR shall remove from area of Work and place in location designated by ENGINEER. Equipment is property of OWNER. Salvage includes disconnecting, removal, repairs, cleanup, loading, transportation, unloading, and all other items required to remove and relocate the material.
- C. "OWNER to Remove": OWNER will remove from area of Work prior to CONTRACTOR commencing demolition Work for this area.
- D. "Relocate": CONTRACTOR shall relocate material shown to new locations shown on Drawings or stated herein. Relocation includes disconnecting, removal, reconnecting, attaching, repairs, and all other items required to relocate material to new location.
- E. "Abandon": CONTRACTOR shall disconnect and leave in place as specified.
- F. "Materials": Any and all items and objects that are scheduled, specified, or shown to be demolished, salvaged, removed, relocated, or abandoned.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Information: Grout, sealants, and bonding agents to be used for patching.
- B. Informational Submittals:
 - 1. Plan and schedule phased demolition, including limits of demolition, as part of and consistent with the progress schedule specified in Section 01320, PROGRESS SCHEDULE.
 - 2. Methods of demolition and equipment proposed to demolish materials.
 - 3. Copies of any authorizations and permits required to perform Work.
 - 4. Copies of Hazardous Materials Inspection Reports.
 - 5. Repair procedures for demolition of materials beyond limits shown on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

A. CONTRACTOR shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the Work shown, specified herein, and as required to complete the Project.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings are based on available information. The Work may differ slightly from what is shown. CONTRACTOR shall be responsible for determining the work required by inspecting the site.

3.2 SAFETY REQUIREMENTS

- A. All Work shall be done in conformance with all applicable rules and regulations pertaining to safety.
- B. Hazardous Materials:
 - 1. See General Conditions.
 - 2. Existing facilities, or portions thereof, to be demolished may contain hazardous materials such as asbestos cement piping, residual chemicals in existing or abandoned piping, lead-based paint, mercury seals, or other unknown hazardous materials.

3.3 SEQUENCE

- A. Be responsible for the sequence of Work.
- B. Conform to constraints as specified in Section 01130, SPECIAL PROJECT CONSTRAINTS.

3.4 COORDINATION

- A. Coordination with ENGINEER:
 - 1. Only materials specified herein, shown on the Demolition Photographs or the Drawings, or approved by ENGINEER in the field shall be demolished, salvaged, removed, relocated, or abandoned.
 - 2. Verify materials scheduled to be demolished, salvaged, removed, relocated, or abandoned with ENGINEER prior to performing Work.
 - 3. Do not remove materials without prior approval of ENGINEER.
 - 4. Provide at least 3 working days' notice to ENGINEER prior to start of Work.
 - 5. Notify ENGINEER to turn off affected services or facilities before starting Work.
 - 6. Provide temporary services during interruptions to affected services or facilities as acceptable to ENGINEER.
 - 7. ENGINEER will indicate limits of Work if not clearly shown.
- B. Coordination with Utility Owners:
 - 1. Notify utility owners to turn off affected services or facilities before starting Work.

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- 2. Provide not less than 72 hours notice to utility owners prior to shutdown, unless otherwise directed by utility owners.
- 3. Provide temporary services during interruptions to affected services or facilities as acceptable to utility owners.

3.5 LIMITS

- A. Drawings define minimum portions of materials to be demolished. Unless otherwise shown, rough cuts or breaks may be made to limits of demolition shown. If rough cuts or breaks are made exceeding limits shown, CONTRACTOR shall repair the cuts or breaks back to the dimensions shown on Drawings at CONTRACTOR's expense.
- B. If limits are not clear on the Drawings or Demolition Photographs, limits shall be as directed by ENGINEER.
- C. All areas not within the limits of demolition Work shown on the Drawings, or as specified herein, shall be left undisturbed, unless necessary for demolition of materials.

3.6 DEMOLITION

- A. General:
 - 1. Inspect condition of materials to be demolished prior to bidding to assess potential for salvage value.
 - 2. Remove all materials associated with existing equipment that is to be demolished.
 - 3. Materials within limits of demolition will become the property of CONTRACTOR.
 - 4. All materials from the demolition process shall be removed safely from the project site as soon as possible. They shall be disposed of in accordance with applicable federal, state, and city regulations. CONTRACTOR is responsible for determining these regulations and shall bear all costs associated with disposal of the materials.
- B. Pavement and Curbs:
 - 1. Provide saw cut at all concrete and pavement surfaces and curb removal limits and where neat connection lines are required.
 - 2. Surfaces exposed by demolition activities shall be repaired and finished to provide a uniform, smooth, level transition between adjacent surfaces.
- C. Concrete, CMU, and Reinforcing:
 - 1. In areas where concrete or CMU portions are to be removed from a structure, the edge of removal shall be cut with a concrete saw to leave a perpendicular edge or by core-drilling where a circular hole is required.
 - 2. Damaged concrete shall be removed to solid concrete. Damaged concrete shall include concrete that is soft, spalled, cracked, or otherwise damaged as determined by ENGINEER.
 - 3. Depth of removal shall be as determined by ENGINEER unless otherwise shown or specified.
 - 4. Reinforcing shall be cut and removed unless otherwise shown or instructed by ENGINEER.
 - 5. Spalled edges may be required to be resawn at the discretion of the ENGINEER.
 - 6. Protect adjacent structures and equipment from damage during Work.
 - 7. Exposed surfaces following demolition activities shall be repaired and finished to provide a uniform, smooth, and level transition between adjacent surfaces.

- 8. Remove and repair designated cracked and damaged concrete areas shown in accordance with this section and Section 03300, CAST-IN-PLACE CONCRETE.
- D. Concrete Embedded Items:
 - 1. Except for core drills, demolish anchor bolts, reinforcing steel, conduit, and other materials that are concrete embedded to a minimum of 1 inch below final finished surface. For core drills, coat rebar exposed by core drilling with System No. 304 in accordance with Section 09900, PAINTING.
 - 2. Plug empty pipes and conduits with fireproof sealant to maintain fire ratings for floors or walls.
 - 3. Patching:
 - a. Demolish damaged concrete. Damaged concrete shall be removed to solid concrete. Damaged concrete shall include concrete that is soft, spalled, cracked, or otherwise damaged as determined by ENGINEER.
 - b. Coat with approved bonding agent.
 - c. Patch with nonshrink, nonmetallic grout.
- E. Piping:
 - 1. Pressurized Services: Install restrained caps or plugs at the demolished ends, unless otherwise shown.
 - 2. Gravity Services: Install concrete plugs, 5-foot minimum length.
- F. Utilities:
 - 1. Excavate utility lines serving structures to be demolished.
 - 2. Demolish electrical, sanitary, and storm drainage lines serving structures to be demolished.
 - 3. Support or relocate utility lines exposed by Work.
 - 4. For water and gas lines to be demolished or capped and terminated, provide a permanent leakproof closure. Closure type shall be as recommended by utility owner.
- G. Electrical:
 - 1. Remove conduits and wiring from materials to be demolished back to nearest junction box.
 - For existing circuits to remain operational, intercept existing conduit at the most convenient location, or as shown, and splice and extend conduit to new location. Install new conductors as required to accomplish intended results. New conductors shall be continuous without splices between junction boxes.
 - 3. For existing circuits no longer needed, demolish conductors from conduits and add pull tapes.
 - 4. Demolish all surface-mounted conduit which is no longer needed.
 - 5. For conduit below grade or concealed within walls, cap and abandon in place.

3.7 SALVAGE

- A. Salvage materials for OWNER's own use where shown.
- B. Remove materials with extreme care so as not to damage.
- C. Promptly remove materials from Work area.
- D. Store materials in location designated by ENGINEER.

E. Clean and protect materials from dust, dirt, natural elements, and store as directed.

3.8 RELOCATION

- A. ENGINEER will determine condition of materials prior to removal.
- B. Remove all materials associated with items to be relocated.
- C. Existing materials shall not be damaged during removal.
- D. Properly store and maintain materials in same condition as when removed.
- E. Clean and protect materials from dust, dirt, natural elements, and store as directed.

3.9 ABANDONMENT

- A. Structures: Break holes into or core drill floor slabs, catch basins, and other below-grade concrete structures to be abandoned in place to allow water to freely migrate through.
- B. Piping and Conduits:
 - 1. General: Piping and conduits to be abandoned shall be capped with a watertight plug at demolished end in a manner that will prevent entrance of soil, groundwater, or moisture.
 - 2. Pressurized Services: Install restrained caps or plugs at the demolished ends, unless otherwise shown.
 - 3. Gravity Services: Install concrete plugs, 5-foot minimum length.

3.10 REPAIR AND REPLACEMENT

- A. Any damaged materials scheduled to be salvaged or relocated shall be repaired by the CONTRACTOR to the satisfaction of ENGINEER or replaced at the CONTRACTOR's expense.
- B. Any damage to areas not within the limits of demolition Work shown on the Demolition Photographs, Drawings, or as specified herein shall be repaired or replaced to original precontract conditions at the CONTRACTOR's sole expense.

3.11 DISPOSAL

A. Dispose of materials offsite in licensed landfills and in accordance with all local, state, and federal regulations. CONTRACTOR is responsible for obtaining any and all necessary permits for disposal.

+ + END OF SECTION + +

SECTION 02930

FABRICATED STEEL GATES AND OPERATORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Detailed drawings, information and specifications for materials, finishes, and dimensions.
- B. Quality Control Submittals:
 - 1. Manufacturer's recommended installation instructions.
 - 2. Evidence of Supplier and installer qualifications.

1.2 SCHEDULING AND SEQUENCING

A. Complete necessary site preparation and grading before installing fabricates steel gates and operators.

PART 2 - PRODUCTS

2.1 FABRICATED STEEL GATES

- A. Fabricate steel access gates and person gates as shown on the Drawings.
- B. Shop fabricate steel gates and deliver to site completely finished and painted.
 - 1. Clean all weld residue and grind welds smooth prior to painting.
 - 2. Paint with System 300, as described in Section 09900 PAINTING.
- C. Steel Frame: Provide steel fabricated in accordance with Section 05500 MISCELLANEOUS METALS.
- D. Metal Panel:
 - 1. Galvanized steel sheet meeting ASTM A653, G-60. Provide profile and thickness shown on the Drawings.

2.2 GATE OPERATORS

- A. Provide gate operators as shown on the Drawings, suitable for operation of the gates, as shown on the drawings.
- B. Features:
 - 1. Drive Unit A/C Power: 230VAC, single phase, 60 Hz.
 - 2. Drive Motor: 1/2 HP, 24VDC, brushless, variable speed, operating temperature: 25°C to 70°C. Provide size "O" contactor type magnetic starter, reversing, prewired with overcurrent and overload protection.
 - 3. Speed Reduction: Heavy duty sprockets, belt and drive chain, permanently lubricated.

- 4. Housing: Heavy gage, weather-resistant, lockable, galvanized steel, NEMA 3R enclosure.
- 5. Drive Chain: No. 50 minimum. Provide all mounting hardware required to connect to gate.
- 6. Safety Clutch: Adjustable friction type, designed to slip if gate meets obstruction.
- 7. Magnetic Brake: Solenoid activated disc type, designed to reduce gate coasting.
- 8. Emergency Operation: Manual no tool disconnect in case of power failure.
- 9. Limit Switches: Adjustable rotary type, full-open and full-closed limit switches.
- 10. Audible Warning: Provide audible warning signal during gate operation, suitable for outdoor installation.
- 11. Capable of operating 1500 pound gate.
- C. Controls:
 - 1. All controls shall be suitable for operation of a 230 volt, single phase, 60 hertz power supply. Provide a fused 230/115 volt transformer, 125 percent sized, to provide power to all controls and devices. Provide all controls, transformers, relays and other equipment as necessary for a complete and functional system installed in a NEMA 3R enclosure.
 - 2. Gate operators shall be controlled as follows:
 - a. Local Operation Station: Provide keypad operated local operation station, Linear AK-11 or approved equal, mounted on a gooseneck pedestal located on the public side of gate location.
 - b. Fire Department Knox Box: Provide a single gate and key switch Knox Box in accordance with the local Authority Having Jurisdiction (AHJ) requirements, Knoxbox #3502 or approved equal. Switch shall have at minimum the following functionality: SPDT or DPDT, 7A Resistive, 4A inductive, 2-position removable key recessed with Stainless Steel, Dust/Tamper proof cover. The box shall include a highly reflective operation decal, RED label indicating "FIRE DEPARTMENT".
 - c. Time Delay System: Close on entry after set time delay.
 - d. Embedded Magnetic Vehicle Detection Loop: Automatic open on vehicle exit, Reno A&E, Type PLH or approved equal.
 - e. Radio remote controls: Provide remote receiver antenna wired directly to gate drive controller for each gate drive unit, HySecurity MX001179 or approved equal. Provide (2) 2-button (Open/Close), DIP switch programmable radio transmitter remotes for each gate drive unit, HySecurity MX001203 or approved equal.
 - f. Photobeam Detectors (Thru-Beam Type): Provide (2) pairs of photobeam detectors for each gate drive unit. (1) pair of photobeam detectors will monitor the gate obstruction zone while closing and (1) pair will monitor the gate entrapment zone while opening, Seco-Larm Enforcer E-960-D90GQ or approved equal.
 - 3. Manufacturer of the automatic gate operators and controls shall provide a "total system" with all accessories required to operate according to the following:
 - a. Embedded 'Free Exit' Magnetic detection loop shall automatically open the gate when a vehicle is detected. After the Free Exit loop triggers gate opening, gate control will defer to the photobeam sensor inputs and timer settings described below.
 - b. Obstruction Zone Photobeam Detectors shall prevent premature gate closure. The photobeam detection system shall hold the gate in an open position until the vehicle or any obstruction such as a pedestrian clears the gate area. When the vehicle or obstruction clears the gate area, the gate operator shall automatically close the gate, after a pre-set period, adjustable from 3 to 90 seconds. Should the gate be closing as a vehicle or obstruction reaches the gate area, the gate

shall automatically reverse to the open position and the timer shall reset for a full time cycle.

- c. Entrapment Zone Photobeam detectors shall prevent premature gate opening if an obstruction is detected in the gate entrapment zone. A detected obstruction in the gate entrapment zone will attempt to close the gate. While closing, the Obstruction Zone photobeam control description will govern gate operation. If both the Entrapment Zone and Obstruction Zone photobeams detect obstructions, the gate will stop operation and audibly alarm.
- d. Provide maximum run timer to limit time of operation in any one direction to a maximum of 90 seconds and to delay reversal of gate 1.5 seconds when signaled from magnetic vehicle detection system.
- D. Product and Manufacturer:
 - 1. SlideSmart DC 15
 - 2. Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all gates level, plumb and in-line for smooth operation.
- B. Install gate operators to provide smooth operation of gate, as described above.
- C. Provide all miscellaneous fittings and accessories required for a complete installation of all gates.
- D. Provide padlock hasps for all gates, attached to adjacent fencing to provide for a secure gate system utilizing OWNER's padlocks.
- E. Touch up all damaged paint after installation.

3.2 FIELD QUALITY CONTROL

A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

+ + END OF SECTION + +

DIVISION 03

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SECTION 03400

PRECAST CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section includes all plant-precast products including valve and meter vaults.
- B. Manholes, influent junction structure and pump station shall be Armorock per 03410.
- C. Include lifting lugs and provisions for removal of the lid on the following structures (valve vaults and meter vault).

1.2 SYSTEM DESCRIPTION

- A. Precast products shall be designed for the indicated service, the loadings specified in the Contract Documents, and all transportation, handling, and erection loads, in accordance with requirements and recommendations of the references.
 - 1. Precast products not subjected to traffic loads shall be designed to meet and exceed the requirements of ACI 318-14.
 - 2. Precast products subjected to traffic loads shall be designed to meet and exceed the requirements of the current AASHTO LRFD Bridge Design Specifications.
 - 3. Liquid containing precast products shall be designed for the additional requirements of ACI 350-06.
- B. If precast products are proposed as substitutes for cast-in-place designed structures, such precast products shall meet the above requirements and any other requirements for which the cast-in-place structures were designed by the ENGINEER. Such products shall be designed by an engineer licensed to practice in the State where the project is performed.
- C. Items located in or adjacent to traffic areas shall be designed to resist AASHTO HL93 loading, unless otherwise indicated.
- D. Lifting inserts shall have a minimum safety factor of 4.

1.3 QUALIFICATIONS

- A. Manufacturer:
 - 1. Manufacturer shall have at least 5 years experience in the design and manufacture of precast concrete products substantially similar to those required for this project.
- B. Installer:
 - 1. Precast Items shall be in stalled by the Manufacturer or by an installer regularly engaged for at least 5 years in erection of precast products similar to those required on this project.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit to the Engineer for review, shop drawings of the proposed details, and design calculations; all calculations and shop drawings shall be stamped and signed by a Civil or Structural Engineer registered in the State of Arizona.
 - 2. Material specifications.
 - 3. All dead, live and other applicable loads used in the design.
 - 4. Applicable standards (from "References") met by the item(s).
 - 5. Setting plans locating and designating all items furnished by the manufacturer, with all major openings shown and located.
 - 6. Details to indicate quantities, location and type of reinforcing and prestressing steel.
 - 7. Sections and details showing connections, edge conditions, support conditions, and connections of the items.
 - 8. Description of all embeds, including stripping, lifting and erection inserts, with piece mark and location, including those cast into products or sent loose to the job site.
 - 9. Description and drawings of all frames and covers.
 - 10. Dimensions and special finishes.
- B. Mix Designs: Submit all precast mix designs for approval. Mix designs shall be prepared by an independent testing facility or qualified employee of the Precast Manufacturer.
- C. Design Modifications:
 - 1. Submit design modifications necessary to meet performance requirements and field conditions. Refer to the Project Geotech Report for soil conditions. Whenever there is a conflict between the Geotech Report and this specification, the most stringent requirement applies.
 - 2. Variations in details or materials shall not adversely affect the appearance, durability or strength of products.
 - 3. Maintain general design concept without altering size of members, profiles and alignment unless otherwise approved by the Architect/Engineer.

1.5 QUALITY ASSURANCE

- A. In-Plant Quality Control
 - 1. The Manufacturer shall have an established PCI quality control program in effect prior to bidding. If requested, a copy of this program shall be submitted to the ENGINEER.
 - 2. Testing of materials and inspection of production techniques shall be the responsibility of the Manufacturer's Quality Control Department.
 - 3. Keep quality control records available for two years after final acceptance.
 - 4. Keep certificates of compliance available for five (5) years after final acceptance.
- B. All other testing and inspection, if any, to be provided by OWNER.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle and transport products in a position consistent with their shape and design in order to avoid excessive stresses or damage.
- B. Lift or support products only at the points shown on the Shop Drawings.

- C. Installer shall be responsible for the repair of damage to items except that caused by others.
- D. After items are installed in their final positions, the CONTRACTOR shall be responsible for their protection. The CONTRACTOR shall be responsible for the repair of any damage to the items caused by someone other than the Manufacturer/Installer.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement ASTM C150 Type I, II or III cement. Use best type for soil condition present.
- B. Aggregates:
 - 1. Fine and coarse aggregate for mix shall conform to ASTM C33 or C330.
 - 2. Aggregates shall be clean, hard, strong, durable, inert, and free of staining and deleterious materials.
- C. Water Potable, free from deleterious material.
- D. Admixtures:
 - 1. Conforming to ASTM C260 and/or ASTM C494.
 - 2. Calcium chloride or admixtures containing chlorides shall not be used.
- E. Concrete Strength: Concrete strength shall be determined by design with a minimum 28 day design strength of 4,000 psi.

2.2 STEEL MATERIALS

- A. Products:
 - 1. Structural Shapes, Bars & Plates (1.6mm and thicker): ASTM A36
 - 2. Pipe: ASTM A53 Grades A or B
 - 3. Tube Steel: ASTM A500 Grades A or B
 - 4. Reinforcing Steel: ASTM A615 Grades 300 & 420 or ASTM A706
 - 5. Prestressing Strand: ASTM A416 Grade 270, low relaxation
 - 6. Deformed Steel Bar Mats: ASTM A184
 - 7. Deformed Bar Anchors: ASTM A496
 - 8. Deformed Welded Wire Fabric: ASTMA497
 - 9. Plain Welded Wire Fabric: ASTM A185
 - 10. Welded Headed Studs: AWS D1.1 Type B
 - 11. Standard Machine Bolts: ASTM A307 Grade A or SAE J429 Grade 2
 - 12. Standard Studs/Threaded Round Stock: ASTM A307 Grade C, ASTM A572 Grade 345
 - 13. Nuts for Standard Machine Bolts and Threaded Studs: ASTM A563 Grade A Hex Nuts
 - 14. High Strength Bolts: ASTM A325 Type 1, ASTM A449 Type 1, or SAE J429 Grade 5
 - 15. Nuts for High-Strength Bolts and Threaded Studs: ASTM A563 Grade DH Heavy Hex Nuts
 - 16. Coil Rods and Bolts: ASTM A108 SAE 1016 to 1026, $F_u/F_Y = 480/380$ MPa minimum
 - 17. Coil Nuts for Coil Rods and Bolts: Nuts passing a proof load stress of 80 ksi, based on the tensile stress area of the matching coil rods and bolts.
 - 18. Carbon Steel Castings: ASTM A27 Grade 415-205

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- B. Protective Coatings:
 - 1. All connection hardware permanently exposed to weather after completion shall be protected. All connection hardware not exposed to weather after completion may be uncoated, except as otherwise explicitly required by the contract drawings. Fasteners can have either an electroplated zinc or cadmium coating.
 - 2. Alkyd Rust Inhibitive Primers (shop primers such as red iron oxide) :
 - a. Tnemec Series FD88 Azeron Primer
 - b. Ameron 5105
 - c. Weld-Thru Primer, Red, 2-0101 & Gray, 2-0102
 - 3. Zinc Coatings:
 - a. Hot-Dip Galvanizing: ASTM A123, or ASTM A153
 - b. Electroplated Zinc for Steel Products and Steel Hardware: ASTM B633
 - c. Zinc Rich Paints: DOD-P-21035
 - 4. Cadmium Coatings:
 - a. Electrodeposited Coatings of Cadmium: ASTM B766

2.3 MISCELLANEOUS PRODUCTS

- A. Grout:
 - 1. Cement Grout: Portland cement, sand and water sufficient for placement and hydration.
 - 2. Non-Shrink Grout: Premixed, packaged non-ferrous aggregate shrink resistant.
 - 3. Epoxy Resin Grout: Two-component mineral-filled resin: ASTM C881.
- B. Joint Sealing Compound: The joint sealing compound shall be a permanently flexible plastic material complying in every detail to Federal Specification SS S-00210 (GSA-FSS) dated July 26, 1965. "Quickseal", or approved equal.
- C. Frames and Covers: Catch basins, manholes, and vaults shall be provided with fabricated aluminum or steel frames and covers as specified or shown on the drawings and shall be built up so that the cover is flush with the surrounding surface unless otherwise specified.

2.4 FABRICATION

- A. Unless otherwise noted, precast concrete structure dimensions called out on the Drawings are interior dimensions.
- B. Manufacturing procedures shall be in general compliance with PCI MNL-116.
- C. Manufacturer shall provide for those openings 10 in. or larger, round or square as shown on the drawings. Other openings shall be located and field drilled or cut by the trade requiring them after the units have been erected. Openings and/or cutting of prestressing strand shall be approved by ENGINEER and manufacturer before drilling or cutting.
- D. Forms:
 - 1. Forms for precast products shall be rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated by this Section, the Contract Documents and the reviewed Shop Drawings.
 - 2. Construct forms to withstand vibration method selected.
 - 3. Release agents shall be applied and used according to manufacturer's instructions.

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- E. Plastic Liner:
 - 1. Where called for on the Drawings, provide cast-in-place plastic liner system.
 - 2. Install liner system per manufacturer's instructions.
 - 3. Follow all requirements of Specification Section 06640, Plastic Liner for Concrete Pipe and Structures.
- F. Concreting:
 - 1. Batching of Concrete shall be in accordance with approved Mix Design(s).
 - 2. Convey concrete by methods which will prevent separation, segregation or loss of material.
 - 3. Consolidate all concrete in the form to minimize honeycombing or entrapped air.
- G. Curing: Procedures sufficient to insure specified concrete strength of all products must be employed. Stripping of a panel shall not occur until concrete strength is sufficient to prevent cracking or damage of the panel.
- H. Manufacturing Tolerances:
 - 1. Cross Sectional Dimensions:
 - a. Less than 24 inches: $\pm 1/4$ "
 - b. 24 to 36 inches: ±3/8"
 - c. Over 36 inches: $\pm 1/2$ "
 - 2. Length:
 - a. Less than 25 ft: ±1/2"
 - b. 25 to 50 ft: ±3/4"
 - c. Over 50 ft: ±1"
 - 3. Variation from square or designed skew (difference in length of two diagonal measurements): Max. $\pm 3/4$ "
- I. Identification: Mark each precast item to correspond to identification mark on Shop Drawings for product location, and with casting date.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Access: Clear unloading areas and access roadways to point of component placement shall be provided and maintained by the CONTRACTOR. The CONTRACTOR shall provide all required traffic controls, barricades, warning lights and/or signs to insure a safe installation.
- B. Sitework: The CONTRACTOR shall excavate and prepare the subgrade, including 2 inches of clean sand, graded level and to the proper elevation.
- C. Installer Responsibility: Prior to installation of the precast products, notify the CONTRACTOR of any discrepancies discovered which affect the work under this contract.

3.2 INSTALLATION

A. General: Precast products shall be lifted with suitable lifting devices at points provided by the Manufacturer to prevent excessive stresses or damage to the products. Brace and secure items before unhooking.

- B. Sitework:
 - 1. Openings or "knockouts" shall be located as shown on the drawings and shall be sized sufficiently to permit passage of the largest dimension of pipe and/or coupling flange. Upon completion of installation, all voids or openings in the vault walls around pipes shall be filled with 4,000-psi concrete or mortar, using an approved epoxy for bonding concrete surfaces.
 - 2. All joints between precast sections shall be made watertight using preformed mastic material. The sealing compound shall be installed according to the manufacturer's recommendations to provide a watertight joint which remains impermeable throughout the design life of the structure. All joints shall be filled with dry-pack non-shrink grout. If plastic liner system is used, after the joint has been made <u>and is cured</u>, install plastic liner weld strip at all joints and seams.
 - 3. Frames and covers shall be built up so that the cover is flush with the surrounding surface unless otherwise specified. The CONTRACTOR is responsible for placing the cover at the proper elevation where paving is to be installed and shall make all necessary adjustments so that the cover meets these requirements.
 - 4. After the structure and all appurtenances are in place and approved, and after any required disinfection or testing, backfill shall be placed to the original ground line or to the limits designated on the plans.

3.3 FIELD QUALITY CONTROL

- A. Hydrostatic Testing:
 - 1. All Manholes, Wetwells, Junction Boxes, or other water bearing structures shall be hydrostatically tested prior to acceptance.
 - 2. Test Procedure:
 - a. Plug all inlets and outlets with temporary plugs
 - b. Fill water bearing structure with clean, potable water
 - c. Let stand for 24 hours, if desired, to allow for "soaking-in"
 - d. Fill to rim elevation
 - e. Let stand for a minimum of 2 hours
 - f. Check distance from rim to water surface
 - g. Calculate water loss. Leakage in each manhole may not exceed 0.1-gallon per hour per foot of water depth during the test.
 - 3. Repair all manholes which do not meet the above test requirements with a method approved by the ENGINEER and re-test until passing.

3.4 PATCHES AND REPAIRS:

A. Patching of products, when required, shall be performed to industry standards for structural concrete. Repairs shall be sound, permanent and flush with adjacent surface.

3.5 WARRANTY:

A. All labor and materials under the Precast Manufacturers contract shall be warranted by the Precast Manufacturer for a period of two (2) years after substantial completion.

+ + END OF SECTION + +

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SECTION 03410

POLYMER CONCRETE STRUCTURES

<u> PART 1 - GENERAL</u>

1.1 SCOPE

A. This specification covers polymer concrete manholes intended for use in sanitary sewers, storm sewers and water lines where corrosion resistance is required

1.2 REFERENCES

- A. This specification covers polymer concrete manholes intended for use in sanitary sewers, storm sewers and water lines where corrosion resistance is required
- B. ASTM C 478 (most current) Standard Specification for Precast Reinforced Concrete Manhole Sections
- C. ASTM C 579 (most current) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes
- D. ASTM C 443 (most current) Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
- E. ASTM C 580 (most current) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
- F. ASTM C 857 (most current) Standard Practice for Minimum Structural Design Loading for Underground Utility Structures
- G. ACI 350-06 Code Requirements for Environmental Engineering Concrete Structures & Commentary
- H. ACI 440.1R-15 Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars
- I. ACI 548.6R-96 Polymer Concrete-Structural Applications State-of-the-Art Report
- J. ASTM D 648 (most current) Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position
- K. ASTM D 6783 (most current) Standard Specification for Polymer Concrete Pipe
- L. ASTM D 2584 (most current) Test Method for Ignition Loss of Cured Reinforced Resins
- M. ASTM C 923 (most current) Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe

- N. ASTM C 990 (most current) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants
- O. ASTM C 497 (most current) Test Methods for Concrete Pipe, Manhole Sections, or Tile

1.3 SUBMITTALS

- A. Conform to bid document requirements
- B. Submit manufacturer's data and details of following items for approval:
 - 1. Shop drawings of manhole sections, base units and construction details, jointing methods, materials, and dimensions
 - Summary of criteria used in manhole design including, as minimum, material properties, loading criteria, and dimensions assumed. Include certification from manufacturer that polymer concrete manhole design meets or exceeds the load and strength requirements of ASTM C 478 and ASTM C 857, reinforced in accordance with ACI 440.1R-15. Include current ISO 9001:2008 certification
 - 3. Frames, grates, rings, and covers
 - 4. Materials to be used in fabricating pipe drop connections
 - 5. Materials to be used for pipe connections
 - 6. Materials to be used for stubs and stub plugs, if required
- C. Submitted sealed drawings by a registered Professional Engineer

PART 2 - PRODUCTS

2.1 POLYMER CONCRETE MANHOLES AND STRUCTURES

- A. Provide polymer concrete manhole sections, monolithic base sections and related components referencing to ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product
- B. Provide base riser section with monolithic floors, unless shown otherwise
- C. Provide riser sections joined with bell and spigot / ship-lap design seamed with butyl mastic and or rubber gaskets (ASTM C 990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure
- D. Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints
- E. Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer
- F. Provide tops to support AASHTO HS-20 or HL-93 or vehicle loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings
- G. DESIGN CRITERIA:

- 1. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.
 - a. AASHTO HS-20 or HL-93 design or as required loading applied to manhole cover and transition and base slabs
 - Polymer manholes will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06
 - c. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections
 - d. Internal liquid pressure based on unit weight of 63 pcf
 - e. Dead load of manhole sections fully supported by polymer concrete manhole base
- H. DESIGN:
 - Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete manhole design as follows:
 - a. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment
 - b. Reinforcement Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design. No steel rebar or matting may be used or substituted.
 - c. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness
 - d. Thermosetting Resin The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed
 - e. Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%. Variations in height of two opposite sides of risers and cones shall not be more the 5/8 inch. The under run in height of a riser or cone shall not be more than 1/4 in/ft of height with a maximum of 1/2 inch in any one section
 - f. Marking and Identification Each manhole shall be marked with the following information Manufacturer's name or trademark, Manufacturer's location and Production Date
 - g. Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity
 - h. Minimum clearance between wall penetrations and joints shall be per manufacturer's design

- i. Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material if needed
- j. Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available. All connectors are to be water tight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions
- I. QUALITY CONTROL
 - Facility Quality Control should be maintained by adhering to ISO 9001:2008 for manufacturing. All fabricators will be ISO 9001:2008 Certified. All fabrication will take place in an all polymer concrete fabrication facility. At no time will the polymer concrete fabrication facility share the facility with a cementitious precast product production facility. Fabricator is also to provide references of 5 previous projects in the last 5 years performed with both owner and contractor for reference and review by owner. Polymer concrete shall be cast in a polymer only facility and shall not be manufactured in a cementitious concrete facility
- J. GROUTING
 - 1. All materials needed for grouting and patching will be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer
- K. MANUFACTURER
 - 1. Armorock LLC

PART 3 - MANHOLE VENT WITH DAMPER ASSEMBLY ACCESSORY

- A. Provide manhole vent assembly per detail 2125.
- B. Materials
 - 1. All piping shall be stainless steel per SECTION 15100 PSDS WSSTP unless noted.
 - 2. Valves shall be per SECTION 15200 VS unless noted.

PART 4 - EXECUTION

4.1 PREPARATION

- A. Access: Clear unloading areas and access roadways to point of component placement shall be provided and maintained by the CONTRACTOR. The CONTRACTOR shall provide all required traffic controls, barricades, warning lights and/or signs to insure a safe installation.
- B. Sitework: The CONTRACTOR shall excavate and prepare the subgrade, including 2 inches of clean sand, graded level and to the proper elevation.
- C. Installer Responsibility: Prior to installation of the precast products, notify the CONTRACTOR of any discrepancies discovered which affect the work under this contract.

4.2 INSTALLATION

- A. General: Precast products shall be lifted with suitable lifting devices at points provided by the Manufacturer to prevent excessive stresses or damage to the products. Brace and secure items before unhooking.
- B. Sitework:
 - 1. Openings or "knockouts" shall be located as shown on the drawings and shall be sized sufficiently to permit passage of the largest dimension of pipe and/or coupling flange. Upon completion of installation, all voids or openings in the vault walls around pipes shall be booted or sealed with polymer concrete grout as supplied or recommended by the manufacturer.
 - 2. All joints between precast sections shall be made watertight using preformed mastic material. The sealing compound shall be installed according to the manufacturer's recommendations to provide a watertight joint which remains impermeable throughout the design life of the structure. All joints shall be filled with dry-pack non-shrink grout. If plastic liner system is used, after the joint has been made <u>and is cured</u>, install plastic liner weld strip at all joints and seams.
 - 3. Frames and covers shall be built up so that the cover is flush with the surrounding surface unless otherwise specified. The CONTRACTOR is responsible for placing the cover at the proper elevation where paving is to be installed and shall make all necessary adjustments so that the cover meets these requirements.
 - 4. After the structure and all appurtenances are in place and approved, and after any required disinfection or testing, backfill shall be placed to the original ground line or to the limits designated on the plans.

4.3 FIELD QUALITY CONTROL

- A. Vacuum Testing
 - 1. All Manholes, Wet wells, Junction Boxes or other water bearing structures shall be negative pressure vacuum tested prior to acceptance.
 - 2. Test procedure:
 - a. Plug all inlets and outlets with temporary plugs
 - b. Determine test time based on diameter and depth of structure
 - c. Pull vacuum on structure to 10 bar
 - d. Commence test time upon reaching 10 bar.
 - e. 1 Bar of vacuum loss is acceptable within the prescribed amount of time for the structure
 - 3. Repair structures which do not meet the above requirement with a method approved by the manufacturer and ENGINEER and re-test until passing.

4.4 PATCHES AND REPAIRS:

A. Patching of products, when required, shall be performed to industry standards for structural concrete with polymer concrete. Repairs shall be sound, permanent and flush with adjacent surface.

4.5 WARRANTY:

A. All labor and materials under the Precast Manufacturers contract shall be warranted by the Precast Manufacturer for a period of two (2) years after substantial completion.

B. A 50 year Warranty against corrosion shall be issued.

+ + END OF SECTION + +

SECTION 03740

CRACK REPAIR BY EPOXY INJECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall furnish all material, tools, equipment, appliances, transportation, labor and supervision required to repair cracks by the injection of an epoxy resin adhesive.

1.2 QUALITY ASSURANCE

- A. Qualifications for Epoxy Injection Staff:
 - 1. Manufacturer's Site Representative:
 - a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
 - b. Understands and is capable of explaining technical aspects of correct material selection and use.
 - c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
 - 2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
 - a. Licensed and certified by epoxy manufacturer.
 - b. Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection including 2,000 linear feet of wet crack injection to stop water leakage.
 - 3. CONTRACTOR shall retain the services of a qualified and authorized technical representative of the materials manufacturer to provide a site visit to specifically address the parameters of the repair and provide recommendations at the beginning of the installation and to make periodic visits to ensure that the work is performed in accordance with the manufacturer's recommendations and achieves the repair objectives.

1.3 SUBMITTALS

- A. Product Data: Submit copies of manufacturer's specifications and installation instructions for all materials and accessories including:
 - 1. Manufacturer's recommended surface preparation procedures and application instruction for epoxy adhesives.
 - 2. Installation instructions for repairing core holes with epoxy grout.
 - 3. Manufacturer's Certificate of Compliance: Certified test results for each batch of epoxy adhesive.
 - 4. Statements of Qualification for Epoxy Adhesive:
 - a. Manufacturer's site representative.
 - b. Injection applicator.
 - c. Injection pump operating technician.
 - 5. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Package adhesive material in new sealed containers and label with the following information:
 - 1. Manufacturer's name.
 - 2. Product name and lot number.
 - 3. Material Safety and Data Sheet, MSDS.
 - 4. Mix ratio by volume.
- B. Store adhesive containers at ambient temperatures below 100°F and above 45°F. Condition adhesive before use as recommended by the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Materials, equipment and accessories specified in this section shall be products of one of the following:
 - 1. Concresive Series, as manufactured by BASF Building Systems.
 - 2. Sikadur Series, as manufactured by Sika Corporation.
 - 3. Euco Series, as manufactured by Euclid Chemical Company.

2.2 EPOXY ADHESIVE

- A. Epoxy adhesive grout shall be a 100% solids 2-part water insensitive low-viscosity epoxy resin system.
- B. Epoxy shall be suitable for grouting both dry and damp cracks.
- C. Adhesive Properties:

7-day, Tensile Strength, psi	ASTM D638	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	1.0% min.
Compressive Yield Strength, 7 days @ 73°F, psi	ASTM D695	8,000 min.
Compressive Modulus, psi	ASTM D695	1.5x10 ⁵ min.
Heat Deflection Temperature, °F	ASTM D648	120 min.
Water Absorption @ 24 hours, percent	ASTM D570	1.0% max.
Bond Strength @ 2 days, psi	ASTM C882	1,000 min.
Bond Strength @ 14 days, psi	ASTM C882	1,500 min.

2.3 SURFACE SEAL

- A. The surface seal material is that material used to confine the injection adhesive in the fissure during injection and cure.
- B. The surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.
- C. Capable of removal after injection adhesive has cured.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean cracks in accordance with epoxy adhesive manufacturer's instructions.
- B. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign matter which may be detrimental to the integrity of the bond between the epoxy and the injection surface. Acids and corrosives used for cleaning shall not be permitted.
- C. Entry ports shall be provided along the crack at intervals of not less than the thickness of the concrete at that location, unless otherwise specified by the adhesive manufacturer.
- D. Unless the crack is in submerged concrete, remove any water that can be seen by visual inspection from the crack before the injection process, and remove water that appears during the injection process.
- E. Do not inject cracks when the temperature of the concrete is below freezing and moisture conditions indicate the possibility of ice on the internal surfaces of the crack.
- F. Do not inject adhesive if the temperature of the concrete is not within the range of application temperatures recommended by the manufacturer of the adhesive.

3.2 INSTALLATION

- A. Sealing: Apply surface seal in accordance with manufacturer's instructions to designated crack face prior to injection. Seal surface of crack to prevent escape of injection epoxy.
- B. Entry Ports:
 - 1. Establish openings for epoxy entry in surface seal along crack.
 - 2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate the full thickness of the wall.
 - 3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
 - 4. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
 - a. Cracks extend entirely through wall.
 - b. Backfill of walls on one side.
 - c. Difficult to excavate behind wall to seal both crack surfaces.
 - d. Core drill to verify epoxy depth where only one side of wall is exposed.
- C. Epoxy Injection:
 - 1. Condition epoxy at a minimum of 70°F, or as recommended by the manufacturer.
 - 2. Start injection into each crack at lowest elevation entry port.
 - 3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
 - 4. Plug first port and start injection at second port until adhesive flows from next port.
 - 5. Inject entire crack with same sequence.

- D. Finishing:
 - 1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.
 - 2. Remove surface seal from cured injection adhesive.
 - 3. Finish crack face flush with adjacent concrete.
 - 4. Indentations or protrusions caused by placement of entry ports are not acceptable.
 - 5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.
- E. Equipment:
 - 1. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.
 - 2. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.
 - 3. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 160 psi.
 - 4. Do not use batch mix pumps.

3.3 FIELD QUALITY CONTROL

- A. Injection Pressure Test:
 - The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge pail. The Operator shall engage the equipment shut-off nozzle valve and subsequently bump the onoff switch while monitoring pressure on psi gauge until the pressure reaches 200 psi. Pressure gauge shall be monitored for one minute. If pressure is maintained between 190 – 200 psi, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, CONTRACTOR shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.
 - 2. The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.
 - 3. The adequacy and accuracy of the equipment shall be solely the responsibility of CONTRACTOR.
- B. Metering Accuracy Ratio Test:
 - 1. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A & B reservoirs full height. After filling reservoirs, the A & B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute at 160 psi discharge pressure.
 - 2. The ratio test shall be run for each injection unit at the beginning of every shift that the unit is used in the work of crack repair and when injection work has stopped for more than 1 hour.
- C. Proof of Ratio and Pressure Test:

- 1. At all times during the course of the work CONTRACTOR shall keep complete and accurate records available to ENGINEER of the pressure and ratio tests specified above.
- In addition, ENGINEER at any time without prior notification of CONTRACTOR, may request CONTRACTOR to conduct the tests specified above in the presence of ENGINEER.
- D. Daily Log
 - 1. Maintain a written daily log for each day of injection work that includes:
 - a. Ambient temperatures at the start and end of the workday and 4 hours after the end of the workday.
 - b. Weather conditions, such as rain, snow, and wind, including changes during the shift.
 - c. Crack cleaning methods, if any, including locations.
 - d. Record of injection adhesive, including manufacturer, product and batch number, and amount used each day.
 - e. Signature and printed name of person responsible for record keeping.
- E. Core Testing
 - 1. Initial Cores:
 - a. Obtain 4-inch diameter cores for the full crack depth taken from ENGINEER selected locations.
 - b. Visual inspection for depth of penetration:
 - 1) Three cores from the first 100-feet and one core for each 100-feet thereafter.
 - 2) It is permitted to obtain 2-inch cores if they are only used to verify adhesive penetration.
 - c. Splitting tensile strength per ASTM C496:
 - 1) One core for the first 100-feet and once core for each 75-feet thereafter.
 - d. Mark each of the cores with a "T" for top or "B" for bottom for cores taken vertically, or "H" for cores taken horizontally.
 - e. Mark the respective end of the core with the letters "IS" (injection side) to indicate the side from which the injection was performed.
 - 2. Test Requirements:
 - a. Adhesive Penetration: Minimum of 90% of the crack shall be full of epoxy adhesive.
 - b. Splitting tensile strength / Compression Test: Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
 - 3. Acceptance Criteria:
 - a. If initial cores pass the tests as specified, epoxy adhesive injection Work at the area represented by cores will be accepted.
 - b. If adhesive penetration or bond strength are not acceptable, stop injection Work until the areas represented by the testing are accepted, and changes in procedures or materials for continued injection Work have been accepted. Reinject adhesive in the locations where injection has not been acceptable. If partial injection has blocked all access to the cracks on surfaces that can be reinjected, drill injection holes into the concrete to intersect the crack in their void areas.
- F. Core Hole Repair:
 - 1. Fill core holes with epoxy grout as required by the Project Specifications. Finish surface shall blend with adjacent concrete.

+ + END OF SECTION + +

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SECTION 05051

ANCHORS, INSERTS, AND DOWELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes all post-installed anchors and inserts required to anchor parts of the Work to supporting concrete or masonry construction, and plaster. This Section also includes adhesives for anchoring reinforcing dowels into existing concrete.

1.2 REFERENCES

A. American Society for Testing and Materials

- 1. ASTM A36, Standard Specification for Carbon Structural Steel.
- 2. ASTM A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
- 3. ASTM D746, Standard Test Method for Brittleness of Temperature of Plastics and Elastomers by Impact
- 4. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique
- 5. ASTM D1525, Standard Test Method for Vicat Softening Temperature of Plastics
- B. 2018 International Building Code (IBC)
- C. American Concrete Institute (ACI)
 - 1. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete
 - 2. ACI 355.4, Qualification of Post-installed Adhesive Anchors in Concrete

1.3 SYSTEM DESCRIPTION

- A. Provide the size, type, and length of anchor shown on the drawings or, if not shown, as specified in the detailed sections of these specifications.
- B. When the size, length or load carrying capacity of an anchor bolt, expansion anchor, toggle bolt, or concrete insert is not shown or specified, provide the size, length and capacity required to carry the design load times a minimum safety factor of 4.
- C. For equipment anchors, if the design load is not specified by the manufacturer, provide anchors of diameter no less than the diameter of the hole minus 3/16 inch. When the design load is not specified by the manufacturer, provide structural calculations in accordance with Section 01610.

1.4 SUBMITTALS

A. Product Data: Submit for approval copies of material certification, manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.

B. Installer's Qualifications: When installing adhesive anchors subject to sustained tension loading or when specifically noted in the Drawings, submit for approval copies of the installer's qualifications certified by the ACI/CRSI Adhesive Anchor Installer Certification program.

1.5 QUALITY ASSURANCE

A. Post-installed concrete anchors shall be ICC approved for seismic applications in cracked concrete and prequalified in accordance with ACI 355.2 or ACI 355.4.

PART 2 - PRODUCTS

2.1 ANCHOR BOLTS

- A. Nonsubmerged Use in areas of wet use, washdown areas, or areas outside heated buildings:
 - 1. Stainless steel Type 316, unless otherwise shown.
 - 2. Diameter, Length and Bend Dimensions: As required by equipment or machinery manufacturer. Unless otherwise required, provide 3/4–inch minimum diameter by 12-inches long and other geometry as shown.
 - 3. Furnish A320 nuts and washers of same material for each bolt, unless otherwise shown.
 - 4. Provide sleeves as required or as shown for location adjustment.
- B. Submerged Use:
 - 1. Submerged use is defined as any connection 1 foot 6 inches below the normal water surface elevation in a water holding basin.
 - 2. As specified for nonsubmerged use, for equipment, machinery or other connections except as follows:
 - a. Coating of anchor bolt threads is not required.
 - b. Where threads are covered with fusion bonded coating, provide nut of proper size to fit and provide connection of equal strength to embedded bolt.
- C. For anchoring fabricated metalwork, structural steel, or other components where connections will be protected or dry:
 - 1. Galvanized Steel, 36 ksi, minimum.
 - 2. Minimum Size: ³/₄-inch diameter by 12-inch long, unless otherwise shown.
 - 3. At base plates with grout pads, furnish two nuts and two washers per bolt of same material as bolt, unless otherwise shown.

2.2 ANCHOR BOLT SLEEVE

- A. High Density Polyethylene Plastic:
 - 1. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
 - 2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor blot projection.
 - 3. Material requirements shall conform to the following:
 - a. Plastic: High density polyethylene.
 - b. Density: 0.956, ASTM D1505.
 - c. Vicant Softening Point: 256°F, ASTM D1525

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- d. Brittleness Temperature: -180°F, ASTM D746
- B. Fabricated Steel Sleeve:
 - 1. Material: A36 steel.
 - 2. Dimensions, welding, and sizes as shown.

2.3 STAINLESS STEEL FASTENERS LUBRICANT (ANTISEIZING)

- A. Provide for stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners.
- B. Lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper as manufactured by:
 - 1. Loc Tite Co., Permatex.
 - 2. Or equal

2.4 CONCRETE INSERTS

- A. For vertical support of grating or floor plate, provide cast-in metal fabrications as shown.
- B. Except as permitted below, or as otherwise shown, provide malleable iron inserts for hanging piping and conduit from concrete ceilings and soffits. Comply with Federal Specification WW-H-171-E (Type 18). Provide those recommended by the manufacturer for the required loading.
- C. Obtain inserts in sufficient time so as not to delay concrete or masonry work.
- D. Product and Manufacturer: Provide inserts of one of the following:
 - 1. Figure 282, as manufactured by Anvil/Grinnell.
 - 2. Sharktooth Insert, as manufactured by Hohmann and Barnard, Incorporated.
 - 3. Or equal.

2.5 ADHESIVE (EPOXY) ANCHORS AND DOWELS

- A. Provide adhesive anchors where specifically shown and where adhesive anchors are allowed. Unless otherwise shown, adhesive anchors are allowed for anchoring:
 - 1. Supports for pipe, conduit, and electrical boxes, devices, and panels, on floors and walls
 - 2. Handrails, guardrails, sunshades, stairs,
 - 3. Fixtures and equipment on floors and walls, and
 - 4. Single pipes and conduits <2 inch in diameter to ceilings and soffits.
- B. Adhesive shall be epoxy resin. Vinylester resin anchors are NOT allowed.
- C. Product and Manufacturer: Provide one of the following:
 - 1. Installation to Concrete:
 - a. HIT-HY 200 as manufactured by Hilti, Inc.
 - b. SET-3G as manufactured by Simpson Strong-Tie, Inc.
 - c. Or approved equal meeting ACI 355.4.
 - 2. Installation to solid-grouted Masonry:
 - a. HIT-HY 270 as manufactured by Hilti, Inc.
 - b. SET as manufactured by Simpson Strong-Tie, Inc.

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2.6 EXPANSION ANCHORS

- A. Provide expansion anchors only where specifically shown and where expansion anchors are allowed. Unless otherwise shown, and except as noted below, expansion anchors are allowed for anchoring:
 - 1. Supports for pipe, conduit, and electrical boxes, devices, and panels, to floors and walls.
 - 2. Handrails, guardrails, and sunshades.
 - 3. Fixtures and equipment which have no moving parts, to floors and walls.
- B. Expansion anchors are NOT allowed in any submerged or chemical containment areas.
- C. Leveling nuts shall not be used with expansion anchors. If leveling nuts are required, provide adhesive anchors, unless otherwise shown.
- D. Wedge anchors: Provide one of the following:
 - 1. Installation to Concrete:
 - a. Hilti Kwik Bolt TZ by Hilti, Inc.
 - b. Strong-Bolt 2 by Simpson Strong-Tie, Inc.
 - c. Or approved equal meeting ACI 355.2.
 - 2. Installation to solid-grouted Masonry:
 - a. Hilti Kwik Bolt-3 by Hilti, Inc.
 - b. Wedge-All by Simpson Strong-Tie, Inc.
 - c. Or approved equal.
- E. Drop-in anchors, only where specific shown on the drawings: Provide one of the following:
 - 1. HDI by Hilti, Inc.
 - 2. Drop-In by Simpson Strong-Tie, Inc.
 - 3. Or equal.

2.7 SCREW ANCHORS

- A. Provide screw anchors only where specifically shown. Provide ICC approved screw anchors suited for seismic and cracked concrete applications.
- B. Installation to Concrete or Masonry:
 - 1. KH-EZ by Hilti, Inc.
 - 2. Titen HD by Simpson Strong-Tie, Inc.
 - 3. Or approved equal.

2.8 TOGGLE BOLTS

- A. Provide toggle bolts only where specifically shown, to fasten single pipes and conduits <1 inch and equipment weighing less than 50 lbs (4-bolts required) to hollow walls.
- B. Provide spring-wing toggle bolts, with two-piece wings, carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.
- C. Product and Manufacturer: Provide toggle bolts of one of the following:

- 1. The Rawlplug Company, Incorporated.
- 2. Haydon Bolts, Incorporated.
- 3. Or equal.

2.9 OTHERS

- A. Powder actuated fasteners and other types of anchors not specified herein shall not be used, unless approved by ENGINEER.
- 2.10 ACCESSORIES
 - A. Provide Belleville washers, or approved equal, at anchorage connections used to transfer anchorage loads at sheet metal equipment housings.

PART 3 - EXECUTION

3.1 INSTALLATION OF ANCHORS

- A. Obtain anchor bolts in sufficient time so as not to delay concrete or masonry work.
- B. Adhesives shall be stored and installed at the service temperature ranges recommended by the manufacturer.
- C. Locate and accurately set the anchor bolts using templates or other devices as necessary.
- D. Protect threads and shank from damage during installation of equipment and structural steel.
- E. Post-installed anchors are NOT acceptable substitutes for cast-in-place anchor bolts.
- F. Assure that embedded items are protected from damage and are not filled in with concrete.
- G. Unless otherwise shown, the minimum diameter of anchor bolts for structural steel is $\frac{3}{4}$ inch, and for other applications, $\frac{3}{8}$ inch.
- H. Unless otherwise shown, provide the following minimum embedment, where "d" is the nominal anchor diameter:
 - 1. Cast-in-place anchors: 12d.
 - 2. Adhesive anchors: 12d.
 - 3. Expansion anchors: 8d.
- I. Unless otherwise shown, provide a minimum edge distance equal to six times the bolt diameter for adhesive anchors, eight times the bolt diameter for expansion anchors and a bolt spacing equal to twelve times the bolt diameter.
- J. Concrete shall have a minimum age of 21 days at the time of post-installed anchor installation.
 - 1. Concrete temperature at the time of adhesive anchor installation shall be at least $50^{\rm o}{\rm F}.$

- K. Existing reinforcing bars in the concrete structure may conflict with specific anchor locations. Unless noted on the Drawings that the bars can be cut, the contractor shall review the existing structural drawings and shall undertake to locate the position of the reinforcing bars at the locations of the concrete anchors by ferroscan, ground penetrating rebar (GPR), x-ray, chipping or other means.
- L. Drilling equipment used and installation of post-installed anchors shall be in accordance with the manufacturer's printed instructions.
- M. For the adhesive and expansion anchors, CONTRACTOR shall comply with the manufacturer's printed installation instructions on the drilled hole diameter and depth.
- N. CONTRACTOR shall properly clean out the hole utilizing a wire brush and compressed air in accordance with the manufacturer's printed installation instructions to remove all loose material from the hole, prior to installing adhesive or expansion anchors. Drilled and cleaned anchor holes shall be protected from contamination until the anchor is installed. A drilled anchor hole shall be re-cleaned assuming the hole was just drilled, if in the opinion of ENGINEER or Inspector that the hole has become contaminated after initial cleaning.
- O. Unless otherwise indicated by the manufacturer, adhesive shall be dispensed through a tube or cartridge extension, beginning at the maximum depth of the hole and withdrawn as adhesive is injected, followed by insertion and rotating the anchor to the specified depth. Where necessary, spaces around anchors at the surface shall be sealed at horizontal to vertically overhead locations to prevent loss of the adhesive during curing.
- P. Anchors to be installed in the adhesive shall be clean, oil-free, and free of loose rust, paint, or other coatings.
- Q. Installed anchors shall be securely fixed in-place to prevent displacement. Unless shown otherwise on the Drawings, anchors shall be installed perpendicular to the concrete surface.
- R. Reinforcing adhesive dowel bars or all-threaded adhesive bars shall not be bent after being adhesively embedded in hardened, sound concrete.
- S. In lieu of the use of stacked standard washers, if threads of an anchor bolt protrude beyond the attachment, the installers shall use a fabricated filler plate of equal or greater size of the washer. Hole on the filler plate shall be 1/16" (or 2 to 3 mm) greater than the bolt size. Coat as appropriate in accordance with the material and installation location requirements.

3.2 FIELD QUALITY CONTROL

- A. Anchors shall be installed by qualified personnel in accordance with the manufacturer's printed installation instructions. Installation of adhesive anchors shall be performed by personnel trained to install adhesive anchors.
- B. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by personnel certified by the ACI/CRSI Adhesive Anchor Installer Certification program.

- C. CONTRACTOR shall employ a special inspector to perform field inspection services in accordance with Chapter 17 of the IBC for all post-installed anchors.
 - 1. The special inspector must be periodically on the jobsite during post-installed anchor installation.
 - 2. Adhesive anchors installed to resist sustained tension loads shall be continuously inspected during installation by an inspector specially approved for that purpose by the building official.
- D. CONTRACTOR shall employ a testing laboratory to perform field quality testing of installed adhesive anchors. A minimum of 10% of randomly selected adhesive anchors and reinforcing dowel bars greater than 3/8 inch diameter are to be tension tested to the least of 50 percent of expected adhesive ultimate bond strength or 80 percent of steel yield strength of the anchor rod. Maintain the proof load at the required load level for a minimum of 10 seconds.
 - 1. Tension testing shall be performed in accordance with ASTM E488.
 - 2. The independent testing laboratory shall submit an anchorage testing plan for approval to ensure the testing requirements are fulfilled.
 - 3. If failure of more than 5 percent of the tested anchors or reinforcing dowel bars occurs, CONTRACTOR will be required to pay for the costs involved in testing the remaining 90%.
 - a. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure.
- E. CONTRACTOR shall correct improper workmanship, remove and replace, or correct as instructed by the ENGINEER, all anchors or bars found unacceptable or deficient, at no additional cost to the OWNER.
- F. The independent testing and inspection agency shall complete a report on each area. The report should summarize the observations made by the inspector and be submitted to ENGINEER.
- G. Provide access for the testing agency to places where Work is being produced so that required inspection and testing can be accomplished.

+ + END OF SECTION + +

SECTION 05500

MISCELLANEOUS METALS

PART 1 - GENERAL

1.1 SUMMARY

A. Work necessary to furnish and install, complete, fabricated metalwork and castings as shown or as required to secure various parts together and provide a complete installation.

1.2 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings for the fabrication and erection of the miscellaneous metal Work. Include plans, elevations and details of sections and connections. Clearly show all field connections. Show anchorage and accessory items.
- B. Product Data: Submit copies of manufacturer's specifications, load tables, dimensions, diagrams, anchor details, and installation instructions for manufactured products.
- C. Samples: Submit representative samples of manufactured products.

1.3 QUALITY ASSURANCE

- A. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of the Work.
- B. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units to the extent necessary for shipping limitations. Clearly mark units for reassembly and coordinated installation.
- C. Qualifications: Qualify welding operators in accordance with requirements of current AWS Standard Performance Qualification Procedures in the applicable structural welding code.
 1. Qualification Tests: Performed by a recognized testing laboratory.
- D. Certification: Certify welders of structural and reinforcing steel for all positions of welding in accordance with such procedure.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Like Items of Materials: Provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
- B. Lifting Lugs: Provide on equipment and equipment components weighing over 100 pounds.

- C. Furnish miscellaneous items:
 - 1. Miscellaneous metalwork and castings as shown, or as required to secure various parts together and provide a complete installation.
 - 2. Items specified herein are not intended to be all-inclusive. Provide metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.

2.2 MATERIALS

- A. Carbon steel structural shapes:
 - 1. Wide flange sections: ASTM A992 Grade 50.
 - 2. Steel pipe columns: ASTM A53 Grade B.
 - 3. Hollow Structural Sections (HSS): ASTM A500 Grade B.
 - 4. Plates, Angles, Channels, and S Shapes: ASTM A36.
- B. Stainless Steel:
 - 1. Plates and Sheets: ASTM A240, Type 304L or 316
 - 2. Structural shapes: ASTM A276, A479 or A1069, Type 304L or 316.
 - 3. Fasteners and fittings: ASTM A320, Type 316
 - a. Where stainless steel bolts are in contact with dissimilar metals provide insulating sleeves and phenolic washers to electrically isolate the bolts and nuts.
- C. Aluminum, Structural Shapes and Plates: Alloy 6061-T6, meeting Aluminum Assoc. Specification for Aluminum Structures
- D. Cast Iron: A48, Class 30
- E. Light Gauge Steel Framing:
 - 1. Manufactured by SSMA ICC ESR-3064P, or equivalent, to meet the requirements of AISI S100.
 - 2. ASTM A570 or A446 with a minimum yield strength of 33 ksi for 18 gauge and 20 gauge, 50 ksi for 14 gauge and 16 gauge.
 - 3. Framing members shall have the section properties as listed on the Drawings.
- F. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 - 1. Quenched and tempered medium carbon steel bolts, nuts and washers, complying with ASTM A325 or:
 - 2. Quenched and tempered alloy steel bolts, nuts and washers, complying with ASTM A490.
 - 3. Provide two ASTM F436 washers for all bolts.
 - 4. Provide beveled washers at connections of sloped/tapered sections.
 - 5. Unless noted otherwise, high-strength fasteners shall be used for all non-stainless steel fasteners.
- G. Cast-in-Place Anchor Rods:
 - 1. ASTM F1554, Grade 36 with weldability supplement S1, galvanized, unless shown otherwise.
 - 2. Provide ASTM F436 washers at all nuts unless shown otherwise.
 - 3. Provide anchor bolt sleeves as required or as shown for location adjustment.
 - 4. Provide stainless steel anchors where shown on the Drawings or listed in another specific specification section.

- H. Galvanizing:
 - 1. Zinc coated hardware: ASTM A153.
 - 2. Fabrications: ASTM A123.
 - 3. Members designated as galvanized on the drawings or as directed by ENGINEER shall be galvanized after fabrication in accordance with ASTM A385. Weight of zinc coating shall not be less than 2.5 ounces per square foot of actual surface and have a coating thickness of 0.0042 inch. Coating weight will be subject to verification by ENGINEER. Thickness of coating will be measured by means of a magnetic thickness gauge.
 - 4. Each fabricated assembly shall be totally immersed in the galvanizing bath. The galvanizing procedure shall be such as to avoid distortion of the assembly. Straightening of members after galvanizing will not be permitted. Assemblies shall be held in the galvanizing bath until the temperature of the assembly is equal to the temperature of the bath. All deviations shall require approval by ENGINEER.
 - 5. Any galvanized surface which has the coating removed for any cause shall be touched up with a zinc-rich cold galvanizing compound so that the entire surface has a uniform coating of 2.5 ounces of zinc per square foot.
 - 6. Galvanized work shall be subject to inspection by ENGINEER at any time to ensure strict compliance with this specification. Any areas found to show defects or signs of improper galvanizing application will be rejected. Repairs shall be made by CONTRACTOR without additional cost to OWNER.
- I. Surface preparation and Finish:
 - 1. Steel: Where not indicated to be galvanized, steel shall be primed in the shop. Comply with Section 09900, Painting.

2.3 ALUMINUM STAIR TREAD

- A. Extruded bearing bars positioned and locked by cross bars. Treads shall be manufactured with a defined visible abrasive nosing and end plates capable of welding or bolting to stair stringers.
- B. Material:
 - 1. All supports, cross members, etc. shall be aluminum
 - 2. Bearing bars: Alloy 6061-T6 or Alloy 6063-T6, conforming to ASTM B221.
 - 3. Fasteners and fittings: ASTM A320, Type 316
 - a. Where stainless steel bolts are in contact with dissimilar metals provide insulating sleeves and phenolic washers to electrically isolate the bolts and nuts.
- C. Manufacturer:
 - 1. Grating Pacific.
 - 2. Borden Metal Products.
 - 3. Ohio Grating.

2.4 ANCHOR BOLT SLEEVE

- A. High Density Polyethylene Plastic:
 - 1. Single unit construction with deformed sidewalls such that the concrete and grout lock in place.
 - 2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor blot projection.
 - 3. Material requirements shall conform to the following:
 - a. Plastic: High density polyethylene.

- b. Density: 0.956, ASTM D1505.
- c. Vicant Softening Point: 256°F, ASTM D1525
- d. Brittleness Temperature: -180°F, ASTM D746
- B. Fabricated Steel Sleeve:
 - 1. Material: A36 steel.
 - 2. Dimensions, welding, and sizes as shown.

2.5 FABRICATIONS

- A. Miscellaneous Framings and Supports:
 - 1. Fabricate units to the sizes, shapes, and profiles shown, or if not shown, of the required dimensions to receive the adjacent gratings, plates, tanks, doors, or other work to be retained by the framing.
 - 2. Except as otherwise shown, fabricate from structural shapes, plates, and bars of compatible material, all-welded construction, using mitered corners, welded brackets and splice plates, and a minimum number of joints for field connection. Cut, drill, and tap units to receive hardware and other items to be anchored to the work.
 - 3. Equip units with integrally welded anchors for casting into concrete or integrating into masonry. Furnish inserts for casting in, if units must be installed after concrete or grout is placed. Anchor spacing shall be 24" on-center, unless otherwise shown.
 - 4. Galvanize where shown.
- B. Miscellaneous Fabricated Metals:
 - 1. The following additional items are listed as a guide. Some items on list may not be required, and list may not be all-inclusive. Submittal data for materials and products must be approved before they are incorporated in the work.
 - a. Access Walkway
 - b. Aluminum Stairways.
 - c. Float Switch Supports
 - d. Lifting Eyes.
 - e. Pipe Supports.
 - f. Steel Bases and Anchors.
 - g. Weir Plates.
- C. Stainless Steel Fabrication: Following welding fabrication all stainless steel assemblies shall be cleaned, descaled and passivated in accordance with ASTM A380.
- D. Anchors, Fasteners, and Fittings: Provide zinc-coated carbon steel for steel fabrications, and stainless steel for aluminum and stainless steel fabrications, unless shown otherwise.
- E. Pipe Sleeves
 - 1. Provide as follows:
 - a. Hot-dip galvanized, Schedule 40 steel pipe sleeves where shown for piping passing through concrete or masonry.
 - b. Holes drilled with rotary drill may be provided in lieu of sleeves in existing walls.
 - c. Provide a center flange for water stoppage on sleeves in exterior or water-bearing walls.
 - d. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

PART 3 - EXECUTION

3.1 FABRICATION

- A. General:
 - 1. Exposed Surfaces Finish: Smooth, sharp, well-defined lines.
 - 2. Provide necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
 - 3. Conceal fastenings where practical.
 - 4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
 - 5. Fabricate materials as specified.
 - 6. Weld connections, except where bolting is directed.
 - 7. Methods of fabrication not otherwise specified or shown shall be adequate for stress and as approved.
 - 8. Grind exposed edges of welds smooth on walkways, guardrails, handrails, stairways, channel door frames, steel column bases and where shown.
 - 9. Round sharp edges to 1/8-inch minimum radius. Grind burrs, jagged edges, and surface defects smooth.
- B. Aluminum:
 - 1. Fabricate as shown, and in accordance with the Aluminum Association Standards and manufacturer's recommendations as approved.
 - 2. Grind smooth sheared edges exposed in finished work.

3.2 WELDING

- A. General
 - 1. Meet codes for Arc and Gas Welding in Building Construction of the AWS and AISC for techniques of welding employed, appearance, quality of welds made, and the methods of correcting defective work.
 - 2. Welding Surfaces: Free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain.
 - 3. A light film of linseed oil may likewise be disregarded.
 - 4. Do not weld when temperature of base metal is lower than zero degrees F.
 - 5. Finished members shall be true to line and free from twists.
 - 6. Prepare welds and adjacent areas such that there is:
 - a. No undercutting or reverse ridges on the weld bead.
 - b. No weld spatter on or adjacent to the weld or any other area to be painted.
 - c. No sharp peaks or ridges along the weld bead.
 - 7. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
- B. Welding Operators: As specified in PART 1, Article 1.3 QUALITY ASSURANCE.

3.3 INSTALLATION

A. Set units accurately in location, alignment, and elevation, level, plumb, true, and square, measured from established lines and levels. Brace or anchor temporarily in formwork where units are to be built into concrete, masonry, or similar construction.

- B. Anchor securely as shown or as required for the intended use, using concealed anchors wherever possible.
- C. Fit exposed edges accurately together to form tight, hairline joints. Do not weld, cut, or abrade the surfaces of galvanized or anodized units which are intended for bolted or screwed connections.
- D. Field Welding: Where field welding is necessary, grind joints smooth and touch-up the shop paint. Comply with the applicable provisions of AWS D1.1 for the procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding.
- E. Field Coat all miscellaneous ferrous and steel metals per Specification Section 09900 Painting, System 300.
- F. Where aluminum is in contact with dissimilar metals, or embedded in masonry or concrete, protect surfaces as specified in Section 09900 Painting, System 305.

+ + END OF SECTION + +

DIVISION 08

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SECTION 08200

METAL SECTIONAL OVERHEAD DOORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide and install interior face-mounted, insulated overhead sectional steel service door assemblies, completely weather sealed and provided with all necessary accessories and components for a complete installation.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data sheets on each product to be used, including:
 - a. Preparation instructions and recommendations.
 - b. Storage and handling requirements and recommendations.
 - c. Installation methods.
- B. Shop Drawings: Indicate plans and elevations including opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- E. Quality Control:
 - 1. Installer's factory authorization.
 - 2. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Qualifications: Experienced, factory authorized installer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store products in manufacturer's unopened labeled packaging until ready for installation.
- B. Protect materials from exposure to moisture until ready for installation.
- C. Store materials in a dry, ventilated weathertight location.

1.5 DESIGN/PERFORMANCE REQUIREMENTS

A. Wind Loads: Design and size components to withstand loads caused by pressure and suction of wind acting normal to plane of wall as calculated in accordance with applicable code.

- 1. Design pressure of 20 lb/sq ft.
- B. Single-Source Responsibility: Provide doors, tracks, motors (where required), and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

PART 2 - PRODUCTS

2.1 METAL COILING OVERHEAD DOOR

- A. Features:
 - 1. Door Assembly: Metal/foam/metal sandwich panel construction, with EPDM thermal break and ship-lap design.
 - a. Panel Thickness: 2 inches (5 mm).
 - b. Exterior Surface: Ribbed, textured.
 - c. Exterior Steel: .015 inch (4 mm), hot-dipped galvanized.
 - d. End Stiles: 16 gauge with thermal break.
 - e. Standard Springs: 10,000 cycles. (High cycles.)
 - f. Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.
 - g. Thermal Values: R-value of 17.50; U-value of 0.057.
 - h. Air Infiltration: 0.08 cfm at 15 mph; 0.08 cfm at 25 mph.
 - i. High-Usage Package: Provide with optional high-usage package.
 - 2. Finish and Color: Two coat baked-on polyester
 - a. Interior: By OWNER
 - b. Exterior: By OWNER
 - 3. Windload Design: ANSI/DASMA 102 standards to meet applicable code.
 - 4. Hardware: Galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.
 - 5. Lock:
 - a. Interior mounted slide lock.
 - 6. Weatherstripping: EPDM rubber bulb-type strip at bottom. (Header seal and jamb weatherstripping.)
 - a. EPDM rubber bulb-type strip at bottom.
 - b. Flexible Jamb seals.
 - c. Flexible Header seal.
 - 7. Track: Provide track as recommended by manufacturer to suit loading required and clearances available.
 - 8. Manual Operation: Chain hoist.
- B. Manufacturers and Products:
 - 1. Overhead Door Corp.; 591 Series Thermacore Insulated Steel Door.
 - 2. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine the substrates and conditions under which the Work is to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of

the Work. Do not proceed with the Work until any unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

- A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.
- B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.
- C. Anchor assembly to wall construction and building framing without distortion or stress.
- D. Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- E. Fit and align door assembly including hardware.
- F. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

3.3 TESTING AND ADJUSTING

- A. Upon completion of installation including the work by other trades, test and adjust doors to operate easily, free from warp, twist or distortion.
- B. Test the door in presence of ENGINEER to demonstrate proper operation.

3.4 ADJUSTING AND CLEANING

- A. Adjust doors and operators for smooth, easy operation.
- B. Repair any damage to paint or finishes.
- C. Leave door assemblies clean and remove all debris from work area.

+ + END OF SECTION + +

SECTION 08305

ACCESS HATCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide all materials, equipment, and accessories to furnish and install the following access hatches:
 - 1. Flush floor hatches for all structures.

1.2 QUALITY ASSURANCE

A. Warranty: Provide a 2-yrs warranty on all hatches from date of installation. Warranty shall cover defects in workmanship, design, and materials. If any component should fail during the warranty period, it shall be corrected and the unit restored to service at no expense to the OWNER.

1.3 DESIGN REQUIREMENTS

- A. In Rights-of-way, service roads, and driveways, and where designated on the drawings, hatches shall be designed for H20 wheel loading.
- B. In other locations and where designated as "Standard" hatches shall be designed for a live load of 300 pounds per square foot.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Detailed drawings showing component and assembly dimensions, location of connections, weights of all equipment, installation details, and accessory details.
- B. Product Data:
 - 1. Descriptive literature, specifications, and engineering data.
 - 2. Materials of construction for all components and accessories.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All equipment and accessories shall be properly protected during shipment such that no damage or deterioration shall occur between shipment and installation.
 - 1. Finished surfaces shall be protected by wooden blanks.
 - 2. Finished ferrous metal surfaces not painted shall be protected from corrosion.
 - 3. Each box and package shall be clearly marked with the contents and total weight.
- B. Manufacturer shall provide any special storage and handling instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted.
 - 1. Aluminum hatches:
 - a. USF
 - b. Or Approved Equal.

2.2 MATERIALS

- A. Unless otherwise noted, all access hatches shall be constructed of aluminum.
- B. Aluminum hatches shall be provided with aluminum frames and stainless-steel hardware.

2.3 FLUSH FLOOR HATCHES

- A. General
 - 1. Doors shall be pre-assembled from the manufacturer.
 - 2. Covers shall open 90 to 180 degrees and be equipped with a hold open arm which automatically locks the cover in the open position with recessed padlock/HASP assembly.
 - 3. Covers shall be fitted with the required number and size of compression spring or torsion operators. Springs shall have an electrocoated acrylic finish. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material.
 - 4. Hardware:
 - a. Hinges shall pivot so that the cover does not protrude into the channel frame.
 - b. A Type 316 stainless steel snap lock with fixed handle shall be mounted to the underside of the cover.
 - 5. Entire door and all hardware components shall be highly corrosion resistant.
 - 6. Doors shall be sealed with an EPDM gasket for odor control purposes.
 - 7. Doors shall all drain into the below structure.
 - 8. Doors shall be 300 PSF rated unless otherwise specified.
- B. **H-100**: Single leaf flush floor hatch for walking areas (up to 42-inch by 42-inch)
 - 1. Furnish and install where indicated on drawings flush floor access hatch. The hatch shall be single leaf.
 - 2. Service: Floor hatch for use in areas of foot traffic.
 - 3. Features:
 - a. Material:
 - 1) Cover: ¼-in aluminum diamond pattern plate or ¼-in steel diamond pattern plate
 - 2) Frame: ¼-in extruded aluminum or ¼-in steel
 - b. The cover shall be reinforced to support a minimum live load of 300 lb/ft² with a maximum deflection of 1/150th of the span.
 - c. Integral safety grating (epoxy coated steel)
 - d. Hinges:
 - 1) Aluminum cover: Provide heavy forged aluminum hinges with a minimum ¹/₄in diameter Type 316 stainless steel pin.
 - 2) Steel cover: Provide heavy forged brass hinges with a minimum 3/8-in diameter Type 316 stainless steel pin

- C. **H-101**: Double leaf flush floor hatch for walking areas (over 42-inch by 42-inch)
 - 1. Furnish and install where indicated on drawings flush floor access hatch. The hatch shall be double leaf.
 - 2. Service: Floor hatch for use in areas of foot traffic.
 - 3. Features:
 - a. Material:
 - 1) Cover: ¼-in aluminum diamond pattern plate or ¼-in steel diamond pattern plate
 - 2) Frame: ¼-in extruded aluminum or ¼-in steel
 - b. The cover shall be reinforced to support a minimum live load of 300 lb/ft² with a maximum deflection of 1/150th of the span.
 - c. Integral safety grating (epoxy coated steel)
 - d. Hinges:
 - 1) Aluminum cover: Provide heavy forged aluminum hinges with a minimum ¹/₄in diameter Type 316 stainless steel pin.
 - 2) Steel cover: Provide heavy forged brass hinges with a minimum 3/8-in diameter Type 316 stainless steel pin

2.4 HATCH SCHEDULE

A. Hatches shall be installed based on the following schedule

В.					
Hatch No.	H-101	H-100			
Location	Wetwells	Valve Vault	Flowmeter Vault	Influent Splitter Structure	
Hatch Type	Double Leaf	Single Leaf	Single Leaf	Single Leaf	
Dimensions	6' x 4'	5′ x 5′	5′ x 5′	3' x 4'	
No. of Leaf Door	2	3	1		
Loading	300 lb/ft ²				
Fall Protection	Fall protection grating (aluminum).				
Drain	Trough frame with drain outlet				
Spring Assist	Compression spring operators for lift assist				
Slamlock	Yes				

В.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install in accordance with the manufacturer's recommendations and approved shop drawings. Install level and square with other construction, without warp or rack.

- B. Unless otherwise shown, hatches shall be cast integrally with concrete decks, and shall not be grouted in later.
- C. Coordinate precise location with equipment to be accessed thereby.
- D. Aluminum surfaces shall be protected with two heavy coats of asphaltic or zinc chromate paint, where they are in contact with concrete or masonry.

+ + END OF SECTION + +

DIVISION 09

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SECTION 09875

CONCRETE COATINGS FOR WASTEWATER STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide and install coatings on all interior concrete surfaces, as indicated herein, in the Specifications and on the Drawings.
- B. System shall be a multi-component resin-based mortar lining system specifically designed to protect the concrete surfaces of municipal wastewater structures from chemical attack. The main purpose of this membrane is to offer protection of the substrate from chemicals or gases that might cause deterioration.

1.2 QUALITY ASSURANCE

- A. Experience: Both coatings manufacturer and coatings installer shall have a minimum 5 years' experience in production and application, respectively, of specified products. Coatings installer shall be approved and endorsed, in writing, by coatings manufacturer.
- B. Regulations: Meet federal, state, and local requirements which apply to the work, including, but not limited to those regulations limiting the emission of volatile organic compounds.
- C. Coatings Manufacturer Recommendations: Coatings installer shall follow all recommendations of the coatings manufacturer regarding storage, handling, surface preparation, application of coatings, re-coat times, environmental conditions during storage, preparation and application of coatings, and all other coatings manufacturer recommendations.
- D. Warranty: Both Coatings Manufacturer and Coatings Installer shall provide a 2-years complete replacement warranty for all coatings. Manufacturer shall provide 5-year warranty for long-term performance of coatings in addition to 2-years warranty.

1.3 SUBMITTALS

- A. Shop Drawings: Coatings Manufacturer shall submit for approval the following:
 - 1. Copies of manufacturer's technical information and application instructions for each material proposed for use. Specify exactly which product is being proposed for each coating type (as specified below). This may be accomplished through a reference table along with information on the various products, or by a separate, tabbed section with information on products being submitted for each system in a separate tab of a binder. Submittal of general manufacturer's literature without detailing which product is proposed for each paint system will be unacceptable.
 - 2. Letter from the Coatings Manufacturer certifying the Coatings Installer as factory trained and qualified.
 - 3. Furnish copies of the final, approved submittal to the coatings installer so that it is clear which product is to be used for which each system.

- 4. Test reports from an independent testing laboratory confirming chemical resistance of coating for chemicals common to municipal wastewater treatment facilities.
- 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING
 - A. Protection: Protect all pre-coated items from coating damage during shipping.
 - B. Store products in accordance with manufacturer's directions.
 - C. Store products in a neat, orderly fashion. Protect products from damage. Protect storage area from damage from stored products.

PART 2 - PRODUCTS

2.1 PRODUCT AND MANUFACTURER:

- A. Sauereisen SewerGard
 - 1. Sewer Shield 150
 - 2. Sewergard 210XHB
 - 3. Raven 405
- B. Or approved equal.

2.2 SERVICE CONDITIONS AND PERFORMANCE

- A. Provide a 100% solids, VOC-free resin based coating system specifically formulated for wastewater applications.
 - 1. The lining system shall be a non-sagging application permitting repair of vertical, horizontal, and overhead surfaces.
 - The lining system shall provide an impermeable, high-strength, corrosion-resistant, monolithic lining for manholes, grit chambers, wetwells, wastewater channels, and related structures subject to attack from hydrogen sulfide and acid generated by microbiological sources.
- B. The lining system, including underlayment, primer and surface materials, shall be from a single manufacturer.
- C. Chemical Resistance (ASTM D 1308):
 - a. Reagent: 6% sulfuric acid solution.
 - b. Film Integrity: Unaffected.
- D. Coating Thickness: 125 mils thick, minimum.
- E. Texture: Semi-smooth for all surfaces.

2.3 PROPERTIES

- A. Either trowel or spray application is acceptable provided the Installer follow all Manufacturer recommendations.
- B. Physical Properties

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- 1. Bond strength to dry or damp concrete: Failure in concrete per ASTM C4541
- 2. Compressive strength: >6,700 psi per ASTM C579
- 3. Flexural strength: >4,600 psi per ASTM C580
- 4. Tensile strength: >2,400 psi per ASTM C580
- 5. Moisture absorption: <0.2% per ASTM C413

PART 3 - EXECUTION

3.1 STORAGE, MIXING, AND THINNING OF MATERIALS

- A. Manufacturer's Recommendations: Unless otherwise specified herein, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.
- B. All protective coating materials shall be used within the manufacturer's recommended shelf life.
- C. Storage: Coating materials shall be protected from exposure to inclement weather, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application.

D. Mixing:

- 1. Coatings of different manufacturers shall not be mixed together.
- 2. Mixing of multi-component coating systems shall be performed in accordance with Manufacturer's recommendations. Components must be mixed in complete batches only and used immediately.

3.2 INSPECTION

A. Contractor and his installer shall examine the areas and conditions under which concrete coatings are to be placed and notify Engineer, in writing, of any conditions which could be detrimental to the proper and timely installation of the Work. Do not proceed with the Work until any unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.3 SURFACE PREPARATION

- A. Surface preparation shall not begin until at least 7 days after new concrete has been placed. Chemical resistant coatings shall not be applied until at least 28 days after new concrete has been placed.
- B. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning in accordance with SSPC-SP1 before abrasive blast cleaning. Surface preparation shall be performed in accordance with the latest editions of the following standards:
 - 1. ASTM D-4258: Standard Practice for Surface Cleaning Concrete for Coating
 - 2. ASTM D-4259: Standard Practice for Abrading Concrete
- C. Concrete surfaces and deteriorated concrete surfaces to be coated or lined shall be abrasive blast cleaned in accordance with SSPC SP13 to remove existing coatings,

laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 60 grit flint sandpaper (surface profile of 2.5 to 4 mils).

- 1. Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE Standard TM-01-70.
- 2. The air compressor must be equipped with efficient oil and water traps to ensure that the compressed air is clean and free of oil particles. Refer to NACE procedure for "Blotter Testing" of compressed air.
- D. Concrete surfaces requiring repairs in excess of one-quarter inch (¼") depth shall be restored with underlayment, and brought flush with the surface, in accordance with the coating manufacturers' recommendations to provide a continuously smooth and even surface for application of top coat.
- E. Surfaces shall be clean and as recommended by the coating manufacturer before coating or lining is started.
- F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model DB, or equal.
- G. All surfaces to be coated shall be completely dry, clean, and contaminant-free prior to application. For polyurethane lining system, after completing surface preparation, surface dryness shall be verified according to ASTM D4263. Any indication of moisture will require an appropriate corrective measure. The surface shall be re-tested after taking the corrective measure.
- H. The concrete surface shall be notched to a depth equal to the total lining thickness with a power grinding tool on the perimeter of all lining termination points. The notch shall be clean and neat.

3.4 APPLICATION

- A. Coatings shall be installed on all surfaces described in Paragraph 1.1.A of this Section, with the systems indicated.
- B. Contractor shall give the Engineer a minimum of 3 days advance notice of the start of any field surface preparation work or coating application Work. All such Work shall be performed only in the presence of the Engineer.
- C. All concrete surfaces shall be coated before installation of any equipment in the area to be protected, including chemical storage tanks, pumps, pipe supports and stands, etc.
- D. Contractor shall supply all temporary heating, cooling or night-time work, if required, and provide protection from the sun, heat, or other environmental conditions which may adversely affect the coatings. Moisture content of concrete, air temperature, relative humidity, and all other conditions shall be within limits recommended by coatings manufacturers.
- E. Contractor shall fill all "bug holes" and other defects in the concrete to which the chemical resistant coatings are applied prior to application of the chemical resistant coatings system in accordance with the recommendations of the coatings manufacturer

approved for use in each area. Filler shall be allowed to cure in accordance with manufacturers recommendation.

- F. All surfaces receiving the polyurethane membrane lining shall be visually dry and at least 5°F (3°C.) above the Dew Point prior to starting the installation to prevent moisture entrapment. The Relative Humidity must be below 85%.
- G. Contractor shall apply coating to prepared concrete surface. Contractor shall repeat coating application as recommended by manufacturer for complete coverage. Application and mixing shall be by the method recommended by the coatings manufacturer with the equipment recommended as the best for installing the coating system supplied. Apply the materials in the recommended quantities to provide the dimensional requirements and chemical resistance specified for the system. Successive topcoats shall be applied within 24 hours so as to not exceed the recoat window.
- H. Contractor shall apply termination and expansion joint strips at the junction of the chemical resistant coating with other surfaces and at expansion joints as recommended by the coatings manufacturers.
- I. Wet film thickness shall be monitored throughout the installation by means of frequent measurements with a high-range wet film thickness gage.
- J. Whether spray or trowel application is used, the application shall be according to the principles of good workmanship outlined in SSPC-PA1-82 and shall provide a finish which is continuous, uniform in thickness, and verified free of pores or other defects using electrical discontinuity testing (high voltage spark testing).

3.5 CURING OF COATINGS

- A. Contractor shall provide curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the highest requirement, prior to placing the completed coating system into service.
- B. In the case of enclosed hydraulic structures, forced air ventilation, using heated or cooled air if necessary, is required for the application and curing of coatings on the interior surfaces.
 - 1. During curing periods continuously exhaust air from the lowest level of the structure using portable ducting. After all interior coating operations have been completed provide a final curing period for a minimum of 10 days, unless a shorter period is recommended by the coating manufacturer, during which the forced ventilation system shall operate continuously.

3.6 FIELD TESTING

- A. Inspection by the Engineer, or the waiver of inspection of any particular portion of the work, shall not relieve Contractor of its responsibility to perform the Work in accordance with this Specification.
- B. Proper, safe access shall be provided in locations where requested by the Engineer to facilitate inspection. Additional illumination shall be furnished when the Engineer requests. Proper ventilation and atmospheric monitoring shall be provided as well as all

other safety equipment and precautions required by OSHA for a safe inspection in all areas.

- C. The Engineer will conduct wet-film thickness testing. Contractor shall recoat any areas found deficient in thickness.
- D. Holiday Testing:
 - 1. Engineer will visually inspect coverage for blisters, sags, and holidays. Contractor shall repair areas identified by this inspection prior to conducting holiday test.
 - 2. Contractor shall holiday test, in the presence of the Engineer, all coated surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems.
 - a. Holiday testing equipment and procedures shall be done in strict accordance with the latest edition of the NACE "Standard Recommended Practice Discontinuity (Holiday) Testing of Protective Coatings."
 - b. Areas that contain holidays shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then retested.
 - 3. Holiday detectors shall be of the following type:
 - a. High voltage pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at a voltage of at least 110 volts/mil desired thickness.
- E. Any damaged areas, faulty areas, or discontinuities (pinholes) found during quality control inspection shall be repaired in accordance with the Manufacturer's recommendations.

3.7 ADJUSTMENT AND CLEANING

- A. At the completion of the Work, Contractor shall remove all material and debris associated with the Work of this Section.
- B. At the completion of the Work, Contractor shall clean all surfaces to which coatings were applied, as well as all adjacent, uncoated surfaces in a manner acceptable to the Engineer.
- C. Coatings shall be protected from damage until Final Acceptance of all Work in the area that was coated. Coatings damaged in any manner by Contractor prior to Final Acceptance of all Work in that area shall be repaired or replaced in a manner acceptable to the Engineer at no additional cost to the Owner.
- D. Just prior to Final Acceptance of all Work in the area that was coated, Contractor shall clean all coatings, as recommended by the manufacturer, to provide a finished product acceptable to the Owner.

+ + END OF SECTION + +

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide and install coatings on all exposed surfaces as indicated herein, in other Specification Sections, and on the Drawings.

1.2 QUALITY ASSURANCE

- A. Experience: Both Coatings Manufacturer and Coatings Installer shall have a minimum 5 years' experience in production and application, respectively, of specified products. Coatings Installer shall be approved and endorsed, in writing, by Coatings Manufacturer.
- B. Regulations: Meet federal, state, and local requirements which apply to the work, including, but not limited to those regulations limiting the emission of volatile organic compounds.
- C. Coatings Manufacturer Recommendations: Coatings Installer shall follow all recommendations of the Coatings Manufacturer regarding storage, handling, surface preparation, application of coatings, recoat times, environmental conditions during storage, preparation and application of coatings, and all other Coatings Manufacturer recommendations.
- D. Warranty: Both Coatings Manufacturer and Coatings Installer shall provide a 2-years complete replacement warranty for all coatings. Manufacturer shall provide 5-year warranty for long-term performance of coatings in addition to 2-years warranty.

1.3 SUBMITTALS

- A. Shop Drawings: Coatings Manufacturer shall submit for approval the following:
 - 1. Copies of Manufacturer's technical information and application instructions for each material proposed for use. Specify exactly which product is being proposed for each coating type (as specified below). This may be accomplished through a reference table along with information on the various products, or by a separate, tabbed section with information on products being submitted for each system in a separate tab of a binder. Submittal of general Manufacturer's literature without detailing which product is proposed for each paint system will be unacceptable.
 - 2. Copies of Manufacturer's complete color charts for each coating system.
 - 3. Letter from the Coatings Manufacturer approving and endorsing Coatings Installer.
 - 4. Letter from Coatings Manufacturer stating that volatile organic compounds (VOCs) meet all Federal, State and Local requirements.
 - 5. Furnish copies of the final, approved submittal to the Coatings Installer so that it is clear which product is to be used for which each system.
- B. Reference Samples:
 - 1. Provide reference samples of paint colors and textures as required by the ENGINEER. Reference samples will show the color and texture of the final paint to be applied and

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City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 shall be approved by the ENGINEER prior to painting. Reference samples should be applied to similar substrates to the final surfaces to be painted. If ENGINEER chooses to forego reference samples, CONTRACTOR must receive the allowance to forego reference samples before painting begins or all painted surfaces will be re-painted at the ENGINEER's discretion and at no additional cost to the OWNER.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect all pre-coated items from coating damage during shipping.
- B. Store products in accordance with Manufacturer's directions.
- C. Store products in a neat, orderly fashion. Protect products from damage. Protect storage area from damage from stored products.

PART 2 - PRODUCTS

2.1 PRODUCT AND MANUFACTURER:

A. Provide coating types as listed in the following table. The systems referenced in the table are those provided by TNEMEC and Sherwin-Williams. If manufacturers other than TNEMEC or Sherwin Williams are desired, the CONTRACTOR shall submit equivalent paint systems.

COATING TYPE	DESCRIPTION	Sherwin Williams Series	TNEMEC SERIES
Clear Polyamine Epoxy	Clear Polyamine Epoxy, high solids, moisture resistant, designed as a one- coat wood sealer.	GP3477	Series 201, Epoxoprime
Acrylic Filler	Waterborne Cementitious Acrylic designed for application on porous surfaces such as rough-faced concrete masonry units	CementPlex 875	Series 130, Envirofill
Interior Acrylic Latex	Single component, finish as required	ProMar 200	N/A
Industrial Acrylic	Single component, high density acrylic finish for interior, exterior surfaces	Pro Industrial High Performance Acrylic	Series 1029
Interior Latex Primer/ Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum wallboard/plaster. Capable of providing uniform seal and suitable for use with specified finish coats.	ProMar 200 Primer	Series 115
Exterior Acrylic Latex Primer/Sealer	Capable of providing uniform seal and suitable for use with specified finish coats.	Extreme Bond Latex Primer	Series 1028
Polyamine Epoxy	Waterborne Polyamine Epoxy,	Multi-	Series 151,

Sealer	penetrating, flexible and low-odor primer designed for sealing porous substrates.	Purpose Acrylic Primer	Elasto-Grip FC
Acrylate	Modified Waterborne Acrylate designed for application on porous surfaces such as rough-faced concrete masonry units or wood surfaces. Flexible and breathable, moisture and UV resistant. Matte Finish	Loxon XP	Series 156, Enviro-crete
Polyamidoamine Epoxy	Polyamidoamine Epoxy designed for use on steel or other ferrous metals not in contact with potable water but submerged or immersed in wastewater or non-potable water.	Sher-glass FF	Series N69, V69 or L69 (type per local VOC regulations), Hi- Build Epoxoline II
	Polyamidoamine Epoxy designed for use on steel or other ferrous metals in contact with potable water.	Macropoxy 5500	Series N140, L140 or V140 (type per local VOC regulations), Pota-Pox Plus
Polyurethane	Aliphatic Acrylic Polyurethane designed for exterior weathering, abrasion and corrosion resistance	HS Polyurethane 250 or Waterbased Acrolon	Series 1095, Endura-Shield
Silane Water Repellent Sealant	Silane/Siloxane penetrating water repellent blend designed for application on above-grade concrete, stucco, block, masonry and stone surfaces	Loxon 7% Siloxane	Series 636, Dur A Pell 20
Wood Sealer / Stain	Single component, 250 g/l wood stain in clear or standard colors	Minwax 250	
Wood Varnish Finish	Single component polyurethane varnish	Minwax	

B. All coatings used shall comply with Federal, State and local VOC limits based on application location.

2.2 COLOR

- A. Color Pigments: Pure, nonfading, lead-free applicable types to suit the substrates and service indicated.
- B. Provide colors as described in the drawings or specifications, or as selected by ENGINEER from standard color palette. For piping system colors, reference pipe schedule.
- C. Where existing colors are to be matched or satisfactory color is not available from standard color palette, provide custom-mixed colors.
- D. Provide samples of each color on the substrate to be coated for approval by the ENGINEER prior to beginning coating application.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Coatings Installer shall prepare all surfaces to be painted in strict accordance with Coatings Manufacturer's recommendations.
- B. Coatings Manufacturer representative shall observe Coatings Installer's methods of preparing surfaces and approve of the work prior to Coatings Installer beginning coating installation. If, after a period of time, Coatings Manufacturer is satisfied with Coatings Installers methods, Coatings Manufacturer can allow Coatings Installer to proceed without inspection following surface preparation. Coatings Manufacturer and installer will still both be held equally accountable for any coatings failure.
- C. Wood surface preparation
 - 1. Coatings Installer shall clean and prepare all wood surfaces in accordance with the Coating Manufacturer's recommendations. Patching may be required where approved by the Engineer. All joints in wood members including trim, siding, soffits, and joints between wood and dissimilar materials shall be filled with joint sealant prior to coating.

3.2 PROTECTION

- A. Protect all adjacent surfaces from overspray, dripping or other transfer of coatings not intended for those surfaces. Use masking, tape, drop cloths, plastic and other protective materials as appropriate.
 - 1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, stainless steel surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
 - 2. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors, fan housings, etc. to prevent coatings from falling inside.
 - 3. Correct all damages by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. Completely remove all masking, tape, drop cloths, plastic and other protective materials within 48 hours of completion of application of finish coat. Take special care to remove masking and plastic which cover tank vent openings, HVAC registers, vents, motor vents, and other areas where airflow is critical to proper operation.

3.3 APPLICATION

A. Paint all exposed surfaces not specifically excluded in 3.3.C, below. Provide and install Coatings in accordance with the following Table, unless otherwise specified in other Sections:

COATING	SURFACE TO	PRIMER	NO OF	PRIME COAT	FINISH	IO OF	FINISH COAT
SYSTEM	BE COATED	COATING	PRIMER	THICKNESS	COATING	INISH	THICKNESS
NO.			COATS	(EACH		COATS	(EACH COAT)
				COAT)			
100	Concrete	Acrylic Filler	1	70 SF/Gal	Acrylate	2	135 SF/Gal
	Masonry			Applicatio			Application
	Units			n Rate			Rate
	(Interior)						

		PRIMER		PRIME COAT		IO OF	FINISH COAT
SYSTEM NO.	BE COATED	COATING	PRIMER COATS	THICKNESS (EACH COAT)	COATING	INISH OATS	THICKNESS (EACH COAT)
101	Concrete Masonry Units (Exterior)	Silane Waterproofing Sealant	1	250 SF / Gal Applicatio n Rate	None		
102	Concrete Roof Slab (Exterior)	Silane Waterproofing Sealant	1	250 SF/Gal Applicatio n Rate	None		
200	Wood (Interior and Exterior)	Polyamine Epoxy	1	250 SF/Gal Applicatio n Rate	Acrylate	2	135 SF/Gal Application Rate
201	Wood (Interior, where noted)	Wood Sealer	1	250 SF/Gal Applicatio n Rate	Wood Finish	1	350 SF/Gal Application Rate
202	Gypsum Board (Interior)	Interior Latex Primer/Sealer	1	350 SF/Gal Applicatio n Rate	Interior Acrylic Latex (Semigloss)	2	400 SF/Gal Application Rate
300	Exposed Ferrous Pipe Systems and Exposed Steel Items	Polyamidoamine Epoxy	2	4-6 MDFT	Polyurethane	2	2-3 MDFT
301	Exposed, Non-metallic Pipe Systems	Exterior Latex Primer/Sealer	1	3-5 MDFT	Industrial Acrylic (Semigloss)	2	3-5 MDFT
302	Immersed Ferrous Pipe Systems and Steel Items	Polyamidoamine Epoxy*	1	6-10 MDFT	Polyamidoamine Epoxy*	1	6-10 MDFT
303	Immersed Non-metallic Pipe Systems	Exterior Latex Primer/Sealer*	1	4-6 MDFT	Industrial Acrylic Acrylic Latex (Semigloss)*	1	4-6 MDFT
304	Buried Ferrous and Steel Items	Polyamidoamine Epoxy	1	8-10 MDFT	Polyamidoamine Epoxy	1	8-10 MDFT
305	Aluminum Surfaces in Contact with Concrete	Polyamidoamine Epoxy	1	4-6 MDFT	None		
	Steel Tank Pumps	Per 09871, Coating Touch up factory a				ns	

- * Where in contact with potable water, coating shall be NSF-61 certified.
 - B. Items Delivered with Factory Applied Primer:
 - 1. For items delivered with a factory applied primer and requiring painting under this Section, the factory applied primer may be used in lieu of field applied primer only under the following conditions:
 - a. The ENGINEER approves the use of the factory applied primer in lieu of field applied primer.
 - b. The factory applied primer is certified by the Coatings Manufacturer as compatible with the field applied finish coat.
 - c. The Coatings Manufacturer's recommended recoat time for the factory applied primer has not been exceeded.
 - 2. If all of the above conditions are not met, the Coatings Installer shall re-prepare all surfaces to be painted in strict accordance with Coatings Manufacturer's recommendations and primer applied, in accordance with this Section.
 - C. Table Definitions:
 - 1. SF/Gal: Square foot of coverage per gallon of coating used.
 - 2. MDFT: mil dry film thickness
 - 3. mil: 1/1000 of an inch paint thickness
 - 4. Ferrous Pipe: Includes Ductile Iron, Cast Iron, Steel, and Galvanized Steel piping
 - 5. Steel Items: Includes steel and galvanized steel items such as structural steel, doors, window frames, overhead coiling doors, bollard posts, steel gates, steel fences, and all other steel and galvanized steel items.
 - 6. Non-Metallic Pipe: Polyvinyl Chloride, Chlorinated Polyvinyl Chloride, Fiberglass Reinforced Plastic, High Density Polyethylene
 - 7. Exposed: Located above grade, exposed to the atmosphere not submerged. Includes surfaces inside and outside of buildings.
 - 8. Submerged: In an area which normally is under water or other liquid or is intermittently under water or other liquid.
 - 9. Buried: Located below grade, surrounded by backfill.
 - D. Surfaces Not Requiring Painting:
 - 1. Unless otherwise stated or shown below or in other sections, the following areas or items will not require painting or coating:
 - a. Concrete surfaces.
 - b. Reinforcing steel.
 - c. Copper, bronze, brass, Monel, aluminum, chromium plate, and stainless-steel surfaces, except where:
 - 1) Required for electrical insulation between dissimilar metals.
 - 2) Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
 - 3) Color coding of equipment and piping is required.
 - d. Existing piping, fittings and pipe supports.
 - e. Pipe unions or portions of piping systems where painting would make disassembly difficult or impossible.
 - f. Prefinished electrical, mechanical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, HVAC equipment enclosures, ductwork, acoustical tile, cabinets, louvers, and wall panels.
 - g. Electrical conduits.
 - h. Cathodic protection anodes.

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- i. Insulated piping and insulated piping with jacket will require prime coat only.
- j. Fiberglass reinforced plastic (FRP) surfaces with an integral ultra-violet resistant colored gel coat do not require painting, provided the color is as selected.
- k. Glass, plexiglass or other transparent or translucent material intended to allow passage of light.
- I. Civil/site materials such as asphalt, gravel, rock, chain-link fence, and plantings.

3.4 RECOAT TIMES:

A. Coatings Installer shall observe all requirements of the Coatings Manufacturer regarding recoat times.

3.5 PAINT LOG

- A. Coatings Installer shall keep a paint log
 - 1. Specific details of the contents and format paint log shall be determined by the Coatings Installer and approved by the ENGINEER.
 - 2. At a minimum, paint log shall record, on a daily basis for any day when coating work is performed:
 - a. Weather conditions, including 3-day forecast
 - b. Which surfaces were prepared for coating
 - c. Approval of surface preparation by the Coatings Manufacturer representative
 - d. Which surfaces or systems were coated that day
 - e. Who the installer was (specific names of persons on crew)
 - f. Which coating type was used
 - g. Which coat was installed
 - h. What the application rate or MDFT was (as approved by ENGINEER)
 - 3. Paint log shall be kept on-site. Paint log shall be signed on a daily basis, for any day when coating work is performed, by the supervisor of the coatings installer field crew and by the ENGINEER.
 - 4. Any painted surface which was not recorded in the paint log shall be stripped, reprepared, and recoated at the ENGINEER's discretion.

3.6 WARRANTY INSPECTION

- A. Warranty inspection shall be conducted during the eleventh month following completion of the Work. All defective Work shall be repaired by the CONTRACTOR in accordance with this Specification and to the satisfaction of the ENGINEER and at the CONTRACTOR'S expense.
- B. Any location where paint has peeled, bubbled, or cracked and any location where rusting is evident shall be considered to be a failure of the system. The CONTRACTOR shall make repair at all points where failures are observed by removing the deteriorated paint, cleaning the surface, and recoating or repainting with the same system. If the area of failure exceeds 25 percent of the total coated or painted surface, the entire coating or paint system may be required to be removed and repainted in accordance with this specification as determined by the ENGINEER.
- C. All costs for CONTRACTOR'S inspection, Manufacturer's inspection and all costs for repair shall be borne by the CONTRACTOR.

+ + END OF SECTION + +

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DIVISION 10

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SECTION 10340

ARCHITECTURAL SUNSHADES AND CANOPIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Work in this section includes furnishing and installation of roll-formed aluminum overhead hanger rod style canopies as shown on the Drawings.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Designer: Professional Civil or Structural Engineer registered in the same state as the Project.
 - 2. Erector: Approved by the manufacturer.
- B. Warranty: Furnish manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing. Warranty shall provide for correction, or at the option of OWNER, removal and replacement of Work specified in this Section found defective during a minimum period of 5 years after date of Substantial Completion. Finish will not chalk, crack, check, blister, peel, flake, chip or lose adhesion for 5 years.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Drawings stamped by manufacturer's Designer:
 - a. Drawings shall be specifically prepared for this Project.
 - b. Show structural component locations and positions, dimensions, and details of construction and assembly.
 - 2. Structural Calculations stamped by manufacturer's Designer:
 - a. Complete analysis and design of structural components and connections in accordance with the design requirements indicated.
 - 3. Samples: Minimum 2-inch by 3-inch metal components requiring color selection.
- B. Product Data:
 - 1. Manufacturer's literature and technical data.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protect components and accessories from corrosion, deformation and other damage during delivery, storage and handling.
- B. Store on wood blocking or pallets, flat and off ground, to keep clean and to prevent damage or permanent distortion. Support bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage. Cover with tarpaulins or other suitable weathertight ventilated covering.

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PART 2 - PRODUCTS

2.1 PRODUCT AND MANUFACTURER

- A. Products manufactured or supplied by the following, and meeting these Specifications, may be used on this Project:
 - 1. Mapes Architectural Canopies
 - a. Canopy: Lumishade
 - 2. Or equal.

2.2 SERVICE CONDITIONS AND DESIGN CRITERIA

- A. Dead Load:
 - 1. As calculated.
- B. Live Load:
 - 1. 0 psf.
- C. Snow Load:
 - 1. 30 psf.
- D. Wind Load:
 - 1. Basic Wind Speed: 85 mph
 - 2. Exposure Category: C.
 - 3. Importance Factor: 1.15
- E. Seismic:
 - 1. Seismic Design Category: D.
 - 2. Importance Factor: 1.0.
 - 3. Site Class: D.
 - 4. Design Spectral Acceleration Parameters:
 - a. $S_{DS} = 0.491$.
 - b. $S_{D1} = 0.326$.
- 2.3 COMPONENTS
 - A. Materials:
 - 1. Decking at sunshades shall consist of louvered blades (.110 inch extruded aluminum).
 - 2. Decking at canopies shall consist of 2-1/2 inches interlocking, role formed .032inch decking.
 - 3. Intermediate framing members shall be extruded aluminum, alloy 6063-T6, in profile and thickness as required by manufacturer.
 - 4. Hanger rods to be powder coated finish to match the canopy.
 - 5. Fascia shall be standard 8-inch extruded, minimum .125 aluminum, flat face (Mapes style `J').

B. Finishes:

- 1. Finish: Two-Coat Kynar Finish.
- 2. Color: Selected by OWNER.

2.4 FABRICATION

- A. All sunshades and canopies shall be factory preassembled to the greatest extent possible.
- B. All connections shall be mechanically assembled utilizing 3/16-inch fasteners with a minimum shear stress of 350 pounds. Pre-welded or factory-welded connections are not acceptable.
- C. Concealed drainage at canopies: Water shall drain from covered surfaces into intermediate trough and be directed to downspouts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Confirm that surrounding area is ready for the canopy installation.
- B. Installer shall field confirm dimensions and elevations to be as shown on shop drawings provided by the manufacturer and the Drawings.
- C. Erection shall be performed by an approved installer and scheduled after all concrete, masonry and roofing in the area is completed.

3.2 INSTALLATION

A. Installation shall be in strict accordance with manufacturer's shop drawings and written instructions. Particular attention should be given to protecting the finish during handling and erection.

3.3 REPAIR AND CLEANING

- A. Immediately following erection, remove unused material, screws, fasteners, and other debris from completed installation. Use caution in removing metal cuttings from surface of prefinished metal panels.
- B. Replace damaged, dented, buckled, or discolored metal panels.

+ + END OF SECTION + +

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SECTION 10400

IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Furnish and install signs, placards, and labels for safety equipment, hazards, and equipment and piping identification.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. Provide manufacturer's literature showing available letter sizes and styles, standard and custom colors, and standard mounting details.
 - 2. Provide drawings showing layouts, actual letter sizes and styles, colors, and project-specific mounting details.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHER LOCATION SIGNS

- A. Material:
 - 1. Subsurface silkscreened graphics on a transparent acrylic sheet, 0.08" thick with Helvetica Medium alphabet and matching arrows type face.
 - 2. Provide 2" high upper case letters and 1" high lower case letters.
- B. Fire Extinguisher Identification Sign:
 - 1. Provide 15"x 15" with 1" radiused corners, unframed.
 - 2. Provide one for each surface mounted fire extinguisher.
 - 3. Background color shall be red with white lettering.
 - 4. Signs shall incorporate a white directional arrow as located by ENGINEER.
- C. Product and Manufacturer: Provide one of the following:
 - 1. ASI/SPE MH (Four Corners) Plaque by ASI Sign Systems, Incorporated.
 - 2. Or equal.

2.2 FIRE PROTECTION PLACARDS

- A. Fire Protection Placards:
 - 1. Provide diamond-shaped placards: 15" square of 0.125" rigid polyethylene.
 - 2. The placard shall meet NFPA 704.
- B. Product and Manufacturer: Provide one of the following:
 - 1. W.H. Brady Company
 - 2. Seton Name Plate Company
 - 3. Or Equal
- C. Provide fire protection placards in accordance with the following schedule:

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LOCATION	MATERIAL	HEALTH	FLAMMABILITY	REACTIVITY	SPECIAL
Diesel Tank	Diesel	1	2	0	

2.3 MISCELLANEOUS SAFETY SIGNAGE

- A. Safety signs shall comply with the following standards:
 - 1. Occupational Safety and Health Administration (OSHA), Standards for General Industry, Subparts 1910.200 Hazard Communication (July, 1986).
 - 2. National Fire Protection Association (NFPA) Standard No. 704 Label System.
 - 3. Uniform Fire Code, Latest Edition.
 - 4. Uniform Fire Code Standard 79-3.
- B. Safety signs shall be of height and width required by layout and shall be formed from semi-rigid butyrate, polyethylene or fiberglass. Lettering shall be 3-inches high and 1/2-inch in stroke.
- C. Provide the following safety signs:

LOCATION	TEXT	BACKGROUND COLOR	LETTERING COLOR
All Hatches	CONFINED SPACE – ENTER UNDER PERMIT ONLY	White	Red
Each Pump Hatch	CAUTION: EQUIPMENT STARTS AUTOMATICALLY	White	Red
All Electrical Gear	DANGER: HIGH VOLTAGE	Yellow	Black

2.4 EXIT SIGNS

- A. Material: Plastic, 1/8-inch minimum thickness.
- B. Lettering: 6 inches high, 3/4-inch stroke, white letters on red background.

2.5 IDENTIFICATION LABELS

- A. Pipe Labels and Flow Direction Arrows:
 - 1. Label, Lettering Color, Size and Placement: In accordance with ANSI A13.1, and as listed below.
 - 2. Label Colors:

Fluid Service	Background Color	Letter Color
Fire quenching fluids	Safety red	White
Toxic and corrosive fluids	Safety orange	Black
Flammable fluids	Safety yellow	Black
Combustible fluids	Safety brown	White
Potable, cooling, boiler	Safety green	White
feed, and other water		
Compressed air	Safety blue	White

3. Label Size:

Outside Diameter of Pipe Covering, inches	Length of Color Field, inches	Size of Letters, inches
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

- 4. Label Placement:
 - a. Labels shall be positioned on the pipes so they can be easily read. Proper label placement is on the lower side of the pipe if the employee has to look up to the pipe, on the upper side of the pipe if the employee has to look down towards the pipe, or directly facing the employee if on the same level as the pipe. Labels should be located near valves, branches, where a change in direction occurs, on entry/re-entry points through walls or floors, and on straight segments with spacing between labels that allows for easy identification.
- 5. Material: Manufacture from or encase in outdoor grade plastic or vinyl that will resist damage or fading from washdown, sunlight, mildly corrosive atmosphere, dirt, grease, and abrasion.
- 6. Message: Matching "Description" per Piping Schedule.
- 7. Labels:
 - a. Snap-Around Type: Size for finished outside diameter of pipe and insulation.
 - b. For 6 Inches and Over Diameter Pipe: May furnish strap-on type fastened without use of tools with plastic or stainless steel straps.
 - c. Firmly grip pipe so labels remain fixed in vertical pipe runs.
- 8. Manufacturers and Products:
 - a. T & B/Westline, Rariton, NJ, Model WSS Snap-Around.
 - b. Seton Name Plate Corp., New Haven, CT, Setmark Series.
 - c. Or equal.
- B. Valve and Equipment Labels:
 - 1. Applies to valves and equipment with assigned tag numbers wherever specified.
 - 2. Lettering: Black bold face, 3/4-inch minimum high.
 - 3. Background: OSHA safety yellow.
 - 4. Materials: Either of the following:
 - a. Aluminum or stainless steel base with a baked-on finish that is suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
 - b. Fiberglass with fiberglass-encased lettering.
 - 5. Furnish 1-inch margin on each end of label for mounting. On fiberglass labels furnish grommets at each end for mounting.
 - 6. Size:
 - a. As appropriate for lettering provided.
 - b. Provide same-size labels for equipment series which are adjacent.
 - 7. Message: Equipment names and tag numbers as used in Sections where equipment is specified and/or on Drawings.
 - 8. Manufacturers and Products:
 - a. T & B/Westline Co., Rariton, NJ; Type KQ.
 - b. Seton Name Plate Corp., New Haven, CT; Style EB.
 - c. Or equal.

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PART 3 - EXECUTION

3.1 INSTALLATION OF SIGNS

- A. Install Fire Extinguisher location signs at all fire extinguisher locations, approximately 12" above fire extinguisher mounting bracket.
- B. Install Exit Signs mounted to each door which leads to the outside of the building, on the panic bar side of the door, mounted to the door approximately 5'-6" above finished floor.
- C. Install all other signs at locations as shown on the drawings. Signs should be installed approximately 5'-6" off of finished floor, attached to doors where appropriate. Where two signs are indicated in the same location, signs should be mounted side-by-side, where possible.
- D. Install all signs plumb and level. They shall be attached with four stainless steel screws or anchor bolts as required for substrate. Provide theft/tamper-resistant fasteners on all signs.

3.2 INSTALLATION OF PIPE IDENTIFICATION LABELS

- A. Provide pipe identification label with flow arrows on all exposed piping systems as follows:
 - 1. At all connections to equipment, valves, tees or wall penetrations.
 - 2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
- B. Install pipe identification labels after all painting has been completed.

3.3 INSTALLATION OF EQUIPMENT IDENTIFICATION LABELS

- A. Install equipment identification labels on all equipment and valves which have been given a tagnumber in the Drawings or Specifications. Provide identification label which includes equipment name and tag number.
- B. Where no damage will be caused to equipment, mount equipment identification label directly to equipment. Otherwise, mount equipment identification labels to concrete equipment base or wall space. Install equipment identification label such that it is clear which piece of equipment is being labeled.
- C. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

SECTION 10520

SAFETY EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. The following safety equipment is to be provided and installed by CONTRACTOR so that it may be integrated into OWNER's safety program for operation of the facility into which it is installed.
 - 2. The following safety equipment does not represent a complete package of safety equipment required to operate the facility. Refer to OWNER's safety program for all required safety equipment and procedures.

1.2 SUBMITTALS

- A. Shop Drawings: Provide manufacturer's product data for each item including sizes, ratings, UL listings, OSHA certifications or other certifications, and mounting/installation information.
- B. Warranty: Provide manufacturer's 5-year warranty on all products provided.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protect all equipment provided from all damage until such time as it is turned over to the OWNER.
- B. Safety equipment provided under this specification shall not be used by the CONTRACTOR in the construction of the facility. Safety equipment shall be turned over to the OWNER in new condition.

PART 2 - PRODUCTS

- 2.1 FIRE EXTINGUISHERS
 - A. Provide at both doors.
 - B. Provide Fire Extinguishers which Conform to NFPA-10 and as follows:
 - 1. Tri-class dry chemical extinguishing agent.
 - 2. Pressurized, red enameled steel shell cylinder.
 - 3. Activated by top squeeze handle.
 - 4. Agent propelled through hose or opening at top of unit.
 - 5. For use on A, B, and C class fires.
 - 6. Minimum UL Rating: 4A:60B:C, 10-pound capacity.
 - C. Mounting Hardware:
 - 1. Furnish heavy-duty brackets with clip-together strap for wall mounting.
 - 2. Use all stainless steel fasteners for attaching brackets to wall.

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- D. Manufacturers:
 - 1. Walter Kidde
 - 2. Master Protection Enterprises
 - 3. Or Equal

2.2 FALL PROTECTION EQUIPMENT

- A. Fall Protection Grating:
 - 1. Standards:
 - a. Comply with all applicable OSHA, UL, ANSI and other applicable standards including, but not limited to, OSHA 29 CFR 1910.23.
 - 2. General Purpose:
 - a. Designed to allow visual inspection and wash down of confined space through grating while preventing falls into open hatches.
 - b. Designed as a factory installed option to be easily opened for confined space entry once entrant is properly harnessed and utilizing proper retrieval system.
 - 3. Features:
 - a. Materials:
 - 1) Metallic parts shall be Aluminum and/or stainless steel.
 - 2) Fiberglass grating panel.
 - b. Fiberglass grating panel shall be equipped with lift assistance and automatic holdopen arm for ease of operation and user safety.
 - c. Fiberglass grating panel shall operate independently of the access cover.
 - d. Fall protection grating shall be rated for 300 psf.
 - 4. Manufacturer and Product:
 - a. The Bilco Co
 - b. Or equal
- B. Portable Davit Arm Retrieval System:
 - 1. Standards:
 - a. Comply with all applicable OSHA, UL, ANSI and other applicable standards.
 - 2. General Purpose:
 - a. Designed to retrieve an entrant into a confined space using a standard personnel harness system.
 - 3. Features:
 - a. 60-inch high center post with winch mounting assembly
 - b. Allows for either 18" or 24" reach on offset arm
 - c. Weight rating of 350 lbs
 - d. Safety factor of 10:1
 - 4. Accessories:
 - a. Winch
 - 1) Designed to attach to a person that is entering or exiting from a confined space.
 - Built with an internal braking system to prevent the accidental pay out of line, as well as a back-up locking pawl system to prevent "free-wheeling" of the winch.
 - 3) Cable extension (payout) should occur ONLY when the handle is turned counterclockwise AND a force of AT LEAST 10 lbs. (4.5 kg.) is applied to the line.
 - 4) The winch frame back plate attaches to a mounting plate which can then be mated to the Portable Davit Arm Retrieval System. Coordinate winch and Portable David Arm Retrieval System.

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- 5) Weight rated to 350 lbs.
- 6) 10:1 safety factor
- 7) 5.5:1 gear ratio single speed drive
- 8) Retrieval rate of 23 feet per minute
- 9) Continuous braking drive prevents free wheeling
- 10)Double pawls on friction brake provide back up safety
- 11)Low wear, high temperature brake pads
- 12) Anti-friction drive bearings
- 13)Three permanent wraps of cable on the drum
- 14)Level wind springs to prevent loosening of cable lays
- 15)Slip clutch drive to prevent back-winding of cable drum
- 16)Galvanic zinc coating of all metal parts
- 17) Double action locking swivel snap hook
- 18) Provide with 70 feet of stainless steel cable
- 5. Flush Floor Mounted Davit Sleeve:
 - a. Provide flush floor mounted davit sleeve by same manufacturer as davit crane.
 - 1) Sleeve shall be designed specifically for davit crane and shall allow for full functionality and load rating of crane
 - 2) Sleeve and anchor bolts shall be stainless steel
 - 3) Sleeve to be designed for installation in concrete after concrete placement by core drilling a hole in the concrete and bolting sleeve to concrete floor using stainless steel chemical anchors, per manufacturers instructions.
 - 4) Provide stainless steel debris cap with sleeve.
- 6. Manufacturer and Product:
 - a. Davit Crane: T.A. Pelsue Company, Model PNUH1824, or equal
 - b. Winch: T.A. Pelsue Company, Model PLPS806MR-70, or equal
 - c. Davit Sleeve: T.A. Pelsue Company, Model PNUS102B-SS, or equal
 - d. Debris Cap: T.A. Pelsue Company, Model PNUS106-SS, or equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all safety equipment per manufacturers written instructions.
- B. Install fire extinguishers where "FEXT" is called out on the drawings, 48" above finished floor or adjacent grade.

+ + END OF SECTION + +

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SECTION 11100

FABRICATED SLIDE GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: This Section describes the design, fabrication, and supply of fabricated slide gates, including wall thimbles (if applicable), pipe adapters (if applicable), discs, guide frames, stem guides, seats, operating stem, operator, and anchorage. Gate supplier shall provide all materials, equipment, and accessories necessary to furnish and install slide gates as described herein and as shown on Drawings.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with requirements and recommendations of the following references, except as otherwise specified:
 - 1. American Water Works Association (AWWA)
 - 2. American Gear Manufacturers Association (AGMA)
 - 3. American National Standards Institute (ANSI)
 - 4. ASTM International (ASTM)
 - 5. Anti-Friction Bearing Manufacturers Association (ABMA)
- B. Unit Responsibility: All equipment specified herein shall be coordinated and provided by a single gate manufacturer. Manufacturer assumes full responsibility for coordination of all components.
- C. Warranty: Provide a 2-years warranty on all equipment from date of start-up. Warranty shall cover defects in workmanship, design, and materials. If any component should fail during the warranty period, it shall be corrected and the unit restored to service at no expense to the OWNER.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Detailed drawings showing component and assembly dimensions, location of mechanical connections, weights of all equipment, installation details, and accessory details.
 - 2. Drawings, templates and directions for installation of anchor bolts and stem couplings.
- B. Product Data:
 - 1. Descriptive literature, specifications, and engineering data.
 - 2. Materials of construction for all components and accessories.
 - 3. Force calculations for gate operator and stem, including seismic loading calculations.
 - 4. Shipping, storage, protection and handling instructions.
 - 5. Installation directions.
 - 6. Operation and Maintenance Manual.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Gate manufacturer shall provide any special unloading, storage and handling instructions.

PART 2 - PRODUCTS

2.1 PRODUCT AND MANUFACTURER:

- A. Golden Harvest
- B. Fontaine
- C. Or equal

2.2 GOVERNING STANDARD

A. Except as modified or supplemented herein, fabricated slide gates and their appurtenances shall conform to the applicable requirements of AWWA C561.

2.3 SERVICE CONDITIONS AND PERFORMANCE

A. Gate Schedule:

Тад	SLG-101	SLG-201	SLG-301	SLG-302	
Location	Splitter Box Lift Station			tation	
Material			316SS		
Operation			Open-Close		
Size (W x H)	24" x 24"	24" x 24"	36" x 36"	36" x 36"	
Self-Contained			Yes		
Seating Head	12′	12′	16′	16′	
Unseating Head	12′	12′	16′	16′	
Inv. Elevation	5328.71 5328.71 5323.20 5328.00				
Operating Floor Elevation	5339.00 5339.00 5339.00 5339.00				
Mounting	Wall				
Top Seal			Yes		
Actuator	Removable Handwheel and Electric Drill Adapter				
Gate Opening Direction	Upward				
Stem Movement	Rising				
Limit Switches	No				
Service	Raw Wastewater				

B. Performance:

1. Closed leakage shall not exceed 0.1 gallons per minute (GPM) per foot of gate periphery under seating or unseating head conditions.

2.4 COMPONENTS

- A. General:
 - 1. Slide gates and all appurtenances shall be provided by one manufacturer.
 - All components of the gates shall have a minimum thickness of ¼-inch. The gates for this project will be wall mounted over plain-end wall fittings provided by the CONTRACTOR or over openings in concrete walls, as shown on the Drawings. No wall thimbles or pipe adaptors are required.
- B. Guide Frame:
 - 1. Material: ASTM A-276 Type 316 SS.
 - 2. Designed for maximum rigidity.
 - 3. If applicable, machine back flange to mount directly to machined face of pipe adapter.

ASTM D4020 Ultra high molecular weight polyethylene seats shall be provided in a retainer slot in sides of frame, on the unseating head side of the gate.

Neoprene seals shall be utilized as necessary to achieve specified closed leakage performance.

- Guide frame corners shall be factory welded. Provide bolt holes in upper portion of sides of frame for connection to supporting angle.
- 5. Weight of guide frame shall not be less than 9.0 pounds per linear foot. Frame:

C. Disc:

- 1. Material: ASTM A-240 Type 316L SS.
- 2. Disc shall be reinforced as necessary to limit deflection under the design operating head to less than 1/360 of the gate span.
- 3. Reinforcing members shall be 316L SS angle or channels welded to the plate.

D. Stem:

1. Material: ASTM A-276 Type 316 SS.

Diameter shall 1-1/4 inch minimum, and be sized as necessary to withstand two times the compressive force when 40 pounds of force are applied at the operator. Stem shall be supported such that the L/r ratio for unsupported lengths does not exceed 200.

Threaded portions of the stem shall be ACME type cold rolled threads with a maximum surface roughness of 0.000016 inches. Machine cut threads will not be accepted.

Stem connections shall be threaded with bolt fastening to both stem segments. Gates having a width equal to or greater than two times their height shall be provided with two geared lifting mechanisms interconnected by a tandem shaft so that all stems move at the same rate. The tandem shaft shall be protected by a full length, removable aluminum or stainless steel cover attached to the actuator.

E. Stem Guides:

1. Provide cast steel, cast iron or fabricated stainless steel stem guides for installation at 120-inch intervals.

Guides shall consist of collar with UHMWPE bushings, and bracket with slotted holes for adjustment in two directions.

2. Inside diameter of the collar and bushings shall be slightly larger than the gate stem to prevent binding.

- F. Manual Actuator:
 - 1. Type: Provide nut, crank arm or handwheel type, as indicated in the schedule.
 - a. Crank Type:
 - 1) Each crank-operated manual actuator shall be provided with a removable crank having a revolving grip.
 - 2) Crank handles shall have an overall length of not less than 6 inches and not more than 15 inches.
 - 3) Crank handles shall be made of corrosion resistant material.
 - 4) Crank shall have fully enclosed single or double gear reducer as required for lifting capacity.
 - a) Gears shall be machine cut.
 - b) Lubrication fitting shall be provided in gear housing to permit housing to permit lubrication of all gears and bearings.
 - c) Arrow marked "open" shall be cast on the housing to indicate direction of rotation to open the gate.
 - b. Handwheel Type:
 - 1) Direct Drive without reduction gearing
 - 2) Maximum handwheel diameter shall be 30 inches.
 - 2. Maximum effort required to open the gate shall not be more than 40 pounds.
 - 3. Furnish threaded bronze lift nut to engage threaded portion of stem.
 - a. Lift nut shall be flanged and supported on roller bearings.

b. Lift nut shall be capable of thrust developed during opening and closing of the gate without damage.

- 4. Provide cast steel housing for bearings and lift nut.
 - a. Housing shall be supported by the terminal stem guide support.
- 5. Provide adjustable bronze stop collar for OPEN and CLOSED position limitation.
- 6. Provide clear butyrate stem guide cover and cap.
- a. Indicate OPEN/CLOSED position with 1-inch marking on clear mylar pressure sensitive adhesive scale for field application.
- 7. Distance from center of radius of crank arm or center of handwheel to ground shall be less than 48 inches.
- G. Fasteners:
 - 1. All fasteners necessary for installation and operation shall be furnished by the gate manufacturer.
 - 2. Fasteners shall be Type 316 SS
 - 3. Fasteners shall be ¹/₂-inch diameter minimum, and adequately sized to withstand all operational stresses.
- H. Portable Operator:
 - 1. Manufacturer to provide one portable operator with 2 inch adaptor to open/close gates utilizing available 115V outlet.
 - 2. Portable operator to be complete with stand and adjustable height to allow for alignment with varying operator nuts.
- I. Spare Parts: Provide the following spare parts:
 - 1. Two bronze stop collars
 - 2. Bronze lift nut
 - 3. Special tools required for servicing operator

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be as shown on the Drawings and in accordance with gate manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

- A. Conduct functional and performance tests under approved simulated operating conditions.
- B. If any portion of the installation does not function properly, adjust, realign, or modify the installation and retest.
- C. Manufacturer's Services:
 - 1. 1 person-day for installation assistance, inspection, testing and alignment.

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SECTION 11300

SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.1 EQUIPMENT TAG NUMBERS

- A. Provide all labor, materials, equipment, and incidentals required to furnish and install Submersible Sewer Pumps complete and operational with motors, base plate, safety guard and accessories as shown on the Drawings and specified.
- B. This specification section refers to pump numbers:
 - 1. PMP-101 (CONTRACTOR to procure new)
 - 2. PMP-201 (CONTRACTOR to procure new)
- C. Use of American Iron and Steel (AIS) applies to this project.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Make, model, weight, and horsepower of each equipment assembly.
 - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - 3. Dimensional outline and installation drawing. Full installation instructions.
 - 4. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and net positive suction head required over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
 - 5. Power and control wiring diagrams, including terminals and numbers.
 - 6. Data on the moisture/temperature protective relay
 - 7. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - 8. Factory finish system.
 - 9. Complete catalog information for the davit crane, including make, model, lifting capacity, materials of construction, and installation drawing with dimensions.
- B. Unit Responsibility: All equipment specified herein shall be coordinated and provided by the pump manufacturer. Manufacturer assumes full responsibility for coordination of all components.
- C. Pump Tests and Data:
 - 1. Pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head whichever is greater.
 - 2. Running Test: Pump assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate.

- 3. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with the methods described in Section A6 of AWWA E101.
- D. Motor Tests and Data:
 - 1. For each motor furnish an inspection report for the motor or for a previously manufactured electrically duplicate motor that has been tested. Provide the following minimum data:
 - a. Running current.
 - b. Locked rotor current.
 - c. Winding resistance measurement.
 - d. High potential test.
 - e. Bearing inspection.
- E. Operation and Maintenance Manuals: Submit complete manuals including: copies of all approved Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
- F. Warranty: Provide a 2-yrs warranty on all equipment from date of start-up. Warranty shall cover defects in workmanship, design, and materials. If any component shall fail during the warranty period, it shall be corrected, and the unit restored to service at no expense to the OWNER.
- G. Test Data: Pumps shall not be shipped until the ENGINEER has approved the test reports. Submit:
 - 1. Four copies of certified pump tests.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Pump equipment shall consist of pump(s) complete with motor(s), cooling jacket(s), guide rails and supports, base elbow(s), anchoring brackets, power cable(s), pump lifting cable(s), and protective control system. Pump metal parts that come into contact with guide rail or cable system shall be made of non-sparking materials.
- B. Pumps shall have capacity no less than 98% and no greater than 103% of the specified capacity at each of the total dynamic head operating conditions shown.

C. Pumps and Motors:

- 1. Pumps PMP 101 and PMP 102:
 - a. Minimum Shutoff Head: 355 feet
 - b. Primary Design Point Flow/Head
 - 1) 1,075 gpm at 303 feet of TDH at 100% speed
 - 2) Min Efficiency = 55%
 - c. Runout Point
 - 1) 1550 gpm at 280 feet of TDH at 100% speed
 - d. Horsepower: 160 hp
 - e. Voltage: 480V, 3 Phase, 60 Hertz

- f. 100% Motor speed: 1780 rpm
- D. Pump Features:
 - 1. Service: Raw Sewage
 - 2. Site Altitude: 5330 feet
 - 3. Type: Non-clog centrifugal submersible sewage pump
 - 4. Capacity: Passing 2" ball, minimum
 - 5. Volute: ASTM A48 CL35B Cast Iron
 - 6. Impeller: Hard Iron (ASTM A-532 (Alloy III A) 25% chrome cast iron)
 - 7. Impeller Insert Ring: (ASTM A-532 (Alloy III A) 25% chrome cast iron)
 - 8. Each unit shall be provided with an integral motor cooling system. A stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for uninterrupted heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.
 - 9. Mechanical Seal: Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small backswept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.
- E. Accessories:
 - 1. Base Elbow: ASTM A48, CL35B Cast Iron, one per pump, coated to match pump/service conditions.
 - 2. Guide Rails: Type 316 Stainless Steel, coordinate length with drawings, 3-inch diameter minimum, two guide rails per pump (guide cables are not acceptable).
 - 3. Upper Guide Rail Brackets (one per pump):
 - a. Type 316 Stainless Steel
 - b. Mount to wetwell hatch opening
 - 4. Intermediate Guide Rail Brackets (one per pump):
 - a. Type 316 Stainless Steel
 - b. Provide if guide rails are longer than 20-feet
 - c. Brackets shall mount to discharge piping

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- 5. Pump Lift System:
 - a. Pumps will be hoisted from the wet-well utilizing City boom truck.
 - b. Lifting Chain: approximately 18" long 316 Stainless Steel, provide one chain per pump.
 - c. 30 feet of nylon line connected to the lifting chain, provide one rope per pump.
 - d. Forged steel grip eye for connecting/disconnecting hook and cable to pump chain, provide one grip eye per pump.
- 6. Safety Hooks and Cable Holders: 316 Stainless Steel, provide one of each per pump
- 7. Wetwell hatch:
 - a. Hatch dimensions per drawings
 - b. See specification section 08305 for hatch requirements

8. Pump monitoring system (per pump)

a. MAS 801 or approved equal.

- F. Motors:
 - 1. Connected load shall not exceed 90 percent of motor nameplate horsepower
 - 2. Motor shall be non-overloading for the entire pump operating curve.
 - 3. Furnish motors suited for operation in a Class 1, Division 1, Groups C & D explosionproof atmosphere and certified as such by Factory Mutual.
 - 4. Vertical mounting
 - 5. Solid shaft
 - a. Shaft seal: Tandem mechanical seals
 - 6. Service factor: 1.15
 - 7. Thermal Protection: Normally closed thermal switch in stator housing
 - 8. Moisture Protection: Leakage Sensor in stator housing
 - 9. Motor capable of 15 starts per hour
 - 10. Motor capable of continuous full-load operation while unsubmerged without overheating or voiding Class 1, Division 1, Group D compliance
 - 11. Class H insulation rated for 180°C (356°F) with Trickle Impregnation method.
 - 12. Provide motor lifting lug
 - 13. Provide motor power and control cables with connections made at the motor inside a junction chamber. Cable entry shall be sealed and provided with means of strain relief. Cables shall comply with applicable code requirements. Coordinate pump cable length with distance between pump and control panel, per drawings and field installation.
 - 14. Motor shall be compatible with VFD.
- G. Controls:
 - 1. Provide moisture protection/thermal protection relay for connection to leakage sensor and thermal switch on each motor for installation in an external control panel by others.
 - 2. Coordinate with programming during pump commissioning to initially run pump at 100% speed to clear the impeller before reducing speed to desired set-point. This was a request of the manufacturer during design.
- H. Manufacturers/Models:
 - 1. Flygt Model NP3315 HT 453
 - 2. No Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in complete accordance with manufacturer's instructions.
- B. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by manufacturer.
- C. Check and align all pumps, motors, etc. after pump assemblies have been installed to ensure alignment and assembly has been unchanged from factory assembly conditions. Make adjustments required to place system in proper operating condition. Pump installation shall place no strain on adjacent piping systems.

3.2 FIELD QUALITY CONTROL

- A. Functional Test: Conduct on each pump.
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

3.3 MANUFACTURER'S FIELD SERVICES

A. A factory trained representative shall be provided for start-up and test services and operation and maintenance personnel training services. The representative shall make one one-day visit to the site for performing these services.

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Addendum 2 April 2024

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SECTION 13100

ODOR CONTROL UNIT (ADSORBENT MEDIA FOUL AIR SCRUBBER)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Provide all labor, equipment, materials, and incidentals as required to furnish, install, check, calibrate, test, document, start-up, and place in satisfactory operation the Odor Control Unit as shown on the Drawings and as specified.
 - 2. The Odor Control Unit shall include, but not be limited to the following:
 - a. Adsorber Canister
 - b. Media
 - c. Drain Line

B.General:

- 1. Descriptions contained hereinafter are for guidance and to show the functions desired. They do not describe or specify all components to interface equipment. All parts and equipment necessary to meet functional requirements shall be provided and fit within the dimensions and configuration shown on the Drawings.
- 2. The mechanical, structural, instrumentation and electrical design have been based on an odor control unit manufactured by Bay Products, Inc. The cost of any changes and modifications to mechanical, structural, instrumentation or electrical facilities necessary to adapt alternate equipment to the layout and design shown shall be borne by CONTRACTOR. Clearances shown on the Drawings shall be maintained. Any such proposed changes or modifications are subject to review and acceptance by the ENGINEER in accordance with the Special Provisions.
- 3. Complete responsibility for the proper operation and functions of the Odor control unit herein specified, belongs to CONTRACTOR. Responsibility for coordination of all interfaces with other contractors to achieve the required Odor control unit operation belongs to CONTRACTOR.
- 4. Odor control equipment outdoor areas are considered corrosive areas. All mechanical and electrical equipment and material shall conform to NEMA 4X, non-metallic requirements.

C.Related Divisions and Sections:

- 1. Section 01610 General Equipment Requirements
- 2. Section 01750 Training, Testing and Start-up
- 3. Section 16010 Electrical

1.2 REFERENCES

- A. American Society of testing and Materials (ASTM):
 - 1. ASTM D-3299-88 Standard Specification for Filament Wound Glass Fiber Reinforced Thermosetting Resin Chemically Resistant Tanks.
 - 2. Voluntary Product Standard
 - a. PS 15-69

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1.3 QUALITY ASSURANCE

- A. Odor control unit Manufacturer's Qualifications:
 - 1. Manufacturer shall have minimum of five years experience of producing substantially similar equipment, and shall be able to show evidence of at least ten installations.
- B. When two or more units of equipment for the same purpose are required they shall be the product of one manufacturer.
- C. Inspection and Testing Requirements: The visual inspection of the equipment shall comply with ASTM D 2563, Visual Acceptance Level II.
- D. Requirements of Regulatory Agencies: Meet federal, state, and local requirements which apply to the work.
- E. Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the production of such items and have a successful history of product acceptability, as interpreted by ENGINEER.
- F. Listing, labeling or marking, as conforming to the Standards of Underwriters Laboratories, Inc., American National Standards Institute, Inc., United States Bureau of Mines, or other nationally recognized testing organization.

1.4 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Submit for review to ENGINEER, sufficient literature, detailed specifications, and drawings to show dimensions, make, style, speed, size, type, horsepower, service factors, efficiency, materials used, design features, internal construction, weights, and any other information required by ENGINEER for review of all odor control equipment.
- B. Operation and Maintenance Manuals:
 - 1. Submit complete installation, operation and maintenance manuals, including, test reports, maintenance data and schedules, description of operation and spare parts information.
- C. Documentation to demonstrate that the manufacturer has been regularly engaged in fabricating odor control units for at least 5 years and provide documentation of at least 10 installations.
- D. Field Assembly Instructions: Provide instructions on proper assembly of odor control unit.
- E. Manufacturer shall provide laboratory analysis from certified laboratory for the high capacity carbon verifying the hydrogen sulfide capacity. The analysis shall be performed within six months of the date of submittal.

1.5 GUARANTEE

A. Manufacturer shall provide a guarantee stating that the hydrogen sulfide (H_2S) removal efficiency (with an average inlet of 25 ppmv H_2S) will be greater than 99% prior to carbon media being spent.

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PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Odor Control Unit
 - 1. The purpose of the odor control unit shall be to remove H_2S and odors or VOCs emanating from ambient sewage emission. Each odor control unit shall include the following:
 - a. Adsorber Canister
 - b. Media
 - c. Mist eliminator
 - 2. Design of the odor control unit has been based on CalgonCarbon Ventsorb PE System.
 - 3. Design and Performance Criteria:
 - a. Each odor control unit shall be designed for the following operating conditions and shall meet the following performance criteria when put in service with fresh carbon media:
 - b. Air Flow Rate, cfm: 200.
 - c. Average Inlet H₂S Concentration, ppmv: 25.
 - d. H_2S Removal Efficiency, (With an average inlet of 25 ppmv H_2S): Greater than 99% prior to Carbon media being spent.
- B. Adsorber Canister
 - 1. The self-contained, adsorber canister shall be a Ventsorb PE Canister, as supplied by CalgonCarbon
 - 2. There will be 2 adsorber canister required.
 - 3. The 55-gallon adsorber canister shall be manufactured of HMW-high density polyurethane. The canister shall have no moving parts.
 - 4. The adsorber canister shall support the carbon bed on FRP grating and screen. Adsorber design shall utilize "Plug Flow" air distribution (influent air shall enter below the carbon bed support grating, this area shall pressurize equally, and the air passes through the media bed uniformly, exiting through the outlet nozzle at the top of the vessel). The inlet plenum shall be void of packing, gravel or any other material and shall be open without air flow restriction.
 - 5. The canister shall have the following features:
 - a. Inlet: 4" plain end connection
 - b. Cover: Removable HMW-HDPE cover with closure and polyurethane gasket.
 - c. Drain: 34" drain with PVC ball valve
 - 6. The canister shall be rated at +/- 7 psig
 - 7. The canister shall be capable of operating at a maximum airflow rate of up to 200 CFM with a maximum headloss of 6 inches W.C.
 - 8. Anchor bolts shall be Type 316L stainless steel and conform to the requirements of Section 05051, Anchor Bolts, Inserts and Epoxy Dowels.
 - 9. Equipment Tags: From the factory, vessel shall be provided with Type 316L stainless steel equipment tags with the following minimum information:
 - a. Media Type.
 - b. Vessel Dimensions.
 - c. Date of Manufacture.
 - d. Design Conditions.

- C. Media
 - 1. The media utilized by the reactor vessel shall be provided by the system supplier and supplied pre-installed in the vessel before shipping.
 - 2. Media: Virgin Grade Vapor Phase Carbon 4mm Pellet
 - 3. 300 cfm @ 6 inches w.c.
- D. Manufacturers/Models:
 - 1. Odor Control Canister: CalgonCarbon Ventsorb PE
 - 2. No equal allowed

2.2 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Each odor control unit shall be furnished with a manufacturer's repair kit which shall include as a minimum the following:
 - 1. Replacement media for two (2) complete media replacement.
 - 2. Special tools required for maintenance and operation.
- B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

2.3 SURFACE PREPARATION AND PAINTING

- A. Motors, drives and appurtenances shall receive shop primer and shop coating conforming to requirements of Section 09900, Painting. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER.
- B. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.
- C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed as specified herein, as indicated on the Drawings, and in accordance with the manufacturer's recommendations and instructions.
- B. All equipment shall be installed with Type 316L stainless steel anchor bolts as specified in Section 05051, Anchors, Inserts and Epoxy Dowels.

3.2 MANUFACTURER'S FIELD SERVICES

A. The manufacturer shall provide one (1) person-day for installation inspection, system start up, flow balancing, air testing and training. Manufacturer shall be provide a written report on the results, air sample results and expected media life.

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+ + END OF SECTION + +

SECTION 13300

INSTRUMENTATION AND CONTROLS – GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Ripple Industries, LLC shall procure the following services and products: 1. Provision of CompactLogix based PLC control panel.
 - a. **10" or larger touch screen.**
 - b. Swing-out sub-panel for touch screen mounting.
 - c. Din-rail mounted battery backup system.
 - d. I/O capacity to meet project requirements plus 20%.
 - e. Fiber-optic analog isolation.
 - f. City of Prescott standard radio equipment.
 - g. UL certification.
 - h. Shop drawings.
 - i. Fuse Schedule.
 - j. O&M Manual.
 - 2. PLC Programming to include monitoring and control of all inputs and outputs, including those coming through the ethernet network as per the project specifications.
 - 3. OIT programming to include monitoring, control, trending, data history, etc of all equipment and signals as per City of Prescott Standards.
 - 4. Radio telemetry design and programming as needed for communications between lift station and SCADA network.
 - 5. Startup and testing of PLC, OIT and HMI.
- B. The Contractor shall procure the services of a single Control System Supplier (CSS) to furnish all materials, equipment, labor and services, except for those services and materials specifically noted, required to achieve a fully integrated and operational system as specified herein and in other Specification Sections listed below.
- C. Items specifically excluded from the scope include the following:
 - 1. PLC programming, testing of PLC logic, and startup/training activities associated with programmed portions of the PLC. These services will be supplied by the Application Engineering System Supplier (AESS) under separate Contract.
 - 2. Human Machine Interface (HMI) graphics development, HMI software configuration, database development, report development, and startup/training activities associated with the configured portions of the HMI system. These services will be supplied by the AESS under separate Contract.
 - 3. *ct.*
- D. The work shall include furnishing, installing and testing the equipment and materials detailed in the following Sections: <u>Section No Title</u>

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- 13300 Instrumentation and Controls (I&C) General Provisions
- 13302 I&C Testing
- 13330 I&C Control Panels and Panel Mounted Equipment
- 13331 I&C Panel Instruments and Devices
- 13332 I&C Programmable Logic Controllers Hardware
- 13333 I&C Human Machine Interface Hardware
- 13335 I&C PLC Programming Software
- 13336 I&C Human Machine Interface Software
- 13341 I&C Flow Devices
- 13342 I&C Level Devices
- 13343 I&C Pressure Devices
- 13733 I&C Network Materials and Equipment

Requirements specified in this Section apply to all equipment specified in the above sections, unless otherwise specified.

- E. The contractor shall install, integrate and test a complete instrumentation and SCADA system except PLC and SCADA programming. Coordinate all work and testing with the programming provider.
- F. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, and signal isolators, to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.
- G. Substitutions on functions or type of equipment specified shall not be acceptable unless specifically noted. In order to confirm compatibility between all equipment, coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.
- H. Equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the project Specifications, Drawings, engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Engineer.
- I. To facilitate the Owner's future operation and maintenance, similar products (e.g., differential pressure transmitters, SCADA I/O cards) shall be supplied from the same manufacturer.
- J. All equipment and installations shall satisfy applicable Federal, State and local codes.
- K. Use the equipment, instrument, and loop numbering scheme that has been developed and shown on the Drawings and specifications in the development of the submittals. Do not deviate from or modify said numbering scheme without the Engineer's approval.

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1.2 RELATED WORK

- A. Process & Instrumentation Diagrams (P&ID) are included in the Drawings.
- B. Specific control system and instrumentation materials and requirements are included in related Sections of Division 13, 16, and 17.
- C. Instrumentation and Controls conduit systems are specified in Section 16130.
- D. Instrumentation signal cable and alarm and status wiring are specified in Section 16120.
- E. Control System network, communication, and fiber optic cabling are specified in Section 16120.

1.3 SUBMITTALS

- A. General submittal requirements include:
 - 1. Refer to Section 01330 for general submittal requirements.
 - 2. Other Division 13, 16 & 17 Sections may have additional submittal requirements.
 - 3. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured and delivered.
 - 4. Submittals shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
 - 5. The submittal drawings' title block shall include, as a minimum, the CSS's registered business name and address, Owner and project name, drawing name, revision level, and personnel responsible for the content of the drawing.
 - 6. **Incomplete or partial submittals not complying with the submittal arrangements outlined in this Section will be returned without review.**
 - 7. Separate submittals shall be made as follows:
 - a. Qualifications Submittal
 - b. Project Plan, Deviation List and Schedule Submittal
 - c. *I/O List Submittal*
 - d. Field Instrument Submittal
 - e. Panel Drawings and Wiring Diagram Submittal
 - f. Testing Plans Submittal
 - g. Spares, Expendables, and Test Equipment Submittal
 - h. Final System Documentation
- B. Qualifications Submittal
 - 1. Submit, within 30 calendar days after Contract Award, detailed information on their staff and organization to show compliance with the Quality Assurance requirements of this Section. The Qualifications submittal shall be submitted and approved before any further submittals

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will be accepted. Failure to meet the minimum requirements shall be grounds for rejection as an acceptable CSS. The Qualifications Submittal shall, as a minimum, contain the following:

- 2. Copy of UL-508 certificate for panel fabrication facilities.
- 3. **Project references for water or wastewater projects as defined in the** *Quality Assurance paragraphs.*
- 4. Sufficient documentation to demonstrate the CSS's capabilities to complete this project including: resumes of key staff, bonding capacities, details on engineering, design, fabrication, and field service capabilities, and location of staff responsible for responding to the site within four hours to resolve startup issues.
- C. Project Plan, Deviation List, and Schedule Submittal
 - 1. Submit, within 45 days, a Project plan. The Project Plan shall be submitted and approved before any further submittals shall be accepted. The Project Plan shall, as a minimum, contain the following:
 - a. Overview of the proposed control system in clear text format describing the CSS understanding of the project work, schedule, startup, and coordination.
 - b. Preliminary testing plan.
 - 2. Exceptions to the Specifications or Drawings shall be clearly defined in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the specifications shall be at the sole discretion of the Engineer. If no exceptions are taken to the specifications or drawings the CSS shall make a statement as such. If there is no statement by the CSS, then it is acknowledged that no exceptions are taken.
- D. Coordination Meetings Agenda:
 - 1. Agendas shall be submitted for the Coordination Meetings as specified herein. Submit proposed Control System Coordination Meeting Agenda a minimum of two weeks prior to the scheduled meeting date for review and comment by the Engineer.
- E. Input/Output (I/O) Address List Submittal
 - 1. Submit, within 60 days, a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
 - 2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included within these specifications), and requirements outlined in the Specifications.
 - 3. The I/O list shall be submitted in a Microsoft Excel readable electronic file format.
 - 4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O.
 - 5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet tables shall include the following information:

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- a. TAG NUMBER(S): The identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
- b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
- c. **PHYSICAL LOCATION: The Control Panel designation of where the I/O** point is wired to.
- d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
- e. LOGICAL POINT ADDRESS: If the CSS is performing the PLC programming, I/O address of each point. If the CSS is not performing the PLC programming, then leave this field blank for use by the AE.
- f. I/O TYPE: use DO Discrete Output, DI Discrete Input, AO Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
- g. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
- h. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
- i. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
- j. **P&ID** the **P&ID** or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the **P&IDs**.
- 6. The I/O list shall be sorted in order by:
 - a. Physical location
 - b. *I/O Type*
 - c. Loop Number
 - d. Device Tag
- 7. After the I/O list is approved, do not modify the PLC I/O addresses without approval by the Engineer.
- 8. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single I/O module will not disable all mechanical components of the redundant system. This applies to all I/O types.
- F. Field Instruments Submittal
 - 1. Submit complete documentation of all field instruments using ISA-S20 data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment ordered by the loop numbering system as shown in the Contract Documents.
 - 2. Submit separate data sheets for each instrument including:
 - a. Plant Equipment Number and ISA tag number per the drawings
 - b. Product (item) name used herein and on the Contract Drawings
 - c. Manufacturer's complete model number
 - d. Location of the device
 - e. Input output characteristics
 - f. Range, size, and graduations in engineering units.

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- g. *Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents.*
- h. Materials of construction for enclosure and wetted parts.
- i. Instrument or control device sizing calculations where applicable
- j. Certified calibration data for all flow metering devices.
- k. Two-wire or four-wire device type as applicable.
- 3. Submit index and data sheets in electronic format. Electronic format shall be in Microsoft Excel or Word.
- G. Panel Layout Drawings and Wiring Diagrams Submittal
 - 1. Where direct hardwired interfaces exist between the CSS control panels and vendor provided control panels furnished under other Divisions or existing control panels, the Contractor shall provide to the CSS the approved shop drawings and submittals in order for the CSS to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings will be included in the Final Documentation submittal. Leaving this information blank on the Final Documentation drawings is not acceptable.
 - 2. Panel Layout Drawings: Drawings shall be furnished for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" minimum in size. As a minimum, the panel drawings shall include the following:
 - a. Interior and exterior panel elevation drawings to scale.
 - b. Nameplate schedule.
 - c. Conduit access locations.
 - d. Panel construction details.
 - e. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be crossreferenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
 - f. Fabrication and painting specifications including color (or color samples).
 - g. Submit construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
 - h. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
 - i. Submit evidence that all control panels shall be constructed in conformance with UL 508/698A and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL

inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Contractor and included in the Project Bid Price.

- 3. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. The diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the CSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the CSS and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and fourwire equipment shall be clearly identified and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x17" minimum in size.
- H. Testing Plan Submittals
 - 1. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures. Testing shall not be considered complete until the signed-off test procedures have been submitted and favorably reviewed. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.
 - 2. Each loop shall have a Loop Status signoff form to organize and track its inspection, adjustment and calibration. These forms shall include the following information and checkoff items:
 - a. Project Name.
 - b. Loop Number.
 - c. Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
 - d. Tag Number for each component.
 - e. Checkoffs/signoffs for each component.
 - 1) Tag/identification
 - 2) Installation
 - 3) Termination wiring
 - 4) **Termination tubing**
 - 5) Calibration/adjustment
 - f. Checkoffs/signoffs for the loop.
 - 1) **Panel interface terminations**
 - 2) **I/O interface terminations**
 - 3) **I/O signal operation**
 - 4) Inputs/outputs operational: received/sent, processed, adjusted
 - 5) Total loop operation
 - 6) Space for comments.
 - 7) Sign off and date fields for the Contractor, the Engineer, and the CSS.

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- 3. Each active analog subsystem element shall have a Component Calibration form. These forms shall have the following information including space for data entry:
 - a. Project Name.
 - b. Loop Number.
 - c. ISA Tag Number and I/O Module Address.
 - d. Manufacturer.
 - e. Model Number/Serial Number.
 - f. Summary of Functional Requirements. For example:
 - 1) For Indicators: Scale ranges
 - 2) For Transmitters/Converters: Scale and chart ranges
 - 3) For Computing Elements: Function
 - 4) For Controllers: Action (direct/reverse) control modes (PID)
 - 5) For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - 6) For I/O Modules: Input or output
 - g. Calibrations; for example:
 - 1) For Analog Devices: Required and actual inputs and outputs at 0, 50 and 100 percent of span.
 - 2) For Discrete Devices: Required and actual trip points and reset points.
 - 3) For Controllers: Mode settings (PID).
 - 4) For I/O Modules: Required and actual inputs or outputs for 0, 50 and 100 percent of span.
 - h. Space for comments.
 - i. Sign off and date fields for the Contractor, the Engineer, and the CSS.
- I. Spares, Expendables, and Test Equipment Lists Submittal
 - 1. This submittal shall include for each Subsystem:
 - a. A list of, and descriptive literature for, spares, expendables, and test equipment as specified in Division 13.
 - b. A list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer.
 - c. Unit and total costs for the additional spare items specified or recommended for each subsystem.
- J. Final System Documentation
 - 1. Submit in accordance with section 01330.
 - 2. The Final System Documentation shall consist of operations and maintenance manuals as specified herein. If the CSS is performing the AE work, provide AE Operator Manuals as specified in Section 13306. The manuals shall be bound in three-ring binders, maximum size of three inches, with Drawings reduced to 11 inch by 17 inch, then folded to 8.5 inch by 11 inch for inclusion. Each section shall have a uniquely numbered tab divider, and each component within each section shall have a separate binder tab divider.
 - 3. The operations and maintenance manuals shall, at a minimum, contain the following information:
 - a. Table of Contents

- 1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
- b. Instrument and Equipment Lists
 - 1) The following lists shall be developed in Excel.
 - 2) An instrument list for all devices supplied including tag number, description, specification section and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - 3) An equipment list for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
- c. Data <u>Sheets with Vendor Operations and Maintenance Information</u>
 - 1) **ISA S20** data sheets shall be provided for all field instruments.
 - 2) Cover page for each device, piece of equipment, and OEM software that lists, at a minimum, date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA S20, general data sheet; however, other formats will be acceptable provided they contain all required information.
 - 3) Final vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project, or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.
 - 4) For any component requiring dip switch settings or custom software configuration, that information shall be included along with the corresponding data sheets and O&M information.
- d. As-Built Drawings
 - 1) Complete as-built drawings, including all drawings and diagram specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system in connected to, including terminal points of equipment not supplied by the CSS.
 - 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.
- e. Original Licensed Software
 - 1) Submit original software diskettes or CD-ROMs of all software provided under this Contract. Submit original paper based and electronic documentation for all software provided. Submit license

agreement information including serial numbers, license agreements, User Registration Numbers and related information. All software provided under this Contract shall be licensed to the Owner at the time of purchase. Provide media in software sleeves within O&M manual.

- f. Electronic O&M Information
 - 1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals CDROM or DVD. Electronic documents shall be supplied in Adobe Acrobat format.
 - 2) Provide electronic files for all custom-developed manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
 - 3) Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, and fonts into individual zip files along with the drawing file.
 - 4) Each computer system hardware device shall be backed up onto CDROM or DVD after Substantial Completion and shall be turned over to the Owner.

1.4 **REFERENCE STANDARDS**

- A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.
- B. International Society of Automation (formerly the Instrumentation, Systems and Automation Society) (ISA)
 - 1. ISA S5.2 Binary Logic Diagrams for Process Operations
 - 2. ISA S5.3 Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 - 3. ISA S5.4, Instrument Loop Diagrams.
 - 4. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - 5. ISA RP60.3, Human Engineering for Control Centers
 - 6. ISA RP60.6, Nameplates, Labels, and Tags for Control Centers
- C. National Electrical Manufacturers Association (NEMA)
- D. National Fire Protection Agency (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC).
 - 2. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
- E. Underwriters Laboratories, Inc. (UL)
 - 1. UL 508 Industrial Control Equipment
 - 2. UL 698A Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations

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- F. American Society for Testing and Materials (ASTM)
 - 1. ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

1.5 QUALITY ASSURANCE

- A. The Control System Supplier (CSS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
 - 2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the CSS. Potential references shall be for projects where the CSS's contract, was of similar size to this project.
 - 3. Has been actively engaged in the type of work specified in this Specification Section for a minimum of five years.
- B. The CSS shall maintain a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the CSS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within four hours of notification starting at two months before scheduled startup to two months after startup completion.
- C. Actual installation of the instrumentation system need not be performed by the CSS's employees; however, the CSS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Shipping Precautions

1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty (5 mil) polyethylene envelopes or secured sheeting to provide protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering.

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Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.

- 2. Manufacturer's special instructions for field handling, storage and installation required for protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other means of protection.
- 3. None of the HMI control and monitoring equipment shall be shipped to the site until the control room areas comply with specified ambient temperature and humidity. Have qualified personnel accept the equipment on delivery and supervise unloading within the control room areas.
- 4. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the owner.

1.7 NOMENCLATURE AND IDENTIFICATION

- A. Field Instrument Tags
 - 1. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section. Equipment shall be tagged before shipping to the site.
 - 2. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.
 - 3. All supplied field instrument transmitters and field instrument transmitter elements shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless steel wire (24 gauge min) to a nonremovable part of the device. The tag size shall be a minimum of 1.5 square inches. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.
- B. Panel Nameplates 1. See Section 13330.

1.8 WARRANTY

A. Provide software updates throughout the warranty period. Provide latest official released version for all software provided under this Contract. Owner shall have the latest software releases at the end of the warranty period.

1.9 **PROJECT/SITE REQUIREMENTS**

A. Environmental Requirements. Refer to Section 16000 for specific environmental and hazardous area classifications.

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- B. Elevation: Equipment shall be designed to operate at the project ground elevation.
- C. **Temperature:**
 - 1. Outdoor areas' equipment shall operate between -30 to 50 C degrees ambient.
 - 2. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.
 - 3. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.
 - 4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.
- D. Relative Humidity. Air conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 0 to 100 percent relative, condensing humidity.

PART 2 - PRODUCTS

2.1 **PRODUCTS GENERAL**

- A. All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
- B. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X on the Drawings or as defined under Section 16000. Provide and size anchors in accordance with Division 1 and 5 as required per the seismic calculations. Provide minimum size anchor of 3/8-inch.
- C. All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.
- D. All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.
- E. All electronic/digital equipment shall be provided with radio frequency interference protection.
- F. **Electrical**

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- 1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
- 2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).
- 3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.
- 4. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
- 5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired fail-safe to the SCADA system unless otherwise shown. A fail-safe condition is an open circuit when in an alarm state.
- 6. Materials and equipment shall be UL approved. Where components are not available with UL approval, integrate the device with ground fault protective devices, isolation transformers, fuses, or other protective equipment necessary to achieve compliance with UL 508/698A requirements.
- 7. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory, and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
- 8. All transmitter output signals shall include signal and power source isolation.

2.2 LIGHTNING/SURGE PROTECTION

- A. General Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the internal plant electrical distribution system. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring. Ground wires for all instrumentation device surge protectors shall be connected to a good earth ground in accordance with Section 16060.
- B. Field Instrumentation Protection Provide individual device protection for the 4-20 mA signal and, if 4 wire field instrument, the power supply of each field instrument mounted outside of the building or facility housing the control panel. Instruments mounted within the structure as the associated control panel shall not require surge protection. Instruments shall be

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housed in a grounded metallic case. Device surge protectors shall be mounted within the instrument enclosure or a separate junction box coupled to the enclosure. Provide gas tube or metal oxide varisters (MOVs) surge protection devices as manufactured by Phoenix Contact, EDCO, Emerson Network Power Control Concepts, or equal.

- C. Control Panel Power Feed Provide protection of all 120 VAC power feeds into the control panels. Source voltage to cabinets/panels regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. Provide gas tube surge suppressors or metal oxide varisters (MOVs) located at the point where the 120V source supply enters the enclosure. Install the surge device to in strict compliance with the manufacturer's recommendation for maximum allowable circuit length between protective device and incoming circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact, EDCO, Emerson Network Power Control Concepts, or equal.
- D. 4-20 mA Signal Lines and Non-Fiber Based Data Highway Circuits Provide protection on all signal and data highway circuits that leave a building or are routed external to a building. Provide gas tube surge arrestors, and Zener diode protectors. Circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Provide signal surge suppression devices as manufactured by Phoenix Contact EDCO, Emerson Network Power Control Concepts, or equal.
- E. Inductive Loads At a minimum, provide coil surge suppression devices, such as varistors, or interposing relays on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.

2.3 TUBING AND FITTINGS

- A. All instrument air header takeoffs and branch connections less than 2-in shall be 316 stainless steel.
- B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. The materials for fittings and valves shall be compatible with process fluids. Where metallic fittings and valves are compatible, wetted materials shall be Type 316 stainless steel.
- C. The materials for instrument tubing shall be compatible with process fluids. Where metallic tubing is compatible, tubing shall be fully annealed ASTM A269 Seamless 316 grade free of OD scratches having the following dimensional characteristics as required to fit the specific installation:
 - 1. 1/4-in to 1/2-in O.D. by 0.035 wall thickness.
 - 2. 5/8-in to 1-in O.D. by 0.049 wall thickness.
 - 3. 1-in O.D. by 0.065 wall thickness.
 - 4. 1-1/4-in O.D. by 0.065 wall thickness.
 - 5. 1-1/2-in O.D. by 0.083 wall thickness.
 - 6. 2-in O.D. by 0.095 wall thickness.

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- D. All process connections to instruments shall be annealed 1/2-inches O.D. stainless steel tubing, Type 316.
- E. All tube track shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.4 SPARE PARTS

- A. Spare parts of the type and quantity as recommended by the manufacturer shall be furnished for all devices furnished under these sections.
- B. All spare parts shall be wrapped in bubble wrap, sealed in a polyethylene bag complete with dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the Engineer.
- C. As a minimum, furnish the following spare parts for control panels:
 - 1. Relays One of each type installed.
 - 2. Fuses and circuit breakers 10% (minimum of 10 fuses and 2 circuit breakers) of each type and size installed.
 - 3. Light bulbs 10% (minimum of 10) of each type installed.
 - 4. Surge protection devices One of each type installed.
 - 5. Provide one quart of touch-up paint, for each type and color used for all RTU/PLC cabinets, panels, and consoles supplied.
- D. The following field Instrument related Spare Parts shall be furnished:
 - 1. Miscellaneous: One year supply of items recommended by the manufacturer of the equipment including all reagents, pH probes, batteries, chart paper, calibration standards as needed to operate and maintain the furnished equipment.

2.5 TEST EQUIPMENT

- A. Provide all test equipment, instruction manuals, carrying/storage cases, unit battery charger, special tools, calibration fixtures, cord extenders, patch cords, test leads, and miscellaneous items for checking field operation of all supplied equipment.
- B. As a minimum, furnish the following test equipment as a separate line item:
 - 1. One complete electronic process calibrator sets with rechargeable batteries, cases, spare fuses, test leads, and PC based software. Provide model 830 as manufactured by Altek, or equal.
 - 2. One calibration pump, Model A-396A as manufactured by Dwyer Instruments, Inc., or equal.
 - 3. One hand-held HART communicator, with case and all necessary accessories, Model 375 by Rosemount, or equal.

4. One (1) portable digital multi-meter (DMM) with rechargeable battery and test leads, and carrying-case, Fluke 189 Series Digital Multimeter, or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of any interference with other work, proceed as directed by the Contractor and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the Owner.
- B. The P&IDs and Drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Where indicated on the P&IDs or Drawings as not requiring installation, provide the instruments suitably packaged for storage.
- C. All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as required for the locations as shown on the Drawings and specified in Division 16. All work shall be in strict accordance with codes and local rulings.
- D. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.
- E. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.
- F. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed as shown and not interfere with any other equipment.
- G. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

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- H. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. Certify that field wiring associated with his/her equipment is installed in accordance with best industry practice. Schedule and coordinate work under this section with that of the electrical work specified under applicable Sections of Division (16).
- I. Installation of fiber optic cable within control panel and console assemblies. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.
- J. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be suitably rated disconnect switches or manual motor starters as specified under Division (16).
- K. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.
- L. Loop Tuning All electronic control stations incorporating PID controllers shall be tuned following device installation but prior to commencement of the field tests.
 - 1. Optimal loop tuning shall be achieved either by auto-tuning software or manually by trial and error, Ziegler-Nichols step-response method, or other documented process tuning method. Assigning common PID factors for identical loops following field tuning of a single typical loop is acceptable. However, tuning documentation shall be submitted for each loop individually as specified in Part 1 of these Specifications.
 - 2. Determine and configure optimal tuning parameters to assure stable, steady state operation of final control elements running under the control of field mounted, dedicated PID controllers or software based PID controllers residing as part of the programmable logic controller system. Each control loop that includes anti-reset windup features shall be adjusted to provide optimum response following startup from an integral action saturation condition.
 - 3. Tune all PID control loops to eliminate excessive oscillating final control elements. Loop parameters shall be adjusted to achieve 1/4 amplitude damping or better. In addition, loop steady state shall be achieved at least as fast as the loop response time associated with critical damping.
 - 4. Loop performance and stability shall be verified in the field following tuning by step changes to setpoint. Submit loop tuning methodology and verification as part of the final system documentation as specified in Part 1.

5. For cascade loops, tune both sets of controllers so that the cascade loop achieves the loop tuning characteristics specified herein.

3.2 **PROCESS CONTROLLER INPUT/OUTPUT (I/O) SCHEDULE**

- A. Process controller I/O schedule itemizes the process controller Local and Remote I/O associated with the hardware provided under this contract. Provide additional I/O signals and hardware as required to furnish a complete and functional system. Process controller I/O schedule is included in Appendix 13300-A.
- B. Each column of the process controller I/O schedule is defined as follows:
 - 1. TAG NUMBER(S): The identifier assigned to a device that performs a function in the control system.
 - 2. **DESCRIPTION:** A description of the function of the device and/or loop.
 - 3. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
 - 4. *I/O TYPE:*
 - a. DO Discrete Output
 - b. DI Discrete Input
 - c. AO Analog Output
 - d. AI Analog Input
 - e. **PI Pulse Input**
 - f. **PO Pulse Output**
 - 5. **RANGE/STATE:** The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
 - 6. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
 - 7. **P&ID the P&ID or drawing where the I/O point appears on.**

+ + END OF SECTION + +

SECTION 13302

INSTRUMENTATION AND CONTROLS – TESTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor and materials required and installed. Complete as shown on the Drawings and as specified herein.
- B. This section covers the testing requirements for all devices and systems furnished and installed detailed on the Drawings, and as described in the related Sections of Division 13.
- C. Refer to Section 13300.
- 1.2 RELATED WORK
 - A. Refer to Section 13300.

1.3 SUBMITTALS

- A. Refer to Section 13300.
- 1.4 **REFERENCE STANDARDS**
 - A. Refer to Section 13300.
- 1.5 QUALITY ASSURANCE
 - A. Refer to Section 13300.
- 1.6 SYSTEM DESCRIPTION
 - A. **N/A**

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.8 **PROJECT/SITE REQUIREMENTS**

A. Refer to Section 13300.

1.9 MAINTENANCE

A. Refer to Section 13300.

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1.10 WARRANTY

A. Refer to Section 13300.

1.11 NOMENCLATURE AND IDENTIFICATION

A. Refer to Section 13300.

PART 2 - PRODUCTS

2.1 **NOT USED**

PART 3 - EXECUTION

3.1 **TESTING – GENERAL**

- A. See execution requirements in Section 13300.
- B. As part of the requirement of this specification section, it is the responsibility of the CSS to provide a complete operational control system. Confirmation of an operational control system is dependent upon results derived from test procedures as specified in this Section. The CSS shall test all equipment at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the CSS shall be tested at the factory as a single fully integrated system.
- C. The CSS shall test the system so that the Owner can verify all the points in the existing control system. The CSS shall coordinate the testing of the ORT and FDT with the Owner.
- D. At a minimum, the testing shall include the following:
 - 1. Unwitnessed Factory Test (UFT).
 - 2. Functional Demonstration Test (FDT).
 - 3. 30-day Site Acceptance Test (SAT).
- E. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.
- F. All tests shall be conducted in accordance with prior Engineer and/or Ownerapproved procedures, forms, and all checklists as submitted by the CSS under Part 1.3 of this Specification. Each test to be performed shall be described and a space provided after it for sign-off by the appropriate parties after its satisfactory completion. The CSS shall include "punchlist" forms with the test procedures to document issues that arise during the testing. Punchlist forms, at a minimum, shall include a specification cross reference; an issues description field; a resolution description field; and a sign-off area for the CSS, Owner, and Engineer.

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- G. Copies of the signed-off test procedures, forms, and checklists will constitute the required testing documentation. The test result forms shall be submitted to the Engineer for approval within 10 days of completion of each test.
- H. The CSS shall provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. These simulation techniques shall be defined in the test procedures.
- I. The CSS shall coordinate all required testing with the Contractor, all affected Subcontractors, the Engineer, and the Owner.
- **J.** The CSS shall furnish the services of field service technicians, all special calibration and test equipment, and labor to perform the field tests.
- K. The Engineer reserves the right to test or retest all specified functions, whether or not explicitly stated on the Test Procedures, as required to determine compliance with the functional requirements of the overall system. Such testing required to determine compliance with the specified requirements shall be performed at no additional cost to the Owner. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.
- L. Correction of Deficiencies
 - 1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.
 - 2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

3.2 FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)

- A. Prior to shipment of the equipment, the entire system, except primary elements, final control elements, and field-mounted transmitters, shall be interconnected and tested to ensure the system will operate as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.
- B. All panels, consoles, and assemblies shall be inspected and tested to verify their conformance with related submittals, Specifications, and Drawings.
- C. During the tests, all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.
- D. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in the Test Procedure submittal.

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- 1. All panels and enclosures being provided shall undergo a thorough inspection to verify the integrity of the cabinet enclosures, frame structures, paint work and finish, etc. Additionally, the CSS shall review the panel drawings with the Owner and/or Engineer to ensure they accurately reflect the panel layout and wiring.
- 2. Panel wire pull tests shall be performed on all wiring to ensure all wiring has been connected to the appropriate torque to prevent wires from coming loose.
- 3. For panels provided in new enclosures, heat loading tests shall be performed to ensure proper cooling/ventilation is being provided.
- E. All control panels provided or modified under the requirements of the related technical specification sections of Division 13 shall be included in these tests.
- F. Upon successful completion of the UFT, the CSS shall submit a record copy of the test results to the Owner and Engineer and coordinate the scheduling of the SIT

3.3 FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)

- A. Prior to startup and the 30-day Site Acceptance Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the ORT. The FDT will be a joint test by the CSS and the AESS.
- B. Once a process area has been started up and is operating, a witnessed FDT shall be performed on that system to demonstrate that it is operating and is in compliance with these Specifications. A witnessed FDT shall be performed on each process area. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
- C. Loop-specific and non-loop-specific tests shall be the same as specified under WFT, except that the entire installed system shall be tested and all functions demonstrated using live field-based data to the greatest extent possible.
- D. Updated versions of the documentation specified to be provided for during the factory tests shall be made available to the Engineer at the job site both before and during the tests. In addition, one copy of all O & M Manuals shall be available for reference at the job site, both before and during testing.
- E. Upon successful completion of the FDT, the CSS shall submit a record copy of the test results to the Owner and Engineer and request the scheduling of the SAT as noted in the following section.

3.4 FIELD TESTING - 30-DAY SITE ACCEPTANCE TEST (SAT)

A. After completion of the Operational Readiness and Functional Demonstration Tests, the system shall undergo a 30-day Site Acceptance Test (SAT), under

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conditions of full plant process operation, without a single non-field-repairable malfunction.

- B. During this test, plant operations and CSS personnel shall be present as required to address any potential issues that would impact the overall system operation. The CSS is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system. When CSS personnel are not on-site, the CSS shall provide cell phone/pager numbers that Owner personnel can use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.
- C. Any malfunction during the tests shall be analyzed and corrections made by the CSS. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- D. Any malfunction during this 30 consecutive day test period which cannot be corrected by the CSS's personnel within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction. Upon completion of repairs by the CSS, the SAT will be re-started from the date which the CSS successfully corrected the malfunction(s) and the Owner and Engineer have accepted and signed off on the repairs.
- E. In the event of rejection of any part or function, the CSS shall perform repairs or replacement within 10 days.
- F. Certification of Installation: Following successful completion of the 30-day test, the CSS shall issue a Certification of Installation. Certification shall be on CSS corporate letterhead and signed by an officer of the firm. Certification shall state that the process control system has been completed in conformance with plans and specifications. Certification shall be submitted to the Engineer as specified herein.

+ + END OF SECTION + +

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City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 13300-6

Addendum 2 April 2024

SECTION 13305

SPECIFIC CONTROL STRATEGIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Coordination:
 - 1. Equipment manufacturer to provide screen shots for the PLC controls at the HMI screen for review and approval. Controls terminology mentioned in this section may differ from the existing plant naming convention. Once PLC and control panel drawings are received and reviewed, these terminologies will be commented upon and will be updated.

B. Section includes:

- 1. Loop descriptions:
 - a. Specific control requirements and functional descriptions for individual control loops.
- C. Related sections:
 - 1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
 - 2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
- D. Trending is to be provided for all instruments provided in this project. Programming and transmitters shall be selected accordingly.

1.2 REFERENCES

A. See Division 1, Division 16 and Division 13.

1.3 DEFINITIONS

A. List of Terms

HMI	human machine interface
LCP	local control panel
LOR	local-off-remote
MCC	motor control center
P&IDs	process and instrumentation diagrams
PLC	programmable logic controller
SCADA	supervisory control and data acquisition
VFD	variable frequency drive

1.4 SUBMITTALS

A. Develop detailed loop descriptions based on the information in the Contract Documents, and submit as specified in Division 1 and Division 17.

- 1. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls shown on the P&IDs:
 - a. Include all functions depicted or described in the Contract Documents.
 - b. Include the following within each loop description:
 - 1) All requirements specific to that loop.
 - 2) Common control requirements applicable to that loop.
 - 3) List of all ranges, setpoints, timers, values, counters, etc.
- 2. Where there are similar loops with identical control, such as multiple loops for individual raw water pumps, only 1 loop description need be developed and the remaining loops may reference that loop description.
- B. Loop description format:
 - 1. Loop number and title.
 - 2. References:
 - a. List P&IDs that are specifically referenced.
 - 3. Abstract:
 - a. General description of how the loop works, what devices are involved, and how the process will be controlled.
 - b. Process values, setpoints, and limits, including units and ranges:
 - 1) Show span and range values for analog inputs and outputs, and operating point and deadband for discrete inputs.
 - 4. Hardwired control:
 - a. Detailed description of the control functions at the local level.
 - b. Function of local operator interfaces.
 - c. Operation of hardwired field pilot controls:
 - 1) Pushbuttons.
 - 2) Selector switches.
 - 3) Potentiometers.
 - 4) Pilot lights, indicators, and other displays.
 - 5. Hardwired interlocks:
 - a. Explanation of the operation of system interlocks and hardwired permissive conditions.
 - 6. PLC control:
 - a. Detailed description of the control functions that are under control of the PLC.
 - b. Operator controls and automatic controls.
 - c. Setpoints, alarms, etc.:
 - 1) Include units and ranges for analog values.
 - 2) Include span and range for analog inputs and outputs.
 - 3) Include operating point and deadband for discrete inputs, and identify conditions where contacts are open, and when they close.
 - d. Control sequences.
 - 7. Software interlocks:
 - a. Operation of system software interlocks.
 - 8. HMI control:
 - a. Detailed description of the operator controls.
 - 9. SCADA control:
 - a. Detailed description of the operator controls.
 - b. Setpoints, alarms, etc.
 - 10. Indicators and alarms:
 - a. List any indicators and alarms specific to the loop that are not covered in the common control strategies.
 - 11. Failure modes:

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a. List any failure modes specific to the loop that are not covered in the common control strategies.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION, APPLICATION, CONSTRUCTION

- A. Lift Station:
 - 1. References:
 - a. P&ID: N-601.
 - 2. The description below is typical for loops 101 and 201.
 - 3. Abstract:
 - a. The Lift Station is designed to lift and convey wastewater from Yavapai Hills to Ranch #1 Lift Station.
 - b. The Pumps are VFD operated and interlocked to allow only one pump running at a time.
 - c. A magnetic flow meter is provided on the lift station discharge to monitor flow.
 - d. The Pumps can be controlled locally by the operator via the local control panel (LCS-101/LCS-201).
 - e. In automatic mode the pump is controlled by the PLC to maintain constant level.
 - 4. Hardwired control:
 - a. When the Local-Off-Remote (LOR) switch (HS-101A/HS-201A) at LCS-101/LCS-201 is in LOCAL position, the pump is controlled by the start/stop hand momentary switches on the respective LCS.
 - b. When the LCS Start button for the pump is pushed by the operator, the pump operates at the speed setpoint set by the operator at the LCS.
 - c. When the Stop button for the pump is pushed by the operator, the pump stops.
 - d. After an alarm condition has cleared the RESET button located on the VFD will release the alarm.
 - 5. Hardwired interlocks:
 - a. The pump is stopped and prohibited from starting if:
 - 1) Motor high temperature switch (TSH-101/201) is activated.
 - 2) Motor leak switch (MSH-101/201) is activated.
 - 3) Low Lift Station level switch (LSL-101/201) is activated.
 - 4) Pumps are hardwired interlocked so that only one pump can run at a time.
 - 6. SCADA/PLC Pump control:
 - a. When the LOR switch at the LCP-VFD is in the REMOTE position, the pump is controlled by the PLC. SCADA will have a software Manual-Off-Auto selector switch for the pump.
 - b. Pumps shall be fully controlled via remote offsite connection at Sundog WRF.
 - c. When the software selector is in the MANUAL setting, the pump is started and stopped using Start-Stop (MN-101 AND MS-101) controls displayed on the SCADA graphic screen. Speed of the pump is varied by changing the set-point (SC-101) on the SCADA graphic screen.

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- d. When the software selector is in the AUTO setting, the pump will be operated in Lead/Lag based on the selected mode of operation.
 - 1) Level Mode:
 - a) The operator sets level setpoint inside the wet well (initially set at 4.2 feet from bottom).
 - b) When pump is called to start, pump speed shall ramp up to 86% (Operator adjustable).
 - c) VFD speed will vary based on PID controller to maintain this level setpoint.
 - d) Pump turns off when one or more of following criteria are met:
 - 1. Operator turns off the pump.
 - 2. Based on Low Level in Lift Station (Operator Adjustable).
 - 2) The pumps shall rotate lead/lag based on an operator adjustable setpoint (initially set at 7 days).
- e. If connection to SCADA/PLC is interrupted, then the pump shall operate based on the floats within the well described as follows:
 - 1) LSHH: 5329'
 - 2) LSH: 5328.5'
 - 3) Pump Start: 5326.33'
 - 4) Pump Stop: 5325.33'
 - 5) LSLL: 5323.8'
- 7. Software interlocks:
 - a. Prohibit the pump from running when:
 - 1) Lift station low level from LIT-101, (Operator Adjustable).
- 8. Indicators and alarms:
 - a. As indicated on the Drawings and Specifications.
 - b. At a minimum provide the following:
 - 1) VFD:
 - a) Amber High motor temperature alarm (TSH-101)
 - b) Amber Motor leak alarm (MSH-101)
 - c) White Power On
 - d) Green Motor On/Running (YL-101)
 - e) Amber Motor Fault (YA-101)
 - f) VFD Speed (HMI)
 - g) Motor run elapsed time
 - 2) SCADA:
 - a) Pump Status
 - 1. Red On/Running (YL1-101)
 - 2. Amber Failed (YA-101)
 - b) Pump remote status (YR-101)
 - c) VFD speed (SI-101)
 - d) Motor run time (K1-101)
 - e) Flow (FI-103)
 - f) Low flow alarm (FAL-103)
- B. Existing Wet Well Pumps (Overflow)
 - 1. References:
 - a. P&ID N-602
 - 2. The description below is typical for loop 601 and 602
 - 3. Abstract:
 - a. The overflow is designed to allow for the accumulation of flow volume in the event of a 100-year 2 hour event.

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- b. The overflow pumps are to discharge into the proposed manhole labeled as Manhole No. 2 while having the ability to pass 2 inch solids.
- c. The pumps are operated on a single frequency of 60 Hz.
- d. The pumps can be controlled locally at the vendor provided LCP (LCP-601).
- e. The pumps are to operate based upon level switch indicating floats, and shall feature an LSHH, LSH, LEAD and STOP floats.
- 4. Hardwired control:
 - a. As indicated on the drawings.
 - b. To be provided by VENDOR, but will at a minimum provide:
 - 1) Hand-Off-Auto (HM)
 - 2) Reset (HMS)
 - 3) Fault light Red
 - 4) Running light Green
 - 5) Power light White
 - 6) Silence (HMS) to silence audible alarm
 - 7) Test (HMS) to test that alarms are functioning properly
- 5. SCADA/PLC Pump Control
 - a. When the HOA (Hand-Off-Auto) is in the Hand position, the pump shall be controlled at the LCP using the hardwired controls.
 - b. When the HOA (Hand-Off-Auto) is in the Off position, the pump shall be off.
 - c. When the HOA (Hand-Off-Auto) is in the Auto position, the pump shall be operated based on the vendor provided floats.
 - 1) Floats to be set at the following levels:
 - a) LSHH: 4'
 - b) LSH: 3.5'
 - c) LEAD: 3'
 - d) STOP: 2.5'
- 6. Hardwired interlocks:
 - a. Per manufacturer.
- 7. Software interlocks:
 - a. Per manufacturer.
- 8. Indicators and alarms:
 - a. As indicated on the drawings.
 - b. At a minimum provide the following
 - 1) SCADA:
 - a) Well high high level alarm.
 - b) Transfer pump general alarm.
 - c) Transfer pump fault.
 - d) Transfer pump running indicator.

++ End of Section ++

SECTION 13330

PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 **DESCRIPTION**

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and place into satisfactory operation control panels and/or enclosures.

1.2 **QUALITY ASSURANCE**

- A. Standards, Codes and Regulations:
 - 1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
 - a. National Fire Protection 79, Electrical Standard for Industrial Machinery (NFPA 79).
 - b. National Electrical Code (NEC).
 - c. National Electrical Manufacturer's Association Standards (NEMA).
 - d. American Society for Testing and Materials (ASTM).
 - e. Operational Safety and Health Administration (OSHA) Regulations.
 - f. State and Local code requirements.
 - g. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
 - 2. All electrical materials and equipment shall be new and shall bear the label of the Underwriters' Laboratory (UL), Inc., Factory Mutual (FM) or equivalent where standards have been established and label service regularly applies.
- B. General Design Requirements: 1. Comply with the requirements of Section 16050.

1.3 SUBMITTAL

A. Comply with the requirements of Section 16050.

1.4 **PRODUCT DELIVERY, STORAGE AND HANDLING**

A. Comply with the requirements of Section 16050.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.

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- B. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
- C. Components for installation on panel exterior shall be located generally as shown. Layouts shall be submitted for approval in accordance with Section 16050.
- D. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.
- E. Provide sub-panels for installation of all relays and other internally mounted components.
- F. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.
- G. *Provide copper grounding studs for all panel equipment.*
- H. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.

2.2 **IDENTIFICATION**

- A. **Provide laminated plastic nameplates for identification of panels and** components mounted thereon as follows:
 - 1. Nameplates shall be of 3/32-inch thick laminated phenolic type with black matte finish surface and white letter engraving.
 - 2. Panel identification nameplates to have 1/2-inch high letter engravings.
 - 3. Panel mounted component identification (e.g., control devices, indicating lights, selector switches, etc.) nameplates to have 1/4-inch high letter engravings.
 - 4. Nameplates shall be attached to the panel face with two stainless steel selftapping screws.
 - 5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.
- B. Tag all internally mounted components in accordance with the following requirements:
 - 1. Tag numbers shall be as shown.
 - 2. The identifying tag number shall be permanently etched.
 - 3. Identification tag shall be installed so that the numbers are easily visible to service personnel.
 - 4. Front of panel mounted instruments shall have the tag attached to rear of device.
- C. Tag all electrical components and devices mounted within control panels and enclosures with embossed plastic tape labels.
- D. Tag all pneumatic lines with plastic tags. Paper tags are not acceptable.
- E. Numerically code terminals on terminal strips using a Brady LS2000 Labeling System, or equal.

- F. Color code and/or numerically code wiring as required by applicable standards. Wires shall be identified at each end with permanent number codes using a Brady LS2000 Labeling System, or equal.
- G. PANELS AND ENCLOSURES
- H. General:
 - 1. Panels and enclosures shall meet the NEMA requirements for the type specified.
 - 2. Sizes shown are estimates. CONTRACTOR shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within.
- I. Construction Features:
 - 1. Control panels located inside control or electrical room areas shall be NEMA 12 rated.
 - a. Fabricate enclosures using minimum 14 gage steel for wall or frame mounted enclosures and minimum 12 gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
 - c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
 - d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
 - e. Use pan type construction for doors. Door widths shall not exceed 36inches.
 - f. Mount doors with full length heavy duty piano hinge with stainless steel hinge pins.
 - g. Provide oil resistant gasket completely around each door or opening.
 - h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
 - i. Use stainless steel fasteners throughout.
 - j. Provide interior mounting panels and shelves constructed of minimum 12 gage steel with a white enamel finish.
 - k. **Provide steel print pocket with white enamel finish.**
 - 1. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
 - m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.
 - n. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
 - o. One coat of primer shall be applied to all interior and exterior surfaces immediately. Exterior surfaces shall then be given sufficient coats of

primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.

- p. All interior surfaces shall be painted with two coats of semi-gloss white enamel.
- q. All exterior surfaces shall be painted with a minimum of three finish coats of enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected from color charts furnished by CONTRACTOR. Provide one extra quart of touch-up paint for each exterior finish color.
- r. Primer and finish paint shall be compatible and shall be Sherwin-Williams "Polane T Polyurethane Enamel", or equal.
- s. **Provide one extra quart of touch-up paint for each exterior finish color.**
- 2. Control panels located in field shall be NEMA 4X rated. Panels shall be either metallic or non-metallic, as shown on the Drawings.
 - a. Non-metallic Panels:
 - 1) Panels shall be constructed of fiberglass mat-reinforced polyester resin, with a minimum thickness of 3/16-inch for all surfaces except those areas requiring reinforcement.
 - 2) Panels shall be precision molded to form a one-pieced unit with all corners rounded.
 - 3) Exterior surfaces shall be gel-coated to provide a corrosion-resistant, maintenance-free satin finish which shall never require painting.
 - 4) Color pigments shall be molded into the resin.
 - 5) Color to be selected from color charts furnished by CONTRACTOR.
 - 6) **Panels shall have "half height" front access doors wherever rear access is not feasible; no devices to be mounted on doors.**
 - 7) **Provide a clear plastic, gasketed, hinged door to encompass all non-NEMA 4 front of panel instruments.**
 - 8) All hardware, including hinge and means of locking shall be corrosion resistant.
 - 9) **Provide 5/16-inch diameter copper ground studs which will be the ground connection points for all panel equipment.**
 - 10) Floor Pad: Refer to Part 3 of this Specification Section.
 - b. Metallic Panels:
 - 1) Panels shall be Type 316 stainless steel construction with a minimum thickness of 12 gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
 - 2) Stainless steel fast-operating clamp assemblies on three sides of each door.
 - 3) Rolled lip around three sides of door and along top of enclosure opening.
 - 4) Hasp and staple for padlocking.
 - 5) **Provide a clear plastic, gasketed lockable hinged door to encompass** *all non-NEMA 4 front of panel instruments.*
 - 6) **Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad for free-standing panel.**
 - 7) Floor Pad: Refer to Part 3 of this Specification Section.
- 3. Where the application applies and with the approval of ENGINEER, wall mounted enclosures may be provided. The enclosure shall comply with Paragraph 2.3.B.1 and Paragraph 2.3.B.2, except for the following:
 - a. Doors shall be full height.
 - b. No extra holes or knockouts shall be provided. No light or convenience outlet need be provided.

- J. Electrical Systems:
 - 1. Power Source and Internal Power Distribution:
 - a. General: Control panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown.
 - b. Disconnect Switch: Each panel shall include a disconnect switch to disconnect the power source from the panel.
 - 2. Electrical Systems:
 - a. Internal wiring shall be Type THHN stranded copper wire with thermoplastic insulation rated for 600 V at 85 deg C for single conductors, color coded and labeled with wire identification.
 - b. For DC panel signal wiring, use No. 16 minimum AWG shielded. For DC field signal wiring, terminal strips shall be capable of handling No. 12 wiring (minimum).
 - c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 14 minimum AWG. For wiring carrying more than 15 amps, use sizes required by NEC and JIC standards.
 - d. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.
 - e. Install wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.
 - f. Adequately support and restrain all wiring runs to prevent sagging or other movement.
 - g. Terminate all field wiring using forked, insulated, crimp-on connectors (soldered type not acceptable) at 600 V rated barrier type terminal strips with screwed connections and permanently affixed numeric identifiers beside each connection. Identifiers to be self-stick plastic tape strips with permanent type, machine printed numbers.
 - h. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
 - i. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.
 - j. For internal component to component wiring only, compression type terminal blocks are acceptable.
 - k. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
 - Provide a separate terminal for grounding each shielded cable.
 - m. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
 - n. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
 - o. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
 - p. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in conformance with NEC.

- B. Unless otherwise noted, install free standing panels on 4-inch concrete pad. Lay grout after panel sills have been securely fastened down. Extend pad 4inches beyond outside dimensions of base, all sides.
- C. Unless otherwise noted, install outdoor non-free standing NEMA 4X panels on a frame support made of steel channel as required.
 - 1. Top of panels shall be no more than 6 feet above finished grade.
 - 2. support shall be designed and installed to handle the full weight of the individual panel and shall be installed to prevent sway motion in all directions. Angle supports shall be utilized to accomplish this.
 - 3. Material of construction shall be appropriate for the area of installation. Corrosive areas require either stainless steel channel and hardware or PVC Coated.
- D. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as shown on the Drawings.

3.2 TESTING AND ADJUSTMENTS

- A. Perform system testing and make any adjustments necessary to provide a complete accurate operating system as shown on the contract drawings. All PLC programming shall be performed by others.
- B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.
 - + + END OF SECTION + +

SECTION 13331

PANEL INSTRUMENTS AND DEVICES

PART 1 - GENERAL

1.1 **DESCRIPTION**

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.
 - 2. Drawings and Specifications illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. CONTRACTOR shall provide all piping, wiring, accessories and labor required for a complete, workable and integrated system.
- B. Coordination: Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.
 - 2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. Obtain all instruments or devices of a given type from the same manufacturer.

1.3 **PRODUCT DELIVERY, STORAGE AND HANDLING**

A. Instruments and devices shall not be assembled in the panels until all product information and system shop drawings for respective components have been approved.

1.4 **IDENTIFICATION TAGS**

- A. All panel instruments and devices shall have an identification tag meeting the following requirements:
 - 1. Tag numbers shall be as shown on the drawings.
 - 2. Identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
 - 3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
 - 4. All instruments and devices mounted within panels shall have the stainless steel identification tag installed so that the numbers are easily visible to

service personnel. Front of panel mounted components shall have the tag attached to the rear of the device.

5. *Front of panel mounted components shall have plastic engraved nameplates.*

PART 2 - PRODUCTS

- A. CONTROL RELAYS
- B. Type: General purpose, plug-in type rated for continuous duty.
- C. Construction Features:
 - 1. Coil Voltages: 24 VDC and 120 VAC as required.
 - 2. Contacts:
 - a. Silver cadmium oxide rated not less than 5 amperes resistive at 120 VAC or 28 VDC continuous.
 - b. For switching low energy circuits (less than 200 mAdc) fine silver, gold flashed contacts rated not less than 3 amperes resistive at 120 VAC or 28 VDC continuous shall be provided.
 - 3. Relays to have clear plastic dust cover.
 - 4. Relays to be UL recognized.
- D. Product and Manufacturer: Provide one of the following:
 - 1. Type R and/or Type K, as manufactured by Square D Company.
 - 2. *IDEC.*
 - 3. Or equal.

2.2 TIME DELAY RELAYS

- A. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break or interval operation.
- B. Construction Features:
 - 1. MOS digital circuit with transformer coupled power.
 - 2. Switch selectable ranges as follows:
 - a. 1 second.
 - b. **10 seconds.**
 - c. **1 minute.**
 - d. 10 minutes.
 - e. **1 hour.**
 - f. **10 hours.**
 - 3. Minimum Setting: 3 percent of range, except 50 ms for 1 second range.
 - 4. Contacts:
 - a. Type: DPDT.
 - b. Rating: 7 amps resistive at 120 VAC, 7 amps at 24 VDC.
 - 5. Housing: Plug-in design with dust and moisture resistant molded plastic case.
 - 6. Power Input: 120 VAC and 24 VDC as required.
 - 7. Relays shall be UL recognized.
- C. **Product and Manufacturer: Provide one of the following:**
 - 1. Series 328, as manufactured by Automatic Timing and Controls Company.
 - 2. *IDEC.*

3. Or equal.

2.3 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

- A. General:
 - 1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
 - 2. **Type:**
 - a. Heavy duty, oiltight.
 - 3. **Provide legend plate for indication of switch, pushbutton or light function** (e.g., Open-Closed, Hand-Off-Auto).
 - 4. Mounting: Flush mounted on control panel front, unless otherwise noted.
 - 5. NEMA rated to match panel in which mounted.
- B. Selector Switches:
 - 1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
 - 2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified but not less than one single pole, double throw contact.
 - b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
 - c. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts but not less than 10 amperes resistive at 120 volts AC or DC continuous.
 - 3. Switch Operator: Standard black knob.
- C. Pushbuttons (Standard or Illuminated):
 - 1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
 - 2. Contacts: Comply with the requirements specified for selector switches.
- D. Indicating Lights:
 - 1. Type: Compact, integral transformer type.
 - 2. Lamps: 6 volt, long life (20,000 hours minimum).
 - 3. Where shown on the Drawings, common, push to test circuitry shall be provided to simultaneously test all indicating lights on the panel using a single pushbutton.
- E. Button and Lens Colors:
 - 1. Red for indication of open, on, running.
 - 2. Green for indication of closed, off (ready), stopped.
 - 3. Amber for indication of equipment malfunction, process trouble and alarms (e.g., high level, low level, etc.).
 - 4. Blue for indication of equipment under local control.
 - 5. White for indication of electric power available.
- F. Rotary Cam Switches:
 - 1. *Provide rotary cam switches with number of positions and poles as required to perform the required signal switching function specified and shown.*
 - 2. Contacts:

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- a. Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required to perform intended functions.
- b. Contact Rating: Compatible with AC or DC throughput current of signals and devices simultaneously operated by the switch contacts but not less than 20 amperes at 600 VAC or 250 VDC continuous.
- 3. Switch Operator: Standard black knob.
- G. **Product and Manufacturer: Provide one of the following:**
 - 1. Square D.
 - 2. Or equal.

2.4 ELAPSED TIME METER

- A. General: The unit shall be a powered, non-reset, solid-state counter which provides silent, accurate and noise immune operation.
- B. Required Features:
 - 1. Power: 120 vac.
 - 2. Display:
 - a. **Digits: Six.**
 - 3. *Input: 120 VAC.*
 - 4. Mounting: Provide accessories for panel mounting.
- C. **Product and Manufacturer: Provide one of the following:**
 - 1. Crompton.
 - 2. Or equal.

2.5 SURGE PROTECTION DEVICE

- A. General: Lightning and surge protection shall be provided for instrument and main power protection.
- B. Required Features:
 - 1. Amp Rating: 10 kA for instruments; 20 kA for main power.
 - 2. Voltage Rating: Compatible with working voltage of protected device.
 - 3. Reaction Time: nanosecond range.
 - 4. Mounting: DIN rail.
 - 5. Enclosure Rating: Intrinsically safe when noted.
- C. Product and Manufacturer: Provide one of the following:
 - 1. Phoenix Contact.
 - 2. Or equal.

2.6 **EXECUTION**

2.7 INSTALLATION

- A. Install each item in accordance with manufacturers recommendations and in accordance with the Contract Documents.
- B. All items shall be mounted and anchored in compliance with Section 13330, Panels and Enclosures.

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2.8 START-UP, CALIBRATION, AND TESTING AND TRAINING

A. Comply with the requirements of Section 13302, Instrumentation and Controls Testing.

+ + END OF SECTION + +

SECTION 13332

CONTROL SYSTEMS – PROGRAMMABLE LOGIC CONTROLLERS HARDWARE (FOR REFERENCE ONLY)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for: 1. Programmable Logic Controller (PLC) based control systems hardware.

1.2 **REFERENCES**

A. Refer to Section 13300.

1.3 **DEFINITIONS**

- A. Refer to Section 13300.
- B. Specific Definitions:
 - 1. CPU: Central Processing Unit.
 - 2. I/O: Input/Output.

1.4 SYSTEM DESCRIPTION

A. Provide all PLC hardware as indicated on the Drawings and in this specification.

1.5 SUBMITTALS

- A. Furnish submittals in accordance with Contract Documents and Section 13300.
- B. Product Data:
 - 1. CPU:
 - a. **Processor type.**
 - b. Processor speed.
 - c. **Memory.**
 - d. Internal processor battery back-up time.
 - 2. I/O Modules:
 - a. **Type.**
 - b. Standard wiring diagram.
- C. Calculations:
 - 1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
 - 2. Submit calculations to verify that spare I/O requirements of this Section are met.

3. Submit calculations to verify that PLC power supply requirements of this Section are met.

1.6 **QUALITY ASSURANCE**

- A. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- B. Additional Requirements:
 - 1. **Provide PLC system components by a single Manufacturer:**
 - a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
 - 2. Use PLC Manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
 - 3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects and produced by Manufacturers regularly engaged in the manufacture of these products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.8 **PROJECT OR SITE CONDITIONS**

- A. Refer to Section 13300.
- 1.9 WARRANTY
 - A. Refer to Section 13300.

1.10 **MAINTENANCE**

- A. Refer to Section 13300.
- B. In addition to the spare parts requirements in Section 13300, furnish:
 - 1. **1** spare CPU for every type of CPU in the system.
 - 2. 1 spare I/O card for every type of I/O card in the system.
 - 3. 1 spare Power Supply for every Power Supply in the system.
 - 4. 1 spare network and/or communications card for every network or communications card in the system.
 - 5. 1 spare remote adaptor for every remote adaptor in the system.

C. Installed Spare Requirements:

- 1. I/O Points:
 - a. 25 percent spare capacity for each type of I/O signal at each PLC or RIO. Calculate the spare capacity as the number of unused points on I/O modules for the given I/O type divided by the total number of points on existing I/O modules for given I/O type.
 - b. Wire all spare I/O points to field terminal blocks in the PCM.

- c. Space shall be available in each PLC or RIO enclosure to support the future addition of 100 percent additional spare I/O.
- 2. PLC Memory:
 - a. 1.5MB or 50 percent spare program volatile memory, whichever is greater.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: 1. Allen Bradley CompactLogix.

2.2 MANUFACTURED UNITS

- A. **Programmable Logic Controller:**
 - 1. Construction:
 - a. Furnish plug-in modular system.
 - b. Chassis wired logic is not acceptable.
 - c. **Provide PLCs capable of operating in a hostile industrial environment** without fans, air conditioning, or electrical filtering:
 - 1) Temperature: 0 60 degrees Celsius.
 - 2) **RFI: 80 1000 MHz.**
 - 3) Vibration: 10 500 Hz.
 - 4) Humidity: 0 95 percent.
 - d. Provide internal power supplies designed to protect against over voltage and frequency distortion characteristics frequently encountered with the local power utility.
 - e. Design the PLC system to function as a stand-alone unit that performs all of the control functions described herein completely independent from the functions of the SCADA system PC-based Operator Interfaces:
 - 1) Failure of the SCADA system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
 - 2. Components General:
 - a. Provide each PLC with the functionality required to implement the control strategies and database shown and specified in the Contract Documents.
 - b. Furnish each PLC with floating point math and PID controller modulating algorithms.
 - c. Provide each CPU with internal fault analysis incorporating a fail-safe mode and a dry contact output for remote location alarming, as well as a local indicator on the PLC frame in the event of a fault in the PLC.
 - 3. Central Processing Unit:
 - a. Configure each central processor unit so that it contain all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
 - b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements including the spare and expansion requirements

- c. Capable of supporting and implementing closed loop floating-point math and PID control that is directly integrated into the CPU control program.
- d. Design the power supply to contain capacitors to provide for orderly shutdown in the event the incoming power does not meet specifications:
 - 1) Cease operation under this condition and force all outputs Off.
- 4. Memory:
 - a. Non-volatile memory: On-Board Complementary Metal Oxide Semi-Conductor (CMOS), electrically erasable programmable read only memory, EEPROM, PCMCIA, Compact Flash card, or SD card.
 - b. Supply with an internal lithium battery to retain non-volatile memory during power outages of up to 30 days. Battery to retain charge for minimum 1 year during normal operations.
 - c. Furnish with an indicator showing the status of the batteries on the OIS graphic screen to alarm the operator that the batteries should be changed.
 - d. Supply with sufficient memory to implement the specified control functions plus a reserve capacity in accordance with the requirements of this Section:
 - 1) This reserve capacity:
 - a) **Totally free from any system use.**
 - 1. Programmed in a multi-mode configuration with multiple series or parallel contacts, counters, timers, and arithmetic functions.
 - 2) Programming:
 - a) **Provide a system where processors are programmed by:**
 - 3) Portable laptop computer both locally and via the PLC data network.
- 5. PLC Power Supply:
 - a. Input: 120 VAC.
 - b. **Provide each PLC power supply sized to meet the following** requirements:
 - 1) **120 VAC RMS plus or minus 15 percent, continuously.**
 - 2) **120 VAC RMS plus or minus 30 percent, maximum 30 seconds.**
 - 3) **120 VAC RMS plus or minus 100 percent, maximum 17 milliseconds.**
 - 4) Line spikes at 1000 VAC:
 - a) **5000** microseconds duration.
 - b) **0.05 percent maximum duty cycle.**
 - c. Mounted in the PLC housing.
 - d. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
- 6. PLC Input/Output, I/O Modules:
 - a. **General:**
 - 1) Compatible with all of the PLCs being furnished under the contract and by the same Manufacturer as the PLCs.
 - 2) **Provide I/O modules that:**
 - a) Isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
 - b) **Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.**
 - c) Accept dual ended inputs.

- 3) The commoning of grounds between I/O points is not acceptable.
- 4) Provide at each PLC location the I/O modules required to provide the I/O points, including designated future I/O points, contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies:
 - a) **Provide at each PLC location an installed spare capacity in** accordance with the requirements of this Section.
 - b) Wire all spares provided to the field terminal strip.
- 5) Condition, filter, and check input signals for instrument limit conditions.
- 6) Filter, scale, and linearize the raw signal into an engineering units based measurement.
- 7) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
- 8) **Provide external fuses mounted on the field connection terminal** block for all discrete input, discrete output, and analog input I/O points.
- b. Discrete Input Modules:
 - 1) Defined as contact closure inputs from devices external to the input module.
 - 2) Provide inputs that are optically isolated from low energy common mode transients to 1500 volts peak from users wiring or other I/O Modules.
 - 3) Individually isolated inputs.
 - 4) With LED's to indicate status of each discrete input.
 - 5) Input signal level: 24 VDC.
 - 6) **Provide input module points that are individually fused with blown** *fuse indicator lights, mounted external of the module on the output terminal strip:*
 - a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.
- c. Discrete Output Modules:
 - 1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
 - a) Triac outputs may be used, with the permission of the ENGINEER, care must be used in applying this type of modules to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
 - 1. Optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak.
 - 2. LED's to indicate status of each output point.
 - 3. Each output point: Individually isolated.
- d. Analog Input Modules:
 - 1) Signal Type: 4 to 20 mA DC.
 - 2) Analog to digital conversion: Minimum 16-bit precision with the digital result entered into the processor.
 - 3) The analog to digital conversion updated with each scan of the processor. Individually isolated each input. Provide individually fused analog input module points with blown fuse indicator lights, mounted external of the module on the output terminal strip:

- a) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
- e. Analog Output Modules:
 - 1) Signal Type: 4 to 20 mA DC.
 - 2) Individual isolated output points each rated for loads of up to 1200 Ohms.
- f. Pre-Wired I/O Cable System:
 - 1) Provide the pre-wired I/O cables to eliminate field wiring between the I/O module and field wiring terminal blocks.
 - 2) The pre-wired I/O cable system consists of the following:
 - a) Interface module terminal block assembly.
 - 1. Installed on standard DIN rail.
 - 2. Provided with terminals for necessary field wiring for one I/O module.
 - 3. Equipped with a Manufacturer standard connector port.
- g. Pre-wired I/O cable:
 - 1) One end terminated with Manufacturer standard connector to connect to the interface module.
 - 2) One end pre-wired to a removable terminal block that plugs into the front of the I/O module.
- 7. Communications Modules:
 - a. Network Communications Modules:
 - 1) Ethernet:
 - a) **Ports: (1) RJ-45.**
 - b) Communication Rate: 100 Mbit/s.
 - 2) **Provide all network taps, connectors, termination resistors, drop** cables, and trunk cables necessary for remote I/O communications.
- 8. PLC Housing:
 - a. Mount the PLC power supply, CPU, rack, and I/O modules in a suitable standard PLC backplane or housing.
 - b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
 - c. **Provide blank slot filler module for each spare slot.**
- B. Programming:
 - 1. Refer to Section 13335.

2.3 SOURCE QUALITY CONTROL

A. As specified in Section 13300.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. Refer to Section 13300.
- B. Utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies:

- 1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.
- C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

3.2 FIELD QUALITY CONTROL

- A. Refer to Section 13300.
- 3.3 *CLEANING*
 - A. Refer to Section 13300.

3.4 **DEMONSTRATION AND TRAINING**

- A. As specified in Section 13300.
- B. Tailor training specifically for this project that reflects the entire control system installation and configuration.
- C. Perform training by pre-approved and qualified representatives of the ICSC and or Manufacturer of the PLC hardware:
 - 1. A representative of the ICSC may perform the training only if the representative has completed the Manufacturer's training course for the PLC hardware.

3.5 **PROTECTION**

A. Refer to Section 13300.

+ + END OF SECTION + +

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SECTION 13333

HUMAN MACHINE INTERFACE HARDWARE (FOR REFERENCE ONLY)

<u> PART 1 - GENERAL</u>

1.1 SUMMARY

A. Section Includes requirements for:
 1. Human machine interface (HMI) control systems hardware.

1.2 **REFERENCES**

A. Refer to Section 13300.

1.3 **DEFINITIONS**

A. Refer to Section 13300.

1.4 SYSTEM DESCRIPTION

A. **Provide all HMI hardware as identified in the Contract Documents.**

1.5 SUBMITTALS

A. Furnish submittals in accordance with Contract Documents and Section 13300.

B. **Product Data:**

- 1. Complete Manufacturer's brochures for each item of equipment.
- 2. Manufacturer's operation and installation instructions.
- 3. Additional requirements:
 - a. Display type and size.
 - b. **Operator input.**
 - c. **Processor type and speed.**
 - d. Memory size.
 - e. **Programming protocols.**
 - f. Communication protocols.
 - g. Power requirements.
 - h. Operating temperature and humidity ranges. NEMA ratings.
- C. Shop drawings:
 - 1. At a minimum, furnish the following:
 - a. System block diagram showing relationship and connections between devices provided. Include Manufacturer and model information, and address settings.

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- b. Mounting drawings with dimensions and elevations for each equipment location, including identification of all components, preparation and finish data, and nameplates.
- c. Electrical connection diagrams.
- d. Complete grounding requirements.
- 2. Furnish data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
- 3. Complete and detailed bills of materials identified by each cabinet. Include with each bill of material item the following:
 - a. **Quantity.**
 - b. **Description.**
 - c. **Manufacturer.**
 - d. Part numbers.
- D. Operation and Maintenance Manuals:
 - 1. Complete installation, operations, calibration, and testing manuals as described in Section 13300.
- E. Record Documents:
 - 1. Electrical connection diagrams revised to reflect any changes made in the field and submitted as record Drawings.

1.6 QUALITY ASSURANCE

- A. Provide HMI hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- B. Additional Requirements:
 - 1. Use HMI manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, communication cable, splitters, terminators, and taps.
 - 2. Provide hardware that is new, free from defects, of first quality, and produced by Manufacturers regularly engaged in the manufacture of HMI products.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.8 **PROJECT OR SITE CONDITIONS**

A. Refer to Section 13300.

1.9 WARRANTY

A. Refer to Section 13300.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following, no equal:
 1. Allen-Bradley: PanelView Plus.

2.2 MANUFACTURED UNITS

- A. Human Machine Interface:
 - 1. General:
 - a. **Provide Human Machine Interfaces located on the face of the PCM as indicated on the Drawings.**
 - b. **NEMA 4Xrated.**
 - c. Human Machine Interface consists of graphical display screen with operator input capabilities.
 - d. Capable of stand-alone operation in conjunction with 1 PLC.
 - e. Equipped with data network communication capabilities.
 - 2. Display:
 - a. Type: Color, TFT LCD screen.
 - b. Resolution: 640 by 480 pixels.
 - c. Size: Minimum 6.5".
 - d. Easy display viewing at any angle in various ambient light conditions.
 - e. Operator Input: Configurable touch screen.
 - f. Screen Update speed: The screen update speed and screen change speed less than 1 second.
 - g. Provide following features for outdoor use:
 - 1) Anti-glare screen overlay.
 - 2) Luminescence: Minimum 450 Nits.
 - 3. Graphic Configuration:
 - a. Easily configured graphics by:
 - 1) Portable laptop computer both locally and via the PLC data network.
 - 2) SCADA Engineer's Console via the PLC data network.
 - b. In accordance with Section 13332.
 - 4. Memory:
 - a. Application: 512 Kb Flash EPROM.
 - 5. CPU:[Minimum 100 MHz.
 - 6. Printer Support.
 - 7. Camera Support.
 - 8. Text Messaging Support.
 - 9. Communications:
 - a. **RS232.**
 - b. **Ethernet.**
 - 10. Environment:
 - a. Temperature: 0 to 50 degrees Celsius.
 - b. Relative Humidity: 10 to 90 percent.
 - 11. Electrical:
 - a. Power Supply:

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Addendum 2 April 2024 1) **24 VDC.**

2.3 ACCESSORIES

- A. Human Machine Interface Programming Software: 1. Refer to Section 13335.
- B. Uninterruptible Power Supply (UPS):
 1. Power the HMI from the UPS at the associated PCM.
- C. Laptop Programming Computer: 1. As required to allow programming of HMI's.

2.4 SOURCE QUALITY CONTROL

A. Refer to Section 13300.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 13300.
- B. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

3.2 FIELD QUALITY CONTROL

- A. Refer to Section 13300.
- 3.3 *CLEANING*
 - A. Refer to Section 13300.

3.4 DEMONSTRATION AND TRAINING

- A. Refer to Section 13300.
- B. **Provide training specifically tailored to the project that reflects the entire control system installation and configuration.**
- C. **Provide training by pre-approved and qualified representatives of the ICSC and or Manufacturer of the HMI hardware:**
 - 1. A representative of the ICSC may perform the training only if the representative has completed the Manufacturer's training course for the HMI hardware.

+ + END OF SECTION + +

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SECTION 13335

PLC PROGRAMMING SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for:
 1. Development software to be used with the specified PLC hardware.

1.2 **REFERENCES**

A. Refer to Section 13300.

1.3 **DEFINITIONS**

- A. Refer to Section 13300.
- B. Specific Definitions:
 - 1. Development Operating Software: The software provided by the PLC Manufacturer for use in programming the PLC.
 - 2. Application software: The software that is programmed specifically for the project.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Contract Documents and Section 13300.

B. Product Data:

- 1. **Programming languages**
- 2. Operating system requirements
- C. Control logic:
 - 1. Fully annotated copy of programmed PLC logic.
 - 2. Cross-referenced index of all PLC registers or points.
- D. Provide Application Software for the specific project process requirements.
 - 1. Fully annotated copy of programmed PLC logic in its native format.
 - 2. Cross-referenced index of all PLC registers or points.

1.5 **QUALITY ASSURANCE**

A. Refer to Section 13300.

1.6 WARRANTY

A. Refer to Section 13300.

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1.7 MAINTENANCE

- A. Refer to Section 13300.
- B. **Provide system upgrades and maintenance fixes for a period of 5 years from** *substantial completion.*

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The PLC programming software system shall be manufactured by PLC hardware manufacturer.
- B. The following, no equal:1. Allen Bradley RSLogix5000.

2.2 MANUFACTURED UNITS

- A. PLC Programming Software:
 - 1. Furnish Operating Software capable of monitoring and/or control of the PLCs via the PLC data network:
 - a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
 - b. Monitor devices at each drop on the PLC data network for proper communications.
 - c. Provide the ability to program all PLCs on the PLC data network from the Engineer's Console.
 - 2. Operating System:
 - a. Microsoft Windows XP.
 - 3. The PLC programming software shall be suitable for the PLCs furnished under Section 13332.
 - 4. PLC programming software for all programming, monitoring, searching, and editing:
 - a. Usable both on-line, while connected to the PLC, and off-line.
 - b. The Operating Software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
 - c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic, forced elements shall be identifiable by means of color change.
 - d. Include a search capability to locate any address or element and its program location.
 - e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
 - 5. The PLC programming software shall support the following programming languages:
 - a. Ladder Diagram.
 - b. Function Block Diagram.
 - c. **Structured Text.**
 - d. Sequential Function Chart.
 - 6. Generate a PLC program printout, which is fully documented, through the PLC programming software:

- a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line by line basis.
- b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
- c. Use a mnemonic associated with each contact, coil, etc, that describes its function.
- d. Utilize the Tag and Loop identification as contained in the P&IDs:
 - 1) If additional internal coils, timers, etc. are used for a loop they shall contain the loop number.
- e. Provide a cross-reference report of program addresses.
- 7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
 - a. Furnish the operating system software that is the standard uncorrupted product of the PLC Manufacturer with the following minimum functions:
 - 1) **Respond to demands from a program request.**
 - 2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
 - 3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are assured.
 - 4) Queuing of requests in order of priority if one or more requested resources are unavailable.
 - 5) **Resolution of contending requests for the same resource in** *accordance with priority.*
 - 6) Service requests for execution of one program by another.
 - 7) Transfer data between programs as requested.
 - 8) Management of all information transfers to and from peripheral devices.
 - 9) **Control and recovery from all program fault conditions.**
 - 10) Diagnose and report real-time hardware device errors.
- 8. **Program Execution:**
 - a. Application Software program execution scheduled on a priority basis:
 1) A multilevel priority interrupt structure is required.
 - 2) Enter into a list of pending programs a program interrupted by a higher priority program:
 - a) Resume its execution once it becomes the currently highest priority program.
 - 3) Schedule periodic programs.
 - 4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
- 9. Start-up and Restart:
 - a. **Provide software that initializes and brings a PLC or any microprocessor** based hardware unit from an inactive condition to a state of operational readiness.
 - b. Initialization:
 - 1) Determination of system status before start -up of initializing operating system software and initializing application software.
 - 2) Loading of all memory resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.

- 10. Shutdown:
 - a. Where possible provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
 - b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
 - c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
 - d. Alarm PLC failure at the operator interface level.
- 11. Diagnostics:
 - a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
 - b. Use the manufacturer's standard diagnostic routines as much as possible.
 - c. Furnish diagnostic software and test programs for each significant component in the control system.
 - d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
- 12. Calendar/Time Program:
 - a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system level and application software.
 - b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
 - c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
- 13. Algorithms:
 - a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
 - b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
 - c. Algorithms must include alarm checks where appropriate.
 - d. *Provide, as a minimum, the following types of algorithms:*
 - 1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
 - 2) A switch algorithm, which reads the current, value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated, two outputs with one input and one output with 2 inputs.
 - 3) A 3-mode Proportional Integral Derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supporting both direct and reverse acting modes.
 - 4) Lead, lag, dead time, and ratio compensators.
 - 5) Integration and totalization of analog process variables.
- 14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
 - a. In addition, provide spare database points for future expansion.
- 15. One integrated database can be utilized for all types of analog points or separate databases for each type, in either case the database for each point must include all specified aspects.

- 16. All portions of the database must be available for use by the display, report, and other specified software modules.
- 17. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:
 - a. Analog Input Signal Types:
 - 1) Provide software at the RTUs and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
 - b. Input Accuracy:
 - 1) Inputs must be read with an accuracy of ± 0.05 percent full scale or better.
 - 2) Data conversion errors must be less than 0.05 percent full scale.
 - 3) **Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once a minute.**
 - 4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
 - c. **Blocking:**
 - 1) **Provide** mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
 - 2) For any input so blocked, the operator may manually enter a value to be used as the input value.
 - d. *Filtering:*
 - 1) For each analog input provide a first order lag digital filter with an adjustable filter factor.
 - e. Linearizing:
 - 1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
 - f. Calculated Values:
 - 1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc.
 - 2) These values must be handled the same as real inputs in terms of record keeping, alarming, etc.
 - g. Scaling and Zero Suppression:
 - 1) **Provide a conversion program to convert input values into engineering units in a floating-point format.**
 - h. **Alarms:**
 - 1) **Provide an alarm program to check all analog variables against** high-high, high, low, and low-low alarm limits.
 - 2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
 - 3) **Provide an adjustable hysteresis band in order to prevent excessive** *alarms when a variable is hovering around an alarm limit.*
 - 4) Report return to normal shall also be reported.
 - 5) Must be possible to inhibit alarms based on external events, ie. Iockout low pump flow alarm when the pump is off.
 - i. Averages:

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- 1) **Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.**
- 2) Continuously compute averages, i.e., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
- 3) Update hourly averages each minute or at the polling interval for the selected variable.
- 4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
- 5) Update monthly averages at least once each day and calculate using the results of the daily averages.
- 6) At the end of each averaging period, store the average values for the period on the hard disk for historical record keeping and reset the present period average register to the present value of the variable.
- 7) The active database must include the present period average and previous period average for each variable and averaging period.
- j. Totals:
 - 1) **Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.**
 - 2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
 - 3) Assign a separate factor for each totalizing interval.
 - 4) Variables for which totalization is inappropriate must have scaling factors of zero.
 - 5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record keeping and reset the present period totalization register to zero.
 - 6) The active database must include the present period total and previous period total for each variable and totalizing period.
- k. Engineering Units:
 - 1) **Provide** software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
 - 2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in GPM, MGD, CFS, and Acre-Feet per day.
 - 3) **Pre-program the conversion of the engineering units, and if not preprogrammed, the operator must be able to program new engineering unit conversions by using simple methods, ie. multiplication of the database attributes by a constant.**
 - 4) The programming method must be at a level and compatible with the specified training of the operator and the OWNER'S personnel.
 - 5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.
- . Control Modules:
 - 1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
 - 2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
 - 3) **Provide control algorithms for manual control with output values adjustable by the operator.**
- m. Analog Outputs:

- 1) Analog outputs must be maintained as part of the database.
- 2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.
- 18. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.
- B. General Control Functions:
 - 1. Analog Control Functions:
 - a. **PID**, lead/lag, signal select, alarm, limit, delay, and time base.
 - b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR and NXOR functions.
 - c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
 - d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.
 - 2. Discrete Control Functions:
 - a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays and time base.
 - 3. Software Support:
 - a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
 - b. Call each function as required by the configured controls to perform the intended function.
 - 4. Control and Status Discrepancies:
 - a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
 - b. For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator programmable time delay (time disagree), and then generate a discrepancy (fail) alarm shall be generated.
 - c. Involuntary change in the device's status must also generate an alarm:
 - 1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
 - d. Each command, status, and alarm must cause the color of the symbol to change.
 - e. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
 - 1) Delay periods for each final control element must be adjustable at the operator interface.
 - 2) List all time delays in the final documentation.
 - 5. Some of the above functions may be better accomplished in the Data Acquisition and Graphic Display Software package, it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

- C. Control Configuration:
 - 1. Provide software to allow control strategies to be developed and their operation initiated through the operator interface.
 - 2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, set points and tuning constants, etc.
 - 3. **Provide a mechanism to link separate control functions together into an integrated control strategy.**
 - 4. Provide a mechanism to download operational/control set points developed at any operator interface to any PLC or RTU for operational implementation.
 - 5. Provide a mechanism to define and implement operational/control set points locally at the PLC or RTU and to upload them to the Operator interface for operational record keeping.
 - 6. Perform control configurations on-line at the operator interface, the PLC or RTU may be taken off-line when being configured or downloaded.

2.3 SOURCE QUALITY CONTROL

A. As specified in Section 13300.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 13300.
- B. **General:**
 - 1. The control system logic program shall reside at the PLC level.
- C. Use the Tag and Loop identifications found on the P&IDs for all tags used and/or assigned as part of the Application Software work provided by the ICSC.

3.2 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

- A. **Provide a minimum of 4 CD/DVD copies of the following:**
 - 1. Application Software:
 - a. Finalized fully annotated copy of programmed PLC logic in its native format.
 - b. Cross-referenced index of all PLC registers or points.

3.3 DEMONSTRATION AND TRAINING

- A. Refer to Section 13300.
- B. Training:
 - 1. Performed by pre-approved and qualified representatives of the ICSC and or manufacturer of the local operator interface software. A representative of the ICSC may perform the training only if the representative has completed the manufacturer's training course for the PLC programming software.

+ + END OF SECTION + +

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SECTION 13336

HUMAN MACHINE INTERFACE SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section is included for CONTRACTOR reference only.
- B. Section includes requirements for:
 - 1. Application software to be used in conjunction with the specified Human Machine Interface (HMI) hardware.
- C. General requirements:
 - 1. Software provided under this Contract represent a complete and operating control software system. Achieve the functionality described in this and other sections through a combination of standard control system software and application software developed specifically for this project.
 - 2. The standard control software listed in this section does not represent a comprehensive list of software necessary to implement the functional requirements of the specifications. Provide all necessary supplemental drivers, utility software and application software, as required, to meet the functional requirements of the Specifications.
 - 3. Applications software requirements are described in Section 13301.
 - 4. License all software for proper operation as described in the Specifications.
 - 5. License all software provided under this Contract to the OWNER.

1.2 **REFERENCES**

A. Refer to Section 13300.

1.3 **DEFINITIONS**

A. Refer to Section 13300.

1.4 SYSTEM DESCRIPTION

A. Provide all HMI hardware as indicated in the Contract Documents.

1.5 SUBMITTALS1

- A. Furnish submittals in accordance with Contract Documents and Section 13300.
- B. Product Data:
 - 1. Complete Manufacturer's brochures that identify HMI software and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
 - 2. Manufacturer's installation instructions.

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- C. Graphic screens:
 - 1. Color printouts of each graphic screen and control pop-ups.
- D. Operation and Maintenance Manuals:
 - 1. Complete installation, operation, and testing manuals.
 - 2. Complete color printouts of each graphic screen and control pop-ups.

1.6 QUALITY ASSURANCE

- A. Refer to Section 17050.
- B. System Compatibility:
 - 1. The software must be the standard operating software system designed specifically for use with the Human Machine Interface hardware.
 - 2. The software must be furnished and developed by the Manufacturer of the HMI hardware.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.8 WARRANTY

A. Refer to Section 13300.

1.9 MAINTENANCE

- A. Refer to Section 13300.
- B. **Provide system upgrades and maintenance fixes for a period of 5 years from** *substantial completion.*

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Provide the HMI graphic software system manufactured by the HMI hardware Manufacturer.**
- B. The following, no equal: 1. Rockwell Software FactoryTalk View Machine Edition.

2.2 MANUFACTURED UNITS

- A. Human Machine Interface Software:
 - 1. **Provide a complete software package to be used for programming the** *necessary screens and operator interaction with the HMI's.*
 - Operating System:
 a. Microsoft Windows XP.
 - 3. Furnish software with preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.

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- 4. Software must allow bitmaps to be imported or exported to or from other applications.
- 5. Capable of generating custom reports, complete with screen prints.
- 6. Capable of working with multiple screens concurrently.
- 7. Provide dialog boxes for defining object attributes.
- 8. Configure objects using fill in dialog boxes.
- 9. Furnish graphic and text editor that allows custom formatting in order to customize and change the appearance of objects and text:
 - a. Allow selection of different fill patterns to define object status.
- 10. As a minimum, provide the following object capabilities:
 - a. Operator Inputs:
 - 1) Momentary Push Button.
 - 2) Maintained Push Button.
 - 3) Latched Push Button.
 - 4) Multistate Push Button.
 - 5) Keypad Enable Button.
 - 6) Cursor Point.
 - b. Control List Selectors:
 - 1) Standard Control List.
 - 2) Piloted Control List.
 - c. **Global Objects.**
 - d. Display Objects:
 - 1) Bar Graph.
 - 2) **Scale.**
 - 3) Message Display.
 - 4) Multistate Indicator.
 - 5) List Indicator.
 - 6) Numeric Data Display.
 - e. Screen Selector Objects:
 - 1) **Go To.**
 - 2) Return.
 - 3) Screen List Selector.
 - f. Embedded Variables:
 - 1) *Time.*
 - 2) **Date.**
 - 3) Numeric Variable.
 - g. Graphics:
 - 1) *Lines.*
 - 2) Shapes.
 - 3) Freeform Drawings.
 - 4) Imported Graphics.
 - 5) Background Text.
 - 6) Selection Table for standard ISA symbols.
 - 7) **PID Controller Faceplate.**
 - a) Alarm screens.
- 11. Documentation:
 - a. **Provide complete user documentation, including examples of how to operate the various modules within the system.**
 - b. **Provide the documentation in electronic format, HTML based with the ability to search for topics by keyword or search or specific text.**
- 12. On-line Help:

- a. *Provide an on-line "help" facility, based upon Windows standard Hypertext:*
 - 1) Useful, context-sensitive information on the operation of the package:
 - a) That can be invoked on-line through a point-and-click operation.
 - b) The "help" facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

2.3 SOURCE QUALITY CONTROL

A. As specified in Section 13300.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. Refer to Section 13300.
- B. All tags used and/or assigned as part of the application programming work are to use the Tag and Loop identifications found on the P&IDs.

C. Station Graphics:

- 1. Configure the graphic display for each device both in the treatment plant, and/or process area, including but not limited to:
 - a. **Symbols for:**
 - 1) **Pumps.**
 - 2) Valves.
 - 3) *Major instruments.*
 - 4) Flowmeters.
 - 5) **Pressure transmitter.**
 - b. Alarm symbols including intrusion alarm.
 - c. **Relevant test and operational data.**
 - d. Status for each controller or controlled device:
 - 1) *Hand.*
 - 2) **Off.**
 - 3) Automatic.
 - 4) *Local.*
 - 5) **Remote.**
 - 6) **Run.**
 - 7) **Call.**
 - 8) *Fail.*
 - 9) **Open.**
 - 10)**Close.**
 - 11)**Hold.**
 - 12) Modulate.

a) Depict a change of state of pumps and valves by a change in color.2. Production and Usage Bar Graph:

a. Depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment

plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.

- 3. System Level Summary:
 - a. Show the level for the plant influent and effluent production, etc, via a display using bar graphs and numbers, as determined during the requisite graphics meeting.
- 4. Furnish a minimum of 10 screens, to be directed by the ENGINEER and OWNER, during construction for each HMI.

3.2 DEMONSTRATION AND TRAINING

- A. Refer to Section 13300 and 13950.
- B. Perform the training using a pre-approved and qualified representatives of the ICSC and or Manufacturer of the HMI software:
 - 1. A representative of the ICSC may perform the training only if the representative has completed the Manufacturer's training course for the HMI software.

+ + END OF SECTION + +

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SECTION 13341

INSTRUMENTATION AND CONTROLS – FLOW DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the flow related instruments.
- B. Refer to Section 13300.

1.2 MAINTENANCE

- A. Refer to Section 13300.
- B. Test Equipment: 1. Refer to Section 13300.

1.3 ACCESSORIES

- A. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
- B. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

1.4 APPROVALS/CERTIFICATIONS

A. Instruments specified herein shall meet at a minimum, the National Electrical Manufacturers Association (NEMA) rating for non-hazardous locations listed with each instrument. Those instruments that are submerged in a liquid or are located in submersible area shall also meet NEMA 6 ratings approval. All instruments that are located in hazardous areas as indicated on the Electrical Classification Drawings or in the Instrument Device Schedule shall meet the Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC Class, Division and Group approvals and certifications listed for that area. The instrument shall have a stainless steel tag identifying the relevant approval or certification.

PART 2 - PRODUCTS

2.1 Magnetic Flowmeter (remote)

- A. Flow Element:
 - 1. **Type:**
 - a. **Pulsed DC type.**
 - 2. Function/Performance:

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- a. Operating Temperature: Process liquid temperatures of 0 to 140 degrees F or greater dependent upon liner and an ambient of minus 30 to 150 degrees F.
- b. Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.
- c. Pressure rating: Equal to piping system where meter is installed.
- d. Additional: Meter shall be capable of running empty indefinitely without damage to any component.
- 3. Physical:
 - a. Metering Tube: 304 stainless steel or equivalent.
 - b. Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated. ANSI 150 lb. or DIN PN 16 stainless steel flanges shall be used on all SS process pipes.
 - c. Liner: Polyurethane or composite elastomer unless otherwise indicated on the Drawings or in the Instrument Device Schedule.
 - d. Electrodes: 316 stainless steel standard minimum requirements. All electrodes to be compatible with process fluid as indicated on the Drawings or electrodes to be supplied as listed in the Instrument Device Schedule.

For sludge, polymer, or any slurry application where the electrodes will be coated, a self cleaning or a removable electrode option must be provided with that meter.

- e. Housing: Meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.
- f. Finish: All external surfaces shall have a chemical and corrosion resistant finish.
- 4. *Power Requirements:*
 - a. Meter shall be 24 VDC powered instrument, receiving its power from transmitter.
- 5. Accessories/Documentation Required:
 - a. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be included in the O&M manual.
 - b. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured and must be compatible with process fluid and with the process pipe.
 - c. Signal cable for installation between the flowtube and the transmitter. Length shall be as required by installation indicated on the Drawings.
- B. Flow Converter/Transmitter
 - 1. **Type:**
 - a. *Micro processor based, intelligent transmitter compatible with flowtube provided.*
 - b. Mounted remote from the flowtube.
 - 2. Functional/Performance:
 - a. Accuracy (including flowtube): Plus/minus 0.5 percent of flowrate.
 - b. Operating Temperature: -20 to 140 degrees F.

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- c. Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument. A dry contact rated for 120 VAC, 2A to indicate reverse flow.
- d. Diagnostics: Self diagnostics with on screen display of faults.
- e. Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.
- f. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.
- g. Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.
- h. Provide electrode cleaning unit to match flow element requirements.
- 3. Physical:
 - a. Transmitter shall be suitable for surface or pipe stand mounting.
 - b. Enclosure shall be NEMA 4X (IP65).
- 4. Power Requirements:
 - a. The transmitter shall be 120 VAC powered instrument.
- 5. Accessories/ Required:
 - a. Keypad where required for transmitter configuration.
- C. Manufacturer:
 - 1. Endress+Hauser
 - 2. Siemens
 - 3. Krohne Optiflux 2000 or 4000 Series with IFC-3000 Transmitter.
 - 4. No Equal

PART 3 - EXECUTION

3.1 GENERAL

A. See execution requirements in Section 13300.

+ + END OF SECTION + +

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SECTION 13342

INSTRUMENTATION AND CONTROLS - LEVEL DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor and materials required and installed complete as shown on the Drawings and as specified herein.
- B. This Section covers the furnishing, installation, and services for the field-mounted instruments as detailed on the Drawings.
- C. Refer to Section 13300.

1.2 RELATED WORK

A. Refer to Section 13300.

1.3 SUBMITTALS

A. Refer to Section 13300.

1.4 **REFERENCE STANDARDS**

A. Refer to Section 13300.

1.5 **QUALITY ASSURANCE**

A. Refer to Section 13300.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.7 MAINTENANCE

- A. Refer to Section 13300.
- B. Accessories
 - 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
 - 2. Each instrument shall be provided with a manufacturer-installed stainless steel tag identifying the instrument tag number. Refer to Section 17050.

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1.8 NOMENCLATURE AND IDENTIFICATION

A. Refer to Section 13300.

1.9 APPROVALS/CERTIFICATIONS

A. Instruments for hazardous locations shall have Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC approvals and certifications as specified herein and as indicated on the Drawings or in the Instrument Device Schedule. The instrument specifications in Part 2 state the Class, Division, and gas groups for FM/CSA approval, followed in parenthesis by the CENELEC certification; however, provided have instruments reauired are only to the approval/certification stated above. The instrument shall have a stainless steel tag identifying the relevant approval or certification.

PART 2 - PRODUCTS

2.1 ULTRASONIC LEVEL/DIFFERENTIAL LEVEL METER

- A. Transducer
 - 1. **Type**
 - a. Non-contact, ultrasonic level transducer.
 - 2. Function/Performance
 - a. Measuring Range: Transducer range shall be suitable for the installation indicated on the Drawings, up to 50 ft (15m).
 - b. Temperature Range: -20 to 60 degrees C.
 - c. Relative Humidity: Zero to 100 percent.
 - d. Temperature Compensation: Transducers shall be provided with integral temperature sensors for temperature compensation at temperature ranges from -50° to 150° C.
 - 3. Physical
 - a. Transducers shall be potted/encapsulated in a Kynar or other chemical and corrosion-resistant housing. Transducers shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.
 - b. The surface of transducers shall be Teflon-coated where mounted on chemical tanks and exposed to vapors in the tanks that are not compatible with the transducer material.
 - c. Transducers shall be capable of being completely submerged without damage.
 - d. Transducers shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or Instrument Device Schedule. Appropriate mounting hardwired shall be provided. Flanges shall be six inch (150 mm) and resistant to attack by the medium being metered or, where required, shall be protected by corrosion- resistant coatings and facings.
 - 4. **Options/Accessories Required**

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- a. Transducers located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
- b. Signal cable as recommended by the manufacturer, for installation between the transducer(s) and the transmitter. Length, up to 1200 feet (365 m), shall be as required by installation indicated on the Drawings.
- 5. Manufacturer(s)
 - a. Siemens-Milltronics.
 - b. **Or Equal.**
- B. Transmitter/Converter
 - 1. **Type**
 - a. Microprocessor based compatible with the transducer(s) provided.
 - 2. Functional/Performance
 - a. Resolution (including transducer): Plus or minus 0.1 percent of range or 0.08 inches (2 mm), whichever is greater.
 - b. Accuracy (including transducer): Plus or minus 0.25 percent of range or 0.24 inches (6 mm).
 - c. Range: As required by the installation indicated on the Drawings.
 - d. Temperature Range: -20 to 50 degrees C.
 - e. Output: Two isolated 4-20 mA output and one, three, or six alarm contacts adjustable to trip at any point in the instrument range. Output contacts shall be rated 5 A at 230 VAC.
 - f. Temperature Compensation: Compensation over the temperature range of the sensor.
 - g. Display: Digital indicator displaying level/differential level or volume in engineering units or percent as indicated on the Drawings or in the Instrument Device Schedule.
 - h. Diagnostics: On-screen instructions and display of selfdiagnostics.
 - i. Loss of Signal: Transmitter shall ignore momentary loss-of-echo signals and shall indicate loss of echo on the transmitter unit.
 - j. Configuration Protection: Programmable parameters shall be protected using E2PROM. Battery backup protection is not acceptable.
 - 3. Physical
 - a. Transmitter shall be suitable for surface or pipe stand mounting.
 - b. Enclosure shall be NEMA 4X (IP65).
 - 4. Accessories Required
 - a. Hand-held programmer where required for configuration and calibration of the instrument.
 - 5. Manufacturer(s)
 - a. Siemens Model HydroRanger 200
 - b. Or Equal.

2.2 FLOAT SWITCHES

A. **Type**

1. Ball float switch.

- B. Function/Performance
 - 1. Differential: Less than one inch.
 - 2. Switch Rating: 5 amps at 120VAC, 10 amps at 240VAC.
- C. Physical
 - 1. Float: 316 stainless steel, Teflon-coated, 5 1/2-in diameter.
 - 2. Totally encapsulated switch.
 - 3. Cable shall be heavy-duty, PVC-jacketed integral to float.
- D. Options/Accessories Required
 - 1. Provide stainless steel hardware.
 - 2. Lead wire shall be a waterproof cable of sufficient length so that no splice or junction box is required in the vault.
 - 3. **Provide cast-aluminum weatherproof junction box outside the** *sump pit with terminals for all floats and tapped as required for conduit connections.*
- E. Manufacturer(s)
 - 1. US Filter Model 9G-EF.
 - 2. Contegra FS 90.
 - 3. Approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. See execution requirements in Section 13300.

+ + END OF SECTION + +

SECTION 13343

INSTRUMENTATION AND CONTROLS – PRESSURE DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing, installation, and services for the field-mounted instruments as detailed on the Drawings.
- B. Refer to Section 13300.

1.2 **RELATED WORK**

A. Refer to Section 13300.

1.3 SUBMITTALS

A. Refer to Section 13300.

1.4 COORDINATION MEETINGS

A. Refer to Section 13300.

1.5 **REFERENCE STANDARDS**

A. Refer to Section 13300.

1.6 QUALITY ASSURANCE

A. Refer to Section 13300.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 13300.

1.8 NOMENCLATURE AND IDENTIFICATION.

A. Refer to Section 13300.

1.9 MAINTENANCE

A. Refer to Section 13300.

B. Accessories:

- 1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.
- 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

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1.10 APPROVALS/CERTIFICATIONS

A. Instruments for hazardous locations shall have Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC approvals and certifications as specified herein and as indicated on the Drawings or in the Instrument Device Schedule. The instrument specifications in Part 2 state the Class, Division, and gas groups for FM/CSA approval, followed in parenthesis by the CENELEC certification; however, instruments provided are only required to have the approval/certification stated above. The instrument shall have a stainless steel tag identifying the relevant approval or certification.

PART 2 - PRODUCTS

2.1 Diaphragm Seal - Threaded

- A. Type:
 - 1. Thread attached.
 - 2. Welded Metal Diaphragm.
- B. Function/Performance:
 - 1. Maximum Pressure: Two times the maximum process pressure.
 - 2. Operating Temperature: -40 to 100 degrees C.
- C. **Physical:**
 - 1. All 316L stainless steel construction.
 - 2. Teflon gaskets and O rings on process connection.
 - 3. Bleeding connection provided. NOTE: filling screw not recommended since it provides poor quality measurement if done incorrectly in the field.
- D. Accessories Required:
 - 1. Stainless steel armored capillary tubing as required for the installation.
- E. Manufacturer(s):
 - 1. Ashcroft.
 - 2. Ronningen-Petter Company.
 - 3. Siemens 7MF4861
 - 4. **Equal.**

2.2 Diaphragm Seal - Annular Flange Mounted

- A. Type:
 - 1. Line mounted, between two flanges.
- B. Function/Performance:
 - 1. Pressure Limit: Correspond to flange ratings.
 - 2. Inside diameter shall conform to the dimensions of the pipe where the seal is installed.
 - 3. ANSI or DIN flange class shall be equivalent to the flange class of the piping where the seal is installed. Bolting dimensions shall conform to ANSI or DIN drilling specifications as required by the installation.

- C. **Physical:**
 - 1. Body material: Carbon steel.
 - 2. Process connection: 1/4-inch NPT.
 - 3. Sensing Sleeve: Buna-N.
 - 4. Sensing Liquid: Silicone Oil.
- D. Manufacturer(s):
 - 1. Red Valve Company, Inc.
 - 2. **Wika.**
 - 3. Siemens 7MF4880
 - 4. **Equal.**

2.3 Gauge Pressure or Pressure Sensing Level Transmitters

A. Type:

- 1. Microprocessor based, intelligent type.
- B. Function/Performance:
 - 1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
 - 2. Accuracy: 0.075 percent of span.
 - 3. Operating Temperature: -20 to 80 degrees C.
 - 4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.
 - 5. Output: 4-20 mA DC linear with pressure or level, with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
 - 6. Stability: 0.05 percent of upper range limit for 1 year.
 - 7. Display: Digital indicator displaying pressure or level in the engineering units indicated in the Instrument Device Schedule.
 - 8. Diagnostics:
 - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
 - b. Simulation capability for inputs and loop outputs.
 - c. Test terminals available to ease connection for test equipment without opening the loop.
 - d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
 - e. *Run-time clock available to determine usage for warranty purposes.* **5-year warranty on this clock reading is included.**
 - 9. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.
 - 10. If required to meet the range or suppression/elevation requirements, a differential pressure transmitter shall be provided.

C. **Physical:**

- 1. Enclosure: NEMA 4X (IP66).
- 2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
- 3. Power Supply: 24 VDC loop power.

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- 4. Sensor Fill Fluid: Silicone.
- D. Accessories Required:
 - 1. Provide span and zero adjustment at each transmitter and through the handheld programming unit.
 - a. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.

NOTE: Siemens, ABB and Foxboro have this capability

- 2. For each transmitter provide a 316 stainless steel block & bleed shut off valve. Valves may be mounted directly to the instrument or separately mounted. Valves shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.
- E. Manufacturer(s):
 - 1. Rosemount
 - 2. Foxboro
 - 3. **Or Equal.**

2.4 Flange Mounted Pressure Sensing Level Transmitter

- A. **Type:**
 - 1. Flanged mounted, microprocessor based, intelligent type.
- B. Function/Performance:
 - 1. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.
 - 2. Accuracy: 0.075 percent of span.
 - 3. Operating Temperature: -20 to 80 degrees C.
 - 4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change NOTE: all manufacturers' specifications for remote seal

NOTE: all manufacturers' specifications for remote seal transmitters will have temperature errors above this level.

- 5. Output: 4-20 mA DC linear with pressure or level with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.
- 6. Stability: 0.05 percent of upper range limit for 1 year.
- 7. Display: Digital indicator displaying level in the engineering units indicated in the Instrument Device Schedule.
- 8. Diagnostics:
 - a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
 - b. Simulation capability for inputs and loop outputs.
 - c. Test terminals available to ease connection for test equipment without opening the loop.
 - d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
 - e. Run-time clock available to determine usage for warranty purposes. 5-year warranty on this clock reading is included.
- 9. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

- C. **Physical:**
 - 1. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (Exx d IIC T5).
 - 2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
 - 3. Flange: Flange shall be ANSI 3-inch, 150 lb. (DN 80, PN 25 or 40) carbon steel.
 - 4. *Power supply shall be 24 VDC loop power.*
 - 5. Sensor Fill Fluid: Silicone.
- D. Accessories Required:
 - 1. **Provide** span and zero adjustment at each transmitter and through the handheld programming unit.
 - a. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.

NOTE: Siemens, ABB and Foxboro have this capability

- 2. Provide seals for the flange connection suitable to the process liquid being metered.
- E. Manufacturer(s):
 - 1. Rosemount
 - 2. Foxboro
 - 3. *Equal.*
- 2.5 Pressure Switch
 - A. Type:
 - 1. Diaphragm actuated.
 - B. *Function/Performance:*
 - 1. Repeatability: Better than 1 percent of full scale.
 - 2. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
 - 3. Dead Band: Fixed unless adjustable dead band requirement is noted in the Instrument Device Schedule.
 - 4. Reset: Unit shall be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.
 - 5. Over Range Protection: Over range protection to 150 percent of the maximum process line pressure.
 - 6. Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the instrument device schedule. Switch rating shall be 10 A at 230 VAC.
 - C. **Physical:**
 - 1. Housing: NEMA 4X (IP65) for non hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB).
 - 2. Switch Assemblies: Hermetically sealed switches.
 - 3. Wetted Parts: 316L stainless steel diaphragm, viton seals, 316 stainless steel connection port.

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- D. Accessories/Options Required:
 - 1. Shutoff Valve: Provide a 316 stainless steel shutoff valve. Valve shall be by D/A Manufacturing, Anderson Greenwood, or Equal.
 - 2. Where indicate on the instrument device schedule, provide a 316 SS snubber for pulsation dampening.
- E. Manufacturer(s):
 - 1. Static-O-Ring (SOR).
 - 2. Ashcroft.
 - 3. *Mercoid.*
 - 4. **Equal.**

PART 3 - EXECUTION

3.1 GENERAL

A. See execution requirements in Section 13300.

+ + END OF SECTION + +

SECTION 13733

NETWORK MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for:
 - 1. Materials and equipment used in process control and LAN networks including:
 - a. Network switches.
 - b. Patch panels and other data network hardware.
 - c. **Related accessories.**

1.2 **REFERENCES**

- A. Refer to Section 13300.
- B. TIA/EIA Standards:
 - 1. TIA/EIA-568-B (Series), Commercial Building Telecommunications Standards.
 - 2. TIA/EIA-569 (Series), "Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3. IEEE Series 802 standards.

1.3 **DEFINITIONS**

A. Refer to Section 13300.

1.4 SYSTEM DESCRIPTION

A. Provide all network equipment identified in the Contract Documents.

1.5 SUBMITTALS

A. Furnish submittals in accordance with Contract Documents and Section 13300.

B. Product Data:

- 1. Include information on all test equipment.
- 2. Manufacturer's operation and installation instructions.

C. Shop Drawings:

- 1. Complete set of drawings including but not limited to:
 - a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information, and address settings.
 - b. Network riser diagram.
 - c. Network port diagram, which physically locates all, ports within the facility, and identifies their patch panel and switch port.

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- d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, nameplates
- e. Electrical connection diagrams.
- f. Complete grounding requirements.
- 2. Furnish Data sheets for each component together with a technical product brochure or bulletin:
 - a. Manufacturer's model number.
 - b. Project equipment tag.
- 3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
 - a. **Quantity.**
 - b. **Description.**
 - c. Manufacturer.
 - d. Part numbers.
- D. Test Reports:
 - 1. As described in Section 13950 and noted herein.
 - 2. Signed test results as described in Part 3 of this Section.
 - 1. Test results shall include:
 - a. Narrative describing the test procedures followed.
 - b. Block diagram of test set up.
 - c. Manufacturer's information on test equipment used.
 - d. Detailed test results.
 - e. A narrative summarizing the results of the testing and identifying any further action required.
- E. Operating Manuals:
 - 1. Complete installation, operation, calibration, and testing manuals as described in Section 13300.
- F. Record Drawings:
 - 1. As described in Section 13300.
 - 2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.6 QUALITY ASSURANCE

A. Refer to Section 13300.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 13300.

1.8 **PROJECT OR SITE CONDITIONS**

A. Refer to Section 13300.

1.9 WARRANTY

A. Refer to Section 13300.

1.10 MAINTENANCE

- A. Spare parts:
 - 1. Provide 3 spare fuses for each size and type used or supplied under any Division of these Specifications.
 - 2. Provide spare fuse cabinet(s):
 - a. Metal cabinet with hinged door and shelves or fuse holders.
 - b. Gray enamel finish.
 - c. Mount near equipment and label "Spare Fuses" on face of cabinet.
 - d. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert.
 - e. *Provide as many cabinets as required to hold entire spare fuse inventory.*

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- 1. **Process Floor Ethernet Switches:**
 - a. *Manufacturers One of the following:*
 - 1) Hirschmann RS40 Series
 - 2) N-Tron 7000 Series.
 - 3) No Equal.
 - b. **Properties:**
 - 1) Hardware:
 - a) **Power supply:**
 - 2) Provide redundant power supplies.
 - 3) 24 VDC, 350 Watts/per power supply.
 - a) No fans or moving parts.
 - 4) **Performance:**
 - a) Switch fabric speed: 8 Gbps, minimum.
 - b) Latency 2.9 microseconds.
 - c) **Enclosure:**
 - 1. All metal hardened housing.
 - 2. **15g Shock for 10ms minimum.**
 - 3. Cat 6 grounding for shield drains.
 - d) (7) 10/100Base-TX RJ-45 Copper Ports (quantity as indicated on the drawings).
 - e) (2) 1000Base-T Mini GBIC Full Duplex (quantity as indicated on the drawings).
 - f) **Ports will auto negotiate speed duplex and MDIX**
 - g) MTBF of 2M Hours.
 - h) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
 - 1. Full SNMP and Web Browser Management
 - 2. Detailed Ring Map and Fault Location Charting Web Browser display.
 - 3. **VLAN**
 - 4. **QoS**
 - 5. Trunking
 - 6. CIP Messaging
 - 7. Port Mirroring

- 8. DHCP Server with Option 61, Option 82 Relay Agent and Local IP Addressing.
- i) OPC 2.0 Compliant Monitoring
- j) **IGMP** Snooping with Ethernet I/P plug & play compatibility
- k) **RJ-45** Copper Ports Auto Negotiates Speed, Duplex, and MDIX
- 1) Store-and-forward Technology
- m) Redundant Power Inputs (10-30 VDC)
- n) 802.1d, 802.1w, 802.1D RSTP
- o) Rapid Spanning Tree protocol.
- p) Ring Management with 30ms heal times.
- 5) Environment:
 - a) Operating Temperature Range: 32 to 140 Degrees Fahrenheit.
 - b) Humidity: 10 to 95 percent, non-condensing.
- 6) *Mounting:*
 - a) **DIN rail mounted.**

2.2 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 13300.
- B. All racks shall be level and plumb.
- C. Install Velcro wrap on all cable bundles within the network rack/enclosure.
- D. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
 - 1. Cables shall be installed avoiding sharp bends.
 - 2. Install cable using lubricant designed for cable pulling.
 - 3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
 - 4. Install LAN cables without splices.
 - 5. Installed bend radii shall not exceed 4 times the cable diameter.
 - 6. Terminated all pairs at the jack and the patch panel.
- E. Install cables a minimum of 40 inches away from electrical motors and transformers.
- F. Install cables a minimum of 12 inches away from fluorescent lighting.
- G. Individual pairs will be untwisted less than 1/2 inch at termination points.
- H. All cables and terminations shall be labeled with cable designations as described in the Division 16 specifications.

- I. Each data port shall be individually labeled with its patch panel/switch port ID:
 - 1. Labeling must be printed no handwritten labels will be allowed.
- J. At the completion of the wiring installation, provide the following documentation:
 - 1. A plan-view of the premise(s) showing the jack numbering scheme.
 - 2. A printed certification report for the entire wiring installation showing compliance with all ANSI/EIA/TIA specifications for data cable.
 - 3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.
 - 4. Each device with a unique IP address shall be individually labeled with its IP address. The labeling must be printed; handwritten labels will not be allowed.

3.2 ADJUSTING

A. **Perform all firmware installations, configuration and other set up, as required,** to place the network into proper operation.

3.3 *CLEANING*

A. Refer to Section 13300.

3.4 DEMONSTRATION AND TRAINING

- A. As specified in Section 13300.
- B. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.
- C. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

+ + END OF SECTION + +

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SECTION 13950

TESTING, CALIBRATION, AND COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Testing requirements that apply to all process control and instrumentation systems for the entire project.

1.2 **REFERENCES**

A. Refer to Section 13300.

1.3 **DEFINITIONS**

- A. Refer to Section 13300.
- B. Specific Definitions: 1. PTO: Profibus Trade Organization.

1.4 SUBMITTALS

- A. Furnish submittals in accordance with Contract Documents.
- B. General:
 - 1. Coordinate with ICSC for master RTU submittals.
 - 2. Reference additional detailed test submittal scheduling and prerequisite requirements in Section 13300.
 - 3. For each test described in Parts 2 and 3, herein, and described in other sections of Division 17, prepare and submit complete Test Plans, Test Procedures, Test Forms, Test Binders, and Test Reports, and other submittals, as specified below.
 - 4. Submit Manufacturer's Certifications and Manufacturer's Field Reports where required.
 - 5. Submit Test Plans, Procedures, Forms, and Binders for approval by the ENGINEER before scheduling or performing tests.
 - 6. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
 - 7. Additional Test Form and Test Procedure requirements are specified with individual test requirements.
- C. Overall Test Plan:
 - 1. Develop and submit an overall testing plan for the PCIS. The Overall Test Plan to be reviewed and approved by the ENGINEER before detailed test plans, procedures, and forms will be reviewed.
 - 2. Describe the test phases, as they apply specifically to this project and each process system.

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- 3. **Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.**
- 4. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
- 5. *Provide examples of proposed forms and checklists.*
- D. Test Procedures:
 - 1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.
 - 2. Provide a statement of test objectives for each test.
 - 3. Prepare specific procedures for each process system.
 - 4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
 - 5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), how the testing equipment will be used.
 - 6. Describe the expected role of the ENGINEER, as well as any requirements for assistance from OWNER's staff.
 - 7. Provide the forms and checklists to be used.
- E. Test Forms:
 - 1. Provide test and calibration forms and checklists for each of the following:
 - a. **Calibration**.
 - b. Factory Acceptance Tests.
 - c. Loop Validation Tests.
 - d. *Pre-commissioning Test.*
 - e. Performance Test.
 - 2. Test forms shall include the detailed test procedures, or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
 - 3. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (ENGINEER and OWNER) witnessing the test.
 - 4. Some sample test forms are included at the end of this Section. These test forms show the minimum required test form content. They are not complete, and have not been customized for this project. The CONTRACTOR is to develop and submit test forms customized for the project and meeting all of the specified test and submittal requirements.
- F. Testing Binders:
 - 1. Sub-system to be tested, provide and submit a Test Binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
 - 2. Fill out in advance headings and all other information known before the test.

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- 3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
- 4. Include or list reference material and provide separately at the time of the test.
- 5. Record test results and verify that all test requirements and conditions have been met.
- G. Factory Acceptance Test Procedure additional minimal requirements:
 - 1. Prepare and submit a factory acceptance test procedure which includes:
 - a. Control system testing block diagram.
 - b. Estimated test duration.
 - c. Details on the simulator construction, components, and operation.
- H. Test Reports:
 - 1. At the conclusion of each test, submit a complete Test Report, including all test results and certifications.
 - 2. Include all completed test binders, forms, and checklists.
 - 3. Submission, review, and acceptance of each Test Report is generally required before the start of the sub-system.

1.5 **QUALITY ASSURANCE**

- A. Test Personnel:
 - 1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this project and the equipment, software, and systems before being assigned to the test program.

1.6 SCHEDULING

A. Refer to Section 13300.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

- A. Panel Inspections:
 - 1. The ENGINEER will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the approved shop drawings.
 - 2. Provide panel inspection forms as part of the Factory Acceptance Test procedures submittal.
 - 3. Inspection to include, as a minimum: layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
- B. *I/O Test:*
 - 1. Verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.

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- 2. Test Methodology:
 - a. Discrete inputs: Apply appropriate input at panel terminal, observe input card indicator, observe data value at each indicated data address, observe data received on all operator interface displays (SCADA workstations and local operator interface (LOI) displays).
 - b. Discrete outputs: Issue commands from operator interface screen verify output card indicator light and measure response at field wiring terminals. Repeat for each operator interface screen.
 - c. Analog inputs: Apply appropriate analog input signal at panel terminals, observe data value at each indicated data address, and observe data properly received at each operator screen. Check each point at 0 percent, 50 percent, and 100 percent of scale.
 - d. Analog outputs: Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at panel wiring terminals.
- 3. Test forms to include, but not be limited to:
 - a. PLC and panel number.
 - b. *I/O Type.*
 - c. I/O tag name.
 - d. Panel terminal block numbers.
 - e. Rack/slot/number of I/O point.
 - f. Check-off for correct response for each I/O point.
 - g. Space for comments.
 - h. Initials of individual performing test.
 - i. Date test was performed.
 - j. Witness' signature lines.
- C. System Configuration Test:
 - 1. Demonstrate and test the setup and configuration of all operator stations, servers, development stations, and peripherals.
 - 2. Demonstrate all utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
 - 3. Demonstrate the proper operation of all peripheral hardware.
 - 4. Coordinate with OWNER's Programmer to demonstrate all general SCADA functions.
 - 5. **Demonstrate proper operation of log-on and other access security** *functions.*
 - 6. **Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.**
 - 7. Test automatic fail over of redundant equipment.
 - 8. Demonstrate the proper operation of the alarm display and acknowledgement functions.
 - 9. Test Forms:
 - a. For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
 - b. List the specific tests and steps to be conducted.
 - c. For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
 1) Include signature and date lines.
- D. Control Logic Test:

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- 1. The purpose of this test is to verify that all software functions and logic work as specified, along with any hardwired logic or functions in the tested control panels.
- 2. Testing Requirements:
 - a. Demonstrate each function described in Section 13301. Demonstrate in detail how each function operates under a variety of operating scenarios. Test to verify the application of each General Control Strategy function to each specific Control Strategy or Loop Description.
 - b. Demonstrate the proper operation of the programming and configuration for each Control Strategy or Loop Description. Test each Strategy or Loop Description on a sentence by sentence and function by function basis. Loops with similar or identical logic must each be tested individually.
 - c. Demonstrate the proper operation of all digital communication links and networks. Verify each digital communication I/O point.
 - d. Failure Testing: In addition to demonstrating correct operation of all specified features, special effort shall be made to demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to: equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to SCADA hardware), process equipment failure, and high system loading conditions.
- 3. Test Forms:
 - a. Include the fully revised and approved Control Strategy for the loop being tested.
 - b. Identify the Cause and Effect as each I/O point is toggled through the simulator. Check boxes shall be provided to track proper and/or improper operation of the loop.
 - c. Any deficiencies or operational changes shall be noted on the forms for correction and documentation:
 - 1) Include signature and date lines.

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. Refer to Section 13300.
- B. Installation Supervision:
 1. Provide in accordance with Section 13300.

3.2 FIELD QUALITY CONTROL

- A. **General:**
 - 1. The OWNER reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
 - 2. Failure Testing:

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- a. In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
 - 1) Equipment failure.
 - 2) **Operator error.**
 - 3) Communications sub-system error.
 - 4) Power failure.
 - 5) **Process equipment failure.**
 - 6) High system loading conditions.
- 3. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day. Testing at other times requires approval of the ENGINEER.
- B. Manufacturer Services:
 - 1. Provide in accordance with Section 13300.
- C. **Sequencing:**
 - 1. See additional requirements in Section 13300.
- D. Calibration:
 - 1. After installation but before starting other tests, calibrate and adjust all instruments, devices, valves, and system, in conformance with the component Manufacturer's instructions and in accordance with these Specifications.
 - 2. Components having adjustable features are to be set carefully for the specific conditions and applications of this installation. Test and verify that components and/or systems are within the specified limits of accuracy.
 - 3. Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
 - 4. Calibration Points:
 - a. Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to National Institute of Testing Standards.
 - 5. Field verify calibration of instruments that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
 - 6. Analyzer Calibration:
 - a. Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the Manufacturers' technical representatives.
 - 7. Complete instrument calibration sheets for every field instrument and analyzer.
 - 8. Calibration Tags:
 - a. Attach a calibration and testing tag to each instrument, piece of equipment, or system.
 - b. Sign the tag when calibration is complete.
- E. Loop Check/Validation:
 - 1. Check all control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the 13950-6

SCADA System. Issue commands from the SCADA system and verify proper responses of field devices. Use actual process inputs wherever available.

- 2. Provide "End-to-End" tests:
 - a. Test SCADA System inputs from field device to SCADA system operator workstations.
 - b. Test SCADA System outputs from SCADA operator workstations to field devices and equipment.
 - c. Observe and record responses at all intermediate devices.
 - d. Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
 - e. For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
- 3. Retest any loop following any necessary corrections.
- 4. Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements, and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.
- 5. Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
- 6. Apply provisional settings on controllers and alarm set points.
- 7. Record all analog loop test data on test forms.
- 8. Exercise each field device requiring an analog command signal, through the SCADA System. Vary, during the validation process, the output from the PLC SCADA System and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal. Manually set the output from the SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any intermediate devices.
- 9. Exercise each field device providing a discrete input to the SCADA System in the field and observe the proper operation shall be observed at the operator workstation:
 - a. Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
 - b. Exercise starters, relay contacts, switch contacts, and observe proper operation.
 - c. Calibrate and test instruments supplying discrete inputs, and observe proper operation.
- 10. Test each device accepting a discrete output signal from the SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
 - a. Stroke valves through outputs from the SCADA System, and confirm proper directional operation. Confirm travel limits and any feedback signals to the SCADA System.
 - b. Exercise motors starters from the SCADA System and verify proper operation through direct field observation.
 - c. Exercise solenoids and other field devices from the SCADA System and verify proper operation through direct field observation.
- 11. *Include in the test forms:*
 - a. Analog input devices:
 - 1) Calibration range.

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- 2) Calibration data: Input, output, and error at each test value.
- 3) Analog input associated PLC register address.
- 4) Value in PLC register at each test point.
- 5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
- b. Analog output devices:
 - 1) Calibration range.
 - 2) Test value at each test point.
 - 3) Analog output associated PLC register address.
 - 4) Control variable value at field device at each test point.
 - 5) **Physical device response at each test point:**
 - a) **Response to be actual valve position, or motor speed, etc.**
- c. Discrete instrument input devices:
 - 1) Switch setting, contact action, and dead band.
 - 2) Valve position switches:
 - a) **Response in the PLC as the valve is stroked from the PLC.**
 - b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
 - 3) **Operator interface switches (control stations and other pilot devices) and associated response.**
 - 4) Starter and drive auxiliary device contact response.
 - 5) **Response of all other discrete inputs to the PLC.**
- d. Discrete output devices:
 - 1) Observed response of field device to the discrete output from the PLC.
 - 2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
- e. Test equipment used and associated serial numbers.

F. Pre-commissioning (Functional) Test:

- 1. General:
 - a. Commence pre-commissioning tests after completion of all loop check/validation tests:
 - 1) Reference Section 13300.
 - b. Pre-commissioning to demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
 - c. **Pre-commissioning testing to generally occur in conjunction with Functional Testing specified in specifications division 1.**
 - d. Additional tests are specified in other Division 13 sections.
 - e. Follow approved detailed test procedures and check lists for all precommissioning and test activities.
- 2. Control Logic Operational Validation:
 - a. The purpose of Control Logic Validation is to field test the operation of the complete control system, including all parts of the SCADA System, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
 - b. Demonstrate all control functionality shown on the P&IDs, Control Schematics, and other Drawings, and specified in the Loop

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- c. Test in detail on a function-by-function and sentence-by-sentence basis.
- d. Thoroughly test all hardware and software functions:
 - 1) Including all hardwired and software control circuit interlocks and alarms.
- e. Test final control elements, controlled equipment, control panels, and ancillary equipment under start-up, shut down, and steady-state operating conditions to verify all logic and control is achieved.
- f. Control Logic Validation tests to include, but not limited to: a repeat of all Control Logic Tests from the Factory Acceptance Tests, modified and expanded to include all field instruments, control panels, circuits, and equipment.
- 3. Loop Tuning:
 - a. Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.
 - b. Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4 wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.
 - c. If excessive oscillations or system instability occur, as determined by the ENGINEER, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.
- 4. Pre-commissioning Validation Sheets:
 - a. Document each pre-commissioning test on an approved test form.
 - b. Document loop tuning with a report for each loop, including two-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the ENGINEER. Show tuning parameters on the charts, along with time, date, and sign-off by CONTRACTOR and ENGINEER.
 - c. Include on the form, functions which can be demonstrated on a loopby-loop basis:
 - 1) Loop number and P&ID number.
 - 2) Control Strategy, or reference to specification tested.
 - 3) Test Procedures: Where applicable, use the FAT function-byfunction, sentence-by-sentence Loop Test Checklist forms modified to meet the requirements of the Pre-commissioning test. Otherwise, create new forms.
 - d. For functions that cannot be demonstrated on a loop-by-loop basis (such as overall Plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
 - 1) Specification page and paragraph of function demonstrated.

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- 2) **Description of function and/or text from specification.**
- 3) **Test procedures: use the FAT Loop Test Checklist forms modified to** meet the specific testing conditions of the Pre-commissioning Test.
- 5. **Pre-commissioning Certification:**
 - a. Document via a certified report the completion of all precommissioning and test activities:
 - 1) Including all test forms with test data entered, submitted to the ENGINEER with a clear and unequivocal statement that all precommissioning test requirements have been satisfied.

3.3 DEMONSTRATION AND TRAINING

- A. **Performance/Reliability/Operational Tests:**
 - 1. After successful completion of the pre-commissioning test as accepted by the ENGINEER and OWNER, the performance test can proceed.
 - 2. Complete training and instruction of the OWNER's personnel in conformance with paragraph 1.09 Sequencing and Scheduling of Section 17050.
- B. The Performance Test may be performed concurrently with the 7-Day Operational Test noted in specifications division 1.
- C. **General:**
 - 1. The performance test is part of the Work that must be completed as a condition of substantial completion for the entire project.
 - The complete PLC control and SCADA system must run continuously for the duration of the performance test. During this period, exercise all system functions, and log for cause of failure, any system interruption and accompanying component, subsystem, or program failure:

 a. Include time of occurrence and duration of each failure.
 - 3. Provide a competently trained technician or programmer on call for the project site during all normal working days and hours from the start of the performance test until final acceptance of the system. Response time to the project site:

a. 24 hours or less, for a major failure.

- 4. The Performance Test duration: a. 7 days.
- 5. Test and use; the entire process control system under standard operating conditions.
- D. SCADA System Testing (Coordinated with OWNER's Programmer):
 - 1. Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
 - 2. Failure of the SCADA System during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications.
 - a. Corrective action is required before restarting the acceptance test.
- E. Failures:
 - Classify failures as either major or minor.
 a. Minor Failure:

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- 1) A small and non-critical component failure or software problem that can be corrected by the OWNER's operators.
- 2) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
- 3) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
- 4) Failure of one printer, or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e. alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
- b. Major Failure:
 - 1) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
 - 2) Cause termination of the performance test.
 - 3) Start a new acceptance test when the causes of a major failure have been corrected.
 - 4) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.
- F. Technician Report:
 - 1. Each time a technician is required to respond to a system malfunction, he or she must complete a report which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
 - 2. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
 - 3. If a technician has performed work but no report is written, then a major failure is considered to have occurred.
 - 4. Each report shall be submitted within 24 hours to the ENGINEER and the OWNER, or its representative.

3.4 SCHEDULES

- A. Example Test Forms:
 - 1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of project-specific test forms for this project.
 - 2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

13950-11

		CHECKLIST DOCUMENTATION						
INS	TRUMENT LOOP NO.							
SER	NVICE DESCRIPTION							
	OPY OF LATEST ISSUE OF	THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS II ON FILE:	NSTRUMEN	r				
	INSTRUMENT SPECIFICA	TION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)						
	INSTRUMENT INSTALLAT	TION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)						
	INSTRUMENT LOOP WIR	ING DIAGRAMS						
	INSTRUMENT INSTALLAT	INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST						
	SIZING CALCULATIONS							
	INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)							
	NAMEPLATE SCHEDULE (APPLICABLE PART)						
	VENDOR LITERATURE CA	LIBRATION INFORMATION						
			_	_				
	TRUMENT LOOP IS PART (DF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?	No					
		DF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?						
		DF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?						
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		DF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?						
	MARKS:	АССЕРТЕД ВУ						
	MARKS:	ACCEPTED BY (COMPANY)						
	MARKS:	ACCEPTED BY (COMPANY) SIGNATURE						

SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP NO.

SERVICE DESCRIPTION

CHECK BELOW, WHEN COMPLETED:

- BENCH CALIBRATED PER SPEC SHEET
- □ VERIFIED PER P&ID NO
- **CORRESPONDS TO SPECIFICATION SHEET NO.**
- WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.
- □ INSTALLATION CORRECT PER DETAIL NO.
- □ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED
- □ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL
- **ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED**

INSTRUMENT LOOP IS PART OF AN EQUIPMENT START UP/SHUTDOWN INTERLOCKS?	Νο	Yes
INSTROMENT LOOF IS FART OF AN EQUIPMENT START OF SHOTDOWN INTEREOCKS:	110	103

CONTAC T NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR	ACTUAL TRIP POIN WAS	
1	🗌 ALARM			SET PT =	SET PT =	
	S/D PERM	DECR		RESET =	RESET =	
2	🗌 ALARM			SET PT =	SET PT =	
	S/D PERM			RESET =	RESET =	
3	🗌 ALARM			SET PT =	SET PT =	
	S/D PERM			RESET =	RESET =	
4	🗌 ALARM			SET PT =	SET PT =	
	S/D PERM			RESET =	RESET =	

NOTE: PERM IS ABBREVIATED FOR PERMISSIVE

City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 13950-14

Addendum 2 April 2024

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	
REMARKS:		
CHECKED BY (COMPANY)	ACCEPTED BY (COMPANY)	
SIGNATURE	SIGNATURE	
DATE	DATE	
	13950-15	
City of Prescott, AZ		
Yavapai Hills Lift Station #1 21-064		Addendum 2 April 2024

				DLLER/INDICATOR CALIBRATION IST		
INSTRUMENT LOOP IS	PART OF	AN EQUIPMENT S	START UP	/SHUTDOWN INTERLOCK	(S? No	o Yes
INSTRUMENT TYPE		TRANSMITTER				
INDICATOR		OTHER	DESCR	RIPTION		
INSTRUMENT TAG NO.			SERIA	L NO.		
SERVICE DESCRIPTION						

	BENCH CALIBRATION CHECK						
INPUT RANGE =			OUTPUT RANGE =				
HEAD CORRECTION =							
CALIBRAT SPAN =	CALIBRATED SPAN =		SQUARE ROOT				
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE			
0							
50							
100							

CHECK BELOW, WHEN COMPLETED:

BENCH CALIBRATED PER SPEC SHEET

□ VERIFIED PER P&ID NO

CORRESPONDS TO SPECIFICATION SHEET NO.

□ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.

□ INSTALLATION CORRECT PER DETAIL NO.

ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

□ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK					
INPUT RANGE =			OUTPUT RANGE =		
% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE	

0		
50		
100		

TRANSMITTER/CONTROLLER/INDICATOR	
INSTALLATION AND CALIBRATION CHECKLIST	

□ DIRECT □ REVERSE

□ ACTION VERIFIED AT 50% SPAN

□ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS

SETTING	GAIN	PB	RESET (INTEGRAL)	DERIV. (RATE)	HIGH LIMIT	LOW LIMIT	ELEV. ZERO	ZERO SUPP
PRE-TUNE								
POST- TUNE								

PRE-TUNE SETTINGS

(MINUTES)	GAIN	PB	RESET (REPEAT/MIN)	RESET (MIN/REPEAT)	DERIVATION
FLOW:	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF
DEMADKS					

REMARKS

CHECKED BY (COMPANY) (COMPANY)	ACCEPTED BY
SIGNATURE	
DATE)	DATE

	STRUMENT LOOP IS I	INSTALLATION	LYZERS AND CALIBRATION CKLIST RT UP/SHUTDOWN INT	ERLOCKS? NO YES	
INS	STRUMENT TAG NO.		SERIAL NO.		
SEI	RVICE DESCRIPTION	1			
СН	ECK BELOW, IF TRUE	5:			
	BENCH CALIBRATE	D PER SPEC SHEET			
	VERIFIED PER P&II	d <i>NO.</i>			
	CORRESPONDS TO	SPECIFICATION SHEET NO.			
	WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.				
	INSTALLATION COP	RRECT PER DETAIL NO.			
	ACCESSORIES ARE	PRESENT AND PROPERLY INS	TALLED		
	INSTRUMENT IS AC	CCESSIBLE FOR MAINTENANCE	E OR REMOVAL		
	ENGRAVED LAMINA	ATED NAMEPLATE (NO SPELLI	NG ERRORS) PERMANE	NTLY INSTALLED	
RE	MARKS				
_		<u> </u>			

_

CHECKED BY (COMPANY) ______ (COMPANY) _____

ACCEPTED BY

DATE _____

DATE

		CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST			
INSTRUMEN	IT LOOP IS PART OF A	N EQUIPMENT START UP/SHUTDOWN INTE	ERLOCKS?	NO	YES
VALVE TAG	NO			SER	IAL NO.
	DUCER TAG NO			SER	TAL NO.
	DID TAG NO			SER	IAL NO.
	E BOOSTER TAG NO			SER	IAL NO.
	ONER	SERIAL NO.			
SERVICE DE	SCRIPTION				

		TRANSD	UCER CHECK		
INPUT RANGE =	=		OUTPUT RANGE	:=	
CALIBRATED SPAN =		CALIBRATED SPAN =			
		В	ENCH		
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

BENCH CALIBRATED PER ABOVE

□ VERIFIED PER P&ID NO.

□ CORRESPONDS TO SPECIFICATION SHEET NO.

□ VALVE SPECIFICATION NO.

TRANSDUCER SPECIFICATION NO.

□ SOLENOID SPECIFICATION NO.

ECIFICATION NO.

□ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO.

□ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS

- □ VALVE DETAIL NO.
- TRANSDUCER DETAIL NO.
- SOLENOID DETAIL NO.

CONTROL VALVES	
INSTALLATION AND CALIBRATION CHECKLIST	

□ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

□ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK

FLOW CHECK	PROCESS FLOW DIRECTION THRU THE VALVE IS CORRECT				
	ON LOSS OF AIR VAL	VE FAILS	ON LOSS OF I	POWER SOLENOID FAILS	
SAFETY					
CHECK		CLOSE	TO VENT		
TRAVEL CHECK	FULL OPEN AT	FULL CLOS	ED AT	MEASURED TRAVEL	
	PSI	PSI		INCHES	
SEATING CHECK		RESULTS		ACTUATOR BENCH SET	

POSITIONER CHECK

VALVE FULL OPEN AT

_____ PSI TO POSITIONER

VALVE FULL CLOSED AT _____

_____ PSI TO POSITIONER

VOLUME BOOSTER CHECK

BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT ______ TURNS FROM CLOSED TO ENSURE QUICK BUT

STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)

REMARKS

CHECKED BY (COMPANY) (COMPANY)	ACCEPTED BY
SIGNATURE	
DATE	DATE

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DIVISION 15

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SECTION 15010

PIPING SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings:1. Details of each pipe support type used.

PART 2 - PRODUCTS

2.1 SUPPORT SYSTEMS:

- A. Channel-type support systems
 - 1. 316 Stainless Steel
 - a. Unistrut
 - b. B-Line
 - c. Or Equal.
 - 2. Non-metallic
 - a. Aikenstrut
 - b. CLIC
 - c. Or Equal.
- B. Hanger- and Clevis-type support systems
 - 1. B-line
 - 2. Anvil
 - 3. Or Equal
- C. Stanchion-type support systems
 - 1. B-Line
 - 2. Anvil
 - 3. Or Equal
- D. Adjustable Pipe Saddle Support
 - 1. B-Line, Figure B-3092
 - 2. Or Equal
- E. Wall Bracket (14-inch to 24-inch pipe)
 - 1. B-Line Figure B-3067 Heavy Duty Angle Bracket
 - 2. Or Equal
- F. Wall Bracket (8-inch to 12-inch pipe)
 - 1. B-Line Figure B-3066 Medium Duty Angle Bracket
 - 2. Or Equal
- G. Wall Bracket (4-inch to 6-inch pipe)
 - 1. B-Line Figure B-3068 Light Duty Angle Bracket
 - 2. Or Equal

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. In addition to the pipe supports specifically called for on the drawings, CONTRACTOR shall provide pipe supports as required to fully support all piping systems.
- B. CONTRACTOR shall design, supply and install pipe support system using manufacturer's standard available pipe support hardware.
- C. Pipe supports shall, at a minimum, be installed at the following locations:
 - 1. On both sides of each valve, piece of equipment or other appurtenance, such that allowance is made for removal of the valve, piece of equipment, or other appurtenance while leaving the pipe system fully supported. Support piping connections to equipment by pipe support and not by the equipment.
 - 2. Along straight runs of pipe, the maximum distance between supports shall be as listed below:

Pipe Diameter	Maximum Distance	Minimum Hanger Rod Diameter	
	Between Supports	(if Hanger Rods are used)	
2" and smaller	6-feet	1/2″	
2-1/2" to 6"	8-feet	3/4 ″	
8" to 12"	10-feet	2 @ ¾″	
14" to 18"	10-feet	2 @ 1″	
Over 18"	Custom Design		

- 3. Directly supporting valves 8-inch in diameter and larger.
- 4. At least two supports on each side of flexible couplings or flanged coupling adapters to provide that no load is applied to the flexible coupling.
- 5. On the pipe within two pipe diameters of each side of elbows and each branch of tees and crosses.
- 6. Where piping passes through walls, such that no load is transferred to the wall.
- D. Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.
 - 1. Support no pipe from the pipe above it.
 - 2. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
- E. Bracing and lateral support:
 - 1. Provide lateral sway bracing on 10-foot maximum centers
 - a. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
 - 2. Install lateral supports for seismic loads at all changes in direction.
- F. Thermal expansion and thrust restraint
 - 1. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
- G. Support types:
 - 1. Horizontal Suspended Piping:
 - a. Single Pipes: Adjustable swivel-ring, splint-ring or clevis hangers.

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- b. Grouped Pipes: Trapeze hanger systems.
- c. For insulated piping, furnish galvanized steel protection shields, welding insulation saddles, or precut sections of rigid insulation (with vapor barrier) at all hanger locations.
- 2. Horizontal Piping Supported From Walls:
 - a. Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall-mounted framing also acceptable.
 - b. Stacked Piping:
 - 1) Wall-mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.
 - 2) Piping clamps that resist axial movement of pipe through support not acceptable.
 - c. Insulated piping shall have the insulation removed in the vicinity of wall brackets and piping clips to allow only direct pipe wall contact with the support system.
- 3. Horizontal Piping Supported From Floors:
 - a. Stanchion Type:
 - 1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
 - 2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.
 - 3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
 - b. Floor-Mounted Channel Supports:
 - 1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
 - 2) Attach channel framing to floors with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles:
 - 1) Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
- 4. Vertical Pipe:
 - a. Support with wall brackets and base elbow or riser clamps on floor penetrations.
 - b. Insulated piping shall have the insulation removed in the vicinity of wall brackets and riser clamps, to allow only direct wall contact with the support system.
- H. Standard Attachments:
 - 1. To Concrete Ceilings: Concrete inserts.
 - 2. To Steel Beams: I-beam clamp or welded attachments.
 - 3. To Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
 - 4. To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
 - 5. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.
 - 6. Repair mounting surfaces to original condition after attachments are made.
- I. Isolation:
 - 1. Install elastomeric inserts designed to isolate piping from pipe supports where copper pipe is run in stainless steel supports, or where other dissimilar metals are in contact with pipe supports.
- J. Materials:

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- 1. Channel-type, hanger-type and trapeze-type support systems and pipe racks constructed of channel systems:
 - a. Provide non-metallic support systems in all chemical storage and feed areas or as otherwise noted on the Drawings. Provide type 316 stainless steel fasteners.
 - b. Provide type 304 stainless steel support systems and fasteners in all other areas.
- 2. Stanchion-type support systems
 - a. Provide steel and ductile iron stanchion components
 - b. Coat stanchions after assembly per specification Section 09900, Painting.

+ + END OF SECTION + +

SECTION 15080

PIPING INSULATION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings:
 - 1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, etc.

PART 2 - PRODUCTS

2.1 PIPE INSULATON

- A. **INS-01:** Flexible Elastomeric Pipe Insulation (up to 6" diameter)
 - 1. Material: Flexible elastomeric pipe insulation, closed cell structure
 - 2. Provide a minimum of ³/₄-inch thickness
 - 3. Temperature Rating: -40 degrees to 200 degrees Fahrenheit
 - 4. Nominal Density: 6 pcf
 - 5. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft2 degrees F at 75 degrees F per ASTM C177 or ASTM C518.
 - 6. Minimum water vapor transmission of 0.10 perm-inch per ASTM E96
 - 7. Flame Spread Rating: Less than 25 per ASTM E84
 - 8. Joint sealant and tape per manufacturer
 - 9. Manufacturers and Products:
 - a. Rubatex: R-180-FS
 - b. Armstrong: Armaflex AP
 - c. Or Equal
- B. INS-02: Rigid Fiberglass with PVC Cover
 - 1. Material:
 - a. Insulation: UL rated, preformed, sectional rigid fiberglass
 - b. Vapor Barrier Jacket: Kraft paper with aluminum foil with pressure sensitive adhesive lap
 - c. Cover: Preformed PVC Cover
 - 1) UV resistant
 - 2) Joints designed to shed water
 - 3) Color: White.
 - 4) Provide Identification Labels per the requirements of 10400 Identification Devices
 - 2. Temperature Rating: 0 degrees to 850 degrees Fahrenheit
 - 3. Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft2 degrees F at 75 degrees F per ASTM C177 or ASTM C518.
 - 4. Minimum water vapor transmission of 0.02 perm-inch per ASTM E96
 - 5. Flame Spread Rating: Less than 25 per ASTM E84
 - 6. Fittings and valves:
 - a. Insulate with fabricated sections of insulation
 - b. Wrap with vapor barrier jacket

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- c. Provide preformed PVC fitting cover specifically designed for fitting or valve
- 7. Manufacturers and Products:
 - a. Owens-Corning Fiberglass; ASJ/SSL-II with PVC Cover
 - b. Johns Manville Corp; Micro-Lok with Zeston 2000 PVC Cover
 - c. Or Equal.

2.2 HEAT TRACING

- A. Parallel resistance, low watt density, self limiting output electrical cable heaters. Designed for use on metallic or non-metallic piping, under insulation, for freeze protection.
- B. Features:
 - 1. Two 16 AWG multistrand copper buss wire
 - 2. Extruded in a self-regulating conductive polymer core with polyolefin inner jacket
 - 3. Tinned copper braid for mechanical protection and ground path
 - 4. Covered with a thermoplastic elastomer overjacket for chemical protection. Suitable for use in chemical areas.
 - 5. Designed to be field-cut and spliced
 - 6. 120VAC
 - 7. 8 watts/foot
 - 8. Allowable circuit length up to 880 feet
 - 9. Approximately 3/8 inch by 1/8 inch
 - 10. Approved for use in Class I, Div 2 hazardous locations
- C. Provide all connectors, cables, termination box, thermostat and other appurtenances required for a complete installation.
- D. Manufacturers and Products:
 - 1. Chromalox; Model SRL
 - 2. Tempco; Style SL
 - 3. Raychem; Model BTV
 - 4. Or Equal

2.3 HEATED FIBERGLASS ENCLOSURES

- A. General:
 - 1. Equipment ID: **HE-01**
 - 2. Provide electrically-heated flip-top fiberglass heater enclosures where indicated on the Drawings.
 - 3. Enclosure shall be specifically designed and thermostatically controlled for protection of piping and equipment from exterior temperatures to -30°F.
- B. Enclosure:
 - 1. The enclosure shall be constructed from minimum 1/8-in thixotropic polyester resin reinforced with fiberglass strands and shall be ASSE 1060 certified.
 - 2. The enclosure shall have smooth molded exterior and shall be provided with a UV-inhibited isophthalic polyester gel coat.
 - 3. Enclosure shall utilize a lockable flip-top design and shall not require removal of the entire unit for maintenance access.
 - 4. Enclosure shall be provided with a continuous hinge and overlapping lid seam design.

- C. Insulation: Minimum 1.25-in. (R8) thick unicellular, non-wicking polyisocyanate foam
- D. Drain Ports:
 - 1. Enclosure shall be provided with two drain ports sized for full port backflow discharge, one at each end of the enclosure.
 - 2. Drains shall be designed for "one way" flow to limit intrusion of debris and/or vermin.
- E. Anchorage:
 - 1. Enclosure shall be anchored to a reinforced concrete pad by means of steel anchors.
 - 2. Enclosure shall be provided with minimum four internal brackets for anchorage.
- F. Heating:
 - 1. Minimum rated capacity: 1,000 W
 - 2. Power: 120V, single phase
 - 3. Controlled by integral thermostat and sized to maintain the interior at a minimum of $+40^{\circ}$ F.
- G. Manufacturers and Products:
 - 1. Hubbell Power Systems, Inc. Hot Box Model HF026070045
 - 2. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Where called for in the drawings or pipe schedule, provide heat tracing between pipe and insulation.
 - 1. Install heat tracing per manufacturer's instructions
 - 2. Provide electrical service to heat tracing from nearest 120V panelboard or receptacle, whether shown on the electrical drawings or not. Electrical service shall be in accordance with all codes and regulations for the installation.
- B. Insulate all piping, valves and fittings for the piping systems (Flow Stream IDs) where insulation is called for in 15100 PS Piping Schedule
- C. Install insulation according to manufacturer's instructions
 - 1. Install insulation only after piping system has passed pressure testing.
 - 2. Requirement for insulation does not negate the requirement for coating of the piping system. Apply piping coating system as called for in 15100 PS Piping Schedule. Allow coating system to completely cure prior to installation of pipe insulation.
 - 3. If heat tracing is required on piping system, do not install pipe insulation until after heat tracing has been installed and successfully tested.
 - 4. Do not "gap" insulation at pipe supports. Trim insulation to allow for pipe support while providing continuous insulation of piping in those parts of the pipe not in contact with pipe support.
 - 5. Install removable/replaceable insulation sections and cover panels over fittings or valves which require maintenance access.
 - 6. Use accessories, adhesives and tapes per manufacturer's recommendations.
- D. Finishing

1. Overall installation shall result in smooth, straight, neat and clean piping insulation system. No frayed ends, irregular lumps or other unsightly installation result will be acceptable.

+ + END OF SECTION + +

SECTION 15100

PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

- 1. Product data sheets for each piping system.
- a. Include information on pipe, fittings and joint systems.
- 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
- 3. Complete descriptions and data for all coatings and linings.
- 4. Tests and inspection data for pipe and coatings/linings.
- 5. Qualifications for welders and/or technicians performing joining processes that requires specialized equipment to perform the work or as specifically identified herein.
- B. Operation and Maintenance Data as specified in Section 01330, SUBMITTAL PROCEDURES.

1.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's directions.

PART 2 - PRODUCTS

2.1 PIPING SYSTEM DATA SHEETS

A. Piping system data sheets (PSDS) have been attached to this Specification and are incorporated herein by reference. Provide piping systems in accordance with piping system data sheets.

2.2 THRUST RESTRAINT

- A. Provide rigid or restrained joints and fittings for all piping systems specified with a test pressure in the Pipe Schedule.
- B. Unless otherwise specified in the Pipe Schedule or shown on the Drawings, thrust blocks shall not be used.

PART 3 - EXECUTION

3.1 PIPE SCHEDULE

A. A Pipe Schedule has been attached to this Specification and is incorporated herein by reference. Install piping systems in accordance with Pipe Schedule.

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City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 B. For pipe which is shown on the Drawings, but not referenced in the Pipe Schedule, CONTRACTOR to provide pipe material and fittings which are appropriate for the intended service and acceptable to the ENGINEER.

3.2 PREPARATION

- A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- B. Repair any coatings or linings which were damaged during shipping and handling using manufacturer-approved coating and lining repair materials in accordance with manufacturer's instructions.

3.3 INSTALLATION

- A. General:
 - 1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- B. Joint Assembly:
 - 1. Flanged Joints (FLG):
 - a. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
 - b. Follow a bolt tightening pattern which produces uniform bearing pressure.
 - c. Do not over-tighten bolts. Follow manufacturer's recommendation for bolt torque.
 - d. Provide gasket at every flanged joint.
 - e. Provide insulating flange kit where indicated on Drawings and required in this Specification.
 - 2. Threaded and Coupled Joints (THR):
 - a. Conform to ANSI B1.20.1.
 - b. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
 - c. Ream pipe ends and clean chips and burrs after threading.
 - d. Make connections with not more than three threads exposed.
 - e. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
 - f. PVC Threaded Joints:
 - 1) Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
 - 2) Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
 - g. HDPE Threaded Joints:
 - 1) Joining HDPE pipe with threaded connections is not allowed unless specifically approved by the ENGINEER
 - h. Provide dielectric union or insulating coupling where indicated on Drawings and required in this Specification.
 - 3. Grooved-End Joints (GRV):
 - a. Type: Rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.
 - b. Grooved end joints are not allowed for plastic pipes unless approved by the ENGINEER.
 - 4. Soldered Joints (SLD):

- a. Before soldering, remove stems and washers from solder joint valves.
- b. Use only solder specified for particular service.
- c. Cut pipe ends square and remove fins and burrs.
- d. Protect adjacent surfaces from damage during soldering.1) Protect from high temperatures due to flame
 - 2) Protect from damage due to dripping flux or solder
- e. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
- f. Solder Joint
- g. Wipe excess solder from exterior of joint before hardened.
- 5. Solvent Welded Joints (SLV):
 - a. Use only solvent cement which is rated for use in the service intended. Check compatibility of solvent cement with service, especially in pipelines which carry chemicals.
 - b. Observe all manufacturer's requirements for environmental conditions for use of solvent cement.
 - c. Cut pipe ends square and remove fins and burrs.
 - d. Apply appropriate primer.
 - e. Apply solvent cement and assemble joint.
 - 1) Hold in place long enough for solvent cement to set-up and hold joint, as assembled, until solvent cement has cured.
 - f. Wipe excess solvent cement from exterior of joint before hardened.
- 6. Proprietary Restrained Mechanical Joints (PRJ):
 - a. PRJ piping shall be furnished with factory-fabricated retainer weldment on spigot end.
 - b. If PRJ piping is field cut, the pipe joint shall be restrained using Restrained Mechanical Joint (RMJ) Glands as specified in Section 15120, Piping Specialties. Field welding of retainer weldment will not be allowed.
- C. Exposed Piping Installation:
 - 1. Piping Runs:
 - a. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
 - b. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.
 - 2. Supports: As specified in Section 15010, PIPING SUPPORT SYSTEMS.
 - 3. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.
 - 4. Provide unions or flanges at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.
 - 5. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection;
 - 6. Install piping to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
 - 7. Piping clearance, unless otherwise shown:
 - a. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - b. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inch, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

- c. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
- d. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
- e. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
- f. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
- g. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.
- D. Buried Pipe Installation:
 - 1. Pipe Placement:
 - a. Keep trench dry until pipe laying and joining are completed.
 - b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
 - c. Prevent foreign material from entering pipe during placement.
 - 1) Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
 - d. Lay pipe upgrade with bell ends pointing in direction of laying.
 - e. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. Utilize a maximum of 75 percent of manufacturer's recommended allowable joint deflection.
 - 1) If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - a) Shorter pipe lengths.
 - b) Fittings/bends.
 - f. Secure pipe which has been placed from movement or damage while placing the next section of pipe.
 - g. Prevent uplift and floating of pipe prior to backfilling.
- E. Cleaning:
 - 1. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. At a minimum, flush for a period of time which will flush the entire pipeline volume three times.
 - a. If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush line at lower velocity. If lower velocity is used, flush the entire pipeline volume five times.
 - 2. Provide temporary means of removing flushing water from pipeline during flushing.
 - 3. Provide means for removal/screening of debris from the flushing water, disposal of debris and disposal of flushing water.

3.4 TESTING

A. Pressure test piping in accordance with the Pipe Schedule, and Section 15990, Pressure Testing of Piping Systems.

3.5 SUPPLEMENTS

- A. The following supplements are attached to this Specification section and incorporated herein by reference:
 - 1. 15100 PS Pipe Schedule
 - 2. 15100 PSDS CPVC Solvent Welded CPVC Pipe
 - 3. 15100 PSDS DIP Ductile Iron Pipe
 - 4. 15100 PSDS PVC1 Solvent Welded Polyvinyl Chloride Pipe

 - 5. 15100 PSDS PVC4 PVC Sewer Pipe
 6. 15100 PSDS SSTP Stainless Steel Pipe

+ + END OF SECTION + +

SECTION 15100 PS

PIPE SCHEDULE

1.1 DESCRIPTION

- A. General:
 - 1. This schedule is provided for the convenience of the CONTRACTOR. Some flow streams may be shown on the drawings, but not listed here.
- B. Flow Stream IDs:
 - 1. DRN Drain
 - 2. DR Air Relief Drain
 - 3. FA Foul Air
 - 4. OVF Overflow
 - 5. FM Forcemain
 - 6. SS Sanitary Sewer
 - 7. V Vent

C. Pipe Materials:

- 1. CPVC Solvent Weld CPVC Pipe
- 2. DIP Ductile Iron Pipe
- 3. PVC1 Solvent Welded Polyvinyl Chloride Pipe
- 4. PVC4 PVC Sewer Pipe
- 5. SSP Stainless Steel Pipe

D. Joint Types:

- 1. MJ Mechanical Joint
- 2. RMJ Restrained Mechanical Joint
- 3. SLV Solvent Welded Socket
- 4. THR Threaded
- 5. BWJ Butt Wrap Joint
- E. Lining Systems:
 - 1. CE Ceramic Epoxy
- F. Coating Systems: As described in Section 09900

1.2 PIPE SCHEDULE

Contractor shall install piping systems in accordance with the following pipe schedule:

FLOW	DESCRIPTION	SERVICE	EXPOSURE	SIZE	MATERIAL	JOINT	TEST	LINING	COATING	NOTES
STREAM				RANGE		TYPE	PRESSURE		SYSTEM/	
I.D.									COLOR	
DR	Air Relief Drain	Air	Exposed	2″	SSP	THR	None	None	300	
DRN	Drain	Sewer	Buried	All	PVC1	SLV	5 psi	None	None	
FA	Foul Air	Air	Exposed	All	CPVC	SLV	None	None	301	
			-		FRP	BWJ				
FM	Forcemain	Sewer	Buried	2″	PVC1	SLV	30 psi	None	None	
			Exposed	10″	DIP	RMJ	400 psi	Ceramic Epoxy	None	
			Exposed	10″	DIP	FLG	400 psi	Ceramic-Epoxy	None	
OVF	Overflow	Sewer	Buried	15″	PVC4	SLV	20 psi	None	None	1., 2.
SS	Sanitary Sewer	Sewer	Buried	15″	PVC4	SLV	20 psi	None	None	1., 2.
V	Vent	Air	Exposed	4″	CPVC	SLV	None	None	301	
			-		FRP	BWJ				

1. Sanitary sewer shall be low pressure air tested per Specification Section 15990.

2. PVC pipe shall be deflection tested in accordance with Section 611 of City of Prescott Technical Specification.

SECTION 15100 PSDS CPVC

PIPING SYSTEM DATA SHEET – SOLVENT WELDED CHLORINATED POLYVINYL CHLORIDE PIPE

ITEM	DESCRIPTION
Pipe	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441. Manufactured with 2 percent titanium dioxide for ultraviolet protection.
	Threaded nipples shall be schedule 80.
Fittings	Schedule 80 CPVC as Specified Under Pipe Above: Conforming to the requirements of ASTM F439 Rev A for socket-weld type and ASTM F437 for threaded type. Manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	Solvent socket-weld except where connection to valves and equipment may require future disassembly.
Flanges	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; 125-pound ANSI B16.1 drilling.
Bolting	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
	Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	Flat-Face Mating Flange: Full faced 1/8-inch thick EPDM rubber.
	Raised-Face Mating Flange: Flat ring 1/8-inch EPDM rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A.
Thread Lubricant	Teflon tape.

SECTION 15100 PSDS DIP

PIPING SYSTEM DATA SHEET – DUCTILE IRON PIPE

ITEM	DESCRIPTION							
Ріре	Buried Piping: Pressure class as indicated in the pipe schedule. If not indicated:							
	• All pipe 12" diameter and smaller shall be pressure class 350.							
	• All pipe 14" through 20" shall be pressure class 250.							
	 All pipe larger than 20" shall be pressure class 200. 							
	Flanged Piping: Special Thickness Class 53							
	Pressure class shall be per AWWA C150/A21.50 and AWWA C151/A21.51							
	All buried pipes designed to carry recycled water shall be distinctively wrapped in purple tape.							
Lining	Wastewater: Ceramic epoxy as follows:							
	 Amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. 							
	 Permeability rating of 0.00 when tested per Method A of ASTM E 96, Procedure A with a test duration of 30 days. 							
	3. Minimum lining thickness: 40 mils nominal dry film thickness.							
	4. The following tests must be run on coupons from factory lined Ductile Iron pipe:							
	a. ASTM B 117 Salt Spray (scribed panel). Results to equal 0.0 undercutting after two years.							
	 ASTM G 95 Cathodic Disbondment (1.5 volts at 77°F). Results to equal no more than 0.5 mm undercutting after 30 days. 							
	c. Immersion Testing rated using ASTM D 714.							
	i. 20% Sulfuric Acid: No effect after two years.							
	ii. 140°F 25% Sodium Hydroxide: No effect after two years.							
	iii. 160°F Distilled Water (scribed panel): No effect after two years.							
	iv. 120°F Tap Water (scribed panel): 0.0 undercutting after two years with no effect.							
	 v. Abrasion Resistance: Less than .075 mm (3 mils) loss after one million cycles on a ±22.5° sliding aggregate slurry abrasion tester using a sharp natural siliceous gravel with a particle size between 2mm and 10 mm (European Standard SN598). 							
	5. Manufacturer and Product:							
	a. Protecto 401 Ceramic Epoxy Lining; Or Equal.							
	b.							

ITEM	DESCRIPTION
Coating	Unless otherwise specified in the Pipe Schedule, piping shall be coated as follows:
	Buried Piping:
	 AWWA C105/A21.5: Polyethylene encasement, 4-mil high- density cross laminated or 8-mil linear-low density, color as required by local/state regulations.
	Exposed/Immersed Piping:
	 Primer Coating: Where shop primer is applied to protect pipe during shipping, storage and handling, primer shall be compatible with pipe coating requirements of Section 09900, Painting.
Fittings	Lined and coated same as pipe.
	Flange (FLG): AWWA C110/A21.10 ductile iron, faced and drilled, 125-pound flat face. Gray cast iron will not be allowed.
Joints	Mechanical (MJ): 250 psi minimum working pressure.
	Restrained Mechanical Joint (RMJ): Standard MJ Joint with RMJ gland conforming to requirements of Section 15120, PIPING SPECIALTIES.
	Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 15120, PIPING SPECIALTIES.
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic.
	Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47 or ductile iron per ASTM A536. Victaulic.
Bolting	T-Bolts and other specialty bolts: Manufacturer's standard. Hex Bolts: ASTM A307, Grade B carbon steel hex head bolts. ASTM A320 B8 Type 304 stainless steel, if exposed.
	Nuts: ASTM A563, Grade A carbon steel hex head nuts.
	T-Bolts and other specialty bolts: Type 304 stainless steel
	Hex Bolts: ASTM A193 B8, Type 304 stainless steel
	Nuts: ASTM A194 Grade 8, Type 304 stainless steel
Gaskets	Push-On, Mechanical, and Proprietary Restrained Joints: Red Rubber (SBR) conforming to ANSI/AWWA C111/A21.11.
	Flanged , Water and Sewage Service: 1/8 inch-thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
	Full face for 125-pound flat-faced flanges, flat-ring type for 250-pound raised-face flanges. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
	Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint	Manufacturer's standard.

ITEM	DESCRIPTION
Lubricant	

15100 PSDS DIP-3

SECTION 15100 PSDS PVC1

PIPING SYSTEM DATA SHEET - SOLVENT WELDED POLYVINYL CHLORIDE PIPE

ITEM	DESCRIPTION
Pipe	Schedule 80 Polyvinyl Chloride (PVC), unless indicated otherwise. Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 1% titanium dioxide for ultraviolet protection.
	All pipes designed to carry recycled water shall be colored purple or distinctively wrapped in purple tape.
Fittings	Schedule to match pipe above, ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 1% titanium dioxide for ultraviolet protection.
Joints	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
Bolting	Hex Bolts: ASTM A193 B8, Type 304 stainless steel Nuts: ASTM A194 Grade 8, Type 304 stainless steel
Gaskets	Flat-Face Mating Flange: Full-faced 1/8-inch thick EPDM rubber.
Solvent Cement	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted.
Thread Sealant	Teflon Tape.

SECTION 15100 PSDS PVC4

PIPING SYSTEM DATA SHEET – POLYVINYL CHLORIDE GRAVITY SEWER PIPE

ITEM	DESCRIPTION
Pipe*	Conform to the requirements of ASTM D3034 (4 to 15-inch) and ASTM F679 (18 to 24-inch). Provide minimum SDR-35 sewer pipe with a minimum pipe stiffness of 115 PSI. PWEagle, or Equal.
Fittings	Conform to the requirements of ASTM D3034 (4 to 15-inch) and ASTM F679 (18 to 24-inch). GPK, or Equal.
Joints	Rubber-gasketed bell and spigot or rubber-gasketed couplings conforming to ASTM D3212.
Gaskets	Conforming to the requirements of ASTM F477.
Joint Lubricant	Manufacturer's standard.

*: Refer to City of Prescott Specifications

15100 PSDS PVC4-1

SECTION 15100 PSDS SSTP

PIPING SYSTEM DATA SHEET – STAINLESS STEEL PIPE

ITEM	SIZE	DESCRIPTION
Pipe		Austenitic stainless steel, ASTM A312, Grade TP 316 seamless, or welded
	2 inch & smaller	Schedule 80
	2-1/2 thru 6 inch	Schedule 40
Joints	3 inch & smaller	Threaded or flanged at valves and equipment.
	4 inch & larger	Flanged at valves and equipment.
Couplings		Threaded, Type 316 Stainless Steel, Class 3000: LF2 ASME B16.11, SA182
Flanges		Class 150, F316/316L, ASTM A102, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded Type 316 Stainless Steel, Class 3000: MSS SP83 ,SA182
Plugs		Threaded Type 316 Stainless Steel, Class 3000: Threads conform to ASME B1.20.1 NPT; Materials conform to ASTM A182, Dimension conform to ASME B16.11
Bolting		Hex Bolts: ASTM A320/A320M, Type 316 stainless steel, grade 5
		Nuts: ASTM F594, Type 316 stainless steel, grade 5
Gaskets	All Flanges	Flanged, Water and Sewage Service: 1/8-inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F., conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
		Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
Thread Lubricant	2 inch & smaller	Heavy duty anti-seize joint lubricant for stainless steel threads that is insoluble in water.

SECTION 15120

PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings:
 - 1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, etc.

PART 2 - PRODUCTS

2.1 SERVICE SADDLES

- A. Double-Strap Iron:
 - 1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
 - 2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
 - 3. Taps: Iron pipe threads.
 - 4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.
 - d. Seal: Rubber.
 - 5. Manufacturers and Products:
 - a. Smith-Blair; Series 313 or 366.
 - b. Dresser; Style 91.
 - c. Or Equal

2.2 FLEXIBLE COUPLINGS

- A. Flexible Couplings (FC)
 - 1. Features:
 - a. Description: Sleeve-type flexible couplings
 - b. Pressure and Service: Same as connected piping.
 - c. Sleeve material: Carbon steel for carbon steel and ductile iron piping systems, or stainless steel for stainless steel piping systems.
 - d. Coating and Lining: All cast and carbon steel components shall be epoxy lined and coated, minimum 16 mils thickness. For potable water service, lining shall be NSF-61 certified.
 - e. Gasket: EPDM
 - f. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
 - 2. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Smith-Blair, Inc.; Style 411.
 - 2) Or Equal.

- B. Flanged Coupling Adapters (FCA)
 - 1. Features:
 - a. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
 - b. Pressure and Service: Same as connected piping.
 - c. Adapter body material: Cast iron or steel.
 - d. Gasket: EPDM
 - e. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
 - 2. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 227.
 - 2) Smith-Blair, Inc.; Style 127.
 - 3) Or Equal.
- C. Restrained Flanged Coupling Adapters (RFCA)
 - 1. Features:
 - a. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
 - b. Pressure and Service: Same as connected piping.
 - c. Adapter body material: Cast iron or steel.
 - d. Gasket: EPDM
 - e. Bolts and Nuts: Alloy steel, corrosion-resistant, prime coated. Buried couplings shall have Type 316 stainless steel bolts and nuts.
 - f. Restraining lug.
 - 2. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Romac Industries; RFCA
 - 2) Or Equal.
- D. Restraint Rods for Flexible Couplings: As shown on the Drawings

2.3 RESTRAINED COUPLINGS

- A. Restrained Mechanical Joint Glands (RMJ)
 - 1. Pressure Rating:
 - a. Minimum Working Pressure Rating: Not less than 150 psi.
 - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
 - 2. RMJ gland shall be designed for use with standard mechanical joint pipe. Pipe restraint products designed for use with push-on joints will not be acceptable.
 - 3. Thrust Restraint:
 - a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
 - b. Products employing set screws that bear directly on pipe will not be acceptable.
 - 4. Manufacturer and Product:
 - a. Ductile Iron Pipe Only
 - 1) EBAA Iron Sales Co.; Megalug.
 - 2) Romac Industries Inc.: RomaGrip
 - 3) Or Equal.

- B. Dismantling Joint
 - 1. Pressure Rating
 - a. Minimum Working Pressure Rating: Not less than 150 psi
 - b. Pressure rating to be no less than test pressure for piping system in which the Restrained Dismantling Joint is used.
 - c. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
 - 2. Thrust Restraint
 - a. Provide steel tie rods, ASTM A 193 GR B7
 - b. Number and arrangement of tie rods to provide dismantling joint assembly which meets pressure rating requirement.
 - 3. Materials of Construction
 - a. Flanged Adapter Body: Steel
 - b. Follower Flange: Ductile Iron
 - c. Gasket: Buna-N, NSF-61 approved
 - d. Flange: Steel, per AWWA C207
 - e. Spigot: Steel
 - f. Studs: Type 304 stainless steel
 - g. Coating: NSF-61 approved epoxy
 - 4. Manufacturer and Product
 - a. Smith-Blair, Model 975 or 972, as required for pressure rating
 - b. Romac Industries, Style DJ400
 - c. Or Equal.

2.4 ELASTOMER BELLOWS:

- A. Type: Reinforced, molded wide-arch elastomer bellows
- B. Features:
 - 1. End Connections: Flanged, drilled 125# ANSI B16.1 standard with split hot-dip galvanized steel retaining rings.
 - 2. Washers: Use with retaining rings to provide leak-proof joint at twice the rated pressure.
 - 3. Thrust Protection: Control rods with gusset connection shall prevent over-extension.
 - 4. Bellows Arch lining shall be Buna-N, nitrile, or butyl.
 - 5. Rated Temperature: 250 deg F.
 - 6. Rated Deflection and Pressure:
 - a. Lateral deflection shall be ³/₄-inch minimum.
 - b. Burst Pressure: Four times the working pressure.
 - c. Compression deflection and minimum working pressure as follows:

Size	Deflection	Pressure		
(inch)	(inch)	(psig)		
2-1/2 to 12	1.06	150		
14	1.65	130		
16 to 20	1.65	110		

- C. Manufacturers and Products:
 - 1. General Rubber Corp.; Style 1015 Maxijoint.
 - 2. Mercer; Flexmore Style 450.
 - 3. Goodall Rubber Co.; Specification E-711.
 - 4. Or equal.

2.5 MODULAR MECHANICAL SEAL

- A. Type: Interconnecting synthetic rubber links shaped and sized to continuously fill annular space between pipe and sleeve, blockout, or core-drilled opening in concrete slabs or walls.
- B. Features:
 - 1. Links: EPDM
 - 2. Bolts and nuts: Type 316 stainless steel
 - 3. Pressure plates: composite
 - 4. Temperature range: -40 to 250 degrees Fahrenheit
 - 5. Pressure rating: guaranteed by the manufacturer to provide a water-tight seal with a differential hydrostatic head of 40-feet of water
- C. Manufacturers and Products:
 - 1. PSI-Thunderline; Link-seal, Type S-316
 - 2. Or equal

2.6 PIPE TO MANHOLE CONNECTORS

- A. Type: Resilient rubber male-to-female wedge-style flexible connector between a circular gravity pipe and a circular opening core-drilled into a precast or cast-in-place concrete structure.
- B. Performance Requirements:
 - 1. Able to hold 10 psi head pressure for 10 minutes with no leakage
 - 2. Load Rating: 150 lbs per inch pipe diameter
- C. Materials:
 - 1. Body: resilient rubber material conforming to ASTM C923
 - 2. Hardware: 300 Series Stainless Steel conforming to ASTM C923, ASTM A666 and ASTM A240
- D. Manufacturer and Products
 - 1. Trelleborg Pipe Seals Milford, Inc., Model Kor-N-Seal I 106 Series for pipes up to 18" diameter and Kor-N-Seal II 206 Series for pipes from 20" to 54" in diameter.
 - 2. Or Equal

2.7 CHEMICAL CONNECTION

- A. Type: Lockable Male Cam-lock
 - 1. Materials:
 - a. Adapter and Cap: Glass-reinforced polypropylene
 - b. Gaskets and O-rings: Viton
 - c. Handles, Rings, and Pins: Stainless Steel
 - 2. Temperature Rating: 0 to 150 deg F
 - 3. Pressure Rating:
 - a. 0 deg F: 100 psi
 - b. 70 deg F: 125 psi
 - c. 150 deg F: 70 psi
 - 4. Adapter:
 - a. 2" FNPT x Male quick connect adapter

- 5. Cap
 - a. 2" Lockable Type
- B. Manufacturers and Products:
 - 1. Banjo
 - a. Adapter: 200A with Viton gasket
 - b. Cap: 200CAP with Viton gasket
 - 2. Or equal

2.8 NON-METALLIC CORPORATION STOP WITH INJECTION QUILL

- A. Type: Complete assembly of corporation stop, injection quill, and safety chain, designed for use on process pipes 4" or larger. Construction shall be fully compatible with service conditions.
- B. Corporation Stop:
 - 1. Process Connection: 3/4" Male NPT.
 - 2. Rated 150 psi at 195 degrees F.
 - 3. ASTM D1784, Type I, Grade 1 chlorinated polyvinyl chloride body, ball, and stem, end entry.
 - 4. Threaded ends.
 - 5. Viton or Teflon seat.
 - 6. Viton O-rings and stem seals.
- C. Injection Quill:
 - 1. Process Connection: 1/2" female NPT.
 - 2. Dimensions:
 - a. Minimum 1/4" inside diameter.
 - b. Tapered injector tip, oriented to maximize chemical dispersion.
 - c. Select injection quill length such that tip of quill extends into process pipe between one-third and one-half of process pipe diameter. Minimum distance from pipe wall to injector tip shall be 2-inches.
 - 3. Materials:
 - a. Solution Tube Assembly: CPVC.
 - b. Ring, Sleeve and Capture Nut: PVDF.
 - 4. Minimum Pressure Rating: 150 psi.
- D. Safety Chain:
 - 1. Designed to prevent injection quill withdrawal before corporation stop is closed.
- E. Manufacturers and Products:
 - 1. Hydro Instruments, CS-075-CPVC.
 - 2. Neptune, CS2-75-PVC.
 - 3. Or Equal

2.9 STRAINERS

- A. PVC Y-STRAINER, 4" diameter and smaller
 - 1. Materials:
 - a. Body: PVC
 - b. Hex Cleanout Cap: PVC
 - c. Screen: PVC

- d. O-rings and gaskets: EPDM
- 2. 1/32" perforated screen
- 3. Minimum Pressure Rating: 150 psi
- 4. Size and connection as shown on the Drawings
- 5. Manufacturer:
 - a. Hayward Flow Control Systems
 - b. Or Equal

2.10 PRESSURE GAGES

- A. Type: Direct mounted, dial type pressure gage.
 - 1. Construction: Weatherproof,
 - a. Case:
 - 1) 4-inch diameter
 - 2) Material: cast aluminum with black finish or 304 stainless steel
 - 3) Flangeless
 - 4) Bottom 1/4-inch N.P.T. connection.
 - b. Ring: Chrome plated or stainless steel, close type.
 - c. Dial: White face, black numbers and graduations.
 - d. Window: Laminated safety glass or clear acrylic plastic.
 - e. Pointer: Micrometer type, black finish, red tip.
 - f. Movement: Stainless steel, rotary type, delrin sector and bushings.
 - g. Bourdon Tube: Seamless phosphor bronze, Grade A over-pressured and stressrelieved.
 - h. Socket and Tip: Forged brass, alloy steel and Type 316 stainless steel.
 - 2. Accuracy: 1 percent minimum.
 - 3. Range: Unless noted otherwise, provide gages with a range from 0 to 150 psi.
 - 4. Gage Cocks: Provide brass tee handle cock before each gage.
 - 5. Diaphragm Seals:
 - a. Provide diaphragm seals on all installations where called for on the Drawings, Details or Specifications
 - b. Diaphragm seals shall be thread-attached type with removable cleanout AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing and stainless steel lower housing.
 - c. The diaphragm shall be of continuous design to safely contain the process fluid in the event of gauge breakage or removal with the system under pressure.
 - d. The lower housing shall be provided with a tapped $\frac{1}{4}$ -inch NPT flushing connection and an M x F stainless steel needle valve.
 - 6. Provide snubber or pulsation dampener to protect gage.
 - 7. Reference ANSI B40.1 for Grade 1A gages.

B. Product and Manufacturer: Provide one of the following:

- 1. Weksler Instrument Company, Regal Gauges.
- 2. H.O. Trerice Company, 700 Series.
- 3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General
 - 1. Follow all manufacturer's directions
- B. Flexible Couplings (FC)
 - 1. Follow all manufacturer's directions
 - 2. No more than 1-inch gap between pipe ends
 - 3. Center flexible coupling in joint
 - 4. Tighten bolts in an alternating pattern to provide even tension around the coupling
 - 5. Tighten bolts to specified torque
 - 6. In buried installations, wrap coupling with plastic fastened to pipe to protect bolts and coupling from backfill material
- C. Flanged Coupling Adapters (FCA)
 - 1. Follow all manufacturer's directions
 - 2. No more than 1-inch gap between pipe plain end and flange face
 - 3. Tighten flange bolts prior to tightening coupling bolts
 - 4. Tighten bolts in an alternating pattern to provide even tension around the coupling
 - 5. Tighten bolts to specified torque
 - 6. In buried installations, wrap coupling with plastic fastened to pipe to protect bolts and coupling from backfill material
- D. Restrained Mechanical Joint Glands (RMJ)
 - 1. Follow all manufacturer's directions
 - 2. Tighten mechanical joint gland bolts before tightening restraint lugs
 - 3. Tighten restraint lugs until torque head breaks off
 - 4. In buried installations, wrap joint with plastic fastened to pipe to protect bolts and coupling from backfill material
- E. Pressure Gages
 - 1. Follow all manufacturer's directions
 - 2. Install diaphragm seals where process liquid would be detrimental to gage life (wastewater, chemical service, etc.)
 - 3. Check gage accuracy
- F. Orifice Plate
 - 1. Follow all manufacturer's directions.
 - 2. The unit shall be "self centering" within the bolt circle of the flanges. No alignment of the orifice shall be necessary.
 - 3. Lubricate & tighten bolts diametrically alternating to recommend flange torque.
 - 4. If the plate is not bi-directional, insure plate is installed with the arrow facing in the same direction as flow.

+ + END OF SECTION + +

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SECTION 15200

VALVES AND OPERATORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data sheets for make and model.
 - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - 3. Certificate of Compliance for: Butterfly valves; full compliance with AWWA C504.
- B. Tests and inspection data.
- C. Operation and Maintenance Data as specified in Section 01330, SUBMITTAL PROCEDURES.

1.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's directions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All valves shall be the same size as the pipe in which they are installed, unless specifically noted otherwise on the Drawings.
- B. All valves shall include all appurtenant parts (operators, chainwheels, handwheels, valve stems, floor stands, gear boxes, operating nut, etc.) for a complete operating valve.
 1. Valve shall be, as much as practical, fully factory assembled.
- C. All valves shall open by turning counter-clockwise. Maximum force required for operation shall be 40 lbs.
- D. Coatings and Linings:
 - 1. Provide factory-applied coatings as described herein.
 - 2. Where liquid epoxy coatings are specified, coatings shall conform to AWWA C550.
 - Field coat the exterior of all valve bodies with the same coating as is required for the adjacent pipe in Section 09900, PAINTING and Section 15100, PIPE AND FITTINGS, unless otherwise specified.
- E. Nuts, Bolts and Washers
 - 1. Hex Bolts: ASTM A320/A320M, Type 316 stainless steel, Grade B8, Class 2
 - 2. Nuts: ASTM F594, Type 316 stainless steel, Grade B8, Class 2
 - 3. Washers: Type 316 stainless steel

2.2 BALL VALVES

- A. BAV-03: Stainless Steel Ball Valve, 3 Inches and Smaller
 - 1. Service: Water, air.
 - 2. Features:
 - a. Threaded ends
 - b. Rated minimum 800 psig WOG (Water-Oil-Gas)
 - c. Stainless steel body
 - d. Polished stainless steel ball
 - e. Teflon seat
 - f. Stainless steel lever-type handle
 - 3. Manufacturers and Products:
 - a. Apollo, Type 76
 - b. Watts Type S-FBV-1
 - c. Or Equal

2.3 CHECK VALVES

- A. **CKV-15:** Slanting Disc Check Valve, 2 Inches to 24 Inches:
 - 1. Service: Wastewater.
 - 2. Features:
 - a. Slanting or tilting disc design
 - b. Off-center pivot
 - c. Body: ductile iron
 - d. Two-piece design
 - e. Disc: buna-n
 - f. Pivot pin and bushing: stainless steel,
 - g. ANSI B16.1, Class 250 flange
 - h. 300 psi working pressure rating,
 - i. Bottom mounted plunger,
 - j. Coatings and Linings:
 - 1) Fusion bonded epoxy, 12 mil minimum, for valve interior and exterior.
 - 3. Manufacturers and Products:
 - a. Val Matic; Surgebuster.
- B. CKV-10: Swing Check Valve (2" to 24")
 - 1. Service: Water, Sewage, Sludge and General Service.
 - 2. Style: Swing Check, Outside lever and weight type, Flanged-End Connections
 - 3. General: Valves shall comply with AWWA C508.
 - 4. Body: Valve body and cover shall be fabricated with cast iron conforming to ASTM A 126 with flanged ends conforming to ANSI B16.1.
 - 5. Disc: The valve disc shall be fabricated of cast iron or ductile iron and rubber faced.
 - 6. Seat and Rings: The valve seat and rings shall be fabricated of bronze conforming to ASTM B62 or B148 or of Buna-N.
 - 7. Disc Bolt: A307 Steel
 - 8. Hinge: Ductile Iron
 - 9. Hinge Pin: The hinge pin shall be fabricated of stainless steel.
 - 10. Coatings and Linings:
 - a. Liquid epoxy, 12 mil minimum, for valve interior and exterior.
 - b. For potable water applications, epoxy lining shall be NSF 61 approved.
 - 11. Manufacturer:
 - a. M&H; Style 159, Lever and Weight

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- b. Milliken; Figure 8001, Lever and Weight
- c. Or equal.

C.

2.4 GATE VALVES

- A. **GAV-10:** Resilient-Seated Gate Valve, 2 Inches to 24 Inches:
 - 1. Service: Water.
 - 2. Features:
 - a. Conforms to AWWA C509 (2") or AWWA C515 (3" to 24")
 - b. Iron body
 - c. Resilient seat, bronze mounted
 - d. Full port
 - e. Valve Ends:
 - 1) Mechanical joint ends for buried service, unless shown otherwise on drawings or valve schedule
 - 2) Flanged ends for exposed service
 - f. Non-rising stem
 - g. Actuator for Buried Service:
 - 1) Stem extension, as required, to bring operating nut to within 12" of ground surface.
 - 2) 2-inch operating nut
 - h. Actuator for Exposed Service:
 - 1) Handwheel
 - i. Design working water pressure: 250 psig
 - j. Coatings and Linings:
 - 1) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
 - 2) For potable water applications, epoxy lining shall be NSF 61 approved.
 - 3. Manufacturers and Products:
 - a. Mueller 2360 (2") or 2361 (3" to 24")
 - b. M&H Valve; AWWA C509 (2") or AWWA C515 (3" to 24").
 - c. Or Equal.

2.5 PLUG VALVES

- A. PLV-10: Eccentric Plug Valve, 3 Inches to 20 Inches:
 - 1. Service: Water, sewage.
 - 2. Features:
 - a. Non-lubricated type.
 - b. Drip-tight shutoff with pressure from either direction.
 - c. Features:
 - 1) Body: Cast iron Type ASTM A126 Class B.
 - 2) Plug:
 - a) Cast iron or 316 stainless steel.
 - b) Round or rectangular port of no less than 80 percent of connecting pipe area.
 - c) Coated with Buna-N, Chloroprene, or Hycar.
 - 3) Seats: Type 316 stainless steel or nickel.
 - 4) Stem:
 - a) Bearing: Self-lubricating stainless steel or reinforced Teflon.
 - b) Seal:

- 1. Multiple V-rings, U-cups, or O-rings of nitrile rubber.
- 2. Externally adjustable and re-packable without removing the bonnet or actuator from the valve under pressure.
- c) Provide upper and lower grit seals on stem.
- 5) Ends:
 - a) Exposed service: Flanged per ANSI B16.1 or grooved, as shown on Drawings or indicated on Valve Schedule.
 - b) Buried service: Mechanical joint per ANSI A21.11.
- 6) Actuators:
 - a) Exposed:
 - 1. Valves 3 Inches through 6 Inches: Wrench lever manual actuator.
 - 2. Valves 8 Inches through 20 Inches: Totally enclosed, geared, manual actuator with handwheel
 - b) Buried: 2-inch nut per Valve Schedule.
- 7) Coatings and Linings:
 - a) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
 - b) For potable water applications, epoxy lining shall be NSF 61 approved.
- d. Pressure Rating:
 - 1) Valves 3 Inches through 12 Inches: 175 psi.
 - 2) Valves 14 Inches through 20 Inches: 150 psi.
- 3. Manufacturers and Products:
 - a. DeZurik; Style PEC.
 - b. Pratt; Ballcentric.
 - c. Milliken; Millcentric.
 - d. Or Equal.

2.6 AIR RELIEF AND VACUUM VALVES

- A. **CARV-02:** Combination Air Release and Vacuum Valve, Sewer Service up to 150 psi:
 - 1. Service: Sewage.
 - 2. Features:
 - a. Combines the operating features of both an air vacuum valve and air release valve, allowing to vent or re-enter system freely in either direction.
 - b. Once air has been exhausted, uses sewer pressure to close valve. In CLOSED position, seat against resilient seat to prevent water leakage.
 - c. Single-body type
 - d. Rated 150 psi working pressure, orifice size by manufacturer (minimum orifice size 1/8-inch).
 - e. Cast iron, ductile iron, or semi-steel body, cover with stainless steel float and trim.
 - f. 2-inch inlet, 1-inch outlet.
 - g. Suitable for use with sewage.
 - h. Provide flushing connections for maintenance.
 - i. Maximum Valve Height: 20-inches
 - j. Provide vent hose or piping and route discharge line to nearest drain/structure.
 - k. Coatings and Linings:1) Liquid epoxy, 12 mil minimum, for valve interior and exterior.
 - 3. Manufacturers:
 - a. ARI D-025

2.7 OPERATORS:

- A. General:
 - 1. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.
 - 2. Operator self-locking type or equipped with self-locking device.
 - 3. Provide position indicator on all valves.
 - 4. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threaded steel reach rods with internally threaded bronze or ductile iron nut.
 - 5. Valve handles, wheels, etc. to be designed to accommodate a padlock.

B. Manual Operator:

- 1. Galvanized and painted handwheels.
- 2. Lever operators allowed on quarter-turn valves 8 inches and smaller.
- 3. Cranks on gear type operators.
- 4. For all valves above 5'-0" above adjacent working surface (finished floor or finished grade), provide chain wheel operator with tiebacks
- 5. For all exposed valves below adjacent working surface (finished floor or walkway), provide extension stem, floor stands, and other accessories to permit operation from 2'-6" above adjacent working surface.
- 6. For all buried valves 3" and larger, provide stem extension, valve bonnet, valve box and 2" AWWA operating nut such that operating nut is within 12" of adjacent finished grade.
 - a. For small-diameter buried valves, provide cross-shaped handle for operating with forked key.

2.8 VALVE SCHEDULE

- A. A Valve Schedule has been attached to this Specification and is incorporated herein by reference. Provide valves in accordance with Valve Schedule.
- B. For valves that are not referenced in Valve Schedule, provide the valve type called for on the Drawings.

2.9 PREPARATION

- A. Cleaning:
 - 1. Clean all mating faces of valve (threads, flange faces, etc.) prior to assembly.
 - 2. Remove all debris from valve body prior to assembly.
 - 3. Take extra care to clean mating faces of existing pipe and fittings which may have corrosion, dirt, debris and mineral build-up which should be removed for a proper fit.
- B. Apply joint compound, lubricant, etc. as recommended by valve manufacturer for proper installation prior to installation.
- C. Install valves in accordance with the following schedule and as noted on the Drawings:

2.10 INSTALLATION

A. Install valves per manufacturer's recommendations.

- B. Install valves so handles operate from fully open to fully closed without encountering obstructions.
- C. Install valves in location and orientation for easy access for routine operation and maintenance. Access should be such that an operator can operate the valve by reaching a handle, chain, etc. at a height between 2'-6" and 5'-0" above adjacent work surface (for buried valves, this is accomplished with a t-handle wrench and the operating nut being within 12" of finished grade).
- D. Install plug valves with the seat side as indicated on the drawings. If manufacturer's recommendations differ from indicated seat direction on the drawings, or if no seat side is indicated, install plug valves with seat side as recommended by the manufacturer after obtaining approval from the ENGINEER.

2.11 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air release and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for all relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the ENGINEER.

2.12 SUPPLEMENTS

- A. The following supplements are attached to this Specification section and incorporated herein by reference:
 - 1. 15200 VS Valve Schedule

+ + END OF SECTION + +

SECTION 15200 VS

VALVE SCHEDULE

1.1 DESCRIPTION

- A. General:
 - 1. This schedule is provided for the convenience of the CONTRACTOR. Some valves may be shown on the drawings, but not listed here.
 - 2. Valve specifications are given in Section 15200, Valves and Operators.
- B. Valve Tag Number:
 - 1. Tag numbers are as noted in the Drawings.
- C. Valve Type:
 - 1. Valve types are as described in 15200, Valves and Operators
- D. Valve Ends:
 - 1. FLG Flanged
 - 2. GRV Grooved End
 - 3. LUG Lugged
 - 4. MJ Mechanical Joint
 - a. Where the surrounding piping system is installed with restrained joints, MJ valves shall be installed using RMJ (restrained mechanical joint) glands per 15120, Piping Specialties.
 - 5. SLV Solvent Welded Socket
 - 6. SLD Soldered Socket
 - 7. THR Threaded
 - 8. W Wafer
- E. Installation Codes
 - 1. Ex Exposed
 - 2. Un Underground
- F. Valve Actuators, as described in 15200, Valves and Operators
 - 1. HW Handwheel
 - 2. L Lever
 - 3. N 2" Nut
 - 4. N/A Not Applicable

1.2 VALVE SCHEDULE

VALVE TAG NUMBER	VALVE TYPE	ENDS	DIAMETER	INSTALLATION	ACTUATOR
BAV-111	BAV-03	THR	2	Ex	L
ARV-111	CARV-02	THR	2	Ex	N/A
CKV-111	CKV-15	FLG	10	Ex	N/A
PLV-111	PLV-10	FLG	10	Ex	HW
BAV-112	BAV-03	THR	1/2	Ex	L

VALVE TAG					
NUMBER	VALVE TYPE	ENDS	DIAMETER	INSTALLATION	ACTUATOR
BAV-113	BAV-03	THR	1/2	Ex	L
BAV-211	BAV-03	THR	2	Ex	L
ARV-211	CARV-02	THR	2	Ex	N/A
CKV-211	CKV-10	FLG	10	Ex	N/A
PLV-211	PLV-10	FLG	10	Ex	HW
BAV-212	BAV-03	THR	1/2	Ex	L
BAV-213	BAV-03	THR	1/2	Ex	L
BAV-331	BAV-03	THR	2	Ex	L
ARV-311	CARV-02	THR	2	Ex	N/A
CKV-311	CKV-10	FLG	10	Ex	N/A
PLV-311	PLV-10	FLG	10	Ex	HW

+ + END OF SECTION + +

SECTION 15812

CORROSION RESISTANT DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install a complete corrosion resistant duct system with all appurtenances required for proper operation.
 - 2. Field verify locations, sizes and elevations for all connections, supports, dampers, test ports, and flexible connections.
 - 3. Items to be furnished and installed under this Section include, but are not limited to the following:
 - a. Fiberglass Reinforced Plastic (FRP) duct, fittings, supports and accessories.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Engage a single firm, with undivided responsibility for performance and other requirements and components of the corrosion resistant ductwork and accessories.
 - 2. Engage a firm which can demonstrate successful experience in the fabrication and erection of corrosion resistant ductwork systems of at least five systems of the scope and type similar to the required Work.
- B. Installer's Qualifications:
 - 1. Engage a single installer regularly engaged in FRP ductwork installation and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications of installers to ENGINEER.
 - 2. Engage a single installer for the entire corrosion resistant ductwork system with undivided responsibility for performance and other requirements.
- C. Requirements of Regulatory Agencies: Comply with the applicable provisions of regulatory agencies below and others having jurisdiction.
 - 1. Underwriters' Laboratories, Incorporated (UL).
 - 2. National Fire Protection Association (NFPA).
- D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
 - 2. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 - a. HVAC Duct Construction Standards.
 - b. Thermoset FRP Duct Construction Manual.
 - c. Fire Damper Guide for Air Handling Systems.

- 3. ASTM A 774, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- 4. ASTM A 778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- 5. ASTM C 581-655 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures.
- 6. ASTM D 2310, Classification for Machine-Made Reinforced Thermosetting Resin Pipe.
- 7. ASTM D 2563, Practice for Classifying Visual Defects In Glass Reinforced Plastic Laminate Parts.
- 8. ASTM D 2583, Test Method for Indentation Hardness of Plastics by Means of a Barcol Impressor.
- 9. ASTM D 2996, Specification for Filament-Wound Reinforced Thermosetting Resin Pipe.
- 10. ASTM D 4024, Specification for Machine Made Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Flanges.
- 11. ASTM D 4097, Specification for Contact Molded Glass Fiber Reinforced Thermoset Chemical Resistant Tank.
- 12. Standards of Society of the Plastic Industry, PS15-69, Custom Contact Molded Reinforced-Polyester Chemical Resistant Process Equipment.
- 13. NFPA 91, Blowers and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
- 14. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
- 15. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
- 16. Gilbert Building Code.
- E. Field Measurements: Take field measurements where required prior to installation to ensure proper fitting of Work.
- F. Provide certification that all hardware and appurtenances including screws, bolts, nuts and other support and expansion joint hardware shall be Type 316L stainless steel.

1.3 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. 1/4-inch scale duct layouts, dimensioned to show length of duct runs, duct sizes, support design and spacing and expansion provisions.
 - 2. Details of construction, including condensate sumps and condensate eductor stations.
 - 3. Details of installation, including tie-in of support systems to building.
 - 4. Manufacturer's literature, illustrations, specifications and engineering data.
 - 5. Flexible connections.
 - 6. Other technical data related to the specified material and equipment as requested by ENGINEER.
 - 7. Duct sealants.
 - 8. Specifications for FRP resins and reinforcing material used.
 - 9. Submit color samples of pigmented gel coat to ENGINEER for selection.
 - 10. Specifications for fire-retardant epoxy FRP ductwork coating and reinforcing material used.
 - 11. Submit FRP round duct schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.
 - 12. Submit FRP rectangular duct schedule with laminate construction, sizes, thickness, vacuum pressure, weight per foot pressure, spans, joint type and flange data.

13. Gasket material.

14. Deviations from Contract Documents.

- B. Test Reports: Submit volume damper leakage tests from an AMCA approved testing laboratory.
- C. Submit a letter stating that the proposed resins proposed in the fabrication of the FRP ductwork will provide satisfactory performance under the specified service conditions or a corrosion resistance chart indicating same.
- D. Manufacturer's calculations indicating the laminate sequence meets the proposed pressure and vacuum classification and deflection criteria indicated below.
- E. Tabulation in check list forms to indicate compliance with ASTM D 2563 Table I, Level II visual acceptance levels.
- F. Calculations for structural support loading and design, and dimensions or materials related to the specified product as requested by ENGINEER.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store equipment and materials so as to keep free from moisture, damage, and deterioration.
- B. Manufacturer shall protect all flange faces and the more fragile appurtenances of the sub-assemblies, with padding between pieces in order to prevent one piece from impacting with another, and by crating or other means for shipment.
- C. Duct sub-assemblies shall be unloaded with care and stored in a location where they will be free from damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and affect the service life of the duct or equipment.
- D. Large sub-assemblies shall be supported during unloading to prevent excessive deflection and overstressing.
- E. Corrosion resistant ductwork shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any corrosion resistant ductwork during transportation.

1.5 GENERAL REQUIREMENTS

A. The Drawings show general arrangement and extent of Work to be done, but the exact location and arrangement of all connections, fittings, dampers, supports and expansion joints shall be determined as the Work progresses, to conform in the best possible manner with its surroundings. The exact location of all parts of the Work must be governed by the general building plans and the actual building conditions. Piping, equipment, ducts, etc. found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc. shall be located to clear such obstructions. Connections shown on the Drawings to the various units are intended as an indication only. The actual connections shall be made and to best suit each particular case, provide for expansion, circulation and minimize the amount of space required.

- B. Drawings do not show all offsets, fittings, accessories and details which may be required. Examine all the Contract Documents for conditions which may affect the installation of the Work, and shall arrange the Work accordingly. Provide all required items to complete the systems to the extent required by the Contract Documents.
- C. If piping or ductwork can be run to better advantage, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval by the ENGINEER.
- D. Resin cure for all FRP ductwork shall be checked by Barcol hardness and acetone tests. Hardness shall be within 90 percent of resin manufacturer's specification. Barcol test shall be required for inside and outside surfaces of all fiberglass fabrications in accordance with ASTM D 2583. Acetone test shall be conducted on interior surfaces of ducts.
- E. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.
- F. A thorough inspection of each piece of ductwork will be conducted upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricator's personnel (not a sales representative).

1.6 DUCTWORK FABRICATION

A. FRP ductwork and accessories shall be fabricated in a heated and well ventilated structure protected from weather and temperature extremes. Entire fabrication, curing and assembly process of any piece of FRP equipment shall occur under appropriate temperature and humidity conditions as recommended by the FRP fabricator and resin provider. Submit an affidavit certifying that all FRP equipment shall be fabricated, cured and assembled as described in this Section.

PART 2 - PRODUCTS

2.1 DESIGN CONDITIONS

- A. Maximum allowable deflection for any size of corrosion resistant ductwork shall be 1/4-inch between supports and for any side of duct under worse case operating conditions.
- B. Tolerances:
 - 1. Out-of-roundness of duct shall be limited to $\pm 1/8$ -inch or \pm one percent of duct inside diameter, whichever is greater for duct sizes 8-inch diameter and greater.
 - 2. Length of all flange pipe sections shall not vary more than $\pm 1/8$ -inch at 70°F.
 - 3. All unflanged duct shall be square on the ends in relation to the pipe axis and $\pm 1/8$ inch up to and including 24-inch diameter and $\pm 3/16$ -inch for all diameters greater than 24-inch.
 - 4. Fittings:
 - a. The tolerance on angles of all fittings shall be \pm one degree, up to and including 24-inch diameter and $\pm 1/2$ degree for 30-inch diameter and above.
 - 5. Flanges:

- a. Flange faces shall be perpendicular to the axis of the duct within 1/2 degree.
- b. Flange faces shall be flat to within $\pm 1/32$ -inch, up to and including 18-inch diameter and flat within $\pm 1/16$ -inch for 20-inch diameter and larger.
- c. Provide custom filler pieces as required to mate flanges squarely.

2.2 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK AND ACCESSORIES

- A. The fiberglass reinforced plastic duct system shall be specifically designed, constructed, and installed as shown on the Drawings for the following minimum conditions.
 - 1. Ambient Air Temperature: 20°F to 125°F.
 - 2. Corrosion resistance to hydrogen sulfide, chlorine, mercaptans and other gases commonly encountered in wastewater treatment plants.
 - 3. Vacuum Service: Minimum 10-inch water gage.
 - 4. Pressure Service: 60-inch water gage.
- B. Fiberglass reinforced plastic (FRP) ductwork shall be of filament wound or hand lay-up construction.
 - 1. FRP ductwork shall be of flame retardant material inside and outside in accordance with NFPA-91.
 - 2. Flame spread rating shall be 25 or less.
 - 3. All ducts shall be installed in accordance with manufacturer's recommendations.
- C. FRP Duct Construction:
 - 1. Duct shall meet the applicable requirements of ASTM D 2310, Type 1, Grade 1 or 2, with Class "E" liner, 20 mils minimum thickness, and be manufactured in accordance with ASTM D 2996.
 - 2. Flanges and bolt drilling circles and diameters shall conform to NBS PS 15-69, except that flanges shall be a minimum of 0.75-inches thick. Ductwork shall be fabricated of vinylester resin as specified herein.
 - 3. All interior and exterior surfaces of ducts, dampers and FRP accessories shall be coated with a minimum 90 percent resin, five percent antimony trioxide and nexus veil reinforcement.
 - 4. Exterior surfaces shall have a factory applied paraffinated pigmented gel coat finish with ultra-violet inhibitors.
 - 5. Ductwork shall be in accordance with SMACNA Thermoset FRP Duct Construction Manual.
- D. Laminates shall consist of a 20 mil chemical resistant liner with a synthetic surfacing veil embedded in a resin rich surface. The corrosion barrier shall be a minimum of 100 mils and include no less than two layers of 1-1/2 ounce mat with 25 percent glass and 75 percent resin content. The structural layer shall be of sufficient thickness to meet the minimum thickness requirements specified. The exposed exterior surface layer shall be resin rich appertured nexus veil not less than 20 mils thick. Exposed outside finish shall have a parrafinated pigmented gel coat finish with an ultra violet inhibitor. Provide standard and custom color chart for color selection. The composition specified for the inner surface and interior layer is intended to achieve optimum chemical resistance.
- E. Resins used in the laminate shall be premium corrosion resistant and fire retardant brominated biphenol-A vinylester resins such as Dow Chemical Company, Derakane 510A with five percent antimony trioxide, Reichhold Dion 9300 FR with five percent Antimony Trioxide or Ashland Chemical Company, Hetron FR 992 with three percent antimony

trioxide or equal. The synthetic surfacing veil shall be Veil-Nexus 1012 (apertured) as manufactured by Burlington Industries.

- F. All cut edges shall be sealed with a resin coating of the same resin as used in the fabrication. The resin shall contain paraffin.
- G. Product and Manufacturer: Provide one of the following:
 - 1. Ershigs Incorporated.
 - 2. Spunstrand.
 - 3. Belco Manufacturing Co.
 - 4. Smith Fibercast
 - 5. Daniel Mechanical
 - 6. Or equal.
- H. Fittings and Joints: All fittings such as elbows, laterals, tees, and reducers shall be of the same resin and equal or superior in strength to the adjacent duct section and shall have the same internal diameter as the adjacent duct. Exposed round duct joints shall be flanged, butt wrapped or bell and spigot joints. Exposed bell and spigot joints shall be sealed with a standard butt joint overlay in accordance with PS 15 69. Buried round duct joints shall be bell and spigot joints with a single EPDM or Isoprene o-ring. All interior surfaces of joint to be coated with a paraffinated resin-rich gel coat.
- I. Total width of overlay for butt-wrap joints shall be not less than 6-inches for diameters from 8-inches up to and including 30-inches, 36-inch and larger shall be not less than 10-inches.
- J. Standard Elbows:
 - 1. Standard elbow centerline radius shall be equal to a minimum of 1-1/2 times the diameter.
 - 2. Standard elbows up to 24-inch diameter shall be smooth radius molded elbows. Standard elbows 30-inch diameter and greater may be mitered sections as specified below.
 - 3. 0 to 44 degree elbows shall contain one mitered joint and two sections. 45 to 80 degree elbows shall have a minimum of two mitered joints and three sections. Elbows greater than 80 degrees shall have a minimum of four mitered joints and five sections.
- K. Maximum allowable deflection for any size ductwork shall be 1/2-inch between supports and for any side of duct under worse case operating conditions. Ductwork supports shown on the Drawings are a minimum number required. Additional sup-ports shall be provided as required to meet the specifications. Additional supports shall be the same as adjacent support details.
- L. Tolerances:
 - 1. Out-of-roundness of duct shall be limited to $\pm 1/8$ -inch or \pm one percent of duct inside diameter; whichever is greater for duct sizes 8-inch diameter and greater.
 - 2. Length of all flange pipe sections shall not vary more than $\pm 1/8$ -inch at 70°F.
 - 3. All unflanged duct shall be square on the ends in relation to the pipe axis and $\pm 1/8$ inch up to and including 24-inch diameter and $\pm 3/16$ -inch for all diameters greater than 24-inch.
 - 4. Fittings:

- a. The tolerance on angles of all fittings shall be \pm one degree, up to and including 24-inch diameter and $\pm 1/2$ degree for 30-inch diameter and above.
- 5. Flanges:
 - a. Flange faces shall be perpendicular to the axis of the duct within 1/2 degree.
 - b. Flange faces shall be flat to within $\pm 1/32$ -inch, up to and including 18-inch diameter and flat within $\pm 1/16$ -inch for 20-inch diameter and larger.
 - c. Provide custom filler pieces as required to mate flanges squarely.
- M. Calculations for wall thickness determination shall be based on the structural fiberglass reinforced wall only. FRP ductwork shall be designed using a safety factor of ten to one for pressure and five to one for vacuum service. Ductwork shall be designed by manufacturer to resist all system forces and meet specified deflection requirements, but in no case shall FRP be less than the thickness listed in the table below. For buried pipe, wall thicknesses shall be based on depth of bury, trench condition, backfill loads and traffic loads, but in no case shall FRP be less than the thickness in the table below.

M	MINIMUM FRP ROUND DUCT DIMENSION AND PERFORMANCE SCHEDULE							
ID (in.)	Structural Wall Thickness (min.) (in.)	Minimum Allowable Vacuum ¹ (in. of water)	Min. Allowable Pressure ¹ (in. of) water)	Flange Thickness (in.)	Bolt Circle Diameter (in.)	Bolt Size and No. of Bolt Holes	Maximum Allowable Span ² (ft)	
2	0.125	405	705	3/4	4-3/4	5/16 /4	9	
3	0.125	405	500	3/4	6	5/16 /4	11	
4	0.125	210	410	3/4	7-1/2	5/16 /8	12	
6	0.125	64	350	3/4	9-1/2	5/16 /8	15	
8	0.187	182	693	3/4	11-3/4	5/16 /8	17	
10	0.187	94	693	3/4	14-1/4	5/16 /12	19	
12	0.187	55	693	3/4	17	5/16 /12	20	
14	0.250	91	693	3/4	18-3/4	1 /12	20	
16	0.250	61	693	3/4	21-1/4	1 /16	20	
18	0.250	44	693	3/4	22-3/4	1-1/8 /16	20	
20	0.250	33	693	3/4	25	1-1/8 /20	20	
24	0.250	18	693	3/4	28-1/2	1-1/4 /20	20	
30	0.312	20	693	3/4	36	1-1/4 /28	20	
36	0.375	23	693	3/4	42-3/4	1-1/2 /32	20	
42	0.375	15	693	3/4	49-1/2	1-1/2 /36	20	
48	0.437	15	693	3/4	56	1-1/2 /44	20	
54	0.437	15	693	3/4	62-3/4	1-3/4 /44	20	
60	0.437	15	693	3/4	69-1/4	1-3/4 /52	20	
96	0.750	15	693	1	(3)	(3)	20	

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- 1. NOTES:
 - a. These ratings were suitable for use up to 180°F (82.2°C) in pressure service and ambient atmospheric temperatures on vacuum service. For ratings at high temperatures, consult manufacturer.
 - b. Based on 1/4-inch span deflection on air conveying systems at 180°F maximum. Also, based on duct systems not subjected to more severe service conditions such as additional weight caused by liquid or solids build-up in duct system, effects of wind loading on outdoor installations, or possible failure of intermediate duct hangers. Provide as a minimum, the number of duct supports as shown on the Drawings. Support continuous at all non-flanged pipe end connections.
 - c. Submit for approval by the ENGINEER.
- N. All connections to expansion joints, butterfly dampers, tanks, or other equipment shall be flanged. Duct flanges shall conform to the FRP Duct Schedule, above. Gaskets shall be EPDM. Bolts, nuts and washers shall be Type 316 stainless steel. Flanges shall be hand laid up to PS 15-69 thickness, except that minimum thickness shall be 3/4-inch. The flange shall be hand laid-up anchored to a waxed table to achieve the flatness tolerance outlined in Paragraph 2.4.M.5., above. The face shall be textured for use with full-face gaskets, as specified above, 1/8-inch minimum thickness. Pipe flange drilling shall be NBS PS 16-69. All FRP duct and pipe flange bolt holes shall be back spot faced for a washer seat. All flange bolts shall be torqued to values as recommended by manufacturer.
- O. Hangers:
 - 1. All ductwork shall be supported from trapeze type hangers. Hanger rods shall be minimum 3/8-inch for all ducts with half perimeter up to 72-inches, and 1/2-inch diameter for all ducts with half perimeter larger than 72-inches. A pair of rods shall be provided at each duct support point.
 - 2. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances located in corrosive areas shall be Type 316 stainless steel.
 - 3. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.
 - 4. Supports shall be provided at each fitting.
- P. There shall be not less than a 1/4-inch buildup of FRP over the duct at each support. Each support shall be furnished with a 1/8-inch thick teflon sheet to shield the duct from the support. The teflon sheet shall extend beyond the support plate at least 1/2-inch on all sides.
- Q. Furnish flexible connectors, as shown on the Drawings and details, with anchors and guides.
 - 1. Product and Manufacturer: Provide one of the following:
 - a. Holz Rubber Company.
 - b. Pathway Bellows Incorporated.
 - c. Mercer Rubber Company.
 - d. Or equal.
- R. Round Fiberglass Reinforced Plastic Dampers:
 - 1. Furnish and install Balancing, Isolation or Backdraft Dampers where shown on the Drawings as detailed herein.

- 2. Damper frame shall be of one-piece construction with a resin rich interior corrosion barrier minimum of 100 mils.
- 3. Structural lay-up shall consist of alternate layers of chopped strand mat and woven roving conforming with ASME/ANSI RTP-1 and ASTM D3982.
- 4. Blade edge seals shall be provided on all Isolation Dampers, and shall be of the "Double Tadpole" design. Seal to be mechanically fastened to the blade perimeter using FRP retainer and fasteners. Seal will be continuous and shall not break at axle. Blade seal shall not be compressed against a blade stop. Blade seal shall be of the wiper design not a compression type. Seal and cored blade combination installed in damper frame shall meet or exceed 2.90 cfm leakage @ 26" of static pressure with bearings installed both upstream and downstream. Damper assembly to be leak tested in both directions.
- 5. Provide AMCA Certification AMCA label for Air Leakage in accordance to AMCA standard 511 on damper.
- 6. Rating Conditions:
 - a. Velocity Through Damper: 3,000 fpm.
 - b. Pressure Rating: 60 inches water column.
 - c. Maximum Allowable Leakage: Three cfm per square foot at 10-inch w.g. pressure.
- 7. Materials:
 - a. Resin: Fire retardant vinyl ester with MEKP cure system
 - b. Bearings: Teflon.
 - c. Blade: fire-retardant vinyl ester FRP
 - d. Frame: fire-retardant vinyl ester FRP
 - e. Axles: Type 316L stainless steel rods, full length of damper size as shown on the Drawings.
 - f. Handle: Type 316L stainless steel.
 - g. Pins: Type 316L stainless steel.
 - h. Bushings: Teflon.
 - i. Hardware: Hastelloy-C.
 - j. Flanged ends with bolt holes drilled to match connecting ductwork.
 - k. Blade Stops: FRP angles with full circumference EPDM seal.
- 8. Dimensions: As required.
- 9. Leakage test and performance data from an AMCA approved testing laboratory shall be submitted.
- 10. Actuators:
 - a. Manual: unless shown otherwise on the drawings or listed herein, provide manual operation with 316 SST locking quadrant hand lever for balancing dampers. Any balancing dampers larger than 20-inch diameter shall have a worm gear.
 - b. Electric:
 - Motorized Isoloation Dampers with electrical actuators shown in the Drawings or listed below shall have electric actuators with local and remote control (automation by Others).
 - Electric actuators shall be provided by the supplier of the dampers, fully integrated and factory-tested with the damper to ensure proper selection, sizing and operability of the damper.
 - a) Provide two position, open-close actuation
 - b) 240 V
 - c) Close-coupled
 - d) Rated torque of the actuator shall exceed the damper required closing torque by a minimum safety factor of 1.5.
- 11. Product and Manufacturer:

- a. Manual Balancing Dampers:
 - 1) Belco Model 202
 - 2) Engineered Composite Systems XO1
 - 3) Swartwout Model 911
- b. Motorized Isolation Dampers:
 - 1) Belco Model 203
 - 2) Engineered Composite Systems XO2
 - 3) Or Equal
- c. Backdraft Dampers:
 - 1) Belco Model 401
 - 2) Engineered Composite Systems ECS BD-01
 - 3) Or Equal
- S. Flexible Bellows:
 - 1. Provide flexible expansion bellows joints where shown on the Drawings. Joints shall provide compensations for misalignment, absorb expansion and contraction, and isolate vibration and shock.
 - 2. Bellows shall be pure white virgin PTFE isostatic resin conforming to ASTM D1457, without pigments, lubricants, hydrocarbons or additives of any kind.
 - 3. Flange allow and reinforcing rings shall conform to ASTM 60-45-12. Composite flanges and reinforcing rings shall have a nominal tensile strength of of 50,000 psi per ASTM D638.
 - 4. All flanges and bands shall be coated with an electrostatically applied epoxy.
 - 5. All materials shall be zinc phosphate treated or have Pureflex Durcor-62 composites.
 - 6. Flange diameter shall conform to ANSI B16.5. Bolt holes shall be tapped.
 - 7. Product:
 - a. Ethylene Flexijoint PTFE Expansion Joint 36-FIPA-4
 - b. Or Équal
- T. FRP Transition Pieces:
 - 1. Provide transition pieces as shown on Drawings and herein specified.
 - 2. Construction:
 - a. 1/4-inch minimum thickness FRP sheets and thickness not to be less than thickness of adjacent FRP ducting.
 - b. All exposed hardware shall be Hastelloy-C screws, nuts, bolts and washers, as required.
 - c. Flanges shall be designed as required to connect to fan or ductwork.
 - 3. Pressure Classification: Manufacturer shall design transition pieces so that they shall be free from buckling, pulsing, warp age, sagging and to the following pressure ratings:
 - a. Vacuum Service: 10-inchs water gage, minimum.
 - b. Pressure Service: 20-inches water gage, minimum.
- U. Install round pipe sleeves and mechanical seals for all round duct wall and floor penetrations as herein specified:
 - a. Non-metallic, non-corrosive, high-density polyethylene construction.
 - b. Integral formed water stop and anchor plate.
 - c. Sleeve and mechanical seal shall be manufactured by Thunderline Link-Seal or equal.
- V. Install end caps on the end of each duct branch and provide a bolted duct access door as shown on the drawings.

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- W. Tools, Spare Parts and Maintenance Materials:
 - 1. The duct system shall be furnished with the following:
 - a. Two sets of special tools required to maintain and repair the system.
 - b. All materials in kit form to make or repair joints. Kits shall be in a number sufficient to repair ten percent of the exposed joints.
 - c. Names and addresses of all manufacturers of: Fiberglass reinforcements, resins, hardeners and components used to repair and maintain FRP duct system.
 - 2. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location, until transferred to the OWNER at the conclusion of the Project.

2.3 SURFACE PREPARATION AND PAINTING

- A. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.
- B. Certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09900, Painting.
- C. All FRP exterior surfaces of pipe duct and fittings shall be painted with an approved epoxy paint system conforming to the requirements of Section 09900, Painting.
- D. Ductwork shall be factory painted in accordance with paint system specified below.
- E. Provide a sample FRP panel not less than two square feet which shall be painted and allowed to dry for not less than 48 hours and then be checked for paint adhesion by the paint system manufacturer and submitted to the ENGINEER.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all ductwork in accordance with manufacturer's recommendations and instructions and as shown on the Drawings and specified.
- B. All ductwork shall conform accurately to the dimensions shown on the Drawings, the ducts shall be straight and smooth inside with joints neatly finished; ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.
- C. Elbows shall have a minimum centerline radius of 1-1/2 times the width of the duct. Turning vanes shall be provided at all square elbows. Turning vanes shall be double wall and shall be quiet and free from vibration when the system is in operation.
- D. Test holes shall be provided at each duct connection at all air moving equipment. Test holes shall be factory installed with no exposed fibers.
- E. Provide manual volume dampers where shown on the Drawings and as required to facilitate accurate volume control. Damper blades shall be reinforced to prevent vibration.

- F. Fire dampers shall be provided and installed where shown on the Drawings and where required by U.L. and shall be approved by the Mesa Building Code and in accordance with the requirements of the NFPA.
- G. Provide access doors for all dampers for inspection and maintenance.
- H. Install all ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.
- I. All expansion joints and ducts shall be suitably supported at each end by support guides within 12-inches of joint.
- J. All ducts at flexible connections with fans shall be supported at free end within 12- inches of flexible connection.
- K. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where required.
- L. All low points in the corrosion resistant ductwork shall be provided with 1-1/4-inch drains, unless otherwise noted. All drains shall be provided with a "P trap", unless otherwise noted. Above grade ductwork drains shall be piped to the nearest wastewater channel. Below grade condensate sumps shall be piped to the adjacent condensate eductor as shown on the Drawings.
- M. All buried ductwork shall be bedded in sand. Sand shall extend a minimum of 6-inches below the bottom of the duct, 12-inches minimum on the sides of the duct, and shall be flush with the top of the duct, unless otherwise noted. Backfill with compacted selected fill in accordance with Section 15051, Buried Piping Installation.
- N. Receive field assistance, if required, from the corrosion resistant ductwork manufacturer to ensure that the corrosion resistant ductwork is installed and jointed correctly.
- O. All fittings, valves, expansion joints, specials and similar items shall be supported within 12-inches of the joint, unless otherwise noted.

3.2 ADJUSTMENT

- A. Set volume control devices for approximate positions in preparation for final testing and balancing.
- B. Start fan system and check for excessive leaks and vibration and correct.

3.3 CLEANING

- A. Remove all loose materials and obstructions from interior of ducts.
- B. Remove debris and waste materials resulting from installation.

3.4 INSPECTION OF DUCTWORK

A. ENGINEER reserves the right to reject any and all equipment found to have the following: blisters, chips, crazing, exposed glass, dry cracks, burned areas, dry spots,

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foreign matter, or entrapped air at the laminate surfaces which do not satisfy the tolerances specified in ASTM D 2563, Table I Acceptance Level II inside and outside surfaces. Unacceptable Barcol hardness and acetone sensitivity shall also be cause for rejection.

+ + END OF SECTION + +

TESTING OF PRESSURE PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide all labor, materials, equipment, and incidentals as shown on the Drawings required to perform the pressure testing of piping systems.

1.2 SUBMITTALS

- A. Testing Plan: Submit prior to testing and include at least the information that follows.
 - a. Testing dates
 - b. Piping systems and section(s) to be tested
 - c. Test type
 - d. Method of isolation
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested
- B. Certifications of Calibration: Testing equipment
- C. Certified Test Report

1.3 REFERENCE

A. Reference Section 15100 PS – Pipe Schedule for test pressure.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

- 3.1 NOTIFICATION
 - A. Notify ENGINEER in writing 5 days in advance of testing. Perform testing in presence of ENGINEER.

3.2 PRESSURE TESTING

- A. General:
 - 1. Complete installation of piping system, including all thrust restraint, prior to pressure testing.
 - a. If thrust blocking is specified, wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
 - 2. Prior to test, remove and replace with pipe spools or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
 - 3. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.

- 4. Piping to be Pressure Tested and Test Pressure: as indicated on Piping Schedule.
- B. Hydrostatic Testing (Pipe Other than PSDS HDPE2):
 - 1. Testing Fluid: Clean, potable water.
 - 2. Pipeline Protection:
 - a. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 - b. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 - 3. Exposed Piping:
 - a. Perform testing on insulated piping prior to application of insulation
 - b. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
 - c. Examine joints and connections for leakage.
 - 1) Correct visible leakage and retest as specified.
 - 2) Empty pipe of water prior to final cleaning or disinfection.
 - 4. Buried Piping:
 - a. Test after backfilling has been completed.
 - b. Expel air from piping system during filling.
 - c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - d. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
 - e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
 - f. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.
- g. Correct leakage greater than allowable, and retest as specified.
- C. Low-Pressure Testing with Air:
 - 1. Perform only where specifically allowed or called for in Pipe Schedule.
 - 2. Testing shall be limited to pipes less than 30-inches in diameter.
 - 3. Use Oil-free, dry air.
 - 4. Procedure:
 - a. Clean and wet the line to be tested.
 - b. Plug all pipe outlets with suitable test plugs and securely brace each plug.
 - c. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
 - d. Check exposed pipe and plugs for leakage by coating with a soap solution. If any failures are observed, bleed off air and make necessary repairs.
 - e. After internal pressure of 4.0 psig is obtained, allow at least two minutes for internal air temperature to stabilize, adding only the amount of air required to maintain pressure.
 - f. After the two-minute period, disconnect the air supply.

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g. When the pressure decreases to 3.5 psig, start timing. Determine the time in seconds that is required for the pressure to fall from 3.5 psig to 2.5 psig. This test duration time must be equal to or greater than the minimum test duration time obtained as outlined below.

TABLE 15990-A	
MINIMUM TEST DURATION TIMES FOR LOW-PRESSURE AIR TESTING	
NOMINAL PIPE SIZE, INCHES	TIME, SECONDS
10	283
15	425

- 5. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- 6. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.3 PIPE PRESSURE TESTING LOG

- A. All pressure tests shall be witnessed by ENGINEER. CONTRACTOR shall keep a pipe pressure testing log to document the pressure testing and ENGINEER's approval of such.
 - 1. Specific details of the contents and format pipe pressure testing log shall be determined by the CONTRACTOR and approved by the ENGINEER.
 - 2. At a minimum, pipe pressure testing log shall record, on a daily basis for any day when pipe pressure testing is performed:
 - a. Test Report Documentation:
 - 1) Test date
 - 2) Description and identification of piping tested
 - 3) Test fluid
 - 4) Test pressure
 - 5) Remarks, including:
 - a) Leaks (type, location)
 - b) Repair/replacement performed to remedy excessive leakage
 - 3. Pipe pressure testing log shall be kept on-site. Pipe pressure testing log shall be signed on a daily basis, for any day when pipe pressure testing log work is performed, by the supervisor of the CONTRACTOR's field crew and by the ENGINEER.
 - 4. Any piping system which was pressure tested, but which was not recorded in the pipe pressure testing log, shall be re-tested at the ENGINEER's discretion.

DIVISION 16

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GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to complete the electrical Work.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that shall be installed with the formwork, walls, partitions, ceilings and panels.
 - 2. CONTRACTOR shall be responsible for the installation of all conduits, inserts and other items to be embedded in the concrete, or built into walls, partitions, ceilings or panels constructed by other contractors. CONTRACTOR shall provide other contractors with detailed plans or sketches of the location of said conduits and other built-in items as may be required. CONTRACTOR shall keep himself fully informed of the construction where conduits and other built-in items are to be installed. CONTRACTOR shall install said conduits and other built-in items in such a manner and within such time periods as will not unnecessarily delay the Work of the other contractors.
- C. General:
 - 1. Interpretation of Drawings:
 - a. Dimensions shown on the Drawings that are related to equipment are based on one manufacturer's equipment. Coordinate the dimensions of the equipment furnished with the space allocated for that equipment.
 - b. The Drawings show the principal elements of the electrical installation. They are not intended as detailed working drawings for the electrical Work but as a complement to the Specifications to clarify the principal features of the electrical systems.
 - c. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
- D. Related Work Specified Elsewhere:
 - 1. Section 01330, Submittal Procedures.
 - 2. Section 01610, General Equipment Requirements.
 - 3. Section 02300, Earthwork.

1.2 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 - 1. Permits: Obtain all permits required to commence work and, upon completion of the Work, obtain and deliver to ENGINEER a Certificate of Inspection and Approval from the State Board of Fire Underwriters or other authority having jurisdiction.

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- 2. Codes: Material and equipment shall be installed in accordance with the current standards and recommendations of the National Electrical Code, the National Electrical Safety Code and with local codes which apply. Where discrepancies arise between codes, the most restrictive regulation shall apply.
- 3. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriters' Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service regularly applies.
- 4. Utilities:
 - a. Work in connection with the electric service and utility metering shall be done in strict conformance with the requirements of the serving electric utility.
- B. Reference Standards: Electrical material and equipment shall conform in all respects to the latest approved standards of the following:
 - 1. National Electrical Manufacturers Association.
 - 2. The American National Standards Institute.
 - 3. The Institute of Electrical and Electronic Engineers.
 - 4. Insulated Power Cable Engineers Association.
 - 5. National Electrical Code (NEC).
 - 6. National Electrical Safety Code (NESC).

1.3 SUBMITTALS

- A. General:
 - 1. Conform to requirements of Section 01330, Submittal Procedures.
- B. Shop Drawings shall include the following information to the extent applicable to the particular item:
 - 1. Manufacturer's name and product designation or catalog number.
 - 2. Electrical ratings.
 - 3. Conformance to applicable standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEC, NEMA, NFPA, OSHA, UL, or other organizations.
 - 4. Dimensioned plan (including weight), section, and elevations showing means for mounting, conduit connection, and grounding.
 - 5. Materials and finish specification, including paints.
 - 6. List of components including manufacturer's names and catalog numbers.
 - 7. Internal wiring diagram indicating all connection to components and numbered terminals for external connections.

1.4 PROJECT CLOSEOUT

- A. Operation and Maintenance Data: Submit complete manuals including:
 - 1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - 2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01330, Submittal Procedures.
- B. Record Drawings:
 - 1. Record Drawings shall include the following:
 - a. One line wiring diagram of the distribution system.
 - b. Actual in place conduit and cable layouts with schedule of conduit sizes and number and size of conductors.

- c. Layouts of the grounding system and lighting arrangement.
- d. Control wiring diagrams with terminal numbers and all control devices identified.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: CONTRACTOR shall instruct the manufacturers and vendors as to the maximum shipping sizes of equipment that can be accommodated at the site.
- B. Handling and Storage of Materials: Conform to the requirements of Section 01650, Transportation, Handling, and Storage.

1.6 CONTROL CABINETS AND PANELS

- A. All control cabinets and panels located in corrosive environments shall be NEMA 4X, stainless steel, unless otherwise specified or noted on the Drawings.
- B. All outdoor panels shall be provided with sunshade structures.
- C. All control cabinets and panels located outdoors shall be weatherproof NEMA 3R steel, unless noted otherwise specified or noted on the Drawings.

1.7 ELECTRICAL EQUIPMENT

- A. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, with an ambient outside air temperature of 25°F to 131°F and an elevation of 1,050 feet (MSL).
- B. All electrical devices and equipment shall have ratings based on 75°C terminations.

1.8 EQUIPMENT IDENTIFICATION. (ELECTRICAL AND INSTRUMENTATION)

- A. Equipment Identification Tags shall be 1"x3" with two holes centered on each end of the tag (available from Brady). The tags shall be constructed of the following materials: Aluminum 0.020" thick and coated with black enamel paint. Each tag shall be engraved with the equipment identification number and description as indicated in the drawings and/or specifications. Print shall be ¼" Gothic. Each tag shall be attached with fasteners of nylon coated 48 mil stainless steel wire (Brady catalog number 23310 or equal) and brass wire clamps double ferrule design (Brady catalog number 23312 or equal) to secure the stainless steel wire.
- B. Instrument Identification Tags shall be GREEN 1-½" round aluminum (Brady catalog number 49903) engraved with the instrument loop number as indicated in the drawings and/or specifications. Print shall be ¼" Gothic". Each tag shall be attached with fasteners of 48 mil stainless steel wire (Brady catalog number 38091 or equal) and zinc wire clamps (Brady catalog number 38090 or equal) to secure the stainless steel wire.

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1.9 AREA CLASSIFICATIONS

- A. Wet Locations: The following areas shall be considered wet locations:
 - 1. Outdoor Areas and indoors in the pump room.
 - 2. Materials, equipment and incidentals in areas identified as wet locations shall meet NEC and NEMA requirements for wet locations. Enclosures installed in wet locations shall meet NEMA 3R requirements unless otherwise indicated. Conduits shall be terminated at enclosures with watertight, threaded hubs.
- B. Corrosive Locations: The following areas shall be considered corrosive locations:
 - 1. Entire area within the chlorination room.
 - 2. Materials, equipment and incidentals in areas identified as corrosive shall meet NEC and NEMA requirements for corrosive locations. Conduit systems shall be PVC coated galvanized steel and enclosures shall meet NEMA 4X requirements. Conduits shall be terminated at enclosures with watertight, threaded hubs. Where PVC coated conduit is required, all components such as device boxes, device covers, flexible conduit, fittings, seal offs, expansion fittings, explosion proof fittings, etc. shall be PVC coated and shall be manufactured by the same manufacturer as the conduit system.

1.10 SCHEMATIC DIAGRAMS

- A. Schematic diagrams are provided for the CONTRACTOR'S guidance in fulfilling the operational intent of the Contract Documents.
- B. It shall be the CONTRACTOR'S responsibility to meet all safety and electrical codes, and to provide all equipment, appurtenances and specialty items required to provide for complete and operable systems.
- C. Review of control schemes submitted by the CONTRACTOR shall not relieve the CONTRACTOR of his contractual responsibility to provide complete and successfully operating systems.

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Furnish and install complete grounding for the electrical systems. The electrical service for this facility is existing. Connect to the existing grounding system as required.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. NEC Article 250, Grounding.
 - 2. UL Standard #467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

- A. Product Data: Submit, for approval, product data for all materials covered herein.
- B. Shop Drawings: Submit, for approval, the following:
 - 1. Listing of grounding connector types identifying where they are to be used.
 - 2. Layouts of each structure ground grid.
 - 3. Test point construction details.
- C. Test Records: Submit for review copies of written results of ground resistance tests at each test point.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bare Ground Cable: Annealed, bare, stranded copper, No. 8 AWG minimum size or as otherwise shown on the Drawings.
- B. Ground Rods: Copperclad rigid steel rods, 3/4-inch diameter, 10 feet long.
- C. Grounding Connectors:
 - 1. Material: Pressure connectors shall be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections shall be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
 - 2. Product and Manufacturer: Provide grounding connectors of one of the following: a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:

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- 1) Cadweld by Erico Products, Incorporated.
- 2) Therm-O-Weld by Burndy Corporation.
- 3) Or equal.

PART 3 - EXECUTION

3.1 STRUCTURE GROUND SYSTEM

- A. Provide ground grids as shown on the Drawings:
- B. Install ground rods where shown on the Drawings. Install additional ground rods if necessary to attain a resistance to ground of less than 5 ohms for each ground grid.
- C. For structures with steel columns, install #4/0 ground cable from grid to each column around the perimeter of the structure. Connect cable to steel using exothermic welds.
- D. Connect grids to a continuous underground water pipe system when practical.
- E. Provide accessible test points for measuring the ground resistance of each grid.
- F. Weld all buried connections, except for test points.

3.2 EQUIPMENT GROUNDING

- A. Ground all electrical equipment in compliance with the National Electrical Code.
- B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where necessary for mechanical protection.
- C. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.
- D. Connect to piping by welding or brazing. Use copper bonding jumpers on all gasketed joints.
- E. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use holddown bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.
- F. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.
- G. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on all gasketed joints.
- H. Scrape bolted surfaces clean and coat with a conductive oxide-resistant compound.

3.3 TESTING

A. Test the completed ground systems for continuity and for resistance to ground using an electrical ground resistance tester.

INSTRUMENTATION CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: This Section includes instrumentation cable of the following types:
 - 1. Shielded instrument cable. Listed as "A" type cable as called out on the drawings.
 - 2. Unshielded instrument cable.
 - 3. Telephone cable.
 - 4. Intercom and Paging system cable.

1.2 SUBMITTALS

- A. Product Data: Submit, for approval, the following:
 - 1. Manufacturer's technical information for shielded instrumentation cable proposed for use.
 - 2. Manufacturer's technical information for telephone cable and underground splicing for approval by the OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Single Shielded Pair Instrument Cable: Tinned copper, stranded, Polyethylene insulated conductors, No. 18 AWG minimum, twisted with aluminum-polyester shield, stranded tinned 20 AWG copper drain wire and PVC outer jacket. Rated for 300 volts. Belden 8760 or equal.
- B. Single Unshielded Pair Instrument Cable: Bare, soft annealed copper, stranded, PVC insulated conductors, No. 18 AWG minimum, twisted. Outer jacket to be PVC. Rated for 300 volts minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in conduit separate from power cables, unless otherwise noted.
- B. Ground shield of shielded cables at one end only and as recommended by instrument manufacturer.
- C. Terminate stranded conductors with pre-insulated crimp type spade or ring torque terminals properly sized to fit fastening device and wire size.
- D. Install and terminate vendor furnished cable in accordance with vendor equipment requirements.

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E. CONTRACTOR shall coordinate the installation and termination of the telephone cables with the OWNER and the Utility.

3.2 TESTING

- A. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.
- B. Connect shielded instrumentation cables to a calibrated 4-20 milliamp DC signal transmitter and receiver. Test at 4, 12, and 20 milliamp transmitter settings.

CONDUIT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: All electrical and instrumentation wiring shall be installed in conduit, unless otherwise shown. Provide conduit and fittings to form complete, coordinated and grounded raceway systems, as follows:
 - 1. Rigid steel conduit for exposed indoor conduit runs above grade level, unless otherwise indicated.
 - 2. PVC coated rigid steel for exposed conduit runs in all indoor areas below grade level, corrosive areas and in all outdoor areas.
 - 3. Schedule 40 PVC for concrete encased duct bank runs.
 - 4. Schedule 40 PVC for conduit runs embedded in structural concrete slabs.
 - 5. Schedule 40 PVC for direct buried conduit with minimum of 2 ft. 6 inches of cover with 6 inches of sand as shown on the details.
 - 6. PVC-coated rigid steel for underground conduit runs buried shallower than noted above (except those encased in concrete). No "taped" conduit allowed.
 - 7. Provide flexible conduit at motors and equipment that are subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch size flexible conduit. Limit flexible conduit length to three feet maximum. Where PVC coated conduit is required, provide PVC coated fittings for flex conduit to match.
 - 8. Provide sealing fittings for hazardous and corrosive locations as required by the National Electrical Code and where shown on the Drawings.
 - 9. Provide expansion fittings in conformance with the National Electrical Code where necessary to compensate for thermal expansion and contraction.
 - 10. Install expansion/deflection fittings where conduits cross structural expansion joints.
 - 11. No more than 270 degrees of bends allowed in a continuous run of conduit.
- B. Coordination:
 - 1. Conduit runs shown are diagrammatic.
 - 2. Coordinate conduit installation with piping, ductwork, lighting fixtures and other systems and equipment and locate so as to avoid interferences.
- C. Related Sections:
 - 1. Section 16136, Underground Duct Banks.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. NEC Article 346, Rigid Metal Conduit.
 - 2. NEC Article 347, Rigid Nonmetallic Conduit.
 - 3. NEC Article 351, Liquid-Tight Flexible Metal Conduit.
 - 4. NEC Article 500, Hazardous (Classified) Locations.
 - 5. UL Standard 467, Electrical Grounding and Bonding Equipment.
 - 6. UL Standard No. 6, Rigid Metal Electrical Conduit.
 - 7. UL Standard No. 360, Liquid-Tight Flexible Steel Conduit.

- 8. UL Standard No. 514, Electrical Outlet Boxes and Fittings.
- 9. UL Standard No. 651, Schedule 40 and 80 PVC Conduit.
- 10. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- 11. UL Standard 1242, Intermediate Metallic Conduit.
- 12. ANSI C80.1, Specification for Zinc Coated Rigid Steel Conduit.
- 13. NEMA FB 1, Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
- 14. NEMA TC2, Electrical Plastic Tubing, Conduit and Fittings.
- 15. NEMA TC3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SUBMITTAL

- A. Product Data: Submit, for approval, product data for all materials covered herein.
- B. Shop Drawings: Submit for approval the following: Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete and conduits directly buried in earth. Drawings shall show locations of pull and junction boxes, expansion fittings, sealing fittings, flexible conduit runs and all penetrations in walls and floor slabs.
- C. Record Drawings: Include the actual routing of exposed and concealed conduit runs on Record Drawings.

PART 2 - PRODUCTS

2.1 RIGID CONDUIT

- A. Rigid Steel Conduit, Elbows and Couplings: Rigid, heavy wall, mild steel, hot dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- B. PVC Coated Rigid Steel Conduit, Elbows and Couplings: Material: Rigid, heavy wall, mild steel, hot dip galvanized, smooth interior, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with a exterior factory coating of 40-mil thick polyvinyl chloride and an interior coating of 2-mil thick urethane. Color of coating shall be the same on all conduit and fittings. Robroy, Permacote or Ocal.
- C. Metallic Conduit Fittings and Outlet Bodies: Cast gray iron alloy, cast malleable iron bodies and covers. Outdoor units shall be gasketed and watertight. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4 and shall be listed by UL. Fittings and bodies in or on PVC coated conduit runs shall have an exterior factory-applied coating of 40 mil thick polyvinyl chloride, an interior coating of 2-mil thick urethane, and V-seal gasketing.
- D. Non-Metallic Conduit: Schedule 40 PVC plastic, NEMA Type EPC-40-PVD, 90°C rated, conforming to UL No. 651. Form elbows, bodies, terminations, expansions and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.
- E. Conduit Hubs: (Myers or T&B).

- 1. Material: Threaded conduit hub, vibration proof, weather proof with captive O-ring seal, zinc metal with insulated throat. Hubs used on PVC coated conduit systems shall have a factory applied PVC coating.
- 2. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures located in areas designated as set locations.
- F. . Conduit Tags: Conduit Identification Tags shall be YELLOW 1-1/2" round aluminum (Brady catalog number 49900) engraved with the conduit number as indicated in the drawings and/or specifications. Print shall be 1/4" Gothic". Each tag shall be attached with fasteners of nylon coated 48 mil stainless steel wire (Brady catalog number 23310 or equal) and brass wire clamps - double ferrule design (Brady catalog number 23312 or equal) to secure the stainless steel wire.

2.2 FLEXIBLE CONDUIT

- A. Non-hazardous Areas: Flexible galvanized steel core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1-1/4 inch. Material shall be UL listed. Provide one of the following:
 - 1. Sealtite UA by Anaconda Metal Hose Division, Anaconda American Brass Company.
 - 2. Liquatite Type L.A. by Electric-Flex Company.
 - 3. Anaconda Metal Hose
- B. Hazardous Areas: Flexible brass inner core with bronze outer braid and protective vinyl plastic coating. Steel end fittings. Suitable for use in Class 1, Group D, Division 1 hazardous area. Minimum of 12-inches in length. Provide one of the following:
 - 1. Type ECGJH or ECLK by Crouse Hinds Company.
 - 2. Type EXGJH or EXLK by Appleton Electric Company.
 - 3. Or equal.
- C. Wet and/or Corrosive areas, including Hazardous wet / corrosive areas: All fittings shall be PVC coated .
- D. Flexible Conduit Fittings: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed. Provide one of the following:
 - 1. Crouse-Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Or equal.

2.3 SEALING FITTINGS

- A. Cast gray iron alloy or cast malleable iron bodies with zinc electroplate and lacquer or enamel finish. Provide with ample opening with threaded closure for access to conduit hub for making dam. Sealing fiber for forming the dam within the hub and the sealing compound shall be approved for use with the fittings furnished. PVC Coated where required per these specifications and Section 16050. Provide one of the following:
 - 1. Series EYS by Crouse Hinds Company.
 - 2. EYS by Appleton Electric Company.
 - 3. T&B.
 - 4. Or Equal.

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2.4 EXPANSION FITTINGS

- A. Cast gray iron alloy or bronze end couplings, malleable iron or hot dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fittings shall be watertight, corrosion-resistant UL listed and compatible with the conduit system. PVC Coated where required per these specifications and Section 16050. Provide one of the following:
 - 1. Type DX for expansion/deflection or AX for expansion only by O-Z Gedney Company.
 - 2. Type XD for expansion/deflection or XJ for expansion only by Crouse Hinds Company.
 - 3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Supports:
 - 1. Rigidly support conduits with clamps, hangers or Unistrut channels.
 - 2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers with steel horizontal members and threaded hanger rods, Kindorff or equal. Rods shall be not less than 3/8-inch diameter, and shall be Type 316 stainless steel.
 - 3. For PVC coated rigid steel conduit, supports and hardware shall be stainless steel.
- B. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures by the following methods:
 - 1. To Wood: Wood screws.
 - 2. To Hollow Masonry Units: Toggle bolts.
 - 3. To Concrete: Reusable Expansion anchors. (Lead drive in or any anchors not reusable are not allowed).
 - 4. To Steel: Steel welded threaded studs, beam clamps or bolts with lockwashers or locknuts.
- C. Exposed Conduit:
 - 1. Install parallel or perpendicular to structural members or walls.
 - 2. Wherever possible, run in groups. Provide galvanized conduit racks of suitable width, length and height and arranged to suit field conditions. Provide support at every 10 feet minimum.
 - 3. Install on structural members in protected locations.
 - 4. Locate clear of interferences.
 - 5. Maintain 6-inches from hot fluid lines and 1/4-inch from walls.
 - 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- D. Conduit Embedded in Concrete:
 - 1. Separation: Three times outer diameter of larger conduit center to center.
 - 2. Minimum Slab Thickness:
 - a. With no crisscrossing of conduit, three times outer diameter of conduit.
 - b. With crisscrossing of conduits, four times outer diameter of larger conduit.
 - 3. Run conduit in center of slab.
 - 4. Before concrete is placed, make the necessary location measurements of the conduit to be embedded so that the information is available to prepare record drawings.

- 5. All conduits entering or exiting concrete shall be PVC coated a minimum of 12-inches on each side of air/concrete interface.
- E. Underground Conduits:
 - 1. Install individual underground conduits a minimum of 24-inches below grade, unless otherwise indicated or as required to avoid existing obstructions.
 - 2. Perform all excavation, bedding, backfilling and surface restoration including pavement replacement where required.
 - 3. Make conduit connections watertight.
- F. Empty Conduits:
 - 1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
 - 2. Identify each empty conduit with a durable tag in accordance with Paragraph 2.1.F and Paragraph 3.3.A, showing the conduit number indicated on the Drawings.
- G. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at any bend.
- H. Joints:
 - 1. Apply conductive compound to all joints before assembly.
 - 2. Make up joints tight and ground thoroughly.
 - 3. Use standard tapered pipe threads for conduit and fittings.
 - 4. Cut conduit ends square and ream to prevent damage to wire and cable.
 - 5. Use full threaded couplings. Split couplings are not permitted.
 - 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
 - 7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where the base metal is exposed.
- I. Terminations:
 - 1. Install insulated bushings on conduits entering boxes or cabinets, except threaded hub types.
 - 2. Provide locknuts on both inside and outside of enclosure for grounding.
 - 3. Bushings shall not be used in lieu of locknuts.
- J. Moisture Protection:
 - 1. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.
 - 2. Make underground and embedded conduit connections watertight.
 - Thruwall Seals: Install for conduits passing through new exterior subsurface walls or base slabs of buildings and for conduits passing through existing exterior walls. For individual exposed conduits passing through interior walls, install non-metallic sleeves to protect the conduit against action of alkaline substances that may be present.
 - 4. Drainage: Pay particular attention to drainage for conduit runs. Wherever possible, install conduit runs so as to drain to one end and away from buildings. Avoid pockets or depressions in conduit runs. Where conduits enter buildings below grade, seal inside of conduit to form a watertight seal around cables to prevent the entry of water into building. Sealant shall be Silicone and shall form an elastomeric compression seal. Sealant shall be Fire Barrier 2001 Silicone RTV Foam or equal.
- K. Corrosion Protection:
 - 1. Conduit Curb:

- a. In concrete slabs or floors, provide a 2-inch high curb extending 2-inches from the outer surface of the conduit penetrating the floor, to prevent corrosion.
- b. Terminate conduit stub-ups in couplings, slightly above the finished concrete curb.
- 2. Dissimilar Metals:
 - a. Take every action to prevent the occurrence of electrolytic action between dissimilar metals.
 - b. Do not use copper products in connection with aluminum work, and do not use aluminum in locations subject to drainage of copper compounds on the bare aluminum.
 - c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.
- L. Reused Existing Conduits:
 - 1. Pull rag swab through conduits to remove water and to clean conduit prior to installing cable.
 - 2. Repeat swabbing until all foreign material is removed.
 - 3. Pull mandrel through conduit, if necessary, to remove obstructions.
- M. Core drill for individual conduits passing through existing concrete walls or slabs. Obtain authorization from OWNER prior to core drilling. Seal spaces around conduit and the wall penetration details as shown on the Drawings.
- N. Non-Metallic Conduit:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Join sections in accordance with manufacturer's installation procedures for push-fit, bell and spigot type joints, if applicable, or with manufacturer's recommended cement.
 - 3. During installation provide expansion fittings for expansion and contraction to compensate for temperature variations. Expansion fittings shall be watertight and of the type suitable for direct burial.
 - 4. Make transition to PVC coated rigid steel conduit before making turn up to enclosures.

3.2 TESTING

- A. Test conduits by pulling through each conduit a cylindrical mandrel not less then two pipe inside diameters long, having an outside diameter equal to 90 percent of the inside diameter of the conduit.
- B. Maintain a record, by number, of all conduits testing clear.

3.3 IDENTIFICATION

- A. Tag all conduits at the ends and in all intermediate boxes, chambers, handholes and other enclosures. Fasten tags to conduits with bare stainless steel wire. Where this method is not practical, fasten to the adjacent masonry by means of expansion bolts.
- B. Use numbers on all conduits as designated in the cable and conduit schedule and record the conduit numbers and the cable content by cable designation, size, quantity, origin and termination of conductors, and name of equipment served. Assign numbers to unidentified conduits such as home runs to panelboards. Lighting conduits are excluded from these requirements. This information shall be included with the Record Drawings.

++ END OF SECTION ++

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OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide boxes, as follows:
 - 1. Provide outlet boxes for mounting wiring devices and lighting fixtures.
 - 2. Provide junction or pull boxes in runs containing more than three 90 degree bends, runs exceeding 200 feet, where shown on the Drawings and where required to conform with the National Electrical Code.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. NEC Article 370, Outlet, Switch and Junction Boxes, and Fittings.
 - 2. UL Standard No. 50, Electrical Cabinets and Boxes.
 - 3. UL Standard No. 514, Electrical Outlet Boxes and Fittings.
 - 4. UL Standard No. 886, Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.

1.3 SUBMITTAL

A. Product Data: Submit, for approval, product data for all materials covered herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Outlet Boxes: PVC Coated where required per these specifications and Section 16050. Cast gray iron alloy, or cast malleable iron, with zinc electroplate finish in damp, wet or exterior locations and zinc-coated sheet steel in dry locations. Provide boxes of one of the following:
 - 1. Crouse-Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Bowers.
 - 4. Or equal.
- B. Pull and Junction Boxes:
 - 1. Material and Construction:
 - a. Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
 - b. Neoprene gaskets. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable.
 - c. Stainless steel cover screws.
 - d. External mounting lugs.
 - e. Drilled and tapped conduit holes.
 - f. Boxes where conduits enter a building below grade shall have 1/4-inch drain hole.

- 2. Product and Manufacturer: Provide pull and junction boxes of one of the following: a. Appleton Electric Company.
 - b. O-Z/Gedney Company.
 - c. Hoffman.
 - d. Or equal.
- 3. Large boxes not generally available in cast construction may be fabricated of copper-free aluminum alloy or Type 316 stainless steel as required by location.
- 4. Boxes for installation in areas classified as hazardous locations shall be explosion proof and shall comply with UL 886.
- 5. For flush-mounted pullboxes in exterior slabs or pavement and where indicated in interior slabs, provide vehicular traffic-bearing covers.
- 6. Junction boxes and pullboxes embedded in concrete slabs shall be cast iron. Junction boxes and pullboxes located in wet, or outdoor areas shall be NEMA 3R or NEMA 4. Junction boxes and pullboxes located in corrosive locations shall be NEMA 4X, Type 316 stainless steel. All other areas shall be NEMA 12.
- 7. PVC Coated where required per these specifications and Section 16050.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided.
- B. Securely fasten boxes to walls, other structural surfaces or slabs on or in which they are mounted. Provide independent galvanized steel supports where no walls or other structural surface exists.
- C. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
- D. Where sizes are not indicated, size junction and pull boxes in accordance with the requirements of the National Electrical Code.
- E. Provide terminal blocks in junction boxes where cable terminations or splices are required.
- F. Leave no open conduit holes in boxes. Close unused openings with capped bushings.
- G. Label each circuit in boxes and identify with durable tag.

UNDERGROUND DUCT BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide underground ductbanks where shown and where required. Duct bank routing on the Drawings is diagrammatic. Coordinate installation with piping and other underground systems and structures and locate clear of interferences.
- B. Related Sections:
 - 1. Section 02300, Earthwork.
 - 2. Section 03200, Concrete Reinforcement.
 - 3. Section 03300, Cast-In-Place Concrete.
 - 4. Section 16130, Conduit.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the National Electrical Code and National Electrical Safety Code.

1.3 SUBMITTAL

- A. Shop Drawings: Submit for approval typical cross-sections and Layouts showing the proposed routing of duct banks.
- B. Record Drawings: Include the actual routing of underground duct bank runs on Record Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill: Select backfill in accordance with Section 02300, Earthwork.
- B. Reinforcement: In accordance with Section 03200, Concrete Reinforcement.
- C. Concrete: In accordance with Section 03300, Cast-In-Place Concrete.
- D. Duct: Schedule 40 PVC conduit and fittings in accordance with Section 16130, Conduit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Make duct bank installations and penetrations through foundation walls watertight.

- B. Top of ductbanks shall be a minimum of 24-inches below grade, unless otherwise approved by the ENGINEER.
- C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum concrete separation between the outer surfaces of the ducts.
- D. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye to concrete mix for easy identification during subsequent excavation.
- E. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to ensure filling of all spaces between ducts.
- F. Make bends with sweeps of not less than 48-inch radius or 5-degree angle couplings.
- G. Make a transition from non-metallic to PVC Coated rigid steel conduit where duct banks enter structures or turn upward for continuation above grade. Continue ducts inside buildings with PVC Coated rigid steel conduit where required per the area classification.
- H. Reinforce all duct banks. Unless otherwise noted on the Drawings, reinforce with No. 4 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 18-inches on centers, and No. 3 tie-bars transversely placed at 18-inch maximum longitudinal intervals. Maintain a minimum clearance of 2-inch from bars to the edge of the concrete encasement.
- I. Where ducts enter structures such as manholes, handholes, pullboxes, transformer and switchgear compartments, or buildings, terminate the ducts in suitable end bells, insulated bushings or couplings on steel conduits.
- J. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material or other materials which can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of fill.
- K. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.
- L. Install a 3/0 bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system and connect to switchgear and motor control center (MCC) ground buses and to steel conduit extensions of the underground duct system.
- M. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12-inches long and with a cross section approximately 1/4-inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand or gravel have been left in the duct.
- N. Install a warning ribbon approximately 12-inches below finished grade over all underground duct banks carrying cables of 480 volts and higher. The identifying ribbon shall be a PVC tape, 3-inches wide, yellow color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters.
- O. Reused Existing Ducts:

- 1. Pull rag swab through duct to remove water and to clean duct prior to installing new cable.
- 2. Repeat swabbing until all foreign material is removed.
- 3. Pull mandrel through duct, if necessary, to remove obstructions.
- P. No more than 270 degrees of bends allowed in a continuous run of conduit.

MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide manholes and handholes where shown on Drawings. Verify final locations in field. CONTRACTOR shall be responsible for all excavation and backfilling required for installation.
- B. Coordination: Coordinate manhole and handhole installation with piping, sheet piling and other underground systems and structures and locate clear of interferences.
- C. Related Sections:
 - 1. Section 02300, Earthwork.
 - 2. Section 03200, Concrete Reinforcement.
 - 3. Section 03300, Cast-In-Place Concrete.
 - 4. Section 16136, Underground Duct Banks.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. National Electrical Code.
 - 2. National Electrical Safety Code.
 - 3. ASTM A 48, Gray Iron Castings.
 - 4. ANSI A14.3, Safety Requirements for Fixed Ladders.
 - 5. OSHA.

1.3 SUBMITTAL

- A. Product Data: Submit, for approval, product data for all materials covered herein.
- B. Shop Drawings: Submit, for approval, drawings showing interior and exterior dimensions and details of openings, jointing, inserts and reinforcing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Material and Construction:
 - 1. Precast or cast-in-place type of reinforced concrete.
 - 2. Minimum interior dimensions as shown on the Drawings.
 - 3. Duct entrances sized and located to suit duct banks.
- B. Accessories:
 - 1. Frames and Covers:
 - a. Material: Cast iron conforming to ASTM A 48, Class 30A.

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- b. Covers: Watertight, sealed type marked "ELECTRICAL" in raised 2- inch letters.
- c. Frame shall be grouted on the manhole or handhole.
- 2. Pulling Irons:
 - a. Material: Galvanized steel.
 - b. Cast in the wall opposite to the centerline of each incoming duct bank and 12inches below centerline of bottom line of ducts.
- 3. Cable Racks:
 - a. Material: Galvanized steel.
 - b. Cable racks shall adequately support cables with space allowed for future cables.
 - c. Each rack shall be a vertical assembly of 24-inch cable racks extending from within 6-inches of the manhole roof slab to within 6-inches of the manhole floor.
 - d. Product and Manufacturer: Provide one of the following:
 - 1) Catalog Number J-5125 by Joslyn Manufacturing and Supply Company.
 - 2) Catalog Number 2125 by Hubbard and Company.
 - 3) Or equal.
- 4. Cable Hooks:
 - a. Material: Galvanized steel.
 - b. Length: 7-1/2-inch minimum.
 - c. Product and Manufacturer: Provide one of the following:
 - 1) Catalog Number J-5132 by Joslyn Manufacturing and Supply Company.
 - 2) Catalog Number 2132 by Hubbard and Company.
 - Or equal.
- 5. Insulators:
 - a. Material: Porcelain.
 - b. Product and Manufacturer: Provide one of the following:
 - 1) Catalog Number J-5122 by Joslyn Manufacturing and Supply Company.
 - 2) Catalog Number 2120 by Hubbard and Company.
 - 3) Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Complete installation of manholes and handholes so that structures are watertight.
- B. Cable Racks:
 - 1. Attach with 3-inch by 3/8-inch diameter "tamp-in" studs mounted in 1-inch holes drilled into walls of manholes in the absence of inserts.
 - 2. Provide cable hooks to support each cable on each rack along the cable run within the manholes.
 - 3. Individually support each cable at each hook on porcelain insulators.
 - 4. In the manhole securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape as manufactured by 3M or tie down with nylon straps.
- C. Grounding: Install a 3/4-inch by 10-foot copper-clad ground rod for each manhole. Bond all exposed metal manhole accessories and the concrete reinforcing rods with No. 4 AWG minimum bare copper wire and connect to the ground rod and to the ductbank ground cable.

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D. Provide grading rings for manholes when required to adjust manhole cover to proper grade. Stacks shall be minimum of 12-inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the grading ring shall be such as is necessary to bring the manhole frame to the proper grade.

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide wiring devices, including:
 - 1. Receptacles.
 - 2. Snap switches for lighting and other systems.
- B. Related Sections:
 - 1. Section 16050, General Provisions.
 - 2. Section 16135, Outlet, Pull, and Junction Boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. National Electrical Code.
 - 2. UL Standard #20, General Use Snap Switches.
 - 3. UL Standard #894, Switches for Use in Hazardous Locations.
 - 4. UL Standard #1010, Electrical Receptacle Plug Combinations for Use in Hazardous Locations.

1.3 SUBMITTAL

A. Product Data: Submit, for approval, product data for all materials covered herein.

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. Non-Hazardous Locations: Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 ampere. All exterior outlets shall be ground-fault interrupting type. Provide one of the following:
 - 1. Catalog Number 53CM62, by Harvey Hubbell Incorporated.
 - 2. Catalog Number 5362-CR, by Arrow-Hart Incorporated.
 - 3. Leviton.
 - 4. Or equal.
- B. Hazardous Locations: Factory sealed receptacle suitable for installation in Class I, Group D hazardous locations. Copper-free aluminum receptacle and cover with cast gray iron alloy or cast malleable iron mounting box with zinc electroplate finish. PVC Coated where required per these specifications and Section 16050. Receptacle rated at 20 amperes, 125-250 volt AC, 2 wire, three pole. Provide one of the following:
 - 1. Series CPS by Crouse-Hinds Company.
 - 2. Type CPS by Appleton Electric Company.
 - 3. Or equal.

C. Special Receptacles: Provide receptacles with number of poles, voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.

2.2 SWITCHES

- A. Non-Hazardous Locations:
 - 1. Single pole AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade. Provide one of the following:
 - a. Catalog Number 1221-I, by Harvey Hubbell Incorporated.
 - b. Catalog Number 1991-I, by Arrow-Hart Incorporated.
 - c. Leviton.
 - d. Or equal.
 - 2. Single pole, 3-way AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade. Provide one of the following:
 - a. Catalog Number 1223-I, by Harvey Hubbell Incorporated.
 - b. Catalog Number 1993-I, by Arrow-Hart Incorporated.
 - c. Leviton.
 - d. Or equal.
 - 3. Two pole AC toggle switch, quiet type, 120/277 volt AC, 20 ampere, Ivory, specification grade. Provide one of the following:
 - a. Catalog Number 1222-I, by Harvey Hubbell Incorporated.
 - b. Catalog Number 1992-I, by Arrow-Hart Incorporated.
 - c. Leviton.
 - d. Or equal.
- B. Hazardous Locations: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. PVC Coated where required per these specifications and Section 16050. Switch rated at 20 amperes, 120/277 volt AC. Provide one of the following:
 - 1. Series EDS by Crouse-Hinds Company.
 - 2. Type EDS by Appleton Electric Company.
 - 3. Or equal.
- C. Key Operated On-Off Switches: Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two (2) keys.

2.3 COVERS

- A. Indoor covers shall be Type 304, stainless steel.
- B. Outdoor or wet location covers shall be weatherproof and corrosion resistant. PVC Coated where required per these specifications and Section 16050.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wiring devices in outlet or device boxes in non-hazardous locations.
- B. Install wiring devices in rigid metallic conduit systems in hazardous locations.

- C. Install receptacles with ground pole in the down position.
- D. Mount receptacles 18-inches above finished floor in non-hazardous locations and 4 feet-6 inches above finished floor in hazardous locations, unless otherwise noted.
- E. Mount wall switches 4 feet-6 inches above finished floor unless otherwise noted.

POWER SYSTEM STUDIES

<u> PART 1 - GENERAL</u>

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, services and incidentals required to perform Power System Studies and distribution system field testing.
 - 2. The Power System Studies shall include a Short Circuit Study, a Protective Device Evaluation Study, a Protective Device Coordination Study, and an Arc Flash Analysis.
- 1.2 REFERENCES
 - A. Standards referenced in this Section are listed below:
 - 1. American National Standards Institute, (ANSI).
 - a. ANSI C37.04, Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
 - b. ANSI C37.010, Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Basis.
 - 2. Institute of Electrical and Electronics Engineers, (IEEE).
 - a. IEEE 141, Electric Power Distribution in Industrial Plants.
 - b. IEEE 399, Recommended Practice for Industrial and Commercial Power System Analysis.
 - 3. National Electrical Code, (NEC).

1.3 QUALITY ASSURANCE

- A. Source Quality Control:
 - 1. Retain the services of a Registered Professional Engineer, to perform the Power System Studies and field services. The Registered Professional Engineer shall be from an independent consulting firm or from the manufacturer of the power distribution equipment.
 - 2. Coordinate with the Engineer performing the studies and assist him in the collection of all information necessary to complete the studies specified.
 - 3. All information pertaining to the existing system necessary to perform the studies shall be obtained in advance prior to performing the studies.
 - 4. All motor starting and transformer information shall be based upon the equipment actually installed.
 - 5. Retain the services of a Field Engineer to perform field testing of the power distribution system. The Field Engineer shall be from the manufacturer of the power distribution equipment.

B. All test equipment and instrument calibration shall be in accordance with the latest edition of the accuracy standard of the U.S. National Institute of Standards and Technology.

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following:
 - 1. Copies of calculations and results of the Short Circuit Study, Protective Device Evaluation, Coordination Studies, and Arc Flash Analysis in a report format. The report shall be stamped and signed by an Arizona Registered Professional Electrical Engineer.
 - 2. Work sequence for the field testing shall be submitted in advance prior to performing tests. The sequence shall indicate the schedule of work, time frame and downtime for the equipment.
 - 3. Time current curves for all protective devices included within the power system studies.
- B. Reports:
 - 1. Field test report shall be submitted.

PART 2 - PRODUCTS

2.1 POWER SYSTEM STUDIES

- A. General:
 - 1. Provide a current and complete Short Circuit Study, Protective Device Evaluation Study, and a Protective Device Coordination Study for the Electrical Distribution System.
 - 2. The studies shall include all portions of the high (12.47KVAC) and low voltage (240VAC) electrical distribution system from the normal and alternate sources of power through the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
 - 3. It is the intent of this Section that a complete study shall be performed to evaluate both new and existing devices and to make recommendations regarding any adjustments. The studies shall include both the normal utility supply and the standby generator supplies.
 - 4. Problem areas or equipment inadequacies shall be promptly brought to the ENGINEER'S attention.
- B. Short Circuit Study:
 - 1. The Short Circuit Study shall be performed with the aid of a computer program.
 - 2. The study input data shall include the utility company's short circuit, single and three phase contributions, with the X/R ratio, the resistance

and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.

- 3. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
- 4. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.
- C. Protective Device Evaluation Study:
 - 1. A Protective Device Evaluation Study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the available fault currents.
 - 2. Appropriate multiplying factors based upon system X/R ratios and protective device rating standards shall be applied.
- D. Protective Device Coordination Study:
 - 1. A Protective Device Coordination Study shall be performed to select or to check the selections of the power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
 - 2. The overcurrent device settings computed in the Protective Device Coordination Study shall provide complete 100 percent selectivity. The system shall be selectively coordinated such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and the duration of a fault current.
 - 3. The Protective Device Coordination Study shall include all voltage classes of equipment starting at the utility's incoming line protective device down to and including each of the medium and low voltage equipment. The phase and ground overcurrent and the phase and ground fault protection shall be included, as well as settings for all other adjustable protective devices.
 - 4. The time-current characteristics of the installed protective devices shall be plotted on the appropriate log-log paper. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete system basis. Sufficient curves shall be used to clearly indicate selective coordination achieved through the utility main breaker, power distribution feeder breakers, and the overcurrent devices at each major load center.
 - 5. There shall be a maximum of eight protective devices per plot. Each plot shall be appropriately titled. Plots shall include the following information as required for the circuits shown:

- a. Representative one-line diagram, legends and types of protective devices selected.
- b. Power company's relays or fuse characteristics.
- c. Significant motor starting characteristics.
- d. Parameters of transformers, ANSI magnetizing inrush and withstand curves.
- e. Operating bands of low voltage circuit breaker trip curves, and fuse curves.
- f. Relay taps, time dial and instantaneous trip settings.
- g. Cable damage curves.
- h. Symmetrical and asymmetrical fault currents.
- 6. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system.
- E. Arc Flash Analysis:
 - 1. Conduct arc flash analysis after acceptance by ENGINEER of the short circuit and coordination studies. Perform arc flash analysis for each operating mode of the system, per IEEE 1584 and NFPA 70E.
 - 2. Document the protection and calculation procedures and coordination review in the report. Analysis results shall be presented in tabular format showing the following:
 - a. Bus and protection device name.
 - b. Bolted and arcing fault values.
 - c. Protective device trip times.
 - d. Arc flash boundary, working distance, and incident energy.
 - e. Required protective FR clothing class.
 - 3. As part of the arc flash analysis, provide personnel protective equipment labels per Section 16075, Electrical Identification.
 - 4. Provide training for OWNER's operation and maintenance personnel in personnel protection equipment. Provide at least four hours of training, per Division 1.

2.2 STUDY REPORT

- A. The results of the Power Distribution System Coordination Study shall be summarized in a final report submitted in a binder with separation tabs for each section. The report shall include the following Sections:
 - 1. Description, executive summary, purpose, basis, written scope, and a single-line diagram of the Power Distribution System which is included within the scope of the study.
 - 2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties, and commentary regarding same.
 - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

- 4. Fault current tabulation including a definition of terms and a guide for interpretation.
- 5. Tabulation of appropriate tap settings for relay seal-in units.
- 6. Tabulation of equipment survey information.

PART 3 - EXECUTION

3.1 FIELD SERVICES

- A. The Registered Professional Engineer shall conduct an equipment survey of existing devices and information necessary to perform the Power System Studies.
- B. The survey shall include the following information to the extent applicable:
 - 1. Manufacturer, type and size of each power fuse.
 - 2. Manufacturer, type, model and settings for each protective relay, trip unit and circuit breaker.
 - 3. Current transformer ratios for each protective relay.
 - 4. Appropriate data of motors and transformers included with the study.
- C. The Registered Professional Engineer, as part of the field service Work, shall collect all data and coordinate with the equipment vendors to establish the proper settings for the actual devices provided.

3.2 FIELD TESTING

- A. Provide field testing of the distribution system in accordance with the manufacturer's recommendations. All field testing shall be performed by the Field Engineer, after the completion and approval of the Power System Studies. The field testing results shall be documented within a report, with the final settings of all protective devices.
- B. The Field Engineer with necessary tools and equipment shall adjust, set, calibrate and test all protective devices. All protective relays and meters in the medium and low voltage equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturer's recommendations, the coordination study and best industry practice.
- C. Proper operation of all equipment associated with the device under test and its compartment, shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and lubrication necessary to achieve proper operation shall be considered part of this Contract.
- D. All solid state trip devices shall be set including all required programming necessary for the protection required. The devices shall be checked and tested for setting and operation. Circuit breakers and/or contactors associated with the trip devices shall be tested for trip and close function with their protective device.

3.3 MAINTENANCE OF OPERATIONS

A. Since the field testing work specified may require that certain pieces of equipment be taken out of service, CONTRACTOR shall perform the Work with due regard to maintenance of operations and construction staging in accordance with the requirements of Division 1 for Coordination with OWNER'S operation. All testing procedures and schedules must be scheduled in advance prior to any work beginning.

+ + END OF SECTION + +

SECTION 16232

SINGLE DIESEL FUELED ENGINE GENERATOR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for:
 - 1. Packaged automatic "standby" diesel engine generator system including:
 - a. Diesel engine with batteries and battery charger.
 - b. Generator.
 - c. Liquid coolant system.
 - d. Fuel system and fuel storage tank(s).
 - e. Exhaust system.
 - f. Control system.
 - g. Supporting and mounting skid.
 - h. Weatherproof acoustical housing.
 - i. All other equipment required for a complete and operable power generation system (coordinate ATS supply and settings with electrical contractor and manufacturer).

1.2 REFERENCES

- A. Refer to Section 16050.
- B. American Society for Testing and Materials (ASTM):
 - 1. A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 2. A 106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - 3. A 181 Standard Specification for Carbon Steel Forgings for General Purpose Piping.
 - 4. A 240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 5. A 536 Standard Specification for Ductile Iron Castings.
 - 6. D 2310 Standard Classification for Machine-Made Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. 250 Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - 2. MG-1 Motor and Generators.
- D. National Fire Protection Association (NFPA):
 - 1. 30 Flammable and Combustible Liquids Code.
 - 2. 37 Combustion Engines and Gas Turbines, Stationary.
 - 3. 99 General Overall Requirements.
 - 4. 110 Standard for Emergency and Standby Power Systems.
- E. Underwriters Laboratories (UL):d
 - 1. 142 Standards for Steel Aboveground Tanks for Flammable and Combustible Liquids.

- 2. 508 Standard for Safety for Industrial Control Equipment.
- 3. 2200 Standards for Stationary Engine Generator Assemblies.

1.3 DEFINITIONS

- A. Refer to Section 16050.
- B. Specific Definitions:
 - 1. Standby Rated Duty: Defined as continuous operation for the duration of any power outage.
 - 2. Equipment Supplier: Defined as the prime manufacturer of at least one of the following items:
 - a. Engine.
 - b. Alternator (Generator).
 - c. Control system.

1.4 SYSTEM DESCRIPTION

- A. Provide a complete automatic standby diesel engine driven generator system, with all necessary components to make a complete and operating diesel-driven power supply. Coordinate the generator control design with the switchgear or transfer switches specified in Division 16 and as indicated on the Drawings. Provide a weatherproof, sound attenuated enclosure and double-wall diesel fuel tank with 24 hour operating capacity at 100% load.
- B. Generator System Performance Requirements:
 - 1. Power Output Rating: Minimum kilowatts and voltage as indicated on the Drawings, delivered at 0.8 power factor, 3-phase, 4-wire, 60 hertz, without exceeding NEMA MG-1 temperature rise limits. Generator must be suitable for the variable frequency drive (VFD) loads as indicated on the drawings.
 - 2. It is the manufacturer's responsibility to properly size the engine generator based upon site conditions and actual loads. The Drawings and Specifications indicate a minimum size that the ENGINEER has determined based upon non-certified information. No increase in Contract amount will be considered if the equipment size needs to be increased to meet the load requirements after Bids have been submitted.
 - 3. Increases in size as a result of manufacturer sizing shall include any and all conduit and wire size changes:
 - a. Manufacturer to size engine generator and provide calculations to substantiate voltage drop at any load step of no more than 10 percent.
- C. Include the supply of such minor details of electrical, plumbing, or mechanical work not specified or indicated on the Drawings, which are necessary for the successful operation of the diesel engine-driven generator required by these Specifications.

1.5 SUBMITTALS

- A. Furnish submittals in accordance with Contract Documents and Section 16050.
- B. Product Data:
 - 1. Submit the following information:
 - a. Weight of engine generator skid.
 - b. Dimensions of engine generator skid, including length, width, and height.
 - c. Type and grade of fuel recommended.

- d. Fuel and Lubricating Oil Consumption at:
 - 1) 50 percent load.
 - 2) 75 percent load.
 - 3) 100 percent load.
 - a) Type and grade lubricating oil recommended.
 - b) Amount of lubricating oil required per oil change.
 - c) Normal lubricating oil consumption.
 - d) Recommended lubricating oil change periods:
 - 1. By hours run.
 - 2. By time.
- e. Gauges to be furnished with engine and the normal operating range of each:
 - 1) Oil pressure.
 - 2) Coolant temperature.
 - 3) Primary fuel tank level.
 - 4) Fuel pressure.
- f. Time interval from start-up contact closure until full load capabilities are available.
- g. List of at least 4 installations using major components of the same type furnished for this application:
 - 1) Include name and telephone number of the persons most familiar with this equipment who can be contacted during the submittal review.
- h. Number of cylinders, bore, stroke, and piston speed.
- i. Displacement in cubic inches.
- j. Compression RATIO.
- k. RPM at 60 Hertz.
- I. Size of exhaust outlet.
- m. The following gaseous exhaust emissions in grams/BHP-HR and Lbs/BHP-HR:
 - 1) NOX.
 - 2) HC.
 - 3) CO.
 - 4) PM.
 - 5) Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
 - 6) These levels shall be reported at rated speed and load as measured by SAE J177 and J215 recommended practices.
- n. Voltage and frequency variation and duration with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.
- o. Battery discharge ampere ratings at the 8 hour rate and the 1 minute rate to 1.75 volts per cell.
- p. Certified published engine horsepower curves showing manufacturer's engine rating for generator set standby and prime power application.
- q. Free field mechanical noise level at 23 feet. Provide overall decibels (A) rating.
- r. Exhaust noise level at 5 feet from discharge end of silencer.
- s. Start battery catalog number and descriptive bulletin.
- t. Recommended spare parts.
- u. Space and ambient temperature requirements for the engine control panel.
- v. Size and capacity of base mounted fuel tank.
- w. Manufacturer of:
 - 1) Engine.
 - 2) Generator.
 - 3) Generator Control Panel.
 - 4) Radiator.

- 5) Enclosure.
- x. Estimated number of days to ship complete unit.
- y. Jacket water heater
- z. Weatherproof acoustical housing:
 - 1) Dimensions:
 - a) Length.
 - b) Width.
 - c) Height.
 - d) Weight.
 - 2) Materials.
 - 3) Acoustic rating.
 - 4) Door locations and access requirements.
 - 5) Finish.
- C. Shop Drawings:
 - 1. Layout Drawings:
 - a. Provide detailed dimensional and to-scale layout drawings including:
 - 1) A single drawing incorporating all equipment furnished:
 - a) Submittals that consist solely of individual Drawings for each component and require that these sheets be compiled by the ENGINEER, in order to view the entire piece of equipment, are not acceptable.
 - 2. Detailed electrical wiring diagrams of the engine and generator including:
 - a. Engine interconnection terminal box.
 - b. Generator interconnection terminal box.
 - c. Fuel system Drawings.
 - d. All interface Drawings between the engine driven generator skid and the transfer equipment.
 - e. All wiring diagrams to show wire numbers and terminal block identifications:
 - 1) Wire numbers are to correspond to the wire number on the equipment.
 - 2) All wires are to be numbered.
 - f. Complete interior and exterior control panel layout:
 - 1) Scaled.
 - 2) With device descriptions.
 - 3) With nameplates.
 - 3. Mounting Drawings:
 - a. Detailed mounting drawings prepared and sealed by a registered Professional Engineer in Arizona:
 - 1) Detailing mounting requirements for the project site seismic requirements as indicated in Section 16050.
- D. Operation and Maintenance Manuals:
 - 1. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this Contract:
 - 2. Operating Instructions:
 - a. Printed and framed instruction chart shall be permanently mounted on the wall. The chart must detail the operational functions of all normally used controls that have been placed on the front of the control equipment.
 - 3. Maintenance Manual:
 - a. Printed and bound instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.
 - b. These manuals must include but are not limited to the following:1) Electrical Controls:

- a) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
- b) Detailed control instructions, which outline the purpose and operation of every control device used in normal operation.
- c) Description of the sequence of operation that outlines the steps, which the controls follow during normal power failure and normal power return conditions.
- d) All schematic, wiring, and external diagrams. Also, internal device wiring and schematic diagrams for all sub assemblies used in the equipment:
- 2) Drawing to be furnished in a reduced 11-inch by 17-inch format and shall be fully legible at that drawing size.
- 3) Engine and Generator:
 - a) Standard operational manuals normally furnished by the manufacturer.
 - b) Repair parts manuals normally furnished by the manufacturer:
 - 1. Detailing all parts and sub-assemblies, which are available as repair parts.
- 4) Shop Maintenance Manuals:
 - a) Provide 1 shop manual on-site that is equivalent to the manual used by factory-authorized shop repair personnel.
 - b) Manuals for the following equipment:
 - 1. Engine.
 - 2. Radiator.
 - 3. Generator.
 - 4. Engine generator control panel.
- c. Material Safety Data Sheets:
 - 1) Complete MSDS forms for all substances.
 - 2) Located in O&M manual.
 - 3) Include separate manual labeled MSDS with additional copies of all MSDS forms.
- d. Furnish a minimum of 6 manuals of each type identified, except for the Shop Maintenance Manual.

E. Test Reports:

1. Furnish complete test reports in accordance with Paragraphs 2.11 and 3.07 of this Section.

F. Certificates:

- 1. For the Complete Package: upon completion of installation, manufacturer must issue a certification of compliance with the Drawings and Specifications.
- G. Calculations:
 - 1. Complete loading calculations to support the recommended size of the enginegenerator based upon actual facility loads, including VFD loads.
 - 2. Supply documentation identifying the maximum static pressure acceptable for the radiator fan. It is the manufacturer's responsibility to then provide calculations as part of the layout drawings, to ensure that the transition ductwork at the discharge of the radiator does not exceed the maximum static pressure acceptable for the radiator fan.
 - 3. Submit certification that a torsional analysis has been completed.
 - 4. Submit exhaust system silencer noise attenuation curves.
 - 5. Structural, mounting, and seismic calculations to be signed and stamped by a licensed Professional Engineer, registered in Arizona:
 - 6. Submit vibration isolator calculations.

- 7. Submit exhaust silencer structural support calculations.
- 8. Submit factory certification of the radiator ambient capability.
- 9. Submit Exhaust System Pressure Loss Calculations: include piping, fittings, silencer, and rain cap in loss calculations.

1.6 QUALITY ASSURANCE

- A. Refer to Section 16050.
- B. Manufacturer Qualifications:
 - 1. The manufacturer of the engine, generator, and all major items of auxiliary equipment must be in current production of such equipment.
 - 2. Factory authorized parts and service facility located within 100 miles of the Project site.
 - 3. System to have complete engine generator unit factory-assembled and tested by the engine manufacturer and then shipped to the jobsite.
 - 4. Materials, equipment, and parts comprising the units specified must be new and unused, of current manufacture, and of the highest grade.
 - 5. Manufacturer is responsible for furnishing, testing, installation supervising, testing, and guaranteeing the system.
- C. Regulatory Requirements:
 - 1. Meet NFPA-110 Type 10 (ten second) transfer requirements.
 - 2. Fuel tanks:
 - a. UL listed.
 - b. Primary and secondary tanks shall be tested to 3 to 5 psi to check for leaks.
 - c. Comply with the following, if applicable:
 - 1) NFPA 30 Flammable and Combustible Liquids.
 - 2) NFPA 37 Installation and Use of Stationary Combustible and Gas Turbines.
 - 3) NFPA 110 Emergency and Standby Power Systems.
 - 3. Regulations of the Fire Prevention Bureau of the Fire Department Having Jurisdiction.
 - 4. Fire Code as specified in Contract Documents.
 - 5. Other applicable state and local codes.
 - 6. EPA approved.
 - 7. Requirements of local Air Quality Management District or Air Pollution Control District.
 - 8. CONTRACTOR to comply with the Specifications that may be in excess of, and not contrary to, the regulations.
- D. The generator set(s) shall be manufactured to the applicable specifications on file with Underwriters Laboratories and labeled with the UL 2200 mark.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 16050.
- B. The engine-driven generator skid must be equipped with removable lifting and jacking angles, eye bolts, etc., to facilitate unloading and move-in operations.
- C. Provisions on skid for the use of "Multiton" type rollers for moving the engine-driven generator skid into position.

- D. Provide a means for jacking the engine-driven generator skid up for removal of the "Multiton" rollers and then for setting the engine generator skid in place.
- E. The engine-driven generator skid is to be shipped from the factory complete with lifting eyes, jacking angles, etc., attached to the structural base.
- F. Provide the services of a manufacturer's authorized representative to:
 - 1. Be present at the jobsite when the engine-driven generator arrives:
 - 2. Act as an advisor in assisting the CONTRACTOR regarding the unloading and movein operations.
 - 3. Ship the engine-driven generator skid and all associated equipment to the jobsite on equipment that will allow the CONTRACTOR to use the equipment he has on site to efficiently unload the engine-driven generator skid.
 - 4. Coordinate the delivery of the shipment with the CONTRACTOR.
 - 5. Before start up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with all Drawings and Specifications.

1.8 PROJECT OR SITE CONDITIONS

A. Refer to Section 16050.

1.9 SEQUENCING

A. Complete factory prototype and factory production tests in accordance with NFPA 110 before equipment is shipped.

1.10 WARRANTY

- A. Refer to Section 16050.
- B. Extended Warranty:
 - 1. Provide a 2-year manufacturer's warranty for all equipment provided under this Section.

1.11 SYSTEM STARTUP

- A. Refer to Section 16050.
- B. Manufacturer services to include, but are not limited to:
 - 1. Furnish the services of manufacturer-certified technicians during the start-up and adjustment period to ensure that all items furnished are in proper operating condition:
 - a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
 - b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
 - c. Provide training in conformance with paragraph 3.10 of this Section.
 - d. Engine technician and electrical technician may be the same individual if certified by the respective equipment manufacturers in both engine and electrical fields.
 - 2. Furnish a written report after the start-up:
 - a. Report must state that the installation is complete and satisfactory:
 - 1) List the items requiring additional attention.

- 3. Minimum required time on site by technician for start-up:
 - a. One day to inspect entire installation, start-up, test operation, and conduct acceptance tests.

1.12 MAINTENANCE

- A. Furnish the following spare parts:
 - 1. Sufficient coolant so that entire system may be flushed and replaced after initial burn-in period.
 - 2. Sufficient lubrication products so that the entire system may be flushed and replaced after initial burn-in period.
 - 3. One complete spare voltage regulator.
 - 4. One complete spare governor and governor controller.
 - 5. Three sets of lube oil filters, fuel filters, and gaskets.
 - 6. Two sets of air filters.
 - 7. Two sets of belts.
 - 8. Twelve spare lamps of each different lamp type.
 - 9. Two fuses (for each control circuit).
 - 10. One set of crankcase breather filters.
 - 11. Two gallons fuel additive.
- B. Special Tools: Furnish a set of specialty tools necessary for routine maintenance of the equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following list of manufacturers is a general guideline and makes no statement as to the capability of the manufacturer to meet the Specification requirements. The burden of proof of conformance with these Specifications lies with the CONTRACTOR and manufacturer. The CONTRACTOR must make special written application to use other than these named manufacturers:
 - 1. Engine Generators:
 - a. Caterpillar
 - b. No Equal
 - 2. Governor:
 - a. Isochronous electronic by engine manufacturer.
 - 3. Battery:
 - a. One of the following, or equal:
 - 1) Hawker.
 - 4. Base Mounted Fuel Tank:
 - a. One of the following, or equal:
 - 1) Pryco.
 - 2) Tramont.
- B. Exhaust System:
 - 1. One of the following or equal:
 - a. Silencer:
 - 1) Harco Manufacturing.
 - 2) Silex Innovations.
 - b. Expansion Joint:
 - 1) DME.

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- c. Exhaust Pipe Insulation:
 - 1) As specified in Section 15082.
- d. Expansion Joint Insulation:1) Pittsburgh-Corning, Temp-Mat.

2.2 EQUIPMENT

- A. Characteristics of assembled unit:
 - 1. The engine-driven generator consists of a diesel engine directly coupled to an electric generator providing continuous electric power for the duration of any power failure of the normal utility power supply.
 - 2. The engine must start, attain full speed, voltage, and assume full load within a maximum of 10 seconds, with jacket water at 85 degrees Fahrenheit.
 - 3. Furnish the engine-driven generator on a steel sub-base to support engine, generator, and accessories as a unit:
 - a. Base: welded construction.
 - b. Engine direct connected through a flexible coupling to a single bearing generator.
 - c. System free of injurious torsional and bending vibrations within a speed range from 10 percent below to 10 percent above synchronous speed.
 - d. Engine-driven generator balanced such that the peak-to-peak amplitude of vibration velocity in any direction does not exceed the engine or generator manufacturer's published limits.
 - e. If shims are required under the feet of the generator for alignment purposes, use 1-piece laminated shim stock that covers at least 90 percent of the foot.
 - f. Provide a complete assembled engine-driven generator skid requiring only the following field mechanical connections:
 - 1) Power leads from generator to the automatic transfer equipment.
 - 2) Control Connections to:
 - a) Automatic Transfer Equipment.
- B. Engine Generator Base:
 - a. Support System:
 - b. Bolt the engine-driven generator to steel pads that are an integral part of structural support base.
 - c. Provide vibration isolators shall be provided between the engine generator and welded steel base or between the base and the floor:
 - 1) As recommended by the manufacturer.
 - d. Support system design must meet the seismic requirements of the project site: 1) Support system design must be stamped by a registered Professional
 - 1) Support system design must be stamped by a registered Professional Engineer registered in Arizona.
 - e. Vibration isolators to properly support the engine driven generator skid on its concrete base:
 - 1) The isolators located for equal load distribution and deflection per isolator.
 - 2) Spring type designed for the load and seismic conditions as identified for the site.
- C. Engine:
 - 1. Full compression ignition, 4-cycle low emission unit, turbocharged, and aftercooled.
 - 2. The rated net horsepower of the engine with all accessories, including radiator fan, must not be less than that required to produce the minimum specified generator capacity at site altitude.
 - 3. Engine is to be equipped and designed as follows:
 - a. Dual spin-on type replaceable lube oil filter cartridges.

- b. Replaceable fuel filters.
- c. Heat treated forged steel crankshaft:
 - Dynamically balanced.
- d. Forged steel connecting rods.
- e. Crankshaft driven gear type lubricating pump.
- f. Electric fuel shut-off valve.
- g. Engine Air Cleaner: Dry type replaceable filter.
- h. 12 or 24 volt direct current positive engagement solenoid shift-starting motor:
 - 1) The starting equipment must include the necessary devices to prevent an overcrank and lockout if the starter pinion fails to engage the flywheel ring gear on the initial crank attempt.
 - 2) This starter disconnect is to electronically sense the speed of the flywheel and when the flywheel setpoint speed has been reached, the electronic control signals the starter disconnect to disengage.
- i. Oil level dip stick and oil drain pipe with valve and pipe plug:
 - 1) Oil drainpipe and valve are to extend 3 inches beyond edge of engine base.
- j. Dry electrical contacts to report:
 - 1) Low oil pressure.
 - 2) Over speed.
 - 3) High water temperature.
- k. Engines requiring glow plugs are not acceptable.
- I. Crankcase breather filter:
 - Provide crankcase ventilation system with coalescing filter/trap for blowby:
 a) Coalescing filter to be replaceable.
 - 2) If engine manufacturer recommends an open crankcase breather system, route outlet of breather filter to outside at 3 inches above grade and away from engine components:
 - a) Provide on breather outlet Nelson "EcoVent" or equal, sized to match engine breather flow.
 - If engine manufacturer recommends a closed crankcase breather system, provide integral crankcase pressure regulator with an automatic internal filter bypass and bypass indicator:
 - a) Unit to be Racor Model CCV 4500 or equal.
- m. Governor:
 - 1) Isochronous type to maintain engine speed:
 - a) Within 0.5 percent for steady state conditions.
 - b) Within 5 percent for a no load to full load step with recovery to within 2 seconds of step load application.
 - c) Suitable for use on diesel engines.
 - d) Electronic governor control of fuel.
 - e) Suitable for automatic, unattended starts.
 - f) Speed sensing failure circuit to signal actuator to close if speed pick-up signal is lost.
 - g) With speed pick-up sensor.
 - h) With capabilities of local or remote speed settings.
 - i) Adjustable acceleration rate control from 0 to 8 seconds.
 - j) Personnel guards over all exposed moving parts.
- n. Equipped with a continuous duty shutdown system for normal remote stopping.
- o. Equipped with gauges to indicate:
 - 1) Lube oil pressure.
 - 2) Fuel pressure.
 - 3) Gauges are to be mounted such that vibration will not cause premature failure.

- p. Monitor engine coolant temperature by a thermometer with thermometer well or a temperature gauge.
- 4. Regulatory Requirements:
 - a. Specifically designed to meet the discharge of gaseous pollutants to the atmosphere as required by the Environmental Protection Agency Tier 2 statute and local agency issuing the permit for the engine generator system.
- D. Fuel System:
 - 1. General: Provide fuel system, accessories, and fuel tanks meeting the following requirements:
 - Base mounted Fuel Tank: Provide a base mounted fuel tank meeting the following:
 a. Provide UL listed tank with secondary containment rupture basin.
 - b. Construction: Reinforced steel channel system with minimum thickness of 7-
 - gauge for channels and 12-gauge for tank construction. c. Provide tank baffle to separate hot fuel return from cooler supply fuel.
 - d. Provide the Following Connections:
 - 1) 1.25-Inch Minimum Vent:
 - a) Pipe vent outside any room or enclosure containing the generator set, using Schedule 40 black steel pipe.
 - 2) Two-inch minimum fill connection.
 - 3) Two-inch minimum main fuel storage level gauge.
 - 4) 1.25-inch minimum low fuel level alarm with level switch connected to control panel.
 - 5) 0.5-inch minimum fuel supply with dip tube.
 - 6) 0.5-inch minimum fuel return with dip tube.
 - e. Provide rupture basin level switch and alarm.
 - f. Provide interior epoxy coating system.
 - g. Provide exterior epoxy coating with urethane top coat.
 - 3. Fuel Filters: Size filters for 10 percent above the engine fuel pump capacity:
 - a. Provide water/fuel separator.
 - b. Provide primary fuel filter.
 - c. Provide secondary fuel filter.
 - 4. Engine Fuel Pump: Provide engine-driven fuel pump which transfers fuel from the fuel tank as indicated on the Drawings:
 - a. Positive displacement pump.
 - b. Capable of 10-foot lift minimum.
 - c. Electrically driven fuel pumps are not acceptable.
 - d. Provide fuel pressure gauges on the pump suction and discharge.
 - 5. Fuel Cooling: When a base mounted fuel tank is specified and engine return fuel is routed back to the tank, or when recommended by the engine manufacturer for the installation configuration indicated, provide a fuel cooling heat exchanger to limit the tank fuel temperature to less than 120 degrees Fahrenheit after 24 hours continuous full load operation.
- E. Exhaust System:
 - 1. Provide a complete exhaust system following the general scheme as indicated on the Drawings and as specified.
 - 2. Back Pressure:
 - a. Provide components such that the maximum back-pressure in the exhaust system including piping and silencer is as required by Engine manufacturer, measured at the exhaust manifold header:
 - 1) Reduce allowable back-pressure when recommended by the engine manufacturer.

- b. Provide each exhaust manifold header with a lugged, tapped connection for the attachment of a test manometer.
- 3. Exhaust Piping:
 - a. Type: Schedule 40 high temperature black steel pipe conforming to ASTM A106.
 - b. Drainage: Slope piping to a drain point and provide drain plug.
 - c. Finishes: Sand blast and coat outside of exhaust piping with not less than 6 mils of inorganic zinc primer:
 - 1) Finish coat in the field as specified in Section 09960.
 - d. Insulation: As specified in Section 15082 for engine exhaust piping.
- 4. Exhaust Expansion Joints:
 - a. Type:
 - 1) Metal with convoluted portion of 0.038 inch thick Type 321 stainless steel.
 - 2) Non-convoluted portions of expansion joint to be Type 304 stainless steel, Schedule 10S pipe.
 - 3) Provide flanged ends with ASME B16.5, Class 150 bolt hole drilling.
 - b. Length: Minimum of 18 inches in length.
 - c. Movement:
 - 1) Rated for a minimum of 1 inch lateral movement, and 1/2 inch axial movement.
 - 2) Rated movement defined as plus or minus travel from neutral or free position.
 - d. Design Life: Infinite cycle life with 1,200 degrees Fahrenheit exhaust, no insulation over the expansion joint, and continuous duty service.
 - e. Insulation:
 - 1) Insulate expansion joints with custom fitted, removable with reusable fastening system, ceramic fiber insulation blankets enclosed between inner and outer high temperature fabric cover rated for 1,200 degrees Fahrenheit continuous duty.
 - 2) Do not insulate expansion joints directly connected to turbocharger outlet.
- 5. Exhaust Silencer:
 - a. Type: Heavy-duty industrial type fabricated of welded steel with ported tubes and snubbing chambers, and a rating meeting the specified sound attenuation.
 - b. Mounting: as indicated on the Drawings.
 - c. End Connections: Steel flanges with Class 150-pound drilling pattern.
 - d. Shell:
 - 1) Sufficiently heavy and reinforced to eliminate excessive vibration, stress, or deflection and to support all operating loads with the silencer at elevated temperatures and insulated as specified.
 - 2) Loads include insulation weight and connecting piping.
 - e. Drain: Provide threaded, plugged condensate drain.
 - f. Sound Attenuation: Attain the following minimum sound attenuation at the listed octave band center frequencies with the engine at full load:

Frequency (Hz)	63	125	250	500	1,000	2,000	4,000	8,000
Attenuation (dB)	39	42	42	40	38	38	38	38

- g. Supports: Provide shell lug supports suitable for supporting and mounting the silencer as indicated on the Drawings; support design to account for elevated temperatures under insulated shell.
- h. Insulation: Insulate as specified for engine exhaust piping in Section 15082.
- i. Pressure drop not to exceed 7 inch water column at maximum engine rating.
- F. Engine Jacket Water Heater:

- 1. Provide an in-line thermostat that disconnects power when coolant temperature exceeds an adjustable setpoint.
- 2. Contacts from the oil pressure switch to disconnect the heater power when the engine is running.
- 3. Equip the water heater with shutoff valves and unions to allow heater replacement without draining the cooling system.
- 4. Make all water heater connections with Aeroquip type hoses and fittings.
- 5. Size heater such that the engine block temperature is maintained at 85 to 100 degrees Fahrenheit in a 40 degree Fahrenheit ambient temperature.
- 6. Connect water heater and thermostat are to be connected to the engine in such a manner as to minimize heated water circulation through the radiator circuit.
- 7. Water heater power is to be supplied from a normal (utility) power source:
 - a. Heaters larger than 3,000 watts shall be 460 volts, 3-phase.
- G. Alternator (Generator):
 - 1. Brushless synchronous alternator.
 - 2. Re-connectable 12 lead if available.
 - 3. Self-ventilated.
 - 4. Full amortisseur windings.
 - 5. Skewed for smooth voltage waveform.
 - 6. With permanent magnet generator pilot exciter.
 - 7. Drip-proof enclosure.
 - 8. Protected against corrosion.
 - 9. Single bearing design.
 - 10. Insulation:
 - a. Insulated for continuous operation at 40 degrees Celsius ambient temperature.
 - b. Temperature rise not to exceed 70 degrees Celsius by thermometer and 80 degrees Celsius by resistance, consistent with a Class B rise.
 - c. Class F (105 degrees Celsius rise by resistance) for medium voltage or Class H (125 degrees Celsius rise by resistance) for low voltage generators.
 - d. Vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092.
 - e. Multiple dipped and baked with a non-hygroscopic varnish with a final dip of epoxy.
 - 11. Terminate alternator power leads using compression lugs on an insulator and bus bar system within the alternator junction box:
 - a. These terminations must not require any taping to complete the connection.
 - b. Utilize copper locomotive type cables to connect from the alternator to the load bank manual transfer equipment:
 - 1) Sized for 125 percent of the alternator full load current.
 - 2) Neutral conductors shall be sized at 100 percent of the alternator full load rating.
 - c. Provide a ground terminal inside the junction box to terminate the ground cables between the alternator to the automatic transfer equipment ground bus:
 - 1) Minimum size of the equipment-grounding conductor: 12 1/2 percent of the size of the phase conductors.
 - 12. Maximum balanced telephone interference factor not to exceed 50.
 - 13. Designed to supply power to the non-linear loads as indicated on the Drawings:
 - a. Variable frequency drives (VFDs).
 - b. Uninterruptible power supplies (UPS).
- H. Alternator Voltage Regulator:
 - 1. Located in the engine control panel.
 - 2. Performance requirements:

- a. Maintain the steady state voltage within 1 percent:
 - 1) From 40 degrees Fahrenheit to 120 degrees Fahrenheit.
 - 2) From no load to full load conditions.
- 3. Constant volts per hertz characteristics.
- 4. Static type:
- 5. Sized to match the power requirements at the permanent magnet generator pilot exciter.
- 6. Include manual control to adjust voltage drop, voltage level, and voltage gain.
- 7. With 3-phase sensing.
- 8. Sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.
- 9. Include loss of sensing shutdown to protect the generator against uncontrolled voltage output when the sensing circuit to the regulator is opened.
- 10. Shut down regulator when the sensing circuit to the regulator does not have continuity.
- 11. Include over-excitation shutdown to protect the generator against damage caused by prolonged field forcing.
- I. Radiator And Cooling System:
 - 1. Unit Mounted:
 - a. Furnish a skid mounted closed type radiator system for the engine driven generator:
 - 1) Sized and selected by Engine manufacturer.
 - b. Provide all necessary coolant specifically suitable for the location and conditions of service throughout the year:
 - 1) Ship both the engine and the radiator with the coolant installed.
- J. Wiring:
 - 1. All external wiring connection to and from the engine and alternator shall be made via 2 engine mounted junction boxes:
 - a. Boxes shall be NEMA 12.
 - b. One box shall be used for all control, and direct current power connections.
 - c. The other box shall be used for the alternator output connections:1) The alternator output breaker may be used for these connections.
 - 2. Enclose wiring in an NEC approved and recognized conduit system selected and sized by the engine generator manufacturer:
 - a. Suitable for the temperatures, vibrations, and conditions on the engine-driven generator skid.
 - 3. Control wiring shall terminate on terminal blocks in the Control Junction Box:
 - a. All connections shall be made to terminal blocks:
 - 1) 600 volt rated.
 - 2) Wires terminated on box with compression type ring type lugs, installed with proper tooling.
 - 3) Terminal blocks shall be numbered.
 - 4) All wiring in terminal box both internal and field connections shall be routed in plastic wire duct.
 - 4. Terminate wires using solderless compression type lugs:
 - a. Lug manufacturer's termination methods and tools must be used.
 - 5. Splices are not allowed:
 - a. All connections are to be made at the terminal blocks in the control junction boxes.
- K. Battery System:
 - 1. Installed on the engine-driven generator skid.

- 2. Provide extra flexible minimum 4/0 welding cable to make the connection between the battery and the engine:
 - a. Proper compression lugs and tooling must be used to terminate these cables.
- 3. Provide a 24-volt lead acid recombination no maintenance engine start battery system:
 - a. The battery rated such that the 90 second cranking current to 1.0 volts per cell exceeds the starter rolling current at 40 degrees Fahrenheit:
 - 1) For the above ratings to be valid, the starter breakaway current must not exceed the rolling current by a factor of more than 2.5.
 - 2) Increase the battery size in order to supply power to the room ventilation louvers, switchgear relaying and controls, and any direct current lighting.
- 4. Charger:
 - a. Sized to provide sufficient power to both fully charge a drained battery and power the room ventilation louvers, controls, and any direct current lighting.
 - b. Charger located on the engine skid.
 - c. With direct current ammeter and direct current voltmeter.
 - d. With On-Off switch.
 - e. Solid-state device with adjustable float voltage control.
 - f. Constant voltage design with current limit.
 - g. With an equalize switch which will allow the battery to be overcharged for maintenance purposes.
 - h. Designed to meet the charge, float, and equalize requirement of the battery furnished.
 - i. Overload and short circuit protection.
- L. Miscellaneous engine generator skid items:
 - 1. Provide the following items:
 - a. Sectionalized drip pans.
 - b. Rain shields for exhaust lines.
 - c. Roof jacks.
- M. Automatic Generator Control Equipment:
 - 1. Provide a microprocessor-based control system for automatic starting, monitoring, and control functions for the engine generator system.
 - 2. Control system features and functions:
 - a. Control Switches:
 - 1) Mode Selector Switch: The mode select switch initiates the following control modes:
 - a) Provide a rotary switch or control panel keypads with status indicators.
 - b) RUN or Manual Position:
 - 1. Generator set starts, and accelerates to rated speed and voltage.
 - c) OFF or STOP Position:
 - 1. Generator set immediately stops, bypassing all time delays.
 - d) AUTO Position:
 - 1. Generator set accepts a signal from a remote device to start and accelerate to rated speed and voltage.
 - 2) EMERGENCY STOP Switch:
 - a) Red "mushroom-head" pushbutton.
 - b) Activating the emergency stop switch causes the engine to immediately stop, and be locked out from automatic restarting.
 - 3) RESET Switch:
 - a) Clears all faults and allow restarting the engine generator after it has shut down for any fault condition.

- 4) PANEL LAMP switch or automatic display panel illumination.
- b. Alternating Current Output Metering: Provide the control system with metering including the following features and functions:
 - 1) Voltmeter:
 - a) RMS Voltage.
 - b) Line-to-line.
 - c) Line-to-neutral.
 - 2) Ammeter:
 - a) RMS current.
 - 3) Frequency.
 - 4) Power Factor.
 - 5) Kilowatts (kW):
 - a) kW-hours.
 - b) Output kW.
 - 6) Kilovars (kVars):
 - a) kVar-hours.
 - b) Output kVar.
 - 7) Provide Digital Metering:
 - a) 1.0 percent accuracy.
- c. Generator Alarm and Status Display:
 - 1) Provide high-intensity LED alarm and status indication lamps. Functions indicated include:
 - a) Red alarm-indicating lamps.
 - b) Red common shutdown lamp.
 - c) Two Green Lamps:
 - 1. One to indicate the engine generator is running at rated frequency and voltage based on actual sensed voltage and frequency on the output terminals of the generator set.
 - 2. The second to indicate a remote start signal has been received.
 - d) Flashing red lamp to indicate that the control is not in automatic state:
 - e) Amber common warning indication lamp.
 - 2) Display the following alarm and shutdown conditions on an alphanumeric digital display panel:
 - a) Low oil pressure (alarm).
 - b) Low oil pressure (shutdown).
 - c) Oil pressure sender failure (alarm or indication).
 - d) Low coolant temperature (alarm).
 - e) High coolant temperature (alarm).
 - f) High coolant temperature (shutdown).
 - g) High oil temperature (warning).
 - h) Engine temperature sender failure (alarm or indication).
 - $i) \quad \mbox{Low coolant level (alarm or shutdown selectable).}$
 - j) Fail to crank (shutdown).
 - k) Fail to start/overcrank (shutdown).
 - 1) Overspeed (shutdown).
 - m) Low direct current voltage (alarm).
 - n) High direct current voltage (alarm).
 - o) High alternating current voltage (shutdown).
 - p) Low alternating current voltage (shutdown).
 - q) Under frequency (programmable for alarm or shutdown).
 - r) Overcurrent (programmed for warning or shutdown).
 - s) Short circuit circuit breaker function (trip).
 - t) Emergency stop (shutdown).

- 1. The control shutdown fault conditions shall be configurable for fault bypass.
- d. Engine Status Monitoring:
 - 1) Display the following status conditions on an alphanumeric digital display panel:
 - a) Engine oil pressure (pounds per square inch or kilopascal).
 - b) Engine coolant temperature (degrees Fahrenheit or Celsius).
 - c) Engine oil temperature (degrees Fahrenheit or Celsius).
 - d) Engine speed (revolutions per minute).
 - e) Number of start attempts.
 - f) Battery voltage (direct current volts).
- e. Data Logging and Display Provision:
 - 1) Log the last 10 warning or shutdown indications on the engine generator.
 - 2) Monitor the total load on the generator:
 - a) Maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments.
 - b) Display total hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
 - 3) The Control System to Log:
 - a) Total number of operating hours.
 - b) Total kW hours.
 - c) Total control on hours.
 - d) Total values since reset.
- f. Engine Control Functions:
 - 1) Provide a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles:
 - a) Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
 - 2) Provide an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification, including adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
 - 3) Provide time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.
- g. Battery Monitoring System:
 - 1) Initiate alarms when the direct current control and starting voltage is less than 25 VDC or more than 32 VDC.
 - 2) Disable the low voltage limit during engine cranking (starter engaged).
 - 3) Monitor direct current voltage as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.
- h. Remote Control Interfaces:
 - 1) Provide a minimum of 4 programmable output relays:
 - a) Configurable for any alarm, shutdown, or status condition.
 - 2) Provide a minimum of 4 programmable inputs:
 - a) Label as indicated on the Drawings.
 - b) Labels shall match other control labels.
- N. Generator Output Circuit Breaker:
 - 1. Engine generator skid mounted and line side connected to alternator.
 - 2. Manually resettable.
 - 3. Line current sensing.
 - 4. Inverse time versus current response.

- 5. Sized and coordinated to protect the generator from damage from overload and/or short circuit:
 - a. Coordinated with down stream devices:
 - 1) Refer to Section 16305.
- 6. Breakers shall be furnished in conformance with Section 16412.

2.3 ACCESSORIES

- A. Weatherproof acoustical housing:
 - 1. Provide engine enclosure to protect engine, generator, starting system, batteries, and other specified accessories from weather exposure.
 - 2. Meet seismic and wind requirements at the Project Site.
 - 3. Construction:
 - a. Minimum 14 gauge steel panel thickness.
 - b. All panels and members hot dip galvanized after fabrication.
 - c. Enclosure removable to allow for maintenance.
 - d. Fitted with lockable latches.
 - e. Stainless steel latches and hinges.
 - 4. Finishing: Factory or shop finished in epoxy and urethane coating system as specified in Section 09960.
 - 5. Noise reduction:
 - a. Provide acoustical insulation and acoustical enclosure ventilation louvers and fan discharge silencers as necessary to achieve a measured sound pressure level of 75 dBA when measured at 23 feet from the enclosure.
 - b. Protect acoustical insulation with perforated metal covers and plastic bagging to prevent damage from abrasion or weather elements.
 - 6. Provide an exhaust silencer matched to the enclosure to reduce the overall noise emissions level of the engine/generator assembly to the levels required above.
 - 7. Coordinate supply of access platforms for both sides of the generator enclosure as shown on the plans. Reference Specification 05500 Miscellaneous Metals.

2.4 SOURCE QUALITY CONTROL

- A. Design prototype tests as follows:
 - 1. Use design prototypes similar to the equipment specified herein for testing, and not the actual equipment for the project.
 - 2. Minimum testing requirements:
 - a. As required by NFPA.
 - b. Maximum power in kW.
 - c. Maximum starting kilovolt-ampere at 35 percent instantaneous voltage dip.
 - d. Alternator temperature rise:
 - 1) By embedded thermocouple.
 - 2) By resistance method.
 - 3) Per NEMA MG1-22.40 and 16.40.
 - e. Governor speed regulation under steady state and transient conditions.
 - f. Fuel consumption at 25 percent, 50 percent, 75 percent, and 100 percent load.
 - g. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
 - h. Cooling airflow.
 - i. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
 - j. Endurance testing.
 - k. A certified copy of the test results will be furnished to the OWNER.

- B. Test each engine generator under varying loads with all machine safety guards and exhaust system in place.
- C. The complete engine generator system is to be tested at full load in the manufacturer's establishment:
 - 1. Test must include:
 - a. Radiator.
 - b. Engine Control Panel.
 - c. Single-step load pickup.
 - d. Transient and steady-state governing.
 - e. Safety shutdown device testing.
 - f. Rated power.
 - g. Maximum power.
 - 2. During the full load tests, re-circulate the radiator cooling air through the radiator as necessary to test the system under the maximum ambient conditions specified herein.
 - 3. Run the unit for 8 hours at 100 percent load with the following recordings made hourly:
 - a. Frequency.
 - b. Voltage.
 - c. Amperage.
 - d. Kilowatts.
 - e. Room temperature as measured at the generator end of the unit.
 - f. Radiator air inlet temperature.
 - g. Coolant temperature.
 - h. Oil pressure.
 - i. Time engine takes to start in seconds.
 - 4. Record the following items:
 - a. Maximum block load capabilities of the unit.
 - b. Maximum fuel pump vacuum in inches of mercury as measured with the fuel suction line closed.
 - c. Point at which Over Temperature Shutdown Occurs:1) By actual test of over temperature switch remote from engine.
 - d. Point at which Over Speed Shutdown Occurs:1) By actual test of speed switch remote from engine.
 - e. Point at which Low Oil Pressure Shutdown Occurs:
 - 1) By actual test of low oil pressure switch remote from engine.
 - f. Point at which overcrank shutdown occurs.
 - g. Point at which overspeed shutdown occurs.
 - h. Low water temperature alarm.
 - i. Low fuel level alarm.
 - j. Fuel leak alarm.
 - k. Overvoltage alarm and shutdown.
 - I. Undervoltage alarm and shutdown.
 - m. Under frequency alarm and shutdown.
 - n. Low battery voltage alarm.
 - 5. Furnish a certified copy of the test results to the OWNER:
 - a. These test results must record any minor adjustments made during the test.
 - b. If major changes, as determined by the ENGINEER, are made, the 8-hour test must be repeated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 16050.
- B. General:
 - 1. Install the equipment as indicated on the Drawings.
 - 2. Perform all work in accordance with manufacturer's instructions and shop drawings.
- C. Installation shall be by personnel experienced and regularly engaged in field installation of power generation systems:
 - 1. Make all field mechanical and electrical connections.
- D. Mount fuel tank at the elevation relative to the engine recommended by the manufacturer to achieve proper engine fuel pump suction conditions while avoiding fuel flooding in the engine return system.

3.2 FIELD QUALITY CONTROL

- A. Refer to Section 16050.
- B. Test actual backpressure during acceptance testing of the system.
- C. Provide the services of a manufacturer's representative for the following:
 - 1. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with all Drawings and Specifications.
 - 2. Furnish the services of factory-certified technicians during the start-up and adjustment period to make sure all items furnished are in proper operating condition:
 - a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
 - b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
 - c. These technicians to instruct the OWNER's personnel regarding the operation and maintenance of all items supplied:
 - 1) Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.
 - d. Furnish a written report after the start-up:
 - 1) Report must state that the installation is complete and satisfactory.
 - 2) List the items requiring additional attention.
- D. Manufacturer to perform installation check, start-up, and load test.
- E. Certify that fuel, lubricating oil, and antifreeze conform with the manufacturer's recommendations under the environmental conditions present.
- F. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine:
 - 1. These accessories include but are not limited to:
 - a. Battery charger.
- G. Start-Up Under Manual Mode:

- 1. Check for the following items:
 - a. Exhaust leaks.
 - b. External path for exhaust gases.
 - c. Cooling airflow.
 - d. Movement during starting and stopping.
 - e. Vibration during running.
 - f. Normal and emergency line-to-line voltage and phase rotation.
- H. Automatic Start-Up:
 - 1. By means of simulated power outage test the following:
 - a. Set all timers for proper system coordination.
 - b. Remote automatic starting.
 - c. Transfer of load.
 - d. Automatic shutdown.
 - 2. Continuously monitor the following parameters during this test:
 - a. Engine temperature.
 - b. Oil pressure.
 - c. Battery charge level.
 - d. Generator voltage.
 - e. Generator amperes.
 - f. Frequency.

3.3 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, ENGINEER, or testing firm.

3.4 DEMONSTRATION AND TRAINING

- A. Refer to Section 16050.
- B. Demonstrate operation of equipment in accordance with Section 01756.
- C. Generating System:
 - 1. Full-load test the generating system at the site in the presence of the ENGINEER for a period of 8 hours, with the manufacturer providing the necessary resistive and reactive load banks to test at 0.8 power factor:
 - a. Permanently installed load banks supplied as part of the project may be utilized to provide part of the specified load.
 - 2. Before acceptance of the installation, subject equipment to process system load tests, with available motor load, but not to exceed the generator's nameplate rating, for a period of 4 hours.
 - 3. Correct defects that become evident during testing.
 - 4. Measure flows, pressures and temperatures of fuel, coolant, exhaust gas, and radiator air at inlets and outlets to system components.
 - 5. Provide test report.
 - 6. Measure radiator performance at full load including airflow, air inlet temperature, and air outlet temperature.
- D. Upon completion of the work, at a time to be designated by the OWNER's representative, manufacturer to demonstrate for the OWNER the operation of the engine installation, including any and all special systems furnished by them, or installed under their supervision.

- E. Test all control functions in conjunction with the engine generator start-up:
 - 1. These tests must include all normal starting and stopping functions as outlined in these Specifications.
- F. Training:
 - 1. Manufacturer's technicians must provide all training:
 - a. Technicians to instruct the OWNER's personnel regarding the operation and maintenance of all items supplied:
 - 1) Supply written handouts during the training period that are suitable for future reference after the training period is completed.
 - b. Mechanical maintenance training must cover:
 - 1) Mechanical operations.
 - 2) Preventative maintenance:
 - a) Daily maintenance.
 - b) Periodic maintenance.
 - c) Detailed and overhaul maintenance of the engine and generator.
 - 3) Conducted by the manufacturer's mechanical technician.
 - 4) Maintenance training:
 - a) Minimum of 8 hours.
 - b) Two sessions of 4 hours each.
 - c. Electrical maintenance training must cover:
 - 1) Preventative maintenance.
 - 2) Normal operational conditions
 - 3) Settings, and adjustments.
 - 4) Electrical training duration:
 - a) Minimum of 4 hours.
 - b) 1 session of 4 hours each.
 - 5) Conducted by the manufacturer's electrical technician.
 - d. Combined maintenance training shall cover the interrelationship between the mechanical and electrical systems:
 - 1) Joint electrical and mechanical session duration:
 - a) Minimum of 4 hours.
 - b) One session of 4 hours each.
 - 2) To be conducted by the manufacturer's electrical and mechanical technicians.
 - e. Operations training covering and detailing the normal, exercising, and day to day operations of the equipment:
 - 1) Operations training duration:
 - a) Minimum of 4 hours.
 - b) Two sessions of 2 hours each.
 - c) Schedule around plant operations shifts.
 - 2. Furnish complete manuals, and training DVD for:
 - a. Training up to three (3) plant personnel.

3.5 PROTECTION

A. Refer to Section 16050.

+ + END OF SECTION + +

SECTION 16269

VARIABLE FREQUENCY DRIVES - 600V

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the design, manufacturing, testing, and delivery to the jobsite of metal enclosed, free-standing Variable Frequency Controller (VFD)(drive), complete with accessories and all auxiliary equipment needed to accomplish the functions required by this specification.
- B. This specification shall cover 6, 12, or 18 pulse and active front-end (AFE) Variable Frequency Controllers for 230V, 460V and 600V loads.
- C. Related Sections
 - 1. 16000 Electrical General Requirements
 - 2. 16075 Electrical Identification
 - 3. 16120 Conductors and Cables
 - 4. 16130 Raceways and Boxes

1.2 REFERENCES

- A. The drive shall comply with the following:
 - 1. National Electric Manufactures Association (NEMA) Safety standards for Construction and Guide for Selection, Installation and Operation of Variable Frequency Controller Systems
 - 2. National Electrical Code (NEC) NFPA 70
 - 3. NEMA 250 Enclosures for Electrical Equipment
 - 4. IEC 146 International Electrical Code
 - 5. ISO 9001
 - 6. UL 508 Qualifications
 - 7. IEEE Standard 519
 - 8. Additional standards as listed in DIV 1 project specifications.

1.3 DEFINITIONS

Section not used.

1.4 SYSTEM DESCRIPTION

- A. The drives will be Manufacturers standard design, suitable for heavy duty industrial use and for the intended service. They will be installed in an industrial facility operating 24 hours a day 7 days a week.
- B. Regulations
- C. This specification requires compliance with all laws and regulations which may be applicable including the Occupational Safety and Health Act (OSHA), as well as rules, regulations, and standards of the Secretary of Labor.

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1.5 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Manufacturer's literature, illustrations, specifications and engineering data which indicate performance, dimensions, materials, size and weight.
 - 2. Complete list of components and catalogue identification.
 - 3. List of in-house manufactured key components.
 - 4. Quality Assurance Program description.
 - 5. Complete description of schematic and wiring diagrams and functional operation.
 - 6. Recommended spare parts list.
- B. Submittal literature, drawings, and documentation shall be clear, legible, and written in English. Failure to comply will result in rejection of submittal.
- C. Product brochures must be sufficiently detailed so that an engineering evaluation may be completed on the suitability and part number of the equipment.
- D. Submit details of the manufacturing quality assurance/quality control program and any QA/QC certifications.
- E. Receipt by Owner or Owner's Representative of all test and calibration submittals is a condition for final payment of the purchase order.
- F. Submit written certification that all assembly, fabrication, and manufacturing has been performed in accordance with manufacturer's written QA/QC policy and standards. Receipt of this submittal is a condition for final payment of the purchase order.
- G. Submit cost for the services of a factory trained technician or engineer to assist in startup and commissioning. Pricing shall include hourly or daily rate, estimated travel and per diem costs, and minimum number of days recommended for this service.
- H. Note any exceptions to this Specification.

1.6 QUALITY ASSURANCE

- A. Manufacturer shall be regularly engaged in the production of these drives and shall have in place a quality assurance program to be applied during the preparation and fabrication of the instruments.
- B. After Sales Support
 - 1. Qualified support shall be available either directly from the manufacturing facility or from a network of factory-trained distributors and certified service centers located throughout North America and Canada.
- C. Drive manufacturing facility shall be an ISO9001 certified manufacturing facility.
- D. Assembly shop to be UL-508 certified.
- E. Regulatory Requirements

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1. Instruments shall have a UL listing and are marked and labeled in accordance with applicable codes and standards. If manufacturer's equipment is approved by a recognized testing laboratory other than UL, then the manufacturer shall provide a letter from the local authority having jurisdiction stating that such testing is acceptable to them.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading
- B. All equipment shall be adequately crated or protected, including export packing where required to prevent damage in handling, transit, and storage at the site.
- C. Each item, piece, or subassembly of equipment shall have a securely attached metal tag stamped with the tag number. All crates and boxes shall be stenciled with the tag number. Tags and stencils shall be in a conspicuous place and readable.
- D. Transmit to Owner or Owner's Representative the shipping lists and delivery dates prior to the day the equipment leaves the shop. Transmittal receipt must be confirmed by Owner or Owner's Representative prior to shipping equipment.
- E. Each shipping piece shall be clearly marked with 2 to 3 inch high contrasting numbers and/or letters, giving tag number as called out on detail drawing. Piece marking shall be with a non-erasable marker.
- F. In addition to the piece marking, a standard 3 inch by 5 inch red shipping tag shall be wired to each shipping lot. This tag shall state the range of tag and mark numbers, Vendor's name and address, owner or Owner's Representative's name, jobsite address and Purchase Order number.

1.8 TAGGING

- A. Each piece of equipment and loose accessory shall be tagged with a non-corroding metal tag as described below and securely affixed to the equipment by pins or non-corroding metal screws.
- B. Tagging information shall include the Owner's Purchase Order Number, P.O. Item Number, Owner's Equipment Number, Vendor's Name, Vendor's Model Number, Vendor's Shop Order Number, and Voltage stamped on the tag. Letters and numbers must be at least 1/8" (.125 inches) high.

1.9 ACCEPTANCE AT SITE

A. Inspect for visible and hidden damage and immediately notify Owner and Shipper of damage. Return to manufacturer for repair or replacement without compromising the construction schedule.

1.10 STORAGE AND PROTECTION

- A. Store and protect equipment in accordance with manufacturer's recommendations. At a minimum, protect equipment from water, excess heat or cold, and construction dirt and debris.
 - 1. project/site conditions
- B. Environmental Requirements
 - 1. In accordance with specification Division 1
 - 2. Drive will be located outdoors. Enclosure must be suitable for outdoor use and must include enclosure air conditioning.

1.11 SCHEDULING

A. Coordinate shipping schedules as per priorities with the Owner or the Owner's Representative.

1.12 WARRANTY

A. The warranty period for the equipment specified herein shall be a minimum two (2) years from the date of commercial operation at Owner's facility or eighteen (18) months from the date of delivery, whichever comes first. Vendor shall retain originals of all test reports through the duration of the equipment warranty period

1.13 MAINTENANCE

Section not used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Allen Bradley 755TL Active Front-End
- B. No Substitution

2.2 GENERAL

- A. This specification covers AC adjustable frequency drives for industrial applications.
- B. The manufacturer shall not have less than fifteen years of experience in the manufacture of AFD's.
- C. The drives shall be manufactured in the United States.
- D. All components will be accessible from the cabinet door for service. Drive(s) must be designed for side-by-side, back-to-back, or against the wall installation.
- E. Drive harmonics are to be meet the requirements of IEEE 519 at the point of common coupling. If drive by itself will not comply with IEEE 519, furnish line reactors or harmonic filters to achieve compliance.

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- F. The unit shall be NEMA type 1, freestanding metal enclosed control cabinet with hinged front access door(s), filtered ventilation system (if required) and containing main circuit breaker, static power conversion equipment, by-pass contactors with overloads (if required), and all necessary controls, protection and metering, mounted, wired and tested, including at least the following:
 - 1. Input disconnect switch, externally operated, with current limiting fuses for inverter. Provide mechanical interlocks with enclosure door.
 - 2. 115 Volt grounded AC control circuit.
 - a. Operator controls as shown on the schematic diagram which may include the following:
 - b. A speed control potentiometer
 - c. Hand/Off/Auto Selector Switch
 - d. Emergency Stop Pushbutton
- G. Furnish each unit with a nameplate of laminated black and white plastic with beveled edges, with letters engraved through the white finish top lamination, exposing black interior lamination, containing the following information:
 - 1. Unit Number
 - 2. Shop Order Number
 - 3. Horsepower
 - 4. Short Circuit Rating
 - 5. Date Manufactured
 - 6. Drawing Number(s)

2.3 DESIGN CRITERIA

- A. Input Power
 - 1. The drive main input power shall be three phase 480VAC 50/60 Hz
 - The drive shall have a voltage tolerance of +/-10% for all 200V and 400V drives. The voltage tolerance for 600V drives twenty horsepower and above shall be +/-10% and +5/-10 for 600V product below 20 Hp.
 - 3. Input frequency tolerance shall be +/-5% for all ratings.
 - 4. The efficiency of the drive shall be a minimum of 97.0% at full load at full speed. Displacement power factor will be greater than 0.95 lagging over the entire speed range.
 - 5. The Maximum Short Circuit Current Rating of the VFD shall be 200,000A RMS symmetrical for all ratings.
- B. Active Front End
 - Use transistor-based Active Front End as the input rectifier that uses a Selective Harmonic Elimination algorithm, mitigating the harmonics enough to meet IEEE-519-2014 without the need for phase shifting transformers and multi-pulse diode rectifiers. Total current harmonic distortion shall not exceed 5% at the VFD input terminals at full load conditions. AFE rectifier shall be phase rotation insensitive, tolerant of line voltage imbalance up to 10% without affecting the harmonic mitigation or VFD output, and capable of operating the motor at full output with a 10% drop on input voltage.
 - 2. Use an LCL filter assembly to filter up to and including the 50th harmonic to reduce EMI/RFI emissions. The LCL filter assembly shall include Passive Dampening. The drive will provide Active Resonance Detection and Protection to minimize any damage to the drive from supply side resonance.

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- 3. The drive shall have the following specific features to enable integration with a Rockwell Automation® ControlLogix® or CompactLogix[™] Automation Controller
 - a. Shall have an Add-on Profile available for use with Rockwell Automation® Studio 5000® programming software
 - b. Shall support Rockwell Automation controller's Automatic Device Configuration functionality
- 4. The drive shall have a built-in circuit breaker as part of the drive's pre-charge circuit (250 hp and up) or provide built-in electrical connections for one to be field connected (10hp-250hp).
- 5. The drive will have two sets of tuning settings for the configuration of the line side converter such that appropriate values can be selected for two input sources (example: main utility power or back-up generator) and can be selected from the Human Interface Module or communications network.
- 6. The VFD shall meet the voltage sag ride-through requirements of SEMI-F47.
- 7. The VFD shall meet the seismic requirements of the following standards when installed according to the manufacturer's instructions
 - a. American Society of Civil Engineering ASCE 7-10 (2010)
 - b. The International Building Code IBC (2015)
 - c. International Code Council Evaluation Service ICC_ES-AC156 (2012)
- 8. The operating elevation shall be up to 1000 Meters (3,300 ft) without derating (at a motor side inverter carrier Frequency of 1.33 KHz) and up to 4000 Meters with derating according to manufacturer's specifications.
- 9. Incorporate phase-to-phase and phase-to-ground MOV protection on the AC input line.
- 10. Use gold plated plug-in connections on printed circuit boards.
- 11. Microprocessor-based inverter and converter logic shall be isolated from power circuits.
- 12. Use latest generation IGBT inverter and converter sections that shall not require commutation capacitors.
- 13. Motor side inverters, line side converters and LCL filter modules (for drives greater than 250 Hp) shall be on roll-out chassis with front accessible connections for ease of repair or replacement and to provide access to load cables. Motor side inverter modules shall be removable without disturbing the load cables after installation.
- 14. Line converter modules and load inverter modules sections (for drives greater than 250 Hp) shall be interchangeable so as to reduce necessary spare parts.
- 15. Built-in managed dual EtherNet/IP ports for direct network connections, allowing linear or Device Level Ring topologies. The same network for control must support safety, I/O, and motion control, as well as be able to switch using standard unmodified Ethernet networking equipment.
- 16. Additional DPI[™] port for handheld and remote HIM options.
- 17. Configurable digital input for hardware enablement.
- 18. Conformal coated printed circuit boards.
- 19. Provision for external 24V DC Auxiliary Control Power Supply.
- 20. Have a lineside converter input frequency range from 47 to 63 Hz
- 21. The carrier frequency of the lineside converter shall be fixed at 4 kHz.
- 22. The motor side inverter frequency output will be sine coded PWM with a carrier frequency that can be selected at 1.33 kHz, 2 kHz, or 4 kHz.

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- 23. The VFD motor side inverter shall be capable of the following maximum frequency outputs:
 - a. 325 Hz when operating with an output carrier frequency of 1.33kHz or 2 kHz.
 - b. 590 Hz when operating with an output carrier frequency of 4kHz
- 24. The VFD enclosure (F7 and up) shall include the following:
 - a. Shall be rated IP65 (UL Type NEMA 4) minimum with Air Conditioning
 - b. The VFDs shall be of modular design with the following major components:
 - i. AC pre-charge module
 - ii. Roll out LCL filter modules
 - iii. Roll out line side converter IGBT power modules
 - iv. Roll out motor side inverters. IGBT power modules
- C. Ratings
 - 1. Voltage
 - a. Capable of accepting nominal plant power of 400V AC, 480V AC, 600V AC, or 690V AC at 50 Hz or 60 Hz as indicated on the contract drawings.
 - b. The supply input voltage tolerance shall be \pm 10% of nominal line voltage.
 - 2. Displacement Power Factor
 - a. AFE Low Harmonic Drive's line side converter shall be capable of maintaining a minimum true power factor of up to 0.98 across the entire speed range.
 - 3. Efficiency
 - a. A minimum of 97% (+/- 2%) at 100% speed and 100% motor load at nominal line voltage.
 - b. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.
 - Operating ambient temperature range without derating: -20°C +40 °C (-4 °F -104 °F), extendable to 55 °C (134 °F) with de-rating if indicated in the contract drawings.
 - 5. Operating relative humidity range shall be 5% to 95% non-condensing.
- D. Hardware Design
 - 1. Overall hardware design is for maximum flexibility, robustness, serviceability, and reliability for the most demanding applications.
 - 2. Power Terminations are oversized for the drive current rating to allow for flexibility on all power terminations.
 - 3. Drive cabinets contain a minimum of three ground termination points.
 - 4. Power Terminations are 'finger safe' and clearly labeled with both the US (NEMA) standards (L1, L2...T2) and IEC standards (R, S...W).
 - 5. The latest technology in packaging, heat sink design, and cooling is utilized to minimize overall size and weight without degrading performance or functionality.
 - 6. Plastics, where used, are UV resistant.
 - 7. Standard packaging is NEMA 1.
 - 8. Interrupting current rating of 200KAIC for all ratings.

- 9. Power Semiconductor heat sinks contain one or more thermal sensors monitored by the microprocessor to prevent semiconductor damage caused by excessive heat or fan loss.
- E. Converter Section
 - 1. The drive employs diode bridge rectification to convert AC to DC. SCRs and other switching power devices are not used in the converter section of the drive to minimize line notching and RFI.
 - 2. The Converter Section is unaffected by phase rotation/phase sequence.
 - 3. Semiconductors on all ratings are sized (current) to allow full operation and overload capabilities at minimum input voltage.
 - 4. PIV Ratings of the rectifier will be as follows:
 - a. 220V drives--rectifier minimum PIV rating of 800V
 - b. 460V drives—rectifier minimum PIV rating of 1600V
 - c. 600V drives rectifier minimum PIV rating of 1700V
 - 5. The drive shall have MOVs mounted phase to phase for surge protection.
 - 6. Isolation transformers are not required for operation on most standard distribution systems.
 - 7. The converter section is usable on 50Hz or 60Hz distribution systems.
- F. DC Bus Section
 - 1. Overall DC Bus design is passive capacitive filter to minimize ripple and maximize power-loss ride-through.
 - 2. DC Bus capacitance (total filter capacitance) is sized to eliminate any requirement for bus inductance (for filtering purposes) when the DRIVE is used on a three-phase distribution system.
 - 3. The DC bus voltage and current are monitored by the control section to prevent damage to either the drive or the driven equipment.
 - 4. All ratings will contain fast acting fuses in the DC Bus section.
 - 5. 220V drives bus capacitance voltage rating 400VDC (minimum)
 - 6. 460V drives bus capacitance voltage rating 800VDC (minimum)
 - 7. 600V drives bus capacitance voltage rating 1050VDC (minimum)
 - 8. All capacitors have balance/discharge resistors to equalize charge voltage and permit safe discharge on power outage
 - 9. Soft charge circuitry does not utilize power transistors nor time delay relays
 - 10. The DC Bus Section has complete power terminations to allowing:
 - a. Rectifier Isolation (positive side)
 - b. Addition of extended 'ride through' capacitor bank
 - c. Line regeneration using third party units
 - d. DC Link inductor
 - e. Common DC bus applications
 - f. DC input
 - 11. A readily visible LED indicates when DC voltages are present
 - 12. The DC Bus section is designed to permit common DC bussing of multiple drives.
- G. Inverter Section
 - 1. The inverter section makes use of the latest generation of IGBT power switching transistors to convert DC to three phase, variable frequency, sinusoidal coded PWM waveform.
 - 2. IGBT initialization testing is performed by the control section on each power up and run command.

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- 3. The inverter section does not require commutation capacitors.
- 4. All drives have software and hardware to limit reflected wave caused by long motor cable lengths.
- 5. The IGBT ratings will be as follows:
- 6. 220V drives IGBT minimum Vce rating 600V
- 7. 460V drives IGBT minimum Vce rating 1200V
- 8. 600V drives IGBT minimum Vce rating 1200V
- 9. All IGBTs have reversed biased diodes (free wheeling) to prevent IGBT failure when subjected to motor discharge spikes
- 10. PWM switching frequencies are adjustable from 0.5 to 15kHz to 100Hp and 0.5 to 5kHz above to minimize audible motor noise and maximize both motor and drive efficiency.
- 11. IGBTs are sized (current) to allow the drive to operate at 110% (current) continuous and 150% (current) for up to 120 seconds. On units greater than 100Hp IGBT's will have an overcurrent rating of 130% for 120 seconds.
- 12. To allow dissipation of regenerated energy, all drives contain a microprocessor controlled dynamic braking transistor. The dynamic braking transistor is an IGBT power semiconductor that is sized to allow 100% motor braking torque when connected to an appropriate resistor.
- 13. The dynamic braking transistor is fully protected by the microprocessor.
- 14. The dynamic braking transistor will not 'turn on' when the drive is not actively engaged in controlling a motor.
- 15. Output currents in each phase are monitored using hall-effect current transducers to enabling control of flux current, torque current, and providing protection to both the drive and driven equipment.
- 16. The inverter section is capable of sensing and interrupting a phase to phase or phase to ground fault on the output of the drive.
- H. Control Section
 - 1. The control section is designed to provide complete monitoring and protection of drive internal operations while communicating with the outside world via one or more user interfaces.
 - 2. The microprocessor used is the latest design CPU with adjustable frequency drive specific circuitry and firmware.
 - 3. Algorithms for sensorless vector speed control, sensorless vector torque control, feedback vector speed, torque, and position control are resident in EEPROM memory and utilized by the microprocessor when applicable.
 - 4. Microprocessor logic circuits are isolated from power circuits
 - 5. Where switching logic power supplies are utilized, they are powered from the DC Bus Section of the drive.
 - 6. Microprocessor diagnostics are performed (on application of power) to prove functionality and viability of the microprocessor.
 - 7. Memory cyclic redundancy check (CRC) is performed (on application of power) to prove integrity of EEPROM and UVPROM memories.
 - 8. Motor diagnostics are performed (on application of power and each start) to prevent damage to a grounded or shorted motor. The motor diagnostics may be disabled when using a low impedance motor.
 - 9. All ratings contain at a minimum the following communications ports;
 - a. 1200 to 9600 baud rate, automatic baud rate and parity setting
 - b. RS222/RS485 automatic switching port 1200 to 28400 baud rate,

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- 10. The control section is designed to allow 'quick change' of the interface sections for both configuration and functionality.
- I. Interface Section
 - 1. Each drive shall have two user interfaces (in addition to the communication ports) as standard:
 - a. Electronic Operator Interface A 90 X 280 (nominal) Graphical Backlit LCD display with the ability to display multiple parameters on one screen. The EOI shall provide complete operating, monitoring, and programming functionality. The EOI shall be capable of operation from an external power source and firmware operating system is flash upgradeable and may be customized for special applications. The EOI shall contain a TTL communication port and an RS485 communications port for remote mounting. A Real Time Clock option shall be available for the EOI that allows provides complete data logging in the event of a fault.
 - b. Terminal Board Interface shall provide complete operation functionality. Standard terminal board interface shall provide eight digital inputs, three digital outputs, four analog inputs, two analog outputs, and one pulse output. Inputs and outputs are independently configurable for both scaling and functionality.
 - 2. The drive shall retain the ability to function with no attached interface.
 - a. Output Power
 - 1) The output voltage is adjustable from 0 to rated input voltage.
 - 2) The output frequency range is adjustable for a maximum frequency output of 60 Hz.
 - 3) The output (inverter) section of the drive will produce a PWM sinusoidal coded waveform.
 - 4) The output power switching devices shall be IGBT devices of the latest design.

2.4 ELECTRONIC OPERATOR INTERFACE

- A. The EOI shall provide a convenient method of programming, operating, and monitoring the AFD. Parameters shall be grouped in a logical manner allowing rapid access to all parameters. All parameters are displayed in an easily understandable format using plain English for all items.
- B. The graphical display shall allow groupings of multiple, logically associated parameters to be displayed on a single screen.
- C. EOI backlighting controls may be configured for the wide range of ambient lighting conditions.
- D. The customizable graphical display enables the use of user friendly units such as feet per minute, gallons per hour.
- E. For security, the EOI functionality and access may be limited and password protected preventing an unauthorized user from accessing parameters, functions, or monitoring.

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2.5 FUNCTIONALITY

- A. Drive shall contain four sets of independently configurable acceleration / deceleration ramps. Each set is configurable as to both time and pattern. Times are adjustable from 0.01seconds to 6000 seconds.
- B. Available patterns are Linear, S-Curve, and Overspeed 'C' Curve with both 'S' and 'C' curves allow user adjustment to customize the pattern
- C. Acceleration/Deceleration sets (total four) are selectable via discrete input, Electronic Operator Interface, communications, or automatic switching based on output frequency.
- D. An automatic acceleration/deceleration selection is available which dynamically structures each change in speed to match conditions of the driven equipment to minimize shock due to changes in velocity and/or load conditions.
- E. Overvoltage stall and overcurrent stall settings prevent damage to the driven equipment should acceleration or deceleration settings exceed the ability of the motor to accelerate or decelerate the driven equipment.
- F. Braking
 - 1. Drive shall have as an integral part of the power and control circuitry an IGBT transistor for dynamic braking. The braking transistor is controlled by the AFD control system and allows, with the addition of an optional resistor, an economical means of rapidly stopping a high inertia load with up to 100% braking torque.
 - 2. The braking transistor, braking resistor, and associated circuitry are fully protected by adjustable protection parameters eliminating the requirement for an external resistor overload protective device.
 - 3. In addition to the dynamic braking, DC injection braking configurable for both standard and emergency stops, allowing full motor current applied as DC to rapidly bring a rotating load to a stop.
- G. Control modes
 - 1. The AFD shall have three distinct modes of operation
 - a. Speed control as V/Hz sensorless vector, or feedback vector
 - b. Torque control both sensorless vector and feedback vector
 - c. Position control with feedback vector
 - 2. The drive has the ability to switch between modes of operation while running.
- H. Current Detection/protection
 - 1. Overcurrent stall adjustable from 0.0 to 250%
 - 2. Configurable undercurrent detection and response
 - 3. UL recognized speed sensitive motor FLA trip curves adjustable from 10 to 100% inverter current rating
 - 4. Motor 150% OL time limits adjustable from 10 seconds to 2400 seconds
 - 5. OL Reduction Frequencies to optimize the speed sensitive motor overload to the application/motor characteristics
 - 6. Configurable overtorque detection levels, times, and reactions
- I. Critical (skip) Frequencies

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- 1. To avoid mechanical resonate frequencies, the AFD shall contains three programmable jump frequencies with adjustable bandwidths.
- 2. The jump frequencies may be any frequency less than or equal to the programmed value of maximum frequency.
- 3. The jump frequency bandwidths are independently programmable from +/- 0.00 to +/- 20.0 Hertz.
- J. Load Sharing
 - 1. AFD shall have the ability to share the load among multiple motors mechanically coupled to a common load. Because of variances in motors and mechanical speed reducers, one motor may experience more load than it counterparts and become overloaded. Drooping allows the overload motor to slow down, thus shedding torque and forcing the other motors to pick up the slack.
 - 2. The drooping parameters allow the user complete adjustment over drooping gain, speed droop and multiple load levels, drooping filters, and drooping torque range.
- K. Process Control (PID)
 - 1. The AFD shall contain an internal PID control algorithm with adjustable proportional, integral, and differential. Feedback may be configured for direct or inverse reaction and is adjustable to span. PID may be enabled via discrete input, Electronic Operator Interface, or communications. Reaction to loss of feedback is configurable and discrete outputs may be configured to indicate loss of feedback or maximum deviation from setpoint.
- L. Electronic Thermal Motor Protection
 - 1. The drive contains four independently configurable electronic thermal motor protection levels. The electronic thermal motor protection level may be selected by Electronic Operator Interface, discrete input, communication protocol, or fixed frequency.
 - 2. The Electronic Thermal Motor Protection is speed sensitive and adjustable for motors with speed ranges of 2:1 to 10000:1 allowing the user to optimize motor protection to suit a variety of motors and applications.
 - 3. The Electronic Thermal Motor Protection levels have configurable 150% motor FLA time limits allowing the user to adjust the I^2T protection slope.
- M. Emergency off Modes and Settings
 - Emergency off response is configurable to either Deceleration Stop, Coast Stop, or DC Injection Stop regardless of the standard stop mode. Emergency stop may be operator initiated via EOI, Discrete input (multiple E-Stop inputs allowed), Communication protocol
- N. Feedback
 - 1. For process control purposes, the drive will accept feedback signals as either an analog signal, binary digital, BCD digital, communication protocol, or 50% duty cycle pulse train.
- O. Input/Output (I/O)
 - 1. As a minimum, the standard control terminal board contains:
 - a. Four discrete inputs independently configurable for any of multiple functions, sink or source selectable and 'true/false' on closure software selectable

- b. Two discrete relay outputs configurable for any of multiple functions with form 'C' contacts rated 2 amps/250v
- c. Three analog inputs with adjustable gains and bias and multiple functions
- d. Potentiometer input
- e. Two analog outputs with adjustable gain and bias 0-1ma or 4-20ma switch selectable
- 2. All control terminal boards are remote mountable (up to fifteen feet) using a standard 25conductor computer cable.
- P. Jog
 - 1. Jog frequency may be configured for any frequency from 0.0Hz to 10Hz. Jog is initiated from an appropriately configured input terminal, Electronic Operator Interface, or communication protocol.
 - 2. Jog stop method is user configurable to coast, controlled deceleration or DC Injection.
 - 3. Jog may be configured to allow reversing or only operate in a configured direction.
 - 4. When jog direction is reverse from direction of motor rotation, the drives jog function will smoothly decelerate the motor to zero then jog in the commanded direction.
- Q. Override Control
 - Override control allows one or more analog signals to act as a trim source to a frequency command. Override may be configured as either a additive (or subtractive) input such as – 5Hz to +5Hz, or as a percent of frequency command. Override may be assigned to any analog input, communication option, or Electronic Operator Interface.
- R. Overvoltage Stall
 - 1. Overvoltage stall prevents faults caused by regeneration. During deceleration, overvoltage stall extends deceleration time when bus levels reach a user configurable level. When applied to overhauling loads, the drive will compensate for rising dc bus levels by momentarily increasing output frequency. Two overvoltage stall levels allow complete configuration and control for most cyclic overhauling loads and high inertia loads.
- S. Pattern Run
 - 1. The Pattern Run feature allows the drive to emulate many of the function of a small programmable logic controller. Useful on any application which requires a set pattern of speed changes, based on either time or contact input, the drive may be programmed for four independent or interactive patterns each consisting of up to 7 changes in speed and/or direction. Each step may be configured to any of the four accel/decel times and patterns, direction, and timed from either step change, speed reached, or contact closure.
- T. Preset Speeds
 - 1. Up to 15 preset speeds may be configured in the drive. Each preset speed may have defined direction, 1 of 4 accel/decel times and patterns, and motor protective set. The preset speed may be selected via input terminals (using BCD selection), Electronic Operator Interface, or communication function.
- U. Ridethrough

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- 1. Ridethrough mode allows the user to configure the drive to utilize motor regenerative voltages to continue operation during brief power outages. Undervoltage detection time and undervoltage stall levels are user configurable items in addition to the drives response to undervoltage conditions.
- V. Retry/Restart
 - 1. The retry/restart drive function allows the drive to smoothly start a rotating load regardless of the direction of rotation. When enabled, the drive will attempt to restart after a fault. The number of attempts and time between attempts are configurable items.
- W. Soft Stall
 - 1. Soft Stall allows the drive to reduce output frequency when the current requirements of the motor exceed the motor's Electronic Thermal Protection setting. If the current drops below the motors overload protection level within the specified time, the output frequency of the drive will return to the commanded output frequency. Soft Stall is highly effective in preventing motor overload trips when used on fans, blowers, pumps, and other centrifugal loads which require less torque and current at lower speeds.
- X. Torque Limiting
 - 1. Drive shall have a torque limiting function prevents mechanical shock to rotating equipment by allowing a user to establish a maximum torque limit. When enabled, the drive will prevent motor torque in excess of the user programmed torque limit.
 - 2. Separate Torque Limits are configurable for positive and negative torque, and user adjustable from 0 to 250% motor torque. This allows complete torque control over both the motoring and generating regions on applications such as vibratory feeders and stamping machines.
- Y. Torque Speed Limiting
 - 1. Speed limits unique to torque control modes are configurable for both forward and reverse operation.

2.6 REGULATION

- A. Speed Control
 - 1. Sensorless Vector 0.1% of motor base speed from 1 to 60HZ
- B. Torque Control
 - 1. Sensorless Vector -- +/-10% of torque setpoint from 50 to 100% of the motors rated torque.

2.7 SOFTWARE AND COMMUNICATION

- A. Programming Software
 - 1. Drive shall be programmable via a computer software program and which shall provide the same functionality as the EOI with the additional capabilities of data logging, trending, storing and restoring multiple parameter sets. Cascading windows allow a user interface similar to the EOI in look and feel while allowing direct parameter access for experienced users. Trending and monitoring functions

allow up to three items be graphically displayed on a standard trend chart and logged to a historical data file for future reference.

- B. Communications
 - 1. All parameters are accessible from any of the following drive supported communication protocols.
 - a. RS222
 - b. RS485
 - c. DeviceNet
 - d. Profibus
 - e. Modbus RTU
 - f. Ethernet IP
- C. Environment
 - 1. Operating environmental ambient conditions without derating shall be:
 - a. Temperature: -10 to +40 C
 - b. Relative humidity: 5 to 95% non condensing
 - c. Elevation: to 1000 meters (2200 ft)
 - d. Shock: 0.5 G maximum
 - 2. Storage environmental ambient conditions:
 - a. Temperature: -10 to +65 C
 - b. Relative humidity: 5 to 98% non condensing
 - c. Elevation: to 5000 meters

2.8 LONG LEAD LENGTH

- A. All drives shall have software and hardware to limit reflected wave caused by long motor cable lengths. When applied to motors with insulation systems that are compliance with NEMA MG-1-1998 Section IV Part 31, output filters shall not be required when motor lead length are within recommended limits.
- B. If motor lead lengths are in excess of recommended limits, provide output filters with the drive.

PART 3 - EXECUTION

- 3.1 ACCEPTABLE INSTALLERS
 - A. Contractor installing and commissioning the facility.

3.2 EXAMINATION

A. Contractor shall be responsible for inspecting the jobsite and identifying site conditions which may affect the installation, storage, or operation of the equipment and notifying Owner or Owner's Representative of such conditions.

3.3 PREPARATION

A. Protect equipment from damage during installation.

B. Prepare installation location in accordance with manufacturers recommendations.

3.4 ERECTION

A. Section not used.

3.5 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Do not locate drives where subject to mechanical damage or where subject to washdown or frequent water spray.
- C. Securely attach wall mount units to a wall or fabricated support stand.
- D. Provide a 3" housekeeping pad extending 2" out from all sides of the drive for floor mount units.
- E. Allow sufficient space around the drive to allow for required cooling.
- F. Install conduit and cable for power and control.
- G. Ground drive in accordance with NEC and manufacturer's requirements.
- H. Coordinate installation with other trades and disciplines.

3.6 APPLICATION

Section not used.

3.7 CONSTRUCTION

- A. Fabricate and assemble drives and test to assure conformance to specification requirements.
- B. Notify Owner or Owner's Representative of factory testing schedule so that they have the option of witnessing the factory tests.
- C. Provide each drive with an engraved nameplate of laminated black and white plastic with beveled edges. Letters shall be black on a white background. Nameplates shall contain the following information:
 - 1. Drive tag number
 - 2. Shop order number
 - 3. Horsepower, voltage, phases
 - 4. Short circuit rating
 - 5. Date manufactured
 - 6. Reference drawing numbers

3.8 REPAIR/RESTORATION

A. Repair or restore to previous condition any facility or equipment damaged or disturbed by the installation of the equipment.

3.9 RE-INSTALLATION

Section not used.

3.10 FIELD QUALITY CONTROL

- A. Verify installation in accordance with manufacturer's recommendations and with the requirements of this specification.
- B. Verify field wiring and equipment calibration.
- C. If required by the purchase order, schedule Manufacturer's Field Services representative for startup assistance. Submit report detailing all actions performed by this individual, all findings and recommendations. Report must state that manufacturer's representative has certified the installation in compliance with manufacturer's requirements.

3.11 ADJUSTING

- A. Perform any field adjustments required by manufacturer or the manufacturer's representative.
- B. Configure all drive parameters required for proper operation. Submit to Owner or Owner's Representative a configuration and startup report documenting all drive settings and containing the following information:
 - 1. Date of startup/configuration
 - 2. Name of technician
 - 3. Tag number and name of drive
 - 4. Complete list of all configured parameters.
- C. If parameters have been downloaded to a computer, submit a CD with this configuration file and labeled with the information required above.

3.12 CLEANING

A. Clean all debris from the equipment. Vacuum out all loose dirt and materials. Wipe down outside of drive.

3.13 DEMONSTRATION

A. Demonstrate proper operation to Owner or Owner's Representative and leave equipment ready for normal operation.

3.14 PROTECTION

A. Protect work at all times from damage by other trades or disciplines. Repair or replace any equipment damaged by other trades or disciplines.

++ END OF SECTION ++

SERVICE ENTRANCE AND UTILITY METERING SECTION

<u> PART 1 - GENERAL</u>

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install the service entrance section as shown on the Drawings.
 - 2. The service entrance section and the low-voltage distribution switchboard shall be provided by the same manufacturer.
 - 3. The service entrance section, automatic transfer switch, and low-voltage distribution switchboard shall be bus connected and comprise a single unit assembly, once installed. The service entrance section manufacturer shall coordinate the required interconnections and provide transition sections with bussing and splicing hardware
- B. Coordination: Provide in accordance with Utility Company requirements for Service Entrance Sections.
- C. Related Sections:
 - 1. Section 01330, Submittal Procedures.
 - 2. Section 01750, Testing, Training and Startup.
 - 3. Section 16445 Low Voltage Distribution Switchboard.
 - 4. Section 16496 Automatic Transfer Switch.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. Underwriters Laboratories, Inc. (UL).
 - 2. Institute of Electrical and Electronics Engineers (IEEE).
 - 3. National Electrical Code (NEC).
 - 4. The serving utility Service Specifications.
 - 5. Insulated Cable Engineers' Association (ICEA).

1.3 SUBMITTALS

- A. Product Data and Drawings: Submit for approval the following:
 - 1. Manufacturer's technical information for equipment proposed for use.
 - 2. Outline and summary sheets with schedules of equipment in each unit.
 - 3. Unit control schematic and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
 - 4. Nameplate schedule.

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- B. Operation and Maintenance Data: Submit complete manuals including:
 - 1. Copies of all Shop Drawings, test reports, maintenance data and schedules, description of operation, and spare parts information.
 - 2. Furnish Operation and Maintenance Manuals.

1.4 WARRANTY

A. Submit manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Service entrance section lineups shall be provided as shown on the Drawings. Service entrance section including structures, appurtenances and all major components (contactors, circuit breakers etc.) therein shall be the product of one manufacturer unless shown on the drawing bill of material lists.
 - 1. Service: Voltage rating and number of wires shall be as shown on the Drawings. Service entrance section shall operate from a 3 phase, 60 Hertz system.
 - 2. Wiring: NEMA Class II, Type B.
 - 3. Enclosure: NEMA 3R for outdoor applications.
- B. Construction:
 - 1. The SES shall be a single panel or assembly of panels on which shall be mounted on a deadfront mounting plate, fused switches, metering equipment provisions, power distribution panel and any monitoring or protection devices as indicated on the plans.
 - The SES shall be a one-piece enclosure with front accessibility and vandal resistant. The SES shall have a metered distribution section and a pull section for underground service, all of which shall comply with the requirements of the serving utility.
 - 3. The enclosure shall be zinc coated steel, minimum 12 gauge thickness. Cabinet shall be protected against corrosion in accordance with UL 50, Cabinets and Boxes, Section 16160. Exterior doors to be minimum 10 gauge steel and shall have heavy duty padlocking provisions. Deadfront shall be a hinged type, 10 gauge minimum, and shall require the use of a tool to expose interior components for installation or servicing. All factory installed components shall be UL listed. All factory installed conductors shall be copper, size and type to conform to NEC and UL requirements. Ventilation openings shall be provided.
 - 4. Finish shall be two (2) coats of ANSI 61 Grey enamel paint.
- C. Bus System and Conductors:
 - 1. Rating: Bus bracing of 65,000 amps symmetrical unless shown otherwise on the drawings and bus current capacities as indicated on the Drawings.
 - 2. All bus bars (including neutral and ground) shall be silver or tin plated copper rated to UL heat rise standards.

- 3. Bus bar connections easily accessible with simple tools.
- 4. Main Bus: Continuous edge mounted, and isolated from wireways and working areas for use on 480 volt 3 phase 4 wire service with entire assembly suitable for 600 volts.
- 5. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity as required. Ground each housing directly to this bus.
- 6. Neutral Bus: Insulated, continuous through section for 4 wire services, drilled with lugs of appropriate capacity as required.
- 7. All control conductors shall be type MTW, No. 14 AWG minimum.
- D. Service Entrance Interrupting Switches:
 - 1. The service entrance interrupting switch(es) shall be operable without opening the compartment door inside of the exterior door. A viewing window shall be provided in the compartment door to allow full view of the switch blades. The compartment door shall be hinged and interlocked with the switch shaft so that the switch must be opened before access to the fuses is possible and the door must be closed before the switch can be closed. True conditions of switch blades when fully open and fully closed shall be accurately and conspicuously labeled for switch handle positions. Handle shall be lockable only in the true, fully-open switch condition. The operator handles shall pivot up-down, with the down position as OFF. The ON-OFF condition of the disconnecting means shall be indicated by the handle position, Red and Green colored indicators which include the words ON and OFF, and the international symbols I and O along with a pictorial indication of the handle position. It shall be possible to lock the handle in the OFF position with up to 3/8" diameter shackle padlocks.
 - 2. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks. A non-defeatable interlock shall be provided between the handle operator and the cam lever to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.
- E. Utility Metering Section:
 - 1. Instrument transformer compartments shall be bussed with rectangular bus bar in accordance with the utility company requirements.
 - 2. Meter panels shall be constructed of 12 gauge steel (minimum) and shall be reversible, sealable, hinged and interchangeable.
 - 3. Meter panels shall have a handle attached at unsupported end.
 - 4. Metering section shall be approved by the utility company, prior to fabrication.
 - 5. Provisions for the utility company seals shall be provided on doors, meter sockets, etc. in accordance with utility company requirements.
- F. Nameplates:
 - 1. Provide engraved plastic nameplates to identify switchgear units, door mounted components, and internal components.
 - 2. White lamicoid with black letters fastened with stainless steel drive pins, engraved with the circuit number, and circuit name, and identification

consistent with the drawings. Nameplates of engraved phenolic shall be provided for each SES compartment measuring a minimum of 1.5"H x 6"W total outside dimensions.

- 3. Label per requirements of NEC, Articles 110-21 and 110-22.
- G. Product and Manufacturer: Provide one of the following:
 - 1. Square D Company.
 - 2. Siemens.
 - 3. General Electric
 - 4. Eaton-Cutler Hammer

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install on raised concrete base at location shown on the Drawings. Install support channels in concrete according to manufacturer's recommendations.
- B. Provide no openings in top or side of units not required for conduit.
- C. Field test all SES components.
- D. Verify that wiring diagrams on inside of door of each compartment reflects the "as-built" circuitry.
- E. Install in conformance with the National Electrical Code, and the serving utility requirements.
- F. Arrange with the utility company for metering installation, feeder installation and inspection prior to energization.

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and install disconnect switches as shown on the drawings and as specified herein.
- B. Related Sections:
 - 1. Section 16140, Wiring Devices, for disconnect switches on 120 volt, single-phase circuits.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. National Electrical Code.
 - 2. UL #98, Enclosed Switches.
 - 3. NEMA KS-1, Enclosed Switches.

1.3 SUBMITTAL

A. Submit, for approval, Product Data for disconnect switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Single Throw, Circuit Disconnect Switches:
 - 1. Type: Fused or unfused, horsepower rated, heavy-duty, single- throw, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
 - 2. Rating: 600 volts, with number of poles and ampere rating as required for motor or equipment circuits being disconnected. Switches shall bear a UL label.
- B. Double Throw Safety Switches:
 - 1. Type: Unfused, double throw with center OFF position, quick-make, quick-break mechanism, visible blades in the OFF position and safety handle.
 - 2. Rating: 600 volts, with number of poles and ampere rating as shown on the Drawings for the circuits being disconnected.

C. Enclosure:

- 1. NEMA 12 for dry, indoor non-corrosive areas.
- 2. NEMA 3R or 4 for all wet or outdoor non-corrosive locations.
- 3. NEMA 4X stainless steel for corrosive locations.
- 4. NEMA 7 or 9 for all hazardous locations.
- 5. Nameplate identifying equipment for which switches serve as the disconnecting means.

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- D. Product and Manufacturer: Provide disconnect switches of one of the following:
 - 1. Square D
 - 2. GĖ
 - 3. Allen Bradley
 - 4. Appleton
 - 5. Killark

3.1 INSTALLATION

- A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls, handrails or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists.
- C. Furnish one (1) set of spare fuses for each fused disconnect switch to be installed.
- D. Install in conformance with National Electrical Code.

CONTROL STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide pushbutton, selector switch and other control stations as shown on the Drawings and/or as specified in the Equipment Sections.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
 - 1. NEMA Standard ICS2-216, Pushbuttons, Selector Switches, Indicating Lights and Pushbutton Stations.
 - 2. National Electrical Code.

1.3 SUBMITTALS

A. Product Data: Submit, for approval, product data for all materials covered herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type: Industrial, heavy duty, oiltight construction with clearly marked legend plates.
- B. Lockout Stop: Maintained contact type with provisions for locking in the "STOP" position.
- C. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
- D. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
- E. Indicating Lights: Transformer type with 6 volt lamp. Lens color red for running, green for stopped or ready and amber for failure.
- F. Enclosures: NEMA 12 for dry indoor locations, NEMA 3R for outdoor and damp or wet locations. PVC coated RGS for corrosive locations.
- G. Nameplates identifying equipment controlled if not readily apparent.
- H. Product and Manufacturer: Provide control stations of one of the following:
 - 1. Square D.
 - 2. General Electric Company.
 - 3. Allen Bradley Company.
 - 4. Or equal.

3.1 INSTALLATION

- A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other surfaces on which they are mounted. Provide independent galvanized steel supports where no wall or other surface exists.
- C. Install in conformance with National Electrical Code.

CUSTOMER POWER METERING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification covers the customer power monitoring system installed on the service entrance section(s), motor control center(s), and other distribution panel(s) as indicated on Plans.

1.2 SUBMITTALS

- A. Products shall be submitted in accordance with Section 16050, and elsewhere in the Contract Documents, prior to installation.
- B. Submit manufacturer's catalog cut sheet indicating all options to be supplied as specified herein.
- C. Submit shop drawing indicating wiring connection diagram and elevation drawing indicating location of component(s) on the service entrance section.

1.3 MANUFACTURERS

- A. Acceptable manufacturers subject to compliance with the specifications herein are as follows:
 - 1. Square D.
 - 2. Multilin.
 - 3. Eaton-Cutler Hammer
 - 4. General Electric.
 - 5. Siemens.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The system shall consist of electronic circuit monitors as required to obtain signals as specified herein. Components shall include CT's, PT's, CPT, etc. and other devices as required.
 - 1. The electronic Circuit Monitors shall report metering values such as frequency, temperature, current, voltage, power factor, power, demand current, and real power, and accumulated energy.
 - 2. Each Circuit Monitor shall retain historical circuit data, time and date, setup and configuration values, and diagnostics data in the event of a control power failure without the need for an internal battery.
 - 3. Each Circuit Monitor shall be capable of capturing current and voltage waveforms, which may be exported to a personal computer where waveform or other power quality analysis may be performed.

- 4. The Circuit Monitor shall include an LED readout which will allow local display of the following electrical parameters:
 - a. Current, per phase RMS.
 - b. Voltage, phase-to-phase & phase-to-neutral.
 - c. Real power, 3-phase total.
 - d. Reactive power, 3-phase total.
 - e. Apparent power, 3-phase total.
 - f. Power factor, 3-phase total & per phase.
 - g. Frequency.
 - h. Peak demand current, per phase.
 - i. Peak demand, real power.
 - j. Accumulated Energy, (MWH and MVARH).
- 5. Reset the following electrical parameters shall also be allowed from the front of the Circuit Monitor:
 - a. Peak demand current.
 - b. Peak demand power.
 - c. Energy (MWH).
 - d. Reactive energy (MVARH).
- 6. Circuit Monitor setup for system requirements shall be allowed from the front of the Circuit Monitor. Setup provisions shall include:
 - a. CT rating (600:5).
 - b. PT rating (480:120).
 - c. System type (3-wire and 4-wire).
 - d. Demand interval (5-60 min.).
- 7. All reset and functions shall be keyswitch protected to prevent unauthorized/accidental changes.
- B. The system shall have System Display units, which display data from the Circuit Monitors. The display unit shall contain the following:
 - 1. Each System Display shall provide real-time access to all metering data available for each circuit (present as well as historical data).
 - 2. Each System Display unit shall access and display the data available from selected electronic Circuit Monitors connected on the individual data transfer network.
 - 3. The System Display unit shall utilize a 4 line by 20 character, high contrast LCD technology display with backlighting to provide high reliability and superior readability in all light conditions.
 - 4. The level of backlighting as well as the contrast shall be adjustable.
 - 5. The System Display unit shall allow for easy operation by providing a keypad with large keys for operator selections.
 - 6. The keys shall have a raised perimeter and tactile feedback to ensure a positive response even with gloved hand operation.
 - 7. The keys shall be clearly marked to indicate the function and separated into meaningful groups with display prompting to assist the user in operation.
 - 8. Each System Display unit shall be configured by the manufacturer with all necessary data such as CT ratios, PT ratios, main and feeder device nameplates, demand alarm set points, etc.
 - 9. It shall be possible to change the configuration for each System Display unit using the keypad provided on each display.
 - 10. This capability shall be password protected to prevent unauthorized modification of the configuration.
 - 11. All data with the exception of the captured waveform shall be accessible by the System Display unit.

- 12. Data shall be displayed in a logically organized manner complete with the proper scaling and units.
- 13. It shall be possible to sequentially view all available data from a selected Circuit Monitor by single keystroke advancing through the various display pages.
- 14. It shall be possible to view the same pages of data from other Circuit Monitors by single keystroke advancing back and forth from Circuit Monitor to Circuit Monitor.
- C. Software for a personal computer shall be provided as specified herein:
 - 1. The Metering System Software to be supplied shall be suitable for operation on a personal computer.
 - System Software shall be capable of alarm reporting, event logging, data logging, online monitoring of instrumentation/status/alarms, waveform analysis, manual control of circuit breakers or other selected devices and shall include sufficient levels of password protection.
 - 3. The software shall be capable of performing background activities such as alarms and automatic logging while the computer is used for other programs such as word processing, spreadsheet, etc.
 - 4. Software shall be supplied by switchgear manufacturer, which will display all information available from the Circuit Monitors. This software shall include the following characteristics/capabilities:
 - a. MicroSoft windows based with mouse.
 - b. View & log instrumentation data.
 - c. View voltage/current waveforms and analyze waveform data.
 - d. Perform diagnostics/setup.
 - e. Display tables, charts & graphs.
 - f. Display meters, meter panels graphically.
 - g. Event logging.
 - h. Alarm reporting.
 - i. Reset energy alarms/historical data.
 - j. Background data logging.
 - k. Three level password protection.
 - I. Manual control of Circuit Monitor outputs.
 - m. Display status (circuit breakers, relays, trip units, etc.).

- 3.1 INSTALLATION
 - A. System Display units shall be installed by the manufacturer in the switchgear as indicated on the plans.
 - B. The System Display units shall be flush mounted on switchgear door panels.
 - C. Electronic Circuit Monitors shall be installed by the switchgear manufacturer for all circuits as indicated by the project drawings.
 - D. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the switchgear lineup.

- E. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.
- F. The metering components included within the service entrance sections shall be factory installed, wired and tested prior to shipment to the job site.
- G. All wiring required to externally connect the personal computer shall be installed by the Contractor per manufacturer's requirements and per other portions of these specifications.
- H. Contractor interconnection wiring requirements shall be clearly identified on the metering system drawings to be submitted for approval.

3.2 TRAINING

- A. On-site start-up and training of the metering system shall be included in the project bid.
- B. Start-up shall include a complete working demonstration of the system with simulation of possible operating conditions, which may be encountered.
- C. Training shall include any documentation and hands-on exercises necessary to enable operations personnel to assume full operating responsibility for the system after completion of the training period.
- D. The project bid shall include 2 days start-up assistance and 1 day training.

LIGHTING AND DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide lighting and distribution panelboards, as shown. Installation of new circuit breakers in existing panelboards shall be included in this specification and shall be rated as specified herein.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. NEC Article 384, Switchboards and Panelboards.
 - 2. UL Standard #50, Electrical Cabinets and Boxes.
 - 3. UL Standard #67, Electric Panelboards.
 - 4. NEMA PB1, Panelboards.

1.3 SUBMITTALS

A. Product Data: Submit, for approval, product data for all materials covered herein, and a listing of the panelboards to be furnished identifying their location and number of branch circuit breakers.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Panelboards:
 - 1. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles shall be as shown on the Drawings.
 - 2. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.
 - 3. Main and branch circuit breakers shall be fully rated with interrupting capacities as follows:
 - a. 22,000 or 35,000 amps or as shown on the drawings for 480/277 volt circuit breakers.
 - b. 10,000 or 22,000 amps or as shown on drawings for 120/240 volt circuit breakers.
 - 4. Bus Bars: 98 percent conductivity copper, tin plated. All 4 wire panelboards shall have a solid neutral bar. All panels shall have ground bus.
 - 5. Main: All panelboards shall have a main circuit breaker, unless Drawings specifically call for main lugs only.
 - 6. Branch circuit breakers connected for sequence phasing.
 - Construction: Code grade steel, NEMA 12, ample gutter space, flush door, flush snaplatch and lock for dry indoor locations. NEMA 3R steel for all damp, or wet locations. NEMA 4X stainless steel for corrosive locations.
 - 8. Trim: Surface or flush as required.

- 9. Directory: Typed card, with glass cover in frame on back of door giving the circuit numbers and the area or equipment served.
- 10. Identification: Nameplate identifying the panel number and voltage.
- 11. Product and Manufacturer: Provide panelboards of one of the following:
 - a. Square D.
 - b. GÉ.
 - c. Eaton-Culter Hammer
 - d. Siemens.

3.1 INSTALLATION

- A. Mounting: Install panelboards at locations shown on Drawings. Set cabinets so that top circuit breaker is not over 6 feet from the floor.
- B. Directory: Complete typewritten directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.
- C. Arrange circuits to balance the loads on the panelboards.

LOW-VOLTAGE DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and install, where indicated, free-standing, dead-front type low-voltage distribution switchboards, utilizing group mounted circuit protective devices as specified herein, and as shown on the Drawings.
- B. Related Sections:
 - 1. Section 01330, Submittal Procedures.
 - 2. Section 01750, Testing, Training and Startup.
 - 3. Section 16350 Service Entrance Section.
 - 4. Section 16496 Automatic Transfer Switch.

1.2 QUALITY ASSURANCE

- A. The low-voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:
 1. NEMA PB-2
 - 2. UL Standard 891.
 - 3. National Fire Protection Association 79, Electrical Standard for Industrial Machinery.
- B. The low-voltage switchboards shall be UL labeled.
- C. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards:
 - The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.
- D. The manufacturer shall provide three (3) certified copies of factory test reports.

1.3 SUBMITTAL

- A. Product Date: Submit, for approval, including:
 - 1. Assembly and major component ratings for:
 - a. Short-circuit/ Interrupt
 - b. Voltage
 - c. Continuous current
 - 2. Cable terminal sizes.
 - 3. Nameplate schedule
 - 4. Component list

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- 5. Conduit entry/exit locations
- 6. Certified production test reports.
- 7. Installation information, including seismic certification and equipment anchorage details.
- B. Shop Drawings: Submit, for approval, including:
 - 1. Copies of manufacturer's technical information.
 - 2. NFPA 79, Annex "D" Standard elementary and wiring diagrams.
 - 3. Master drawing index
 - 4. Front view elevation
 - 5. Floor plan
 - 6. Top view
 - 7. Single line
 - 8. Wiring diagrams.
 - 9. Schematic diagram
- C. Where applicable, the following additional information shall be submitted to the ENGINEER:
 - 1. Busway connection
 - 2. Connection details between close-coupled assemblies
 - 3. Composite floor plan of close-coupled assemblies
 - 4. Key interlock scheme drawing and sequence of operations
- D. Operation and Maintenance Data: Furnish Operations and Maintenance Manuals in conformance with requirements of Section 01780, Operation and Maintenance Data.

1.4 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the circuit protective devices within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The switchboards shall be suitable for and certified to meet all applicable seismic requirements of the Uniform Building Code (UBC) for zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment.

PART 2 - PRODUCTS

2.1 SWITCHGEAR

- A. Product and Manufacturer:
 - 1. Cutler-Hammer, "Pow-R-Line C".
 - 2. Square D.

- 3. GE.
- 4. Siemens.
- B. Ratings:
 - 1. The assembly shall be rated to withstand mechanical forces exerted during shortcircuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.
 - 2. Voltage rating shall be 480/277 volts, 3 phase, 3 or 4 wire as shown...
- C. Construction:
 - 1. Switchboards shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
 - 2. All sections of the switchboard shall be rear aligned with depth as shown on the Drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.
- D. Bus:
 - 1. All bus bars shall be tin-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
 - 2. Provide a full capacity neutral bus where a neutral bus as shown on the Drawings.
 - 3. A copper ground bus (minimum 1/4 by 2-inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
 - 4. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.
- E. Wiring/Terminations:
 - 1. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
 - 2. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as shown on the Drawings.
 - 3. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as shown on the Drawings.
 - 4. All control wire shall be Type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminals blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.
- F. Molded Case Protective Devices:

- 1. Main breakers and feeder circuit breakers of 600 amp frame and above shall be molded case circuit breakers with microprocessor based trip unit which shall provide adjustable long time pickup and delay, adjustable short time pickup and delay, adjustable instantaneous and adjustable ground fault pickup and delay-Cutler-Hammer Digitrip RMS 310 or equal. Interrupting rating shall be 65,000 amps symmetrical. Circuit breakers of 600 amp frame and below shall have thermal-magnetic trip units and inverse time characteristics. Molded case breakers shall be Cutler-Hammer Series C, or equal.
- 2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- 3. Circuit breakers shall have a minimum symmetrical interrupting capacity as shown on the Drawings.
- 4. Where indicated circuit breakers shall be current limiting.
- G. Miscellaneous Devices:
 - 1. Control power transformers with primary and secondary protection shall be provided, as shown on the Drawings, or as required for serving space heaters.
 - 2. Each section of the switchboard shall be provided with a thermostatically controlled space heater. Power for the space heaters shall be obtained from a control power transformer within the switchboard. Supply voltage shall be 120 volts AC.
- H. Enclosures shall be NEMA 1 for indoor installations and NEMA 3R for damp, wet or outdoor installations.
- I. Nameplates:
 - 1. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as shown on the Drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number and item number.
 - 2. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- J. Finish. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

3.1 INSTALLATION

A. CONTRACTOR shall install all equipment in accordance with the manufacturer's instructions, Drawings and National Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to CONTRACTOR supplied floor sills to be set level in concrete in accordance with manufacturer's recommendations. All necessary hardware to secure the assembly in place shall be provided by CONTRACTOR.

3.2 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, startup and test services, and operation and maintenance personnel training services. The serviceman shall make three (3) visits to the site. The first visit shall be for assistance in the installation of the equipment. The second visit shall be for checking the completed installation and startup of the system. The third visit shall be as described under Section 01750, Testing, Training and Startup.

AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Automatic transfer switch shall be furnished and installed, as indicated on the Drawings, with full load current rating as indicated on the Drawings. The switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure. Withstand current rating shall be as indicated on the Drawings.
- B. The automatic transfer switch (ATS) shall be bus connected and shall be an integral piece to the Service Entrance Section (SES) and Distribution Switchboard assembly. The automatic transfer switch manufacturer shall coordinate the installation and bus connection requirements with the service entrance section manufacturer.
- C. The automatic transfer switch shall be a true double throw non-circuit breaker type.
- D. Related Sections:
 - 1. Section 01330, Submittal Procedures.
 - 2. Section 01750, Testing, Training and Startup.
 - 3. Section 16350 Service Entrance Section.
 - 4. Section 16445 Low Voltage Distribution Switchboard.

1.2 REFERENCES

- A. NFPA 70 National Electrical Code.
- B. NEMA ICS 1 General Standards for Industrial Control and Systems.
- C. NEMA ICS 2 Standards for Industrial Control Devices, Controllers, and Assemblies.
- D. NEMA ICS 6 Enclosures for Industrial Controls and Systems.

1.3 SUBMITTALS

- A. Submit in compliance with the special provisions.
- B. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit in compliance with the special provisions.
- B. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment when engine generator is running.
- C. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 250 miles of Project.
- B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site per the instructions of the owner.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

1.8 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated by manufacturer.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of transfer switch for one year from Date of Substantial Completion.

1.10 MAINTENANCE MATERIALS

- A. Provide maintenance materials as required.
- B. Provide two of each special tool required for maintenance.

PART 2 - PRODUCTS

- A. Acceptable manufacturers subject to compliance with the specifications herein are as follows:
- B. Automatic Switch Company.
- C. Russelectric.
- D. Or equal.

2.2 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 2, automatic transfer switch.
- B. Configuration: Electrically operated, mechanically held transfer switch.

2.3 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 1.
- B. Temperature: 130 degrees F ambient.
- C. Altitude: 1,300 feet.

2.4 RATINGS

- A. Voltage: 480/277 volts, three phase, four wire, 60 Hz.
- B. Switched Poles: 3.
- C. Continuous Rating: 600 amperes.
- D. Interrupting Capacity: 600 percent of continuous rating at 0.5 power factor.
- E. Withstand Current Rating: 65,000 rms symmetrical amperes.

2.5 PRODUCT OPTIONS AND FEATURES

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
- D. Transfer Switch Auxiliary Contacts: 12 normally open; 12 normally closed.
- E. Normal Source Monitor: Monitor normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.

F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.

2.6 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay To Start Alternate Source Engine Generator: 0 to 5 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
- G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.
- H. Delayed transition automatic transfer. Incorporate a timed center off position for motor load decay. Transfer time shall be adjustable from 0.1 seconds to 2 minutes minimum. A mechanical and electrical interlock shall be provided to ensure that both sets of contacts cannot be closed at the same time.
- I. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

2.7 ENCLOSURE

A. Enclosure: Install in Service Entrance Section.

2.8 SPARE PARTS

A. One of each type of control board.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions suitable for installation.
- B. Verify that surface is suitable for transfer switch installation.

3.2 PREPARATION

A. Provide all equipment as required.

3.3 INSTALLATION

A. Install transfer switches in accordance with manufacturer's instructions.

3.4 INSTALLATION TESTING

- A. When conducting temperature rise tests in accordance with UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the switches to carry full rated current after completing the overload and endurance tests.
- B. On completion of the installation, start-up shall be performed by a factory-trained service representative in the presence of the OWNER and the ENGINEER.

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Provide lighting fixtures as shown and/or scheduled.
- B. Coordination:
 - 1. Coordinate location of fixtures with piping, ductwork, openings and other systems and equipment and locate clear of interferences.
 - 2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed for use.
- C. Related Sections:
 - 1. Section 16135, Outlet, Pull, and Junction Boxes.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. National Electrical Code.
 - 2. UL Standard #57, Electric Lighting Fixtures.
 - 3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Locations.
 - 4. UL Standard #1570, Fluorescent Lighting Fixtures.
 - 5. UL Standard #1571, Incandescent Lighting Fixtures.
 - 6. UL Standard #1572, High Intensity Discharge Lighting Fixtures.

1.3 SUBMITTALS

- A. Product Data: Submit, for approval, including the following:
 - 1. Fixture construction details.
 - 2. ETL photometric and isocandle curves for each fixture proposed.
 - 3. Verification that recessed fixtures that are to be mounted in hung ceilings are compatible with the ceiling suspension system proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type: Lighting fixtures are noted in the Fixture Schedule in the Drawings. Fixtures to be complete with supports, ballasts, lamps and incidentals as required.
- B. Lamps:
 - 1. Fluorescent: Cool white, energy efficient type.
 - 2. High Pressure Sodium: Color corrected.
 - 3. Incandescent: Inside frosted.
 - 4. Metal Halide.
 - 5. Spare: Ten (10) percent spare lamps of each type and wattage.

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- C. Ballasts:
 - 1. Fluorescent: High power factor, energy efficient type, equipped with thermal protectors (Type "P" ballast), compatible with the lamps installed. Fixtures shall be equipped with no less than one ballast for every two lamps. For example, four lamp fluorescent fixtures shall be equipped with two ballasts.
 - 2. High Intensity Discharge: High power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
 - 3. Ballasts to have "C" sound rating (min.) and be ETL/CBM certified.
 - 4. Spare: Ten (10) percent spare ballasts of each type.
- D. Fixtures located in an area which is identified as a hazardous location shall be approved as a complete assembly for the hazardous location classification shown on the Drawings, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and shall be protected against physical damage by suitable guards.
- E. Hardware: All necessary hangers, supports, conduit adaptors, reducers, hooks, brackets and other hardware required for safe fixture mounting shall be furnished. Hardware shall have a protective, non-corrosive finish.

3.1 INSTALLATION

- A. General: Fixture mounting heights and locations shown on the Drawings are approximate and are subject to revision in the field, where necessary to clear conflicts and obstructions.
- B. Suspended Fixtures: Pendant mount using 1/2-inch conduit stems. Ground to outlet box. Attach mounting to building structure with expansion anchors. Fixtures shall not be dependent on the outlet box cover screws for support.
- C. Surface Mounted Fixtures: Attach to appropriate outlet box.
- D. Boxes and Fixtures:
 - 1. For units mounted against masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
 - 2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers or Unistrut.
 - 3. No boxes shall be installed with open conduit holes.
 - 4. Cable each circuit and identify with tag.
- E. Mounting Heights: Mounting heights or elevations are to bottom of the fixture or to centerline of device.
- F. Relamp all fluorescent fixtures with new lamps at end of construction period, prior to final acceptance of the new facilities by OWNER.

++ END OF SECTION ++

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LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: Provide lighting controls, as shown and specified herein.

1.2 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified:
 - 1. UL Standard #917, Clock-Operated Switches.
 - 2. National Electrical Code.

1.3 SUBMITTALS

A. Product Data: Submit, for approval, including wiring diagrams.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Time Switch where shown on drawings:
 - 1. Type: Astronomic dial time switch with day-omitting device.
 - 2. Timing Motor: Heavy duty, synchronous, self-starting, high torque, 120 volt or 277, 60 cycles, as shown on the Drawings.
 - 3. Capacity: 40 Amps per pole at 277 volts.
 - 4. Dial: 24 hour rotation, with gear to provide one revolution per year which automatically raises the ON and OFF settings each day according to seasonal changes of sunset and sunrise for the Town of Buckeye, Arizona area.
 - 5. Reserve Power: Spring driven reserve sufficient to operate time switch contacts for a minimum of 30 hours after power failure. On restoration of power, time switch shall transfer to synchronous motor drive and automatically rewind reserve.
 - 6. Product and Manufacturer: Provide one of the following:
 - a. Z Series by Tork Time Controls, Incorporated.
 - b. Or equal.
- B. Combination Lighting Contactors:
 - 1. Rated 600 volts, 30 amps, electrically held number of poles as shown on the Drawings, housed in NEMA 12 enclosure.
 - 2. Additional devices such as selector switches, circuit breakers, control power transformers, fuses, time clocks etc. as shown on the Drawings.
 - 3. Product and Manufacturer: Provide one of the following:
 - a. Class 8903 by Square D.
 - b. Or equal.
- C. Photocell:

- 1. Cadmium sulphide hermetically sealed cell, fully temperature compensated, with time delay of at least 15 seconds to prevent false switching.
- 2. Built-in fail safe light level selector, adjustable within limits of 2 to 50 foot candles and factory set at 25 foot candles.
- 3. Product and Manufacturer: Provide one of the following:
 - a. 2100 Series by Tork Time Controls, Incorporated.
 - b. Or equal.

3.1 INSTALLATION

- A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Mount photocell in appropriate outside location or as shown on the Drawings and adjust footcandle setting for proper dusk and dawn photocontrol. Provide wiring in conduit from the photocell to controls.
- C. Securely fasten equipment to walls or other surfaces on which they are mounted.

STANDBY DIESEL ELECTRIC GENERATOR

<u> PART 1 - GENERAL</u>

1.1 SCOPE OF WORK

- A. The outdoor standby electric generating system shall be rated for standby service and sized as shown on the Drawings.
- B. The Contractor shall be responsible for obtaining any required air quality permits on behalf of the Owner, posting all public notices, and shall include all associated fees in their bid, listed as separate line items in the schedule of values. The generator vendor shall provide the Contractor with the documentation required for permitting, showing published proof of EPA certification on the engine specified and furnished herein.
- C. engine specified and furnished herein.

1.2 SUBMITTALS

- A. Submit product data in accordance with Division 16 and the Contract Documents.
- B. Submit shop drawings containing actual dimensions, complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated, and will properly function as a unit. Shop drawings shall show proposed layout, anchoring, support and appurtenances, including clearances for maintenance and operations. Shop drawings shall show details of piping connections for fuel.
- C. Submit a complete list of equipment and material, including manufacturer's specifications, performance charts, catalog cuts and installation instructions, and recommended spare parts list. Submit data for each different item of equipment specified, including but not limited to engine, generator, switchgear, automatic transfer switch, vibration isolators, radiator, and other components. The data shall include a complete list of parts and source of supply.
- D. ations, performance charts, catalog cuts and installation instructions, and recommended spare parts list. Submit data for each different item of equipment specified, including but not limited to engine, generator, switchgear, automatic transfer switch, vibration isolators, radiator, and other components. The data shall include a complete list of parts and source of supply.
- E. Submit performance test reports in booklet form showing all field tests, and adjustments performed to prove compliance with specified criteria.
- F. iteria.
- G. Operation and maintenance (O&M) manuals shall describe the step-by-step procedure required for system start-up, operation and routine maintenance. The O&M manuals shall include troubleshooting and repair guidelines, as well as wiring diagrams of the system as installed.

- H. Miscellaneous:
 - 1.—Manufacturers kilowatts output curve and fuel consumption.
 - 2.—Manufacturers transient response data of the complete engine generator set upon 50%, 75%, and 100% block loads at 1.0 pf. Data shall include maximum voltage dips, maximum frequency dips, and recovery time periods.
 - 3.—Engine altitude duration curve.
 - 4.—Generator motor starting curves showing the voltage dips versus starting KVA.
 - 5.—Prototype test certifications showing all components comply with specifications.
 - 6.—The following spare parts for the engine generator shall be supplied to the OWNER prior to acceptance of work.
 - a. Two sets of oil filters
 - b. Two sets of heavy duty air filters
 - c. One dozen spare lamps
 - d. Two fuses (for each control circuit)
- 1.3 MANUFACTURERS
 - A. Generator set shall be manufactured by Cummins (Onan), Caterpillar, or equal.

PART 2 - PRODUCTS

2.1 ENGINE GENERATOR SET

- A. The provision of a standby electric generating system shall be rated for standby service as indicated on Drawings and as described in these Specifications, delivered at 0.8 power factor, 480 volts, three phase, four wire, 60 hertz, for ambient air temperature of 50 degrees C, and specifically rated for the operating altitude shown on the Drawings, without exceeding NEMA MG1 temperature rise limits.
- B. The system shall be a package of:
 - 1.—A diesel engine driven electric plant to provide standby electric power.
 - 2.-Engine mounted control system.
 - 3.—An automatic load transfer switch for switching of the load and control to provide automatic starting and stopping of the engine generator system, as specified in Section 16496 of these Specifications.
 - 4.—Mounted accessories as specified
 - 5.—Integral fuel and exhaust systems.
 - 6.—All other equipment as required to provide a complete and operable system.
 - 7.—Fully Enclosed weatherproof enclosure.
- C. The engine-generator set and all its accessories shall be constructed for outdoor installation and operation all electrical components shall be housed in NEMA 3R enclosures.
- D. All materials, equipment, and parts comprising the units specified herein, shall be new and unused, or current manufacture and of the highest grade.
- E. The engine, generator and all major items of auxiliary equipment shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment. The unit shall be factory assembled and tested by the engine manufacturer and shipped to the job site by his authorized dealer having a parts and service facility in the area. The performance of the electric plant shall be certified by

manufacturer as to the plant's full power rating, stability and voltage and frequency regulation, and field load tested at site.

- F. Id load tested at site.
- G. The units offered under these Contract Documents shall be covered by the manufacturer's standard warranty, or guarantee, on new machines, and shall be a minimum of two years after the date of substantial completion.

2.2 ENGINE

- A. The engine shall be water cooled in line, or Vee-type compression ignition diesel, designed to operate on No. 2 fuel oil. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters; lube oil coolers, fuel transfer pump, fuel priming pump, and gear driven water pump.
- B. The engine governor shall maintain frequency regulation not to exceed 1 percent from no load to full rated load.
- C. The unit shall be mounted on a structural steel sub-base and shall be provided with suitable vibration isolators.
- D. Safety shut-offs for high water temperature, low oil pressure, overspeed, and engine overcrank shall be provided. An engine-mounted radiator with blower type fan shall be sized to maintain safe operation at specified ambient temperature. The radiator shall be equipped for a duct adapter flange. Air flow restriction from the radiator shall not exceed 0.5 inch of water.
- E. The engine cooling system shall be filled with a solution of 30 percent ethylene glycol.
- F. Provide a Critical Grade type silencer as manufactured by Kittel, Maxim, or GT Exhaust Systems, including stainless steel flexible exhaust fitting, properly sized and installed, according to the manufacturer's recommendation. Mounting shall be provided as part of the generator set assembly. Silencer shall be mounted so that its weight is not supported by the engine. Exhaust pipe size shall be sufficient to ensure that measured exhaust back pressure does not exceed the maximum limitations specified by the generator set manufacturer. Noise attenuation shall limit the exhaust note to 85dBA within 15 feet of the exhaust stack.
- G. nerator set manufacturer. Noise attenuation shall limit the exhaust note to 85dBA within 15 feet of the exhaust stack.
- H. Exhaust piping shall have stainless steel automatic exhaust cap, and shall be coated with not less than 6 mils of inorganic zinc after sandblasting to "white metal".
- I. The fuel storage tank shall be a subbase type, with integral secondary containment, gauges, piping, fittings, and valves shall be supplied as part of the generator set. The fuel storage tank shall be aboveground and an integral part of the generator. The fuel tank shall be U.L. listed.
- J. The tank shall be provided with a level gauge in the primary tank, and leak detection in the secondary tank capable of producing low level and leakage alarm.

- K. The tank shall be of sufficient capacity to run the generator set at full load for 12 hours.
- L. The level gauges shall be Liquidometer industrial type as manufactured by Hersey Products Company, Petro-Meter Company, or equal.
- M. An engine-mounted fuel filter, fuel pressure gauge, and engine fuel priming pump shall be provided.
- N. A DC electric starting system with positive engagement drive shall be furnished.
- O. Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide two auxiliary contacts for activating accessory items. Controls shall include a 30 second cranking cycle limit with lockout. (Three 10 second cranks or a single 30 second crank.)
- P. A unit mounted thermal circulation type water heater shall be furnished to maintain engine jacket water to 90 degrees F in an ambient temperature of zero degrees F. The heater shall be single phase, 60 hertz, 120/240 volts. Heater shall be Chromalox, General Electric, or equal.
- Q. 20/240 volts. Heater shall be Chromalox, General Electric, or equal.
- R. A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. The battery set shall be of sufficient capacity to provide for 1-1/2 minutes total cranking time without recharging and shall be rated no less than 220 amp-hours. A battery rack and necessary cables and clamps shall be provided as part of the generator set.
- S. A current limiting battery charger shall be furnished to automatically recharge the batteries. The charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressers, DC ammeter, DC voltmeter and fused AC input. Amperage output shall be no less than 10 amperes.
- T. volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressers, DC ammeter, DC voltmeter and fused AC input. Amperage output shall be no less than 10 amperes.

2.3 GENERATOR

A. The generator shall be a 4 pole or 6 pole revolving field type with static exciter and magnetic amplifier or SCR voltage regulator. No commutator or commutator brushes shall be allowed. Class F insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration. The starter shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semi-flexible driving flange to insure permanent alignment. Voltage regulation shall be within plus or minus 2 percent of rated voltage, from no load to full-load. The instantaneous voltage dip shall be less than 15 percent of rated voltage when full load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 5 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant within plus or minus 5

percent voltage adjustment from rated value. Temperature rise at full-load determined by resistance shall be within rating as defined by NEMA MG-1.

- B. -one percent of rated voltage. A rheostat shall provide a minimum of plus or minus 5 percent voltage adjustment from rated value. Temperature rise at full-load determined by resistance shall be within rating as defined by NEMA MG-1.
- C. The specified standby kW shall be for continuous electrical service during interruption of the normal utility source.
- D. These ratings must be substantiated by manufacturer's standard published curves. Special ratings or maximum ratings are not acceptable.
- E. A generator mounted vibration isolated 14 gauge steel control panel shall be provided.
- F. Control panel shall be microprocessor-based, and shall provide the following features: 1.—Voltmeter, 3-1/2 inch, 2 percent accuracy
 - 2.—Ammeter, 3-1/2 inch, 2 percent accuracy
 - 3.–Voltmeter/Ammeter phase selector switch
 - 4.—Frequency meter, 3-1/2 inch, dial type
 - 5. Automatic starting controls
 - 6.—Panel illumination lights and switch
 - 7.--Voltage level adjustment rheostat
 - 8.-Engine oil pressure gauge
 - 9.—Engine water temperature gauge
 - 10. Dry contacts for remote alarms wired to terminal strips for the following:
 - a. Run status
 - b. Trouble alarm
 - c. Fault alarm
 - 11. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank
 - 12. Four position function switch marked AUTO, MANUAL, OFF/RESET, and STOP
 - 13. Battery charge rate ammeter if not furnished on separate charger
 - 14. Running time meter
- G. A generator mounted main line molded case circuit breaker shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions.
- H. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.
- I. Provide a sign at the service entrance equipment indicating type and location of standby power generator per NEC.

2.4 MINI POWER CENTER

A. The generator system shall be equipped with a mini power center to provide power to the water jacket heater(s), battery charger, and other single phase loads. The mini power center shall be rated for 15kVA, 480-120/240 volt, single phase, and shall include an integral transformer with primary circuit breaker, and distribution panelboard with a main circuit breaker. Circuit breakers shall bolt on and buses shall be copper. Higher amperage rated transformers panelboards shall be provided if required by the generator system. The panelboard shall be UL 67 listed.

- B. The mini power center shall be mounted where fully accessible. The mini power center enclosures shall be NEMA 3R. The minimum interrupting capacity of any device shall be 10,000 amps unless indicated otherwise on Drawings.
- C. All devices requiring power inside the generator system shall be prewired to the mini power center in accordance with NEC requirements. Provide grounding per NEC, and Section 16060 of the Specifications.
- D. The mini power center shall be as manufactured by Square D, or equal.

PART 3 - EXECUTION

3.1 FACTORY TESTS

A. Before the equipment is installed, a factory certified test log of the generator set showing a minimum of ³/₄ hour testing with ¹/₂ hour at 100 percent rated load, continuously, shall be submitted to the ENGINEER.

3.2 INSTALLATION

A. The generating system shall be installed as indicated on the Drawings, per manufacturer's recommendations and shall meet all applicable codes and regulations.

3.3 START-UP

- A. On completion of the installation, start-up shall be performed by a factory-trained dealer service representative.
- B. This generating system shall be full-load tested at site in the presence of the ENGINEER for a period of 8 hours, with supplier providing necessary resistive load banks. Any defects which become evident during this test shall be corrected by the CONTRACTOR at his own expense.
- C. After installation the tank shall be filled with No. 2 fuel oil. The tank shall be refilled after the 8-hour on-site test.

3.4 GROUNDING

A. Provide grounding as shown on the Drawings, and as per NEC.

+ + END OF SECTION + +

SECTION 16671

TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope: The manufacturer or representative of the manufacturer shall furnish and arrange for the installation of the Transient Voltage Surge Suppression (TVSS) equipment having the warranties, guarantees, electrical characteristics, ratings, energy savings performance, and modifications as specified herein.

B. Related Sections:

1. Division 16, Electrical.

1.2 QUALITY ASSURANCE

- A. The USA manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement. The company shall be in the TVSS manufacturing business for over 10 years in the USA.
- B. The TVSS units and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards of the following:
 - 1. UL Listed under UL 1449 2nd Edition
 - 2. The UL 1449 suppression voltage ratings (SVR) shall be permanently affixed to the TVSS unit.
- C. TVSS units shall be Underwriters Laboratories listed.

1.3 SUBMITTAL

A. Provide verification that the TVSS device complies with the required UL 1449 specification.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. This specification is written to describe the REDI/VOLT II System IV (or equal in all respects) as supplied by ENER/TECH SALES, INC. or their authorized representatives. In

City of Prescott, AZ Yavapai Hills Lift Station #1 21-064 the state of Arizona, the authorized representative includes, but is not necessarily limited to, ENERGY REDUCTION, INC.

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSION - GENERAL

- A. ELECTRICAL REQUIREMENTS
 - 1. Unit Operating Voltage Refer to drawings and product specifications for operating voltage and unit configuration.
 - 2. Maximum Continuous Operating Voltage (MCOV) The MCOV shall not be greater than 115% of the nominal system operating voltage.
 - 3. The TVSS unit shall have a response time of less than 90 picoseconds (trillionths of a second).
 - 4. The TVSS units shall have clamp response activation at 10 % above line voltage.
- B. TVSS DESIGN:
 - 1. Balanced Suppression Platform The surge current shall be equally distributed to all MOV components to insure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
 - 2. Internal Connections No plug-in component modules shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
 - 3. The TVSS unit shall have monitoring lights indicating that the unit is performing. Fault detection is indicated by the failure of any one of the monitoring lights on the front of the TVSS unit.
 - Warranty The manufacturer shall provide a lifetime warranty from the date of installation against any TVSS part failure when installed in compliance with the manufacturer's written instructions and any applicable national or local electrical code.
 - 5. Protected Equipment The manufacturer shall provide a lifetime protected equipment warranty to repair or replace any equipment damaged by a transient voltage surge/spike while properly connected through the TVSS unit. The warranty is for repair or replacement, at ENER/TECH's option, for an amount equal to the fair market value of the damaged equipment or the original price of the equipment, whichever is less, up to a maximum amount of \$100,000. (See attached Sample Warranty page for complete details).
 - 6. The manufacturer must guarantee and insure 20% savings in kwhr consumption over the first two years of TVSS operation following installation. The insurance policy must be issued to the customer and underwritten by a major third party insurance carrier.

2.3 SYSTEM APPLICATION

- A. The Products covered by this specification have been tested and demonstrated that they are suitable for ANSI/IEEE C62.41 Category C1 environments. (See attached product specification page)
- B. The TVSS units are capable of withstanding a total surge current 8 x 20 microsecond waveform shall be 80 kA per phase.
- C. Each TVSS unit must be capable of surviving more than 2500 category C1 transients without failure or degradation of UL 1449 Suppression Voltage Rating.

- D. A direct bus bar connection may be used to mount the TVSS component to the panelboard bus bar to reduce the impedance of the shunt path.
- E. The maximum conductor lead length between breaker and suppressor shall not exceed 18 inches, but should be as short as possible.

2.4 ENCLOSURES

A. The TVSS units shall be contained in a NEMA 4 watertight steel casing for indoor or outdoor use primarily to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from external ice formation.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Standard Factory tests are performed on the equipment in accordance with the latest version of NEMA and UL standards.

TRANSIENT VOLTAGE SURGE SUPPRESSOR PERFORMANCE SPECIFICATIONS

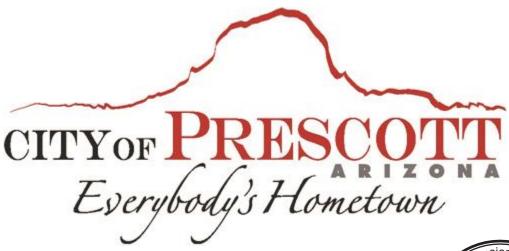
	S/C 120/240	3D 120/240	3W 120/208	"3" 377/480		
UNIT MODEL	Volt Single	Volt Three	Volt Three	Volt Three		
	Phase	Phase Delta	Phase WYE	Phase WYE		
Wiring	3 Wire plus	4 Wire plus	4 Wire plus	4 Wire plus		
	ground	ground	ground	ground		
Maximum Surge Current	80 kA	80 kA	80 kA	80 kA		
	per phase	per phase	per phase	per phase		
Response Time	85 picoseconds	85	85	85 picoseconds		
		picoseconds	picoseconds			
Clamp Voltage (VPeak)	<u>Cat. C1/B3</u>	<u>Cat. C1/B3</u>	<u>Cat. C1/B3</u>	<u>Cat. C1/B3</u>		
	ANSI/EEE	ANSI/EEE	ANSI/EEE	ANSI/EEE		
	<u>C62.41 - 1991</u>	<u>C62.41 - 1991</u>	<u>C62.41 - 1991</u>	<u>C62.41 - 1991</u>		
	(6kV-1.2/5.0	(6kV-1.2/5.0	(6kV-1.2/5.0	(6kV-1.2/5.0		
	□s, 3kA-8/20	□s, 3kA-8/20	□s, 3kA-8/20	□s, 3kA-8/20		
	□s)	□s)	s)	□s)		
Line to Neutral	330 volts	600 Volts(A &	330 Volts	800 Volts		
		<u> </u>				
Line (B-Hi-Leg) to Neutral		700 Volts (B)				
Rating of Varistor						
Component						
Line to Neutral	130 Volts	130 Volts(A &	130 Volts	320 Volts		
		C)				
Line (B-Hi-Leg) to Neutral		230 Volts (B)				
Rated Voltage (RMS)						

UNIT MODEL	S/C 120/240 Volt Single Phase	3D 120/240 Volt Three Phase Delta	3W 120/208 Volt Three Phase WYE	"3" 377/480 Volt Three Phase WYE	
Line to Neutral	120 Volts	120 Volts (A & C)	120 Volts	277 Volts	
Line (B-Hi-Leg) to Neutral		240 Volts (B)			
Line to Line	240 Volts	240 Volts (A &C)	208 Volts	480 Volts	
Line (B-Hi-Leg) to Line		360 Volts (B)			
Total Capacitance (F:1Mhz)	1900	1900	1900	750	
Relative Humidity Range	100%	100%	100%	100%	
Operating Frequency	50 - 60 Hertz	50 - 60 Hertz	50 - 60 Hertz	50 - 60 Hertz	
Operating Temp. Range (°C)	- 55°C to +85°C	- 55°C to +85°C	- 55°C to +85°C	- 55°C to +85°C	

++ END OF SECTION ++

CITY OF PRESCOTT, YAVAPAI HILLS LIFT STATION # 1 STANDARD DETAILS

FOR CONSTRUCTION ADDENDUM 2 VOLUME 3 OF 4

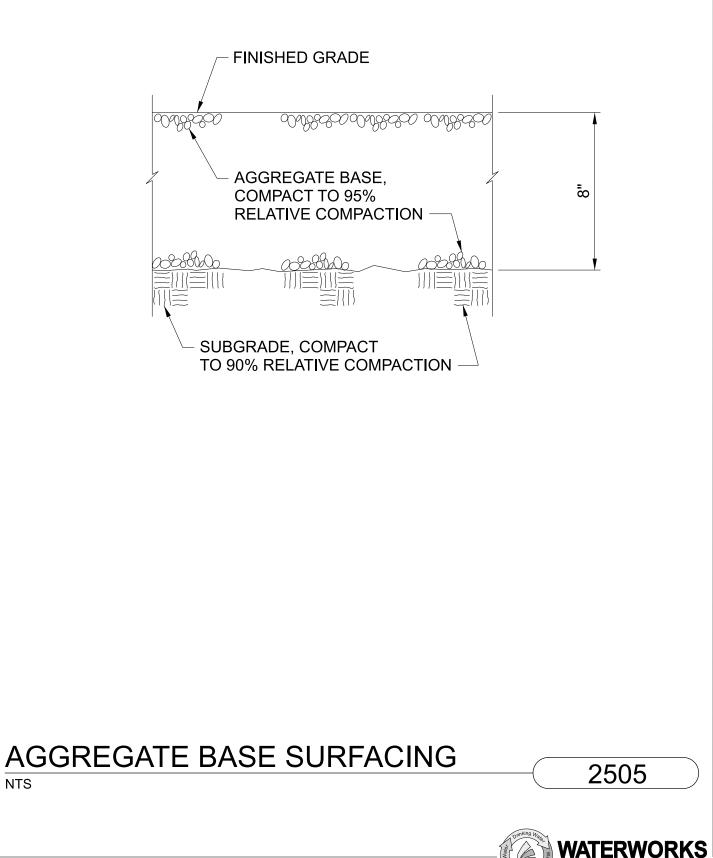




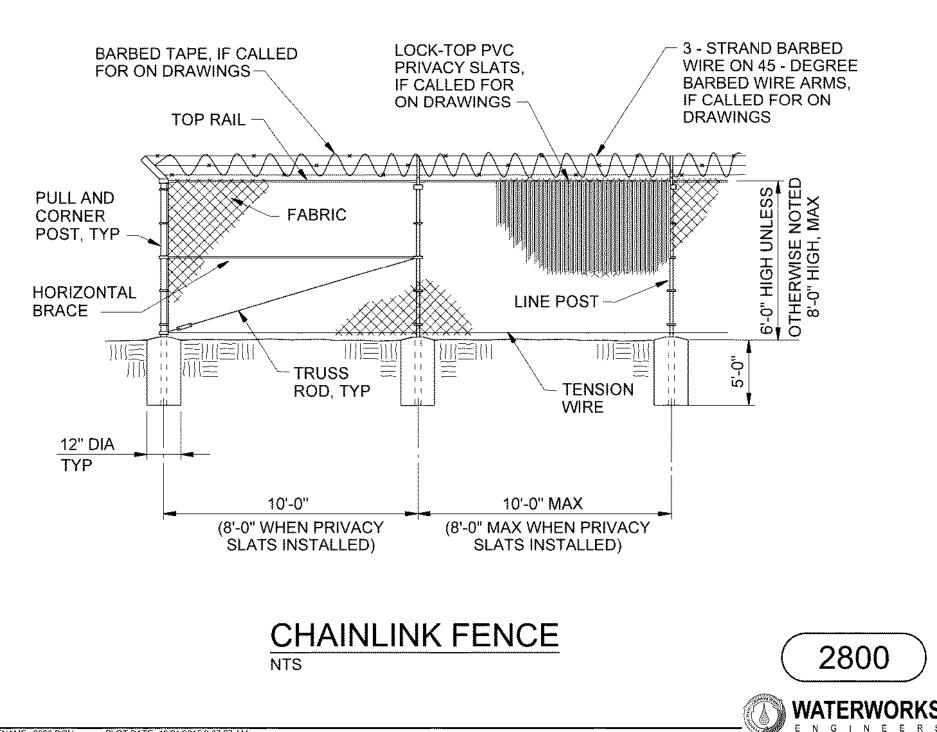
April 2024

PREPARED BY: WATER WORKS ENGINEERS, LLC. 7500 N. Dobson Road #200 Scottsdale, AZ 85256 (480) 661-1742

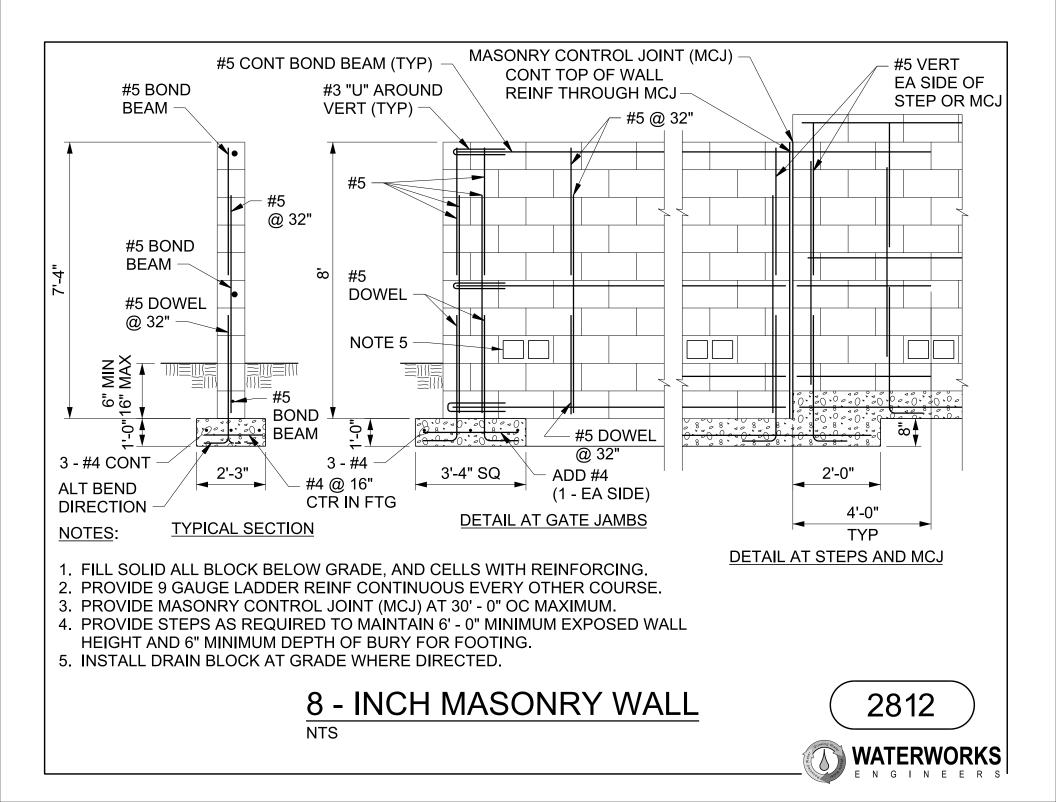


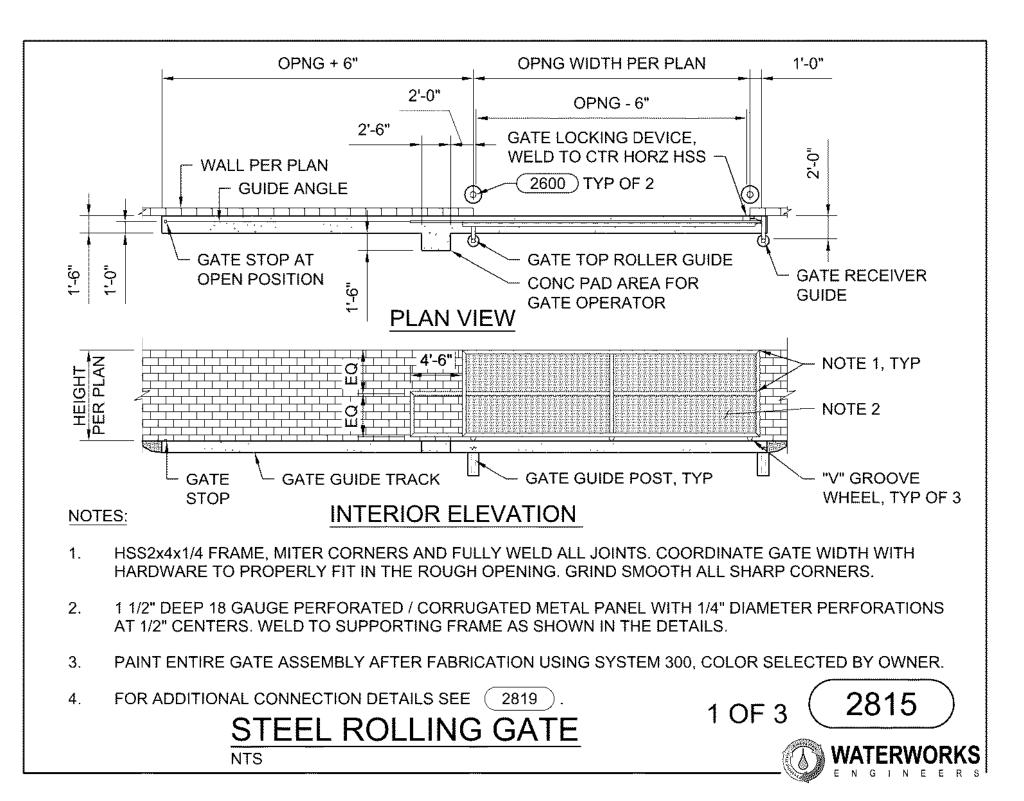


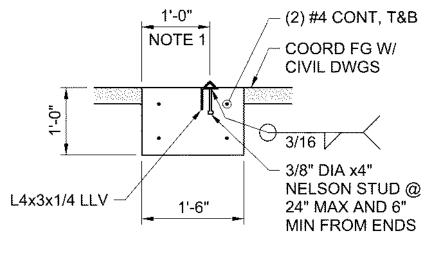
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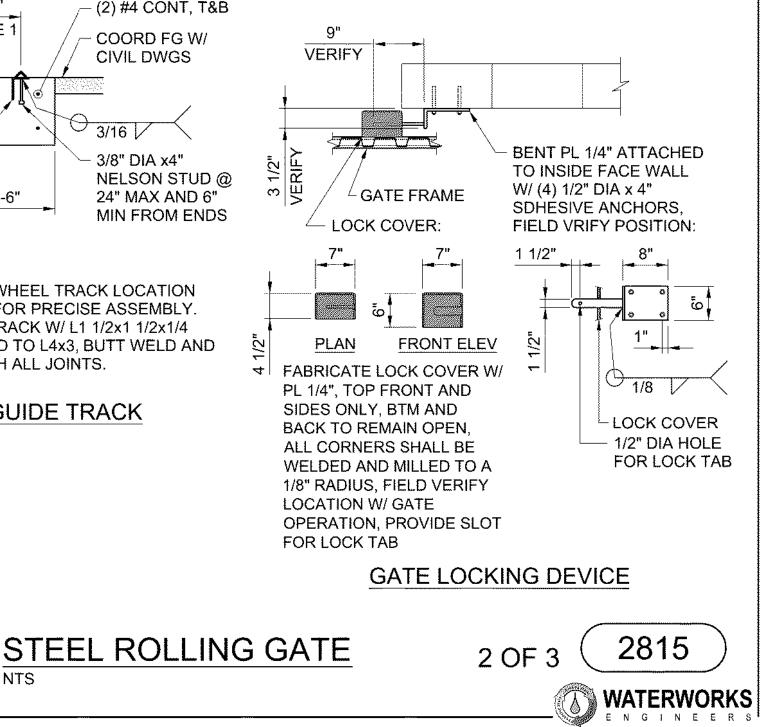


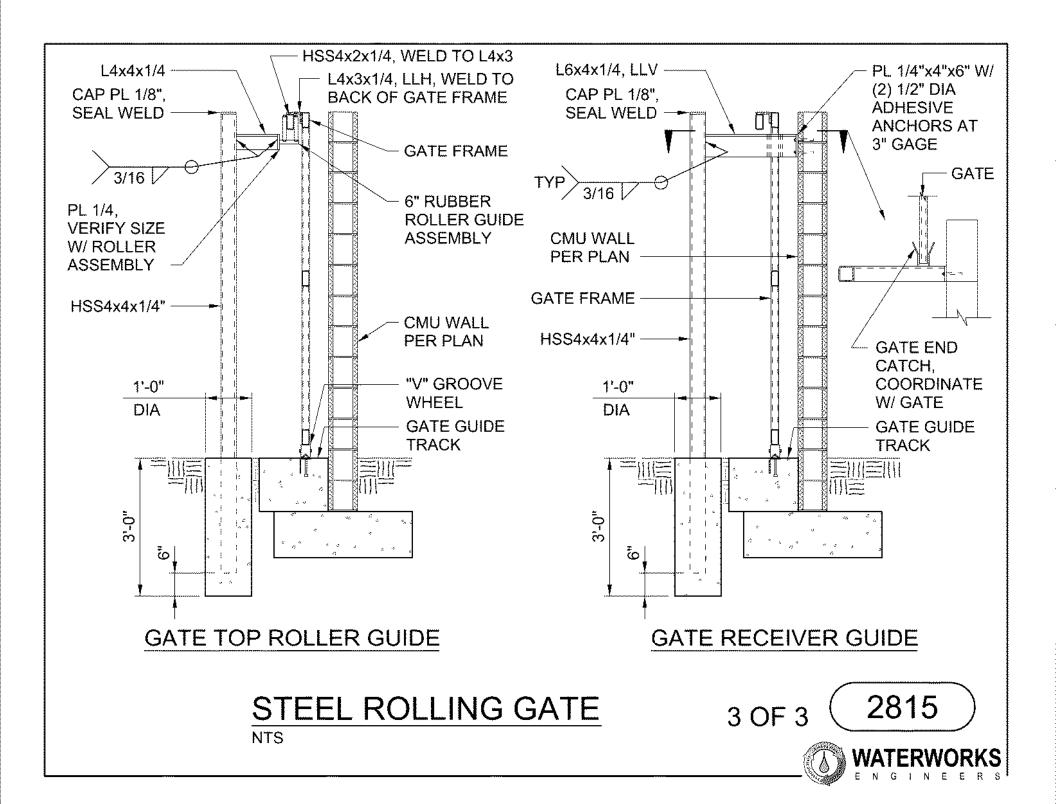




COORDINATE WHEEL TRACK LOCATION 1. W/ GATE MFR FOR PRECISE ASSEMBLY. CONSTRUCT TRACK W/ L1 1/2x1 1/2x1/4 ANGLE WELDED TO L4x3, BUTT WELD AND GRIND SMOOTH ALL JOINTS.

GATE GUIDE TRACK





- 1. PAD SIZE SHALL BE MINIMUM INDICATED OR AS SHOWN ON THE DRAWINGS OR AS INDICATED BY THE MANUFACTURER AND APPROVED BY THE ENGINEER.
- THE SIZE, NUMBER, TYPE, LOCATION, AND THREAD PROJECTION OF THE ANCHOR BOLTS SHALL BE DETERMINED BY THE EQUIPMENT MANUFACTURER, AND SHALL BE AS APPROVED BY THE ENGINEER. ANCHOR BOLTS SHALL BE HELD IN POSITION WITH A ONE PIECE TEMPLATE, MATCHING THE BASE PLATE, WHILE PAD IS BEING POURED.
- 3. ANCHOR BOLT SLEEVES SHALL BE USED TO PROVIDE THE ANCHOR BOLT A MINIMUM MOVEMENT OF 1/2" IN ALL DIRECTIONS. THE MINIMUM SLEEVE LENGTH SHALL BE 8 TIMES THE BOLT DIAMETER. SLEEVES SHALL BE FILLED WITH NON-SHRINK GROUT.
- 4. ANCHOR BOLT SLEEVES SHALL HAVE A MINIMUM INTERNAL DIAMETER 1" GREATER THAN BOLT DIAMETER AND A MAXIMUM INTERNAL DIAMETER 3" GREATER THAN ANCHOR BOLT DIAMETER. SLEEVES SHALL BE FILLED WITH NON-SHRINK GROUT.
- 5. EQUIPMENT BASES SHALL BE INSTALLED LEVEL UNLESS SPECIFIED OTHERWISE.
- 6. TYPE "D" DETAIL SHALL BE USED ONLY FOR SLABS ON GRADE AND AT GRADE. THE SURROUNDING FLOOR SLAB SHALL NOT BE PLACED UNTIL THE EXACT SIZE AND LOCATION OF THE PAD IS KNOWN.
- 7. WEDGES OR SHIMS SHALL BE USED TO SUPPORT THE BASE WHILE THE NON-SHRINK GROUT IS PLACED. TEMPORARY LEVELING NUTS SHALL BE BACKED OFF. IF LEFT IN, THE WEDGES OR SHIMS SHALL NOT BE EXPOSED TO VIEW.
- 8. HEIGHT OF PADS SHALL BE MINIMUM REQUIRED FOR ANCHOR BOLT CLEARANCE TO KEEP ANCHOR BOLT OUT OF SLAB (SEE TABLE BELOW). WHERE EQUIPMENT OR PIPING ELEVATION REQUIRE A PAD HEIGHT LESS THAN THE MINIMUM SHOWN, USE TYPE B WITH BLOCKOUT.

AB DIA (IN.)	1/2	5/8	3/4	7/8	1	1 1/4	1 3/8	1 1/2	1 3/4	2
MIN PAD HT (IN.)	7	8 1/2	10	11	12 1/2	15	16 1/2	18	21	24

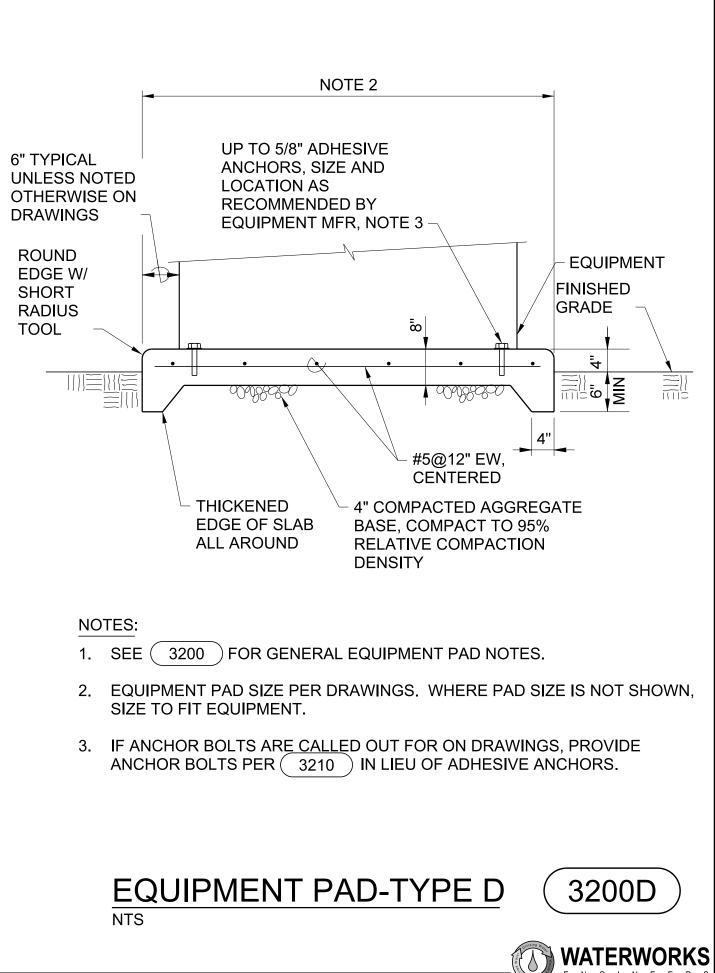
9. TYPE "F" PADS MAY BE SUBSTITUTED FOR TYPE "A" PADS FOR LOCATIONS APPROVED IN WRITING BY THE ENGINEER.

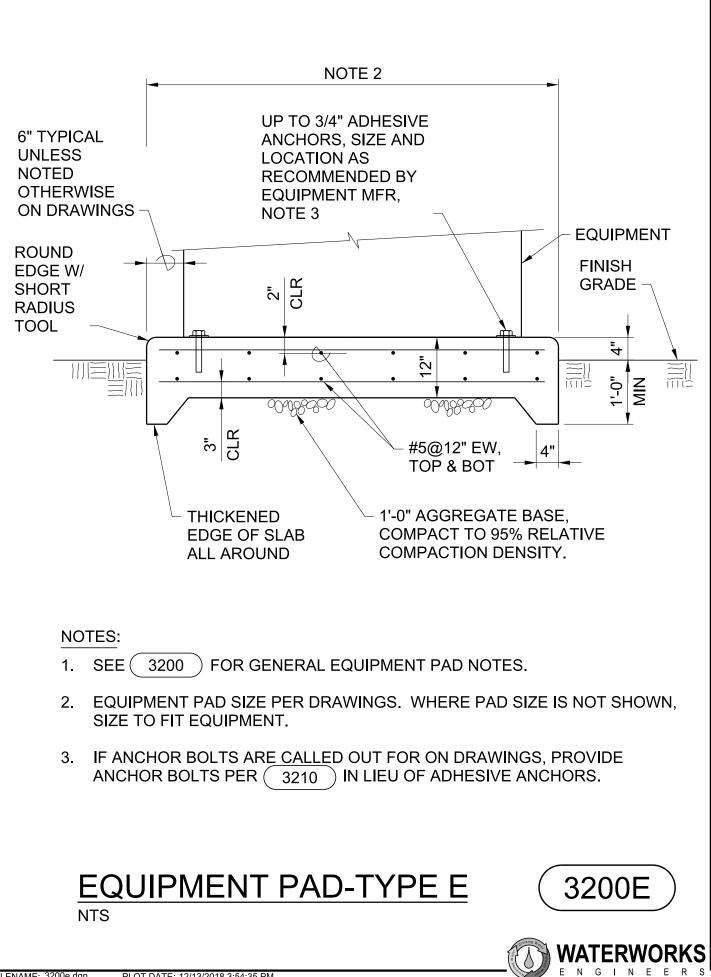
10. SEE ANCHOR BOLT AND BLOCKOUT DETAILS $(3210)_{1}$

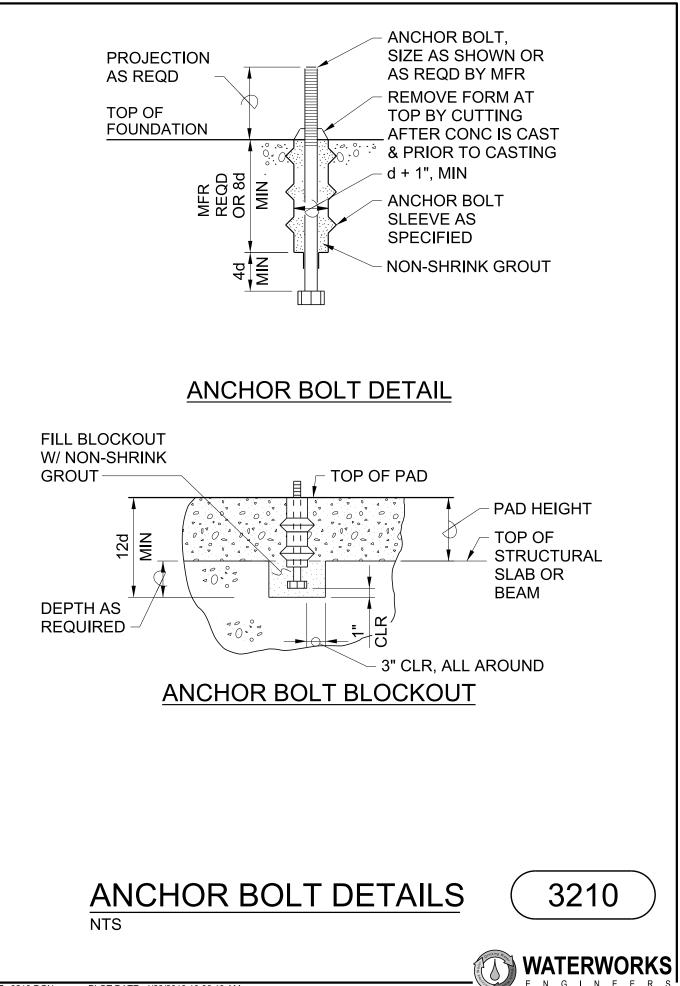
EQUIPMENT PAD NOTES

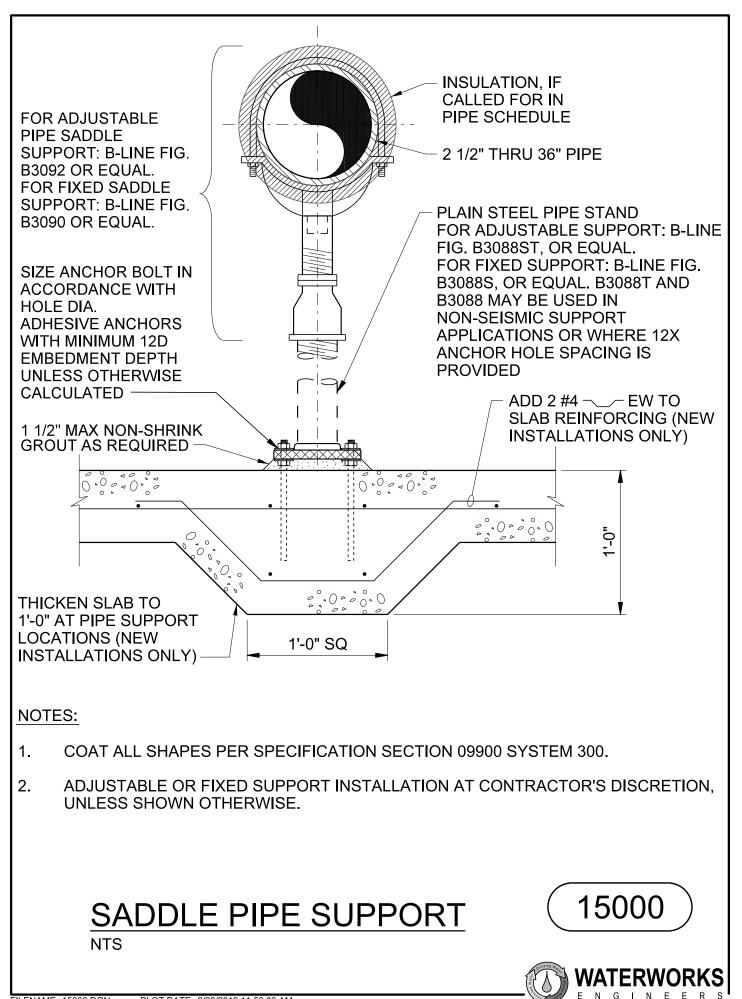
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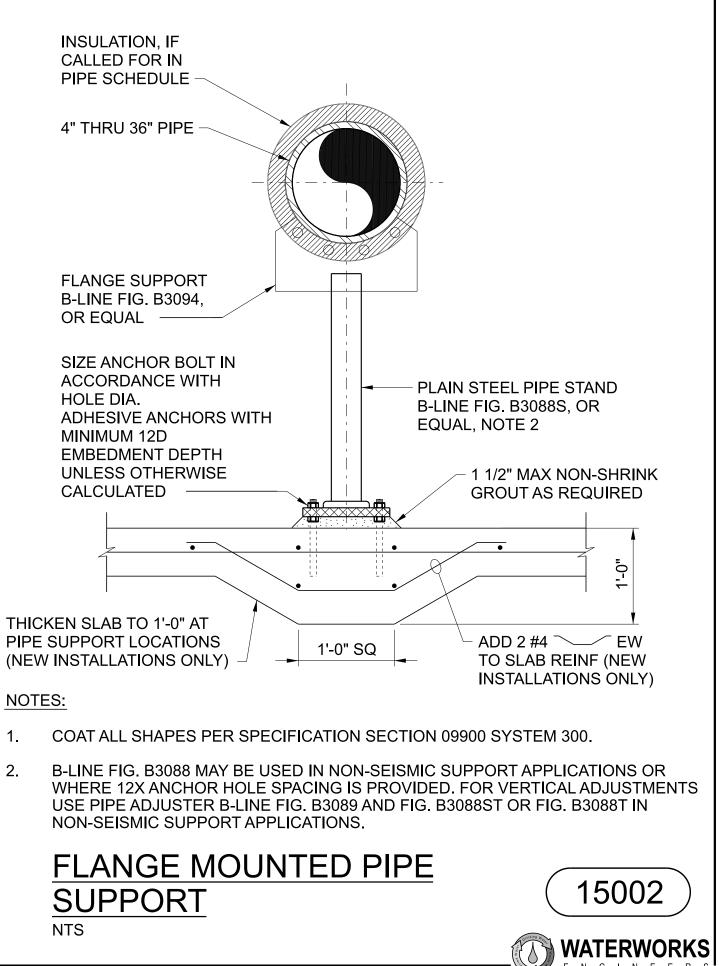


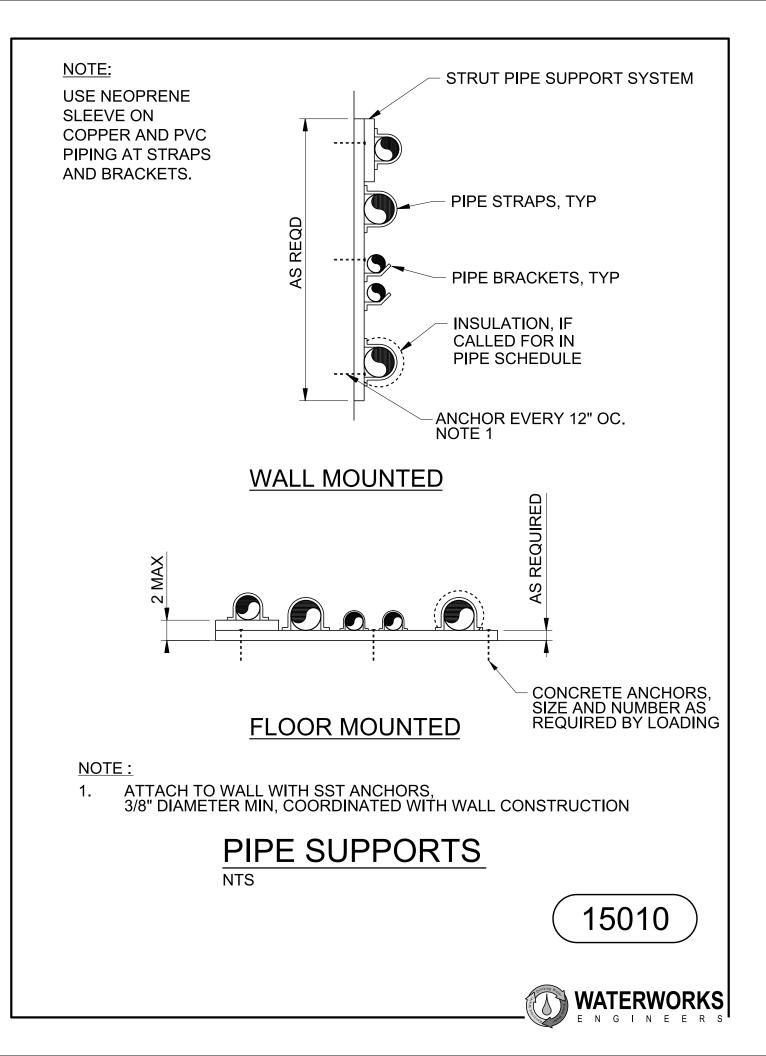


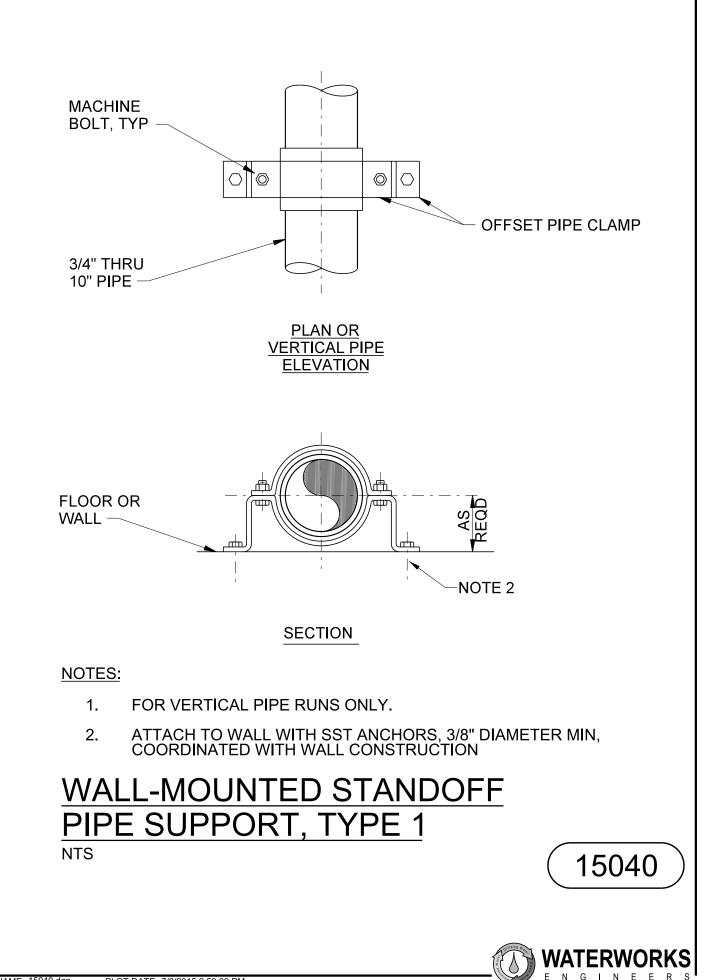


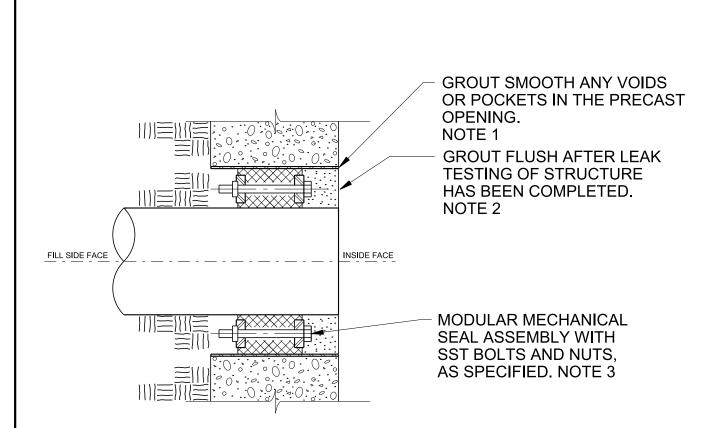










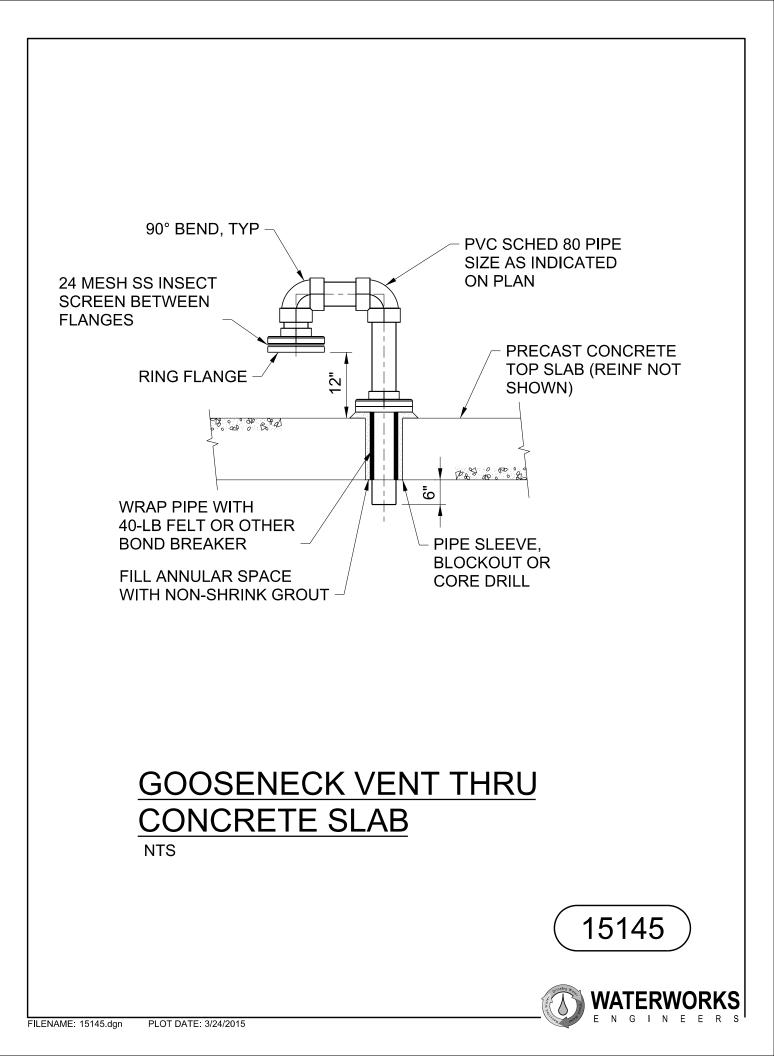


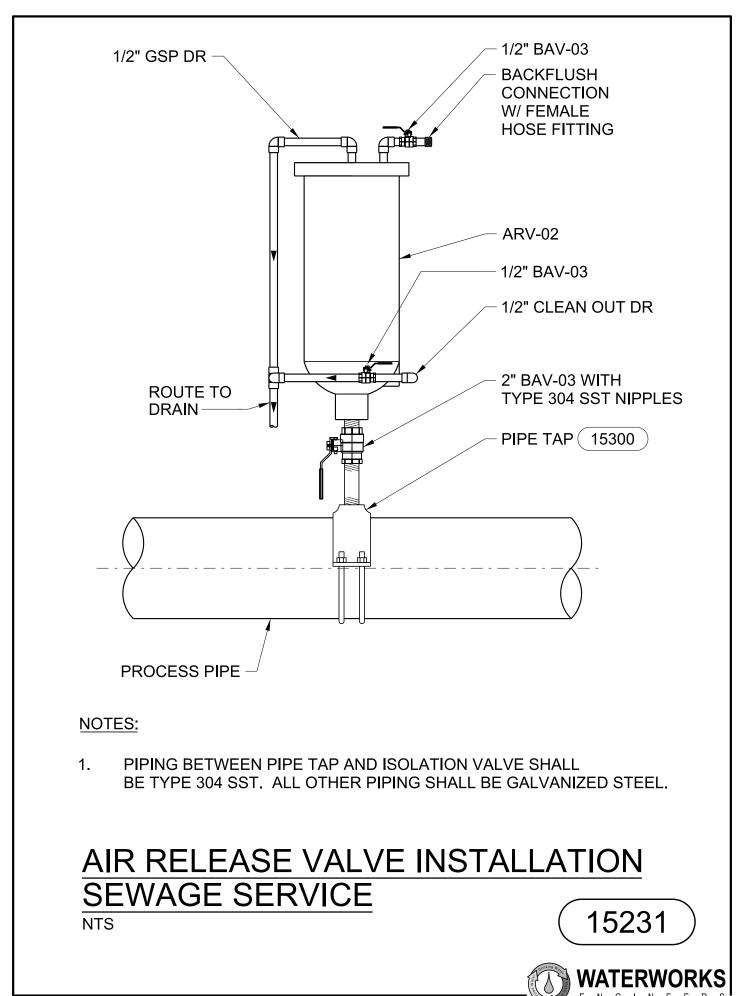
- 1. COORDINATE MODULAR SEAL SPACE REQUIRMENTS WITH PRECAST VENDER FOR OPENING SIZES PRIOR TO PLACING ORDER OF PRE-CAST STRUCTURE.
- AFTER MODULAR SEAL INSTALL AND LEAK TEST BUT 2. BEFORE GROUT IS PLACED, GREASE INSIDE FACE OF SEAL.
- INSTALL PER MANUFACTURER'S INSTRUCTIONS WITH THE 3. BOLT HEADS FACING THE INSIDE FACE OF THE STRUCTURE.

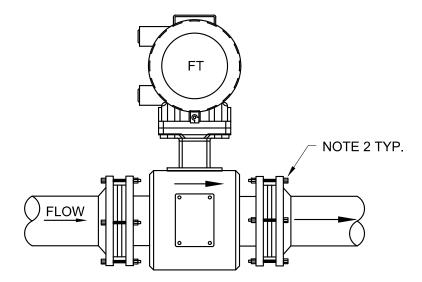
PRE-CAST OPENING WITH MODULAR MECHANICAL SEAL (BURIED) 15132A











- 1. INSTALL WITH A MINIMUM OF FIVE (5) STRAIGHT PIPE DIAMETERS UPSTREAM AND TWO (2) STRAIGHT PIPE DIAMETERS DOWNSTREAM.
- 2. PROVIDE MATING FLANGES, GASKETS, AND BOLTING PER THE PDT OF THE PROCESS PIPE.

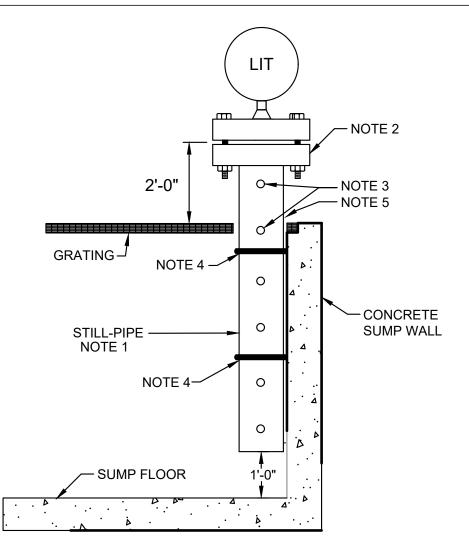
MAGNETIC FLOWMETER DETAIL

15235

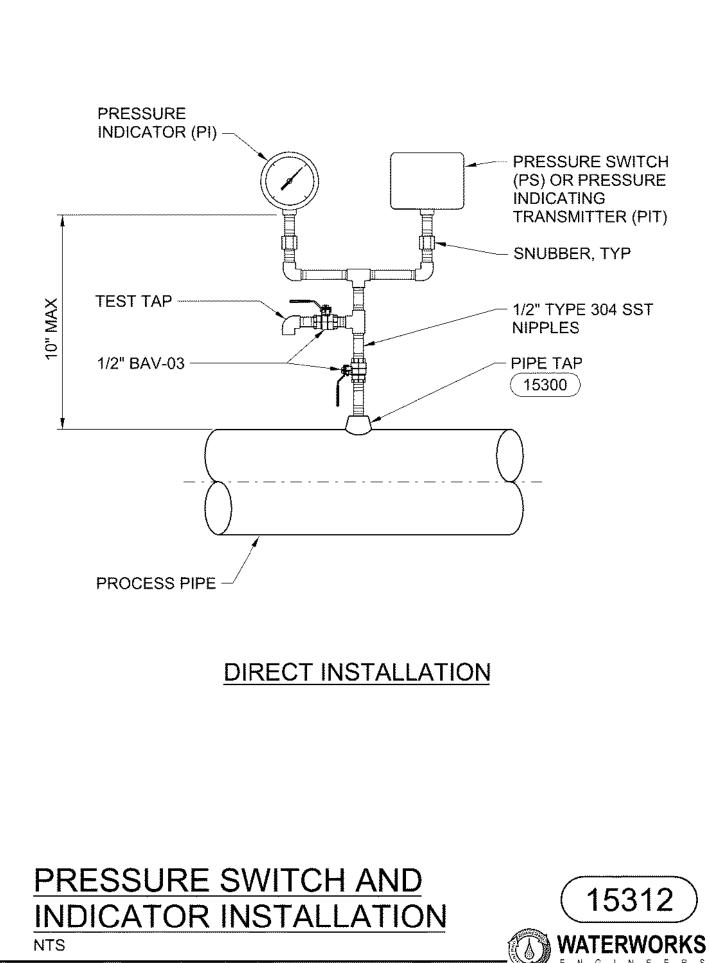


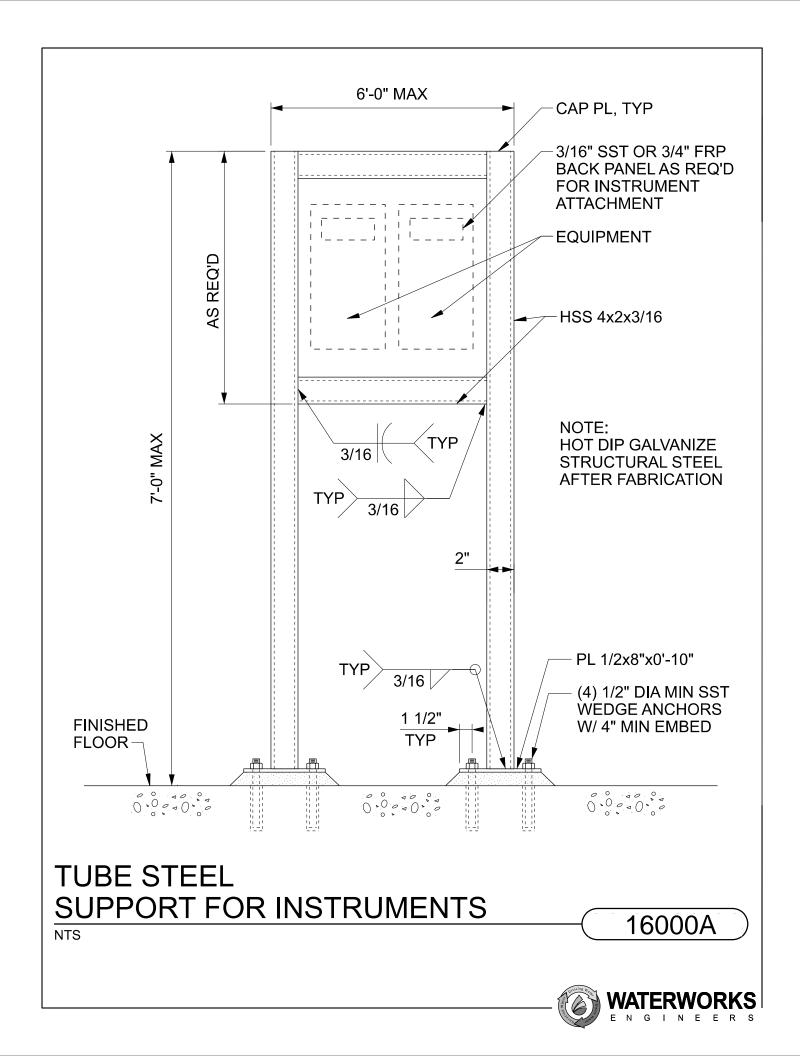
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- 5. CUT ACCESS IN GRATING FOR STILL-PIPE. IF GRATING IS METAL, COLD GALVANIZE CUT ENDS.

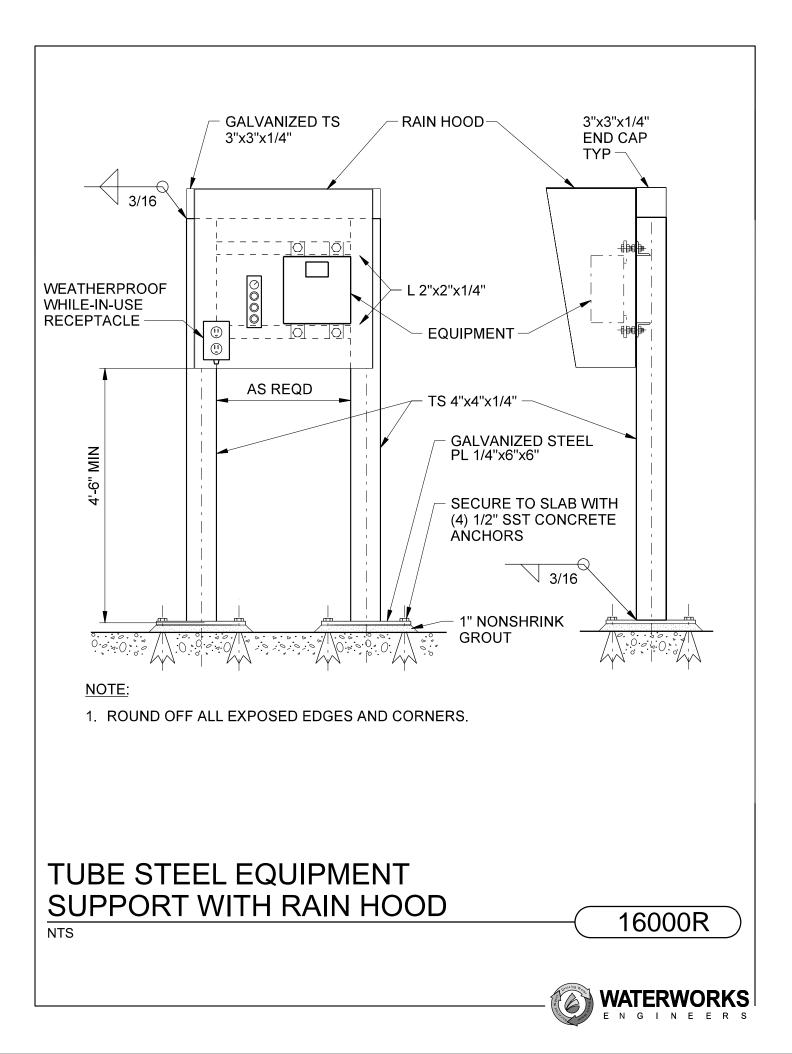
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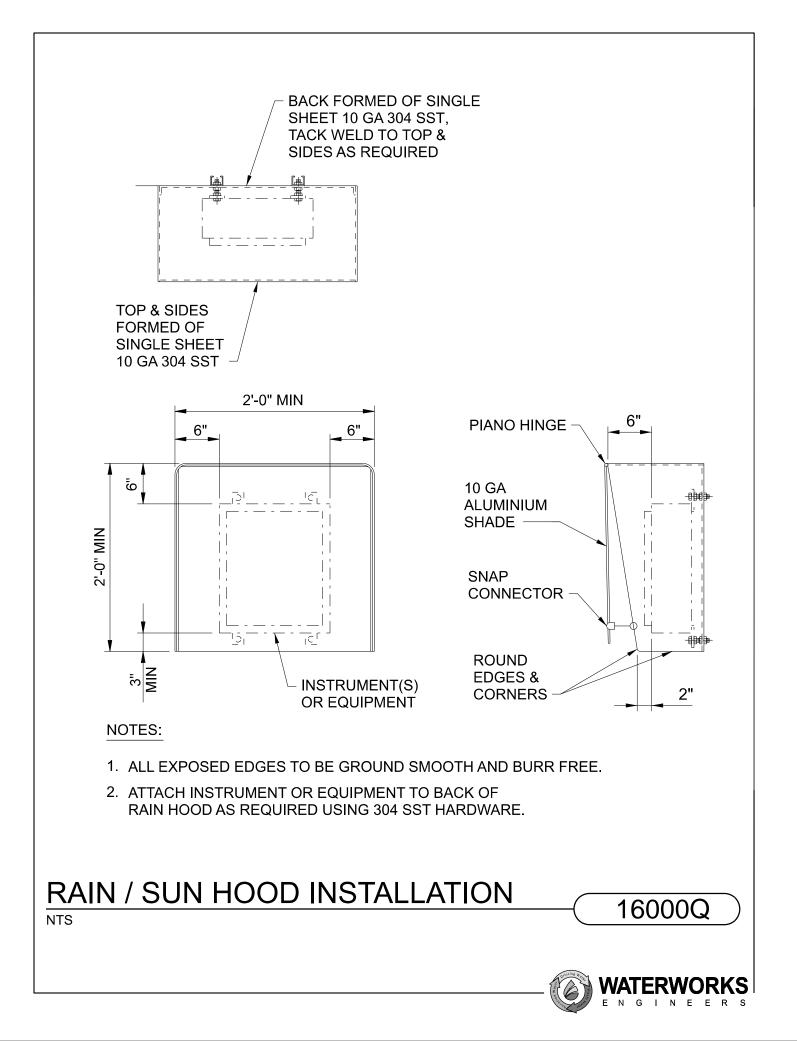


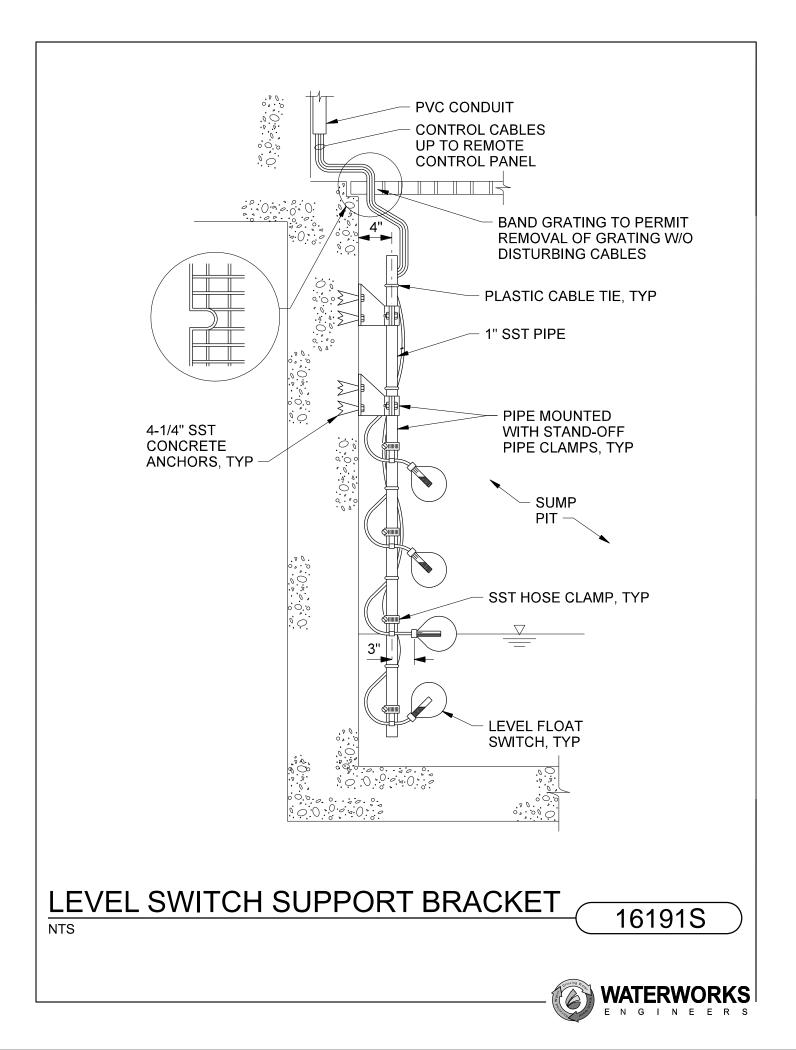
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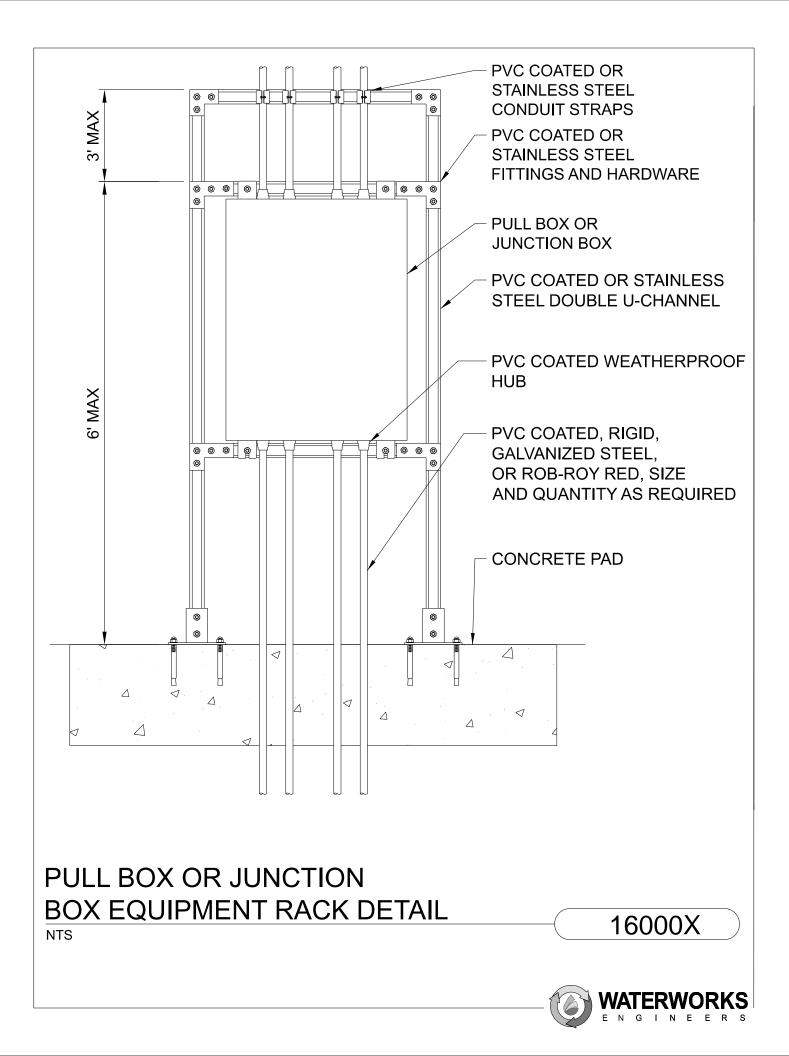


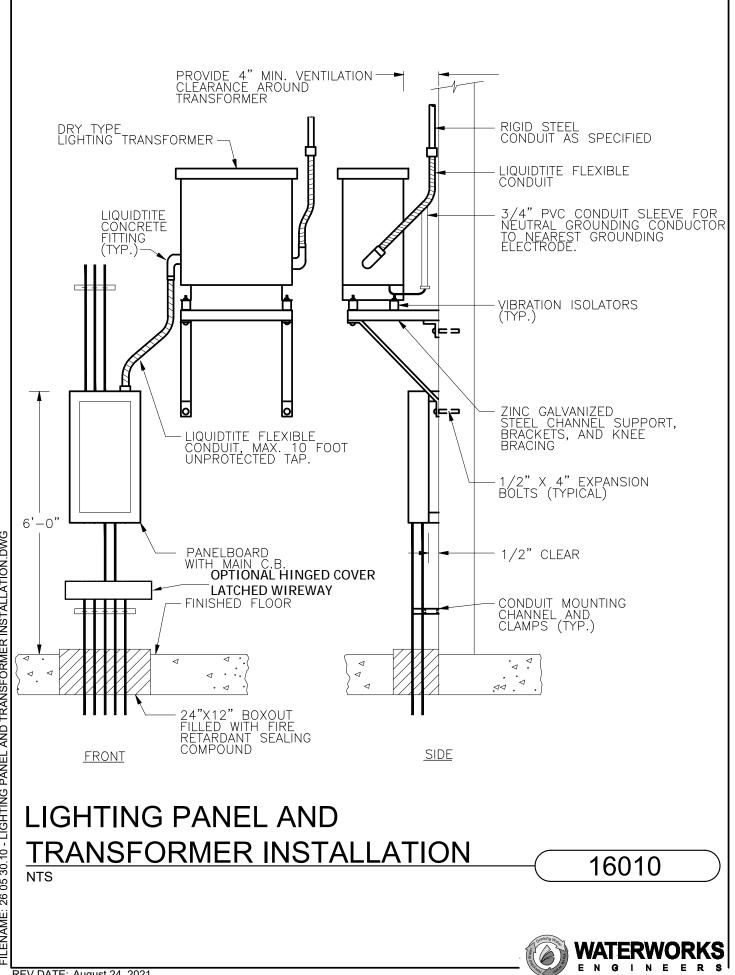




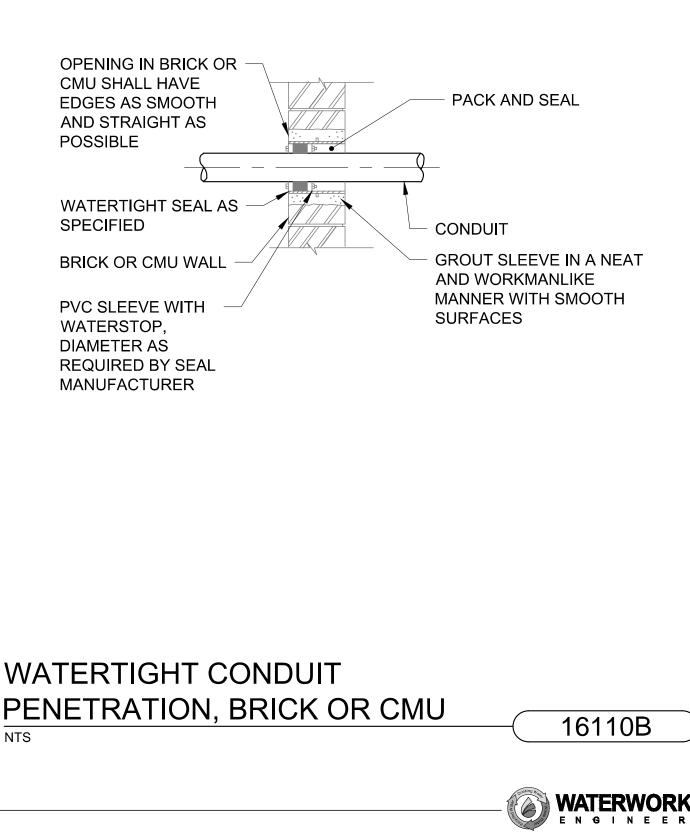


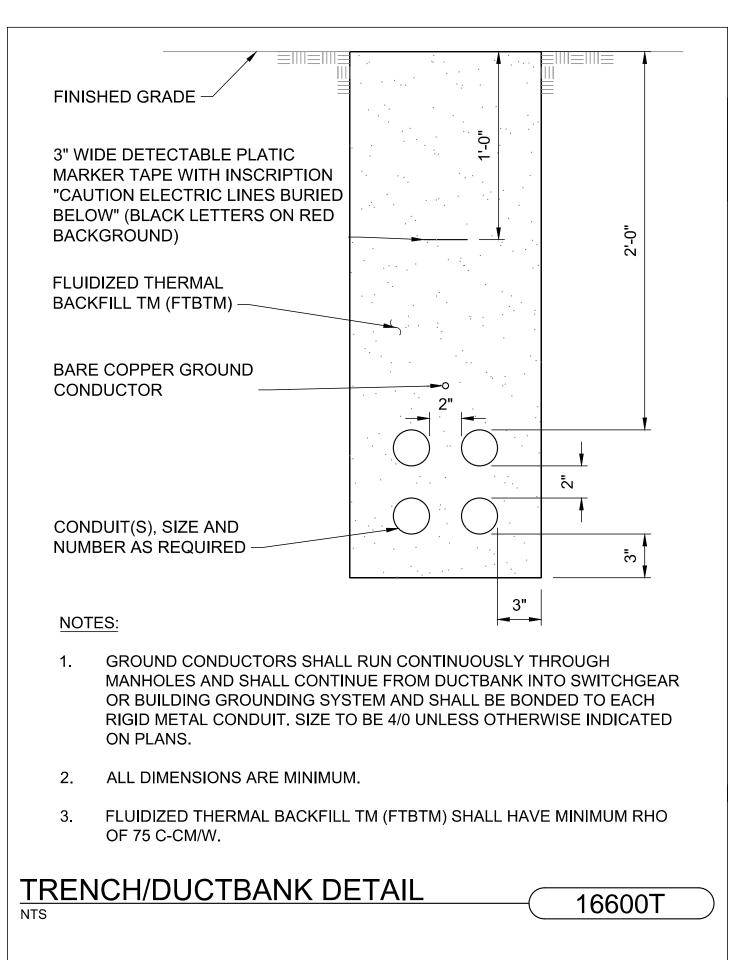




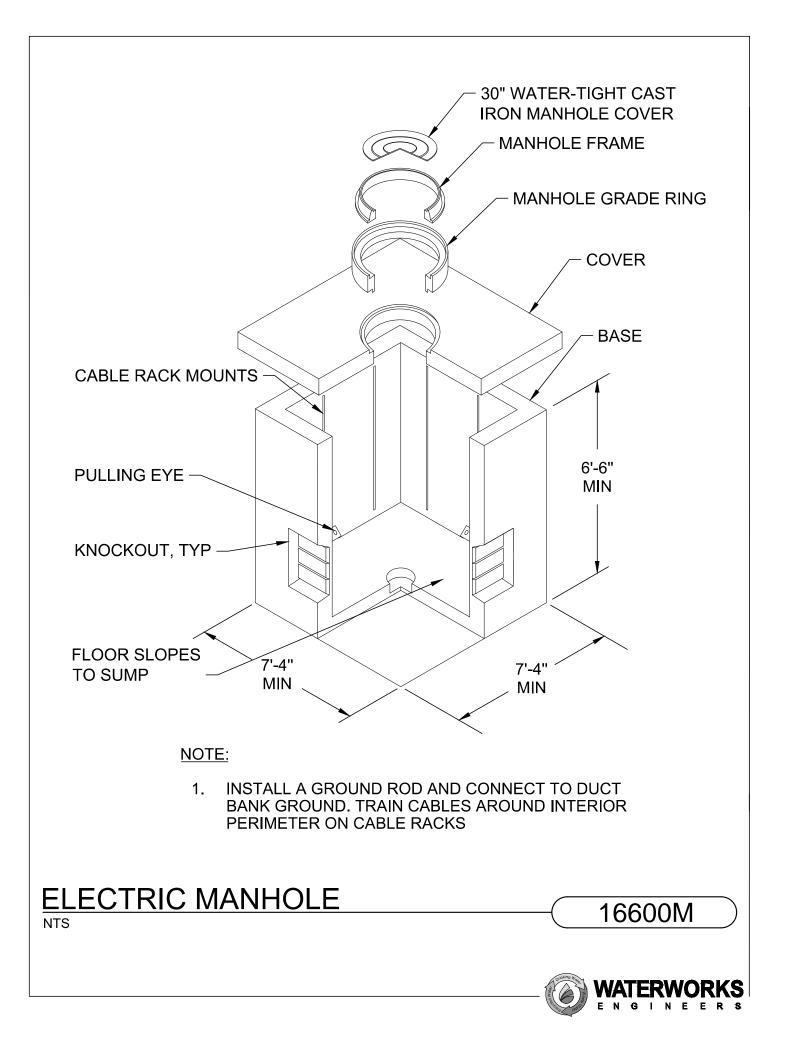


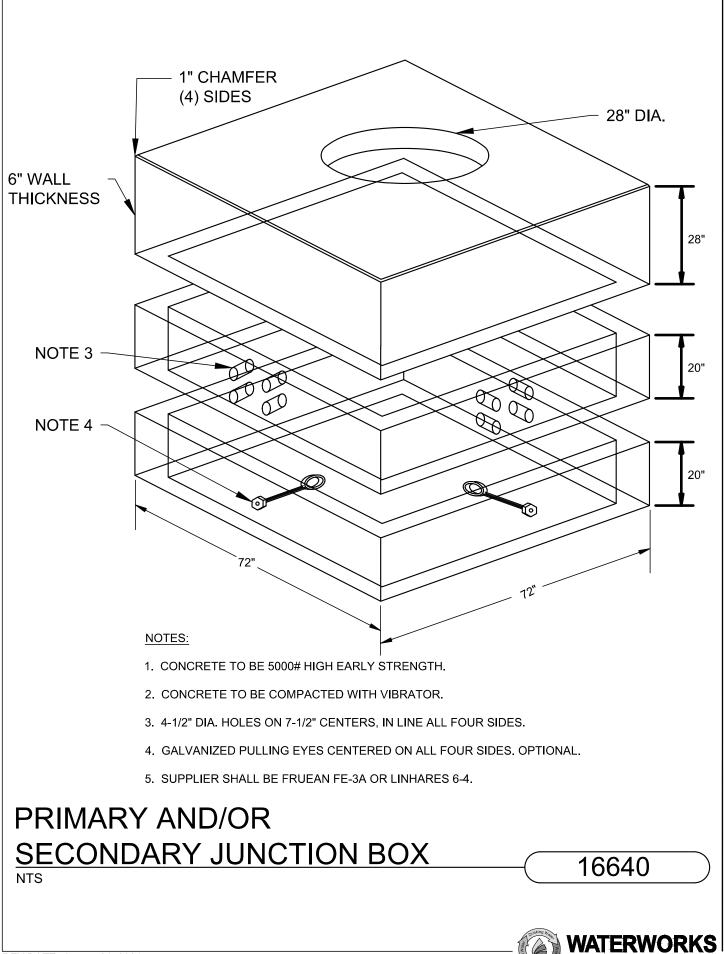
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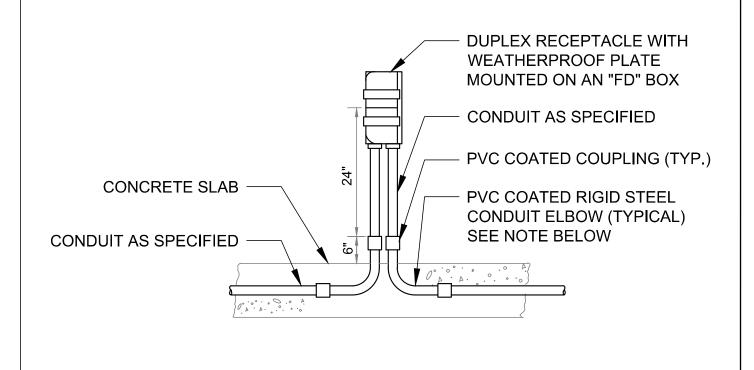










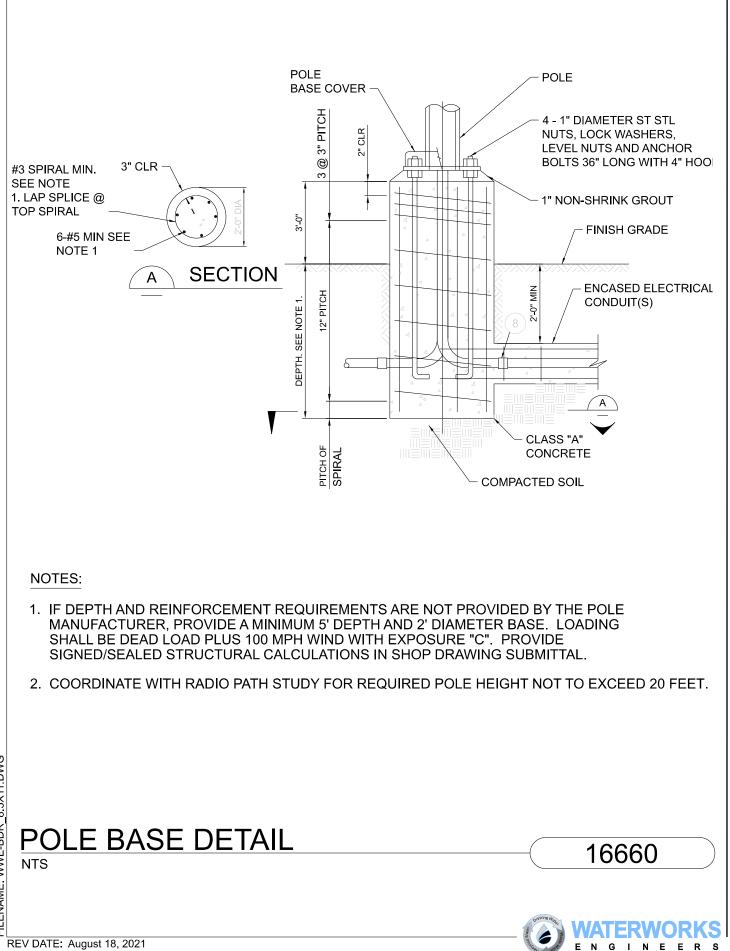


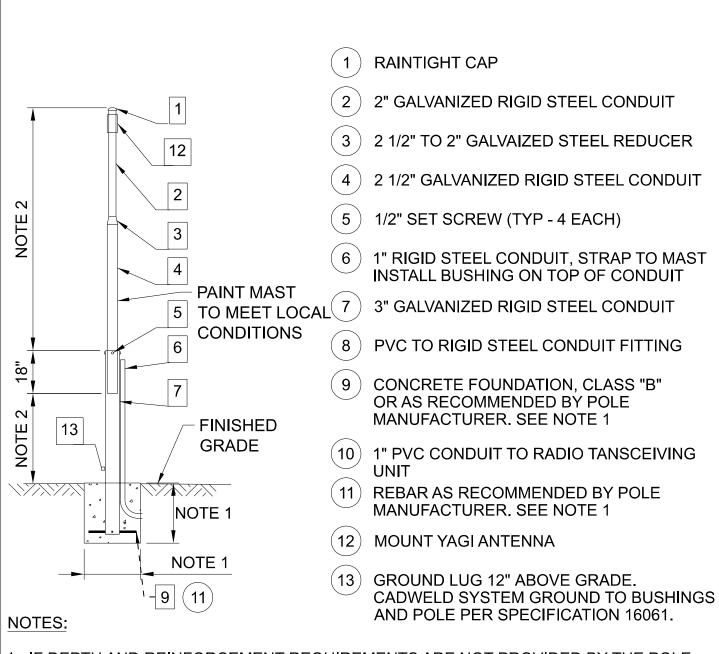
NOTE:

1. ELBOW TO BE CAPPED IN SLAB ON LAST RECEPTACLE IN ROW (FOR SUPPORT)

16650







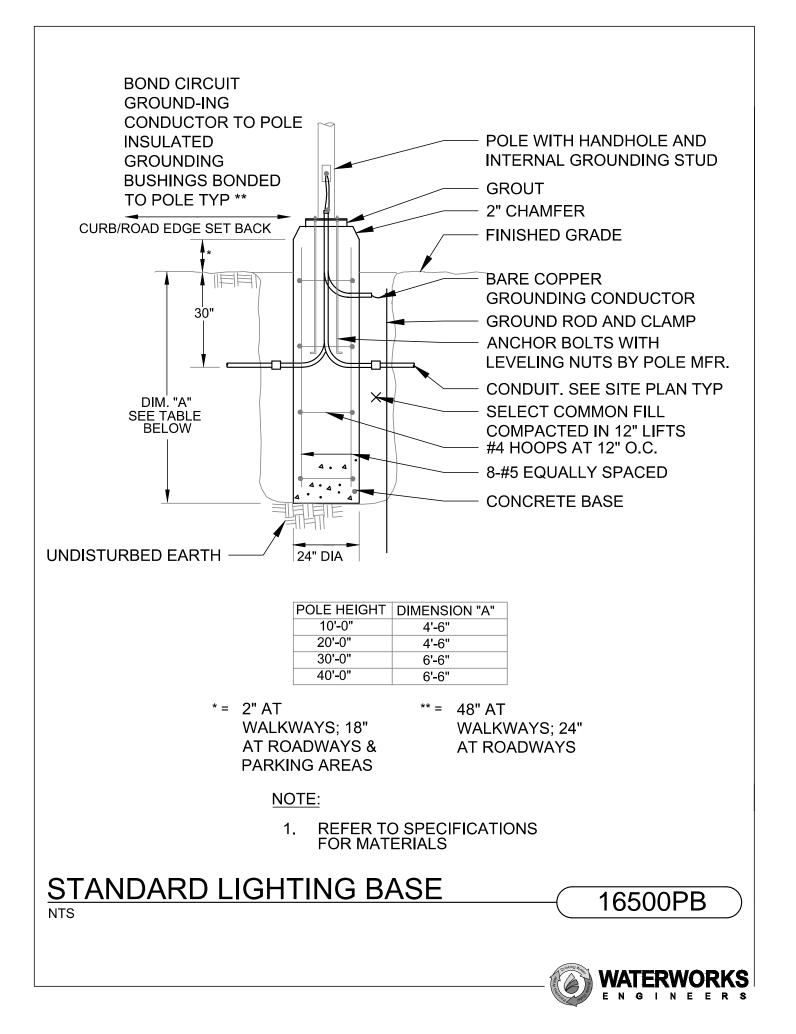
- 1. IF DEPTH AND REINFORCEMENT REQUIREMENTS ARE NOT PROVIDED BY THE POLE MANUFACTURER, PROVIDE A MINIMUM 5' DEPTH AND 2' DIAMETER BASE. LOADING SHALL BE DEAD LOAD PLUS 100 MPH WIND WITH EXPOSURE "C". PROVIDE SIGNED/SEALED STRUCTURAL CALCULATIONS IN SHOP DRAWING SUBMITTAL.
- 2. COORDINATE WITH RADIO PATH STUDY FOR REQUIRED POLE HEIGHT NOT TO EXCEED 20 FEET.

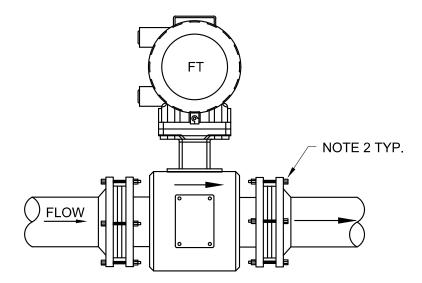
POLE DETAIL

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NTS





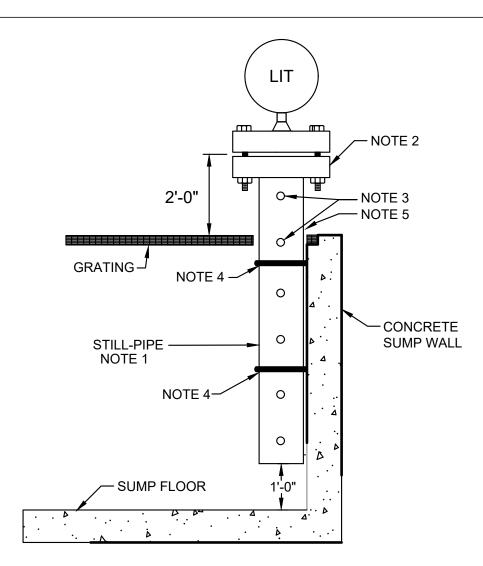
NOTES:

- 1. INSTALL WITH A MINIMUM OF FIVE (5) STRAIGHT PIPE DIAMETERS UPSTREAM AND TWO (2) STRAIGHT PIPE DIAMETERS DOWNSTREAM.
- 2. PROVIDE MATING FLANGES, GASKETS, AND BOLTING PER THE PDT OF THE PROCESS PIPE.

MAGNETIC FLOWMETER DETAIL

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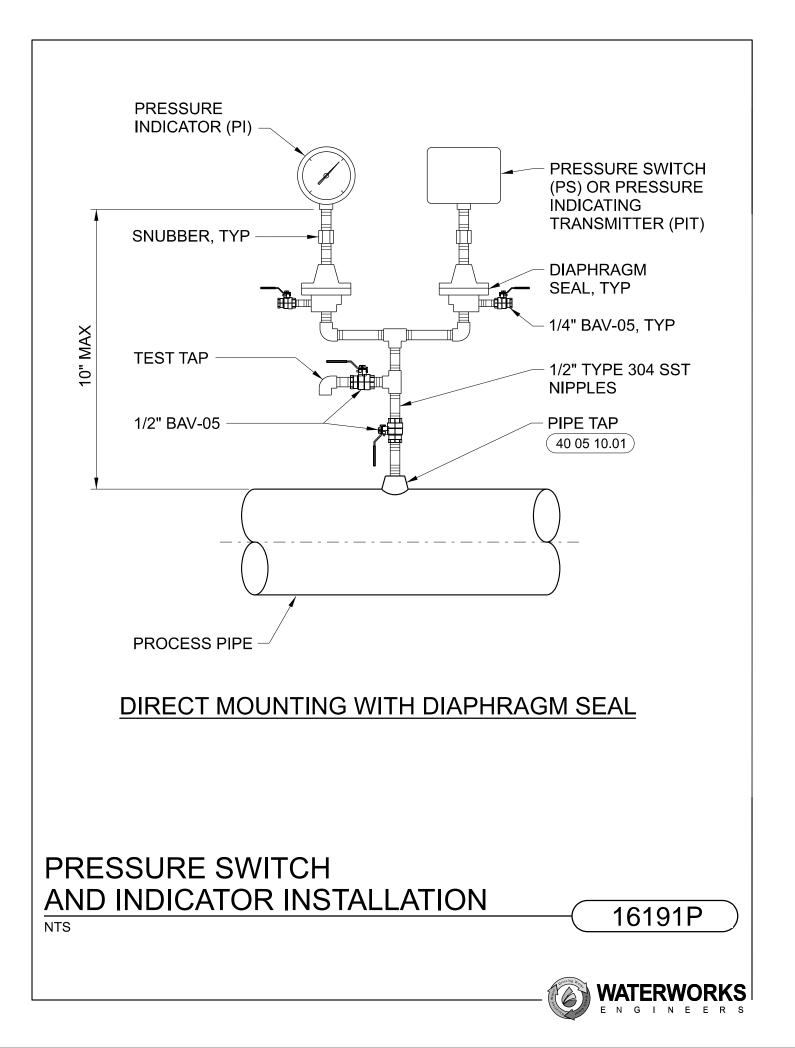
NOTES:

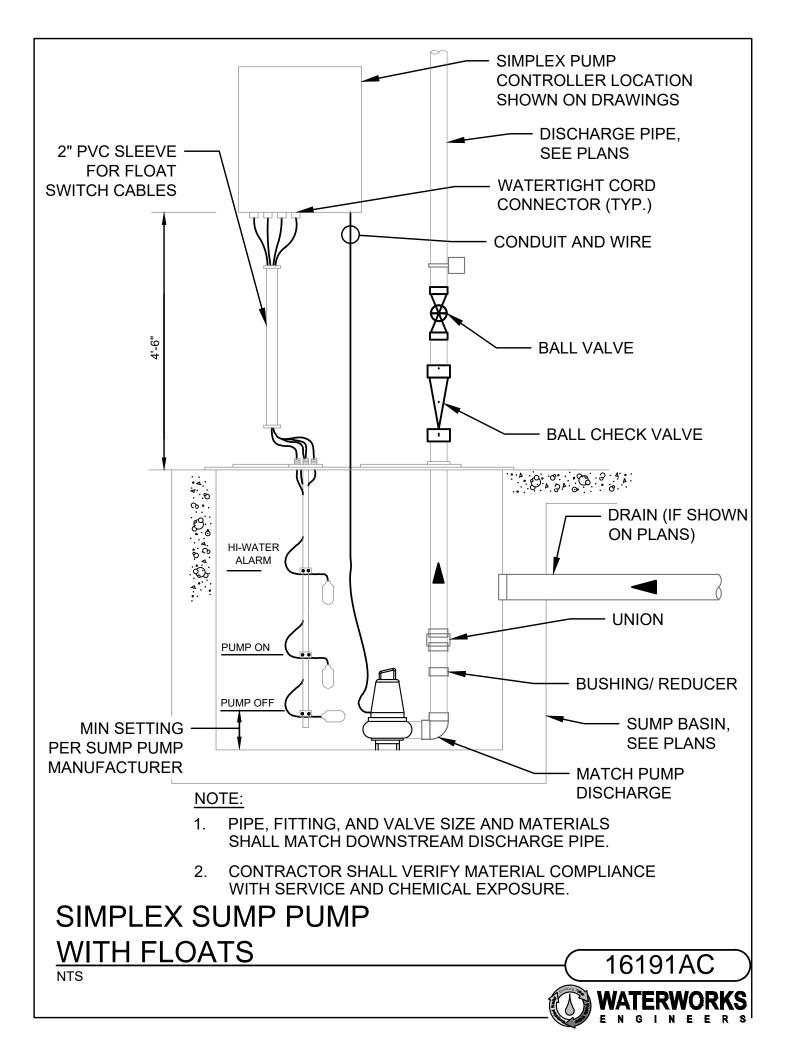
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NON-CONTACT RADAR LEVEL TRANSMITTER



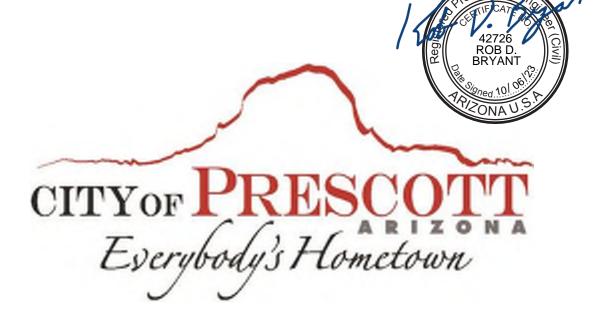
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CITY OF PRESCOTT, YAVAPAI HILLS LIFT STATION # 1 TECHNICAL MEMORANDUM

FOR CONSTRUCTION VOLUME 4 OF 4



October 2023

PREPARED BY: WATER WORKS ENGINEERS, LLC. 7500 N. Dobson Road #200 Scottsdale, AZ 85256 (480) 661-1742





Yavapai Hills #1 Lift Station 100% Design Report

Prepared For:	City of Prescott, Arizona			
Prepared By:	ed By: Michael Roman, E.I.T.			
Reviewed By:	Rob Bryant, P.E.			
Date:	October 5, 2023			

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City of Prescott	October 2023
Vavanai Hills Lift Station #1	Daga

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1 Abbreviation Table

	Table 1: Abbreviations
AADF	Annual Average Daily Flow
ATS	Automatic Transfer Switch
WWTP	Wastewater Treatment Plant
СОР	City of Prescott
WWF	Wet Weather Flow
во	Build-out
LS	Lift Station
GPM	Gallons per minute
GPD	Gallons per day
WWPF	Wet Weather Peaking Factor
DU	Dwelling Units
WWPHF	Wet Weather Peak Hour Flow
HIS	Hydraulic Institute Standard
ADEQ	Arizona Department of Environmental Quality
SS	Sanitary Sewer
FM	Forcemain
LIT	Level Indicator Transmitter
LI	Level Indicator
EL	Elevation
CL	Centerline
DIP	Ductile Iron Pipe
HP	Horsepower
NPSH	Net Positive Suction Head Available

2 Background

The Yavapai Hills #1 Lift Station (Yavapai Hills Lift Station) is owned and operated by the City of Prescott, Arizona (COP). Due to its aging condition, installation of a new lift station and use of the existing wet wells for overflow containment is planned. The new lift station is expected to provide redundant pumping with sufficient overflow containment and improve system operations. The new pumps are submersible which maintains consistency with the pumps throughout the City's existing collection system. This project is intended to improve the safety of operations by removing a decommissioned wastewater treatment plant (WWTP) and indoor pumps.



3 Overview

The existing site and project location is west of State Route 69 and south of East Robin Drive in the Yavapai Hills neighborhood of Prescott, Arizona as shown in Figure 1. The existing submersible and indoor pumps are intended for removal, and the pump house is to be repurposed for storage. The unused WWTP is planned for demolition. Site improvements include an aggregate road and new chainlink fence with vinyl privacy slats extended to include site modifications with some fencing relocated out of the stormwater wash.

The new lift station design capacity accommodates buildout wet weather flows. The onsite gravity lines are to be replaced with new lines to convey flow to the new lift station. Intake consists of a rectangular polymer concrete splitter box and a rectangular wet well. The wet wells direct flow to two submersible pumps (duty/standby). The pumps convey flow through the existing 10-inch ductile iron forcemain to the "Ranch 1" lift station. No forcemain improvements are included in this project, however, installation of piping to allow for connection to a secondary future forcemain is intended.

Additional upgrades include installation of an upsized generator with automatic transfer switch (ATS) and a passive carbon odor control unit to minimize foul odors in the surrounding neighborhood.

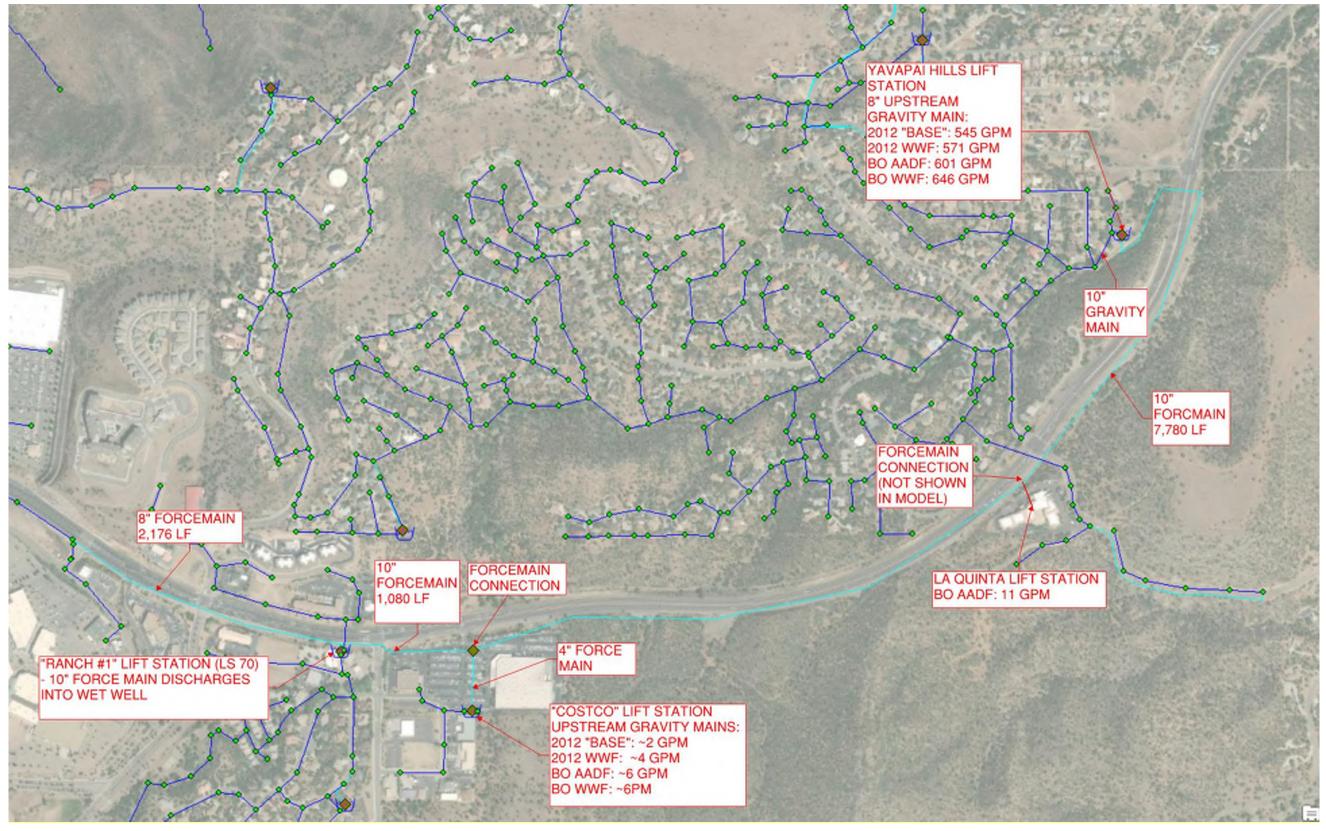


Figure 1 - Site Location & COP Sewer Model



4 Yavapai Hills Lift Station Design Flows

Flows for the design of Yavapai Hills Lift Station were estimated utilizing the COP Sewer Model. Within the current model, annual average day flow at buildout is 601 gpm, as shown in Figure 1. For the design of the new lift station, 601 gpm is referred to as the current annual average day flow. Buildout design flow for the new lift station includes the only known planned development. The planned development is an apartment building with approximately 200 dwelling units to the north of the lift station. The updated buildout wet weather flow was utilitzed to model the hydraulic capacity of the new lift station and size the on-site gravity sewer pipes and wet well pumps.

The wet weather peaking factor was calculated using the COP Sewer Model and was applied to the buildout conditions. Population and peak hour flow peaking factors for current buildout conditions were calculated in accordance with the Arizona Administrative Code (AAC). The resulting peaking factors were higher in comparison with the COP 2018 Water and Wastewater Masterplan peak hour flow peaking factor of 1.66. The peak hour flow peaking factors calculated in accordance estimate and were chosen for the design.

Two additional smaller forcemains, known as the Costco Lift Station and La Quinta Hotel Lift Station, pump into the main 10-inch forcemain. The Costco Lift Station is servicing nearby businesses and the La Quinta Hotel Lift Station serves the 82-room hotel. The Costco Lift Station has an annual average day flow of 6.0 gpm in the sewer model, Figure 1. A previous report from Lyon Engineering assigned an AADF of 11.0 gpm for the La Quinta Lift Station. The owner of the La Quinta Hotel confirmed the pumps are the same and are described in more detailed within Appendix A. To account for the additional flows, a sum of 17.0 gpm was added to flows in the force main calculations. Flow from either small lift station will vary based on the real-time flow in the forcemain and is outside of the scope of this report.

Existing and buildout flow calculations used to size the gravity sewer and wet well pumps are summarized in 2 and 3 below.



Table 2 - New Apartment Flows

Dwelling Units	Flow/DU ¹		Total New Flow		Estimated Apartment	Peak Hour Flow Peaking Factor	Peak Hour Flow	Wet Weather Peak Hour Flow ²
DU	gpd	gpm	gpd	gpm	Population ³	Per 18 AAC 9 ⁴	gpm	gpm
200	300	0.21	60000	42	640	2.5	105	113

Table 3 - Yavapai Hills #1 Lift Station Flows

Flow Condition	•	ner Annual Day Flow	Wet Weather Peaking Factor ²	Annual	/eather Average Flow ²	18 AAC 9 Equivalent	ent PF Per 18 AAC 9 ⁴	Dry Weather Peak Hour Flow		Wet Weather Peak Hour Flow ²	
	gpm	MGD		GPM	MGD	Population ⁵		GPM	MGD	GPM	MGD
Current	601	0.87	1.075	646	0.93	10,818	1.84	1,104	1.59	1,186	1.71
Buildout	643	0.93	1.075	694	1.00	11,574	1.83	1,181	1.70	1,269	1.83

Notes:

- 1. 300 GPD for 2-bedroom apartment per Arizona Administrative Code (18 AAC 9).
- 2. Wet Weather peaking factor of 1.075 from the flows in the COP WW model. 646/601=1.075 from flows shown in Figure 1 above.
- 3. 3.2 persons per Dwelling Unit (DU) assumed.
- 4. Peak Factor = 1.66 per COP 2018 Water & Wastewater report. Higher peak factors per ACC (18 AAC 9) peak factor used.
- 5. AAC equivalent population uses an assumption of 80 GPD/person to calculate population.



5 Gravity Sewer at Lift Station Site

The existing gravity lines conveying flow to the lift station are 12-inch SDR 35 PVC from the south and 10-inch SDR 35 PVC from the north. The COP sewer model does not show the north line connected to the current residential sewer. It isassumed that all flow through the north is from the planned apartment development. The gravity sewer upstream of the lift station site is outside of the scope of this project. All onsite gravity sewer to be demolished is to be completely removed rather than left in place. The gravity lines convey flow to the splitter box and then to the lift station wet wells. The wastewater is pumped from the Yavapai Hills Lift Station via a 10-inch force main to the Ranch #1 Lift Station.

The new gravity lines on site are designed for buildout wet weather peak flow conditions. The following are assumptions for gravity sewer sizing:

- Maximum d/D ratio of 0.75.
- Manning's constant (n) is 0.013, per COP 2018 Master Plan.

Pipe slope from the splitter box to the wet well is designed to be 0.0022 ft/ft, per ADEQ Bulletin 11 for 15-inch pipe. Polymer concrete manholes will be utilized. Additional details of the gravity sewer lines are summarized in Table 4 Detailed hydraulic calculation for the gravity sewer is included in Appendix .

Location	Existing Flow	Buildout Flow	Pipe Size	Material	ID	OD
Location	gpm gpm		in	Wateria	in	in
From North to Splitter Box 0		113	10	SDR 35 PVC	9.9	12.5
From South to Splitter Box	1,186	1,156	15	SDR 35 PVC	14.4	15.3
Total	1,186	1,269				
Splitter Box to Wet Well	1,186	1,269	15	SDR 35 PVC	14.4	15.3



6 Yavapai Hills Lift Station

6.1 Layout

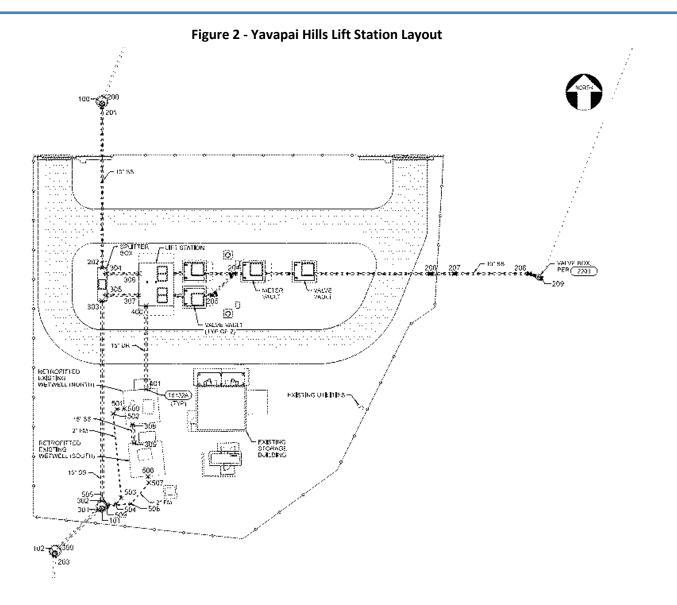
The new lift station is expected to be installed slightly north on the same site as the existing lift station. Site improvements include demolition of an old unused WWTP, a new paved access road, new expanded fencing with vinyl privacy slats, and relocation of existing fencing out of a stormwater wash.

Flows from the north and south gravity lines enter the lift station at the polymer concrete junction box. Flow is then split into the rectangular wet well with center dividing wall, designed to 2012 Hydraulic Institute Standards. The wet well is sized to handle the buildout wet weather peak hour flow and have sufficient volume to hold all the wastewater in the forcemain. Flow within the wet well is directed to two submersible pumps with variable frequency drives (VFDs) to allow controlled pump flow to/within the 10-inch forcemain. Precast valve boxes and a precast flowmeter box downstream of the wet well are designed at sufficient depths to prevent the pipes from freezing.

The existing wet well and pumpback wells are to be used for additional overflow containment. The existing pump room is to be repurposed for storage with a new shelving and roll up door. The existing pump room piping should be cut and capped below the finished floor. The existing generator is to be demolished and a new generator placed on the same pad.

The lift station layout is shown in Figure 2 below.







6.2 Wet Well Design

The lift station has one large 19-foot by 13.5-foot (internal dimensions) precast (Armorock) wet well with a 1-foot thick dividing wall in the center. The dividing wall makes the individual wet wells 13.5-feet by 9.0-feet and is equipped with a manually actuated slide gate to connect the wet wells. The dividing wall allows for maintenance to take place without having to fully shut down the lift station.

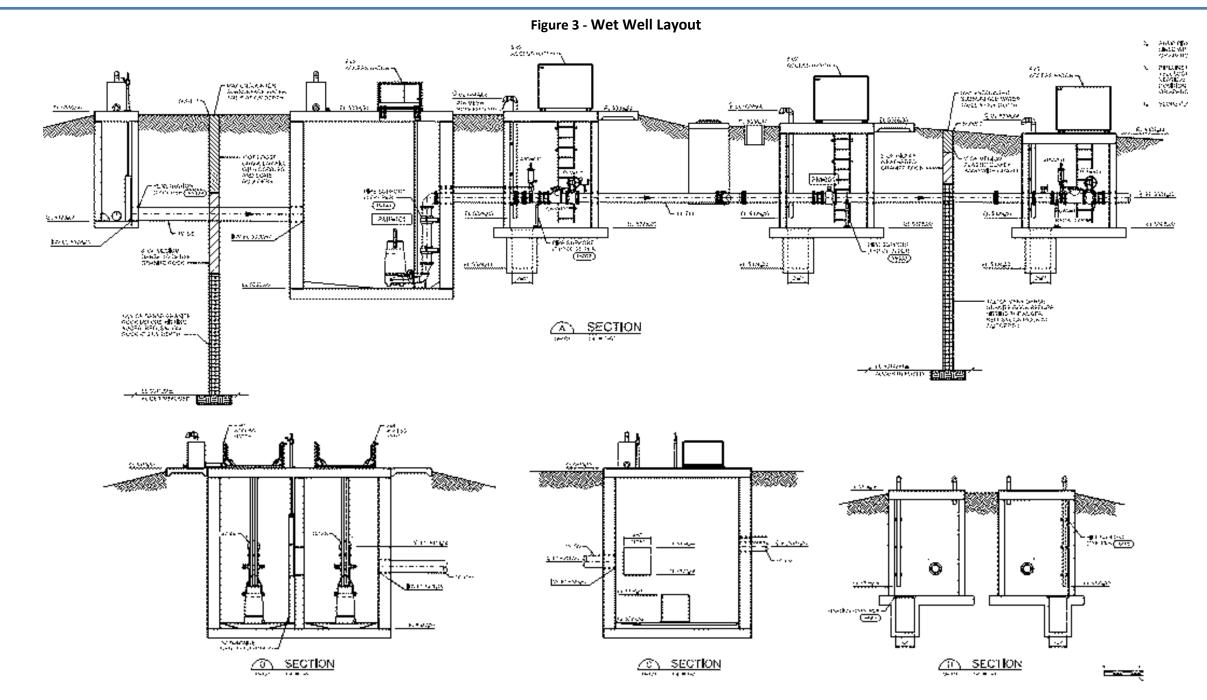
The wet well is designed to house a total of two submersible pumps, one on each side. The wet well was designed based on the Hydraulic Institute 2012 Pump Intake Design Manual for a minimum pump submergence of 2-feet. The pumps are to be interlocked to prevent two from running together as a result of the existing service size.

Level control should be used so that the pumps maintain a near constant water surface elevation. Backup floats should start/stop the pump station in the event the level indicating transmitter (LIT) fails when the water levels reach the points specified in Table 5. Six allowable starts per hour were specified for each pump.

Parameter	Elevation (ft)
Sanitary Sewer Invert	5328.67
High High Alarm	5329
High Alarm	5328.50
Pump 1 Start	5326.33
Low Low Alarm	5323.80

Table 5 - Pump Operation Levels

The wet well is designed to have square access hatches located on top and a 4-inch PVC connection to passive odor control. A section view of the wet well, valve vault, and pumps is presented in Figure 3.



YAVAPAI HILLS LIFT STATION #1 100% Design Report



6.3 Submersible Pump Design

The new pumps are sized to convey flow via an existing 10-inch DIP forcemain to the Ranch #1 Lift Station. Hydraulic analysis carried out for minimum and maximum static head requirements utilized the Hazen-Williams Equation with a roughness coefficient of C = 120 for Class 350 ductile iron pipe (DIP). Detailed hydraulic calculations are attached in Appendix.

A submersible self-cleaning Flygt N-series pump is consistent with pumps throughout the collection system. An NP 3315.185 pump, shown in Figure 4, was selected for the design given the 40 feet static head required. Specifications for the selected pump is summarized in Table 6 below and the associated pump curves are presented in Figure 5. Pump data is available in Appendix A.



Figure 4 - Flygt NP 3314.185 Submersible 160Hp Pump

Table 6 - New Pump Information

Parameter, Unit	Value
Number of Pumps (Duty/Standby)	2 (1/1)
Manufacturer	Flygt
Pump Model Number	N3315.185
Pump Type	Submersible
Suction (Bell) Diameter, in	20
Discharge Diameter, in	6
Drive Type	Variable Frequency Drive
Motor, V/Ph/Hz	460 / 3 / 60
Horsepower, Hp	160
Pump Design Flow (1 pump running), gpm	1,075
Design Head (1 pump running), ft	303



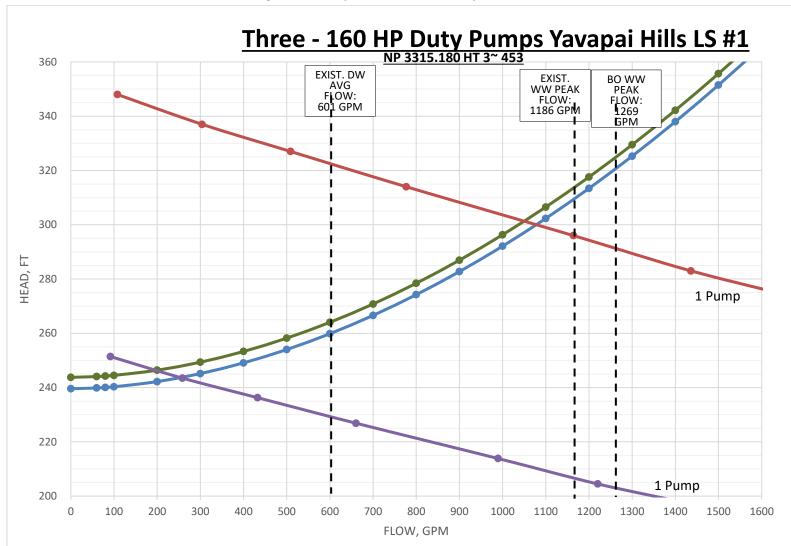


Figure 5 - Yavapai Hills Lift Station System Curve

Due to the large range of flows required for this pump station, no single pump is able to meet all flow conditions. A VFD will be required to achieve a turndown to reach the current AADF of 601 gpm. One pump is intended to meet flow requirements except during peak hour flow conditions or wet weather events.

Wet weather peak hour flow at buildout (1,269 gpm) exceeds pumping capacity (1,075 gpm), as shown in Figure 5. The unpumped volume accumulated during a wet weather peak hour event (1,269 gpm - 1,075 gpm = 194 gpm), can be retained within the new wet wells as demonstrated in Table 7. Additonal detail of the available volume in the wet wells is presented in Table 9 and 9.

Flo	w	Tir	ne	Volume Required	Volume Available
gpm	cfs	hr	sec	cf	cf
194	0.43	1.0	3,600	1,557	2,745

Table 7 Retention During Wet Weather Peak Hour

One existing pump from the pump-back well is the same model as the new pumps and is to be repurposed for the new lift station. One new pump should be purchased. The pumps are expected to be hardwired interlocked to allow only one pump to run at a time, and pump order should be programmed to be changed after a set time to ensure equal runtime of each pump.

6.4 NPSH Calculations

The selected pump requires a net positive suction head (NPSH) of 15 feet at full capacity. To avoid cavitation at the pump, the available NPSH at the lift station must match or exceed the required NPSH of each pump. The following equation was used to calculate the available NPSH at the pump station.

$$NPSH_A = H_A \pm H_Z - H_F - H_{VP} - H_{SA}$$

Where, $NPSH_A = Net Positive Suction Head Available (ft)$ $H_A = Atmospheric Pressure (28.1 ft at 5156 ft elevation)$ $H_Z = Min Static Head (2.5 ft, Min WSE)$ $H_F = Suction Friction Losses (Negligible)$ $H_{VP} = Vapor Pressure (1.17 ft at 80°F)$ $H_{SA} = Safety Allowance (1 ft)$

 $NPSH_A = 28.1 ft + 2.5 ft - 0 ft - 1.17 ft - 1 ft = 28.43 ft$



Following this calculation, the available NPSH must be compared to the required NPSH, as shown below.

$$28.43 ft NPSH_A \ge 15 ft NPSH_R$$

Based on these NPSH calculations, the chosen pump will be able to operate without cavitation in all conditions.

6.5 Pump Controls/Monitoring

The pumps are to use 18-pulse VFDs to maintain water level in the wet well (level element controlled). Float switches should be used for a low-level shutdown and high-level alarm. The site control panel is planned to be equipped with a radio connection to the City SCADA system for remote monitoring and control.

7 Discharge Piping System

The discharge line of the submersible pumps to the yard includes an air relief valve, a 10-inch check valve, 10-inch plug valve, and a redundant 10-inch check valve as shown in Figure 3. The air relief valves should be connected to a drain line which discharges back into the wet well. The discharge from each pump combines into a common header equipped with a 10-inch flow meter. The design includes the ability to connect two pumps to a future secondary forcemain and flowmeter on the site, if necessary. A minimum of three pipe diameters and five pipe diameters of pipe length should be provided upstream and downstream, respectively, of the flow meter installation to ensure an accurate measurement. The discharge piping is expected to continue outside the lift station perimeter fence and connect to the existing 10-inch DIP forcemain. Accessibility to valves located in underground vaults should be provided by the addition of access hatches which are 4ft X 4ft for the valves and the flow meter.

7.1 Pressure Surge

Pressure surge, or water hammer, is a result of elastic waves formed as a result of changing flow velocity in a closed conduit and can cause pipe, valve, and pump failure. A surge analysis was undertaken to ensure that the maximum pressure ratings for the selected pipe material and equipment does not exceed estimated surge pressure within the system. At maximum pumping conditions (1,050gpm at 305 TDH), the internal pipe pressure under surge is estimated at 347 psi. The selected pipe, Class 350 DIP, is adequate for the rated working pressure (350 psi) plus 100 psi. Calculations are documented in Appendix D.



8 Forcemain Draining Volume

The volume within the forcemain is shown in Table 8 below.

	orecinant volume	-	
Linear Length of Forcemain	Pipe Diameter	Volume	Volume
ft	in	cf	gal
8,705	10.46	5,195	38,856

Table 8 - Forcemain Volume

The combined capacities of the wet wells, splitter box, and gravity sewer allows for the entire forcemain volume to be drained and remain contained within the existing and proposed structures. The retention capacity of each structure is summarized in Table 9 below.



Location	Length	Width	Radius	Area	Invert Elevation	Water Elevation	Height	Volu	ume
Location	ft	ft	ft	ft	ft	ft	ft	cf	gal
New Wet Well #1	13.5	9	N/A	121.5	5323	5334.30	11.30	1373	10,266
New Wet Well #2	13.5	9	N/A	121.5	5323	5334.30	11.30	1373	10,266
Old Pumpback Well	N/A	N/A	6	113	5327	5334.30	7.30	825	6,172
Old Wet Well	N/A	N/A	6	113	5327	5334.30	7.30	825	6,172
Splitter Box	10	3	N/A	30	5328	5334.30	6.30	189	1,413
Gravity Sewer + MH	100	1	N/A	100	5328	5334.30	6.30	630	4,710
							Total	5214	39,000

Table 9 - Forcemain Volume Retention Summary



9 Electrical Services

The electrical service is expected to continue to utilize the existing APS utility transformer providing, 480/277V, 3-phase, 4-wire service to the existing Service Entrance/Utility Meter (SES) during the normal plant operation. There is an existing 150kW standby diesel engine-generator on site, which is planned to be demolished and replaced with a 200ekW standby diesel engine-generator and new ATS. The existing SES is sufficient to serve both existing and new equipment.

The area inside the wet wells are classified as Class 1, Division 1 per NFPA 820. The area immediately outside of the wet well access hatches, within 3-feet horizontally and 18-inches above grade or slab, should be Class 1, Division 2 per NFPA 820. All the electrical devices and panels should be located outside these areas.

10 Access, Safety, & Security

For access, safety, and security, the site is intended to be fully enclosed within an 8-foot chain link fence with manual rolling gates to allow access. The existing fence should be moved out of the stormwater wash and a complete replacement of all vinyl privacy slats. In addition, all valves and the flow meter should be located within locked underground vaults with access hatches. A paved access road is designed to be added to assist in maintenance and repairs.

11 Odor Control System

Odor control is to be passive Calgon Ventsorb PE canisters. The piping is to enter 2-feet below grade into the wet well and be 4-inch Schedule 80 PVC pipe. The canister is to be centered on a 4-foot by 4-foot, 6-inch thick concrete pad. There should be two canisters, with one for the splitter box and one for the wet well. A similar system presently installed at Cliff Rose Lift Station is shown in Figure 6. Equipment data is provided in Appendix B.



Figure 6 - Calgon Carbon Ventsorb PE at Cliff Rose Lift Station

12 Opinion of Probable Construction Cost

Table 10 shows the opinion of probable construction cost associated with the construction of the Yavapai Hills LS. This estimate includes all items detailed in Divisions 1 through 17 of the Technical Specifications. For further detail refer to Appendix C.



Table 10 – Opinion of Probable Construction Cost

Engineer's Estimate

		Engineer's Estimate Yavapai Hills Regional Lift Station :	#1			
* 1		CIP #2105-004				
Line No.	Item ral Constructi	Description	Qty	Unit	Unit Cost	Amount
1	MAG 105.8		1.00	LS	\$4,400.00	\$4,400.00
2	MAG 107.16	Stormwater Pollution Prevention Plan	1.00	LS	\$11,000.00	\$11,000.00
3	MAG 109.10	Mobilization/Demobilization	1.00	LS	\$80,000.00	\$80,000.00
4	MAG 109.11	Contract Allowance	1.00	LS	\$687,538.00	\$687,538.00
5	MAG 420	Permanent Fencing	650.00	LF	\$22.00	\$14,300.00
		General Construction	Items Subi	otal		\$797,238.00
	r Improvemen	ts Piping, Existing Fencing, Pumps, Concrete, Valves, Slide Gates, Manholes	1.00	1.0	6445 500.00	¢445 500.00
6	2200 SP	and ATS Demolition	1.00		\$445,500.00	\$445,500.00
7		Splitter Box - Polymer Pre-Cast	20.00	CY	\$3,000.00	\$60,000.00
8	03410-B SP	Wet Well - Polymer Pre-Cast	110.00	CY	\$3,000.00	\$330,000.00
9	MAG 725	Storage Building Pad - Slab - on - Grade	10.00	EA	\$2,000.00	\$20,000.00
10		Meter Vault - Pre-Cast		EA	\$38,500.00	\$38,500.00
11	MAG 744	Manhole - Polymer Pre-Cast	3.00	EA	\$7,200.00	\$21,600.00
12	03400-B SP	Valve Vaults - Pre-Cast	3.00	EA	\$72,000.00	\$216,000.00
13	08305 SP	Access Hatches	6.00	EA	\$11,000.00	\$66,000.00
14	2930 SP	Fabricated Steel Gates and Operators	2.00	EA	\$11,000.00	\$22,000.00
15	15010 SP	Pipe Supports	8.00	EA	\$2,750.00	\$22,000.00
16	8200 SP	Storage Roll Up Door	1.00	EA	\$50,000.00	\$50,000.00
17	MAG 626.3	Coatings	1.00	LS	\$25,000.00	\$25,000.00
18	11000 SP	Passive Odor Scrubber	2.00	EA	\$25,000.00	\$50,000.00
19	11300 SP	Flygt NP3315 HT 452	2.00	EA	\$315,000.00	\$630,000.00
20	5500 SP	Misc Shelving	1.00	LS	\$11,000.00	\$11,000.00
21	15100 PSDS PVC1 SP	15" SDR-35 PVC Pipe	50.00	LF	\$120.00	\$6,000.00
22	15100 PSDS DIP SP	10" Class 350 DIP	210.00	LF	\$280.00	\$58,800.00
23	15200.2.2.5. A SP	10" Plug Valve	3.00	EA	\$4,400.00	\$13,200.00
24	15200.2.2.3. B SP	10" Check Valve	3.00	EA	\$9,900.00	\$29,700.00
25	15812 SP	4" FRP Duct	200.00	LF	\$75.00	\$15,000.00
26	11100 SP	10" Shice Gate Manually Actuated	4.00	EA	\$30,000.00	\$120,000.00
27	16050 SP	General Electrical Provisions	1.00	LS	\$687,537.50	\$687,537.50
28	16496 SP	ATS	1.00	Ea	\$3,000.00	\$3,000.00
29	16232 SP	Genset	1.00	Ea	\$78,750.00	\$78,750.00
30	13305 SP	Programming	1.00	EA	\$30,000.00	\$30,000.00
31	13310.2.2.4 SP	Level Indicator Transmitters	2.00	EA	\$10,000.00	\$20,000.00
32	13310.2.2.5 SP	Level Switch (High, High High and Low Low)	10.00	EA	\$5,000.00	\$50,000.00
33	13310.2.2.2 SP	Flow Element and Indicator Transmitter	1.00	EA	\$7,500.00	\$7,500.00
34	MAG 343.2	Aggregate	1,010.00	SY	\$20.00	\$20,200.00
35	MAG 215.4	Grading	9,035.00	SY	\$20.00	\$180,700.00
		Sewer Improve	ments Subi	otal		\$3,327,987.50
		Total Engineer's Estimate			\$4,125,225	.50



Appendix A – Pump Data Sheet

NP 3315 HT 3~453

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.



Technical specification



Curves according to: Water, pure ,39.2 $^\circ\text{F}$,62.42 lb/ft³,1.6891E-5 ft²/s [ft] 360-Head 1 3 Pumps Rumps Pun Eff. 73% 453 420mm [Pump 1+2] 1] 453 420mm [Pump 1+2+3] 453 420mm [Pump 1] 460 347mm [Pump 1+2] 460 347mm [Pump 1+2+3] 460 347mm [Pump 1] . [US g.p.m.] 2000 4000 6000 8000 0 Curve: ISO 9906

Configuration

Motor number N3315.185 35-45-4AA-W 160hp Impeller diameter 420 mm Installation type P - Semi permanent, Wet

Discharge diameter 1/4 inch

Pump information

Impeller diameter 420 mm

Discharge diameter 1/4 inch

Inlet diameter 200 mm

Maximum operating speed 1780 rpm

Number of blades 3

Max. fluid temperature

40 °C

ProjectMesa - Project ThunderbirdCreated byEthan WillatsBlock0Created on10/11/2021 Last update 10/11/2021

Materials

Impeller Hard-Iron ™

NP 3315 HT 3~ 453

Technical specification

Motor - General

Motor number	Phases	Rated speed	Rated power
N3315.185 35-45-4AA-W 160hp	3~	1780 rpm	160 hp
ATEX approved	Number of poles	Rated current	Stator variant
No	4	190 A	1
Frequency	Rated voltage	Insulation class	Type of Duty
60 Hz	460 V	Н	S1
Version code			
185			
185 Motor - Technical			
Motor - Technical Power factor - 1/1 Load	Motor efficiency - 1/1 Load 94.7 %	Total moment of inertia 32.6 lb ft ²	Starts per hour max. 15
Motor - Technical Power factor - 1/1 Load 0.83 Power factor - 3/4 Load	94.7 % Motor efficiency - 3/4 Load	32.6 lb ft ² Starting current, direct starting	-
Motor - Technical Power factor - 1/1 Load 0.83 Power factor - 3/4 Load	94.7 %	32.6 lb ft ²	-
Motor - Technical Power factor - 1/1 Load 0.83	94.7 % Motor efficiency - 3/4 Load	32.6 lb ft ² Starting current, direct starting	-

FLYGT

a xylem brand

0.68

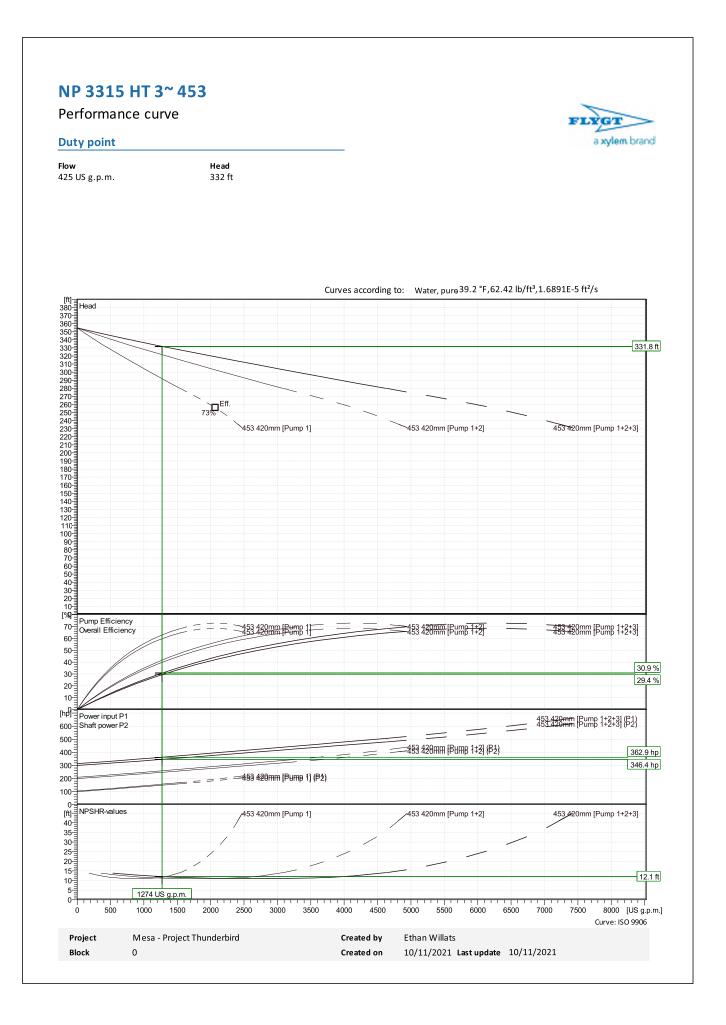
Mesa - Project Thunderbird

Created by Ethan Willats Created on 10/11/2021 Last update 10/11/2021

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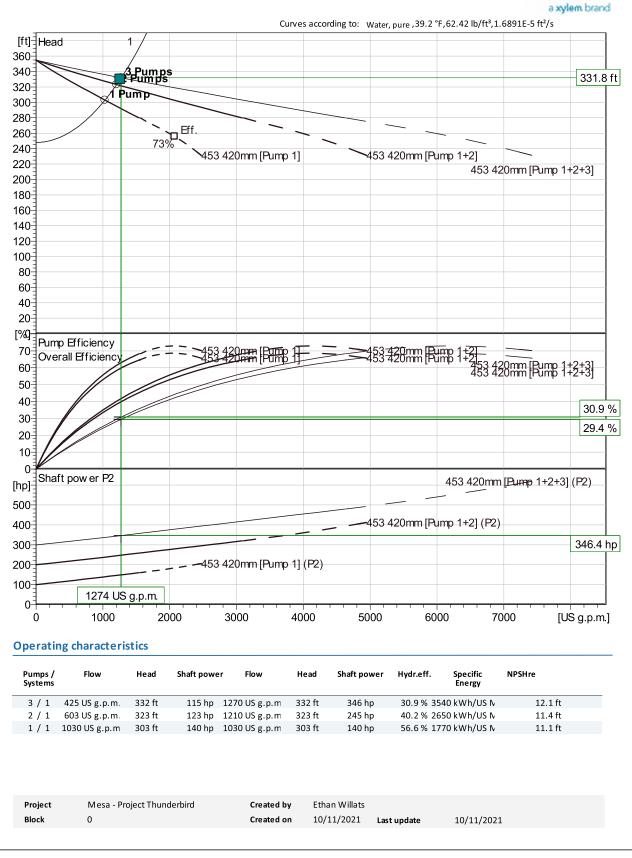
Project Block

Program version 59.0 - 6/21/2021 (Build 118)



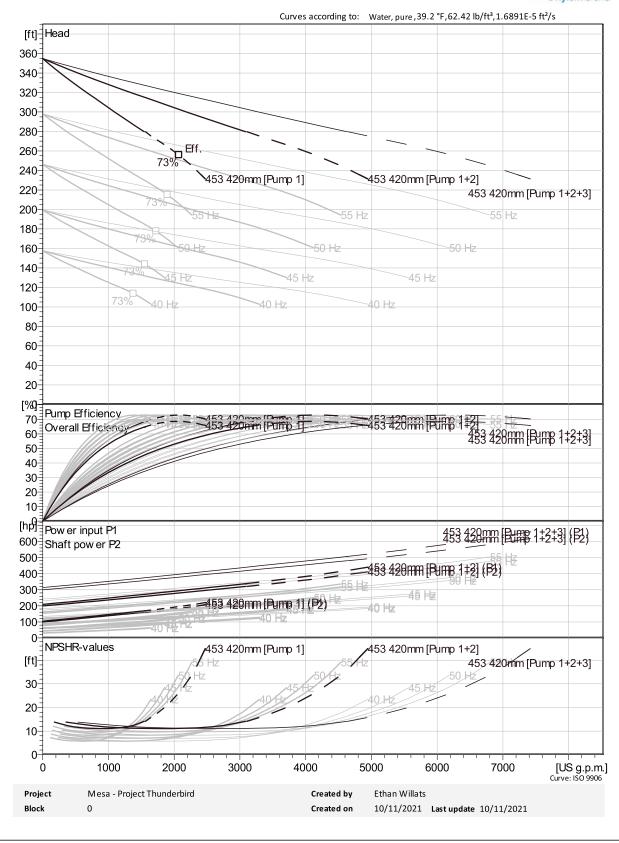


Duty Analysis



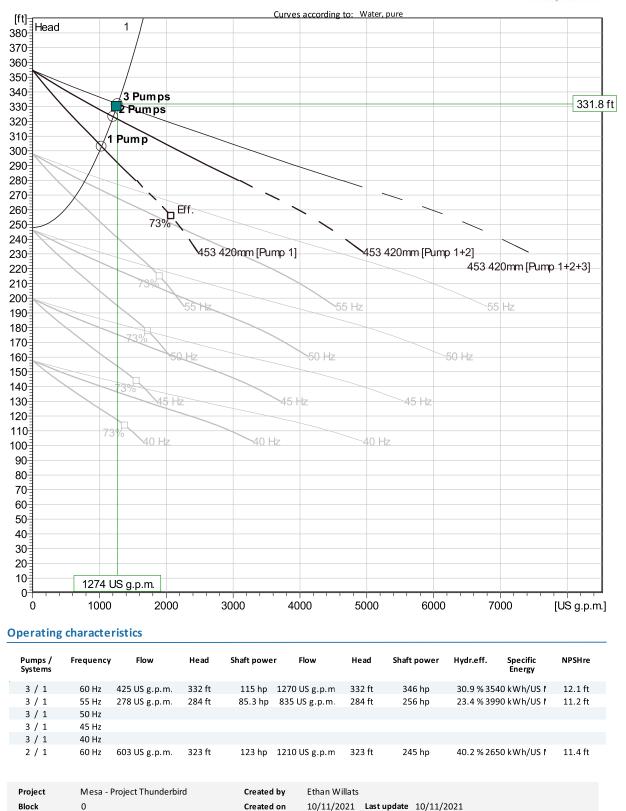


VFD Curve



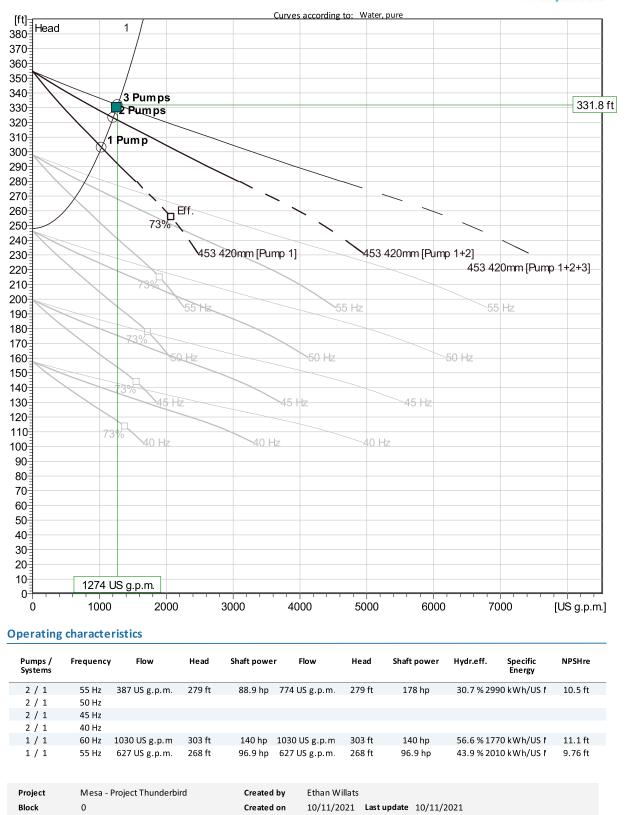
VFD Analysis





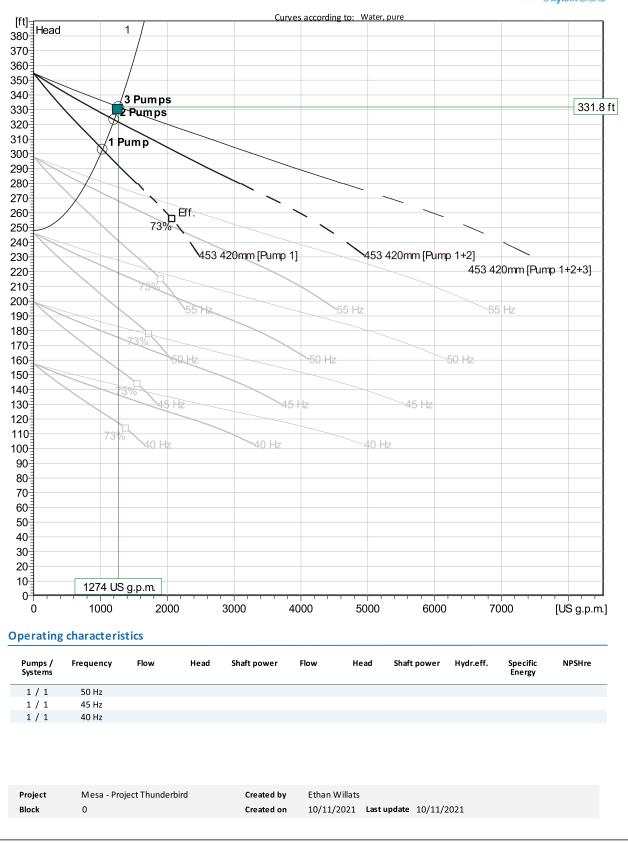
VFD Analysis





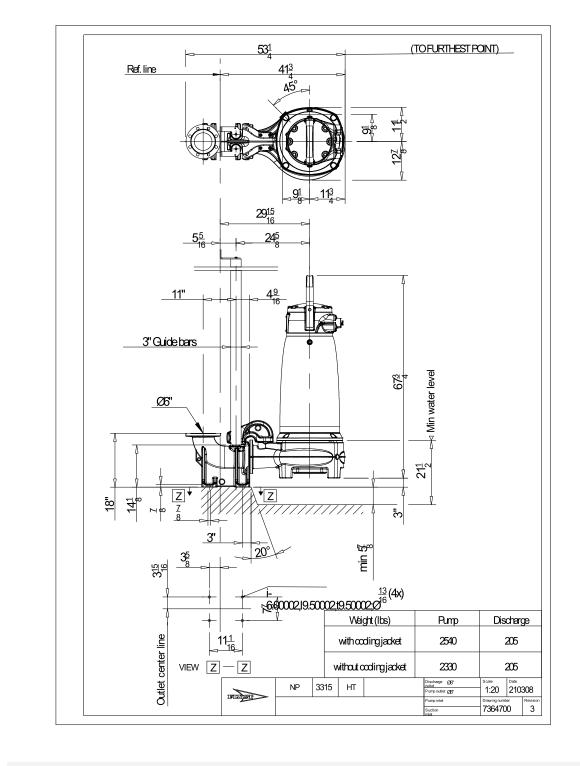
VFD Analysis





Dimensional drawing





Project Block Mesa - Project Thunderbird 0 Created byEthan WillatsCreated on10/11/2021 Last update 10/11/2021



Appendix B – Odor Control



VENTSORB® PE FOR INDUSTRIAL APPLICATIONS

Description

VENTSORB PE canisters, containing 180 pounds of activated carbon, are ideal for low-flow treatment applications. These economical adsorption systems control small volume organic contaminants and/or odorous gas emissions from:

- Storage tank vents
- Reactor vents
- API separator vents
- Sludge thickener tanks at waste treatment plants
- Chemical plant wastewater holding tanks
- Laboratory hood exhausts
- Landfills
- Air-stripper off-gases

The 55-gallon VENTSORB PE canister contains all the elements found in a full-scale adsorption system vessel: activated carbon, inlet connection and distributor, and an outlet connection for the purified air stream.

Features

VENTSORB PE canisters offer several important features and benefits including:

- Effective treatment to remove a variety of vapor phase organic contaminants and odor-causing compounds
- · All plastic construction for reliable non-corrosive service
- Continuous treatment at varying flow rates and concentrations
- Simple installation and operation
- · Flexibility to be installed in series or multiple units in parallel
- Supplied with activated carbon selected specifically for the application
- Practical disposal option: pre-approved spent carbon canisters may be returned to Calgon Carbon Corporation for safe carbon reactivation
- · Low cost per unit makes carbon treatment economical

Activated Carbon Selection

The standard VENTSORB PE is provided with Calgon Carbon's bituminous coal-based AP4-60 4 mm pellet activated carbon. Calgon Carbon offers a wide variety of activated carbons for special applications that can be used in the VENTSORB PE. Contact Calgon Carbon for more information on other activated carbon products.

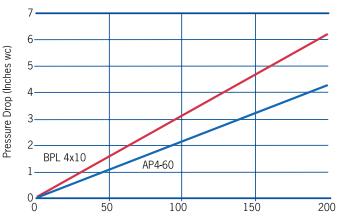
Typical Carbon Products Available

VPR	Reactivated Grade Vapor Phase Carbon
AP4-60	Virgin Grade Vapor Phase Carbon–4 mm Pellet
BPL	4X10 Virgin Grade Vapor Phase Carbon–Granular 4X10 Mesh

Materials of Construction

Canister	Open top 55 gallon plastic drum
	125 mil thick (min) HMW-high
	density polyethylene
Cover	175 mil thick HMW-HDPE with closure
	and polyurethane gasket
Inlet/Outlet Fittings	4" diameter FNPT polyethylene coupling
Internal Distributor	High density polyethylene
Inlet/Outlet Shipping Plugs	PVC, threaded
Weight Empty	24 lbs.
Carbon Load	180 lbs.
Operating Temperature	120° F (max)
Operating Pressure	1.0 PSIG (max)

Pressure Drop

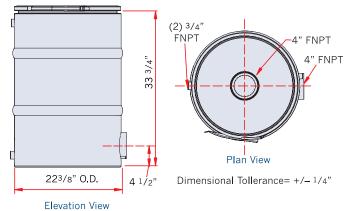


Pressure drop through a VENTSORB PE unit is a function of the process air flow as shown in the graph. A VENTSORB PE canister can handle up to 200 cfm at a pressure drop of less than 6 inches of water column. If a higher flow or lower pressure drop is needed, multiple canisters may be installed in parallel operation.

Safety Message

Wet activated carbon can deplete oxygen from air in enclosed spaces. If use in an enclosed space is required, procedures for work in an oxygen deficient environment should be followed.

Drum Dimensions



Installation

VENTSORB PE canisters are shipped ready for installation. Each canister is self-supporting and should be placed on a level, accessible area as near as possible to the emission source. Installation is simple, requiring just a flexible hose or pipe to connect the source to the 4" FNPT bottom inlet of the canister.

If the VENTSORB PE will be vented directly to outside air; a U-shaped outlet pipe or rain hat (such as a pipe tee) is recommended to prevent precipitation from entering the unit.

VENTSORB PE canisters operate from a continuous flow across the carbon. The flow can be produced by a blower or by using the positive pressure inside the tank or process vessel. In many cases, the pressure or surge of pressure within the tank or vessel is sufficient to overcome the pressure drop across the canister, thus eliminating the need for a blower. Please consult the pressure drop data in this bulletin for more information.

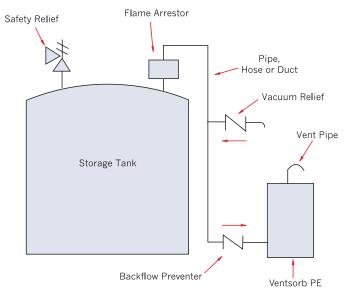
Maximum recommended air flow through a VENTSORB PE is 200 cfm. If higher flows are encountered, plant operators should install two or more canisters in parallel configuration. When VENTSORB PE canisters are used to control vapors from organic solvent storage tanks, (see drawing of typical installation) the following precautions are recommended:

Storage Tank Installation

- A safety relief valve must be provided. This protects the storage tank should the VENTSORB PE become plugged or blocked in any fashion. Such a vent would open in an emergency situation, thereby relieving pressure.
- Under appropriate conditions, a flame arrestor and/or backflow preventor must be installed as shown in the storage tank installation drawing below. This prevents backflow of air through the VENTSORB PE when the storage tank is empty.
- Pre-wetting the carbon helps dissipate excessive heat that may be caused by high organic compound concentrations (>0.5 to 1.0 Vol.%).

If VENTSORB PE canisters are used to control organic emissions from air-strippers or other high moisture content air streams, Calgon Carbon Corporation recommends that humidity in the air stream be reduced to under 50 percent. Lower humidity optimizes adsorptive capacity of the carbon. In addition, for similar applications that generate a condensate, Calgon Carbon Corporation recommends installation of a drain on the inlet piping.

Typical Installation at a Storage Tank



Carbon Life Estimate

The table below lists the theoretical adsorption capacities for several compounds. The adsorption capacity for non-polar organics increases with the boiling point, molecular weight, and concentration of the air contaminant. Estimate the life of a VENTSORB PE canister for other organic compounds by matching them with compounds of similar boiling points and molecular weight in this table. Low molecular weight (less than 50) and/or highly polar compounds such as formaldehyde, methane, ethanol, etc. will not be readily adsorbed at low concentrations.

Safety Message

Wet activated carbon can deplete oxygen from air in enclosed spaces. If use in an enclosed space is required, procedures for work in an oxygen deficient environment should be followed.

Theoretical VENTSORB PE Capacities*

Pounds Adsorbed per VENTSORB PE at Given Concentration of Contaminant**

	Approximate				
	Boiling Point (°C)	Molecular Weight	Lbs. @ 10 ppm	Lbs. @ 100 ppm	Lbs. @ 1,000 ppm
Acrylonitrile	77.3	53.1	8	15	26
Benzene	80.1	78.1	14	22	34
n-Butane	-0.5	58.1	7	10	16
Carbon Tetrachloride	76.8	153.8	45	60	78
Dichloroethylene -1,1	31.7	97.0	16	25	38
Methylene Chloride	40.2	84.9	4	9	19
Freon 114	3.8	170.9	16	26	40
n-Hexane	68.7	86.2	21	27	34
Styrene	145.2	104.1	47	56	65
Toluene	110.6	92.1	35	43	51
Trichloroethylene	87.2	131.4	32	47	67

*Theoretical capacity based on 70° F, 1 atm pressure, less than 50 percent humidity, and 180 pounds of carbon using isotherm data for AP4-60 carbon.

**This information has been generated using Calgon Carbon's proprietary predictive model. There is no expressed or implied warranty regarding the suitability or applicability of results.

Return of VENTSORB PE

Arrangements should be made at the time of purchase to return canisters containing spent carbon. Calgon Carbon Corporation can provide instructions on how to sample the spent carbon and arrange for carbon acceptance testing. The spent carbon is reactivated by Calgon Carbon Corporation and all of the contaminants are thermally destroyed. Calgon Carbon Corporation will not accept VENTSORB PE for landfill, incineration, or other means of disposal.

VENTSORB PE cannot be returned to the company unless the carbon acceptance procedure has been completed, an acceptance number provided, and the return labels (included with the unit at the time of purchase) are attached. VENTSORB® PE must be drained and inlet/outlet connections must be plugged prior to returning the unit to Calgon Carbon Corporation.

Other Air Purification Systems

VENTSORB PE is specifically designed for a variety of small applications. Calgon Carbon Corporation offers a wide range of carbon adsorption systems and services for a range of flow rates and carbon usages to meet specific applications.

Safety Considerations

Continuous process temperatures above 120° F are to be avoided. High concentrations of Hydrogen Sulfide and VOC's could cause excessive heat build–up. Care must be exercised in the design of the treatment system for flammable gases or reactive vapors.

The use of a pressure safety relief, flame arrestor and/or backflow device is recommended for installations venting storage tanks. VENTSORB PE units with Centaur HSV carbon that are washed with

water produce a dilute acid that must be handled appropriately. Slight pressure may accumulate in a sealed VENTSORB PE canister due to extreme changes in ambient temperature conditions. Use care when removing the plastic shipping plugs.

Activated carbon may cause an exothermic reaction in the presence of oxygen bearing compounds, such as peroxides, ketones, organic acids, aldehydes and also organic sulphur compounds. The introduction of flammable compounds into the unit while an exothermic reaction is occurring will ignite the gas stream causing fire and explosion. Flooding the unit with water will extinguish the flames but generate steam and pressure. USE CAUTION!

Heat of adsorption can lead to severe temperature excursions at high concentrations of organic compounds. Heating may be controlled by diluting the inlet air, time weighting the inlet concentration to allow heat to dissipate, or pre-wetting the carbon.

If you are unsure of the reaction of an organic compound on activated carbon or have other questions, please contact a Calgon Carbon Corporation Application Engineer or Sales Representative.

Safe Handling and Storage of Wet Carbon

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable federal and state requirements.

Safety Message

Wet activated carbon can deplete oxygen from air in enclosed spaces. If use in an enclosed space is required, procedures for work in an oxygen deficient environment should be followed.



Appendix C – Cost Estimate

Engineer's Estimate

		Yavapai Hills Regional Lift Station	#1			
		CIP #2105-004				
Line No.	Item	Description	Qty	Unit	Unit Cost	Amount
Gene	ral Constructio	on Items				
1	MAG 105.8	Construction Stakes Lines and Grades	1.00	LS	\$4,400.00	\$4,400.00
2	MAG 107.16	Stormwater Pollution Prevention Plan	1.00	LS	\$11,000.00	\$11,000.00
3	MAG 109.10	Mobilization/Demobilization	1.00	LS	\$80,000.00	\$80,000.00
4	MAG 109.11	Contract Allowance	1.00	LS	\$687,538.00	\$687,538.00
5	MAG 420	Permanent Fencing	650.00	LF	\$22.00	\$14,300.00
		General Constructio	n Items Sub	total		\$797,238.00
Sewei	r Improvement		Ι			
6	2200 SP	Piping, Existing Fencing, Pumps, Concrete, Valves, Slide Gates, Manholes and ATS Demolition	1.00	LS	\$445,500.00	\$445,500.00
7	03410-A SP	Splitter Box - Polymer Pre-Cast	20.00	CY	\$3,000.00	\$60,000.00
8	03410-В SP	Wet Well - Polymer Pre-Cast	110.00	CY	\$3,000.00	\$330,000.00
9	MAG 725	Storage Building Pad - Slab - on - Grade	10.00	EA	\$2,000.00	\$20,000.00
10	03400-A SP	Meter Vault - Pre-Cast	1.00	EA	\$38,500.00	\$38,500.00
11	MAG 744	Manhole - Polymer Pre-Cast	3.00	EA	\$7,200.00	\$21,600.00
12	03400-В SP	Valve Vaults - Pre-Cast	3.00	EA	\$72,000.00	\$216,000.00
13	08305 SP	Access Hatches	6.00	EA	\$11,000.00	\$66,000.00
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17	MAG 626.3	Coatings	1.00	LS	\$25,000.00	\$25,000.00
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20	5500 SP	Misc Shelving	1.00	LS	\$11,000.00	\$11,000.00
21	15100 PSDS PVC1 SP	15" SDR-35 PVC Pipe	50.00	LF	\$120.00	\$6,000.00
22	15100 PSDS DIP SP	10" Class 350 DIP	210.00	LF	\$280.00	\$58,800.00
23	15200.2.2.5. A SP	10" Plug Valve	3.00	EA	\$4,400.00	\$13,200.00
24	15200.2.2.3.B SP	10" Check Valve	3.00	EA	\$9,900.00	\$29,700.00
25	15812 SP	4" FRP Duct	200.00	LF	\$75.00	\$15,000.00
26	11100 SP	10" Sluice Gate Manually Actuated	4.00	EA	\$30,000.00	\$120,000.00
27	16050 SP	General Electrical Provisions	1.00	LS	\$687,537.50	\$687,537.50

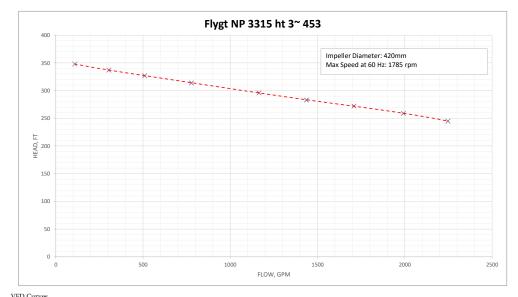
Engineer's Estimate

		Yavapai Hills Regional Lift Station	#1			
		CIP #2105-004				
Line No.	Item	Description	Qty	Unit	Unit Cost	Amount
28	16496 SP	ATS	1.00	Ea	\$3,000.00	\$3,000.00
29	16232 SP	Genset	1.00	Ea	\$78,750.00	\$78,750.00
30	13305 SP	Programming	1.00	EA	\$30,000.00	\$30,000.00
31	13310.2.2.4 SP	Level Indicator Transmitters	2.00	EA	\$10,000.00	\$20,000.00
32	13310.2.2.5 SP	Level Switch (High, High High and Low Low)	10.00	EA	\$5,000.00	\$50,000.00
33	13310.2.2.2 SP	Flow Element and Indicator Transmitter	1.00	EA	\$7,500.00	\$7,500.00
34	MAG 343.2	Aggregate	1,010.00	SY	\$20.00	\$20,200.00
35	MAG 215.4	Grading	9,035.00	SY	\$20.00	\$180,700.00
		Sewer Improv	vements Sub	total		\$3,327,987.50
		Total Engineer's Estimate			\$4,125,225	.50



Appendix D – Calculations

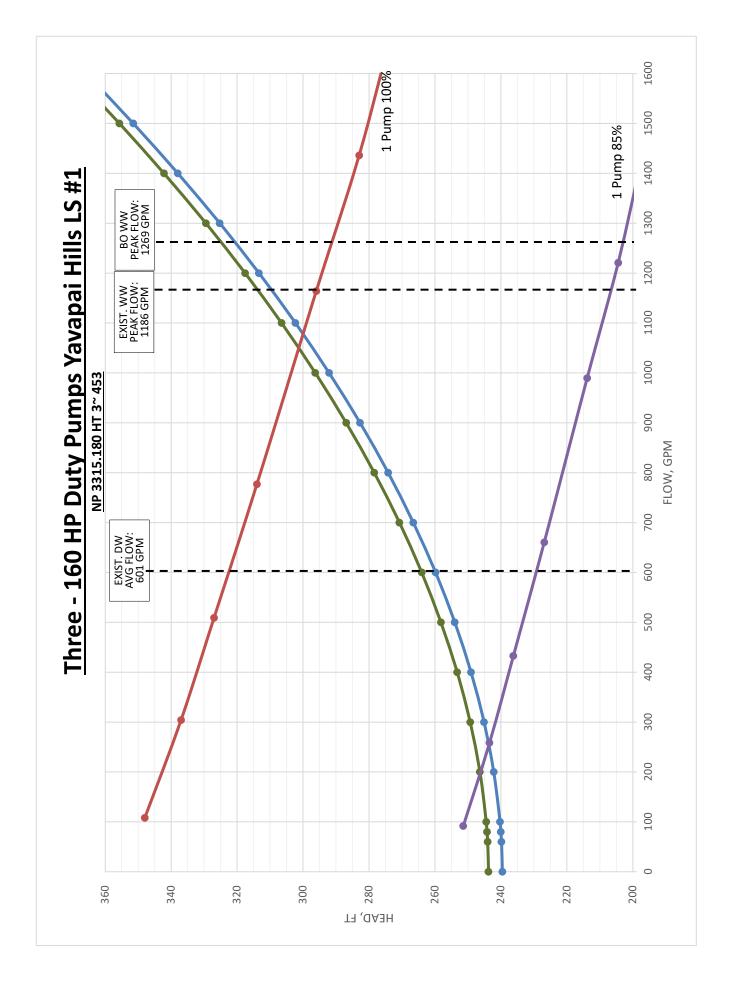
Project Number Project Name: Building / Room Numbe Location:	Yavapai Hill LS ar: Prescott AZ	#1		WORKS	Date: Calc By:	12/2/2022 Michael Roman
Hz From Curve	60					
Impeller Diameter:	420mm					
Flygt NP 3315.180 HT	Г 3~ 273		VFD, Hz	60		
Pump 1 x	1		Pump 1 x	1		
Flow	Head		Flow	Head		
108	348.0		0	348	No MCSF for Flygt Pumps	
304	337.0		304	337		
509	327.0		509	327		
777	314.0		777	314		
1164	296.0		1164	296		
1436	283.0		1436	283		
1708	272.0		1708	272		
1991	259.0		1991	259		
2246	245.0		2246	245		
1						



VFL	Curves											
	VFD, Hz	60	VFD, Hz	54	VFD, Hz	51	VFD, Hz	42	VFD, Hz	36	VFD, Hz	30
	RPM	1785	RPM	1607	RPM	1517	RPM	1250	RPM	1071	RPM	893
	Pump 1 x	x 1	Pump 1	x 1	Pump	1 x 1	Pump	1x1	Pump	01x1	Pump	01x1
	Flow	Head	Flow	Head	Flow	Head	Flow	Head	Flow	Head	Flow	Head
	108	348.0	97	281.9	92	251.4	76	170.5	65	125.3	54	87.0
	304	337.0	274	273.0	258	243.5	213	165.1	182	121.3	152	84.3
	509	327.0	458	264.9	433	236.3	356	160.2	305	117.7	255	81.8
	777	314.0	699	254.3	660	226.9	544	153.9	466	113.0	389	78.5
	1164	296.0	1048	239.8	989	213.9	815	145.0	698	106.6	582	74.0
	1436	283.0	1292	229.2	1221	204.5	1005	138.7	862	101.9	718	70.8
	1708	272.0	1537	220.3	1452	196.5	1196	133.3	1025	97.9	854	68.0
	1991	259.0	1792	209.8	1692	187.1	1394	126.9	1195	93.2	996	64.8
	2246	245.0	2021	198.5	1909	177.0	1572	120.1	1348	88.2	1123	61.3

		Calcs By:	Michael Roman			Job #							
Client:	City of Prescott	Date:	12/2/2022			,							
Project:	21-064 WATERWORK	Checked B	y: RDB										
Facility:													
Detail:	PS Details:	Submittal:	100% Comments		Hazen Williams Coeffi	ients C							
Pump EL		5319.64 ft			Ductile Iron Pipe	120							
MAX Water	Tank WSL EL: r Tank WSL EL:	5324.8 ft 5329 ft			Welded Steel	100.0							
Max Discha	arge Elevation	5568.57 ft											
Max Static		243.77 ft 239.57 ft											
Discharge p	pressure	0 psi	Discharge into gravity sewer										
	Head+discharge pressure, ft Head+discharge pressure, ft	243.77 ft 239.57 ft											
S.G. of cher	nical	1.00	Water Assumed										
No. Duty Pu No. Standb		1.0 1.0											
						249							
Item No.	NPS (in)	Pipe ID Type (in)	Pipe/Fitting	Description	Length (ft)	Q (gpm)	Velocity V2/2g (fps)	к	c	H _t (ft)	H _L SUM	Pipe Losses (ft)	Fitting Losses (ft)
				Exit into existing diversion manbole SW corner of Walker Rd and SR		2300							
1	12	C900 - 235 psi (DR 18) 11.73	Exit	69		2300	6.83 0.72	1.00	-	0.72	0.72	0.00	0.72
2	12 12	C900 - 235 psi (DR 18) 11.73 C900 - 235 psi (DR 18) 11.73	Pipe Valve, Ball	PVC pipe going E between ball valve and diversion manhole Ball valve between 90 deg bend and diversion manhole	22.0	2300 2300	6.83 0.72 6.83 0.72	0.00	120	0.34	1.06 1.09	0.34	0.00
4	12	C900 - 235 psi (DR 18) 11.73	Pipe	PVC pipe between 90 degree expansion and ball valve	4.0	2300	6.83 0.72	0.04	120	0.06	1.05	0.06	0.00
5	12	C900 - 235 psi (DR 18) 11.73 C900 - 235 psi (DR 18) 9.87	Increaser, d/D = 5/6	Expansion after 90 degree bend going into diversion manhole		2300	6.83 0.72	0.09	ļ.	0.07	1.22	0.00	0.07
6 7	10 10	C900 - 235 psi (DR 18) 9.87 C900 - 235 psi (DR 18) 9.87	90 deg elbow Pipe	90 degree elbow turning towards diversion manhole Pipe S towards 90 degree elbow	46.5	2300 2300	9.66 1.45 9.66 1.45	0.42	- 120	0.61	1.83 3.50	0.00 1.67	0.61
8	10	C900 - 235 psi (DR 18) 9.87	45 deg elbow	45 degree bend changing direction from SE to S transition from DIP		2300	9.66 1.45	0.22	- 1	0.32	3.82	0.00	0.32
17	10	DIP Class 50 10.52	Pipe	to PVC DIP connecting 45 degree bends from SR 69 FM	20.0	2300	8.49 1.12	0.00	120	0.52	4.34	0.52	0.00
18	10	DIP Class 50 10.52	45 deg elbow	45 degree bend exiting from SR-69 into COP lift station	340.0	2300	8.49 1.12	0.22	- 1	0.25	4.59	0.00	0.25
19 20	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Pipe 45 deg elbow	Pipe along SR 69 to 45 degree bend E of Walker Rd 45 degree bend changing direction from NW to W	340.0	2300 2300	8.49 1.12 8.49 1.12	0.00	120	8.92 0.25	13.51 13.75	8.92 0.00	0.00
21	10	DIP Class 50 10.52	Pipe	DIP connecting 45 degree bends NW	150.0	2300	8.49 1.12	0.00	120	3.93	17.69	3.93	0.00
22 23	10 10	DIP Class 50 10.52 DIP Class 50 10.52	45 deg elbow Pipe	45 degree elbow chnaging direction from W to NW DIP between CKV station and 45 degree bend NW	465.0	2300 2300	8.49 1.12 8.49 1.12	0.22	- 120	0.25 12.20	17.93 30.13	0.00 12.20	0.25
24	10	DIP Class 50 10.52	Valve, Gate	Gate valkve prior to CKV in check valve station		2300	8.49 1.12	0.11		0.12	30.25	0.00	0.12
25 26	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Slanted Disk Check Pipe	CKV in CKV station DIP between CKV station and 45 degree bend W	545.0	2300 2300	8.49 1.12 8.49 1.12	1.70	- 120	1.91 14.29	32.16 46.45	0.00 14.29	1.91 0.00
27	10	DIP Class 50 10.52	45 deg elbow	45 deg bend heading W into CKV station		2300	8.49 1.12	0.22	-	0.25	46.70	0.00	0.25
28 29	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Pipe 45 deg elbow	DIP between 45 deg bends W to SW to W 45 deg bend SW	202.0	2300 2300	8.49 1.12 8.49 1.12	0.00	120	5.30 0.25	52.00 52.25	5.30 0.00	0.00
30	10	DIP Class 50 10.52	45 deg eldow Pipe	DIP between 45 deg SW and CKV station	750.0	2300	8.49 1.12	0.00	120	19.67	71.92	19.67	0.00
31 32	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Gate Valve, Slanted Disk Check	Gate valve in CKV station prior to CKV CKV in CKV station		2300 2300	8.49 1.12 8.49 1.12	0.11		0.12 1.91	72.04 73.95	0.00	0.12
32 33	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Slanted Disk Check Pipe	-CKV in CKV station Pipe between CKV stations	1500.0	2300 2300	8.49 1.12 8.49 1.12	0.00	- 120	1.91 39.34	73.95 113.29	0.00 39.34	1.91 0.00
34 35	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Gate Valve, Slanted Disk Check	Gate valve in CKV station prior to CKV CKV in CKV station		2300 2300	8.49 1.12 8.49 1.12	0.11 1.70	······	0.12	113.41 115.32	0.00 0.00	0.12
36	10	DIP Class 50 10.52	Pipe	Between CKV station and 22.5 degree bend SW	600.0	2300	8.49 1.12	0.00	120	15.74	131.06	15.74	0.00
37 38	10 10	DIP Class 50 10.52 DIP Class 50 10.52	45 deg elbow Pine	22.5 degree bend SW	130.0	2300 2300	8.49 1.12 8.49 1.12	0.22	- 120	0.25 3.41	131.30 134.71	0.00 3.41	0.25
38	10	DIP Class 50 10.52 DIP Class 50 10.52	45 deg elbow	DIP between 22.5 degree bends W to SW 22.5 degree bend S	130.0	2300	8.49 1.12	0.00	- 120	3.41 0.25	134.71	3.41 0.00	0.00
40 41	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Pipe Valve, Gate	DIP between 22.5 degree bedn S and CKV vault	300.0	2300 2300	8.49 1.12 8.49 1.12	0.00	120	7.87 0.12	142.83 142.95	7.87 0.00	0.00
41 42	10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Slanted Disk Check	Gate valve in CKV station prior to CKV CKV in CKV station		2300	8.49 1.12	1.70	····· [·····	1.91	142.95	0.00	1.91
43 44	10 10	DIP Class 50 10.52 DIP Class 50 10.52	Pipe Valve, Gate	DIP between CKV stations Gate valve in CKV station prior to CKV	1256.0	2300 2300	8.49 1.12 8.49 1.12	0.00	120	32.94 0.12	177.80 177.93	32.94 0.00	0.00 0.12
44	10	DIP Class 50 10.52 DIP Class 50 10.52	Valve, Slanted Disk Check	CKV in CKV station		2300	8.49 1.12	1.70		1.91	179.83	0.00	1.91
46	10	DIP Class 50 10.52	Pipe	DIP between CKV station and 45 degree bend turning W onto Robin	1450.0	2300	8.49 1.12	0.00	120	38.03	217.87	38.03	0.00
47	10	DIP Class 50 10.52	45 deg elbow	45 degree elbow turning into Robin		2300	8.49 1.12	0.22		0.25	218.11	0.00	0.25
48 49	10 10	DIP Class 50 10.52	Pipe	DIP between 45 degree elbows turning into Robin	45.0	2300	8.49 1.12 8.49 1.12	0.00	120	1.18	219.29	1.18	0.00
50	10 10	DIP Class 50 10.52 DIP Class 50 10.52	45 deg elbow Pipe	45 degree elbow turning onto Robin DIP between 45 degree bends turning into Yavapai Hill L5	224.0	2300 2300	8.49 1.12 8.49 1.12	0.22	- 120	0.25 5.88	219.54 225.41	0.00 5.88	0.25 0.00
51	10	DIP Class 50 10.52	45 deg elbow	45 degree elbow turning into Yavapai Hills DIP between 45 degree elbow and 22.5 degree elbow going into		2300	8.49 1.12	0.22		0.25	225.66	0.00	0.25
52	10	DIP Class 50 10.52	Pipe	yavapai hills LS	60.0	2300	8.49 1.12	0.00	120	1.57	227.23	1.57	0.00
53	10	DIP Class 50 10.52	45 deg elbow	22.5 degree bend heading towards Yavapai Hills DIP between 22.5 degree bend and 11.25 degree bend heading into		2300	8.49 1.12	0.22		0.25	227.48	0.00	0.25
54	10	DIP Class 50 10.52	Pipe	Yayapai Hills	58.0	2300	8.49 1.12	0.00	120	1.52	229.00	1.52	0.00
55	10	DIP Class 50 10.52	45 deg elbow	11.25 degree bend heading towards Yavapai Hills LS DIP between 11.25 degree bend and Tapping Sleeve going into		2300	8.49 1.12	0.22		0.25	229.25	0.00	0.25
56	10	DIP Class 50 10.52	Pipe	Yavapai Hills LS	81.3	2300	8.49 1.12	0.00	120	2.13	231.38	2.13	0.00
57	10	DIP Class 350 10.58	Branch Tee	Tapping Sleeve going into Yavapai Foothills lift station Plug valve at valve box prior to tapping sleeve connection to existing		2300	8.40 1.10	0.84	·····	0.92	232.30	0.00	0.92
58	10	DIP Class 350 10.58	Valve, Plug	FM	70.0	2300	8.40 1.10	0.25	· · · · · · · · · · · · · · · · · · ·	0.27	232.58	0.00	0.27
59	10	DIP Class 350 10.58	Pipe	DIP between valve vault box at tapping sleeve and 22.5 degree bend	5.0	2300	840 110	0.00	120	0.13	232 70	0.13	0.00
60	10	DIP Class 350 10.58	45 deg elbow	22.5 degree elbow turning NE towards the existing FM		2300	8.40 1.10	0.22		0.24	232.94	0.00	0.24
61 62	10	DIP Class 350 10.58 DIP Class 350 10.58	Pipe 45 dag albow	DIP between 22.5 degree bend and 45 degree bend upwards 45 degree bend upwards	35.0	2300 2300	8.40 1.10 8.40 1.10	0.00	120	0.89	233.84 234.08	0.89 0.00	0.00
63	10 10	DIP Class 350 10.58	45 deg elbow Pipe	DIP between 45 degree bends to align with CL	11.0	2300	8.40 1.10	0.00	120	0.28	234.36	0.28	0.00
64 65	10 10	DIP Class 350 10.58 DIP Class 350 10.58	45 deg elbow	45 degree bend alighning with CL	54.0	2300 2300	8.40 1.10 8.40 1.10	0.22	- 120	0.24	234.60 235.98	0.00	0.24
66	10	DIP Class 350 10.58	Pipe Valve, Plug	DIP between valve vault and 45 degree bend aligning with Cl Plug valve within valve vault prior to discharge into FM	54.0	2300	8.40 1.10	0.25	- 120	0.27	236.25	0.00	0.27
67 68	10 10	DIP Class 350 10.58 DIP Class 350 10.58	Valve, Slanted Disk Check	CKV within valve vault prior to plug valve	23.0	2300 2300	8.40 1.10 8.40 1.10	1.70	- 120	1.86 0.59	238.12 238.70	0.00	1.86 0.00
68 69	10 10	DIP Class 350 10.58	Pipe Pipe	DIP between CKV within secondary valve vault and Flow Meter DIP between flow meter vault and y tee connection	23.0 12.0	2300 2300	8.40 1.10 8.40 1.10	0.00	120 120	0.59 0.31	238.70 239.01	0.59 0.31	0.00
70	10	DIP Class 350 10.58	Branch Tee	DIP Y branch changing direction to E		2300	8.40 1.10	0.84		0.92	239.93	0.00	0.92
71	10 10	DIP Class 350 10.58 DIP Class 350 10.58	Pipe Branch Tee	DIP between y branch connections Branch tee going into valve vault	14.0	2300 2300	8.40 1.10 8.40 1.10	0.00	- 120	0.36 0.92	240.29 241.21	0.36	0.00
73	10	DIP Class 350 10.58	Pipe	DIP between y tee and valve vault prior to wet well	4.0	2300	8.40 1.10	0.00	120	0.10	241.31	0.10	0.00
74 75	10 10	DIP Class 350 10.58 DIP Class 350 10.58	Valve, Plug Valve, Slanted Disk Check	Plug valve after CKV in valve vault CKV in valve vault		2300 2300	8.40 1.10 8.40 1.10	0.25		0.27	241.58 243.45	0.00	0.27
76	10	DIP Class 350 10.58	Pipe	DIP between valve vault and 90 degree bend to pump	12.0	2300	8.40 1.10	0.00	120	0.31	243.75	0.31	0.00
77	10 10	DIP Class 350 10.58 DIP Class 350 10.58	90 deg elbow Pine	.90 degree elbow going into the pump DIP to 90 degree bend going into the pumps discharge	6.5	2300 2300	8.40 1.10 8.40 1.10	0.42	- 120	0.46	244.21 244.38	0.00	0.46
79			ripe	Expansion into 10" FM from 90 degree bend	~-3	2300	8.40 1.10	0.41	120	0.17	244.38	0.00	0.45
78 79	10	DIP Class 350 10.58	Increaser, d/D = 3/5	Expansion into 10 FM from 90 degree bend									
78 79 80		DIP Class 350 10.58 DIP Class 350 6.40	Increaser, d/D = 3/5 90 deg elbow	SO degree bend into pump		2300	22.95 8.19	0.45		3.68	248.51	0.00	3.68
78 79					8495.26								

		Max Static N	lin Static
Pump Flow	Loss	TDH	TDH
gpm	ft	ft	ft
0	0.00	243.77	239.5
60	0.28	244.05	239.8
80	0.48	244.25	240.0
100	0.72	244.49	240.2
200	2.62	246.39	242.1
300	5.57	249.34	245.1
400	9.52	253.29	249.0
500	14.43	258.20	254.0
600	20.27	264.04	259.8
700	27.02	270.79	266.5
800	34.66	278.43	274.2
900	43.17	286.94	282.7
1000	52.54	296.31	292.1
1100	62.76	306.53	302.3
1200	73.82	317.59	313.3
1300	85.70	329.47	325.2
1400	98.41	342.18	337.9
1500	111.92	355.69	351.4
1600	126.25	370.02	365.8
1700	141.37	385.14	380.9
1800	157.28	401.05	396.8
1900	173.97	417.74	413.5
2000	191.45	435.22	431.0
2100	209.70	453.47	449.2
2200	228.72	472.49	468.2
2300	248.51	492.28	488.0



WATERWORKS			Calcs By:	Michael Roman	
Client:	City of Presco	ott	Date:	12/6/2022	
Project:	21-064		Checked By:	RDB	
Facility:			Date:		
Detail:			Submittal:	100%	
Peak WW Build Out Flow			Sublittai.	100/0	
Flow GPM	1269				
Flow MGD	1.828530259				
Maximum Pumping Flow Rate GPM	1050				
Maximum Pumping Flow Rate MGD	1.5129683		Datum Correction Used ft		3 57
Flow Surplus GPM	219				
Flow Surplus MGD	0.31556196				
Gallons Accumulated During Event (no pumps online)	152280				
Cu ft Accumulated (no pumps online)	20358.28877				
Gallons Accumulated During Event	26280				
Cu ft Accumulated	3513.368984				
Maximum Elevation (invert in at existing manhole) ft	5331.04				
(, ,					
Us	eable Volumes B	ased On Invert El	evation		
Description		Width/Radius ft		Volume cu ft	
10" Pipe from southern existing manhole to manhole 102	73	0.416666667	N/A	39.8153	32356
15" Pipe from MH 102 to MH 101	26	0.625	N/A	31.9068	30039
15" Pipe from MH 101 to Influent Splitter Structure	93	0.625	N/A	114.128	31706
Influent Splitter Structure	14	3			97.86
15" Pipe going into Wet Well	15	0.625		18.4077	
15" Pipe going into Wet Well	15	0.625		18.4077	
Wet Well	18	27	7.18	3 34	89.48
15" Drain into existing wet well	38	0.625	N/A	46.6330	01595
Existing Wet Well Overflow 1 Upper	N/A	6			
Existing Wet Well Overflow 1 Lower	N/A	2		3 37.6991	
Existing Wet Well 12" Pipe Connecting 1 and 2	9	0.5	N/A	7.06858	33471
Existing Wet Well Overflow 2 Upper	N/A	6			
Existing Wet Well Overflow 2 Lower	N/A	2		3 37.6991	
Total Retention Volume cu ft	N/A	N/A	N/A	6201.05	52367
Time Required to Reach Retention Volum					
Peak WW BO Flow GPM	1269	ſ			
Time to Max Retention Volume (No Pumps on) Minutes	36.55151435				
Time to Max Retention Volume (No Pumps on) Hours	0.609191906				
Time to Max Retention Volume (One Pumps On) Minutes	211.7985009				
Time to Max Retention Volume (One Pumps On) Hours	3.529975016				

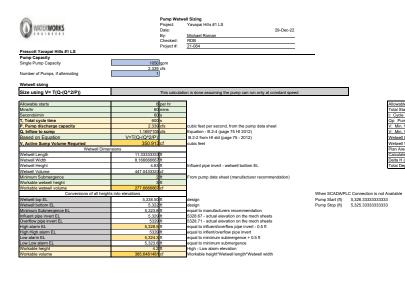




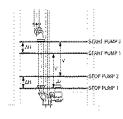


WATERWORKS E N G I N E E R S		Project: Date: By: Checked: Project #:
Pump Capacity	Buildout	
Wet Well Invert (ft)	5322.00	
Single Pump Capacity (gpm)	1050	
Bell Diameter (in)	7.87	
Pump Height (in)	67.75	
Distance from Invert to Bell (in)	8.88	
Equation:	S = D + 0.574Q/D ^{1.5}	
Min Submergence for Suction	35.15	-
Submergence for Full Pump Coverage	76.63	
Manufacturer Recommended Min Submergence (in)	22.00	
Min WSE for Suction	5325.67	-
Min WSE for Coverage	5328.39	1
Min WSE from Manufacturer	5323.83]
Minimum Water Surface Elevatior	5325.67	1
Use for Min WSE	5325.70	1

Michael Roman		
RDB 21-064		= from Manufactu rom Design
		0
Notes:		
As per Design		
One Pump intersection with system curve		
Per Manufacturer		
Per Manufacturer. Bottom of pump to top of lifting loop.		
Per Manufacturer. Bottom of pump to top of lifting loop.		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer.		
Per Manufacturer. Bottom of pump to top of lifting loop.		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer.		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer.		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer. From HI Pump Intake Design, Page 32		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer. From HI Pump Intake Design, Page 32 From HI Pump Intake Design, Page 32		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer. From HI Pump Intake Design, Page 32 From HI Pump Intake Design, Page 32 Required to cover pump (wetwell invert + length of the pump)		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer. From HI Pump Intake Design, Page 32 From HI Pump Intake Design, Page 32 Required to cover pump (wetwell invert + length of the pump)		
Per Manufacturer. Bottom of pump to top of lifting loop. Per Manufacturer. From HI Pump Intake Design, Page 32 From HI Pump Intake Design, Page 32 Required to cover pump (wetwell invert + length of the pump) Per Manufacturer. Above invert.		









Project No.	21-064 Yavapai Hills LS	Computed E
Title	Surge Analysis	Dat
	Total Surge Pressure, 10" DIP	Checked E
	FM	Dat
		Sheet N

mputed By BLT Date 12/10/2021 Checked By Date Sheet No. 1 of 1

Reference: AWWA M11, Chapter 5

Fluid Velocity

Parameter	Value
Equation	$V = 0.4085 \left(\frac{Q}{d^2} \right)$
Flowrate (Q), gpm	1075
Inside Diameter of Conduit (d), inches	10.455
Fluid Velocity (V), fps	4.02

Wave Velocity

Parameter	Value
Equation	$a = \frac{12}{\sqrt{\frac{VV}{g}\left(\frac{1}{k} + \frac{d}{Et}\right)}}$
Specific Weight of Fluid (W), lb/ft ³	62.4
Acceleration Due to Gravity (g), ft/sec ²	32.2
Bulk Modulus of Compressibility of Liquid (k), psi	300,000
Pipe Material	Ductile Iron
Young's Modulus of Elasticity for Pipe Wall Material (E), psi	24,000,000
Thickness of Conduit Wall (t), inches	0.3225
d/t ratio	32.4
Wave Velocity (a), fps	3,983

Pressure Rise

Parameter	Value
Equation	$P = \frac{aWV}{144g} = \left(\frac{a}{g}\right) \left(\frac{spgr}{2.3}\right) V$
Specific Gravity of Fluid (sp gr)	1.0
Pressure Rise Above Normal (P), psi	216

Total Internal Pressure

Parameter	Value
Normal Pressure, psi	131.2
Internal Pressure	347

Minimum Closing Time

Parameter	Value
Equation	$T_{min} = 2\frac{L}{a}$
Length of Conduit (L), ft	8705
Minimum Closing Time (T _{min}), sec	4.4

Surge Distance

Parameter	Value		
Equation	$D = L - \left(\frac{T_{actual}a}{2}\right)$		
Actual Closing Time (T _{actual}), sec	0.0		
Surge Distance (D), ft	8705		



Appendix E – La Quinta LS Report

RAMADA INN RESORT

SEWER REPORT & SPECIFICATIONS

PREPARED BY: Lyon Engineering and Development Inc. 121 W. Navajo Dr. Suite C Prescott, AZ 86301 (520) 776-1750 07/13/98

PRIVATE SEWER LIFT STATION AND CONNECTION TO CITY OF PRESCOTT 10" FORCE MAIN

A. <u>OVERVIEW</u>

The proposed Ramada Inn at Highway 69 and Old Black Canyon Highway is an 82 room hotel with proposed lounge and restaurant. A boring across Highway 69 accesses all utilities except sewer. The only feasible alternative for sewer is to connect to the existing 10" City of Prescott force main along the north boundary of the site. A proposed private lift station within the basement of the building will provide the pressure and flow to pump sewage from the facility, into the existing 10" force main, with enough pressure to outfall at the existing lift station servicing the Ranch next to the AM/PM Mini Mart along Highway 69.

II. <u>SEWER FLOW ANALYSIS</u>

A projected flow computation must be performed in order to properly size the proposed pumping facility. Flow to the proposed private lift station is based on the attached table 2-8, "Average Wastewater Flows from Commercial Sources" from the "Wastewater Engineering" reference book by Metcalf & Eddy, Inc. Based on historic values from the reference book and conversation with the owner regarding his previous hotel experience, the following average daily flow can be projected:

200 guests @ 50 gallons/day 50 employees @ 11 gallons/day 100 restaurant meals x 3 sittings x 2.7	= 10,000 gallons/day = 550 gallons/day gal/meal/day = 810
gallons/day	
53 Lounge customers & employees @ 1	3 gal/day = 689
gallons/day	
6-50 pound washers (a) 689 gallons/day each	= 4,134 gallons/day
Total average daily flow	= 16,183 gallons/day
Total gallons per minute	= 11 gallons/minute
	C

With D.E.Q. peaking factor of 3.0, Total flow = 33 gallons/minute

Ramada Inn Sewer Report, Page 2

III. <u>PUMP SYSTEM DESIGN</u>

Total dynamic head = elevation difference between pump and outfall + friction loss through 4 inch and existing 10 inch force main = TDH

TDH = 5566 (outfall elevation @ the Ranch) – 5419 (suction) + headloss through 4" force main + headloss through exist. 10" force main as itemized in the pumping scenarios outlined in table below.

The City of Prescott lift station at Yavapai Hills is pumping at 825 g.p.m. to the Ranch outfall per its attached system curve (Exhibit "C"). System curves for various pumping conditions with and without the City of Prescott lift station are attached as Exhibit "B". When the Ramada pump station is discharging at the same time as the Yavapai Hills station, it must overcome the dynamic pressure at the connection point to start any flow out. The total dynamic head computations for the two pumping scenarios are outlined as follows:

Flow Cond.	Vert. Lift	HL 3" F.M.	HL 10" F.M.	T.D.H.
(G.P.M.)	(Feet)	(Feet)	(Feet)	(Feet)
10 + 825	147	0.1	30.8	177.9
20 + 825	147	0.3	31.5	178.8
30 + 825	147	0.6	32.1	179.7
40 + 825	147	1.1	32.8	180.9
10	147	0.1	0.01	147.1
20	147	0.3	0.03	147.3
30	147	0.6	0.06	147.7
40	147	1.1	0.1	148.2
50	147	1.7	0.2	148.9
60	147	2.3	0.2	149.5
70	147	3.1	0.3	150.4
80	147	4.0	0.4	151.4

Ramada Inn Sewer Report, Page 3

As can be observed in the above table, the two pumping scenarios are approximately 30 T.D.H. apart in operating conditions and will require a pump that will meet both conditions on its curve. After a great deal of research, only two pumps were found that would meet the flow conditions the pumps would have to achieve and stay on the curve. Flygt manufactures a high head solids pump that will meet both conditions on its curve but has the disadvantage of too high a discharge at the low head condition that will be experienced approximately 75 percent of the time (based on city flow data attached as Exhibit E). The proposed 7.5 horsepower Hydromatic Model SPGH/G2HX 750 grinder pump will deliver 30 g.p.m. @ 180 TDH and 60 g.p.m. @ 150 g.p.m. (see attached Exhibit B system curve). The grinder pump will deliver a flow within 3 g.p.m. of the calculated peak at the high head condition (experienced approximately 25 percent of the time) and an acceptable high flow of 60 g.p.m. when running in the low head condition (experienced approximately 75 percent of the time). The proposed pumping station will be duplex system that will provide a backup pump and capability of pumping in excess of the required flow in times of extreme demand or after a power outage. The proposed Hydromatic grinder pump provides an ideal fit to our low flow high head condition in both pumping scenarios.

IV. WETWELL DESIGN

The pump cycling limitations and the desire to provide holding capacity in case of power outages governs the size of the proposed wet well. The following computations for required capacity of the proposed wet well are from D.E.Q. Bulletin No. 2:

Vw = 0q/4, 0 = min. time between pump cycles = 20 min., q = pump capacity = 60 g.p.m.

Vw = 20(60)/4 = 300 gallons

Ramada Inn Sewer Report, Page 4

The proposed wet well is a 6 foot deep by 6 foot wide by 12 foot long concrete vault allowing a great deal of storage buffer without having to blast deep through the rock below the basement floor as would be required with a manhole. The vault would have an active capacity of 1,355 gallons. The additional holding capacity will provide adequate buffer in times of short power outages, but use of sanitary facilities will have to be curtailed in power outages longer than 1 to 2 hours. A trip switch with an exterior connection for a portable generator will be provided at the building exterior.

V. DETENTION COMPUTATIONS

The total detention time in the wetwell, based on average daily flow, is as follows:

Difference between pump on & pump of f = 1.5 feet

Detention volume = 1.5' x area x 7.48 gal/cf = 1.5 x 60.4 x 7.48 = 678 gallons

Detention time = detention vol. / ADF = 678/11 = 62 minutes

Due to the relatively long detention time, aeration will be required to minimize odors. A diffused aeration and ventilation system is proposed with this installation. The owner of the proposed Ramada Inn Hotel is planning to install the grinder pump system in the basement of his hotel, allowing the basement support facilities such as washers to gravity flow to the pump station. The top of the vault hatch will be flush with the basement floor and be built to a depth of 10 feet. The attached Exhibit D station diagram delineates the relative elevation of the pump controls and inlet and outlet elevations. A diffused aeration system (see Exhibit D) is proposed to minimize odors associated with the lift station, particularly due to its location within the building. All the pumping equipment, controls, and aeration equipment will be provided by Mountain Country Supply or approved equal supplier. The proposed lift station will require three-phase power and the owner is providing three-phase power for this and other facility requirements. Lift station controls will be wall mounted in the basement.



Appendix F Geotechnical Report



ENGINEERING & TESTING CONSULTANTS INC.

December 3, 2021

Mr. Rob Bryant, PE Water Works Engineers 7500 N. Dobson Rd. STE 200 Scottsdale, AZ 85256

SUBJECT: SUBSURFACE SOIL EXPLORATION FOR YAVAPAI HILLS LIFT STATION NO. 1, PRESCOTT, ARIZONA

Dear Mr. Bryant:

Engineering & Testing Consultants, Inc. (ETC) has completed a subsurface soil exploration for the above referenced project. The purpose of this exploration is to evaluate the general subsurface soil conditions at the site, and to present geotechnical engineering recommendations with regard to foundation support, slabs-on-grade, lateral soil pressures, and site grading for the proposed improvements.

PROJECT AND SITE CONDITIONS

The property is generally located south of E. Robin Drive and west of E. State Route 69, the second parcel east of Tawa Court (Parcel No. 103-20-487A).

The property is located along the west side of a creek. *Existing fills and grading have been performed within the facility*. An existing building and other structures are present throughout the area of the facility.

The northwest boring, B-1, is located just outside of the fenced in facility, on undisturbed land. Some native trees and brush are located in the area easterly sloping area of boring B-1.

GEOTECHNICAL ENGINEERING • SOILS & MATERIALS TESTING • SPECIAL INSPECTION

417 NORTH ARIZONA AVENUE • PRESCOTT, ARIZONA 86301 928-778-9001





Water Works Engineers Geotechnical Engineering Services – Yavapai Hills Lift Station No. 1 Prescott, AZ December 3, 2021 Page 2 of 11

Existing fill is present in the area of the northeast boring, B-2. Boring B-2 is located approximately 30 feet south of open, below grade, concrete tanks. The tanks extend approximately 12 feet below the existing ground surface. The top of the eastern fill slope, adjacent to the creek is located approximately 23 feet east of the boring. Concrete, asphalt, and rock pieces were observed on the fill slope.



Drill Rig at Boring B-2 – Looking North

SUBSURFACE CONDITIONS

ETC drilled two exploratory test borings at the locations provided to us. The borings were performed to determine general subsurface soil conditions and collect soil samples for laboratory testing. If soil conditions encountered during construction differ from those described herein, this firm should be contacted to review our recommendations made in this report.

The borings were performed utilizing a truck mounted CME 75 drill rig with 8-inch diameter continuous flight augers. A more detailed description of the soil conditions encountered by the exploratory test borings is presented on the boring logs included in Appendix A. A Boring Location Map is attached as Figure 1.

The northwest boring, B-1, was drilled outside of the fenced-in area, on undisturbed land. This boring encountered approximately 2 feet of medium plasticity Clayey Sand with Gravel (SC) and

ETC 11531



Water Works Engineers Geotechnical Engineering Services – Yavapai Hills Lift Station No. 1 Prescott, AZ December 3, 2021 Page 3 of 11

a high percentage of clayey fines. At a depth of approximately 2 feet, boring B-1 encountered highly weathered granite rock, becoming very dense within 5 feet of the surface. This boring encountered refusal on granite rock at a depth of 22.5 feet.

The northeast boring, B-2, was drilled within the facility. This boring encountered approximately 6 to 7 feet of loose, granular fill with cobbles and some boulders.

Below the loose fill, the northeast boring, B-2, encountered medium dense to dense weathered granite rock at a depth of approximately 8 feet, becoming very dense within 15 feet of the surface. Auger refusal on rock was encountered in boring B-2 at a depth of 27 feet.

A subsurface water table was encountered within the northeast boring at a depth of approximately 6.5 feet. The water appears to be perched on top of the lower granite stratum. As discussed herein, a creek is located along the eastern side of the property.

A significant amount of loose fill soils with varying amounts of cobbles and boulders were encountered in the area of boring B-2. The depth of fill may increase to the south and east. In addition, the bottom of the below-grade tanks north of B-2 are at least 12 feet below existing grade.

The loose soils and existing fills shall be removed from building areas, extending at least 5 feet outside of building footprints. The removed soils may be re-used and replaced in controlled, compacted lifts, in accordance with the compaction criteria herein, provided any debris and over-sized rock pieces are removed, as further discussed in the Earthwork section herein.

In addition, the higher plasticity clayey soil, encountered within approximately 2 feet of the surface in the area of boring B-1, shall be removed from floor slab and foundation areas of any proposed building. The removed clayey soils may be replaced with other granular, low plasticity soils encountered below the upper clayey soil or elsewhere on the site.



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LABORATORY

Atterberg limits, gradation, and moisture content laboratory tests were performed for representative soil samples collected during the field operation. A summary of the laboratory test results is presented below in Table 1. Laboratory testing was performed in accordance with applicable ASTM standards.

As shown in Table 1, the clayey soil collected from the upper 2 feet in the northeast boring, B-1, is medium to high in plasticity with a high percentage of clayey fines.

The on-site fill soils tested from boring B-2, and the lower soils/decomposed granite tested from boring B-1 consist of low plasticity granular soils.

Boring	Depth (feet)	Liquid Limit (%)	Plasticity Index	Fines Content (%)	Gravel Content (%)	Moisture Content (%)	USCS
	0 – 2	36	18	42	18	12.3	SC
B – 1	2 – 5	22	7	25	11	4.2	SC-SM
B – 2	0 4	** **	Nonplastic	29	17	7.7	SM

 TABLE 1

 SUMMARY OF LABORATORY TEST RESULTS

Corrosivity

Selected samples of the on-site soils were also tested for corrosion potential of the soils to buried pipeline, and for concrete corrosivity.

ETC has performed the following laboratory tests to evaluate the soil corrosivity: resistivity, pH, oxidation-reduction potential (redox), chlorides, sulfides, and sulfates. A summary of the test results is presented below in Table 2.

Utilizing the 10-point scale developed by the American Water Works Association, Standard C105-05, and ASTM A888, Appendix X, the soil tested does not meet the 10-point criteria for needing protection against corrosion for ductile iron pipe.



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TABLE 2PH & RESISTIVITY TEST RESULTS

•	Boring	Depth (feet)	pH	Resistivity Saturated (Ohm-cm)	Redox Potential Eh(mV)	Chloride Content (mg/kg)	Sulfide Content (mg/kg)	Sulfate Content (mg/kg)
	B – 1	0-2	8.5	3,752	170	12.5	0.19	4.2

Per Table 4.3.1 of ACI 318, the sulfate exposure will be negligible and modified Portland cement criteria are not required. In addition, additional concrete coverage for reinforcing steel in concrete is not required based on the negligible chloride content of the soil.

FOUNDATIONS

As discussed herein, existing fill and loose soils, where encountered, shall be removed from any building site, extending at least 5 feet outside of the building footprint. The removed soils may be re-used and replaced in controlled, compacted lifts, in accordance with the compaction criteria herein, provided over-sized rock pieces are removed. ETC is also providing an option for partial removal due to the lower water table, provided the bottom of the over excavation can be adequately compacted and stabilized, as further discussed herein.

The medium to high plasticity clayey soil, encountered within approximately 2 feet of the surface shall be removed from any building site. The removed upper clayey soil may be replaced with the underlying excavated granular material, or low plasticity granular material from elsewhere on the site.

ETC recommends any proposed building be supported on conventional, shallow foundations (continuous/spread footings). All footings shall be seated in firm, native soils and/or adequately compacted and tested fill, per the compaction criteria herein.

All foundations seated in low plasticity, granular, adequate bearing soils shall be seated at a minimum embedment depth of **18 inches** below lowest adjacent finished grade.



Water Works Engineers Geotechnical Engineering Services – Yavapai Hills Lift Station No. 1 Prescott, AZ December 3, 2021 Page 6 of 11

If refusal on relatively hard, intact rock is encountered, foundations on intact rock may be seated at a minimum embedment depth of **12 inches** or pinned to hard rock, as approved by the engineer.

In determining minimum foundation embedment depths, landscaping shall not be considered as finished grade. Lowest, adjacent finished grade should be measured from within 5 feet of the foundations for exterior footings and may be measured from finish floor for interior footings.

Construction, as recommended herein, will have all foundations seated in firm, native soils and/or adequately compacted and tested fill. ETC recommends that foundations be designed for a maximum allowable foundation pressure of **2,000 psf**, including design dead and live loads. Any deeper foundations within the relatively shallow, weathered rock stratum may be designed for an increased foundation pressure of **3,500psf**. The weathered rock stratum was encountered at a depth of approximately 2 feet in boring B-1, and 8 feet in boring B-2.

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements and long exposed walls should be provided with control joints to accommodate these movements. Reinforcement and control joints are suggested to allow slight movement and minimize cracking.

Increased movements can occur if adequate drainage is not maintained adjacent to foundations, slabs, and around the perimeter of the building, or foundation soils experience significant increases in moisture.

SLABS-ON-GRADE

As discussed herein, ETC is recommending removal and replacement of existing granular fill soils within building pads in compacted and tested lifts. The higher plasticity clayey soils encountered within 2 feet of the surface in boring B-1 shall also be removed.

ETC recommends a minimum thickness of **4** inches of processed aggregate base course in accordance with MAG Specifications, Section 702, be placed between the prepared granular subgrade soils and all concrete slabs.

A turn-down edge is recommended for exterior slabs to help mitigate exterior moisture migration into the underlying subgrade soils.



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Additional Considerations

ETC recommends the American Concrete Institute (ACI) be used as a guide for placement, curing, and finishing of Portland cement concrete (PCC). Concrete should be placed at the appropriate slump determined by mix design, required strength, and application. After placement, concrete should be cured properly and special attention shall be given to ensure adequate moisture is present during the initial curing process to prevent/reduce shrinkage and stress cracks.

Concrete slabs should be properly jointed, with maximum joint spacing of 24 to 36 times the slab thickness, unless noted otherwise. Any required saw cutting should be performed to an appropriate depth and in a timely manner, typically within 12 hours of concrete finishing.

It should be noted that for exterior concrete, that the use of deicing salt within the first year of concrete placement can cause damage to the concrete surface. This can be avoided by using 4,500psi concrete with a water/cement ratio of 0.45.

DRAINAGE

Positive drainage is critical to the successful performance of any foundation or slab system. Excess moisture infiltration into foundation soils is often the primary cause of soil-related problems below structures. Efficient surface and subsurface drainage should be established prior to and maintained during and after construction to prevent water from ponding and/or saturating the soils within or adjacent to building and slab areas. Increased movements can occur if the underlying soils experience significant increases in moisture content.

The design should divert water away from where it could penetrate the ground, particularly if granular fills are used. Care should be taken in design and construction to assure that water is contained to prevent seepage into the underlying soils.

ETC recommends that vegetation not be planted within 5 feet of any building. Backfill against footings, exterior walls, and in utility trenches shall be adequately compacted to reduce the possibility of moisture infiltration through loose soil.

Positive drainage of surface water away from the buildings, and adequate compaction of soils around the buildings and in utility trenches is very important for the long-term stability of foundation soils.



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EARTHWORK

Excavation conditions are further discussed below.

As discussed herein, a significant amount of existing fills and/or loose soils were encountered in the area of boring B-2, to a depth of approximately 6.5 feet.

Due to the subsurface water table encountered near the bottom of the fill, gravel may be required to stabilize the bottom of the over-excavation prior to fill placement. Alternatively, the existing fills may be removed to a minimum depth of 5 feet below existing grade. However, if the bottom of the over-excavation cannot be adequately stabilized with conventional compaction methods, additional over-excavation may be required. Other alternatives for stabilization may include the use of coarse, angular rock for stabilization, as determined by the engineer.

Removal of loose soils and existing fills, where encountered, shall extend at least 5 feet outside of the building footprint. The removed low plasticity granular soils oils may be re-used and replaced in controlled, compacted lifts, in accordance with the compaction criteria herein, provided any debris and over-sized rock pieces are removed. Rock size limits are provided below.

In addition, the higher plasticity clayey soil, encountered within approximately 2 feet of the surface in the area of boring B-1, shall be removed from the building footprint. The removed clayey soil may be replaced with underlying excavated granular materials or other low plasticity granular soils encountered elsewhere on-site.

The areas where fill is required must be stripped of all vegetation, debris, loose, or other unstable material, and such materials should be removed. Depressions and sloped ground should be widened or benched as necessary to accommodate compaction equipment and provide a level base for placing fill.

Prior to fill placement, the exposed ground surface shall be scarified, moisture conditioned, and thoroughly compacted to a minimum depth of 8 inches. Special attention shall be given to ensure adequate moisture is present throughout the entire 8-inch depth.

ETC shall be contacted prior to fill placement to observe adequate removal of loose material, and to verify that the ground surface has been adequately prepared for fill placement.

Engineered fill, where required, shall be clean, granular soil free of vegetation, debris, organic soil, and shall conform to the following requirements, as approved by the engineer:

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Water Works Engineers Geotechnical Engineering Services – Yavapai Hills Lift Station No. 1 Prescott, AZ December 3, 2021 Page 9 of 11

- 100 percent passing 6" sieve (depths greater than 5 ft. below finished grade);
- 100 percent passing 4" sieve (within 5 feet of finished grade in structural areas);
 - 3 to 36 percent passing No. 200 sieve
- 30 to 97 percent passing No. 4 sieve
- Maximum Plasticity Index (PI) of 15
- Maximum expansion index of 20

All subbase fill required to bring the structured areas up to subgrade elevation should be placed in horizontal lifts not exceeding 8 inches compacted thickness.

All granular soils in structural areas, including soils within or adjacent to the building, slabs, and backfill in utility trenches and behind retaining walls shall be compacted to a minimum relative density of 95% maximum dry density at -2% to +2% of optimum moisture, ASTM D698.

ETC recommends the observation of the site grading operation with sufficient tests to verify adequate compaction.

Excavation Conditions

At the locations explored, granite rock is present, encountered within 2 feet of the surface in the undisturbed area of boring B-1. Therefore, any significant excavations will likely not easily be accomplished with standard excavation equipment. The Contractor should expect excavations to require heavy equipment and other special excavation methods and rock removal techniques.

As noted, the fill material encountered at the location of boring B-1 was found to be relatively loose with larger cobble and boulder sized rock pieces. The cohesionless, rocky fill material should not be expected to stand vertical without collapsing trench sidewalls, due to the consistency of the material.

The weathered rock and granular, rocky fill will not easily allow for neat-lined trench excavations.



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LATERAL DESIGN PARAMETERS

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ETC recommends the following parameters be used for design of retaining structures. Retaining wall foundations shall be constructed in accordance with the foundation recommendations herein.

Retaining wall backfill shall consist of on-site or imported, granular, non-expansive, engineered fill, as specified herein. Retaining walls shall be waterproofed prior to being backfilled against, and drains shall be installed to help prevent saturation of wall backfill.

¹ Foundation Toe Pressure		1.33 x allowable bearing pressure
² Lateral Backfill Pressure: unrestrained walls restrained walls		36 psf/foot 56 psf/foot
Lateral Passive Pressure: firm native/compacted fill		370 psf/foot
Coefficient of Base Friction: firm native/compacted fill weathered rock (where enc	countered)	0.35 0.55

Increase in allowable foundation bearing pressure (provided herein) for foundation toe pressure due to eccentric or lateral loading. The entire footing-bearing surface should remain in compression.

² Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (maximum 12foot height). Pressures do not include temporary forces imposed during compaction of the backfill, swelling pressures developed by overcompacted clayey backfill, hydrostatic pressures from inundation or saturation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and deflection.

When calculating the stability of the wall against sliding, independent of passive resistance, the factor of safety should be 1.5 minimum. When calculating the stability of the wall against sliding, in conjunction with the passive pressure, the factor of safety should be 2.0 minimum.



Water Works Engineers Geotechnical Engineering Services - Yavapai Hills Lift Station No. 1 Prescott. AZ December 3, 2021 Page 11 of 11

LIMITATIONS

The figures and recommendations in this report were prepared in accordance with accepted professional engineering principles and soil mechanics practices. We make no other guarantee or warranty, either implied or expressed. If during subsequent planning and construction, conditions are different than as indicated, this firm should be notified for evaluation.

We like to inform our clients that Portland cement concrete is not a perfect construction material. Due to the characteristics of Portland cement itself, cracking of the concrete may occur. Cracking will be minimized, but not eliminated, by providing appropriate control, isolation, construction joints, and quality control testing. Drying and thermal shrinkage of the slabs with resultant hairline cracking or curling may occur even if the slabs are cured under optimum curing conditions. In short, there is no practical method of insuring that all floor cracking is eliminated utilizing slab-on-grade construction at the site.

This report is not a bidding document. Any contractor reviewing this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

For your use. Should you have any questions or concerns, please contact us at (928) 778-9001.

Sincerely,

ENGINEERING & TESTING CONSULTANTS, INC.



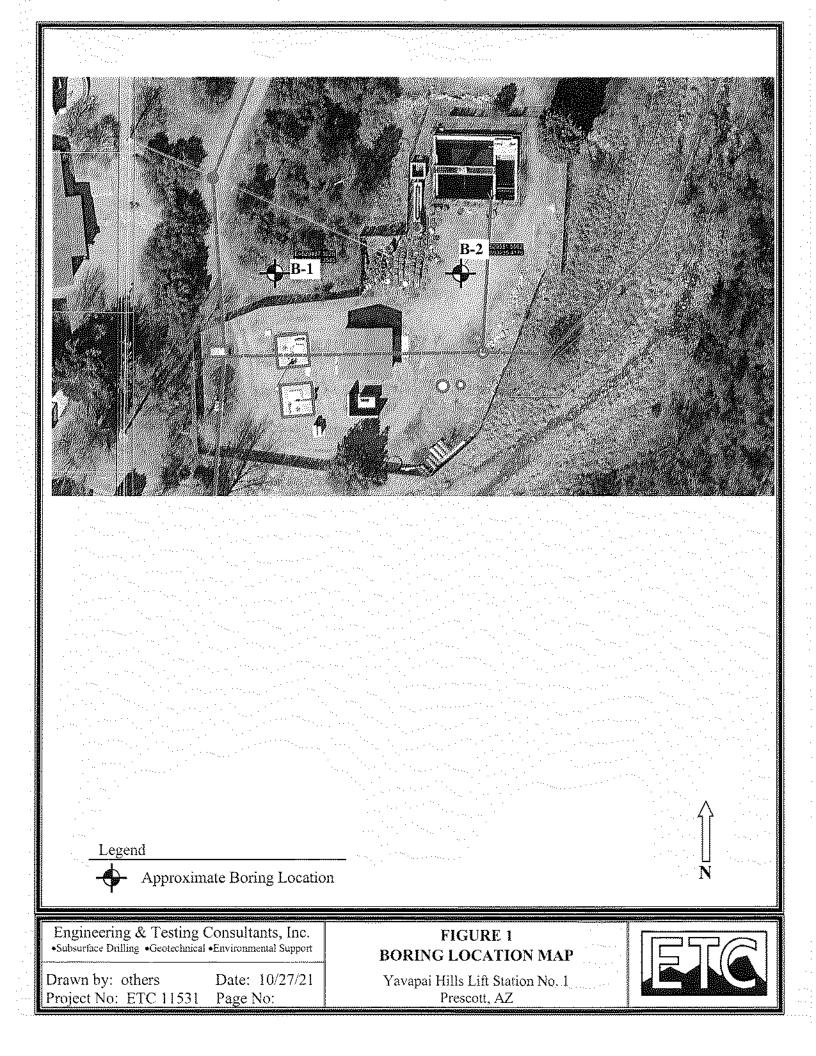


Michael P. Wilson, P.E. Project Engineer

Reviewed by: Richard G. Kelley, P.E. Project Manager

Attachments: Figure 1 and Appendix A

ETC File No. 11531 cc:





APPENDIX A

FIELD EXPLORATION

GENERAL NOTES

DESCRIPTIVE SOIL CLASSIFICATION:

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: Clays, if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse grained soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

CONSISTENCY OF FINE-GRAINED SOILS:

RELATIVE DENSITY OF COARSE-GRAINED SOILS:

Passing #200 sieve (0.075mm)

N-Blows/ft.	Consistency	N-Blows/ft.	Relative Density
0-2 3-4 5-8 9-16 17-32 33+	Very Soft Soft Medium Stiff Very Stiff Hard	0-3 4-9 10-29 30-49 50+	Very Loose Loose Medium Dense Dense Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL:

GRAIN SIZE TERMINOLOGY: Description Term(s) (of Components Also Present in Sampling) Percent of Major Component Dry Weight of Sampling Size Range Trace < 15 Boulders Over 12 in. (300mm) With 15 - 29 Cobbles 12 in. to 3 in. (300mm to 75mm) Modifier > 30 Gravel 3 in. to #4 sieve (75mm to 4.75mm) Sanđ #4 to #200 sieve (4.75mm to 0.075mm)

RELATIVE PROPORTIONS OF FINES:

Description Term(s) (of Components Also Present in Sampling)	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

Engineering & Testing Consultants, Inc. •Subsurface Drilling •Geotechnical •Environmental Support

KEY TO CLASSIFICATION (Unified Soil Classification System)

Silt or Clay



Page No: A-2

TERMS & SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM*

			JUI	L VLASSIEI	ATION SYSTEM*		Seil Classification
		· · ·				Group Symbo	
	COARSE-GRAINED SOILS	Gravels	· .	Clean Gravels	$Cu \ge 4$ and $1 \le Cc \le 3^{\frac{p}{2}}$	GW	Weil-graded grave!
· **** ·	More than 50 % retained on No. 200 sieve	More than 50 % of coars fraction retained on No.		Less than 5 % fines ^c	$Cu < 4$ and/or $1 > Cc > 3^{\epsilon}$	GP	Poorly graded gravel*
		sieve	7	Gravels with Fines	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H,}
1				More than 12 % fines ^c	Fines classify as CL or CH	GC	Clayey gravel ^{e.o.H}
		Sands		· Clean Sands	$C_{V} \ge 6$ and $1 \le C_{C} \le 3^{5}$	SW	Well-graded sand
anta Anta an		50 % or more of coarse fraction passes No. 4 si-	. ·	Less than 5 % fines ^p	Cu < 6 and/or 1 > Cc > 3 [£]	SP	Poorly graded sand
		nacioni pesses iso, 4 ar	646	Sands with Fines	Fines classify as ML or MH	SM	Silty sand a.H.
				More than 12 % fines ^p	Fines classify as CL or CH	SC	Clayey sand ^{O,H,I}
	FINE-GRAINED SOILS	Silts and Clays		Inorganic	PI > 7 and plots on or above "A" line"	CL	Lean clay KLM
	50 % or more passes the No. 200 sleve	Liquid fimit less than 50			PI < 4 or plots below "A" line "	ML	Silt ^{x,L,W}
	THR BICAL	·· ·		erganic	Liguid limit - oven dried Liguid limit - not dried < 0.75	ÖL.	Organic day ^{K,L,M,N} Organic silt ^{K,L,M,D}
		Silts and Clays		Inorganic	Pi plots on or above "A" line	СН	Fat clay KLM
		Liquid limit 50 or more			Pi plots below "A" line	MH	Elastic silt ^{K,L,M}
	. *			graspie			
				organic	Liquid limit - over dried Liquid limit - not dried < 0.75	он	Organic day ^{KLMP} Organic silt ^{KLMQ}
	HIGHLY ORGANIC SOILS A Based on the material passi		rimanly	organic matter, dark in co	ar, and organic odor	PT	Peat
	GP-GM poorly graded grave GP-GC poorly graded grave P Sands with 5 to 12% symbols: SW-SM well-graded sand wit SW-SC well-graded sand wit SP-SM poorly graded sand v SP-SC poorly graded sand v	I with clay fines require dual. C th silt -, th clay d with silt	o group ~11 A L-ML, 4 ~11 s ominant ~11 s ominant fine-	nerberg limits plot in hetc. sity day. oil contains 15 to 29 % p and* or "with gravel," v t. soil contains a 30 % plu ity sand, add "sandy" to gr	ned erea, soil is a lus No. 200. add vhichever is pre- s No. 200. pre-		
	LI SOL	salls. quation of $A \sim line$ orizontal at PI=4 to then PI=0.73 (LL-2 quotion of $"0"$ -line ertical at LL =16 to then PI=0.9 (LL-8)	10) PI=7	CH1	OH WILLING		
gineer ssurface E	ing & Testing Cons Prilling •Geotechnical •Envir	Ultants, Inc.	G G G G G G G G G G G G G G G G G G G	AO 50 60	70 80 90 1	00	
e No:	A-3		• •	•	& SYMBOLS		

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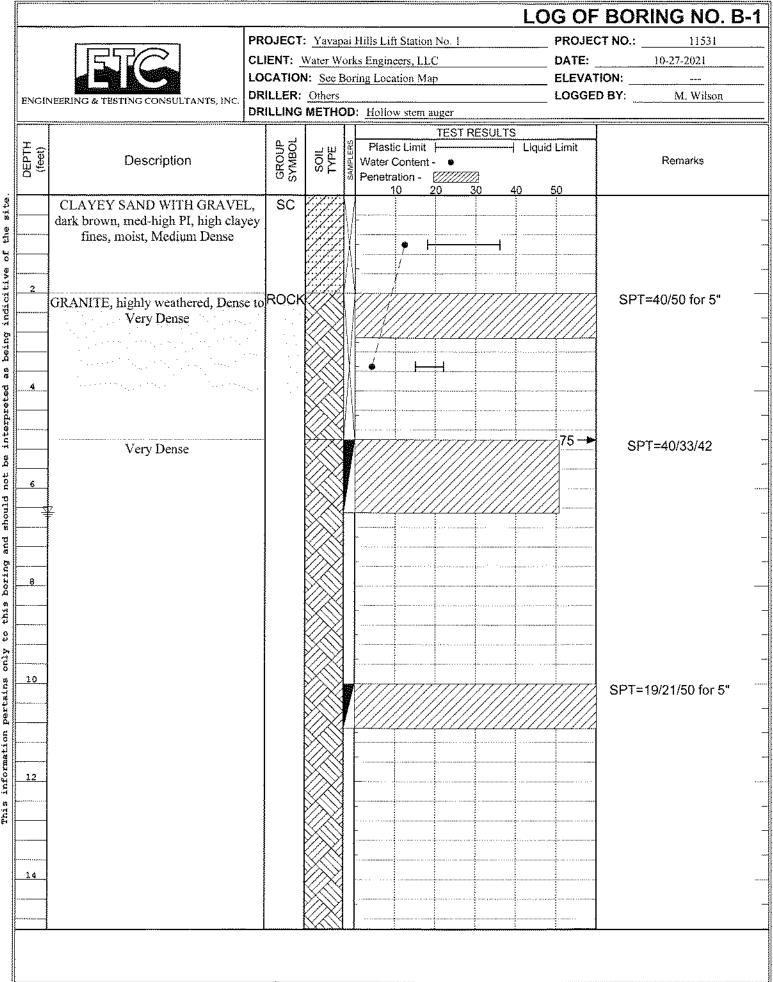
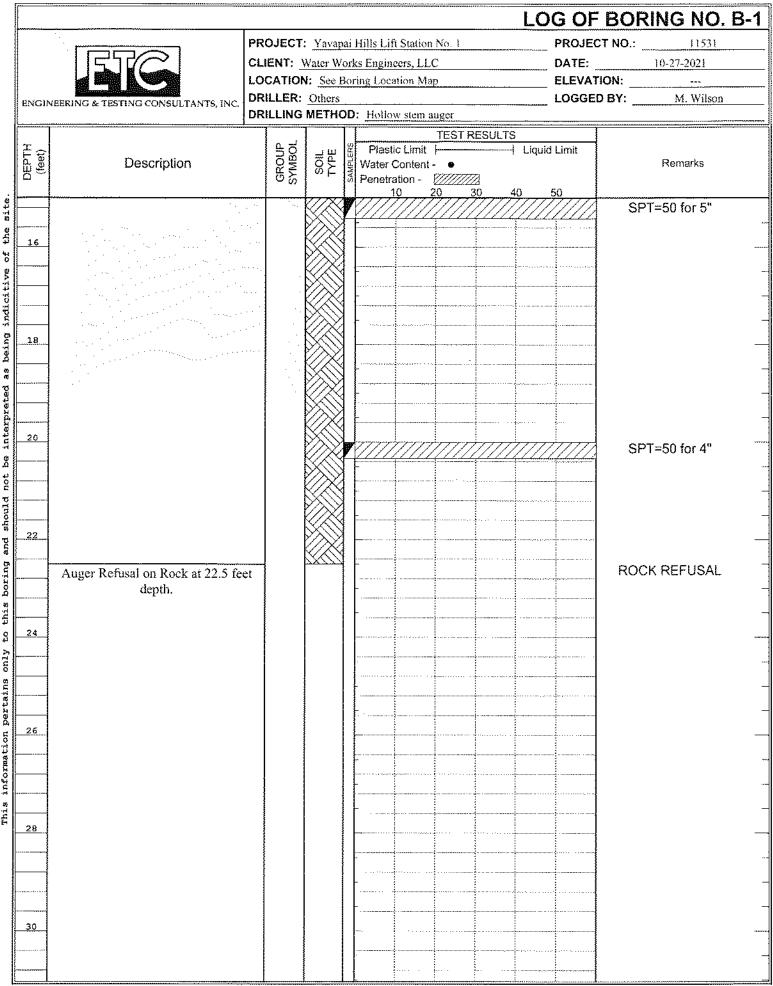
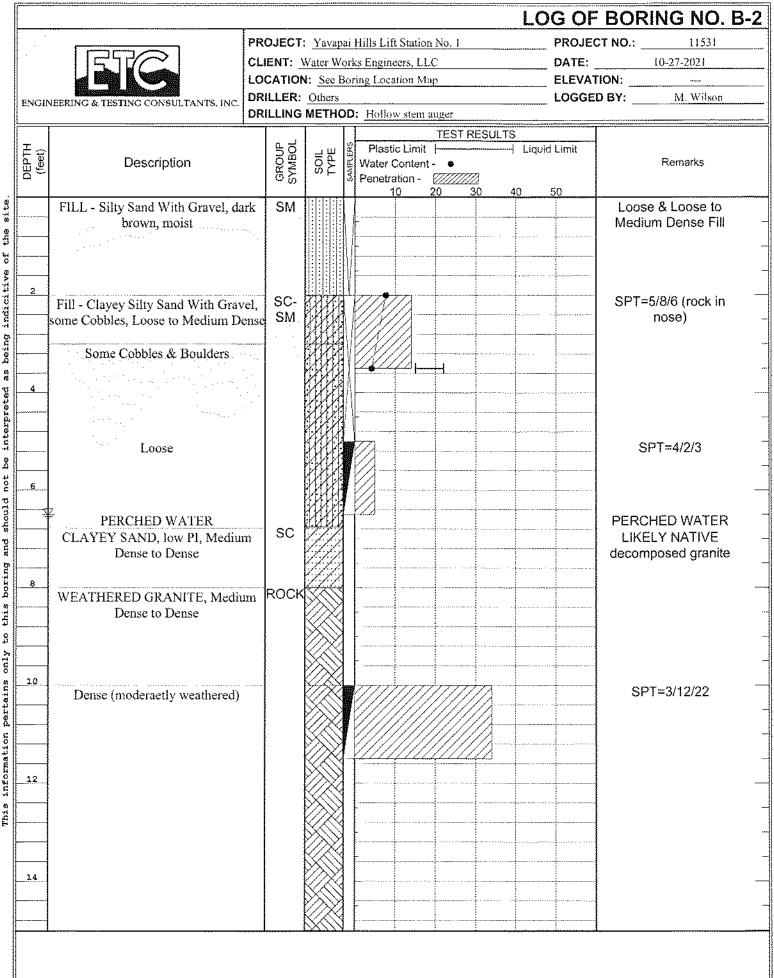
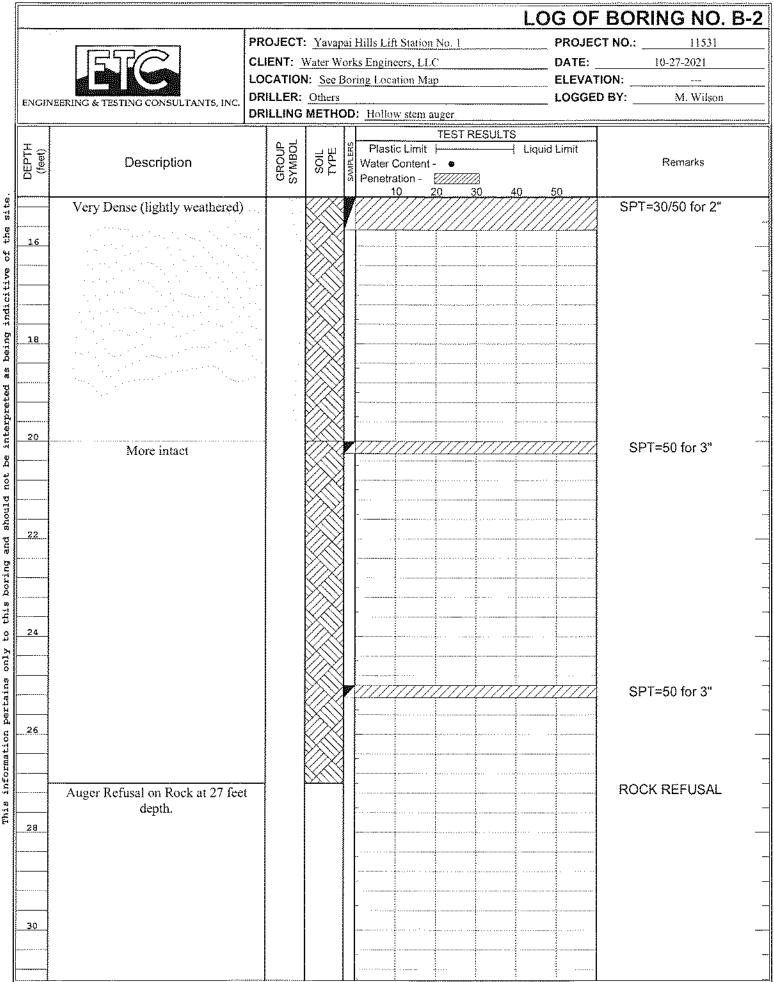


Figure A-4 PAGE 1 of 2







SYNDOL	Description	KEY TO SYMBOLS
<u>Strata</u>	symbols	
	Clayey sand	
	Weatherd rock	
	Silty sand	
	Poorly graded claye	\mathbf{Y}_{i} and \mathbf{y}_{i} is the second sec
BARKA	silty sand	
<u>Misc. S</u>	ymbols	
<u></u>	Water table during	
	drilling	
Soil Sa	molers	
	Bulk sample taken from 4 in. auger	
Notes:		
1. Explo	ratory borings were w stem auger.	drilled on 10-27-2021 using
1. Explo hollo	w stem auger.	drilled on 10-27-2021 using t the time of drilling - As noted on the logs.
1. Explo hollo 2. Free 3. Borin	w stem auger. water was observed a	
 Explo hollo Free Borin a pre These 	w stem auger. water was observed a g locations were est liminary site plan.	t the time of drilling - As noted on the logs. imated from existing site features using the limitations, conclusions, and