

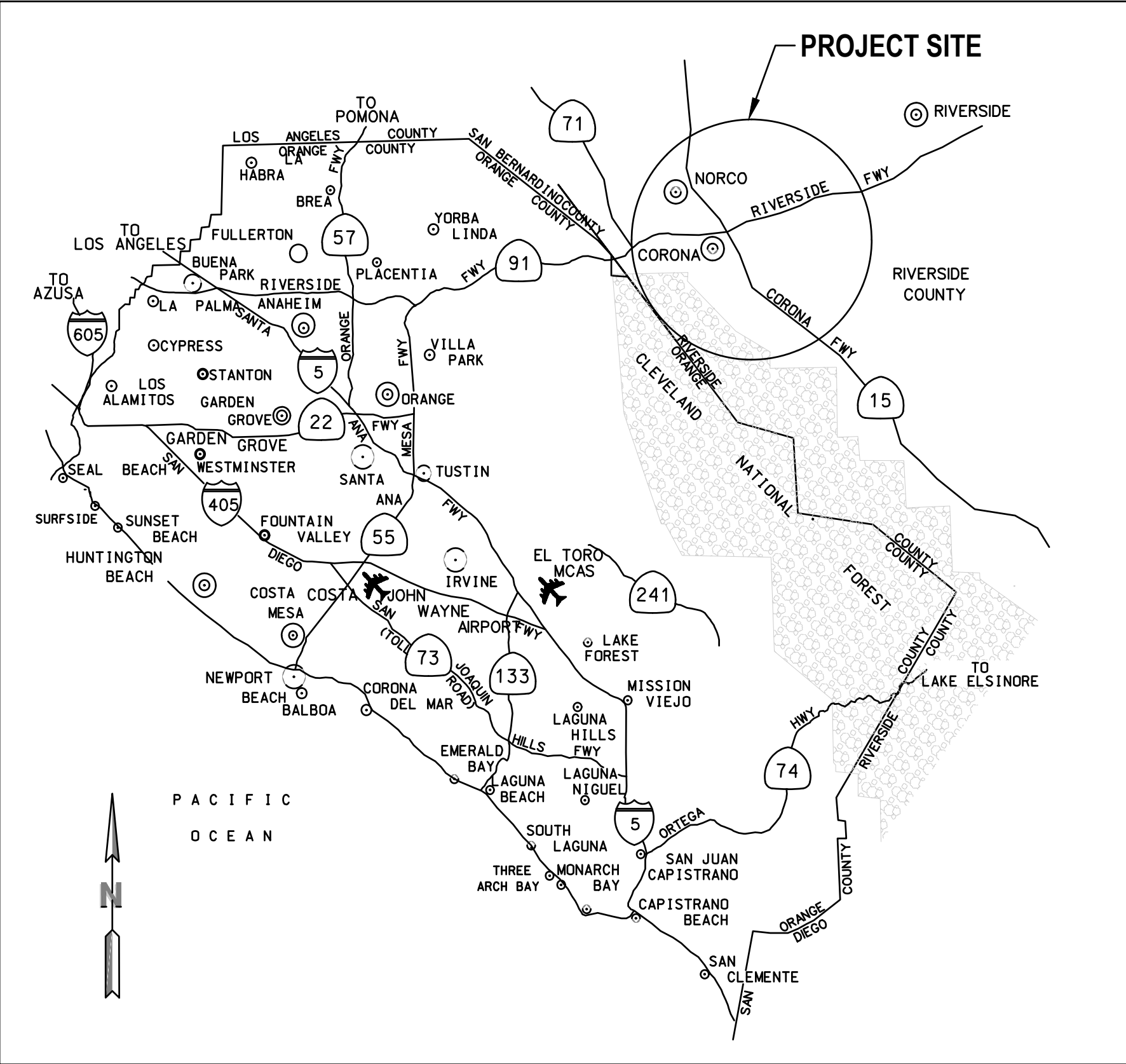
CITY OF CORONA

CIP

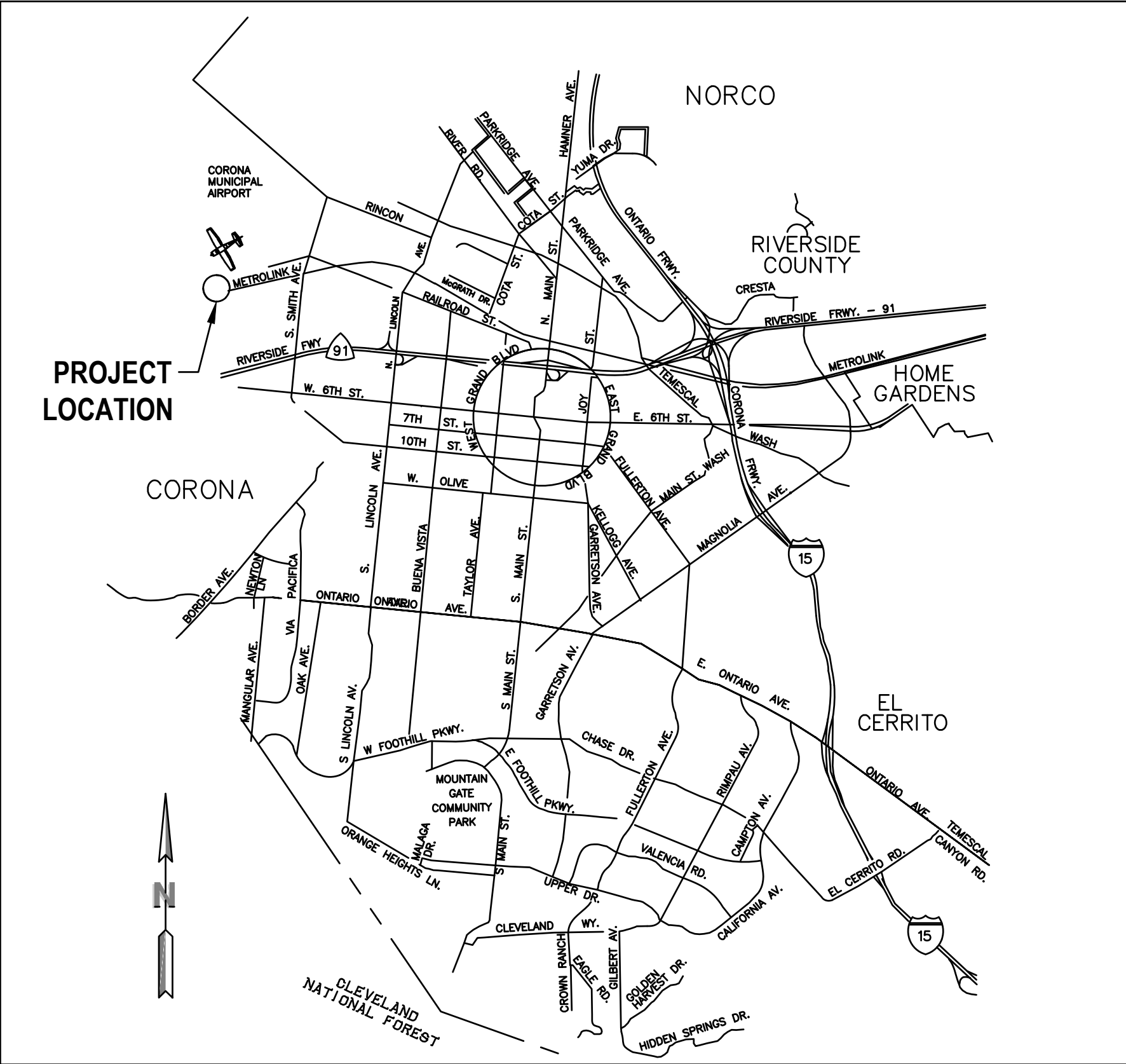
FOR

WRF1-CCT INFLUENT VAULT STATIC MIXER AND FILTER INFLUENT FLASH MIXER

PROJECT NUMBER 77820572



VICINITY MAP
N.T.S.



LOCATION MAP
N.T.S.

BASIS OF BEARING:

THE BEARINGS SHOWN HEREON ARE BASED UPON THE CALIFORNIA COORDINATE SYSTEM OF 1983, CCS83, ZONE 6, (2023.25) IN ACCORDANCE TO THE CALIFORNIA PUBLIC RESOURCES CODE SECTIONS 8801-8819; SAID BEARINGS ARE DETERMINED LOCALLY UPON FIELD-OBSERVED TIES TO THE FOLLOWING LEICA SMARTNET NORTH AMERICA (S.N.N.A.) CONTINUOUSLY OPERATING REFERENCE STATIONS (C.O.R.S.):

S.N.N.A. CAIV:
NORTHING = 2180252.19' EASTING = 6108845.01'

S.N.N.A. CANC:
NORTHING = 2268575.46' EASTING = 6160124.10'

THE COMBINATION FACTOR FOR THIS PROJECT WAS APPLIED AT THE FOLLOWING POINT:
NORTHING = 2270320.53' EASTING = 6151559.95'

MAPPING ANGLE = -0°44'33" SCALE FACTOR = 1.00002127

CONTROL POINTS				
CP#	NORTHING	EASTING	ELEVATION	DESCRIPTION
CP101	2270746.03'	6149696.12'	552.93'	SET MAGNETIC NAIL/SHINER
CP102	2271051.18'	6149341.11'	551.33'	SET MAGNETIC NAIL/SHINER
CP103	2270893.58'	6149807.74'	548.66'	SET 60D NAIL W/WHISKER
CP106	2271211.60'	6149388.60'	551.14'	SET MAGNETIC NAIL/SHINER
CP107	2271356.94'	6149233.14'	555.29'	SET MAGNETIC NAIL/SHINER

CORONA CITY COUNCIL:

MAYOR: TOM RICHINS

VICE MAYOR: JIM STEINER

COUNCIL MEMBER: JACQUE CASILLAS

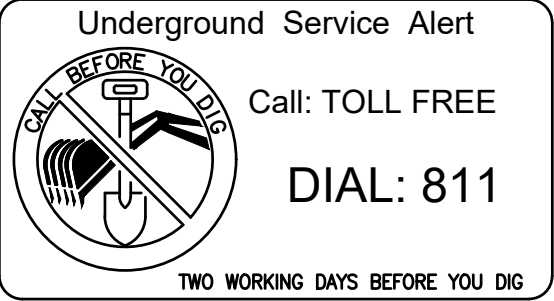
COUNCIL MEMBER: TONY DADDARIO

COUNCIL MEMBER: WES SPEAKE

TREASURER: CHAD WILLARDSON

SHEET INDEX:

DWG. NO.	SHEET NO.	DESCRIPTION
G-1	1	TITLE SHEET
G-2	2	GENERAL NOTES, ABBREV., AND LEGEND
C-1	3	STATIC MIXER SITE PLAN
C-2	4	CCT CHEMICAL FEED DEMOLITION
C-3	5	FLASH MIXER SITE PLAN
C-4	6	CONCEPTUAL BYPASS PLAN
M-1	7	STATIC MIXER AND VAULT PLAN
M-2	8	STATIC MIXER AND VAULT SECTION (1 OF 2)
M-3	9	STATIC MIXER AND VAULT SECTION (2 OF 2)
M-4	10	FLASH MIXER PLAN AND SECTION
D-1	11	DETAILS (1 OF 6)
D-2	12	DETAILS (2 OF 6)
D-3	13	DETAILS (3 OF 6)
D-4	14	DETAILS (4 OF 6)
D-5	15	DETAILS (5 OF 6)
D-6	16	DETAILS (6 OF 6)



GHD INC.
320 GODDARD SUITE 200
IRVINE CALIFORNIA 92618 USA
T 1 949 648 5200

PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:

DRAWN BY:

CHECKED BY:

REFERENCES

BENCHMARK:

APPROVED BY:

Savat Khamphou
SAVAT KHAMPHOU, P.E.
CIP MANAGER

DATE 4/15/2024

APPROVED BY:

Savat Khamphou
SAVAT KHAMPHOU, PE.
CITY ENGINEER / PUBLIC WORKS DIRECTOR

DATE 4/16/2024



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
TITLE SHEET



DRAWING NO.

G-1

SH 1 OF 16

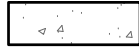
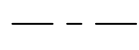
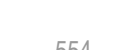
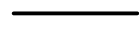
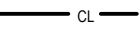
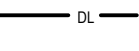
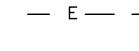
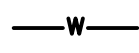
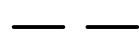
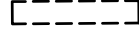
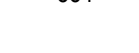
GENERAL NOTES:

1. ALL WORK AND MATERIALS SHALL COMPLY WITH THE SPECIFICATIONS AND STANDARD PLANS OF THE DEPARTMENTS OF WATER AND POWER AND PUBLIC WORKS OF THE CITY OF CORONA AND THE LATEST EDITION OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION.
2. THE CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT (DIAL 811) TWO FULL WORKING DAYS (48 HOURS MINIMUM) IN ADVANCE OF ANY CONSTRUCTION ACTIVITIES, THAT COULD AFFECT ANY UNDERGROUND UTILITY, INCLUDING PAVEMENT REMOVAL, EXCAVATION, OR AC OVERLAY AND OBTAIN AN IDENTIFICATION NUMBER PRIOR TO PERMIT ISSUANCE.
3. THE CONTRACTOR SHALL OUTLINE THE EXCAVATION IN ACCORDANCE WITH GOVERNMENT CODE 4216 AND NOTIFY ALL AFFECTED UTILITY COMPANIES AT LEAST TWO FULL WORKING DAY (48 HOURS MINIMUM) PRIOR TO ANY CONSTRUCTION.
4. ALL SURVEY MONUMENTS SHALL BE PROTECTED AND PERPETUATED IN PLACE. ANY DISTURBED OR COVERED MONUMENTS SHALL BE RESET BY A REGISTERED CIVIL ENGINEER OR A LICENSED LAND SURVEYOR.
5. UTILITIES SHOWN ON THESE PLANS ARE CORRECT AND ACCURATE TO THE EXTENT OF AVAILABLE RECORDS. THE CONTRACTOR IS REQUIRED TO ASCERTAIN THE EXACT LOCATION OF UNDERGROUND FACILITIES PRIOR TO DOING WORK THAT MAY DAMAGE SUCH FACILITIES OR INTERFERE WITH THEIR SERVICE. THE CONTRACTOR SHALL BEAR THE TOTAL EXPENSE OF REPAIR OR REPLACEMENT OF ANY UNDERGROUND FACILITIES DAMAGED BY HIS OPERATION.
6. PUBLIC WORKS INSPECTION SHALL BE CALLED FOR ANY WORK THROUGH THE CITY OF CORONA, 48 HOURS PRIOR TO STARTING WORK: (951) 279-3511.
7. PUBLIC WORKS ENCROACHMENT PERMIT SHALL BE REQUIRED FOR ANY IMPROVEMENT WORK IN THE PUBLIC RIGHT-OF-WAY.

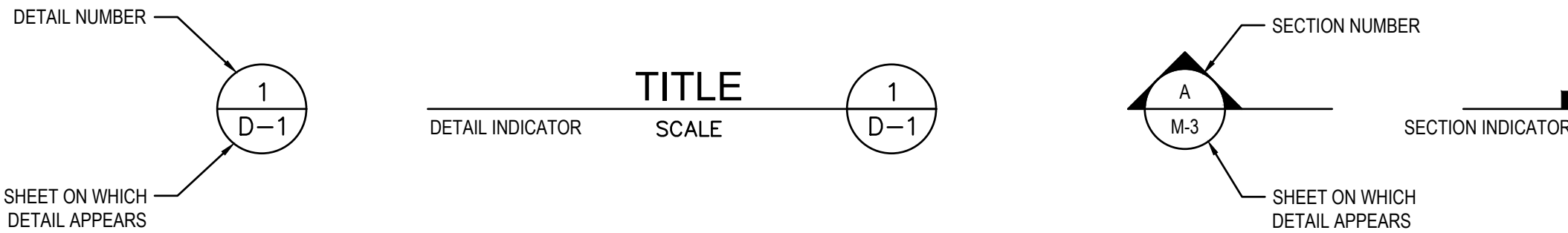
ABBREVIATIONS:

A	AMPS	GFCI	GROUND-FAULT CIRCUIT INTERRUPTER
AL	ALUMINUM	GPH	GALLONS PER HOUR
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE	GPM	GALLONS PER MINUTE
AWWA	AMERICAN WATER WORKS ASSOCIATION	GRD	GROUND
BLDG	BUILDING	HP	HORSE POWER
BOT	BOTTOM	I.D.	INNER DIAMETER
C/W	COMPLETE WITH	JB	JUNCTION BOX
CL	SODIUM HYPOCHLORINE	KVA	KILOVOLT-AMPS
CLR	CLEARANCE	LB/LBS	POUNDS
CML&C	CEMENT MORTAR LINED AND COATED	LG	LONG
CMU	CONCRETE MASONRY UNITS	LM	LUMENS
CONC	CONCRETE	LSH	LEVEL SWITCH HIGH (FOR VAULT LEAK DETECTION)
CONT	CONTINUOUS	MAX	MAXIMUM
CORP.	CORPORATION	MCC	MOTOR CONTROL CENTER
CPVC	CHLORINATED POLYVINYL CHLORIDE PIPE	MH	MANHOLE
CS	CONTROL STATION	MGD	MILLION GALLONS PER DAY
CTR	CENTER	MI	MALLEABLE IRON
DEMO	DEMOLISH/DEMOLISION	MIN	MINIMUM
DI	DUCTILE IRON	MJ	MECHANICAL JOINT
DIA	DIAMETER	N	NEW
DIP	DUCTILE IRON PIPE	NO	NUMBER
DWG	DRAWING	N.P.T.	NATIONAL PIPE TAPERED THREADS
DWLS	DOWELS	N.T.S.	NOT TO SCALE
E	EXISTING	O.C.	ON CENTER
EG	EXISTING GRADE	O.D.	OUTER DIAMETER
EL/ELEV	ELEVATION	OSHA	OCCUPATIONAL SAFETY AND HEALTH
EMBED	EMBEDDED	PE	PLAIN END
ERSC	ELECTRICAL RIGID STEEL CONDUIT	PFA	PERFLUOROALKOXY
ETC	ETCETERA	PLC	PROGRAMMABLE LOGIC CONTROLLER
EW	EACH WAY	PP	POLYPROPYLENE
FF	FINISHED FLOOR	PREFAB	PREFABRICATED
FG	FINISHED GRADE	PROP	PROPOSED
FI	FILTER INFLUENT	PSI	POUND FORCE PER SQUARE INCH
FIP	FEMALE IRON PIPE	PVC	POLYVINYL CHLORIDE PIPE
FIG	FIGURE	QTY	QUANTITY
FLG	FLANGE	RAS	RETURN ACTIVATED SLUDGE
FRP	FIBERGLASS-REINFORCED PLASTIC	REQ'D	REQUIRED
FS	FORGED STEEL	RGS	RIGID GALVANIZED STEEL
FT	FEET	SCH	SCHEDULE
GALV	GALVINIZED	SPECS	SPECIFICATIONS
GE	GROVED END		

LEGEND:

	AGGREGATE BASE
	ASPHALT
	CEMENT MORTAR
	CONCRETE
	DEMOLISH
	(E) EARTH
	(N) EARTH
	CENTERLINE OF PIPE
	CURB
	EDGE OF PAVEMENT
	(E) UTILITY PIPING
	(E) STORMDRAIN
	(E) UNDERGROUND HYPOCHLORINE PIPING
	(E) UNDERGROUND DRAIN
	(E) UNDERGROUND ELECTRICAL CONDUIT
	(E) UNDERGROUND LIQUID ALUM PIPING
	(E) STORMDRAIN
	(E) CONTOUR
	(E) TOE OF SLOPE
	(E) TOP OF SLOPE
	(N) ABOVE GROUND UTILITY PIPING
	(N) UNDERGROUND HYPOCHLORINE PIPING
	(N) UNDERGROUND DRAIN
	(N) UNDERGROUND ELECTRICAL CONDUIT
	(N) UNDERGROUND LIQUID ALUM PIPING
	(N) UNDERGROUND WATER PIPING
	(N) UNDERGROUND UTILITY PIPING
	(N) UNDERGROUND ENCASEMENT
	(N) CONTOUR
	(E) SITE LIGHT
	(N) EYEWASH/SHOWER
	(N) SITE LIGHT

GENERAL SHEET SYMBOLS:



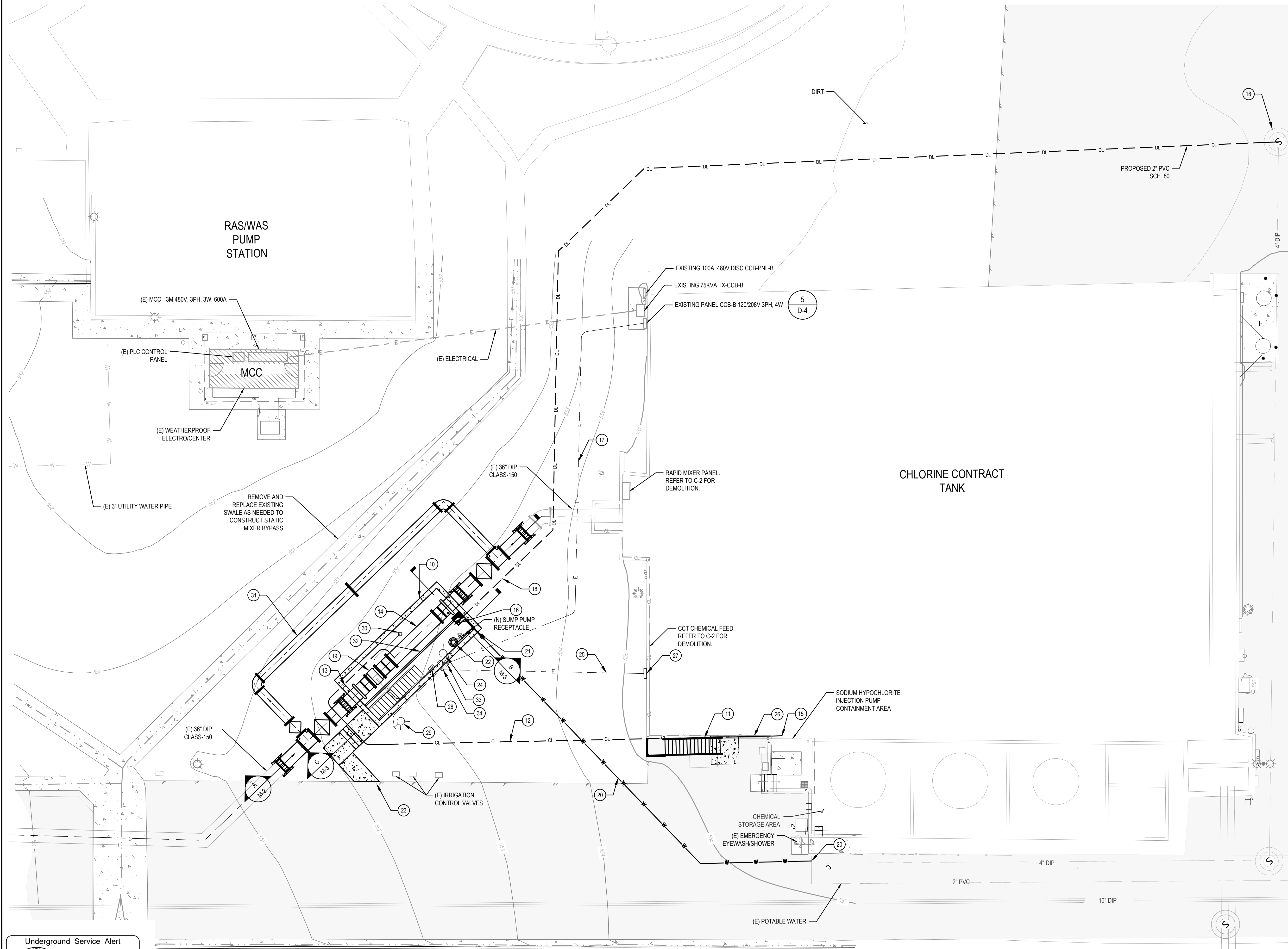
Underground Service Alert



Call: TOLL FREE

DIAL: 811

TWO WORKING DAYS BEFORE YOU DIG



CONSTRUCTION NOTES:

- CONSTRUCT CHEMICAL INJECTION STATIC MIXER PER DWG. M-1 AND M-2, AND FLOW METER VAULT PER DETAILS B AND C ON DWG. M-3.
- CONSTRUCT CCT ALUMINUM STAIR PER DETAIL 1 ON DWG. D-6.
- CONSTRUCT 1\" PFA TUBING WITH 4\" PVC CONTAINMENT PIPE FROM CHLORINE FEED PUMPS DISCHARGE LINE TO PROPOSED STATIC MIXER AT A -0.5% SLOPE DOWN FROM FEED TO VAULT. MAINTAIN MIN. COVER OF 36\" FROM EXISTING GRADE.
- PROVIDE AND INSTALL WALL SLEEVE ON PROPOSED VAULT WHERE THE CHEMICAL CONTAINMENT PIPE PASSES THROUGH THE WALL.
- REFURBISH EXISTING STATIC MIXER BY COATING THE EXTERIOR TO DIVISION 09 SPECIFICATION AND CLEANING TO CITY REQUIREMENTS. INSTALL CITY FURNISHED STATIC MIXER.
- TIE-IN PROPOSED 1\" PFA TUBING INTO EXISTING 1 1/2\" TUBING. REFER TO DETAIL 4 ON DWG D-6.
- PROVIDE AND INSTALL SUMP PUMP, C/W GFCI WEATHER-PROOF DEDICATED RECEPTACLE.
- PROVIDE AND INSTALL TWO (2) 1\"C PVC-COATED RGS INCLUDING A SPARE, DIRECT BURIED, C/W 6/12 THWN + #12 GND FROM EXISTING PANEL CCB-B TO FEED STATIC MIXER ASSOCIATED LOADS. ALL CONDUIT INSIDE VAULT TO BE PVC COATED.
- PROVIDE AND INSTALL 2-INCH PVC SCH 80 SUMP DRAIN LINE AND COREDRIILL MANHOLE. SEAL AT ELEVATION 551.7'. PLUMB 2\" PVC WITH ELBOW AND VERTICAL PIPE TO BOTTOM OF INSIDE MH NO. 5 AT INV. ELEVATION 545.74'. SLOPE UP +0.5% TO VAULT FROM MANHOLE.
- PROVIDE AND INSTALL 36\" ENDRESS+HAUSER ELECTROMAGNETIC FLOW METER, WITH GROUNDING RINGS AND ISOLATING BOLT KITS PER SPECIFICATIONS.
- TAP EXISTING 2-INCH POTABLE WATER (USING S.S. TAPPING SADDLE AND CORPORATION STOP) FOR CONNECTION OF PROPOSED 1 1/2\" PVC SCH 80.
- PROVIDE AND INSTALL WALL SLEEVE IN PROPOSED VAULT WHERE THE 1 1/2\" STAINLESS STEEL UTILITY LINE CROSSES THE WALL.
- PROVIDE AND INSTALL EMERGENCY EYEWASH AND SHOWER PER DETAIL 1 ON DWG. D-3.
- 4\" CONCRETE WALKWAY PER DETAIL 1 ON DWG. M-3.
- PROVIDE AND INSTALL NEW PXLW 5000LM LED LOW BAY FIXTURES C/W SUBSTATION ARM (DOWN ORIENTATION) AND WEATHERPROOF LIGHT SWITCH MOUNTED ON NEW ALUMINUM HANDRAIL.
- PROVIDE AND INSTALL FOUR (4) 1\"C PVC-COATED ELECTRICAL RIGID STEEL CONDUIT (PVC-ERSC) UNDERGROUND, INCLUDING TWO (2) SPARES FOR 100% REDUNDANCY, C/W #16 TSP, 2#14 + #12 GND FROM NEW FLOW TRANSMITTER AND 5/8\" FROM LEAK DETECTION LSH, AND NEW CITY-FURNISHED JUNCTION BOX. PLC TERMINATION AND INTEGRATION IS BY THE CITY. CONTRACTOR SHALL CONFIRM WITH THE CITY THE FINAL ROUTING AND LANDING POINT OF FLOW METER AND LEAK DETECTION SIGNALS PRIOR TO INSTALLATION. ALL CONDUIT INSIDE VAULT TO BE PVC-COATED.
- INSTALL 1\" PFA TUBING WITH 4\" PVC CONTAINMENT PIPE ALONG THE CCT WALL PAST CONTROL PANEL, THEN UNDERGROUND PER CONSTRUCTION NOTE 12.
- LOCATE AND PROVIDE A WALL MOUNTED NEMA 4X JUNCTION BOX IN CLOSE COORDINATION WITH THE CITY. THE FLOW METER AND LEAK DETECTION SIGNALS WILL BE TERMINATED AND INTEGRATED TO PLC BY THE CITY.
- PROVIDE A LEAK DETECTION LSH C/W TRANSMITTER, CABLES AND CONDUIT PER CONSTRUCTION NOTE 25. SUPPLY SUFFICIENT SLACK IN CABLE TO TEMPORARILY RELOCATE SENSOR UNIT OF CONTAINMENT AREA DURING WASH-DOWN. NEATLY COIL AND SUSPEND WITH CORROSION RESISTANT EXCESS CABLE STRAPS NEXT TO THE TRANSMITTER.
- PROVIDE AND INSTALL NEW PXLW 8000LM LED LOW BAY FIXTURE WITH DIMMING PHOTOCELL C/W 12FT HIGH STANCHION MOUNT POLE. REFER TO DETAIL 5 ON D-6 FOR POLE MOUNT.
- CONNECT NEW FLOW METER GROUND RINGS TO A GROUND ROD INSIDE THE VAULT WITH #2 BARE COPPER GROUND WIRE AND REFER TO DETAIL 6 ON D-4 FOR GROUND WELL.
- PROVIDE AND INSTALL 24\" DIP BYPASS LINE PER DWG. NO. M-1.
- 4\" SLOT DRAIN. REFER TO DWG. NO. M-1 AND DETAIL 9 ON DWG. NO. D-2.
- PROVIDE AND INSTALL NEW NEMA 4X JUNCTION BOX FOR POWER.
- PROVIDE AND INSTALL NEW NEMA 4X JUNCTION BOX FOR CONTROLS.

Underground Service Alert
Call: TOLL FREE
DIAL: 811
TWO WORKING DAYS BEFORE YOU DIG

GHD
GHD INC.
320 GODDARD SUITE 200
IRVINE CALIFORNIA 92618 USA
T 1 949 648 5200

PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:
REFERENCES

BENCHMARK:
NO. DATE REVISIONS ENGR. APP'D. DATE

APPROVED FOR CONSTRUCTION:
ENGINEER DATE

CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC MIXER & FILTER INFLUENT FLASH MIXER
STATIC MIXER SITE PLAN

DRAWING NO.
C-1
SH 3 OF 16

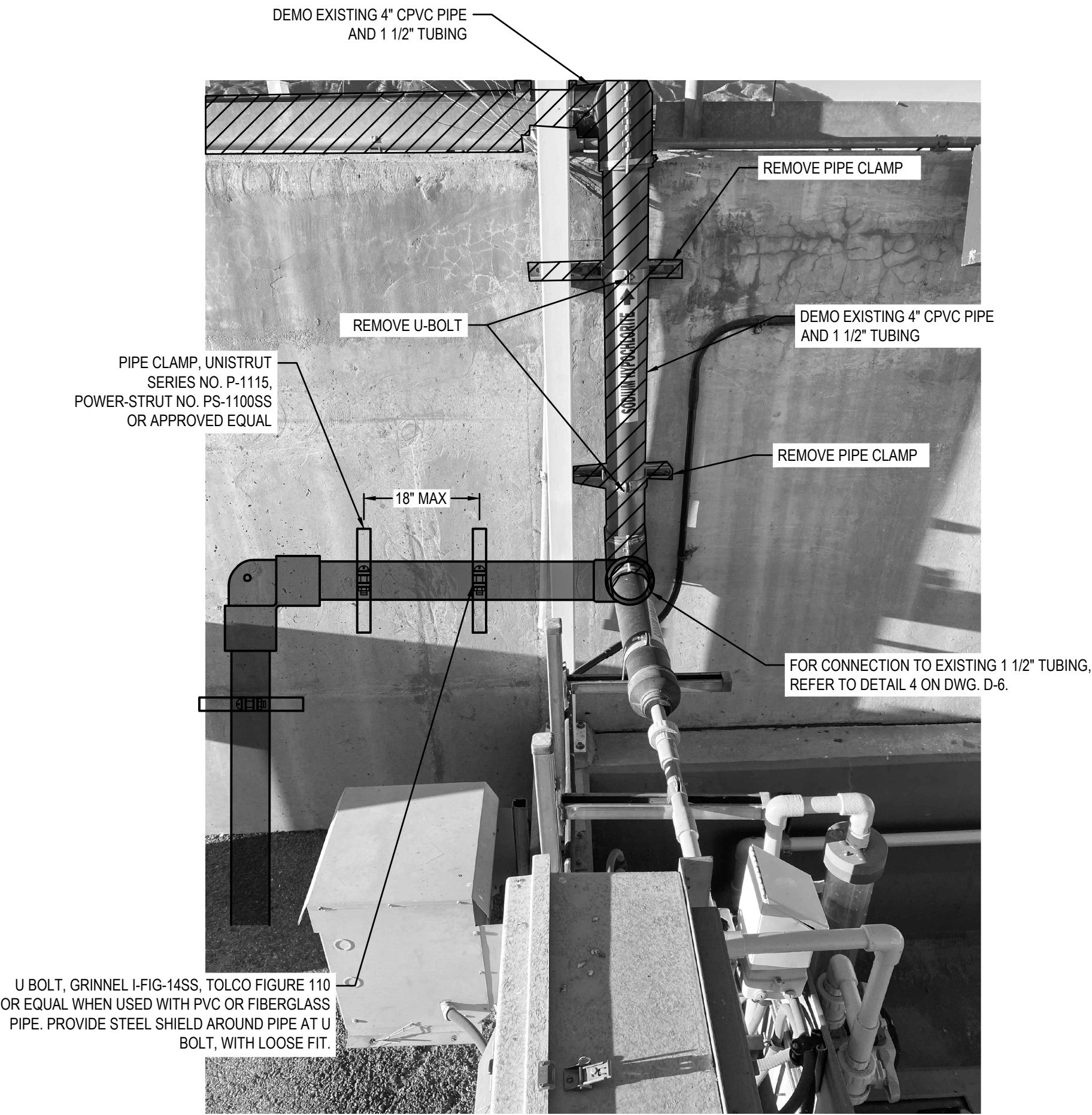
SCALE: 1\"=10'
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N
REGISTERED PROFESSIONAL ENGINEER
CHRIS A. BARTLEMAN
No. CB1075
Exp. 09-30-25
CIVIL
STATE OF CALIFORNIA



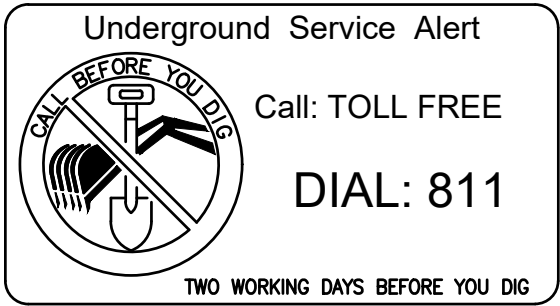
REMOVE AND DISPOSE OF
RAPID MIXER PANEL



REMOVE AND DISPOSE
OF EXISTING CHEMICAL
FEED AND SUPPORTS.



U BOLT, GRINNELL I-FIG-14SS, TOLCO FIGURE 110
OR EQUAL WHEN USED WITH PVC OR FIBERGLASS
PIPE. PROVIDE STEEL SHIELD AROUND PIPE AT U
BOLT, WITH LOOSE FIT.



GHD INC.
320 GODDARD SUITE 200
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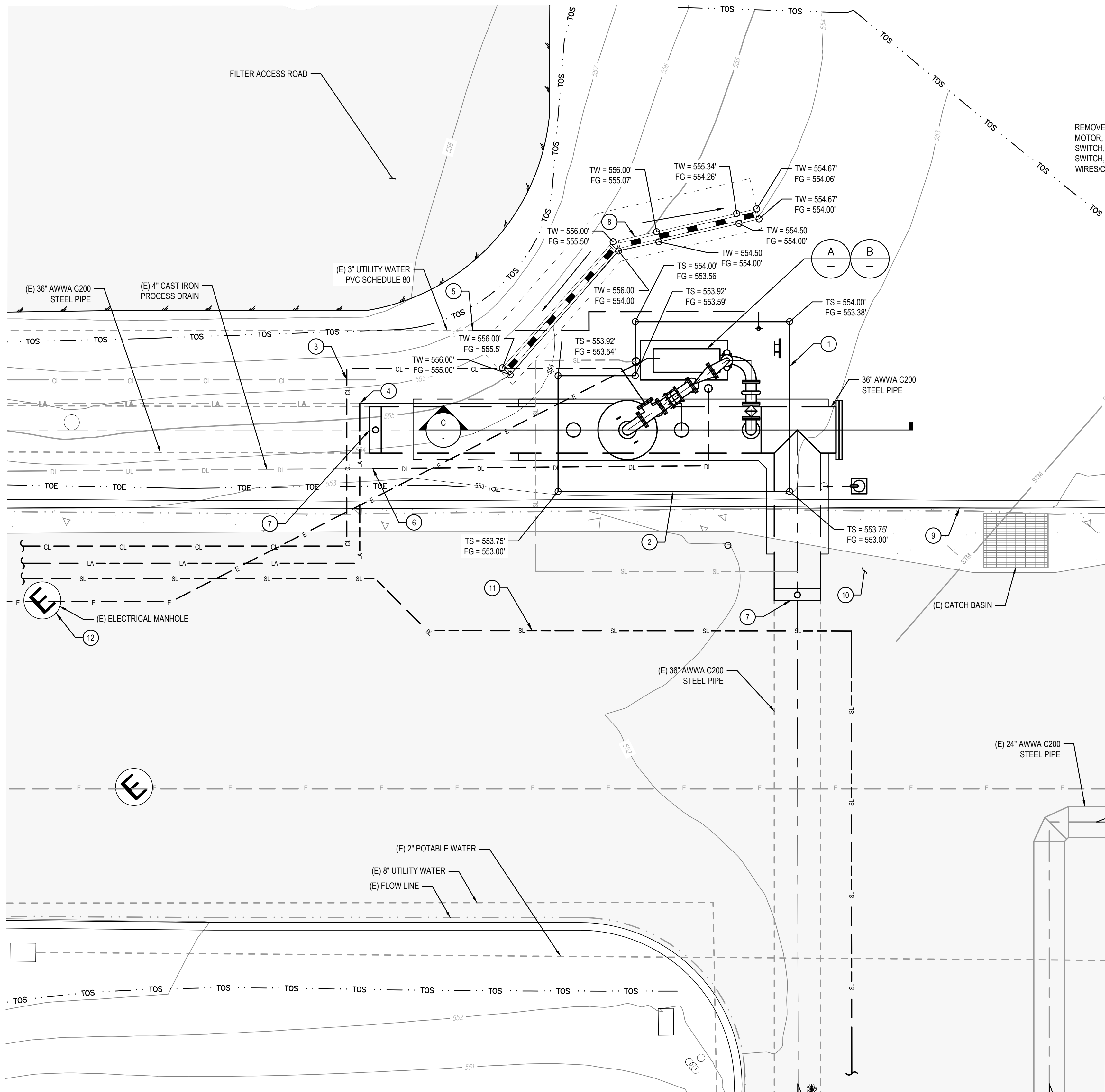
1					
2					
3					
NO.	DATE	REVISIONS	ENGR. APP'D.	DATE	

APPROVED FOR CONSTRUCTION:
DATE
ENGINEER

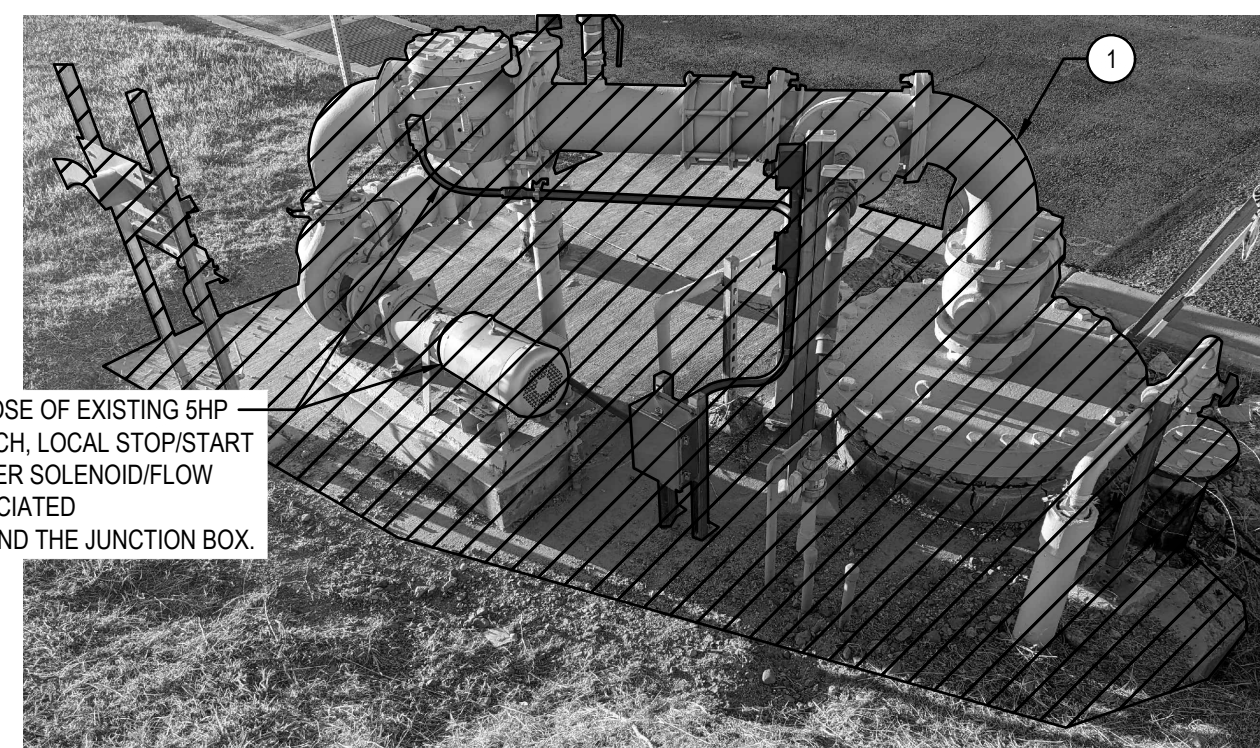
CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
CCT CHEMICAL FEED DEMOLITION



DRAWING NO.
C-2
SH 4 OF 16

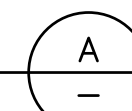


REMOVE AND DISPOSE OF EXISTING 5HP MOTOR, LIMIT SWITCH, LOCAL STOP/START SWITCH, SEAL WATER SOLENOID/FLOW SWITCH, AND ASSOCIATED WIRES/CONDUITS AND THE JUNCTION BOX.



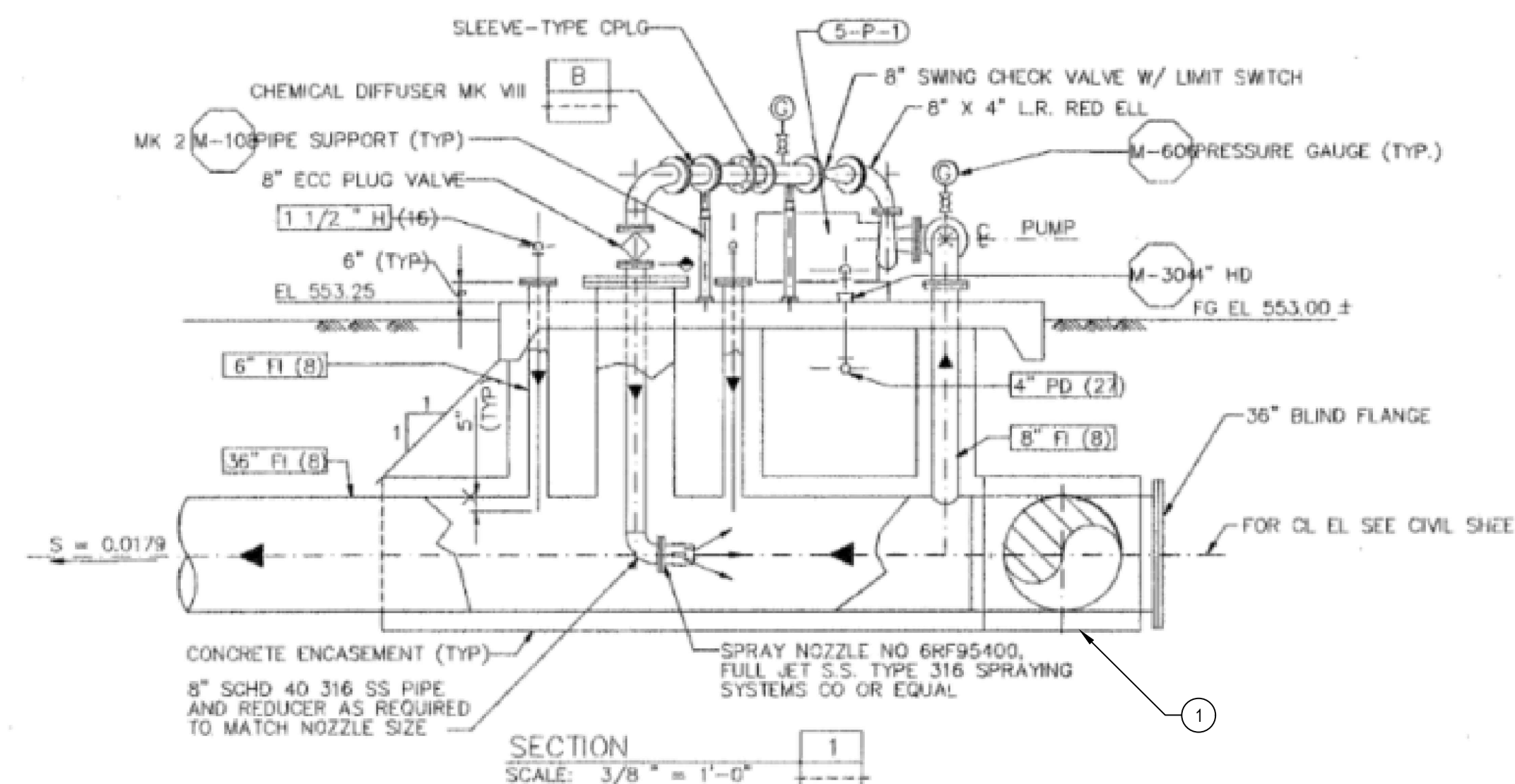
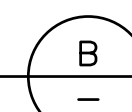
PHOTOGRAPH OF FLASH MIXER

NOT TO SCALE



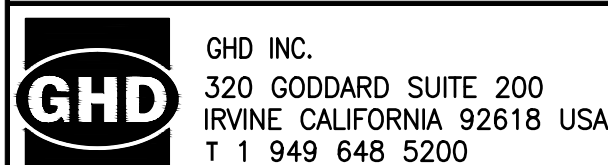
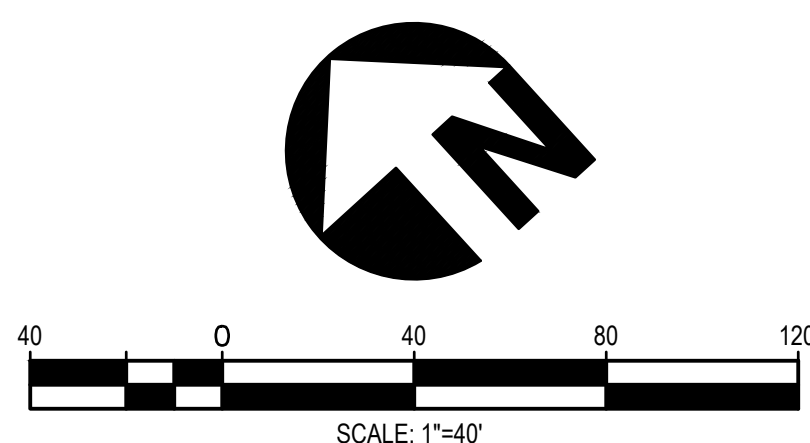
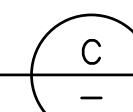
PHOTOGRAPH OF FLASH MIXER

NOT TO SCALE



(E) FLASH MIXER RECORD INFORMATION SECTION

NOT TO SCALE



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:
REFERENCES

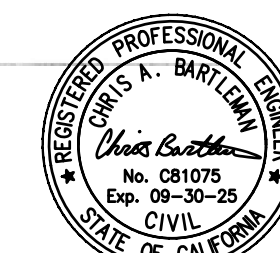
BENCHMARK:

1					
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3					
NO.	DATE	REVISIONS	ENGR.	APP'D.	DATE

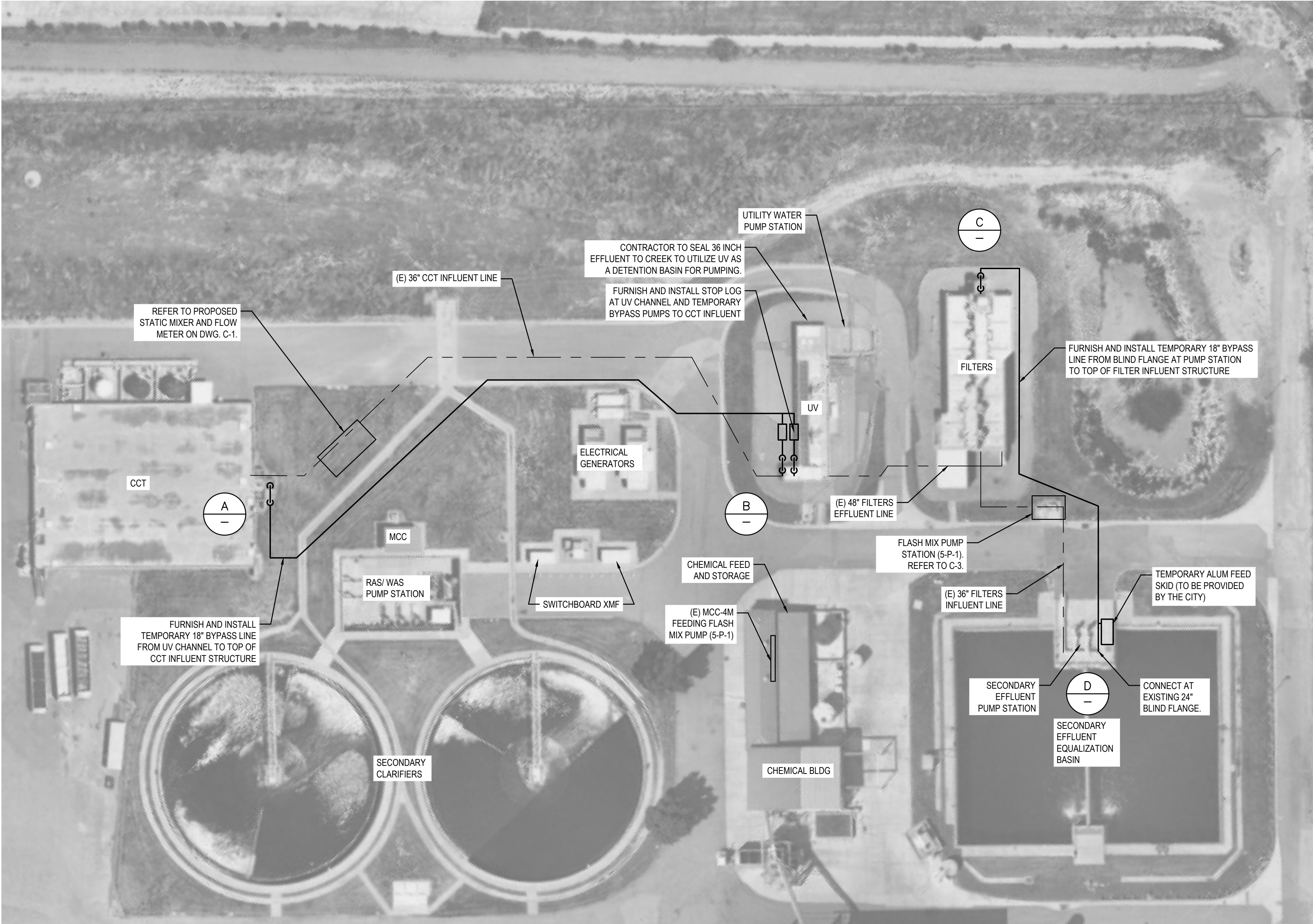
APPROVED FOR CONSTRUCTION:
ENGINEER
DATE



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
FLASH MIXER SITE PLAN



DRAWING NO.
C-3
SH 5 OF 16



PHOTOGRAPH OF CCT INFLUENT
NOT TO SCALE

A
C-4



PHOTOGRAPH OF UV CHANNEL
NOT TO SCALE

B
C-4

SUGGESTED PHASING:

SUGGESTED PHASING FOR FLASH MIXER:

- RELOCATE CITY COMPLIANCE WATER SAMPLE LINE FROM SECONDARY EFFLUENT PUMP STATION TO CHEMICAL CONTAINMENT AREA.
- INSTALL BYPASS PIPELINE FROM SECONDARY EFFLUENT PUMP STATION TO FILTER INFLUENT BOX.
- FILL AND PRESSURE TEST FOR LEAKS WITH CLEAN WATER.
- PROVIDE CONNECTIONS AND APPURTENANCES NEEDED FOR CITY TO INSTALL TEMPORARY CHEMICAL FEED AND COMPLIANCE SAMPLE WATER LINE.
- COORDINATE WITH CITY AND BEGIN BYPASS PUMPING AROUND FLASH MIXER ASSEMBLY.
- DE-WATER EXISTING FILTER INFLUENT LINE AND CHEMICAL FEED LINES AT FLASH MIXER TO SECONDARY EFFLUENT EQUALIZATION POND.
- DEMOLISH EXISTING FLASH MIXER ASSEMBLY AND APPURTENANCES.
- INSTALL NEW FLASH MIXER ASSEMBLY AND APPURTENANCES.
- TEST, START UP AND RECEIVE APPROVAL FROM CITY FOR PROPOSED FLASH MIXER ASSEMBLY AND APPURTENANCES.
- REMOVE BYPASS PIPELINE AFTER 5 DAYS OF ACCEPTABLE OPERATION.

CONCEPT STATIC AND FLASH MIXER BYPASS PLAN

SCALE: 1" = 40'

SUGGESTED PHASING FOR STATIC MIXER:

- INSTALL BYPASS PIPELINE, FLOW METER, AND REDUNDANT PUMPS FROM UV STRUCTURE TO CHLORINE CONTACT TANK (CCT) INFLUENT BOX.
- FILL AND PRESSURE TEST PIPING FOR LEAKS WITH CLEAN WATER.
- COORDINATE WITH CITY AND BEGIN BYPASS PUMPING AROUND STATIC MIXER ASSEMBLY.
- DE-WATER EXISTING CCT INFLUENT LINE TO SECONDARY EFFLUENT EQUALIZATION POND.
- DEMOLISH EXISTING CCT INFLUENT LINE.
- INSTALL NEW STATIC MIXER BYPASS AND APPURTENANCES WITH BLIND FLANGES ON MAINLINE PLUG VALVES.
- TEST, START AND RECEIVE APPROVAL FROM CITY FOR PROPOSED STATIC MIXER BYPASS ASSEMBLY AND APPURTENANCES.
- REMOVE BYPASS PIPELINE AFTER 5 DAYS OF ACCEPTABLE OPERATION.
- INSTALL NEW STATIC MIXER VAULT AND APPURTENANCES.

NOTE: IF CONTRACTOR IS UNABLE TO INSTALL PERMANENT STATIC MIXER BYPASS AND MAINTAIN FLOWS TO CCT DURING STATIC MIXER VAULT INSTALLATION THEN ALL COSTS FOR TEMPORARY BYPASS DURING STATIC MIXER VAULT AND APPURTENANCE INSTALLATION SHALL BE BORNE BY CONTRACTOR.



PHOTOGRAPH OF FILTER INFLUENT
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C
C-4



PHOTOGRAPH OF SECONDARY EFFLUENT
NOT TO SCALE

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C-4

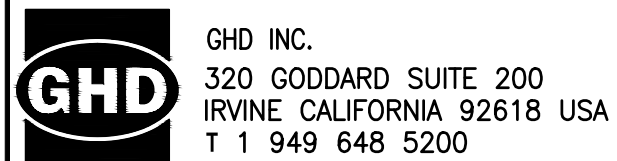
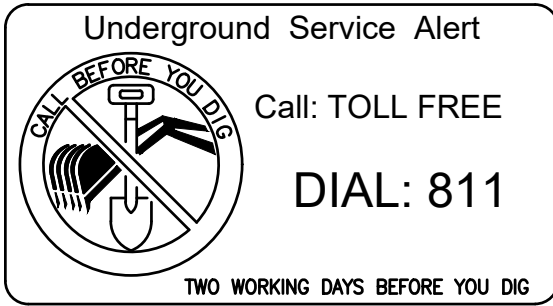
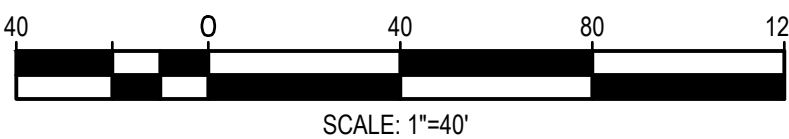
SHEET NOTES:

- THE EXISTING UTILITY LOCATIONS SHOWN ARE BASED ON AVAILABLE CITY OF CORONA RECORD DRAWINGS. CONTRACTOR SHALL FIELD VERIFY EXACT LOCATIONS, ELEVATIONS, SIZES, AND DIMENSIONS OF UTILITIES.
- THIS DRAWING IS A CONCEPTUAL LAYOUT PLAN. CONTRACTOR SHALL SUBMIT BYPASS PLAN, INCLUDING PROPOSED EQUIPMENT AND EXPECTED SHUTDOWN DURATION, FOR CITY OF CORONA REVIEW AND APPROVAL NO LESS THAN 30 DAYS FROM NTP PRIOR TO STARTING BYPASS OPERATION.
- BYPASS PUMPING SHALL BE MANNED CONTINUOUSLY BY CONTRACTOR 24-HOURS PER DAY WHILE IN USE.
- DURING BYPASS PASS STARTUP, THE PUMP SHALL BE TESTED WITH CLEAN WATER TO ENSURE THAT THERE IS NO LEAKAGE. THE PUMPS SHALL BE RUN FOR ONE HOUR TO DEMONSTRATE THAT THERE IS NO LEAKAGE.
- CONTRACTOR SHALL PRESSURE TEST ALL NEW PIPING WITH CLEAN WATER AT A MINIMUM OF 50 PSI FOR TWO HOURS TO CONFIRM THERE IS NO LEAKAGE.
- CONTRACTOR SHALL PROVIDE TEMPORARY CONNECTION TO BYPASS LINE FOR WATER QUALITY COMPLIANCE SAMPLE. CONTRACTOR SHALL PROVIDE FLOW METER FOR SAMPLING.
- CITY TO PROVIDE TEMPORARY ALUM FEED FOR FILTERS. CONTRACTOR SHALL PROVIDED 1" CORP. STOP FOR ALUM INJECTION POINT.
- CONTRACTOR SHALL DE-WATER EXISTING FILTER INFLUENT AND CCT INFLUENT LINES REQUIRED FOR BYPASS CONNECTIONS. ANTICIPATED APPROX. VOLUME FOR FLASH MIXER = 3330 GALLONS AND STATIC MIXER = 20400 GALLONS.
- REMOVE AND REINSTALL RAILING, GRATING, AND APPURTENANCES AS NECESSARY TO IMPLEMENT BYPASS.

CONCEPT TEMPORARY BYPASS DESIGN CRITERIA

FLOW	10,000 GPM
STATIC HEAD	4'
LENGTH OF 18" STATIC MIXER BYPASS PIPING	480'±
LENGTH OF 18" FLASH MIXER BYPASS PIPING	270'±

CONTRACTOR TO ALLOW FOR ADDITIONAL DYNAMIC LOSS IN THE LINE



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:

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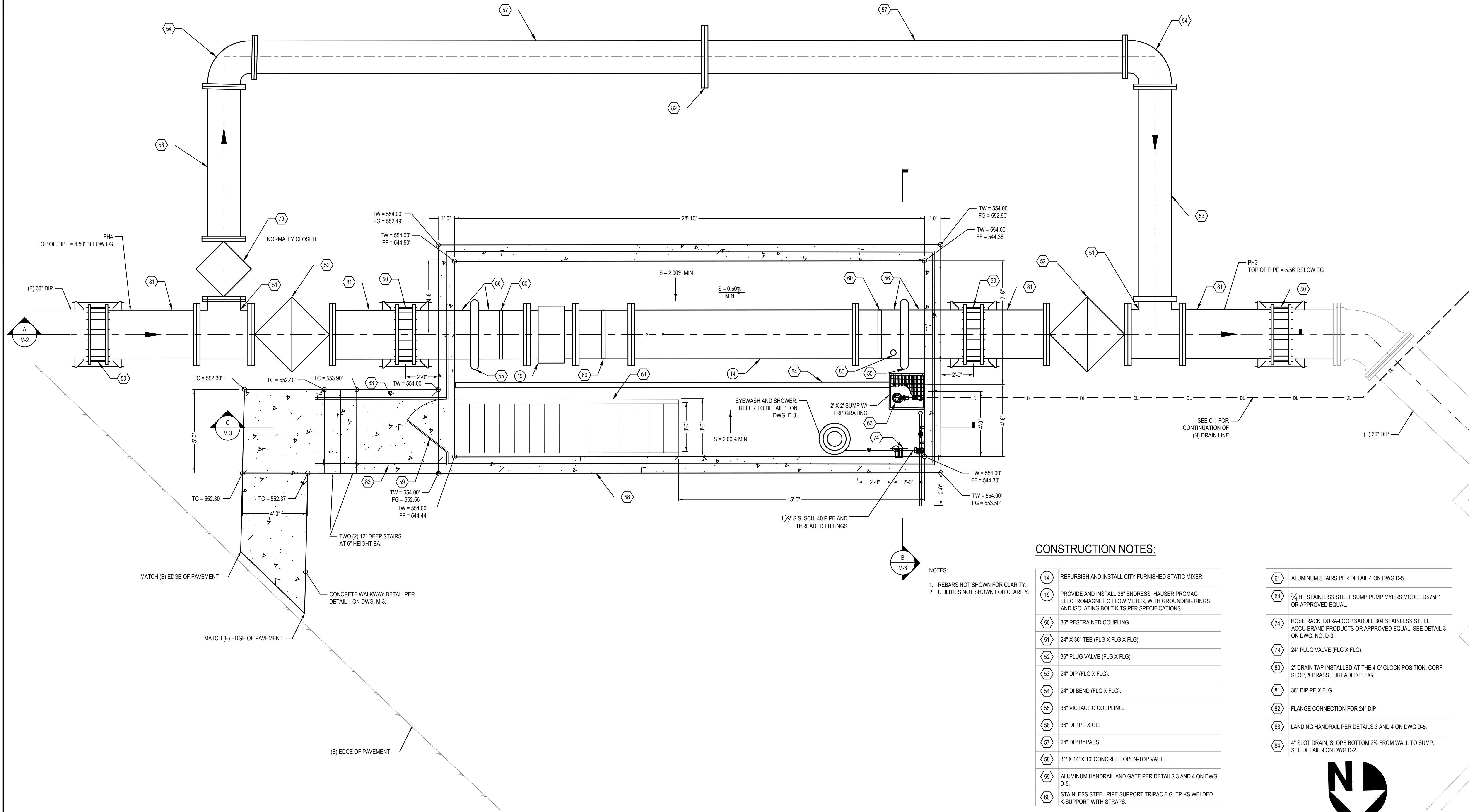
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CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC MIXER & FILTER INFLUENT FLASH MIXER CONCEPTUAL BYPASS PLAN

DRAWING NO.
C-4
SH 6 OF 16



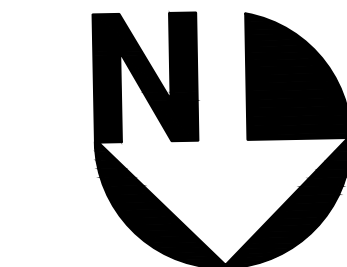


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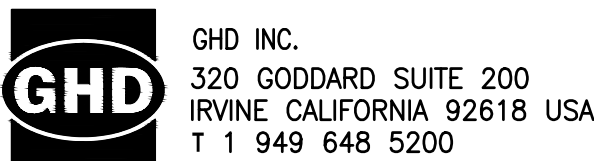
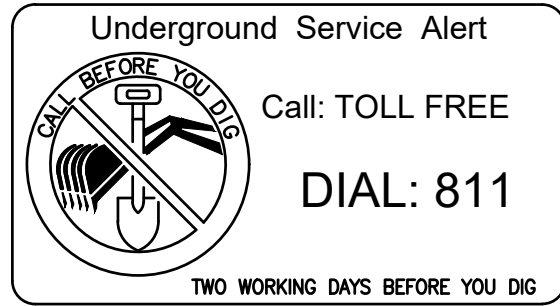
14	REFURBISH AND INSTALL CITY FURNISHED STATIC MIXER.
19	PROVIDE AND INSTALL 36" ENDRESS+HAUSER PROMAG ELECTROMAGNETIC FLOW METER, WITH GROUNDING RINGS AND ISOLATING BOLT KITS PER SPECIFICATIONS.
50	36" RESTRAINED COUPLING.
51	24" X 36" TEE (FLG X FLG X FLG).
52	36" PLUG VALVE (FLG X FLG).
53	24" DIP (FLG X FLG).
54	24" DI BEND (FLG X FLG).
55	36" VICTAULIC COUPLING.
56	36" DIP PE X GE.
57	24" DIP BYPASS.
58	31' X 14' X 10' CONCRETE OPEN-TOP VAULT.
59	ALUMINUM HANDRAIL AND GATE PER DETAILS 3 AND 4 ON DWG D-5.
60	STAINLESS STEEL PIPE SUPPORT TRIPAC FIG. TP-KS WELDED K-SUPPORT WITH STRAPS.

61	ALUMINUM STAIRS PER DETAIL 4 ON DWG D-5.
63	3/4" HP STAINLESS STEEL SUMP PUMP MYERS MODEL DS7SP1 OR APPROVED EQUAL.
74	HOSE RACK, DURA-LOOP SADDLE 304 STAINLESS STEEL ACCU-BRAND PRODUCTS OR APPROVED EQUAL. SEE DETAIL 3 ON DWG. NO. D-3.
79	24" PLUG VALVE (FLG X FLG).
80	2" DRAIN TAP INSTALLED AT THE 4 O' CLOCK POSITION, CORP STOP, & BRASS THREADED PLUG.
81	36" DIP PE X FLG
82	FLANGE CONNECTION FOR 24" DIP
83	LANDING HANDRAIL PER DETAILS 3 AND 4 ON DWG D-5.
84	4" SLOT DRAIN, SLOPE BOTTOM 2% FROM WALL TO SUMP. SEE DETAIL 9 ON DWG D-2.

- NOTES:
- REBARS NOT SHOWN FOR CLARITY.
 - UTILITIES NOT SHOWN FOR CLARITY.



SCALE: 3/8" = 1'



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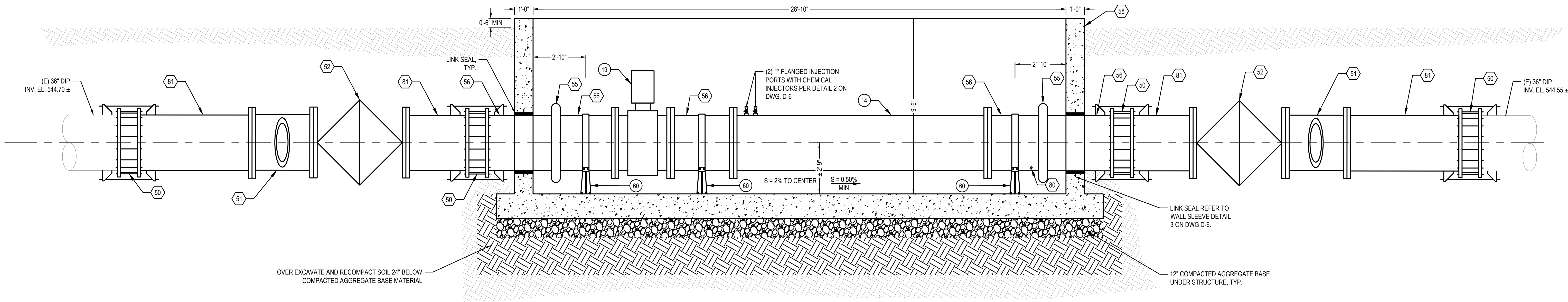
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DRAWING NO.
M-1
SH 7 OF 16



- NOTES:
1. REBARS NOT SHOWN FOR CLARITY.
 2. HANDRAIL NOT SHOWN FOR CLARITY.
 3. SUMP PUMP AND EYEWASH NOT SHOWN FOR CLARITY.
 4. GROUNDING ROD AND RINGS NOT SHOWN FOR CLARITY.

STATIC MIXER AND METERING VAULT SECTION

SCALE: 3/8" = 1'-0"

A
M-1

CONSTRUCTION NOTES:

14	REFURBISH AND INSTALL CITY FURNISHED STATIC MIXER.
19	PROVIDE AND INSTALL 36" ENDRESS+HAUSER PROMAG ELECTROMAGNETIC FLOW METER, WITH GROUNDING RINGS AND ISOLATING BOLT KITS PER SPECIFICATIONS.
50	36" RESTRAINED COUPLING.
51	24" X 36" TEE (FLG X FLG X FLG).
52	36" PLUG VALVE (FLG X FLG).
55	36" VICTAULIC COUPLING.
56	36" DIP PE X GE.
58	31" X 14" X 10" CONCRETE OPEN-TOP VAULT.
60	STAINLESS STEEL PIPE SUPPORT TRIPAC FIG. TP-KS WELDED K-SUPPORT WITH STRAPS.
80	2" DRAIN TAP INSTALLED AT THE 4 O' CLOCK POSITION, CORP STOP, & BRASS THREADED PLUG.
81	36" DIP PE X FLG

Underground Service Alert

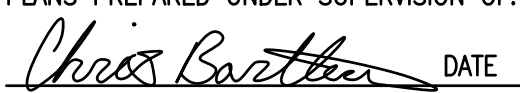


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IRVINE CALIFORNIA 92618 USA
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PLANS PREPARED UNDER SUPERVISION OF:

CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:

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ENGINEER



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
STATIC MIXER AND VAULT SECTION (1 OF 2)

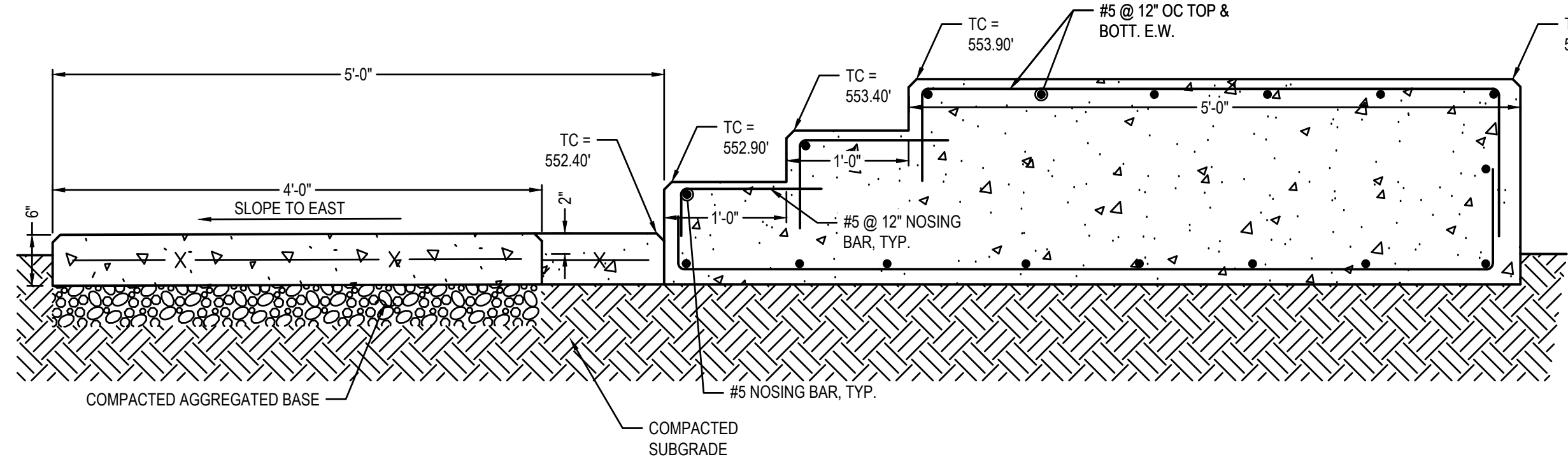
REGISTERED PROFESSIONAL ENGINEER

CHRIS A. BARTLEMAN

NO. CB1075
Exp. 09-30-25

CIVIL
STATE OF CALIFORNIA

DRAWING NO.
M-2
SH 8 OF 16



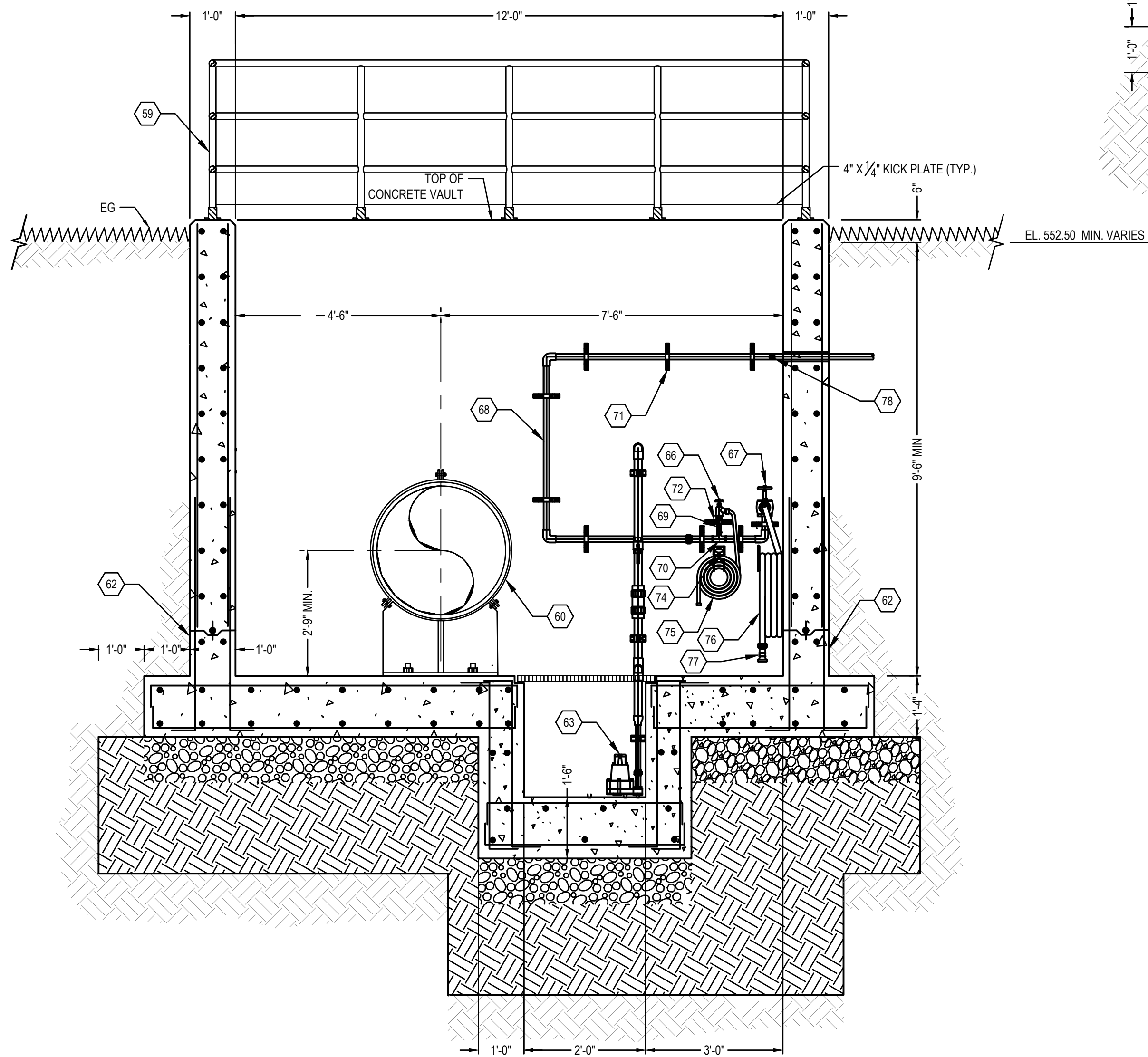
NOTES:

1. CONTRACTOR SHALL STRIKE CONTROL JOINTS EVERY 4'-0".
2. CONCRETE PADS SHALL HAVE 6 X 6 - W1.4 X W1.4 WWF ON CENTER OF SLAB.

CONCRETE WALKWAY DETAIL

SCALE: 1" = 1'-0"

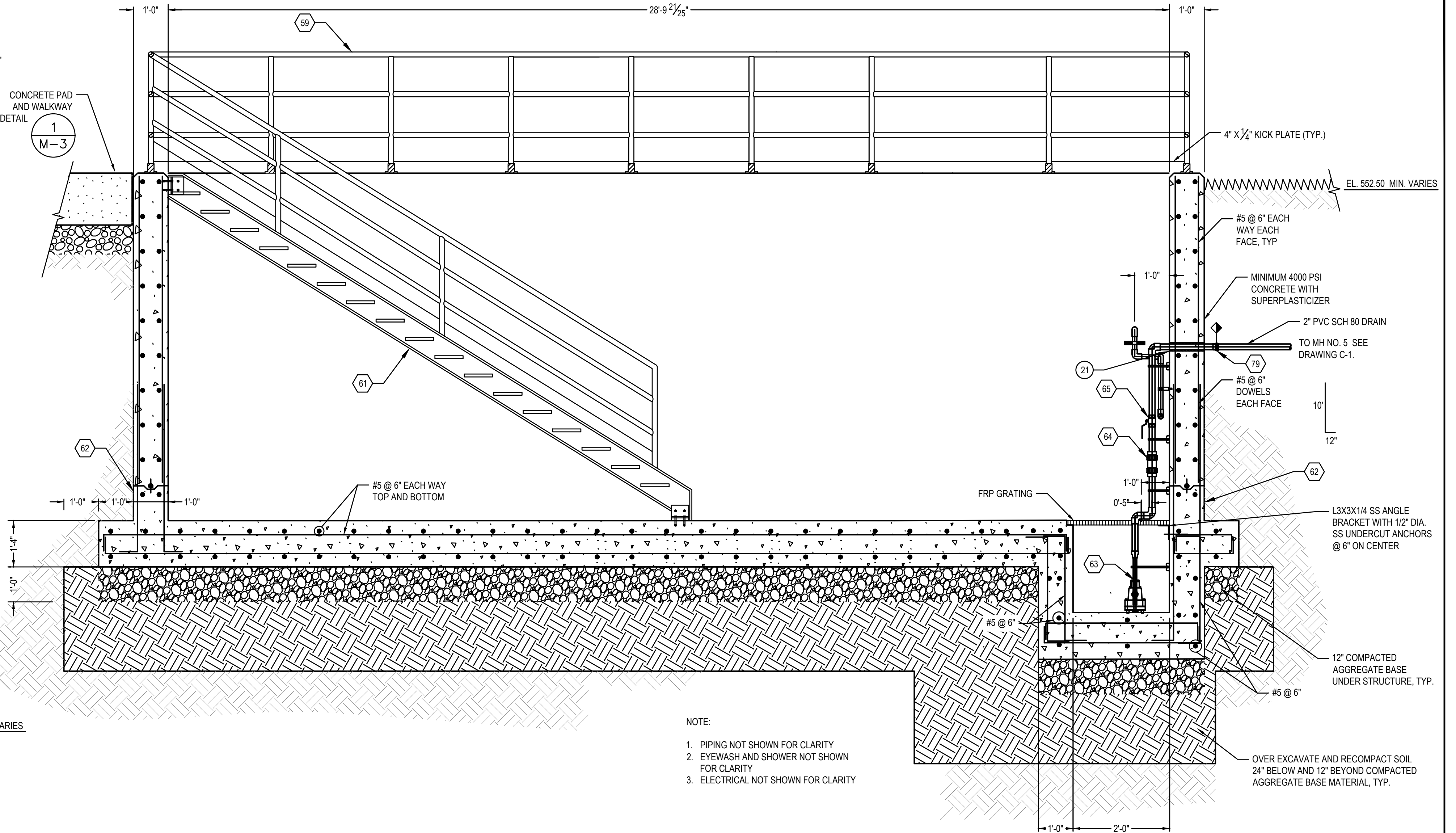
1
M-3



STATIC MIXER AND METERING VAULT SECTION

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

B
M-1



NOTE:

1. PIPING NOT SHOWN FOR CLARITY
2. EYEWASH AND SHOWER NOT SHOWN FOR CLARITY
3. ELECTRICAL NOT SHOWN FOR CLARITY

STATIC MIXER AND METERING VAULT SECTION

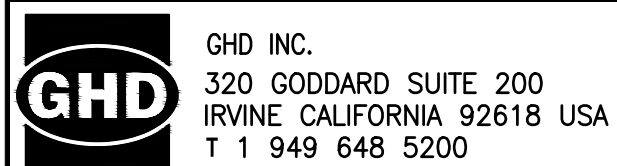
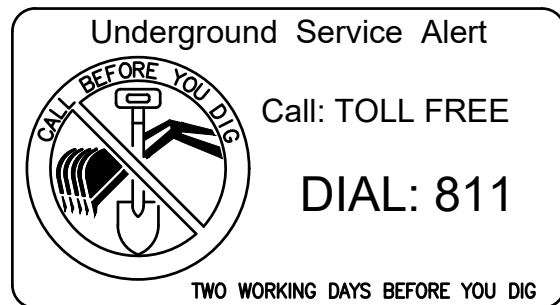
SCALE: 1/2" = 1'-0"

C
M-1

CONSTRUCTION NOTES:

21	PROVIDE AND INSTALL WALL SLEEVE IN PROPOSED VAULT WHERE THE 1 1/2" STAINLESS STEEL UTILITY LINE CROSSES THE WALL.
59	ALUMINUM HANDRAIL AND GATE PER DETAIL 3 ON DWG D-5.
60	STAINLESS STEEL PIPE SUPPORT TRIPAC FIG. TP-KS WELDED K-SUPPORT WITH STRAPS.
61	ALUMINUM STAIRS PER DETAIL 4 ON DWG D-5.
62	1" STEP WALL, KEY WAY, AND WATER STOP.
63	3/4" HP STAINLESS STEEL SUMP PUMP MYERS MODEL DS75P1 OR APPROVED EQUAL.
64	2" SS BALL CHECK VALVE.
65	2" SS BALL VALVE.
66	1" X 3/4" BRASS GARDEN VALVE, FIP X HOSE.
67	1 1/2" BRASS ANGLE PATER HOSE VALVE, FIP X HOSE.
68	1 1/2" STD. SS PIPE AND FITTINGS THREADED.
69	1" STD. SS PIPE AND FITTINGS THREADED.

70	1 1/2" X 1" SS REDUCING TEE.
71	1 1/2" TOLCO FIGURE 7 OFFSET PIPE CLAMP, STAINLESS STEEL.
72	1" TOLCO FIGURE 7 OFFSET PIPE CLAMP, STAINLESS STEEL.
73	NOT USED.
74	HOSE RACK, DURA-LOOP SADDLE 304 STAINLESS STEEL ACCU-BRAND PRODUCTS OR APPROVED EQUAL. SEE DETAIL 3 ON DWG. NO. D-3.
75	3/4" BLACK SYNTHETIC RUBBER HOSE WITH BRASS FITTINGS, GOODYEAR SURELINE OR APPROVED EQUAL.
76	1 1/2" BLACK SYNTHETIC RUBBER HOSE WITH BRASS FITTINGS, GOODYEAR SURELINE OR APPROVED EQUAL.
77	1 1/2" BRASS HOSE NOZZLE, ELKHART BRASS L-205 SPECIAL USE OR APPROVED EQUAL.
78	ADD 1 1/2" TEE, THREADED BALL VALVE, AND ROUTE 1 1/2" WATER TO EYEWASH AND SHOWER.
79	2" SS TO PLASTIC ADAPTER WITH COLLAR, FEMALE SOCKET TO FEMALE NPT.



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
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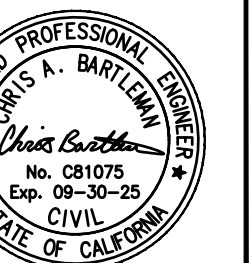
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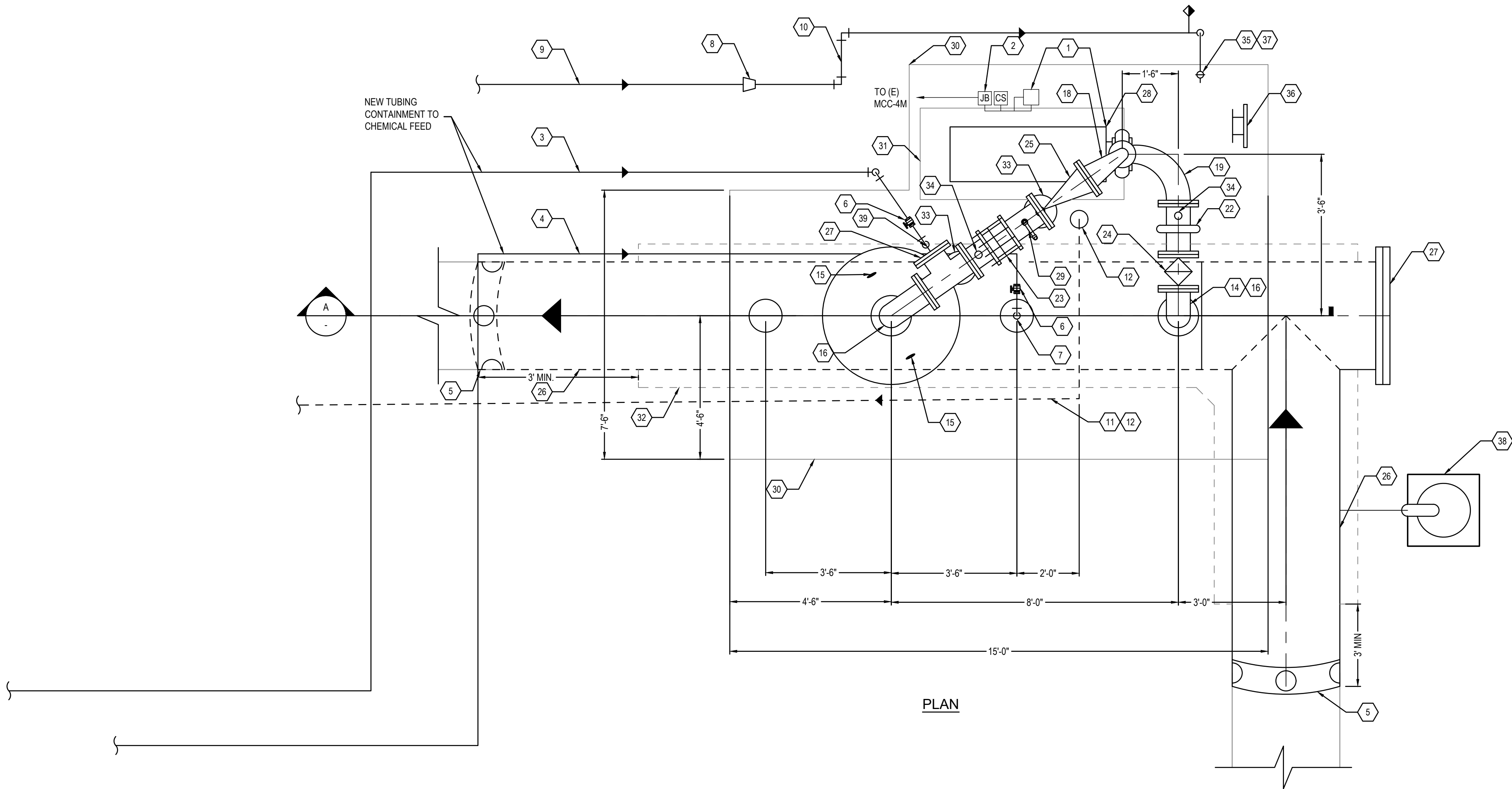
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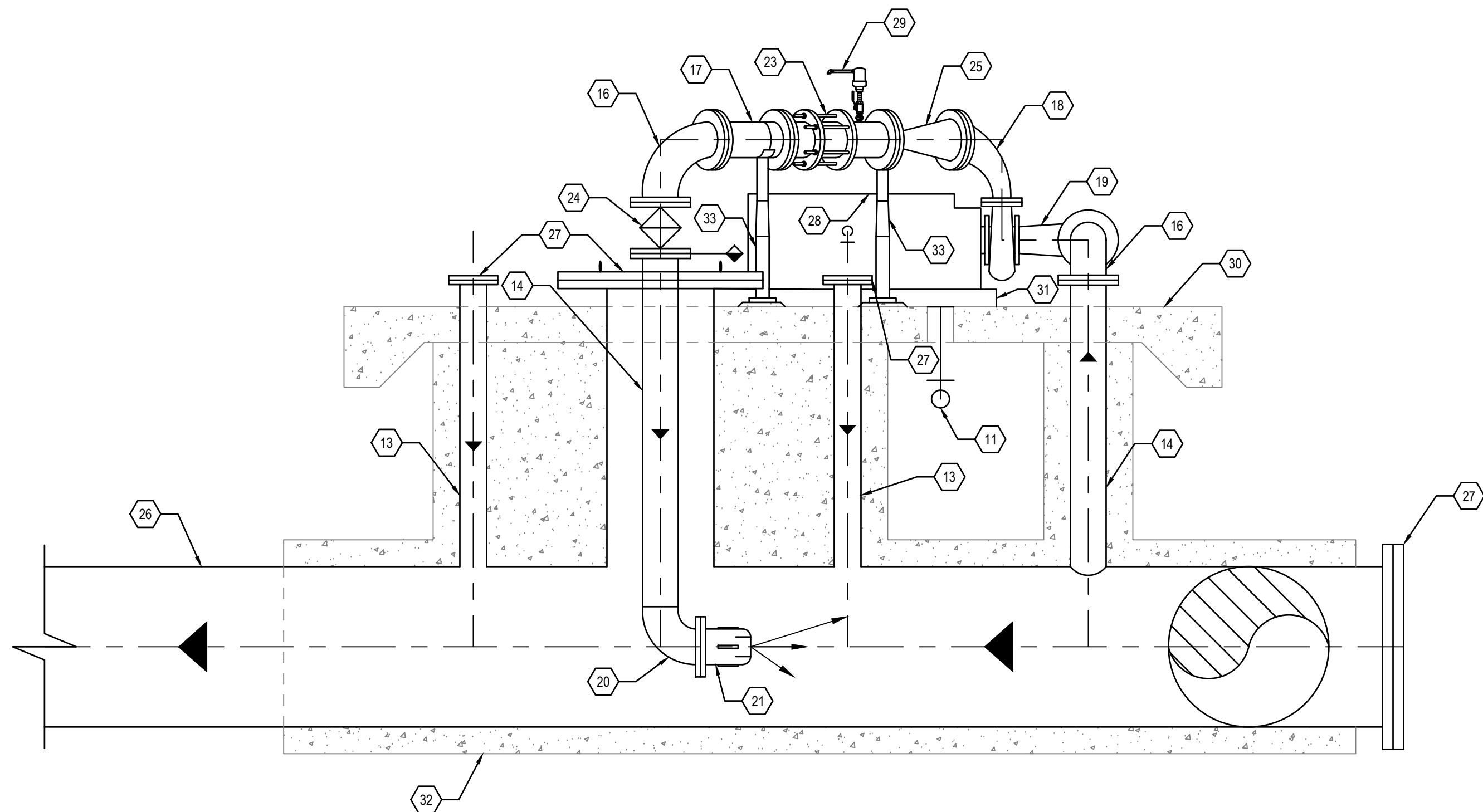
CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
STATIC MIXER AND VAULT SECTION (2 OF 2)

DRAWING NO.
M-3
SH 9 OF 16





PLAN

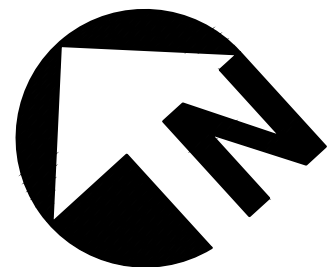


FLASH MIXER SECTION

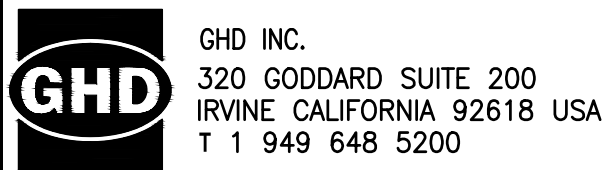
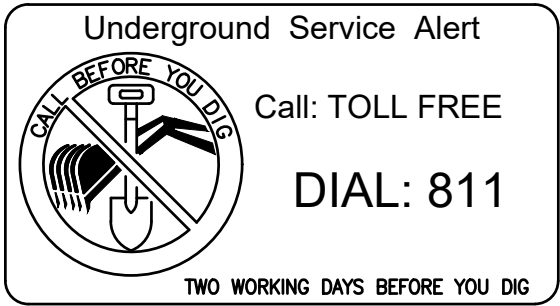
SCALE: 3/8" = 1'-0"

CONSTRUCTION NOTES:

- 1 PROVIDE NEMA-4X JUNCTION BOX, LOCAL PUMP CONTROL STATION EMERGENCY STOP, AND 30A DISCONNECT SWITCH.
- 2 INSTALL NEW POWER AND CONTROL CABLES/CONDUIT. CONTRACTOR SHALL PROVIDE NEW RACEWAYS, JUNCTION BOXES AS REQUIRED TO INTERCEPT EXISTING CONDUITS AT ELECTRICAL MH. REFER TO DETAIL 5 ON DWG D-5 FOR FLASH MIXER CONTROL ELEMENTARY DIAGRAM.
- 3 CONSTRUCT 1/2" HYPOCHLORITE PFA TUBING WITH 4" SCH 40 PVC CONTAINMENT PIPE FROM CHEMICAL FEED CONTAINMENT AREA TO INJECTION POINT.
- 4 CONSTRUCT 1/2" LIQUID ALUM PFA TUBING WITH 4" SCH 40 PVC CONTAINMENT PIPE FROM CHEMICAL FEED CONTAINMENT AREA TO INJECTION POINT.
- 5 BUTT STRAP CONNECTION TO EX 36" AWWA C200 WELDED STEEL PIPE PER DETAILS 3 AND 4 ON DWG D-4.
- 6 1/2" HASTELLOY C THREADED BALL VALVE.
- 7 1/2" HASTELLOY C DIFFUSER PER DETAIL 1 ON DWG D-4.
- 8 3" X 1 1/2" REDUCER
- 9 3" UTILITY WATER PVC SCHEDULE 80 PIPE.
- 10 1 1/2" UTILITY WATER PVC PIPE.
- 11 4" PVC GRAVITY DRAIN PIPE.
- 12 4" HUB DRAIN PER DETAIL 2 ON DWG D-4.
- 13 6" WELDED STEEL, AWWA C200.
- 14 8" WELDED STEEL, AWWA C200.
- 15 LIFTING LUGS.
- 16 8" DI 90° BEND (FLG X FLG).
- 17 8" DI TEE (FLG X FLG X FLG)
- 18 8" X 4" DI LONG RADIUS REDUCING 90° BEND (FLG X FLG).
- 19 8" X 6" DI LONG RADIUS REDUCING 90° BEND (FLG X FLG).
- 20 8" SS SCHEDULE 40 316 SS PIPE AND REDUCER AS REQUIRED TO MATCH NOZZLE SIZE.
- 21 6" SPRAY NOZZLE NO. 6RF-95400, FULL JET SS TYPE 316 SPRAYING SYSTEMS CO OR APPROVED EQUAL.
- 22 8" VICTAULIC COUPLING.
- 23 8" SLEEVE-TYPE COUPLING.
- 24 8" ECCENTRIC PLUG VALVE WITH HANDWHEEL (FLG X FLG).
- 25 8" SWING CHECK VALVE WITH LIMIT SWITCH (FLG X FLG). PROVIDE CONDUIT AND WIRE FROM JUNCTION BOX.
- 26 36" WELDED STEEL AWWA C200 PIPE.
- 27 BLIND FLANGE.
- 28 4" X 6" 450 GPM 3 HP AT 15 TDH HORIZONTAL END SUCTION PUMP.
- 29 1" AIR RELEASE ASSEMBLY PER STD. DWG. NO. 410.
- 30 8" THICK CONCRETE SLAB PER DETAIL 1 ON DWG NO. D-1.
- 31 CONCRETE EQUIPMENT PAD PER DETAIL 3 ON DWG. NO. D-1.
- 32 CONCRETE PIPE ENCASEMENT PER DETAIL 5 ON DWG. NO. D-1.
- 33 STAINLESS STEEL PIPE SUPPORT PER STD. DWG. NO. 418.
- 34 PRESSURE GAUGE PER DETAIL 4 ON DWG. NO. D-3.
- 35 HOSE BIB PER DETAIL 2 ON DWG. NO. D-3.
- 36 HOSE RACK PER DETAIL 3 ON DWG. NO. D-3.
- 37 WARNING SIGN PER STD. DWG. NO. 411R.
- 38 2" AIR RELEASE ASSEMBLY PER STD. DWG. NO. 413R.
- 39 RETRACTABLE INJECTOR 250 PSI RATED 1/2" MAIN CONNECTION X 1/2" SOLUTION TUBE, HC-100-H-H-4-CV (CKV) BY SAF-T-FLO AND FLEXIBLE HOSE WITH CPVC BALL VALVE INLET AND FNPT END CONNECTION 146 PSI RATED, FTA-PVDF-050-C-V (FKM) BY SAF-T-FLO.



0 0.25 0.5 1 Feet
SCALE: 1/2" = 1'-0"



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
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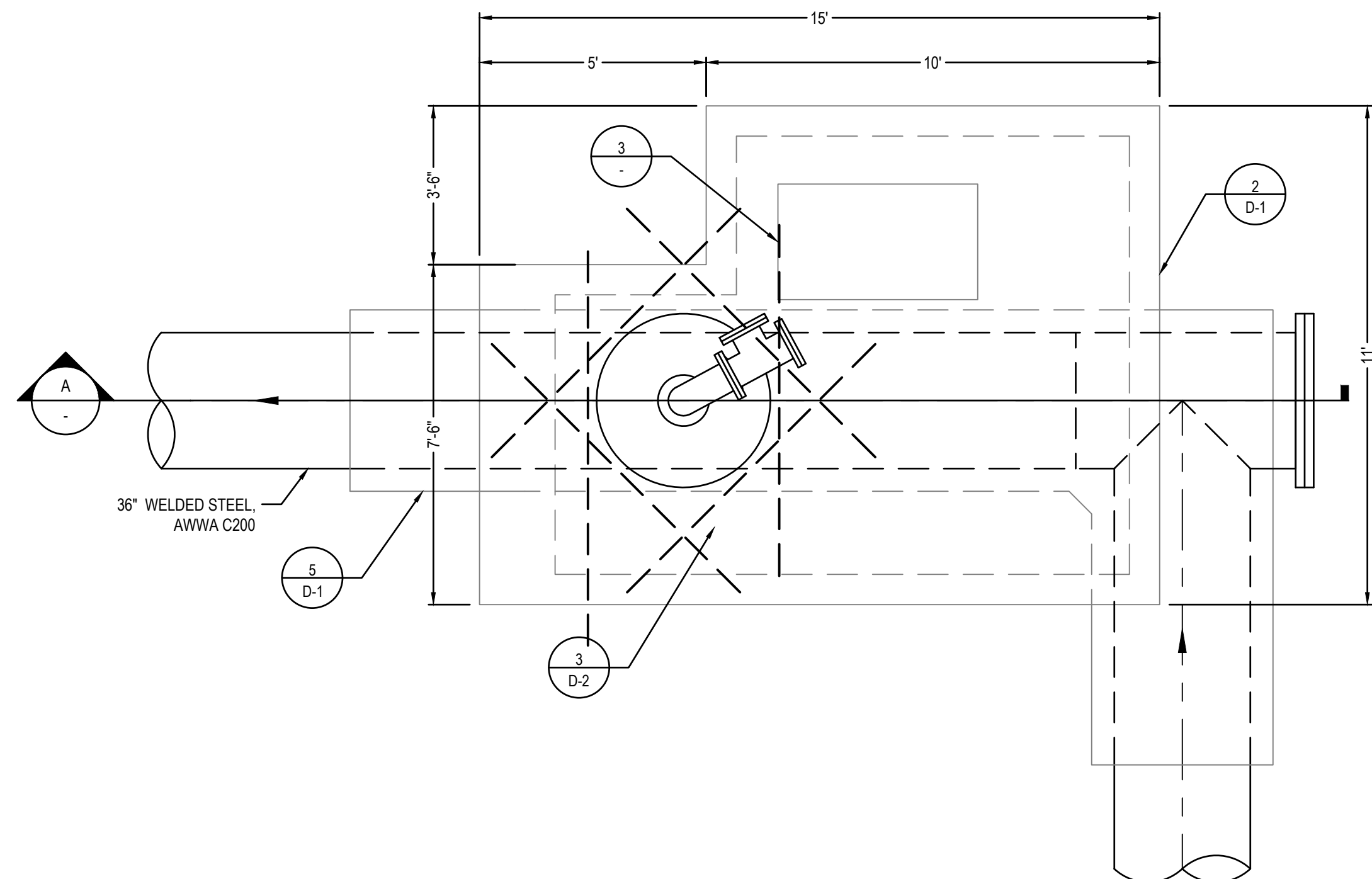
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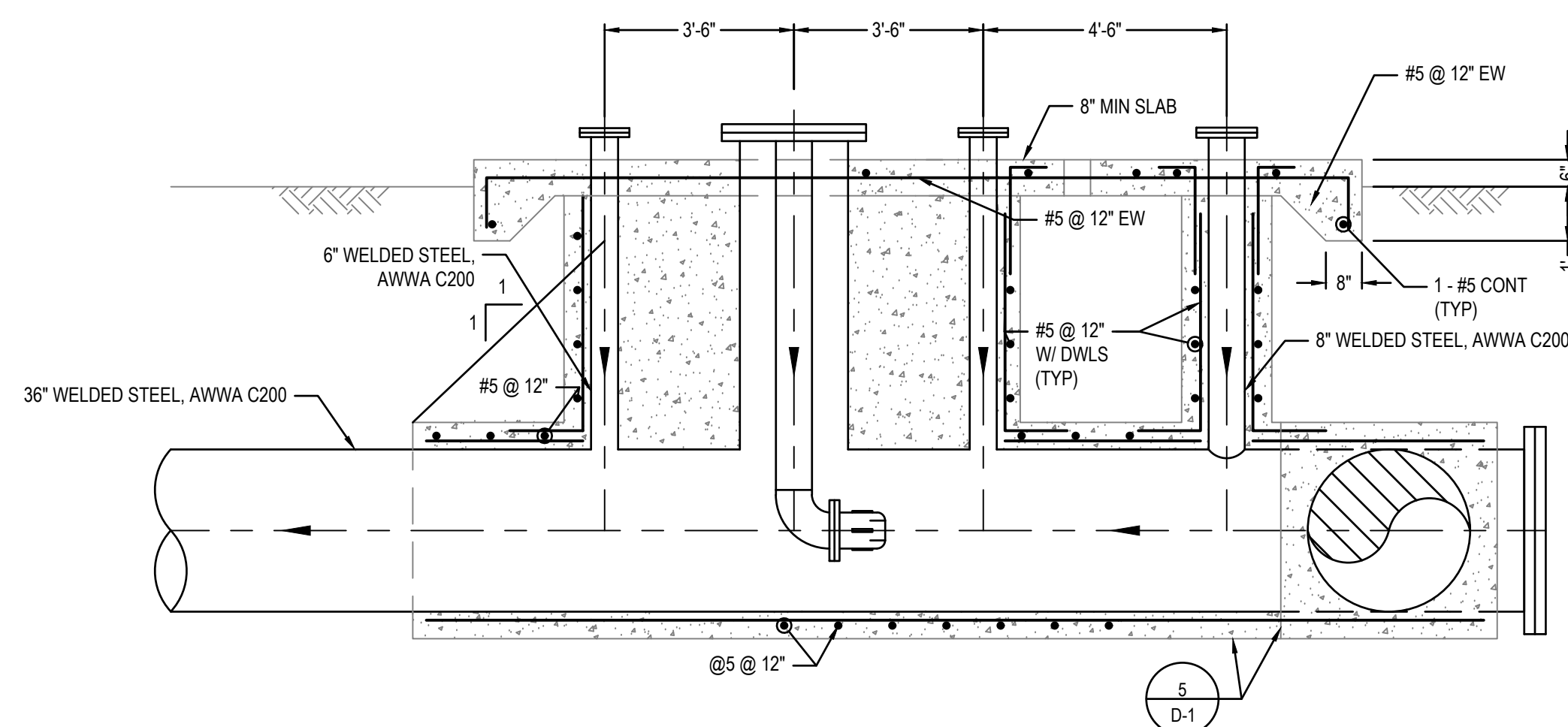


CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
FLASH MIXER PLAN AND SECTION

DRAWING NO.
M-4
SH 10 OF 16



PLAN

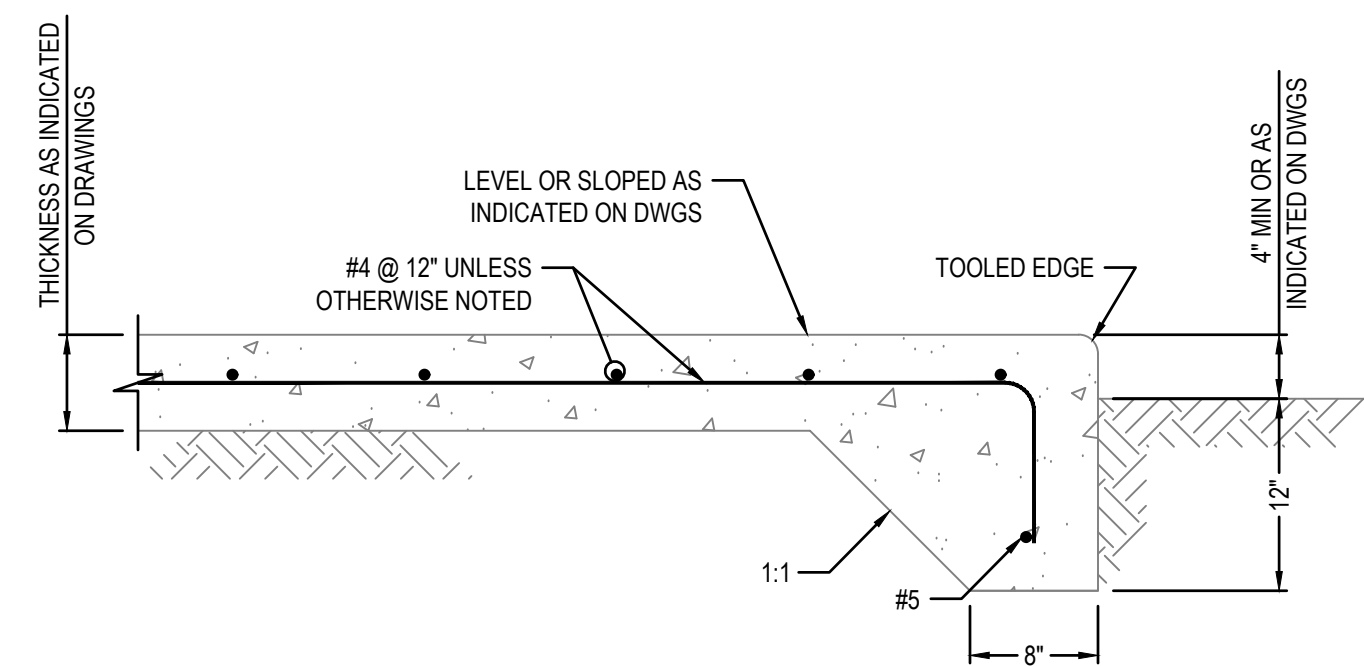


SECTION A

FLASH MIXER ENCASEMENT AND SLAB ON GRADE DETAIL

SCALE: 3/8" = 1'-0"

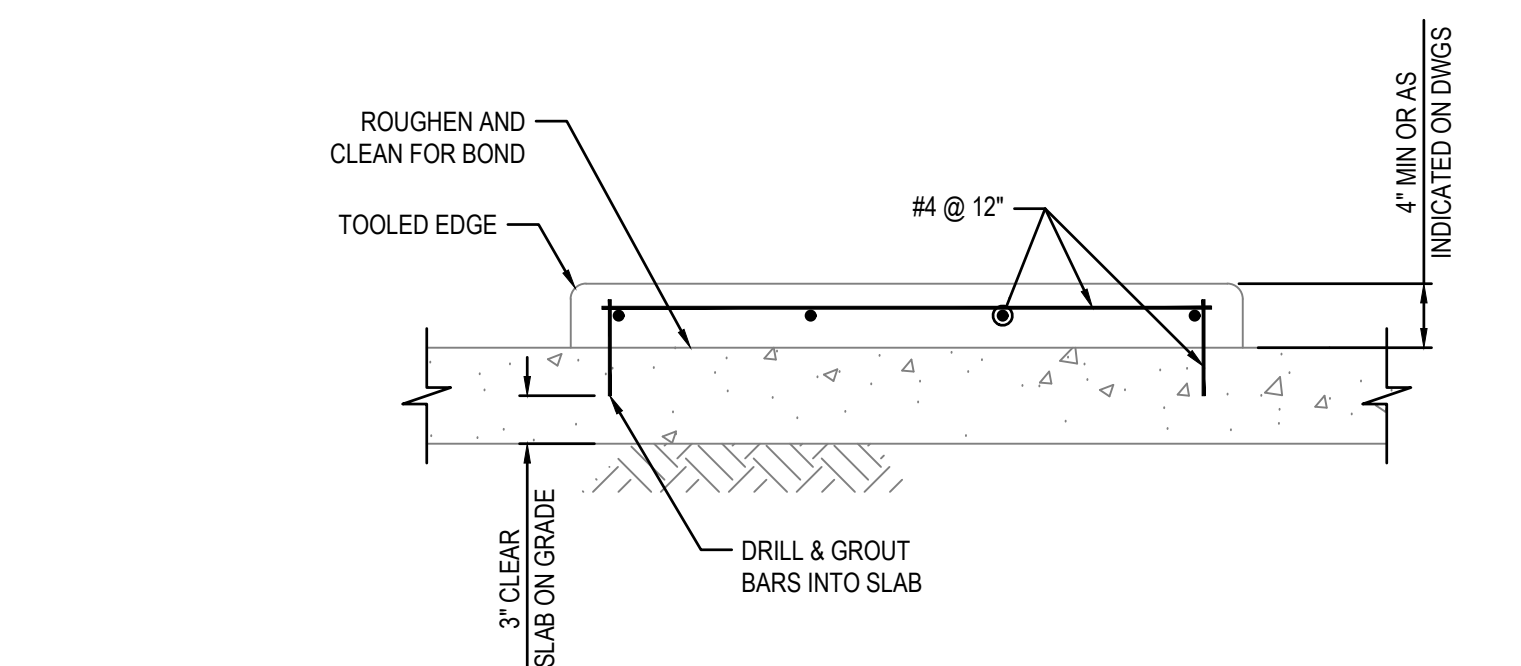
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SLAB ON GRADE DETAIL

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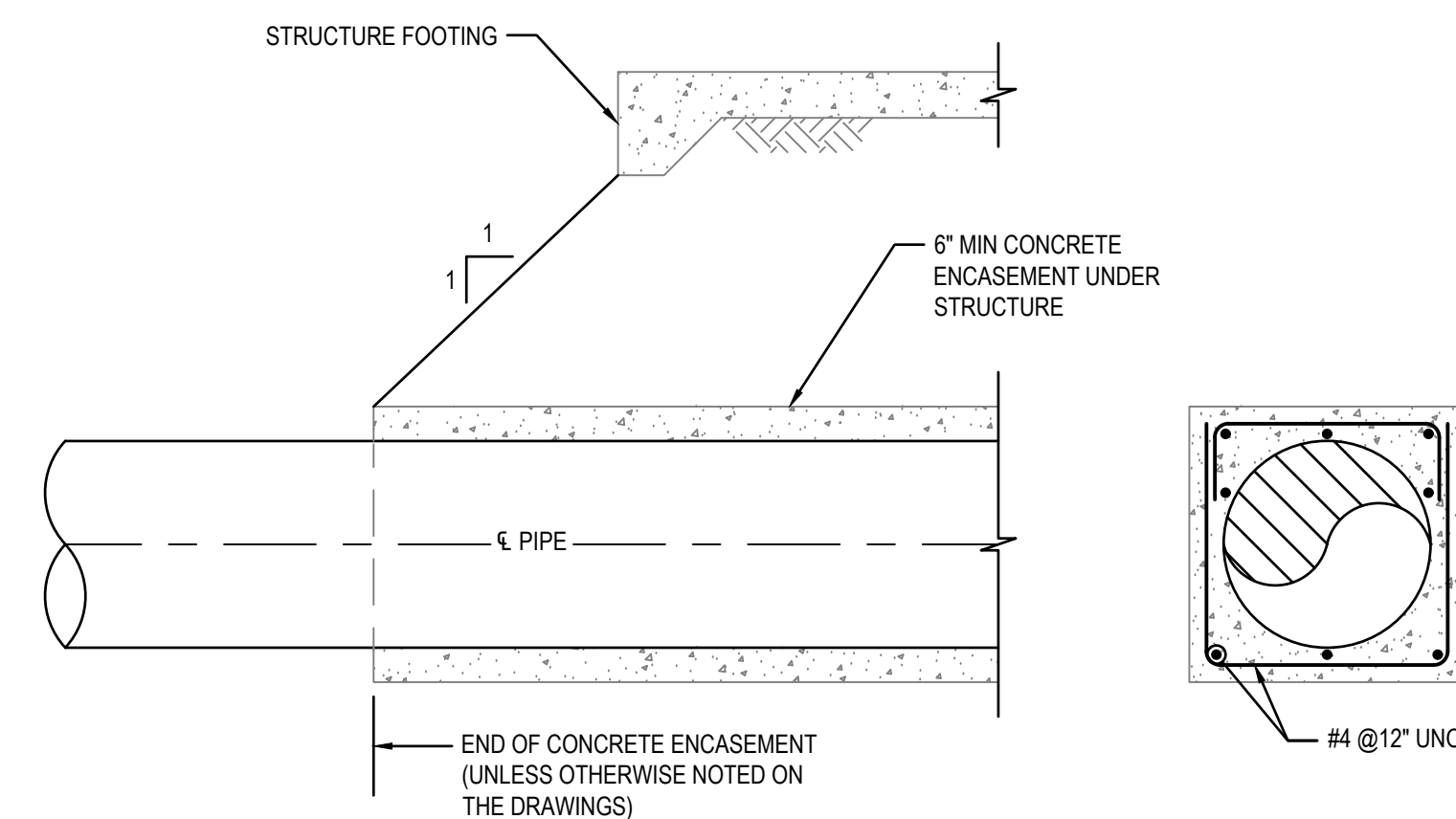
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EQUIPMENT PAD DETAIL

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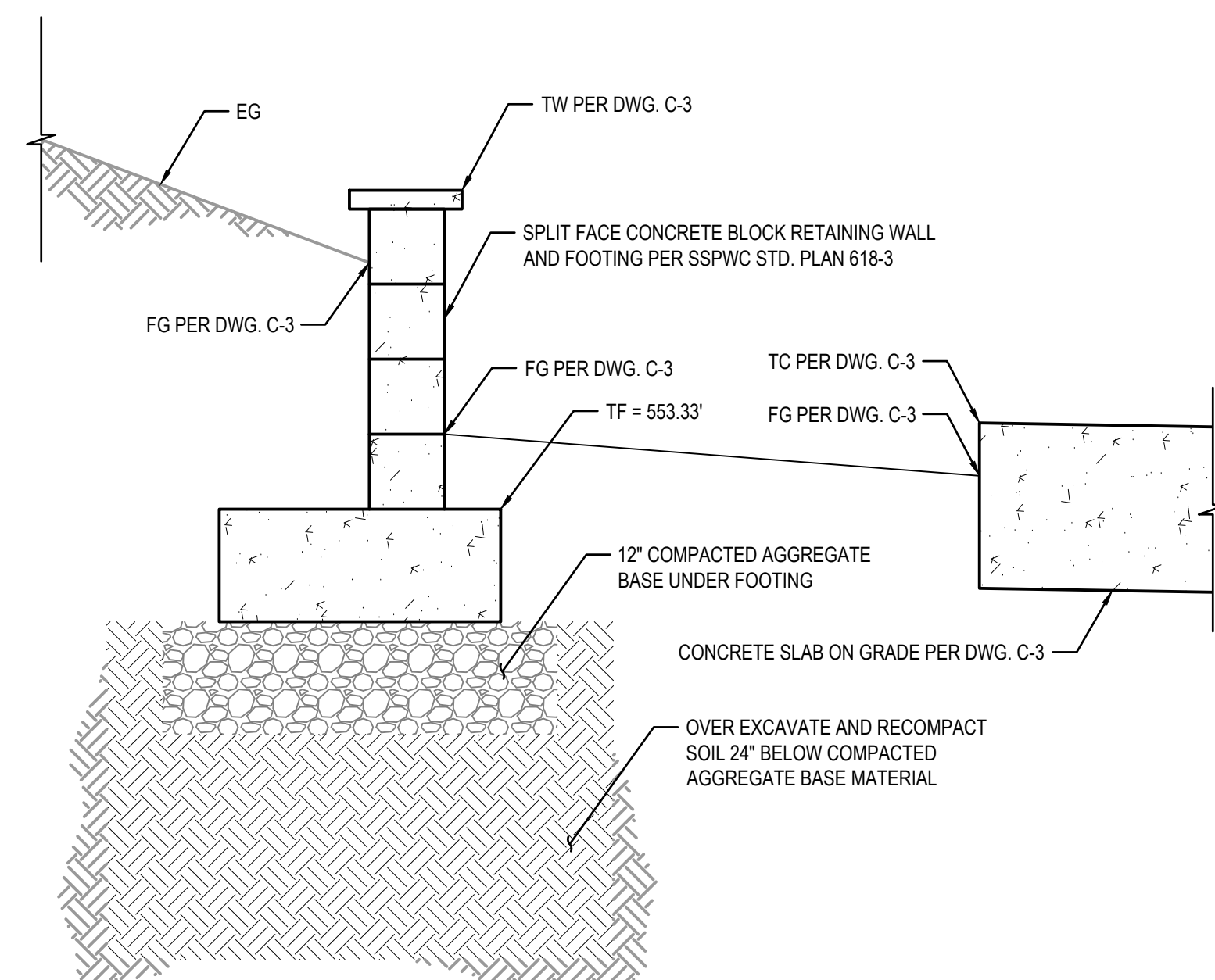
END OF PIPE ENCASEMENT UNDER STRUCTURES

NOT TO SCALE

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D-1

NOT USED
NOT TO SCALE

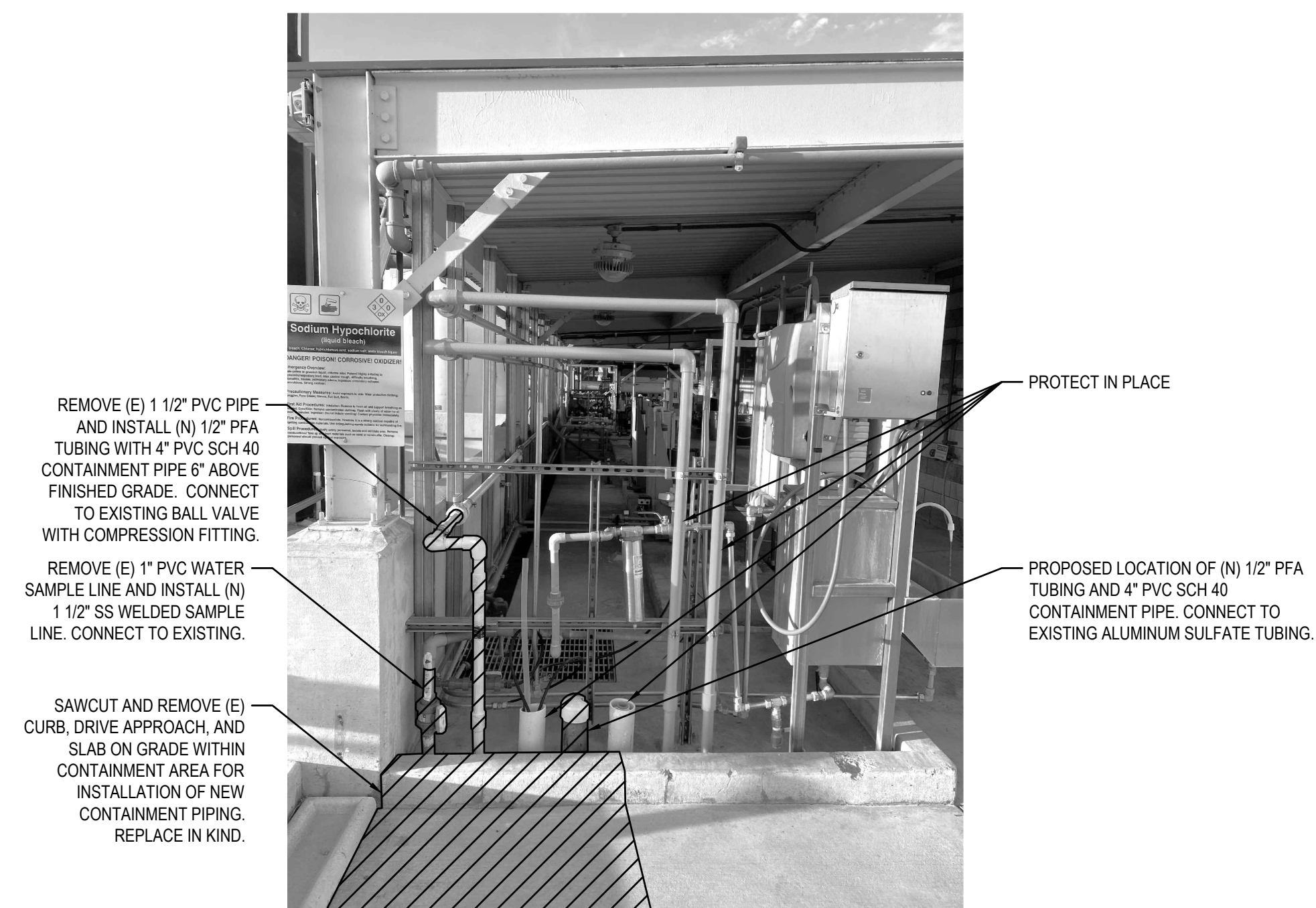
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D-1



CMU RETAINING WALL DETAIL

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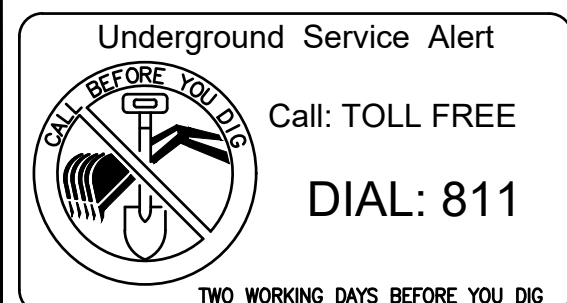
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C-3



FLASH MIXER CONTAINMENT AREA

NOT TO SCALE

7
C-4



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CHRIS BARTLEMAN R.C.E. NO. 81075

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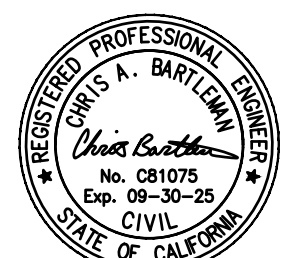
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CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (1 OF 6)

DRAWING NO.
D-1
SH 11 OF 16

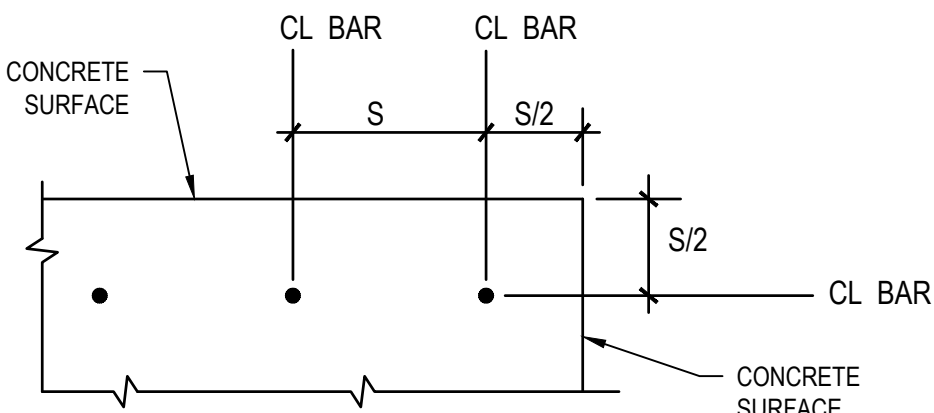


BAR SIZE	DEVELOPMENT LENGTH (ℓ_d)											
	3000 PSI CONC (f'c)				4000 PSI CONC (f'c)				5000 PSI CONC (f'c)			
	TOP		OTHER		TOP		OTHER		TOP		OTHER	
	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"
#3	13	22	12	17	12	19	12	15	12	17	12	13
#4	18	29	14	22	15	25	12	19	14	23	12	17
#5	22	36	17	28	19	31	15	24	17	28	13	22
#6	26	43	20	33	23	37	18	29	20	34	16	26
#7	38	63	29	48	33	54	25	42	29	49	23	38
#8	43	72	33	55	37	62	29	48	34	56	26	43
#9	49	81	37	62	42	70	33	54	38	63	29	48
#10	56	89	43	69	49	78	38	60	44	69	34	54
#11	68	98	52	76	59	85	45	66	53	76	41	59

BAR SIZE	TENSION LAP SPLICE LENGTH (CLASS 'B' SPLICE)											
	3000 PSI CONC (f'c)				4000 PSI CONC (f'c)				5000 PSI CONC (f'c)			
	TOP		OTHER		TOP		OTHER		TOP		OTHER	
	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"	s $\geq$ 6"	s < 6"
#3	17	28	16	22	16	25	16	19	16	22	16	17
#4	23	38	18	29	20	33	16	25	18	29	16	23
#5	28	47	22	36	25	41	19	31	22	36	17	28
#6	34	56	26	43	29	49	23	38	26	44	20	34
#7	49	82	38	63	43	71	33	55	38	63	30	49
#8	56	93	43	72	49	81	38	62	44	72	34	56
#9	63	105	49	81	55	91	42	70	49	81	38	63
#10	73	116	56	90	63	101	49	78	57	90	44	70
#11	88	128	68	99	76	111	59	85	68	99	53	76

NOTES:

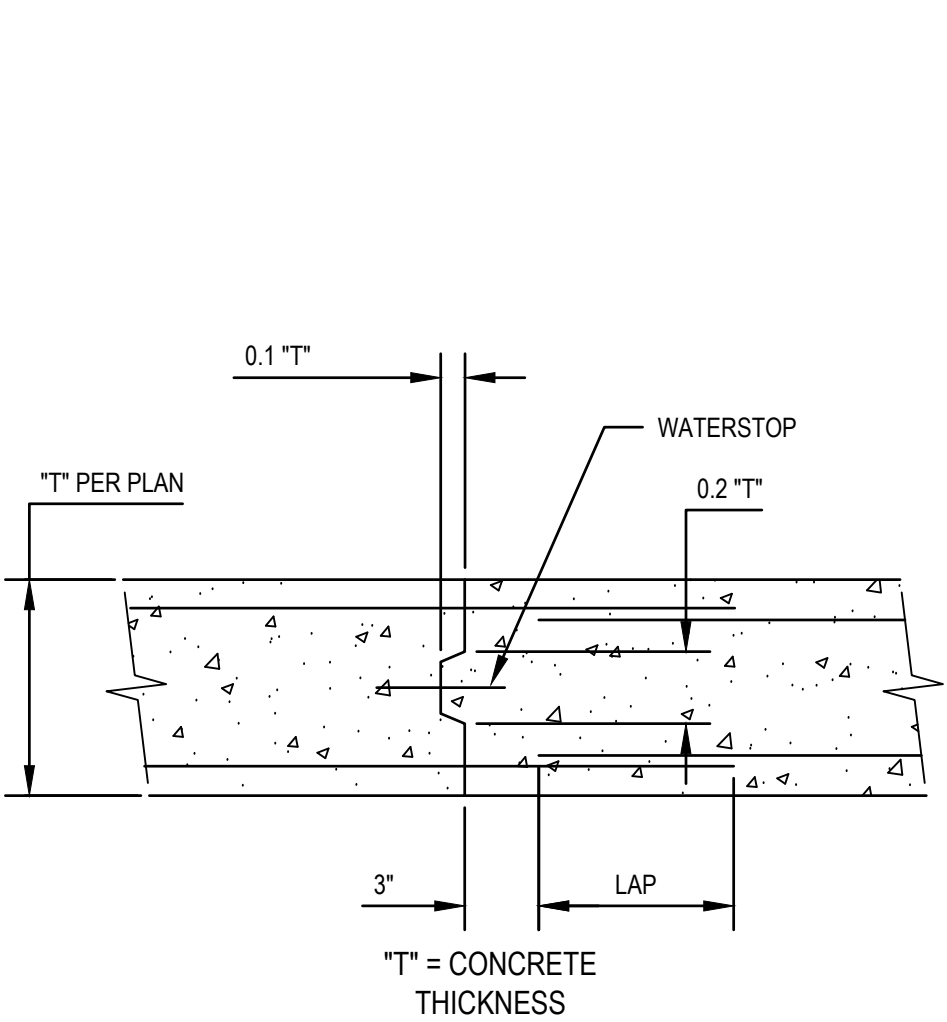
- LENGTHS SHOWN ARE FOR GRADE 60 UNCOATED BARS.
- LENGTHS SHOWN ARE IN INCHES.
- INCREASE LENGTHS 30% FOR LIGHT WEIGHT CONCRETE.
- TOP BARS: HORIZONTAL BARS WITH MORE THAN 12" OF FRESH CONCRETE CAST BELOW THEM.
- THE QUANTITY 'S' IS DEFINED AS FOLLOWS:



BAR DEVELOPMENT LENGTHS AND LAP SPLICE LENGTHS

NOT TO SCALE

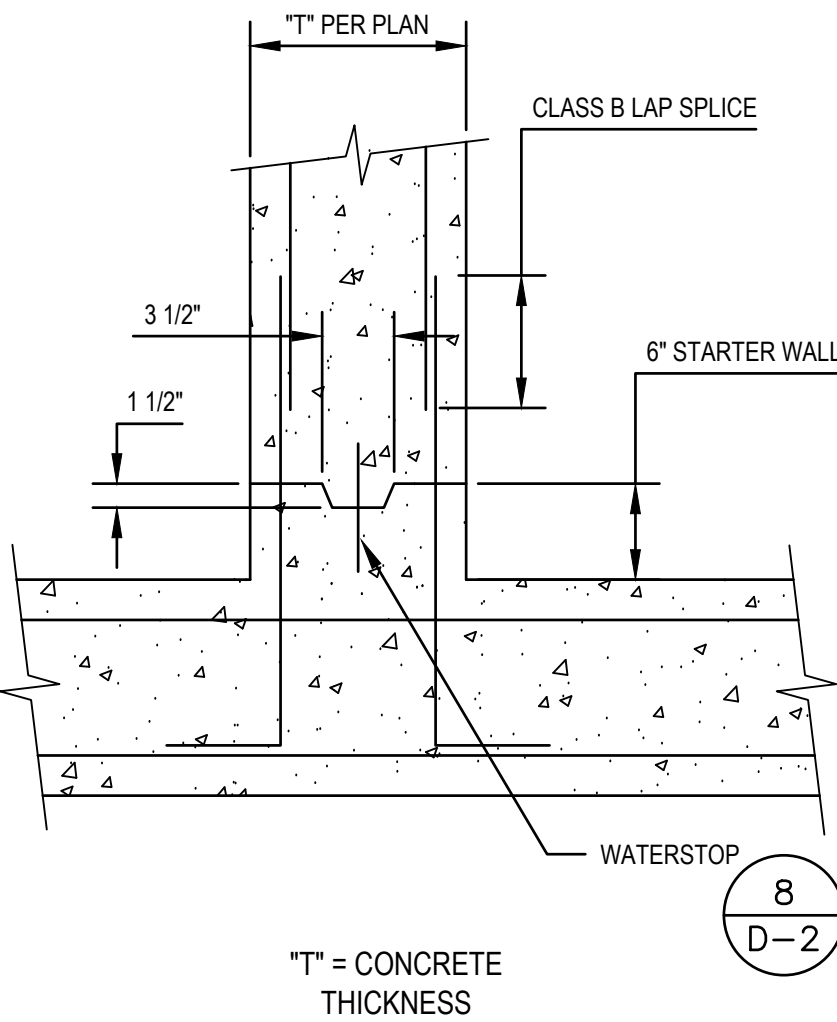
1
D-2



SLAB CONSTRUCTION JOINT

NOT TO SCALE

5
D-2



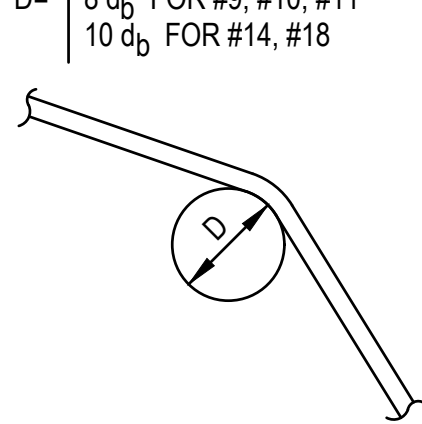
STARTER WALL

NOT TO SCALE

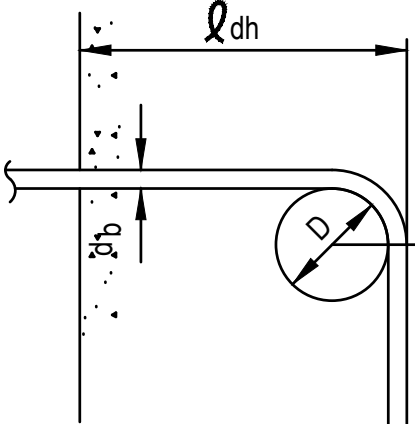
6
D-2

BAR SIZE	MINIMUM TENSION EMBEDMENT LENGTHS FOR STANDARD END HOOKS ON REINFORCING BARS ℓ_{dh} (IN.)			
	NORMAL WEIGHT CONCRETE, f'c PSI			
	3000	4000	5000	6000
#3	6	6	6	6
#4	8	7	6	6
#5	10	9	8	7
#6	12	10	9	9
#7	14	12	11	10
#8	16	14	12	11
#9	18	15	14	13
#10	20	17	16	14
#11	22	19	17	16
#14	38	33	29	27
#18	50	43	39	35

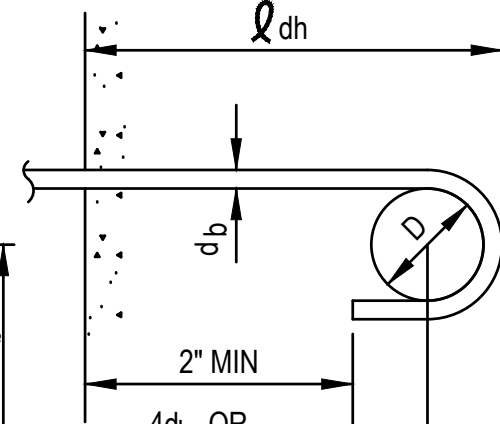
D= 6 d_b FOR #3 TO #8
8 d_b FOR #9, #10, #11
10 d_b FOR #14, #18



TYP BAR BEND DIAMETER



TYP 90° END HOOK

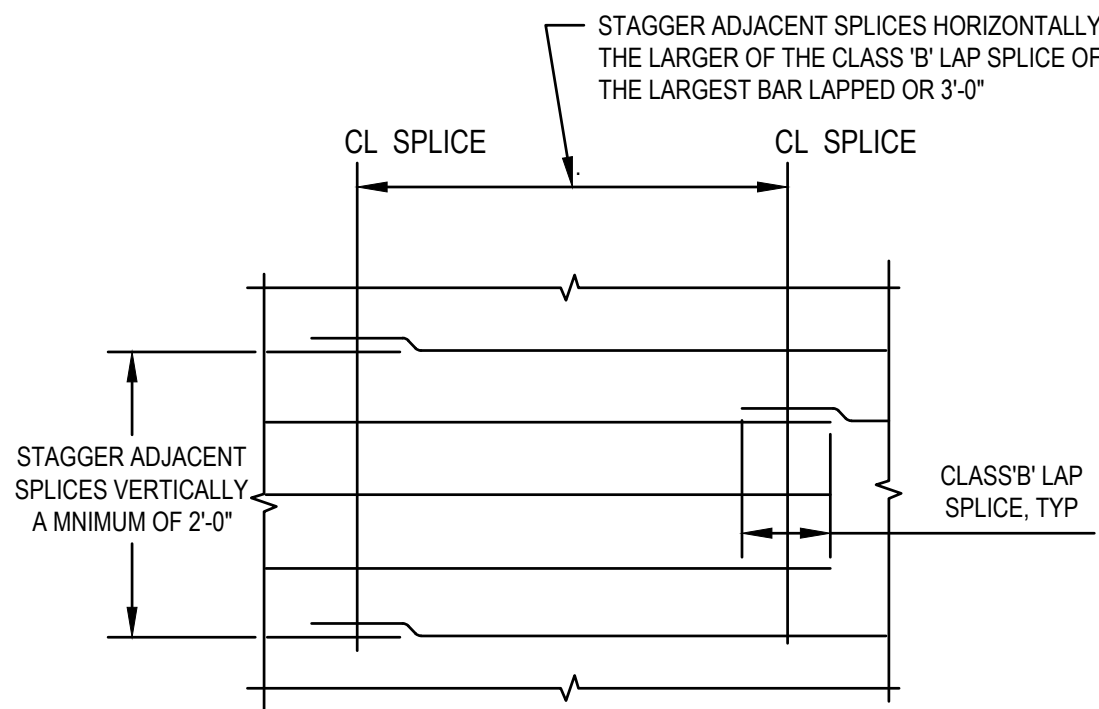


TYP 180° END HOOK

BAR ENDS AND END HOOKS

NOT TO SCALE

2
D-2

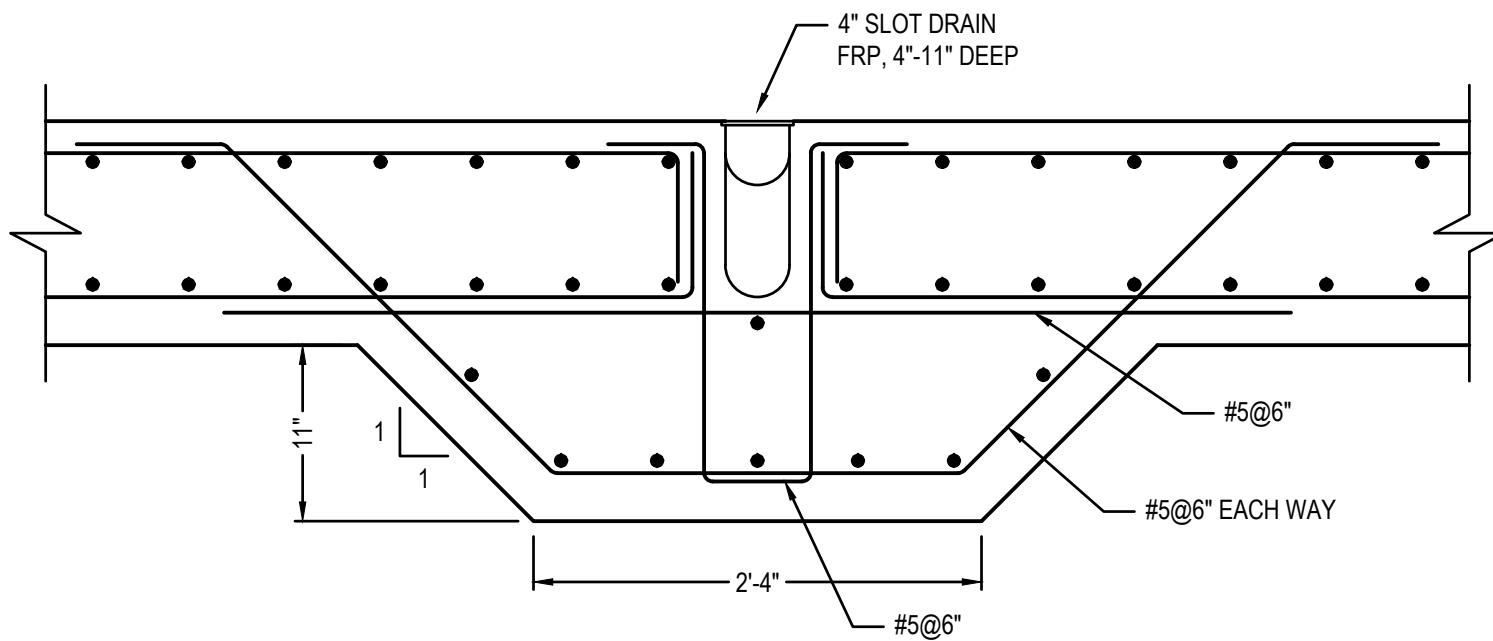


ELEVATION

CONCRETE WALL SPLICE DETAIL FOR HORIZONTAL WALL REINFORCEMENT

NOT TO SCALE

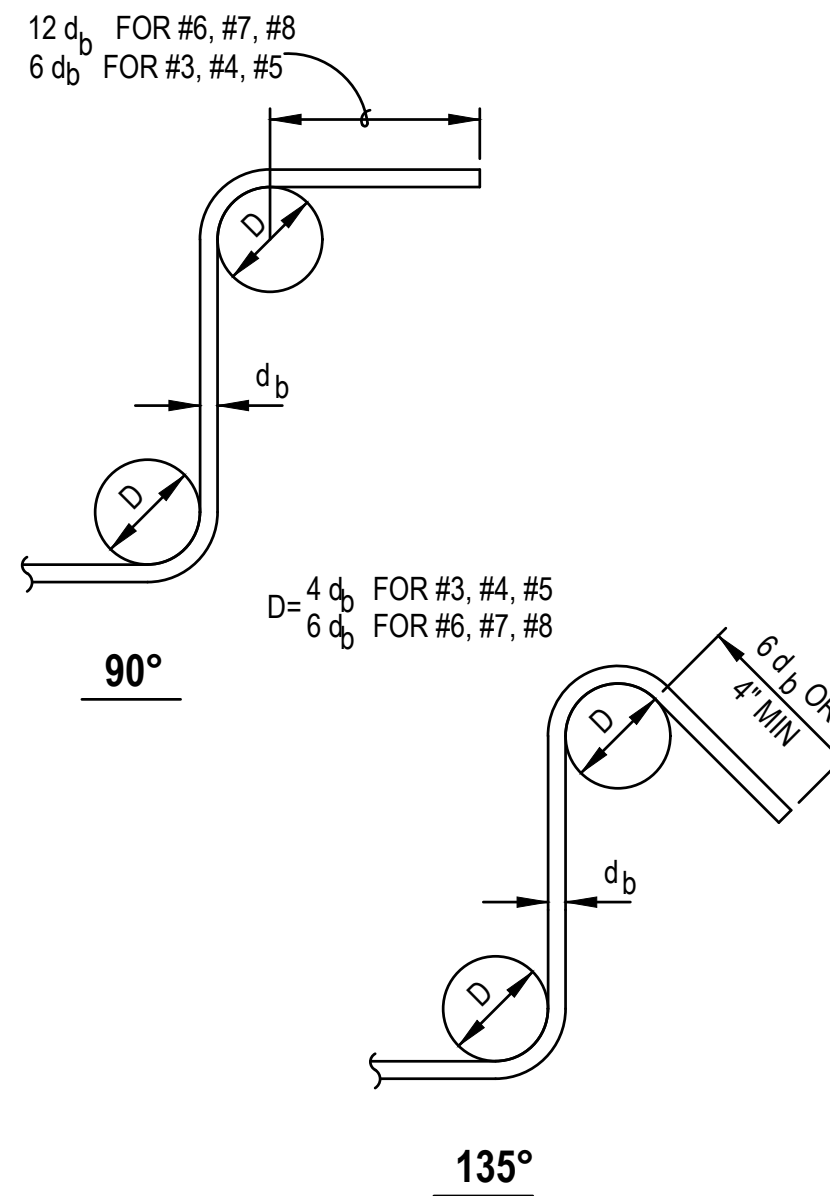
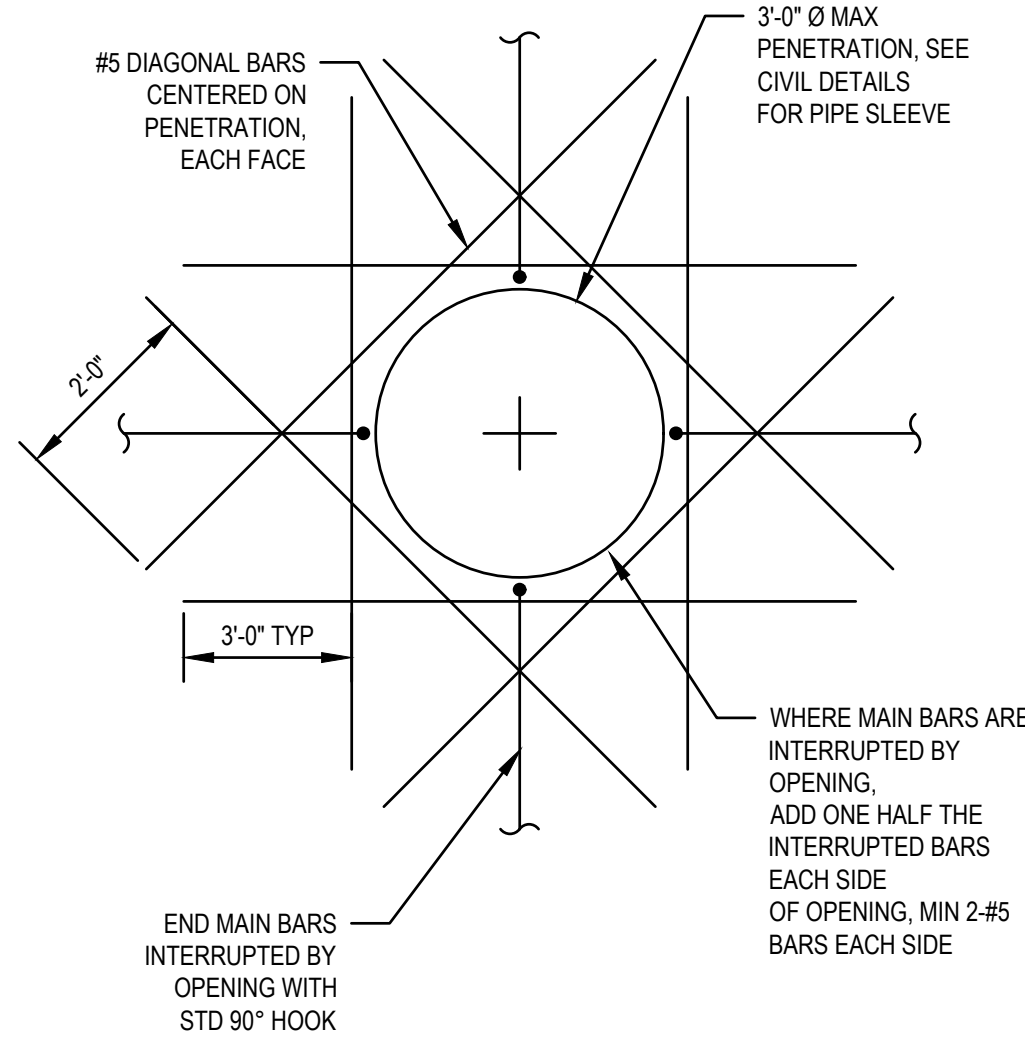
7
D-2



SLOT DRAIN SECTION

NOT TO SCALE

9
M-1



EXTRA REINFORCEMENT AT BAR OPENINGS

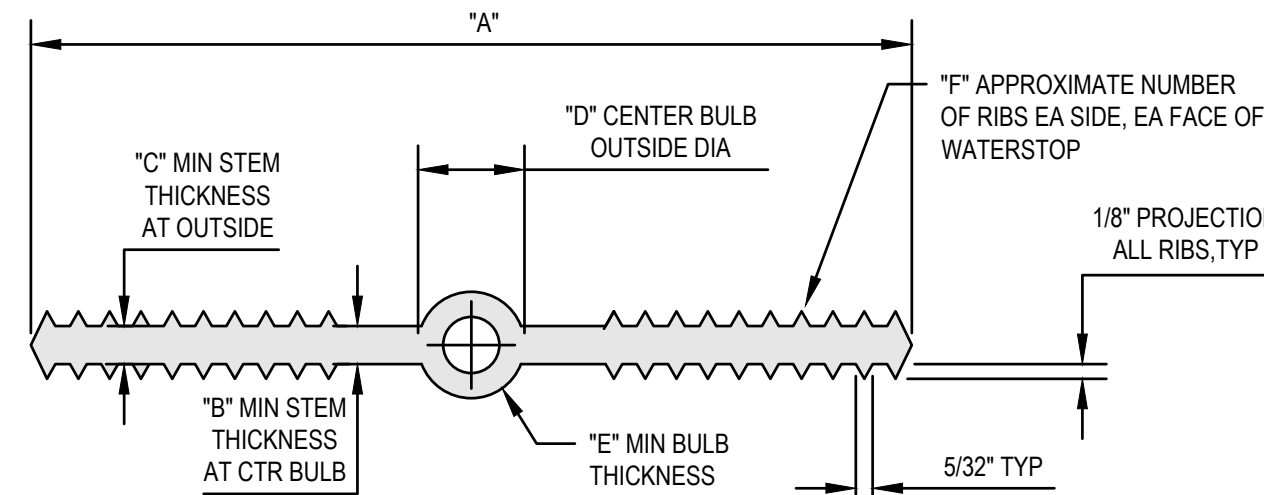
NOT TO SCALE

3
D-2

STIRRUP AND TIE HOOKS

NOT TO SCALE

4
D-2

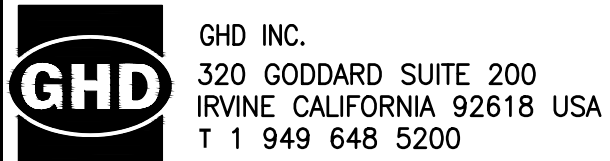
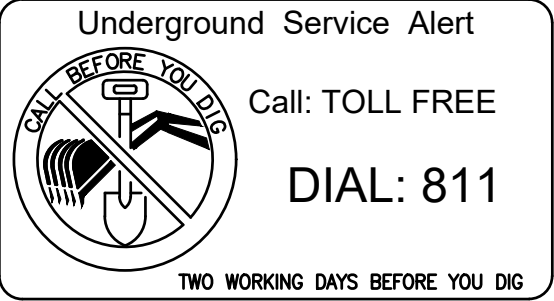


PLASTIC WATERSTOP

NOT TO SCALE

8
D-2

SIZE	A	B	C	D	E	F
4" x 3/16"	4"	3/16"	3/16"	3/4"	1/4"	4
6" x 3/8"	6"	3/8"	3/8"	7/8"	1/4"	6
9" x 3/8"	9"	3/8"	3/8"	1"	1/4"	8



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:

REFERENCES

BENCHMARK:

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2
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NO. DATE

REVISIONS

ENGR. APP'D. DATE

APPROVED FOR CONSTRUCTION:

DATE

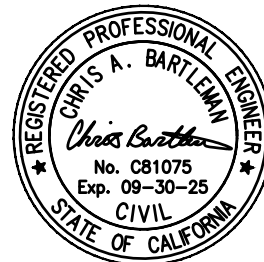
ENGINEER

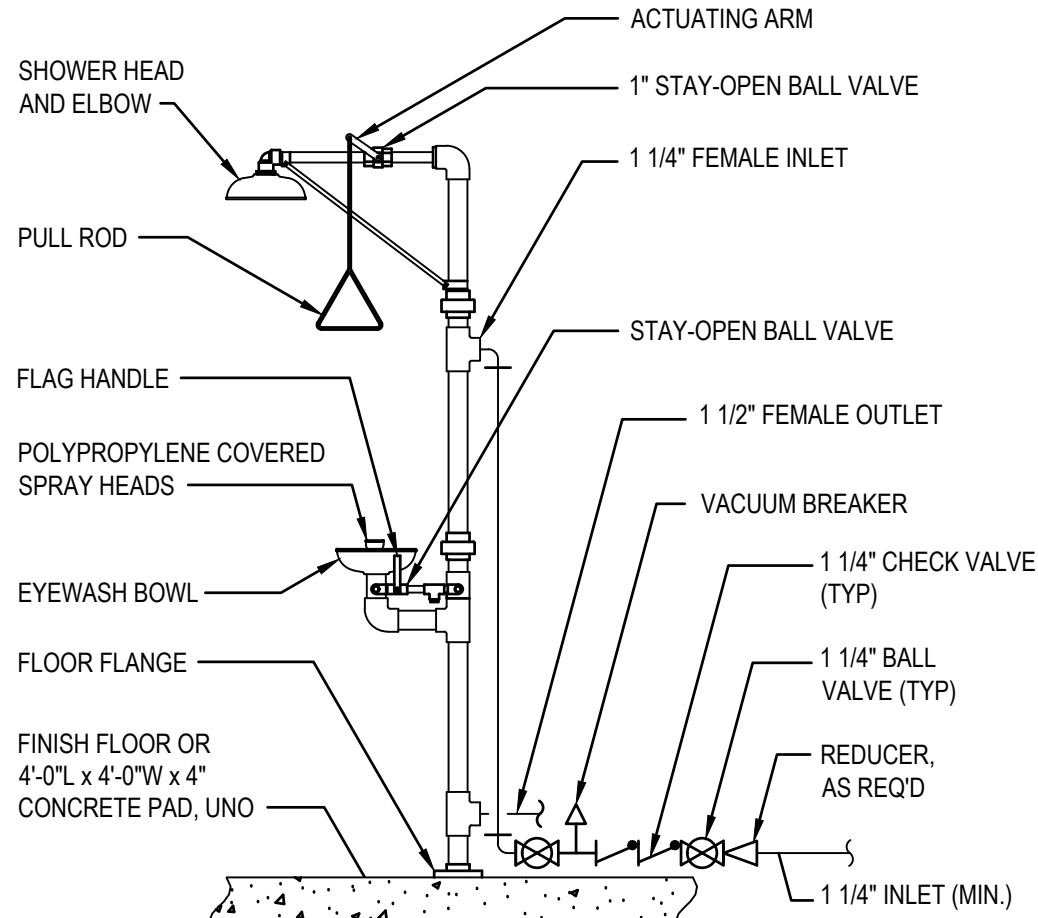


CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (2 OF 6)

DRAWING NO.
D-2

SH 12 OF 16



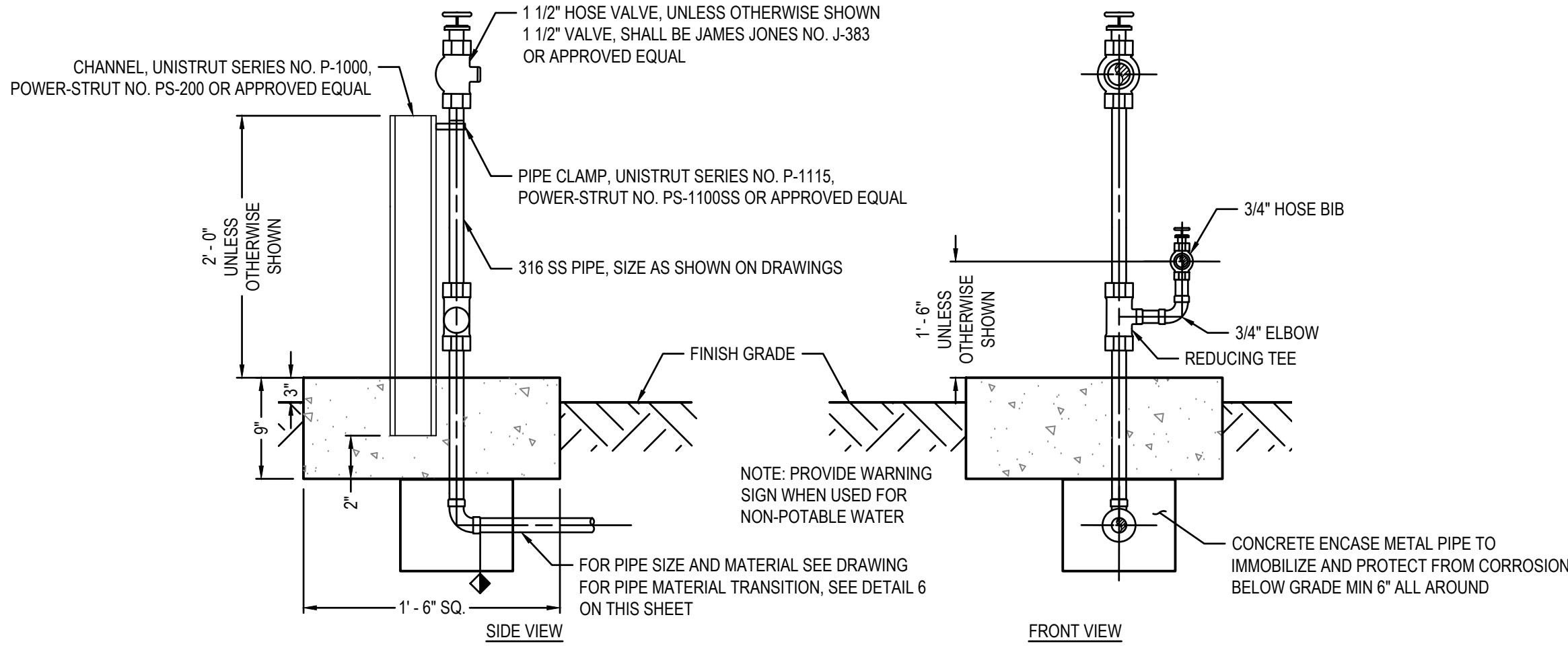


- NOTES:
- FOR OUTSIDE INSTALLATION, CONTRACTOR SHALL DRAIN EYEWASH TO A 3'x3'x3' SUMP FILLED WITH 1/2" PEA GRAVEL.
 - ALL EYEWASHES SHALL BE EQUIPPED WITH ANTI-SCALD FEATURE.
 - INSULATE PIPING AND FITTINGS.

EMERGENCY EYEWASH

NOT TO SCALE

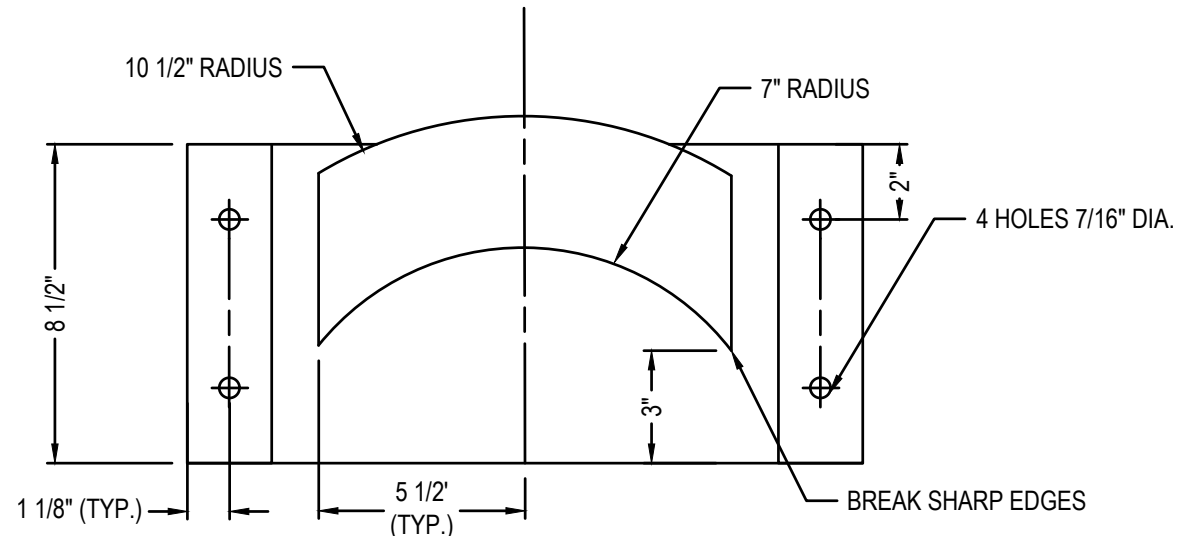
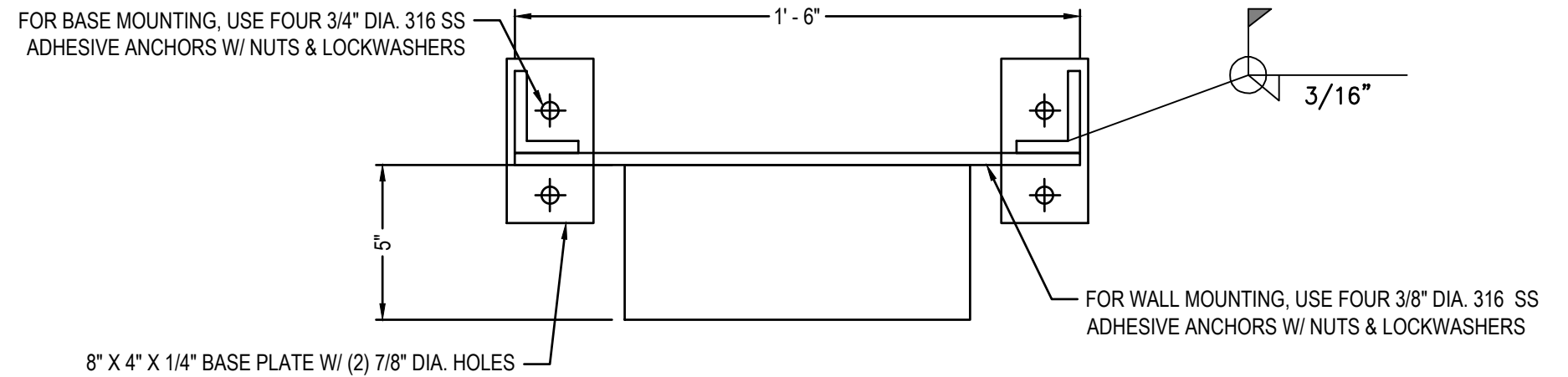
1
M-1



HOSE BIB

NOT TO SCALE

2
M-3

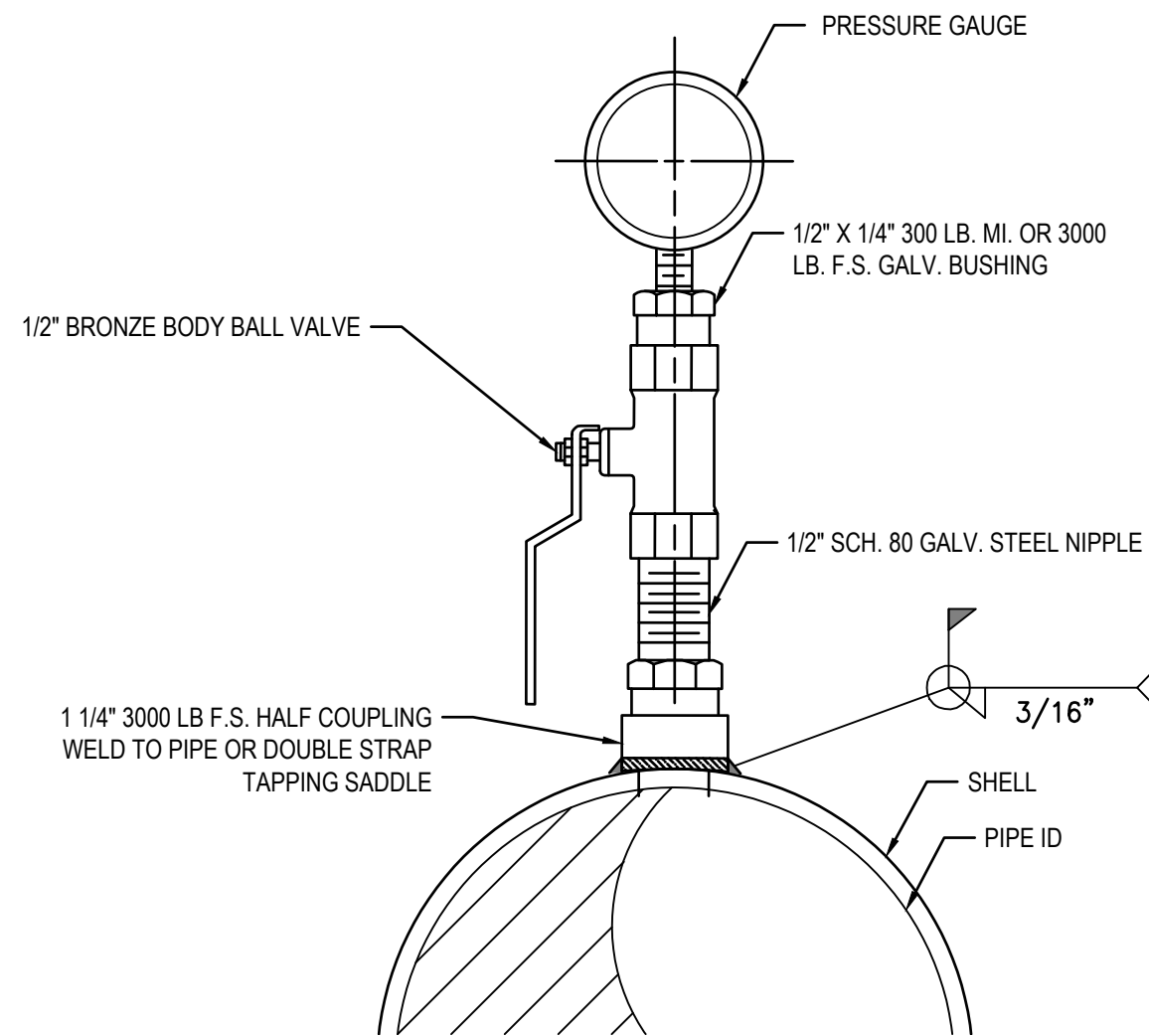


- NOTE:
- WHERE HOSE RACK IS FREE-STANDING, PROVIDE (2) STS 2 X 2 X 1/4" WITH BASE PLATES. (OMIT BASE PLATES WHERE ANGLE CAN BE SET IN CONCRETE.)
 - CONSTRUCTION: 8" 316 SS SHEET, ALL WELDED.

HOSE RACK

NOT TO SCALE

3
M-3

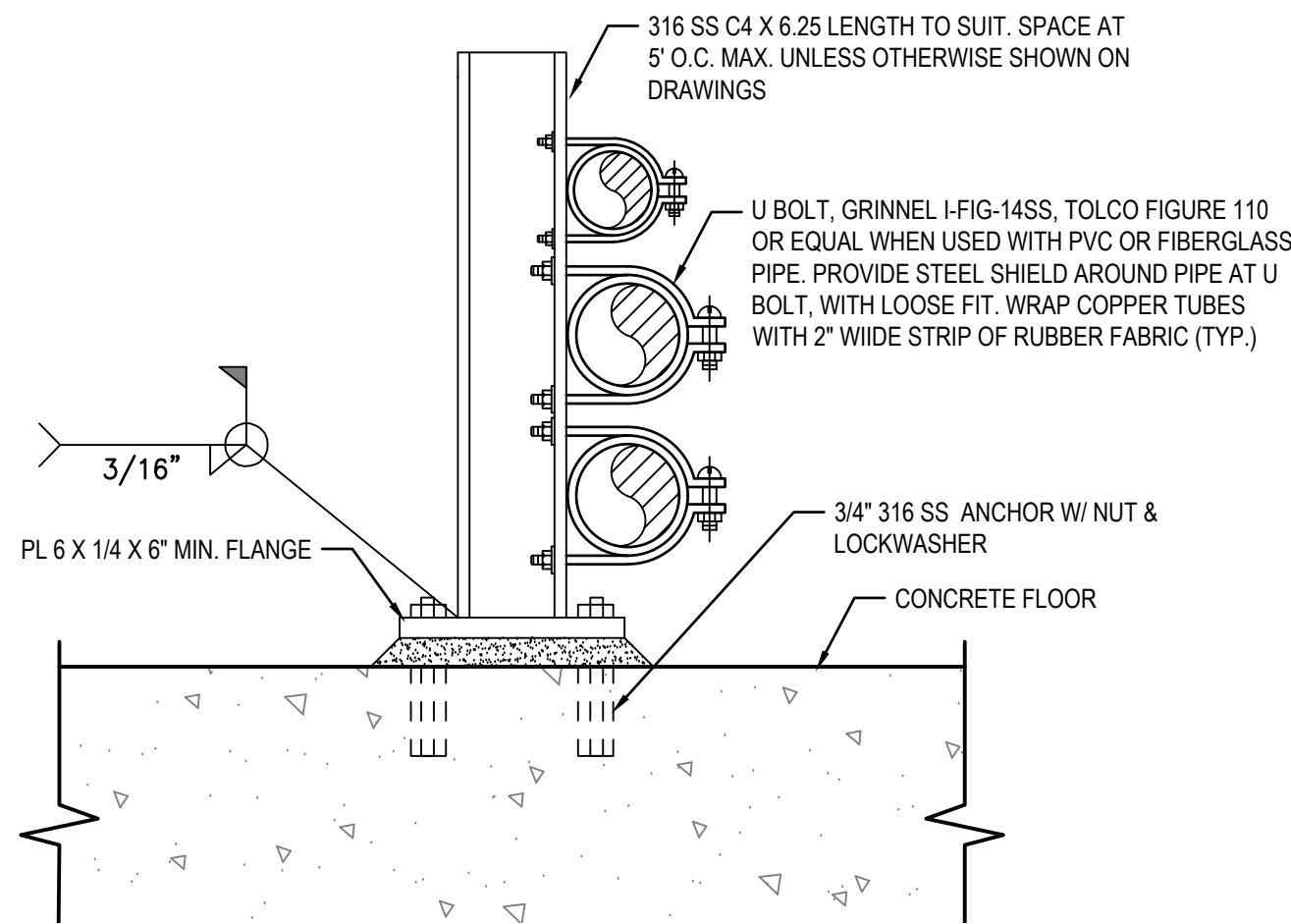


- NOTE:
- MAX INDICATING RANGE ON SCALE SHALL NOT EXCEED 2X OF NORMAL MAX OPERATION PRESSURE.
 - PROVIDE SNUBBER IF REQUIRED TO STABILIZE READINGS.

PRESSURE GAUGE

NOT TO SCALE

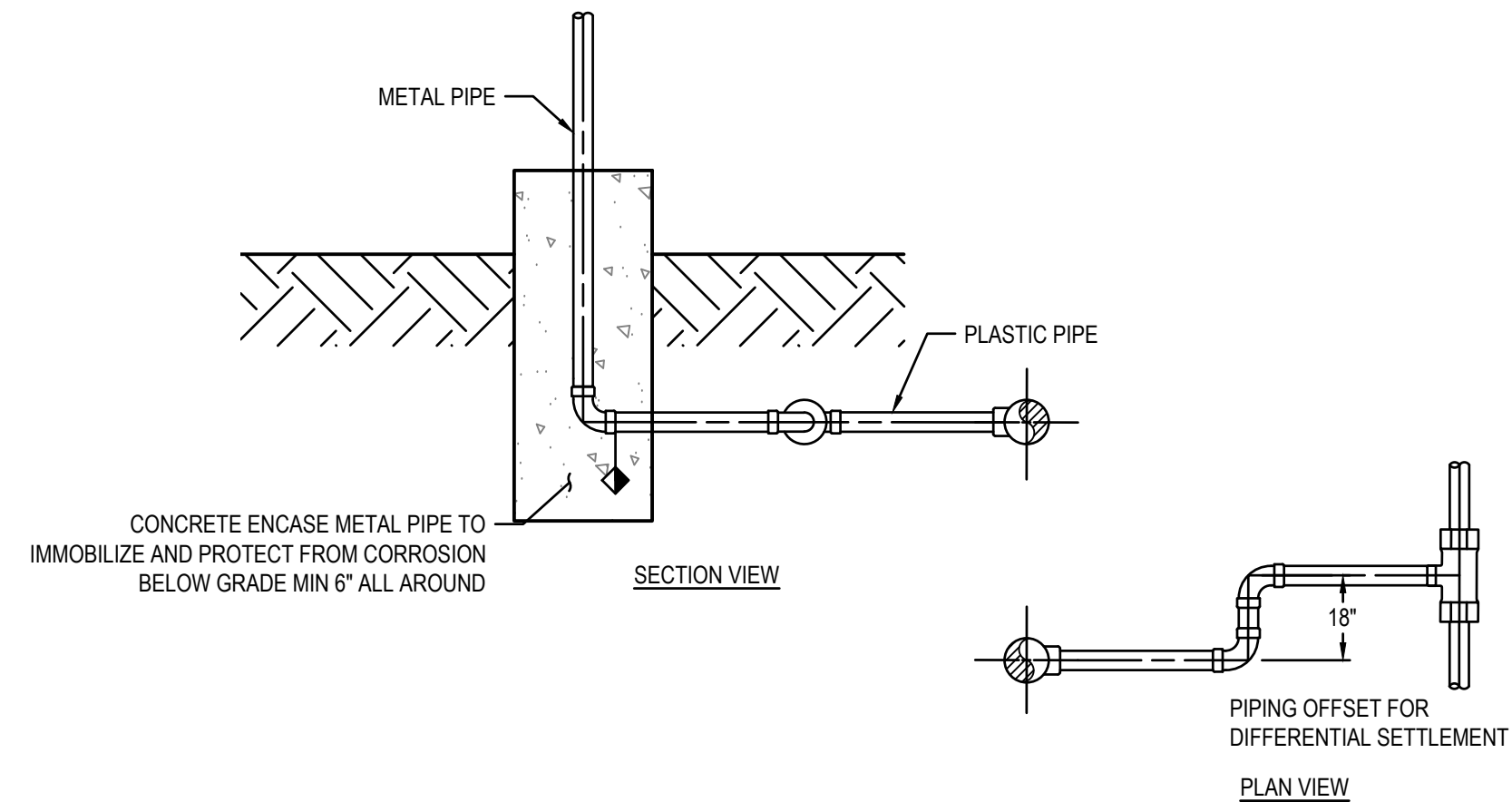
4
M-4



PIPE SUPPORT

NOT TO SCALE

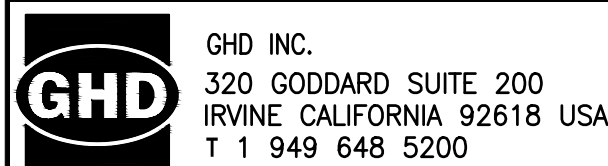
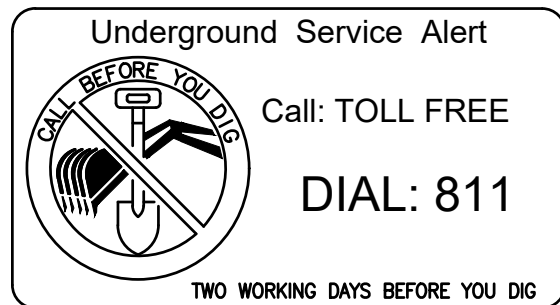
5
C-3



PIPE TRANSITION

NOT TO SCALE

6
-



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Chris Bartleman DATE
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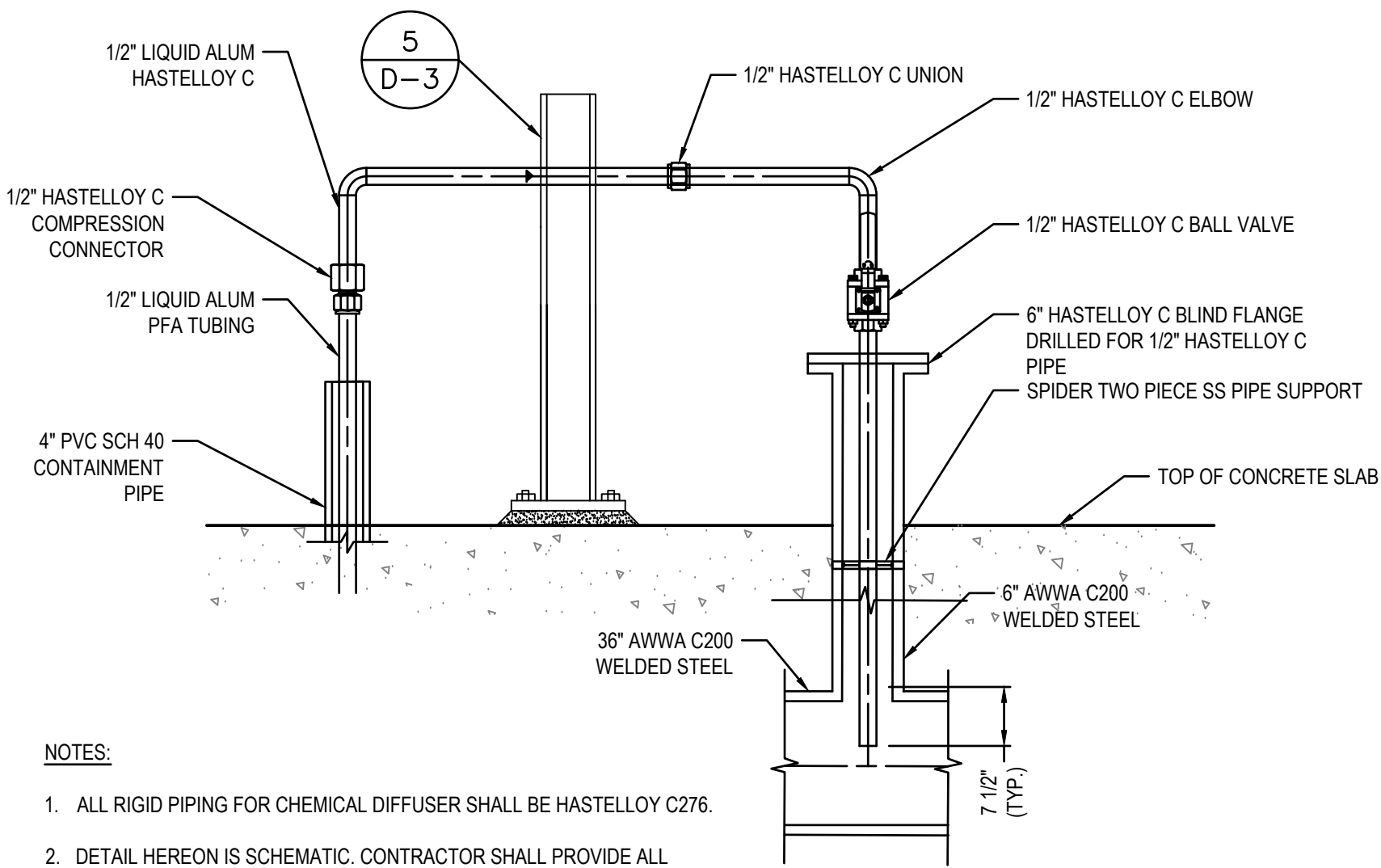
ENGINEER



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (3 OF 6)

DRAWING NO.
D-3
SH 13 OF 16





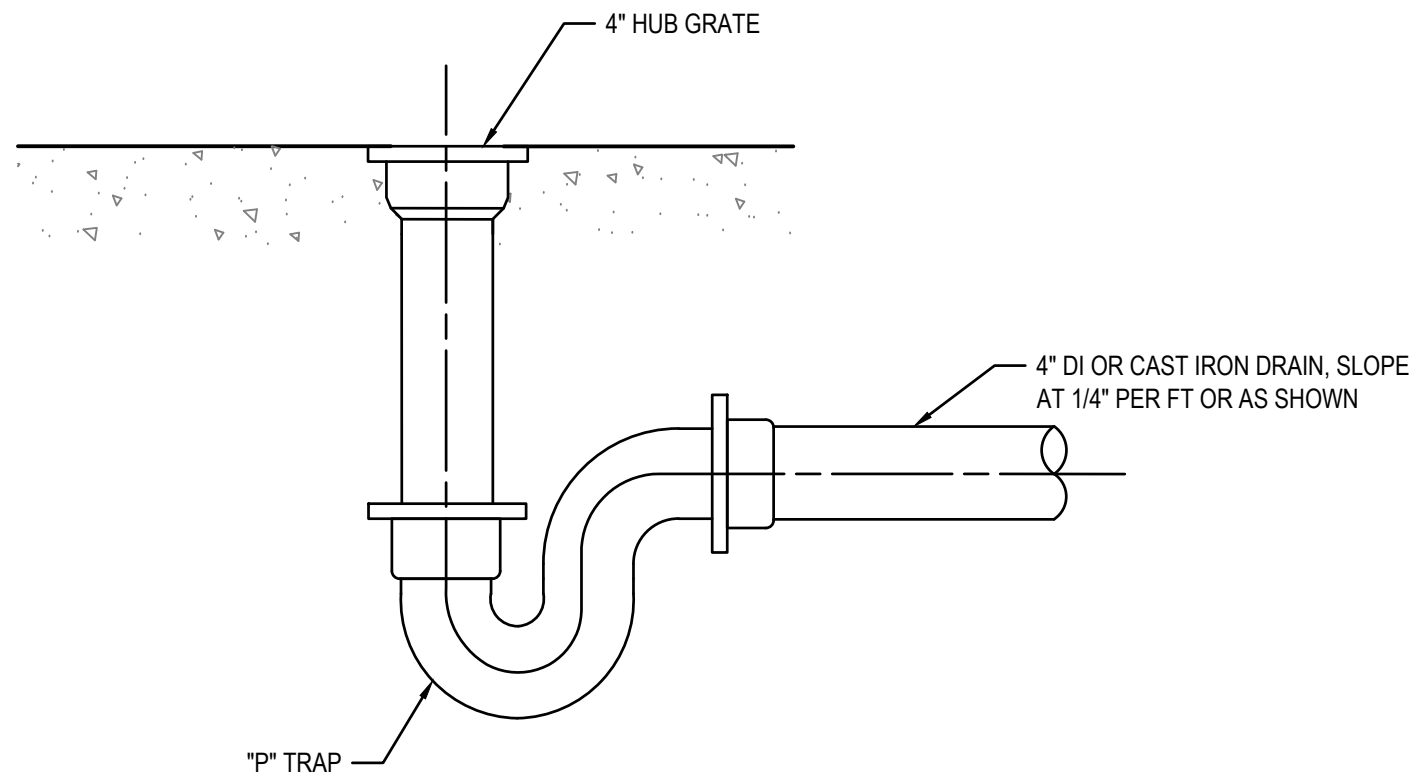
NOTES:

1. ALL RIGID PIPING FOR CHEMICAL DIFFUSER SHALL BE HASTELLOY C276.
2. DETAIL HEREON IS SCHEMATIC. CONTRACTOR SHALL PROVIDE ALL MATERIALS, FITTINGS, SUPPORTS AND ACCESSORIES.
3. ALUM FLOW= 0-32 GPH

CHEMICAL DIFFUSER

NOT TO SCALE

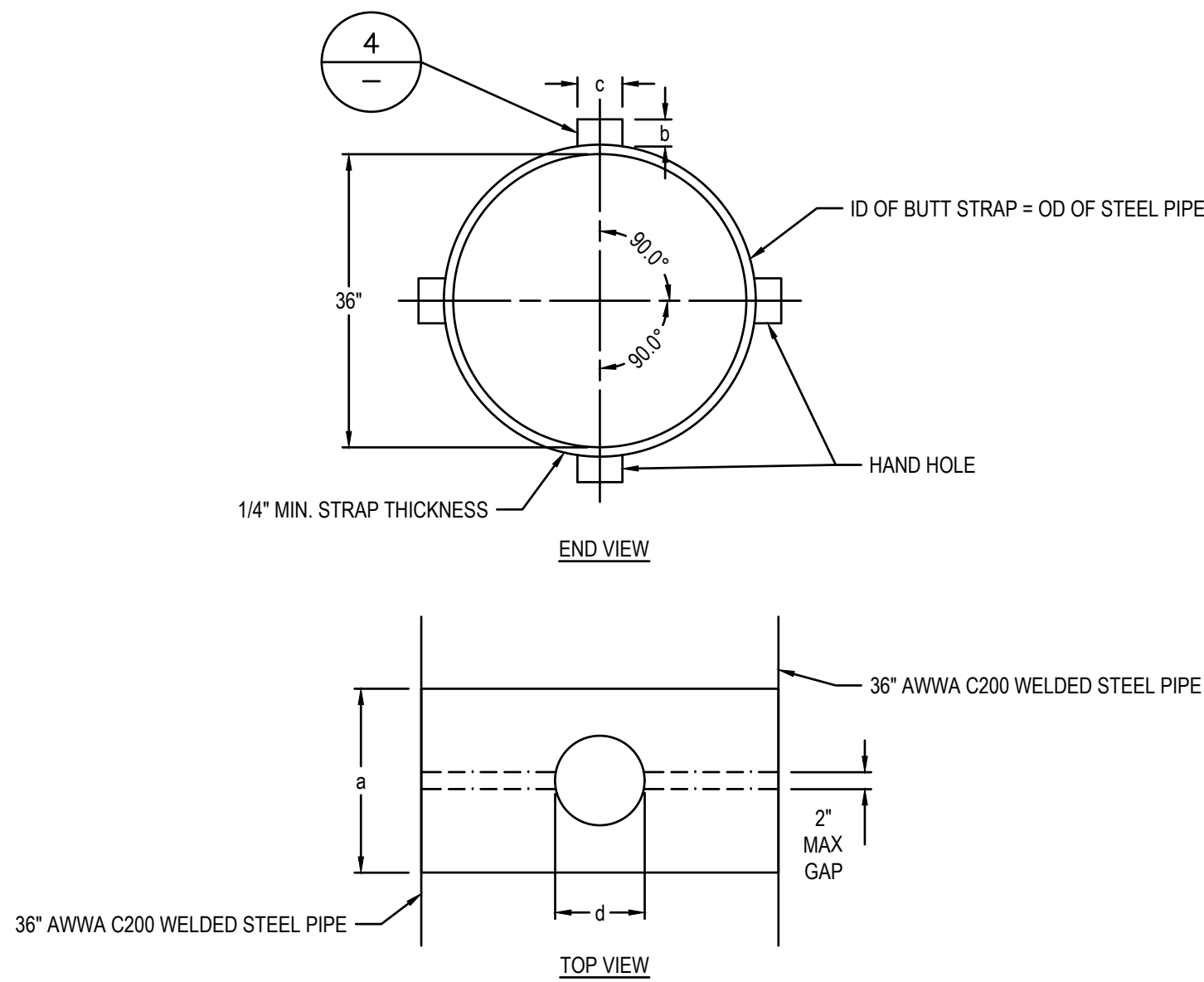
1
C-3



HUB DRAIN DETAIL

NOT TO SCALE

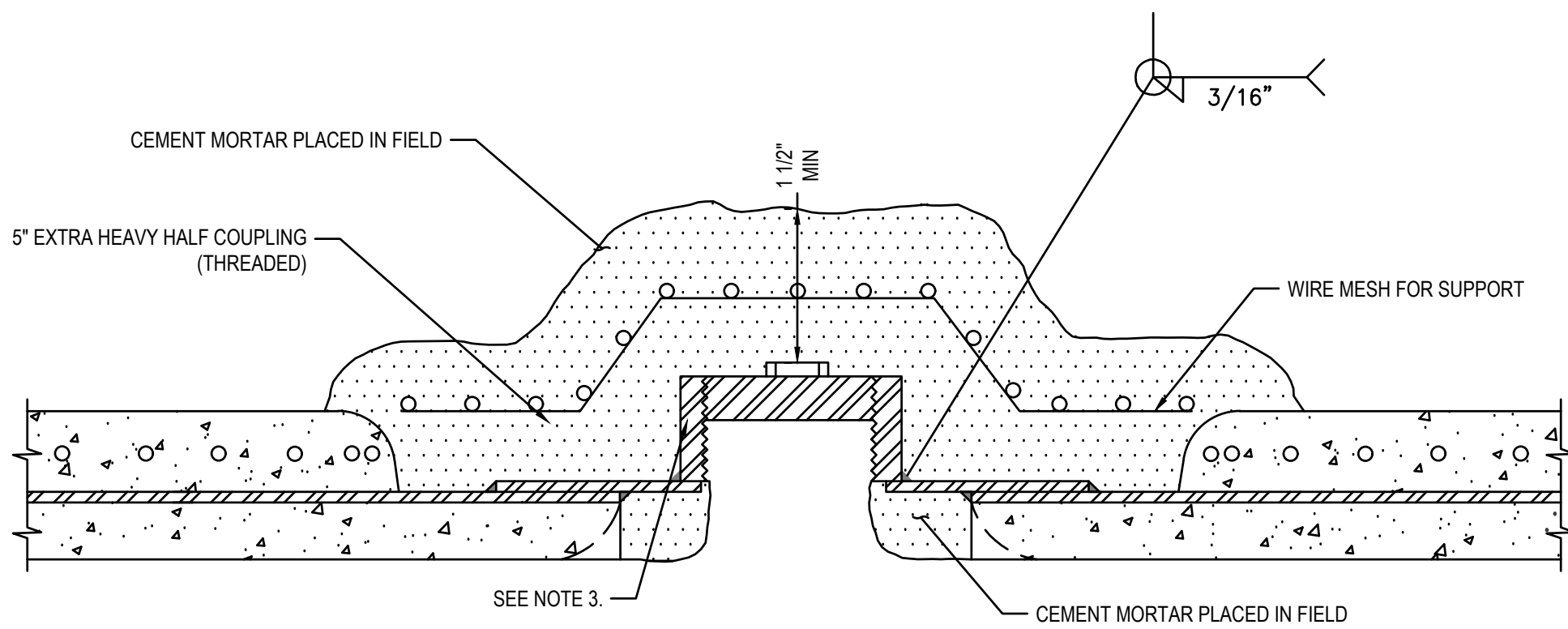
2
M-4



BUTT STRAP DETAIL

NOT TO SCALE

3
M-4



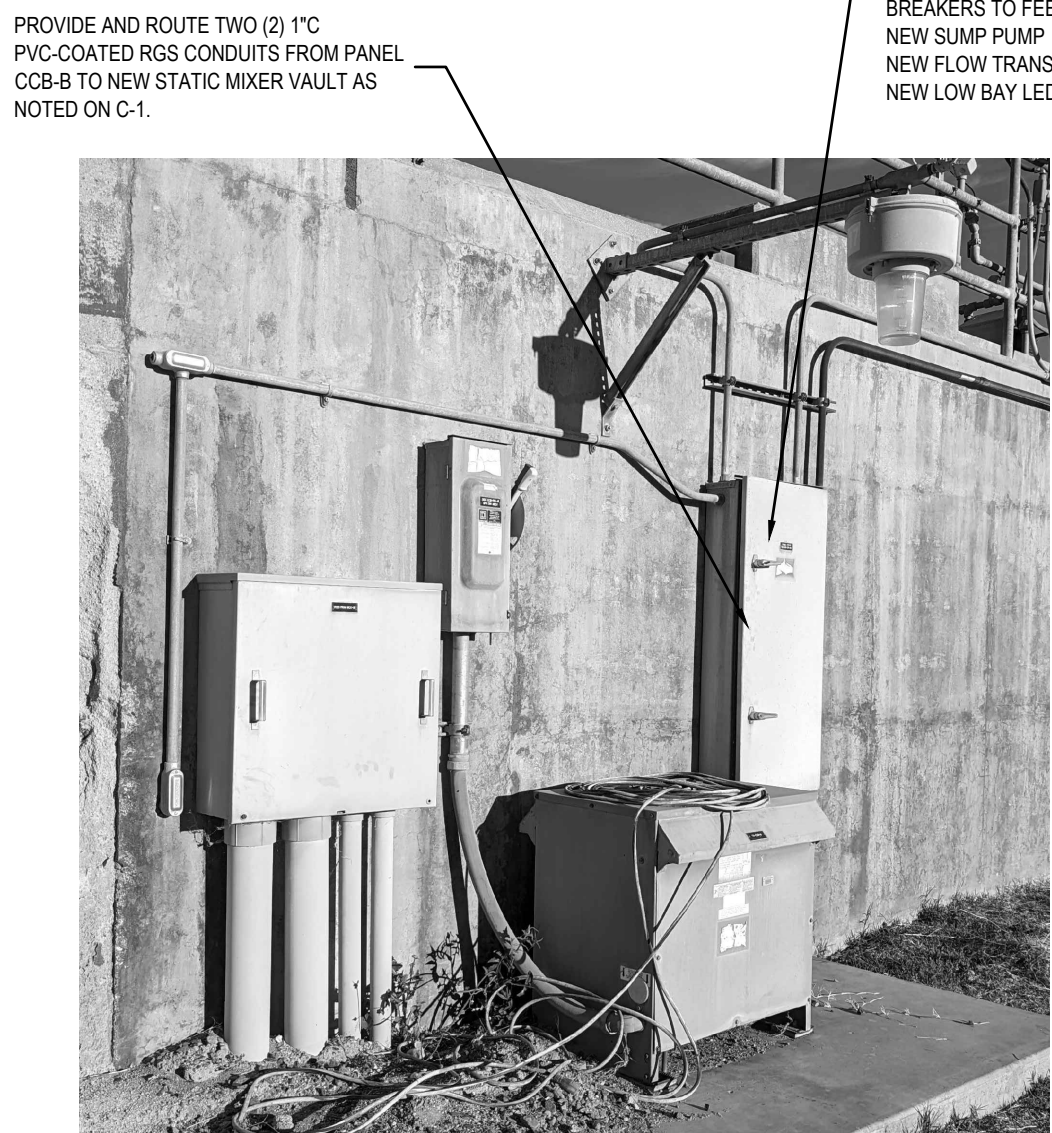
NOTE:

1. BUTT-STRAPS TO BE FURNISHED IN TWO PIECES AND SHIPPED LOOSE FOR FIELD JOINING. (BACKING PLATE SHALL BE 3/8\"/>

HANDHOLE DETAIL

NOT TO SCALE

4
M-4



PROVIDE AND ROUTE TWO (2) 1\"/>

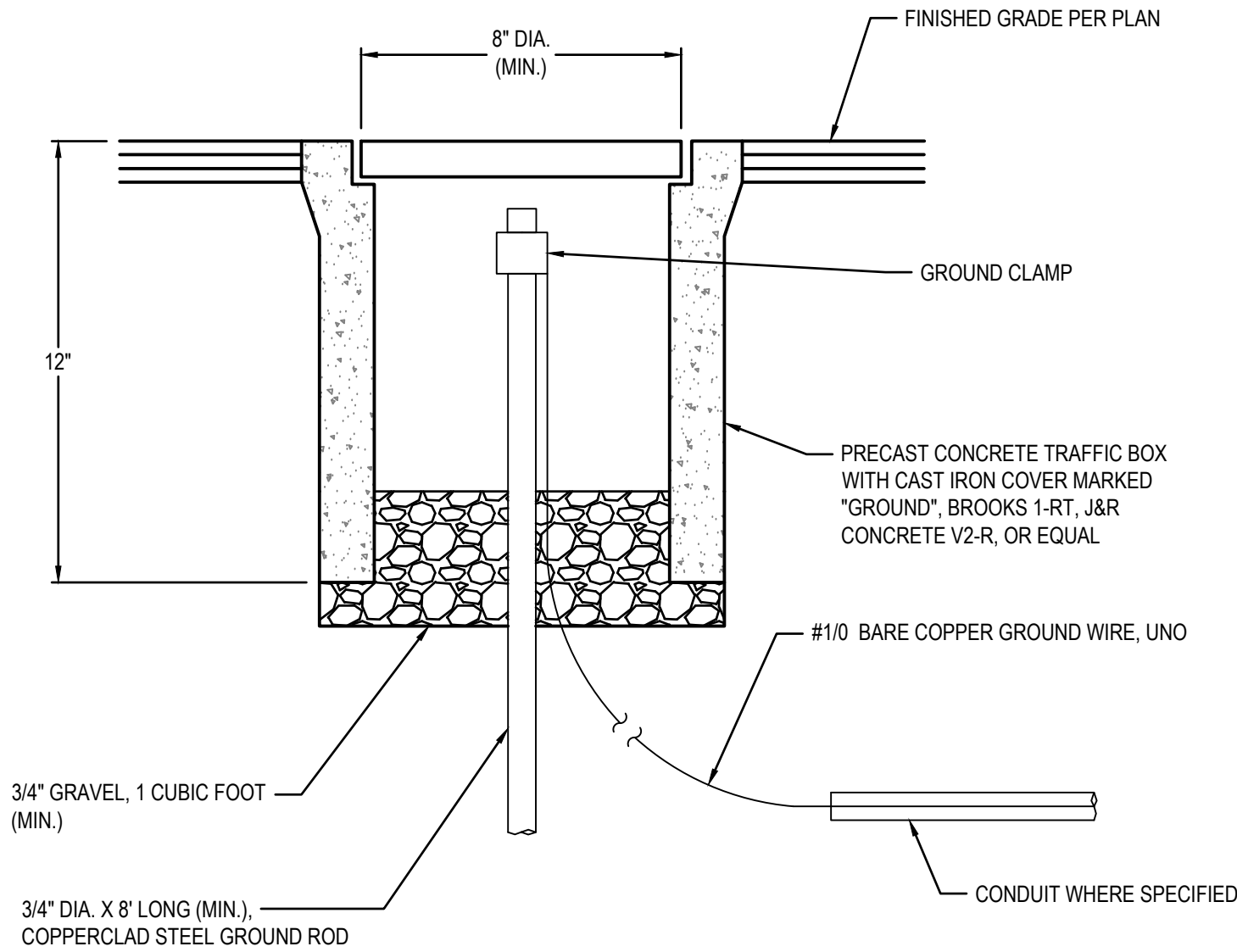
(E) PANEL CCB-B
PROVIDE THREE (3) 15A-1P BREAKERS TO FEED:
NEW SUMP PUMP
NEW FLOW TRANSMITTER
NEW LOW BAY LED LIGHTS



(E) PANEL CCB-B ELEVATION

NOT TO SCALE

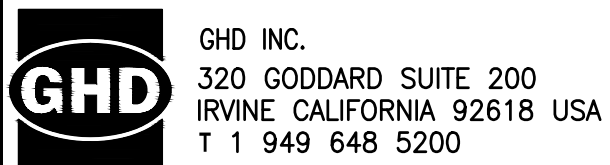
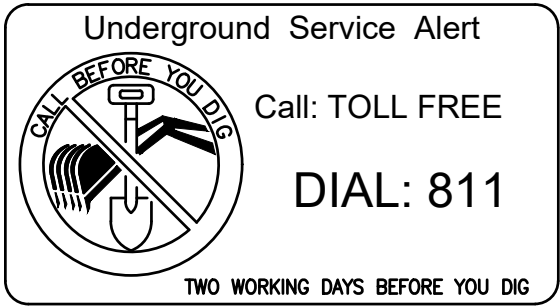
5
C-1



GROUND WELL DETAIL

NOT TO SCALE

6
C-1



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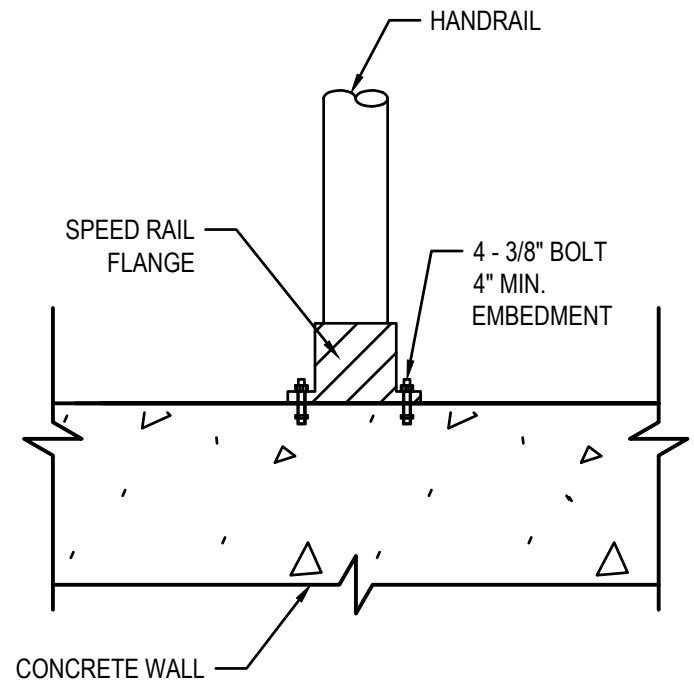
DATE

ENGINEER



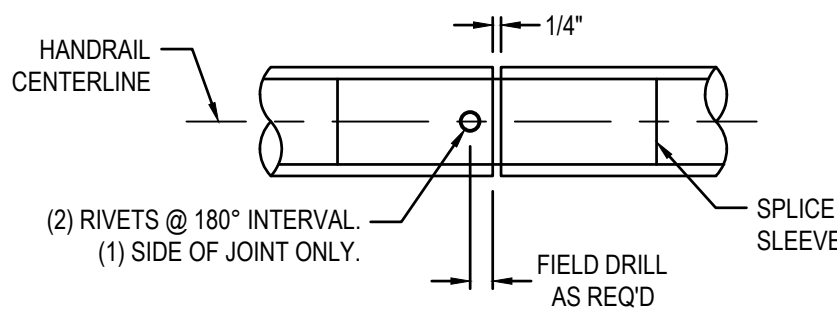
CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (4 OF 6)

DRAWING NO.
D-4
SH 14 OF 16



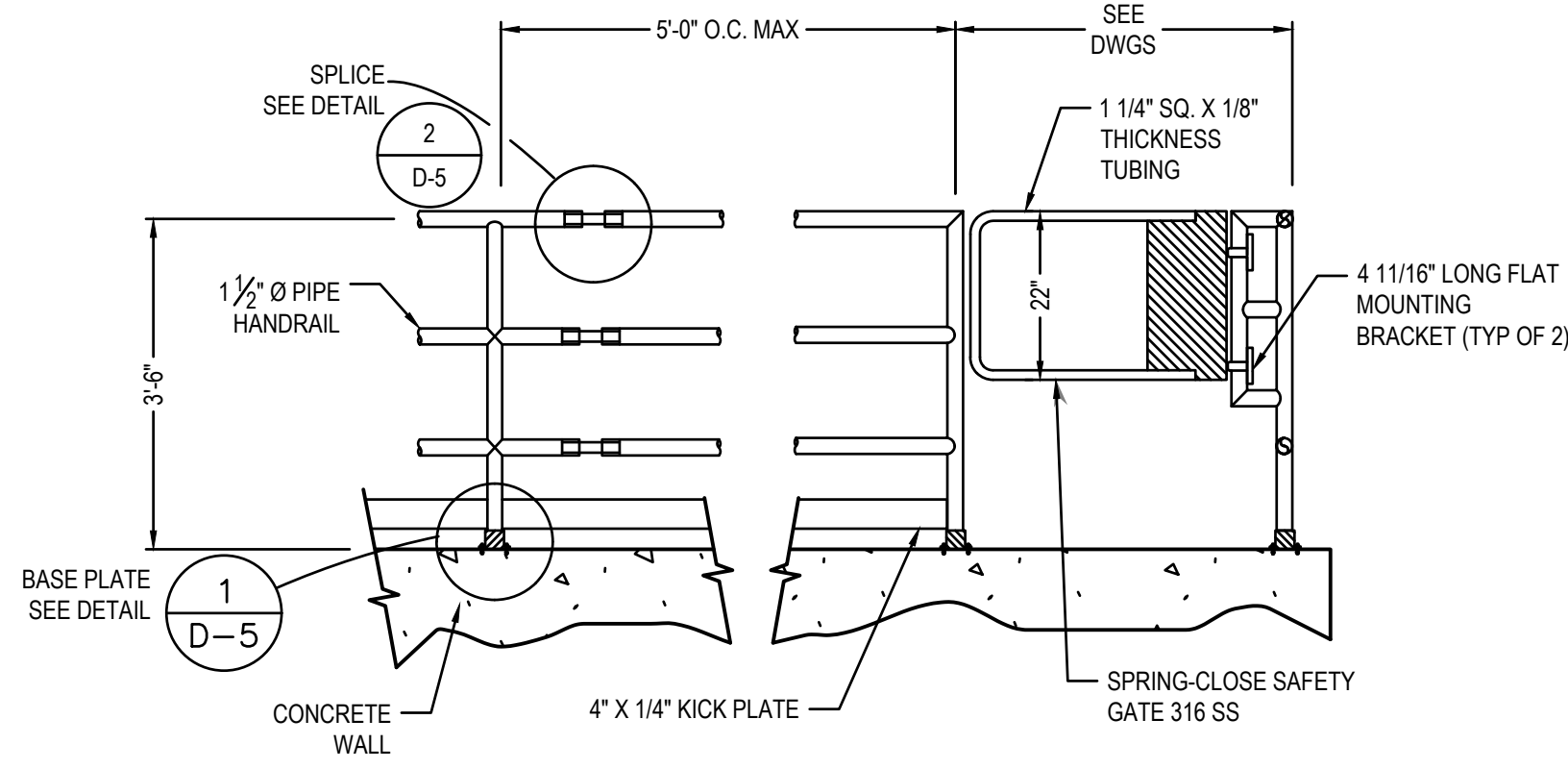
BASE PLATE DETAIL
NOT TO SCALE

1
D-5



SPLICE DETAIL
NOT TO SCALE

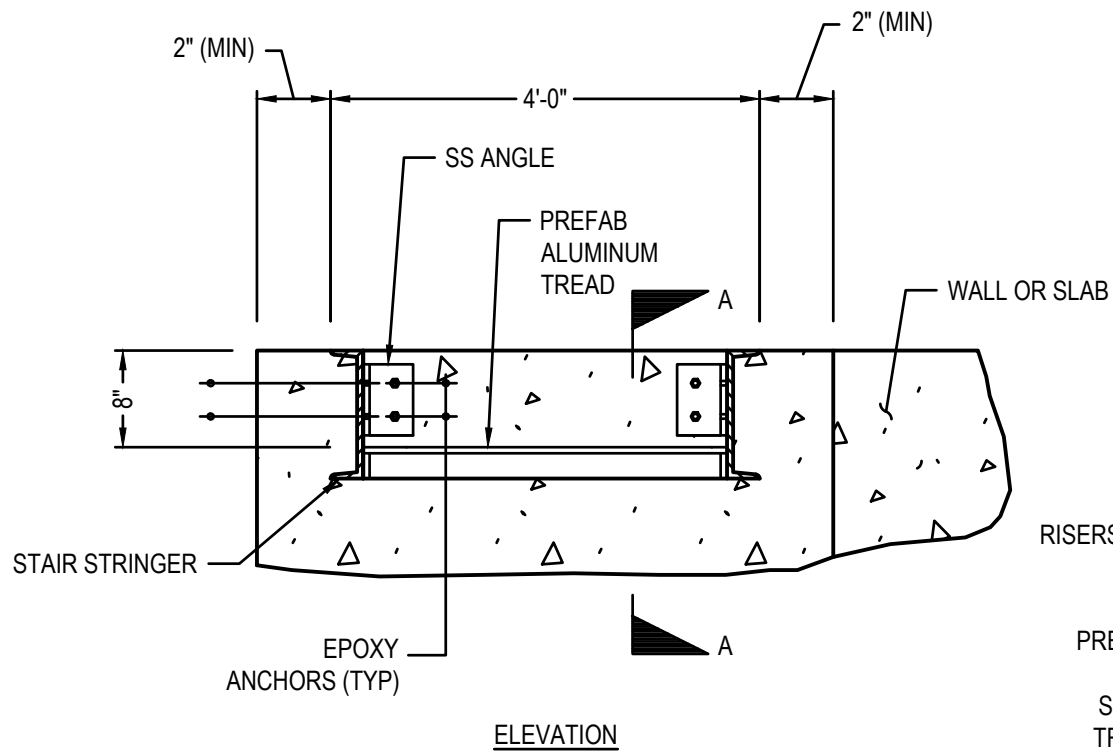
2
D-5



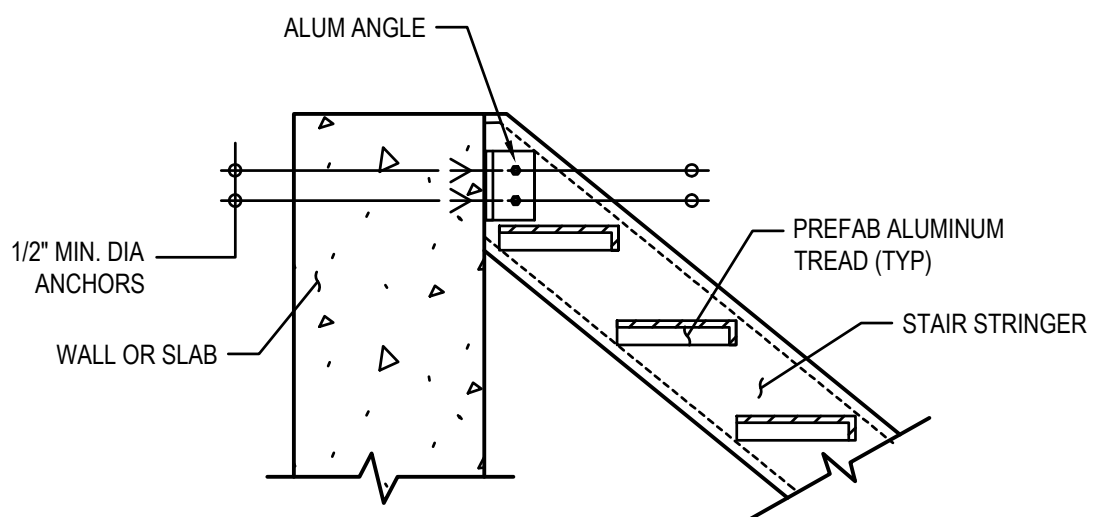
TYPICAL GUARDRAIL ELEVATION
NOT TO SCALE

3
M-1

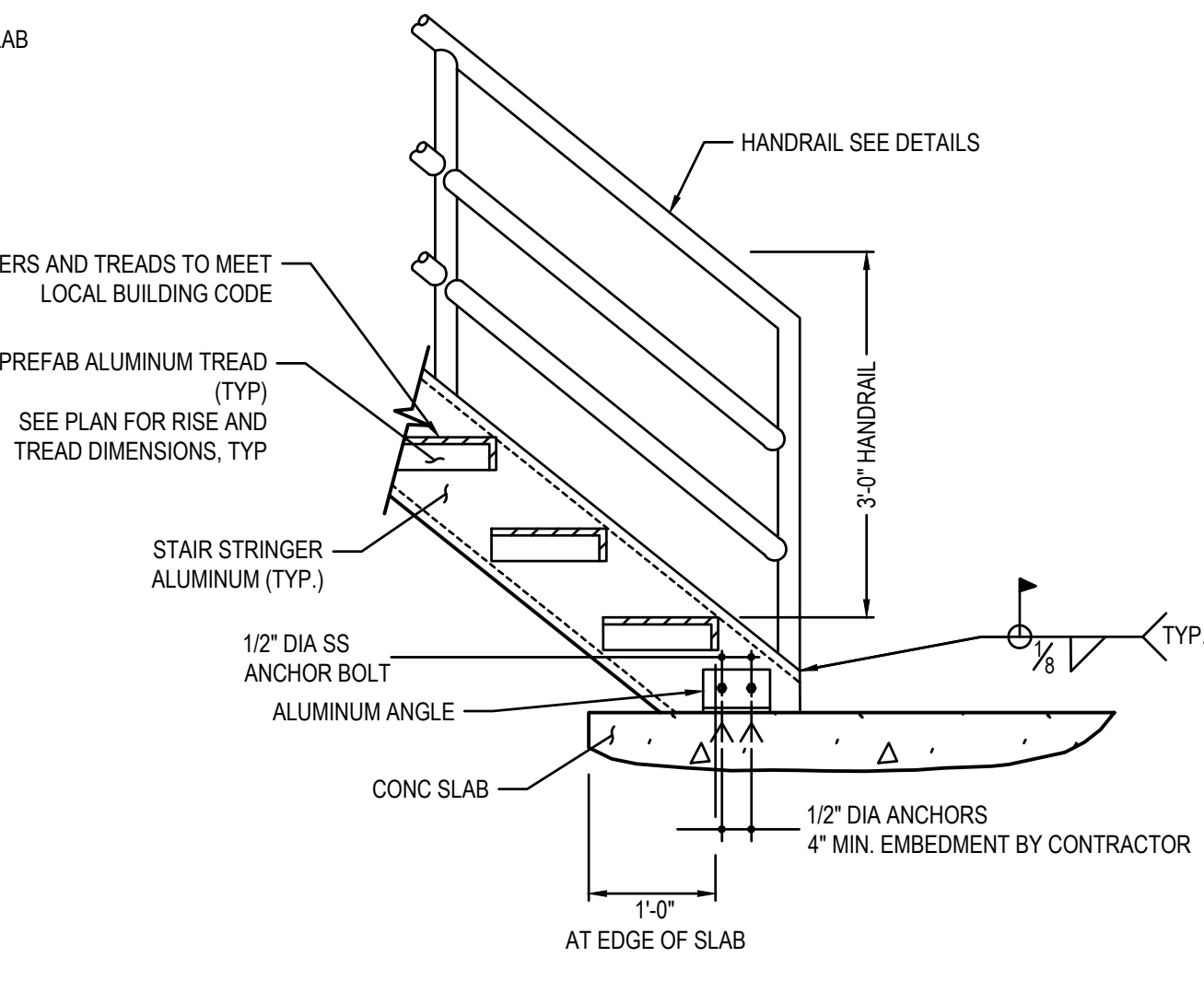
- NOTES:
1. ALL HANDRAILS SHALL BE IN ACCORDANCE W/ OSHA CODE REQUIREMENTS.
 2. ALL HANDRAIL KICKPLATES AND ACCESSORIES SHALL BE ALUMINUM PER SPECS.
 3. COAT ALL SURFACES OF ALUMINUM THAT COME IN CONTACT W/ STEEL & CONC. W/ BITUMASTIC COATING PER SPECS.
 4. ALL FASTENERS SHALL BE STAINLESS STEEL.
 5. ALL STAINLESS STEEL (SS) SHALL BE TYPE 316.
 6. ALL HARDWARE SHALL BE RATED AT 750 LBS.



ELEVATION



SECTION A-A

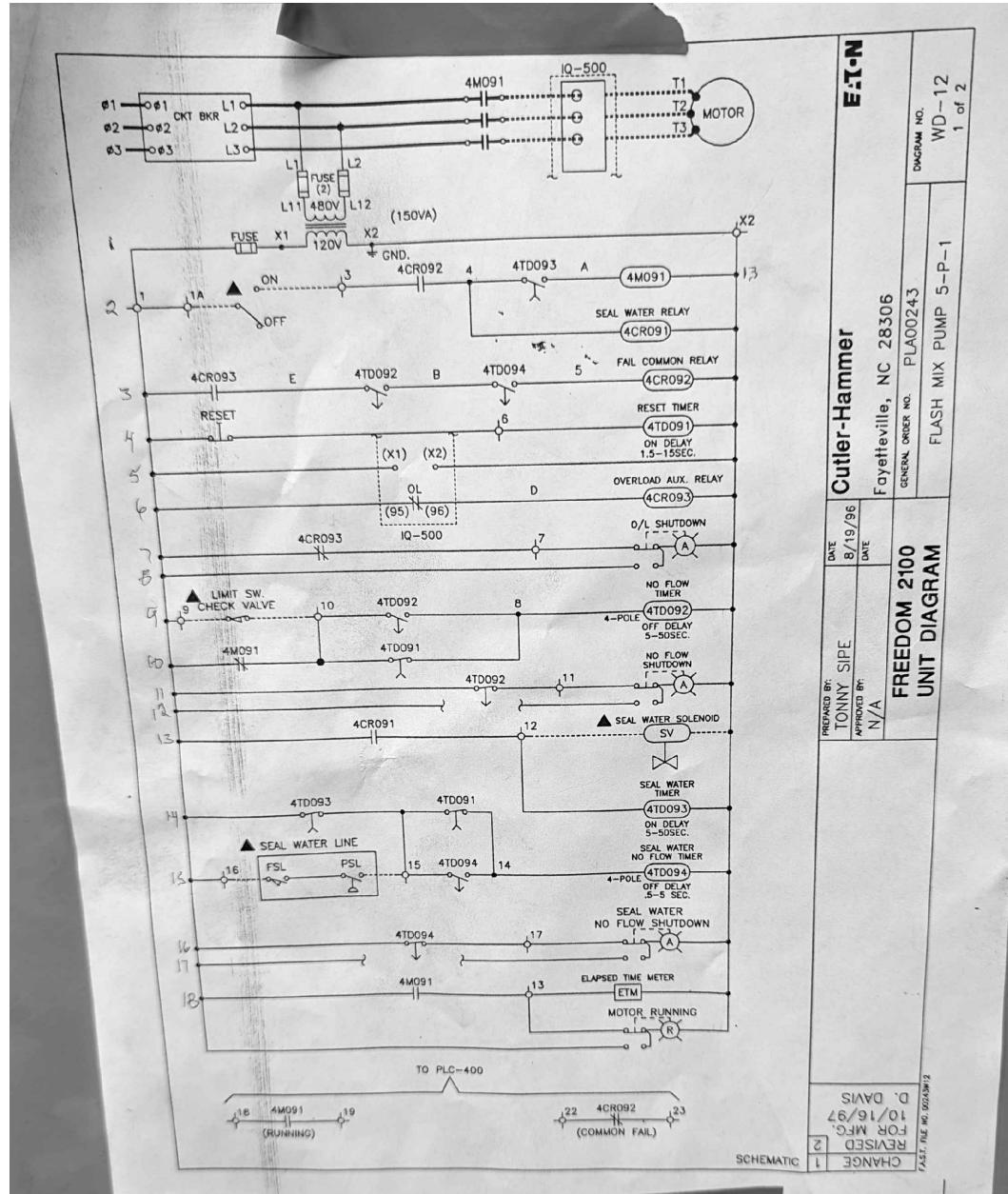


STAIR/SLAB

- NOTES:
1. ALL CHANNELS, PLATES, PIPE AND TREADS SHALL BE ALUMINUM PER SPECS.
 2. ALL FASTENERS SHALL BE STAINLESS STEEL TYPE 316.
 3. CONTRACTOR SHALL PROVIDE THE DESIGN BY A LICENSED ENGINEER IN THE STATE OF CALIFORNIA FOR ALL STAIRWAY, RAILING, AND LANDING COMPONENTS.

ALUMINUM STAIR DETAILS
NOT TO SCALE

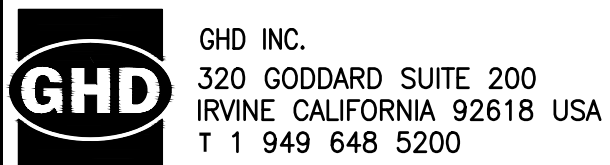
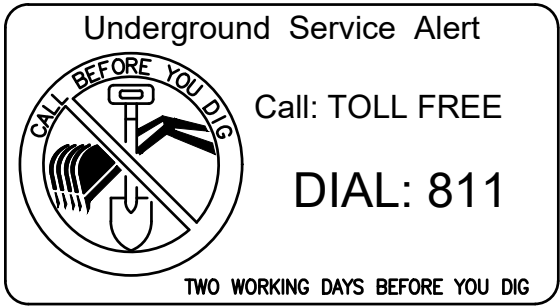
4
M-3



- NOTES:
1. CONTRACTOR SHALL REMOVE SEAL-WATER SYSTEM RELAYS AND AUXILIARIES, INCLUDING LIMIT SWITCHES, TIME DELAYS AND SEAL-WATER NO FLOW PILOT LIGHT.
 2. CONTRACTOR SHALL PROTECT IN PLACE FLASH MIXER STARTER, OVERLOADS, AND ALL CONTROL AUXILIARIES TO BE UTILIZED FOR THE NEW FLASH MIXER SYSTEM. REWIRE FROM FLASH MIXER EQUIPMENT TO MCC-4M.

(E) FLASH MIXER SECTION IN MCC-4M
NOT TO SCALE

5
M-4



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
CHRIS BARTLEMAN R.C.E. NO. 81075

DESIGNED BY:
DRAWN BY:
CHECKED BY:

BENCHMARK:

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2					
3					
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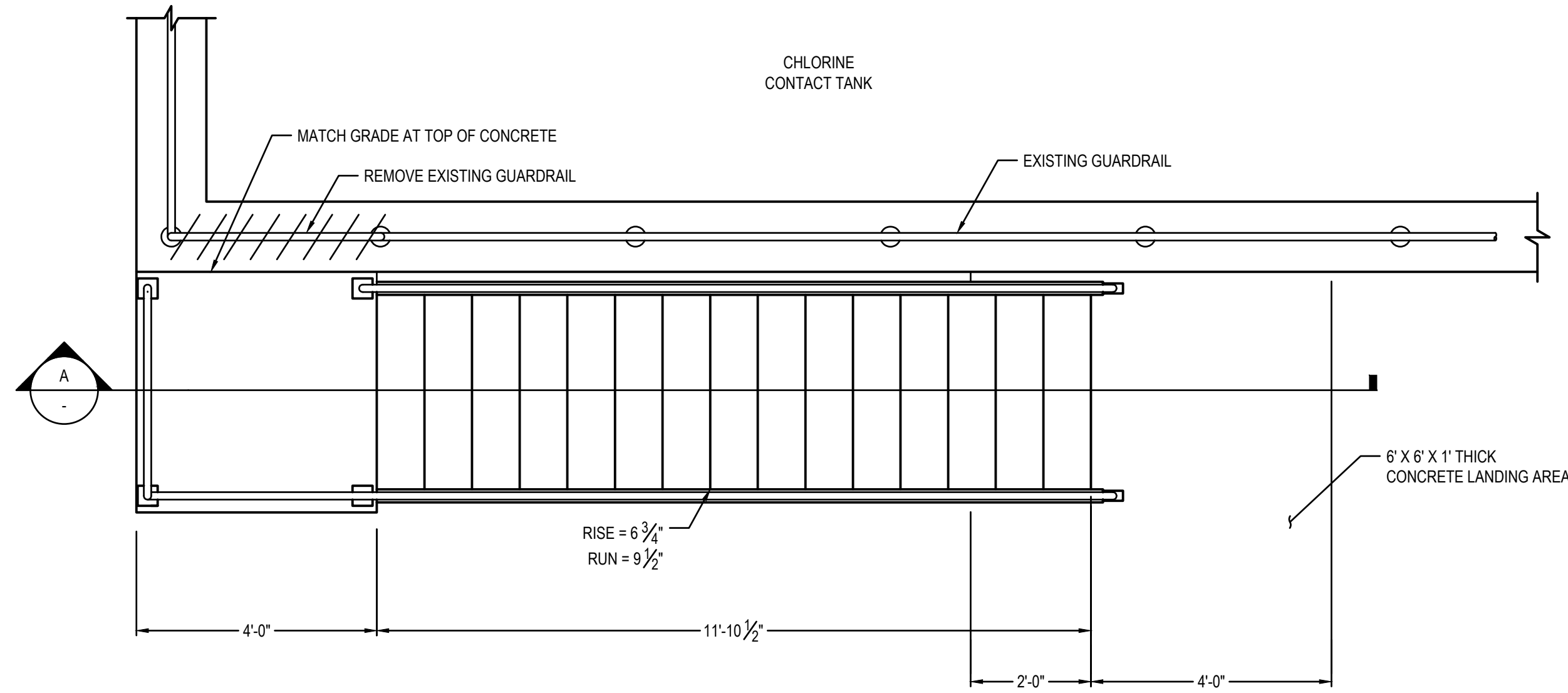
APPROVED FOR CONSTRUCTION:
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ENGINEER



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (5 OF 6)

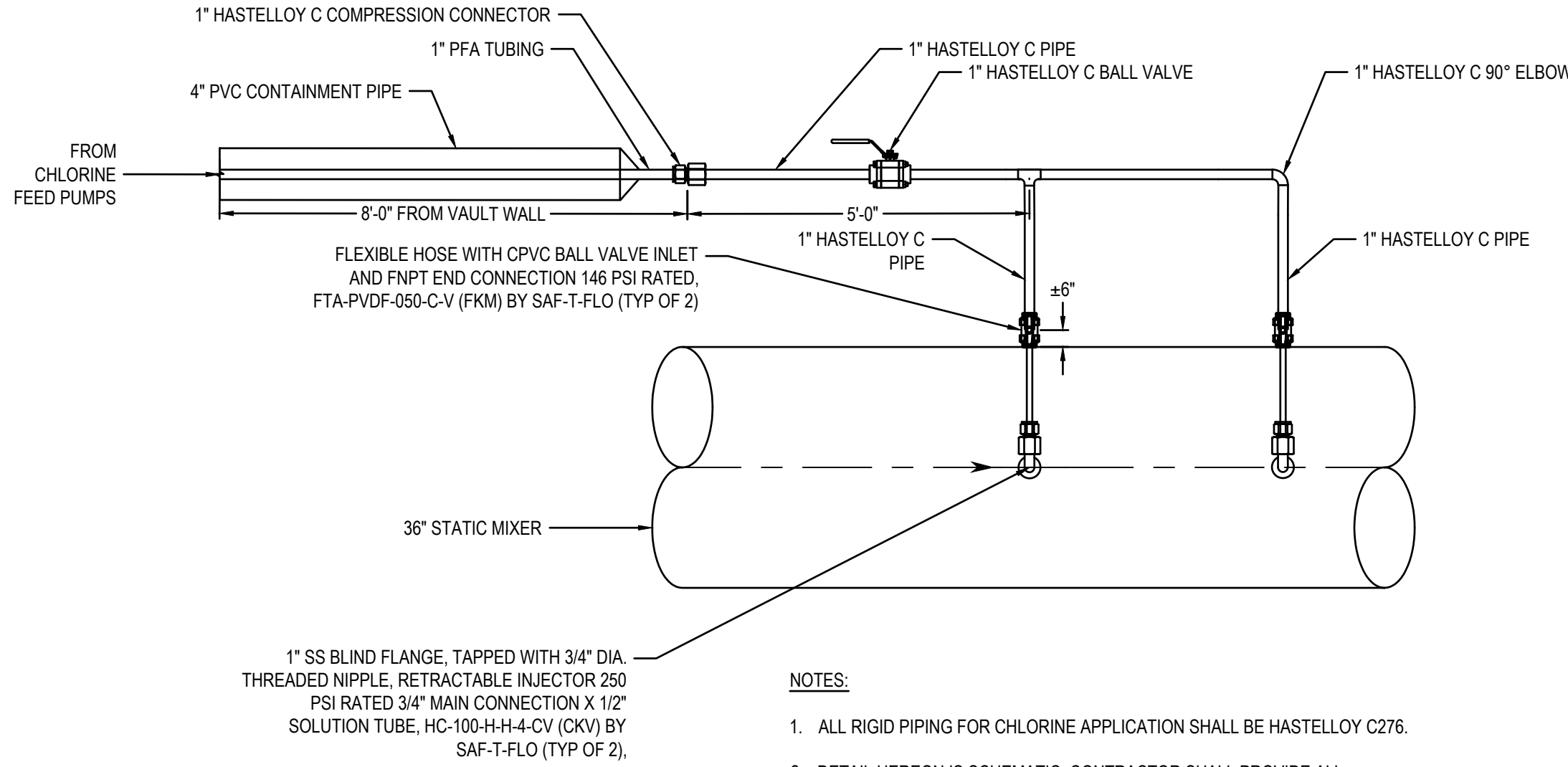


DRAWING NO.
D-5
SH 15 OF 16



CCT STAIRS PLAN
NOT TO SCALE

1
C-1

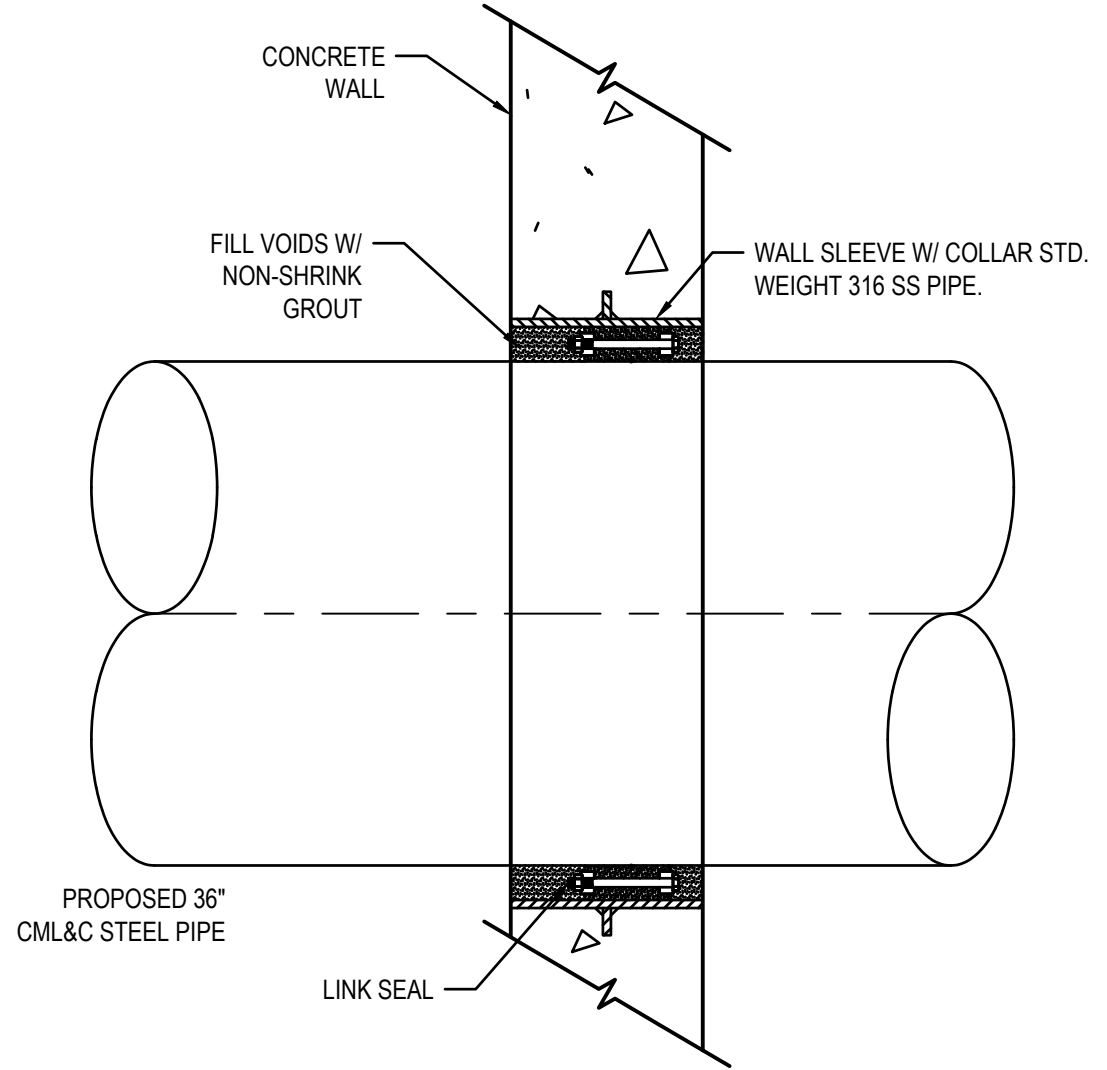


NOTES:

1. ALL RIGID PIPING FOR CHLORINE APPLICATION SHALL BE HASTELLOY C276.
2. DETAIL HEREON IS SCHEMATIC. CONTRACTOR SHALL PROVIDE ALL MATERIALS, FITTINGS, SUPPORTS AND ACCESSORIES FOR A FULLY FUNCTIONAL SYSTEM FOR REDUNDANT CHEMICAL FEED TO BOTH INJECTION POINTS.
3. CHEMICAL FEED RATE MAXIMUM OF 300 GPH.

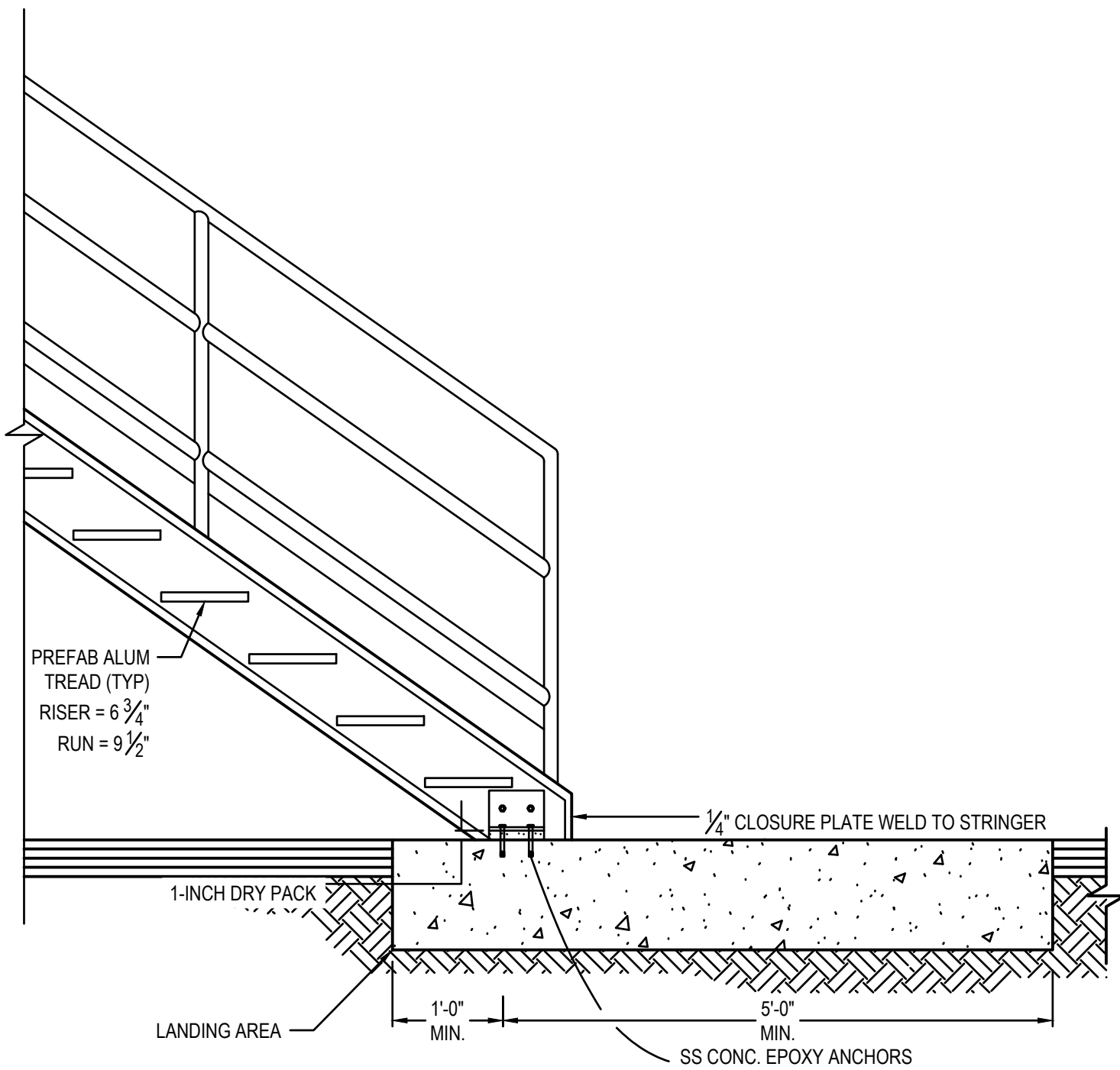
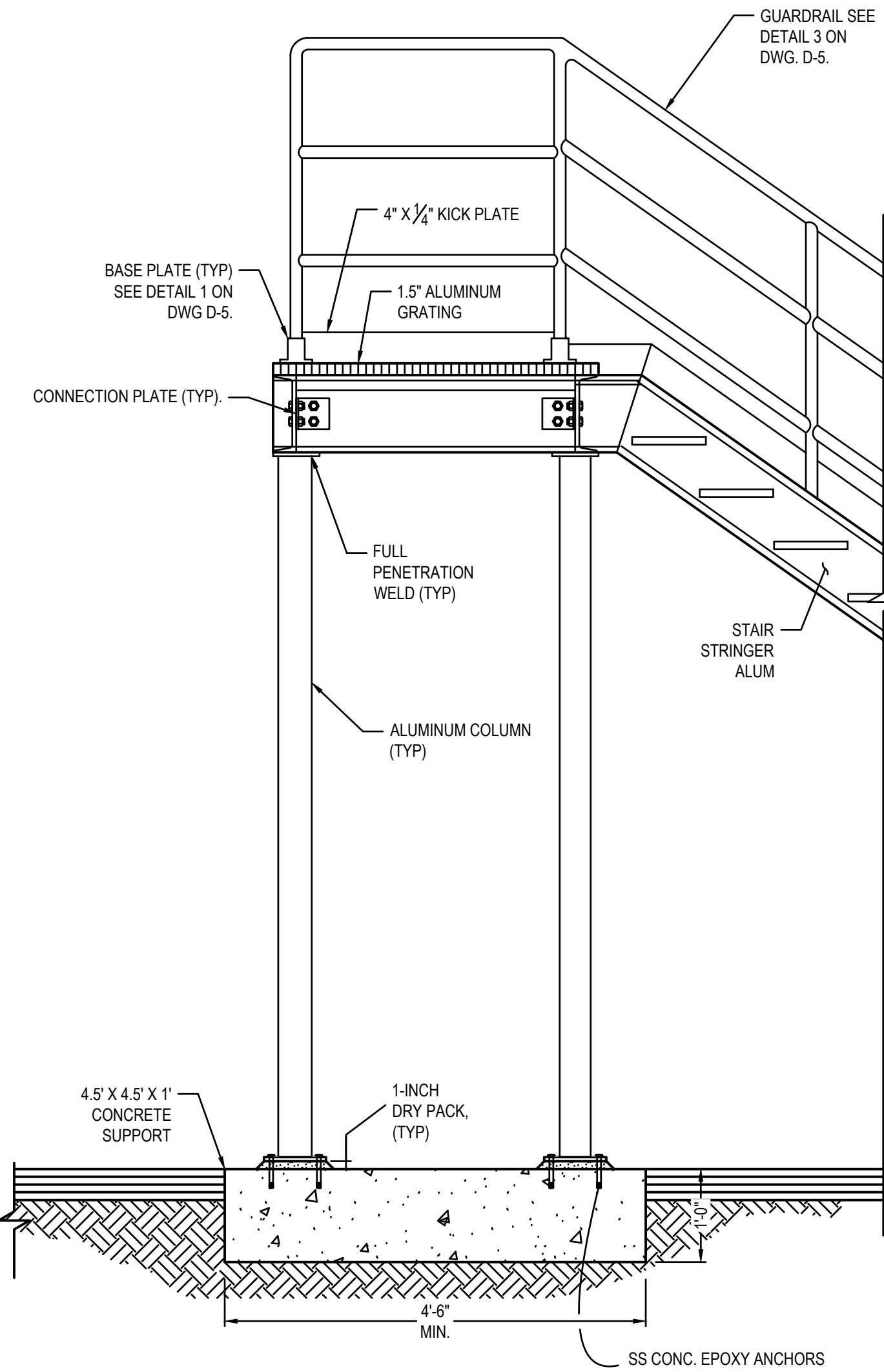
CHEMICAL INJECTION POINT DETAIL
NOT TO SCALE

2
M-2



WALL SLEEVE DETAIL
NOT TO SCALE

3
M-3

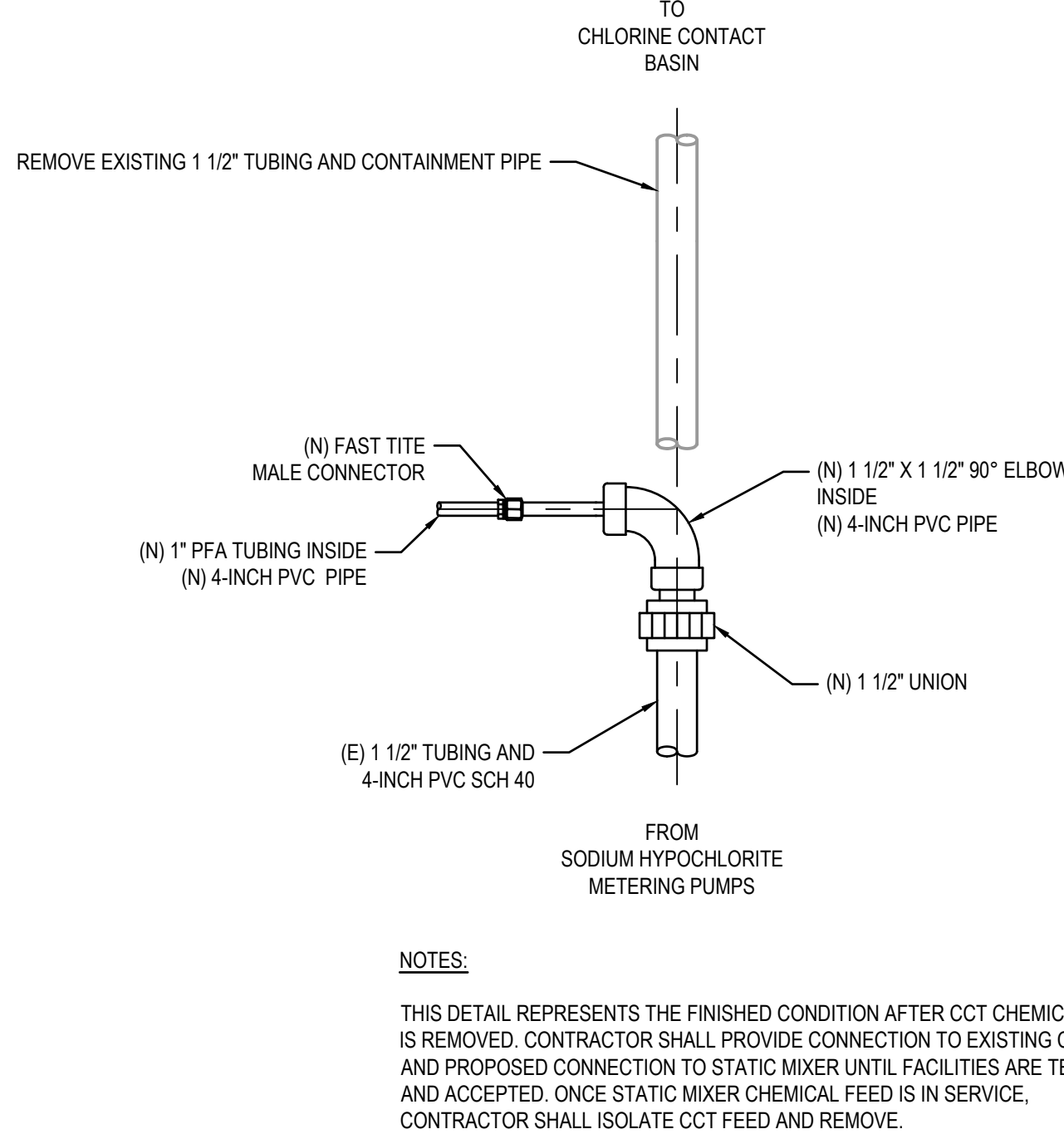


NOTES:

1. ALL CHANNELS, PLATES, PIPE AND TREADS SHALL BE ALUMINUM PER SPECS.
2. ALL FASTENERS SHALL BE STAINLESS STEEL TYPE 316.
3. CONTRACTOR SHALL PROVIDE THE DESIGN BY A LICENSED ENGINEER IN THE STATE OF CALIFORNIA FOR ALL STAIRWAY, RAILING, AND LANDING COMPONENTS.

CCT STAIRS SECTION
NOT TO SCALE

A
C-1

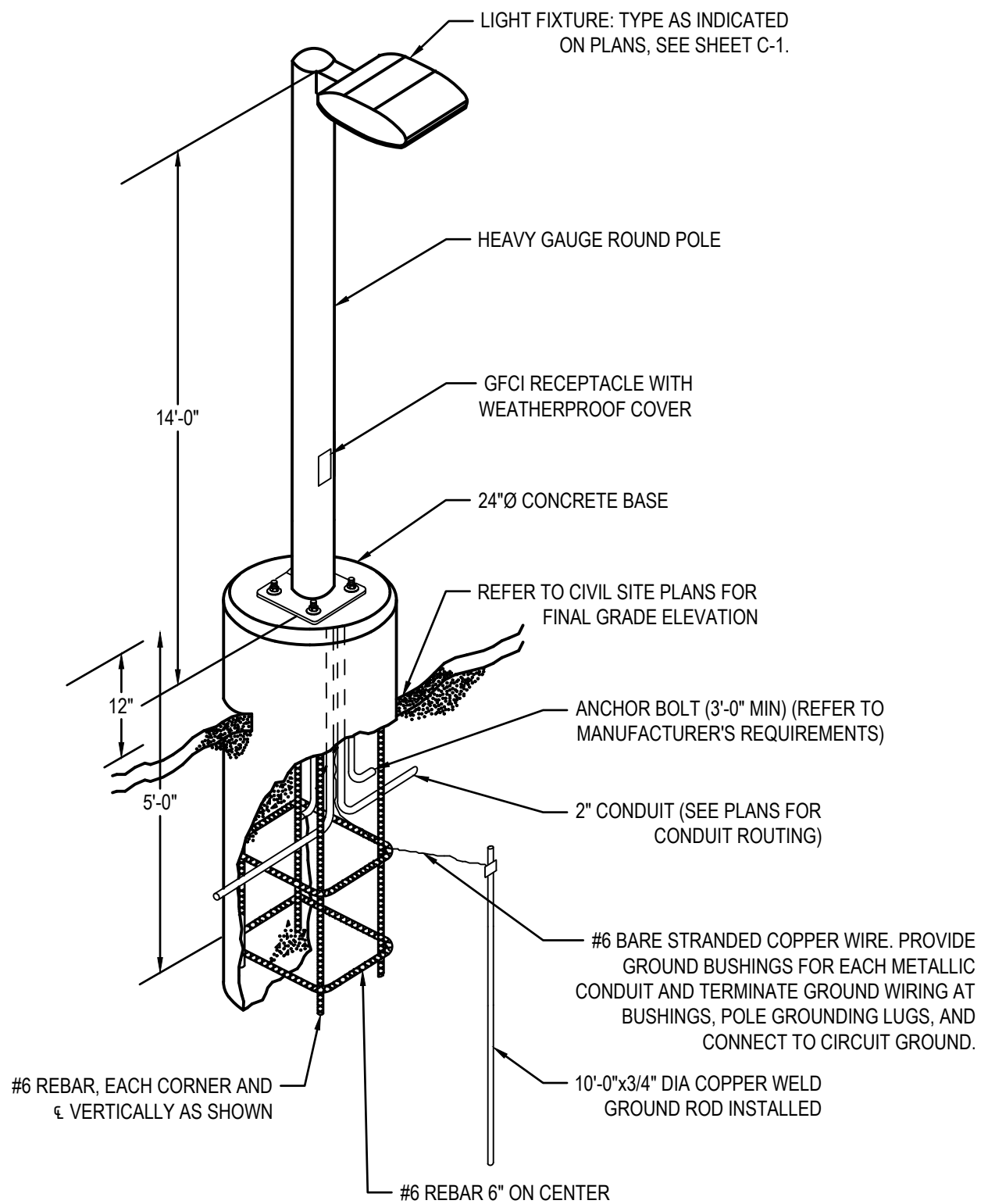


NOTES:

THIS DETAIL REPRESENTS THE FINISHED CONDITION AFTER CCT CHEMICAL FEED IS REMOVED. CONTRACTOR SHALL PROVIDE CONNECTION TO EXISTING CCT AND PROPOSED CONNECTION TO STATIC MIXER UNTIL FACILITIES ARE TESTED AND ACCEPTED. ONCE STATIC MIXER CHEMICAL FEED IS IN SERVICE, CONTRACTOR SHALL ISOLATE CCT FEED AND REMOVE.

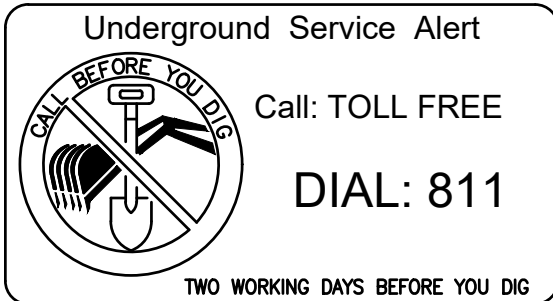
SODIUM HYPO INJECTION
PIPE CONNECTION
NOT TO SCALE

4
C-2



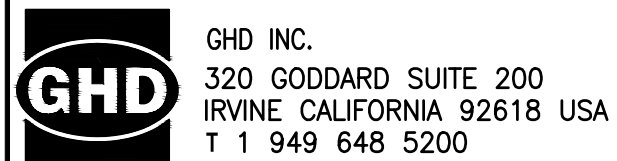
POLE MOUNT AND LIGHT FIXTURE DETAIL
NOT TO SCALE

5
C-1



CCT STAIRS SECTION
NOT TO SCALE

A
C-1



PLANS PREPARED UNDER SUPERVISION OF:
Chris Bartleman DATE
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ENGINEER

DATE



CITY OF CORONA
WRF1-CCT INFLUENT VAULT STATIC
MIXER & FILTER INFLUENT FLASH MIXER
DETAILS (6 OF 6)

DRAWING NO.
D-6
SH 16 OF 16



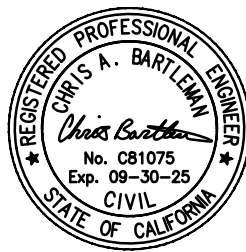
CITY OF CORONA

WATER RECLAMATION FACILITY #1

**CCT INFLUENT VAULT STATIC MIXER AND
FILTER INFLUENT FLASH MIXER UPGRADES**

TECHNICAL SPECIFICATIONS

FOR BIDDING



FEB 2024

**TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS****DIVISION 1 – (01 00 00) – GENERAL REQUIREMENTS**

01 10 01	SUMMARY OF WORK AND CONTRACT
01 29 73	SCHEDULE OF VALVES
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01 32 23	CONSTRUCTION SURVEY STAKING
01 32 33	CONSTRUCTION PHOTOGRAPHIC AND VIDEO DOCUMENTATION
01 33 00	SUBMITTAL PROCEDURES
01 35 26	GOVERNMENTAL SAFETY REQUIREMENTS
01 35 44	ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIALS
01 40 00	QUALITY REQUIREMENTS
01 50 00	TEMPORARY FACILITIES AND CONTROLS
01 61 00	COMMON PRODUCT REQUIREMENTS
01 65 00	PROJECT DELIVERY REQUIREMENTS
01 66 00	PRODUCT STORAGE AND HANDLING REQUIREMENTS
01 73 00	BASIC EXECUTION AND INSTALLATION REQUIREMENTS
01 73 24	SEISMIC RESTRAINT
01 73 33	MECHANICAL IDENTIFICATION

DIVISION 2 – (02 00 00) – SITE WORK

02 41 13	SELECTIVE SITE DEMOLITION

DIVISION 3 – (03 00 00) – CONCRETE

03 10 00	CONCRETE FORMWORK
03 15 00	CONCRETE ACCESSORIES
03 20 00	CONCRETE REINFORCING
03 30 00	CAST IN PLACE CONCRETE
03 32 10	CEMENT MORTAR
03 39 00	CONCRETE CURING
03 60 00	GROUTING

DIVISION 5 – (05 00 00) – METALS

05 05 19	POST-INSTALLED CONCRETE ANCHORS
05 05 23	METAL FASTENINGS AND WELDS
05 50 00	METAL FABRICATIONS
05 51 00	STAIRS, LADDERS, AND PLATFORMS
05 52 00	RAILINGS
05 53 00	GRATINGS AND FLOOR PLATES

DIVISION 9 – (09 00 00) – FINISHES

09 90 00	PAINTING AND COATING
09 92 00	GALVANIZING
09 96 56	EPOXY LINING AND COATING

DIVISION 26 – (26 00 00) – ELECTRICAL

26 05 10	COMMON WORK RESULTS FOR ELECTRICAL
26 05 19	LOW-VOLTAGE ELECTRICAL CONDUCTORS AND CABLES
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
26 05 47	CABINETS AND ENCLOSURES
26 08 00	COMMISSIONING OF ELECTRICAL SYSTEMS

DIVISION 31 – (31 00 00) – EARTH WORK

31 05 50 PROTECTING EXISTING UTILITIES
31 23 00 EXCAVATION AND FILL
31 23 13 SUBGRADE PREPARATION

DIVISION 33 – (33 00 00) – UTILITIES

33 05 26 UTILITY IDENTIFICATION
33 05 31 PIPELINE JOINT MATERIALS
33 05 33 COUPLINGS, TIE RODS, FLANGE CONNECTORS, AND UNIONS
33 05 34 GROOVED AND SHOULDERED (VICTAULIC STYLE) COUPLINGS
33 05 38 HANGERS AND SUPPORTS
33 05 39 MANUAL VALVE OPERATORS
33 11 18 CEMENT MORTAR LINING AND COATING OF STEEL PIPE
33 11 20 POLYETHYLENE ENCASEMENT FOR IRON PIPE, FITTINGS, COUPLINGS, AND
 VALVES
33 12 26 AIR VACUUM ROOL SEAL WATER VALVES

DIVISION 40 – (40 00 00) – PROCESS INTEGRATION

40 23 38 CHEMICAL FEED SOLUTION PIPING, VALVES, AND APPURTENANCES
40 71 13 MAGNETIC FLOW METER

DIVISION 43 – (430000) – PROCESS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

43 23 13 HORIZONTAL CENTRIFUGAL FRAME MOUNTED END SUCTION PUMPS

DIVISION 46 – (46 00 00) –EQUIPMENT

46 41 17 INLINE STATIC MIXER AND INJECTION EQUIPMENT

SECTION 01 10 01

SUMMARY OF WORK AND SEQUENCE OF CONSTRUCTION

PART 1 - GENERAL

1.1 Work Covered by Contract Documents

- A. Summary of Work, location, Work sequence, closeout, Contractor use of premises, and activities by others at Project site.
- B. Work includes furnishing products, labor, tools, transportation, and services to:
 - 1. Protect existing facilities in place.
 - 2. Maintain water compliance sample service.
 - 3. Maintain compliance for chlorine contact feed throughout construction.
 - 4. Continuously maintain filter influent and chlorine contact tank influent flows throughout construction.
 - 5. No demolition work shall proceed prior to receipt of confirmation of delivery dates from Manufacturers of manufactured items having >30 days lead time.
 - 6. Modify existing facilities as required to facilitate interface and connection to new improvements.
 - 7. Construct static mixer and flow meter vault facilities
 - 8. Demolish existing Chlorine Contact Tank chemical feed, influent piping, flash mixer facility, chemical feed pipe, CCT Rapid Mixer panel, and associated electrical.
 - 9. Construct chlorine contact tank (CCT) stairway and landings.
 - 10. Construct flash mixer pump station and chemical feed facilities
 - 11. Construct sitework, including grading, retaining walls, concrete flatwork, paving, , landscaping, and miscellaneous site improvements.
 - 12. Pressure test new work
 - Regrade and pave site to restore paving and sitework to preconstruction condition and provide access to new equipment.
- C. Furnish and install complete operating engineered systems, including appurtenant structural, mechanical and/or electrical mountings fittings or connections required for
 - 1. Compliance with Manufacturer's installation requirements,
 - 2. As needed to permit systems to perform functions required by Contract Documents and described in Manufacturer's printed literature.
- D. Contractor's submission of bid shall constitute acknowledgment that, if awarded contract, they have relied upon and are relying upon their own examination of:
 - 1. Contract Documents
 - 2. Available geotechnical information.
 - 3. Work site
 - 4. Access to Work site
 - 5. Electrical service available at Work site.
 - 6. Conditions under which Work is to be performed.
 - 7. Existing facilities on and near Work site.
 - 8. Data and matters requisite to completion of Work.

1.2 Related Work

- A. Section 01 32 00: Construction Progress Documentation
- B. Section 01 35 26: Governmental Safety Requirements
- C. Section 26 05 10: Common Work Results for Electrical

1.3 **Project Location and Site Conditions**

A. Site conditions and required equipment environmental ratings are:

VARIABLE	SITE LOCATION		RATED RANGE
Owner	City of Corona, California		
Site Address	2205 Railroad Street, Corona, CA 92880		
Coordinates	Latitude	33.8891980N (33°52'34")	
http://itouchmap.com/latlong.html	Longitude	117.609745W (117°33'08")	

B. Anticipated handled fluids and their properties are:

FLUID	VISCOSITY (77°F)	SPECIFIC GRAVITY	TEMP	FREEZING POINT	BOILING POINT	VAPOR PRESS (77°F)	pH	SOLIDS CONTENT
Recycled Water	0.894cP	1.00	33-90°F	32°F	212°F	0.46 psia	6.5- 8.5	<1.0%
Wastewater	0.894cP	1.01	33-90°F	32°F	212°F	0.46 psia	6.5- 8.5	<1.0%
38% Ammonium Sulfate (NH ₄) ₂ SO ₄ Solution		1.23	33-90°F	28°F	212°F	0.46 psia		<1.0%
15% Sodium Hypochlorite NaOCl Solution		1.20	33-90°F	-14°F	230°F		12	<1.0%

C. Work and equipment shall be designed to satisfactorily operate under above conditions at project site.

1.4 **Normal Working Hours**

A. Conduct Work within the following City-accepted schedule:

1. Normal Work Hours:
 - a. 7:00 am to 5:00 pm as amended by permit or noted on Plans.
2. In addition, applicable permit conditions from governing agencies may further restrict working hours.

B. Exceptions to this Work schedule shall be only as accepted in writing by City.

1. No Work shall be done outside of normal work hours and work days, except where necessary for public safety, care and protection of Work already performed, or other emergency
 - a. Provide written notice to City's Representative prior to any such emergency Work outside normal working hours.
 - b. Provide written request to City's Representative 7 Calendar Days prior to Work outside normal working hours not required by emergency.
2. Requests to work on Saturdays, Sundays, or legal holidays will be reviewed case-by-case and considered for acceptance based on additional costs to City, location of Work, nature of planned Work, and inconvenience to residents, businesses, community facilities, public events and activities associated with the proposed work day.
3. City reserves right to back-charge Contractor for costs incurred outside of standard work hours and days stated above.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Work Sequence

- A. The following staged sequence of construction shall apply, except as otherwise accepted in writing by City. If Contractor is unable to install the proposed static mixer bypass piping and maintain flows into the Chlorine contact tank continuous highline bypass shall be provided.
- B. The following Work sequence is provided for Contractor's convenience.
 - 1. It is not intended to dictate means and methods or cover every specific item of Work necessary.
 - 2. It shall not relieve Contractor from their responsibility to coordinate and perform Work in accordance with Plans and Specifications.
 - 3. Elements under each stage are not necessarily sequential and may be subject to change by City.
 - 4. Prepare project schedule and as specified in Section 01 32 00.
 - 5. Changes to construction stages identified herein shall be proposed by Contractor and accepted in writing by City before implementation as described in Section 01 32 00.
 - 6. Complete Work not itemized in construction sequencing stages below in accordance with Contract documents and Contractor's proposed, City-accepted schedule.
- C. Notify City of conflicts of staging process within 30 calendar days of Notice of Award.
- D. General sequence of Work shall be:
- E. Stage 1 Preparation
 - 1. Before beginning Work, complete the following:
 - a. Coordinate with Servicing Electrical Utility regarding electric service to site.
 - b. Obtain required permits, licenses and construction easements.
 - c. Call **Underground Service Alert** and utilities to obtain staking and marking of buried utilities.
 - d. Submit proposed schedule of Work, insurance and bonds.
 - e. Pothole as needed to supplement staking and marking.
 - f. Take preconstruction photographs.
 - g. Verify utility locations, field dimensions, pipe types and voltage and phase of on-site electrical services.
 - h. If discrepancies or conflicts are found, bring these to attention of City's Representative.
 - i. Submit Shop Drawings and other submittals.
 - j. Complete additional preliminary matters required by Contract Documents.
 - 2. Begin manufacturing and shipping materials and equipment after receiving accepted submittals.
- F. Stage 2 Mobilization for Flash Mixer Facilities
 - 3. Mobilize construction equipment.
 - 4. Provide BMP's
- G. Stage 3 Bypassing (Highlining) for Flash Mixer Facilities
 - 5. Coordinate with the City Operations staff and submit bypass plan for acceptance.
 - 6. Install bypass pipelines in accordance with City-accepted bypass plan.
 - 7. Provide connections and appurtenances needed for the City to install temporary chemical feed and relocate compliance sample water line.
 - 8. Dewater existing pipelines as outlined in the bypass plan.
 - 9. Maintain bypass through completion of construction Work and remove after 5 days of acceptable operation.

- H. Stage 4 Demolition, Clearing, Grubbing, Preliminary Grading, and Cleaning for Flash Mixer Facilities
10. Demolish, remove and dispose of the following:
 - a. Existing flash mixer chemical feed piping
 - b. Existing electrical wiring, conduit and control equipment
 - c. Existing flash mixer facilities
 - d. Existing filter influent and effluent line.
 11. Complete demolition Work as shown and required.
 12. Complete site rough grading.
- I. Stage 5 Construction for Flash Mixer Facilities
13. Construct underground infrastructure, utilities, buried piping, chemical feed, flash mixer pump station, electrical, controls and appurtenances.
- J. Stage 6 Startup, Commissioning, and System Demonstration for Flash Mixer Facilities
14. Perform pressure testing.
 15. Test control loops
 16. Demonstrate satisfactory installation and operation of installed work, including performing vendor and system functional tests.
 17. Perform initial equipment startup procedures in presence of Manufacturer, City's Representative and other parties as requested by City.
 - a. Each respective Manufacturer shall be represented during startup and commissioning.
 18. Perform operational testing in accordance with specifications.
- K. Stage 7 Closeout for Flash Mixer Facilities
19. Remove temporary bypass pumping, paving and construction equipment.
 20. Provide operator training, including O&M manuals containing engineering Product Data and Shop Drawings on equipment.
 21. Provide record drawings.
 22. Clean up and restore construction areas.
 23. Provide warranty as specified.
- L. Stage 8 Mobilization for Static Mixer and Flow Meter Vault Facilities
24. Mobilize construction equipment.
 25. Provide BMP's
- M. Stage 9 Bypassing (Highlining) for Static Mixer and Flow Meter Vault Facilities
26. Coordinate with the City Operations staff and submit bypass plan for acceptance.
 27. Install temporary bypass pipelines, flow meter, and redundant pumps in accordance with City-accepted bypass plan.
 28. Dewater existing CCT influent line as outlined in the bypass plan.
 29. Maintain temporary bypass through completion of construction of the permanent bypass and remove after 5 days of acceptable operation.
- N. Stage 10 Demolition, Clearing, Grubbing, Preliminary Grading, and Cleaning for Static Mixer Permanent Bypass
30. Demolish, remove and dispose of the following:
 - a. CCT influent line
 31. Complete demolition Work as shown and required.
- O. Stage 11 Construction for Static Mixer Permanent Bypass
32. Install permanent static mixer bypass and appurtenances with blind flanges on the mainline plug valves.

- P. Stage 12 Startup, Commissioning, and System Demonstration for Static Mixer Permanent Bypass
- 33. Perform pressure and flow testing.
 - 34. Test control loops
 - 35. Demonstrate satisfactory installation and operation of installed work, including performing vendor and system functional tests.
 - 36. Perform initial equipment startup procedures in presence of Manufacturer, City's Representative and other parties as requested by City.
 - a. Each respective Manufacturer shall be represented during startup and commissioning.
 - 37. Perform operational testing in accordance with specifications.
 - 38. Complete demolition Work as shown and required.
- Q. Stage 13 Construction for Static Mixer and Flow Meter Vault Facilities
- 39. Construct static mixer and vault facilities, landing and guardrails, underground infrastructure, utilities, buried piping, chemical feed, CCT stairway and landing, electrical, controls and appurtenances valves.
- R. Stage 14 Startup, Commissioning, and System Demonstration for Static Mixer and Flow Meter Vault Facilities
- 40. Perform pressure testing and chemical feed testing.
 - 41. Test control loops
 - 42. Demonstrate satisfactory installation and operation of installed work, including performing vendor and system functional tests.
 - 43. Perform initial equipment startup procedures in presence of Manufacturer, City's Representative and other parties as requested by City.
 - a. Each respective Manufacturer shall be represented during startup and commissioning.
 - 44. Perform operational testing in accordance with specifications.
 - 45. Coordinate requirements with City for chemical feed switchover.
- S. Stage 15 Closeout for Static Mixer and Flow Meter Vault Facilities
- 46. Remove paving and construction equipment.
 - 47. Provide operator training, including O&M manuals containing engineering Product Data and Shop Drawings on equipment.
 - 48. Provide record drawings.
 - 49. Clean up and restore construction areas.
 - 50. Provide warranty as specified.
- T. Stage 16 Demolition, Clearing, Grubbing, Preliminary Grading, and Cleaning for Static Mixer and Flow Meter Vault Facilities
- 51. Demolish, remove and dispose of the following:
 - a. CCT chemical feed and rapid mixer panel
 - b. Existing electrical wiring, conduit and control equipment
- U. Stage 17 Closeout for Static Mixer and Flow Meter Vault Facilities
- 52. Remove paving and construction equipment.
 - 53. Provide operator training, including O&M manuals containing engineering Product Data and Shop Drawings on equipment.
 - 54. Provide record drawings.
 - 55. Clean up and restore construction areas.
 - 56. Provide warranty as specified.

3.2 Activities by Others

- A. City, utilities, and others may perform activities within the Project area while Work is in progress.
 - 1. Schedule Work with City, utilities, and others to minimize mutual interference and delays.
- B. Activities performed by others may include the following construction projects, or maintenance and operational activities:
 - 1. SCADA programming and system integration by City.
 - 2. Routine inspection, maintenance, and repair of existing facilities.
 - 3. Maintenance of landscaping, irrigation, and recreation facilities.
 - 4. Plant operations.
 - 5. There are no known concurrent construction projects at this location.
- C. When cooperation fails, submit recommendations and perform Work in coordination with work of others as directed.
- D. When Work depends, for proper execution or results, upon work performed by others, inspect and promptly report apparent discrepancies or defects in work performed by others.

3.3 Cooperation with Other Contractors

- A. City may have additional work performed in this area by other Contractors.
 - 1. Contract requires cooperation with those contractors in the area.
 - 2. Differences or conflicts which arise between Contractor and other contractors will be adjusted and determined by City.
 - 3. Contractor shall conduct their operations to minimize interference with work being done by other contractors.
 - a. Make good, promptly, injuries or damages to other contractors' work caused at Contractor's hands.

3.4 Contractor Use of Premises

- 1. Do not shut off pipelines or power or take action which might adversely affect City's use or operation of their facilities or premises without prior written authorization from City.
- 2. Construct accepted signs, barricades and lights necessary to ensure public safety and safety of City's operators and personnel.
 - a. Provide steel plates across ditches to facilitate safe access of City's personnel to facilities.
- B. Contractor shall legally dispose of material removed.
- C. Substructures or other improvements removed or disturbed by Contractor during construction shall promptly be replaced and/or repaired at Contractor's sole expense to City's satisfaction.

3.5 Responsibility for Job Site Conditions

- A. Contractor shall assume sole and complete responsibility for jobsite conditions during course of construction of Work, including safety and health of persons and property; that this requirement shall apply continuously and not be limited to normal working hours
- B. Contractor shall defend, indemnify, and hold City and design consultant GHD Inc. harmless from any and all liability except that arising from sole negligence of City or design consultant.
- C. Refer to Section 01 35 26 for jobsite safety requirements.

3.6 Occupancy

- A. Successful completion of pre-startup checkout and functional testing shall precede City's use or acceptance of completed Work.

END OF SECTION

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 – GENERAL

1.1 Work Included

- A. Preparation of Schedule of Values providing breakdown of labor, materials, tools, equipment and other costs for measurement and payment purposes.
 - 1. Schedule shall show division of Work between Contractor and each Subcontractor.
 - 2. Break Schedule of Values down according to each Specification Division within each project area or structure on site.
 - 3. Include item in Schedule for County and State taxes plus cost items for bond, insurance, temporary facilities and mobilization.
 - 4. Schedule shall itemize items for purchase/delivery, costs for each item and material for which Contractor will request payment prior to installation.
 - 5. Each item shall include overhead and profit directly proportional to direct cost of that item over total Contract cost.
- B. Provide Schedule of Values breakdown:
 - 1. On lump sum Bid Items >\$25,000.
 - 2. On smaller lump sum Bid Items where Contractor desires to break down Work items for their convenience or to facilitate payment.
 - 3. On pipeline unit prices for quantities >1000'
- C. Assign prices to Bid Items which aggregate to Contract Price.
 - 1. Base prices on costs associated with scheduled activities for each Bid Item.
- D. Finalized Schedule of Values will not be accepted until Contractor has responded to City's review comments.
 - 1. Provide supporting data, including certified payrolls, as requested by City's Representative for Schedule items.
- E. Refer to General Conditions §46 "Cost Breakdown and Periodic Estimates" for additional Corona requirements for submittals.
- F. Prepare Schedule of Materials and Equipment Costs providing information necessary for City to document asset valuations for City's Enterprise Asset Management program.

1.2 Related Work

- A. Section 01 32 00: Construction Progress Documentation

PART 2 – MATERIALS (not used)

PART 3 – EXECUTION

3.1 Submittals

- A. Submit Schedule of Values and Schedule of Equipment and Materials Costs deliverables as described herein and in accordance with the following timeline:

DELIVERABLE	SUBMITTAL TIME
MOBILIZATION SUBMITTALS	
Schedule of Values	Within 7 Calendar Days from Notice of Award
Schedule of Values; review and resubmittal	Within 14 Calendar Days from Notice of Award
Schedule of Equipment and Materials Costs	Coincident with first submittal of O&M manuals / record

drawings

- B. Upon request, support prices with data which will substantiate their correctness.

3.2 **Schedule of Values**

- A. Submit Schedule of Values listing each Bid Item identified in Bid Schedule and breaking down large Bid Items for major subcomponents of Work.
- B. Schedule of Values shall contain itemized list of Bid Items and also include detailed breakdown of lump sum or unit price Bid Items >\$25,000 (before extension) to facilitate payment and City's asset management.
- C. Schedule of Values may contain additional breakdown where desired to substantiate requests for partial payment as Work progresses.
- D. Separate Work under bid items as follows:
 1. Where Work occurs at multiple sites, itemize value of Work at each site.
 2. Where Work occurs within multiple structures, itemize value of Work within each structure.
 3. Where Work is divided between Work within structures, in yard, and/or offsite Work, separate value of Work by structure, yard, and off-site Work.
 4. Where Work supports multiple large (and different) equipment items, separate value of Work by equipment category supported.
 5. Where Work supports multiple utilities separate Work by utility type.
- E. Itemize proposed values for the following major Work components.
 1. Total value of Division 1 Overhead and General Requirements Work.
 - a. Separate by milestones for mobilization, ongoing expenses, and startup-commissioning.
 2. Total value of Division 2 demolition Work
 3. Total value of Division 3-6 structural Work.
 - a. Itemize value of earthwork, subgrade preparation, concrete foundation, concrete slabs, concrete columns, concrete roofs, concrete stairs, masonry walls, metal framing, metal roofing, wood framing, and wood roofing as appropriate.
 - b. Minor structures valued at <\$25,000 may be listed as 1 item.
 4. Total value of Division 7-14 architectural Work.
 - a. Itemize value of thermal and moisture protection, openings, finishes, and other Work as appropriate.
 5. Total value of Division 21-23 mechanical Work.
 - a. Itemize value of fire suppression, plumbing, and HVAC Work as appropriate.
 6. Total value of Division 25-28 electrical Work
 - a. Separate electrical yard facility work by duct bank designation and substations.
 - b. Itemize value of conduit-raceways, cable-wire installation, switchgear, equipment installation, communications, electronic safety-security, terminations, and lighting as appropriate.
 7. Total value of Division 31 and 32 civil site Work.
 - a. Itemize value for clearing and grubbing, earthwork, import or export, finish grading, base courses, asphalt paving, concrete paving, fencing and site improvements, irrigation, and planting as appropriate.
 8. Total value of Division 33 utilities Work
 - a. Itemize breakdown by each utility category (water, recycled water, wastewater, stormwater, fuel or natural gas, hydronic or steam, electrical, and communications as appropriate.

- b. Itemize value of each pipeline.
 - c. Itemize value for inspection-bypassing-rehabilitation, earthwork, boring-jacking-microtunneling, piping, incidentals, valves, equipment items, structures, tanks, and testing-disinfection,
- 9. Total value of Division 40-48 process Work.
 - a. Provide itemized breakdowns for each major improvement.
 - b. Provide itemized breakdowns for site preparation, piping systems, major equipment items, instrumentation, and telemetry-control,
- F. Contractor and City's Representative shall meet and jointly review preliminary Schedule of Values and make adjustments in value allocations if, in City's opinion, these are necessary to establish fair and reasonable allocation of values for major Work components.
 - 1. Front end loading will not be permitted.
 - 2. City may require reallocation of major Work components from items in above listing if in opinion of City's Representative such reallocation is necessary.
- G. City shall be sole judge of acceptable numbers, details and description of values established.
 - 1. If, in City's Representative's opinion, more Schedule of Values items are necessary than proposed, add additional items and provide greater detail as requested.
 - 2. Make adjustments deemed necessary to value allocation or level of detail and submit revised detailed Schedule of Values to City for record.

3.3 Changes to Schedule of Values

- A. Changes to CPM Schedule to add activities not included in original schedule but included in original work (schedule omissions) shall have values assigned as accepted by City's Representative.
 - 1. Reduce other activity values to provide equal value adjustment increases for added activities as approved by City.
- B. If Contractor and City agree to adjust original Schedule of Values because of inequities discovered in original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

3.4 Schedule of Materials and Equipment Costs

- A. Submit Schedule of Materials and Equipment Costs for items as described herein and shown in example below to establish baseline value for City's Enterprise Asset Management system.
- B. The following does not represent complete list of materials and equipment required for this project.

EXAMPLE

SCHEDULE OF EQUIPMENT AND MATERIALS COSTS

EQUIPMENT / MATERIALS / FUNCTION / DESCRIPTION	SIZE / CAPACITY	DESCRIPTION / MFG / MODEL NUMBER	LOCATION	MATERIALS COST (UNIT PRICE)	ESTIMATED INSTALLED COST (UNIT PRICE)
Sewer Force Main	6"	DIP, Class 350, restrained joint, ceramic epoxy lined	Buried	\$54/LF	\$75/LF
Magnetic Flow Meter	4"	E+H, Proline Promag 53W1H- ULGBAA0BAAA1	Lift Station Discharge Piping	\$3,750	\$5,000
Submersible Sewage Pump	5 hp, 125 gpm	KSB, Model KRT E 80- 200/34XG	Lift Station Wet Well	\$5,250	\$7,500
Swing Check Valve	4"	APCO, 6000 series	Lift Station Discharge Piping	\$775	\$1,100

- C. Provide required information for equipment and materials listed in City-furnished equipment and materials cost spreadsheet.

END OF SECTION

SECTION 01 32 00

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 Work Included

- A. Contractor's scheduling of Work using computerized Critical Path Method (CPM) scheduling to satisfy Contract schedule and project status reporting requirements.
- B. Refer to General Conditions §6 "Schedule" for additional Corona requirements for protecting existing utilities.
- C. Times and durations in schedules prepared by Contractor shall be in Calendar Days.

1.2 Related Work

- A. Section 01 33 00: Submittal Procedures
- B. Section 01 73 00: Execution

1.3 Quality Assurance

- A. Prior to submittal deadline shown below under "Submittals", submit name and qualifications of person responsible for preparing, maintaining, updating and revising schedules.
 - 1. This person shall have authority to act on Contractor's behalf and have ≥3 years verifiable experience preparing and updating construction schedules for projects of similar type, size, and complexity.
- B. Scheduler shall be proficient in use of software used.
 - 1. If Contractor has no employee with required scheduling experience and expertise, as determined by City, retain qualified CPM consultant who regularly performs these services and who in City's opinion possesses qualifications required to perform Project CPM scheduling.
 - 2. City reserves right to remove scheduler from Project if schedules submitted do not conform to requirements of this section.
- C. Qualifications of scheduler shall be verified with references ≥3 previous projects of similar type, size, and complexity on which Contractor's Construction Scheduler has used CPM scheduling using scheduling software.
 - 1. Construction Scheduler shall attend all meetings pertaining to scheduling and progress of Work.
- D. City's acceptance of Contractor's CPM scheduling person is prerequisite to issuance of Notice to Proceed.

1.4 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. AGC publication "Use of CPM in Construction"

1.5 Submittals

- A. Submit 4 copies of each submittal listed below plus electronic copy on compact disk or thumb drive in accordance with deadlines shown.

SUBMITTAL	PARAGRAPH REFERENCE	SUBMITTAL DEADLINE
MOBILIZATION SUBMITTALS		
Name and Qualifications of Contractor's Scheduler	1.3A	≤7 Calendar Days after Contract Award
Preliminary Progress Schedule to	3.2	≤14 Calendar Days after receipt of notice to proceed.

SUBMITTAL	PARAGRAPH REFERENCE	SUBMITTAL DEADLINE
Include 60-day Plan of Operation and Project Overview Bar Chart		
Revised Preliminary Progress Schedule	3.2	≤7 Calendar Days after receipt of City review comments.
Original Baseline Critical Path Method (CPM) Schedule	3.4A	≤14 Calendar Days after submittal of Revised Preliminary Progress Schedule
Original Baseline Critical Path Method (CPM) Meeting	3.4C	≤10 Calendar Days after submittal of Original Baseline CMP Schedule
Revised Baseline CPM Schedule	3.4D	≤10 Calendar Days after Original Baseline CPM Schedule Meeting
Updates and Periodic CPM Schedule Submittals	3.4E	Monthly

- B. In addition to submittals listed above, City may require recovery schedule, Time Impact Evaluation, and mitigation plan when appropriate.
- C. Procedures for submission, review and acceptance of schedule submittals shall conform to Section 01 33 00 and applicable sections of General Conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers of scheduling software products include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Scheduling Software	Microsoft Project	Redmond, WA (800) 642-7676
	Oracle Primavera 6	Santa Clara, CA (408) 276-8345
	Accepted equal	

- B. Scheduling system shall be capable of handling, processing, printing and plotting data to satisfy requirements of this Section.

PART 3 - EXECUTION

3.1 Progress of Work

- A. Time of beginning, progress rate, and time of completion of Work are of the essence of this Contract.
- Execute Work with such progress as required to prevent delays to completion of Contract, Contract milestones, and to other contractors working on other contracts at site.
- B. By preparing and submitting Construction Schedule, Contractor represents they can and intend to execute contracted Work, including activities of subcontractors, equipment vendors and suppliers, submittals and resubmittals within specified times and constraints and bid covers costs associated with execution of Work in accordance with Construction Schedule.

3.2 Preliminary Progress Schedule Submittal

- A. Prior to deadline shown in Part 1, submit 4 hard copies and 1 electronic copy of cost-loaded Preliminary Progress Schedule package which shall serve as Contractor's Plan of Operation for initial 60 Calendar Day period of Contract Time and to identify the manner in which Contractor intends to complete Work within the Contract Time.
- Submit 60-Day Plan of Operation bar chart, and
 - Submit project overview bar chart type plan for Work as indicated below.
- B. During initial 60 Calendar Days of Contract Time, conduct Contract operations in accordance with 60-Day bar chart Plan of Operation.

1. Bar chart prepared and submitted shall show dates for accomplishment of Contractor's early activities including:
 - a. Mobilization
 - b. Permits
 - c. Coordination with serving electric utilities
 - d. Coordination with other utilities
 - e. Submittals needed for early material and equipment procurement, including specified City's review period
 - f. Submittals needed for long lead equipment procurement, including specified City's review period
 - g. CPM submittals
 - h. Initial site work, and
 - i. Other submittals and other activities required and planned for execution in first 60 Calendar Days.
- C. Information shall provide sufficient durations for administration, fabrication, and transportation to produce realistic delivery dates for procurement items.
- D. Project Overview Bar Chart shall show major components of project Work and sequence relations between major components and subdivisions of major components.
 1. Overview bar chart shall show relationships and time frames in which components of Work will be completed and placed into service to meet project milestones.
 2. Include sufficient detail for identification of subdivisions of major components into such activities as
 - a. Coordination with serving electric utilities
 - b. Coordination with other utilities
 - c. Excavation
 - d. Foundation subgrade preparation
 - e. Foundation concrete
 - f. Completion of structural concrete
 - g. Utility Work
 - h. Mechanical Work
 - i. Electrical Work
 - j. Instrumentation and control Work
 - k. Other important Work for each major facility within project scope.
- E. Show approximate durations and start dates for each work item subdivision representing Contractor's best estimate for Work the summary activity represents.
 1. Total duration of summary activities shall equal Contract Time.
 2. Accurately plot each major component and subdivision component on time scale sheets $\leq 24"$ by $36"$ in size.
 3. Use ≤ 4 sheets to represent this overview information.
- F. Owner will review Preliminary Progress Schedule and provide comments at meeting with Contractor within 14 Calendar Days after submittal to City.
 1. City's review and comment on schedules will be limited to Contract conformance with sequencing and milestone requirements stated in other sections of Contract Documents.
- G. Make corrections to schedules needed to comply with Contract requirements and adjust schedules to incorporate missing information requested by City.

1. Resubmit revisions needed as result of City review and meeting with Contractor for review to City prior to deadline shown in Part 1.
- H. Preliminary Progress Schedule will be used to record and monitor Work progress until Baseline Schedule, specified hereinafter, has been developed and accepted by City.
 1. Incorporate recorded data on Preliminary Progress Schedule into Baseline Schedule during first schedule update.

3.3 Schedule Methodology

- A. Scheduling method shall present CPM activity and node Precedence Diagram Network (PDN) showing critical path.
- B. Submit Work Breakdown Structure to City for acceptance, including:
 1. Work Breakdown Structure,
 2. Associated alphanumeric coding structure to implement Work Breakdown Structure, and
 3. Activity identification system for labeling Work activities.
- C. Designate code fields as follows:
 1. 1st code field shall designate Bid Item.
 2. 2nd code field shall identify activity as 1 of following types:
 - a. Submittal,
 - b. Review/Acceptance
 - c. Procurement/Fabrication,
 - d. Delivery,
 - e. Construction/Installation,
 - f. Start-up, or
 - g. Change order
 3. 3rd field shall identify applicable Contract Document section under which activity is described.
 4. 4th code field shall identify who is responsible to perform activity (i.e., Contractor, subcontractor(s), supplier, etc.).
 5. 5th code field shall identify area being worked in or facility, if appropriate.
 6. 6th code field shall identify construction phase or project element (if phasing of Work or project elements are identified in Contract).
 7. Include Change Orders and Notices of Non-Compliance as separate code fields.

3.4 CPM Schedule Submittals

- A. Original Baseline CPM Schedule Submittal: Prior to deadline shown in Part 1, submit hard copy of Original Baseline CPM Network Schedule and Computerized Schedule Report tabulations.
 1. Also submit compact disk or thumb drive containing schedule submittal information and data.
 2. Submit new disk with updated information with each change or submission of CPM schedule.
- B. Disk shall contain data compatible with scheduling software to generate network diagrams and schedule reports identical to hard copies submitted.
 1. This submittal shall have already been reviewed and accepted by Contractor's Project Manager, Project Superintendent, and Project Estimator prior to submission.
 2. CPM Schedule shall be time-scaled network diagram of "I-j" activity-on-arrow or precedence type.

3. Network Diagram shall describe activities to be accomplished and their logical relationships and show Critical Path.
- C. Computerized Schedule Report tabulations shall include:
1. Report of activities sorted by Activity Number
 2. Report of activities sorted by Early Start date
 3. Report of activities sorted by Total Float.
 4. Report of activities sorted by Responsibility Code.
 - a. Responsibility Codes shall be established for Contractor, City, utilities, subcontractors, suppliers, and other parties.
 - b. Identify codes in Network Diagram.
 5. A successor-predecessor report which shall identify successor and predecessor activities for each activity and ties between schedule activities
 6. Original Baseline CPM Schedule Review Meeting: Within time stipulated above, meet with City to review Original Baseline CPM Schedule submittal.
 - a. Contractor's Project Manager, Project Superintendent, and Project Scheduler shall be in attendance.
 - b. City's review will be limited to submittal's conformance to Contract requirements.
 7. Review may also include:
 - a. Clarifications of design intent, process, and startup requirements.
 - b. Directions to include activities and information missing from submittal.
 - c. Requests to Contractor to clarify schedule.
- D. Revised Baseline CPM Schedule: Within submittal time shown in Part 1, revise Original Baseline CPM Schedule submittal to address review comments from Original Baseline CPM Schedule Meeting and resubmit network diagrams and reports for City's review.
1. City, within 14 Calendar Days from receipt of Revised Baseline CPM Schedule will either accept schedule as submitted or advise Contractor in writing to review part or parts of schedule which either do not meet Contract requirements or are unsatisfactory for City to monitor project's progress and status or evaluate monthly payment requests by Contractor.
 2. City may accept schedule with conditions that first monthly CPM schedule update be revised to correct deficiencies identified.
 3. When schedule is accepted, it shall be considered as "Original Baseline CPM Construction Schedule" until updated schedule has been submitted.
 4. City reserves right to require Contractor to adjust, add to, or clarify portions of schedule which may later be discovered to be insufficient for monitoring of Work.
 5. No additional compensation will be provided for such adjustments, additions or clarifications.
- E. City's acceptance of Contractor's schedule will be based solely upon schedule's compliance with Contract requirements.
1. By way of Contractor assigning activity durations and proposing sequence of Work, Contractor agrees to use sufficient and necessary management and other resources to perform Work in accordance with schedule.
 2. Upon submittal of schedule update, updated schedule shall be considered "current" project schedule.
- F. Submission of Contractor's progress schedule to City shall not relieve Contractor of Contractor's total responsibility for scheduling, sequencing, and pursuing Work to comply with requirements of Contract Documents, including adverse effects such as delays resulting from ill-timed work.

- G. Monthly Updates and Periodic CPM Schedule Submittals: Following acceptance of Contractor's Original Baseline CPM Schedule, monitor progress of Work and adjust schedule continuously to reflect actual progress and any changes in planned future activities.
 - 1. Submit complete schedule updates in accordance with General Conditions Article 6, including all information requested in original schedule submittal and as specified herein.
 - 2. Each update shall continue to show all Work activities including those already completed.
 - 3. These completed activities shall accurately reflect Record Drawing information by indicating when Work was actually started and completed.
- H. Neither submission nor updating of Contractor's original schedule submittal nor submission, updating, change or revision of other reports, curves, schedules or narratives submitted to City by Contractor under this Contract, nor City's review or acceptance of such reports, curves, schedules or narratives shall amend or modify Contract completion date or milestone dates or modify or limit Contractor's obligations under this Contract.
 - 1. Only signed, fully executed change orders can modify these contractual obligations.
- I. Monthly schedule update submittal will be reviewed with Contractor during monthly construction schedule review meeting held on 20th Work Day of each month.
 - 1. Goal of these meetings is to enable Contractor and City to initiate appropriate remedial actions to minimize known or foreseen delay in completion of Work and to determine amount of Work completed since last month's schedule update.
 - 2. Status of Work will be determined by percent complete of each activity shown in Network Diagram.
 - 3. These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend.
 - 4. At minimum, Contractor's Project Manager and General Superintendent shall attend meetings.
 - 5. Submit within 7 Calendar Days after monthly progress meeting revised CPM Network Diagram, revised CPM computerized tabulations as noted herein, revised successor/predecessor report, Project Status Reports as defined in Paragraph 3.8 and Contractor's Application for Payment.
 - 6. Within 7 Calendar Days of receipt of above noted revised submittals, City will accept or reject monthly schedule update submittal.
 - 7. If accepted, percent complete shown in monthly update will be basis for Application for Payment to be submitted by Contractor.
 - 8. If rejected, correct and resubmit update before Application for Payment for update period can be processed.
- J. Schedule Revisions: Highlight or otherwise identify changes to Network Diagram Schedule Logic or activity durations made from previous schedule.
 - 1. Modify portions of CPM schedule which become infeasible because of activities behind schedule or for any other valid reason.

3.5 Change Orders

- A. Upon acceptance of Change Order, or upon receipt by Contractor of authorization to proceed with additional Work, change shall be reflected in next submittal of CPM schedule by Contractor.
 - 1. Use sub-network in schedule depicting changed Work and its effect on other activities.
 - 2. This sub-network shall be tied to main network with appropriate logic, so true analysis of Critical Path can be made.

3.6 CPM Standards

- A. CPM, as required by this Section, shall be as outlined in Association of General Contractors (AGC) publication, "Use of CPM in Construction" except either "I-j" arrow diagrams or precedence diagramming format may be used.
 - 1. In case of conflicts between Contract Documents and AGC Document, Contract Documents shall govern.
- B. Include in construction schedules graphic network diagram and computerized construction schedule reports as described in Paragraph 3.4.
- C. CPM network shall be in form of pure logic diagram or, if directed or accepted by City, a time scaled "I-j" activity-on-arrow or precedence type diagram and may be divided into separate sheets with suitable match lines relating interface points among sheets.
 - 1. Individual sheets shall not exceed 36" by 60" (≤ 2 sheets).
- D. Except for pure logic diagrams, show construction activities and procurement activities in time-scaled format.
 - 1. Show calendar time line along entire sheet length.
 - 2. Plot each activity arrow or node to accurately represent beginning and completion dates of each activity along calendar time line.
 - 3. Show activities using symbols clearly distinguishing between critical path activities, non-critical activities and free float for each non-critical activity.
 - 4. Identify activity items by their respective Activity Number, Responsibility Code, Work Duration, and their Dollar Value.
 - 5. Non-critical path activities shall show their total float time in scale form using dotted line or other graphical means.
- E. Compute duration estimate for each activity in Calendar Days considering scope of activity Work and resources planned for activity.
 - 1. Except for certain non-labor activities, such as concrete curing or delivery of materials, activity durations shall be 1-14 Calendar Days unless otherwise accepted by City.
- F. Float time shall be total float defined as the number of Calendar Days each non-critical path activity may be delayed before it and its succeeding activities fall on critical path.
 - 1. If non-critical path activity is delayed beyond its float period, that activity then becomes part of critical path and controls project end date.
 - 2. Thus, delays of non-critical path activities beyond their float times delay Project completion.
- G. Liability for delay of Project completion date rests with party causing delay to Project completion date.
 - 1. If Party A uses some, but not all of float time and Party B later uses remainder of float time plus additional time beyond float time, Party B will be liable for costs associated with time that represents delay to project's completion date.
 - 2. In this case Party A is will not be held responsible for any costs since it did not consume all float time, and additional float time remained, therefore, Project's completion date was unaffected.
- H. Refer to Paragraph 3.9 for allowances for lost days for inclement weather and holidays..

3.7 Schedule Reports (Format)

- A. Schedule Reports: Prepare Schedule Reports based on Construction Schedule to include the following minimum data for each activity:
 - 1. Activity Numbers and Responsibility Codes
 - 2. Contract Number
 - 3. Estimated Activity Duration

4. Activity Description
 5. Activity's Percent Completion
 6. Early Start Date (Calendar Dated)
 7. Early Finish Date (Calendar Dated)
 8. Late Start Date (Calendar Dated)
 9. Late Finish Date (Calendar Dated)
 10. Status (Whether Critical)
 11. Total Float for Each Activity
 12. Free Float for Each Activity
 13. Cost Value for Each Activity
- B. Project Information: Preface each Schedule Report with the following summary data:
1. Project Name
 2. Contractor.
 3. Contract No
 4. Type of Tabulation
 5. Project Duration
 6. Contract Completion Date (revised to reflect time extensions)
 7. Commencement Date Stated in Notice to Proceed
 8. Data Date and Plot Date of Network Diagram
 9. If update, new schedule completion date

3.8 Project Status Reporting

- A. In addition to submittal requirements for CPM scheduling, submit monthly project status reports (Overview Bar Chart and written narrative report) in conjunction with revised CPM Schedules as specified in Paragraph 3.6.
1. Status reporting shall be in form specified below.
- B. Prepare and submit monthly Overview Bar Chart schedule of major project components.
1. Overview bar chart schedule shall summarize current CPM schedule (original and as updated and adjusted throughout construction period).
 2. Overview bar chart shall contain ≤ 2 sheets which shall not exceed 36" by 60".
 3. Represent major project components as time bars subdivided into various types of Work including demolition, excavation and earthwork, yard piping, concrete construction, mechanical, electrical and instrumentation installations.
 4. Major components shall include each new structure by area designation, sitework, modifications to existing structures, tie-ins to existing facilities and plant startups.
- C. Accurately time scale plot each major component and subdivision consistent with project overview bar chart specified above.
1. Time-scale plot shall represent same status shown by early start and finish activity information contained in latest update of CPM schedule.
 2. In addition, show percent completion for each major component and subdivision.
 3. Make initial submittal of overview bar chart schedule at time revised Original Baseline CPM Schedule is submitted to City within submittal deadline shown in Part 1.
 4. Amend overview schedule to include additional detail required by City.
 5. Include additional information requested by City during construction of Work.
- D. Submit monthly written narrative reports including:

1. Status of major project components (Percent Complete, amount of time ahead or behind schedule) and an explanation of how project will be brought back on schedule if delays have occurred.
 2. Progress made on critical activities indicated on CPM schedule.
 3. Explanations for lack of Work on critical path activities planned to be performed during last month
 4. Explanations for schedule changes, including changes to logic or to activity durations.
 5. List of critical activities scheduled to be performed in next 2-month period.
 6. Status of major material and equipment procurement.
 7. Value of materials and equipment properly stored at site, but not yet incorporated into Work-in-place.
 8. Delays encountered during reporting period.
 9. Assessment of inclement weather delays and impacts to progress of Work.
- E. Contractor may include other information pertinent to status of project.
1. Include additional status information requested by City.

3.9 Allowance for Holidays and Inclement Weather in CPM Schedule

- A. Include ≥ 14 lost Calendar Days on CPM schedule's critical path for inclement weather.
- B. Include lost days for City-observed holidays (listed in General Provisions) in CPM schedule.
- C. No Work other than Work necessary to respond to emergencies or Work necessary to meet SWPPP requirements shall be performed from December 24th (Christmas Eve) through January 1st (New Year's Day)
 1. Include lost days for this period.

END OF SECTION

SECTION 01 32 23

CONSTRUCTION SURVEY STAKING BY CONTRACTOR

PART 1 - GENERAL

1.1 Work Included

- A. This section describes survey information to be furnished by the Contractor.
- B. City will provide Contractor with ACAD basemap to be used for Construction staking.

1.2 Related Work

- A. Section 01 33 00: Submittal Procedures
- B. Section 01 40 00: Quality Requirements
- C. Section 01 73 00: Execution

1.3 System Description

- A. Provide construction stakes and cut sheets in writing ≥ 2 working days in advance of Construction.
- B. Preserve stakes, reference markers, monuments, and survey points.
 - 1. Where survey Work is disturbed, City will charge Contractor for replacement.
 - 2. Contractor shall pay, at their sole cost, expense resulting from loss or disturbance of stakes or markers.
 - 3. Should City be required to reset construction stakes, cost for resetting will be at current per diem rate.
 - 4. Charges will be deducted from progress payments due Contractor, for month in which City performs surveying work.
- C. Unless otherwise specified, City will only provide ACAD survey files for items specified to be constructed or reconstructed for Contract Documents.
- D. Do not proceed with Work until construction stakes, are verified by the City.

1.4 Quality Assurance

- A. Perform surveys under supervision of California Registered Land Surveyor or California Registered Civil Engineer experienced in and licensed to practice surveying.
- B. City's Representative will perform field observation to verify Work is being performed in accordance with Contract Documents.
 - 1. Cooperate with City's Representative and make necessary provisions to facilitate safe observation of Contractor's Work.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. California Business and Professions Code §8771.

PART 2 – PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Preparation

- A. Protect benchmarks, monuments, and project control points.
 - 1. Conform to requirements of California Business and Professions Code §8771.

2. Do not disturb monuments, survey markers, or bench marks without permission from City's Representative and City surveyor.
 - a. Preserve permanent reference points during construction.
 - b. Do not change or relocate benchmarks, monuments, or project control points without prior written approval.
 3. If it is necessary to remove or replace monument(s) in conjunction with Work, provide 2 week's notification to City's Representative and office of City surveyor.
 - a. Under direction and supervision of City surveyor, monument will either be temporarily removed and later replaced, or it will be relocated by Contractor.
 4. Bear expense of resetting monuments, survey markers, or bench marks disturbed without permission.
- B. Promptly report lost or destroyed benchmarks, monuments, or project control points or requirements to relocate reference points because of necessary changes in grades or locations.
- C. Record horizontal and vertical data, and benchmark locations, on Project Record Drawings.

3.2 General Survey Requirements

- A. Work from lines and levels established from field survey control.
- B. Advise subcontractors engaged in construction activities of marked lines and elevations provided for their use and their responsibility to protect and preserve these points.
- C. Furnish information necessary to adjust, move, or relocate existing structures, utility poles, lines, services, or other appurtenances located in or affected by construction.
 1. Coordinate with local authorities having jurisdiction.

3.3 Survey Staking for Pipelines

- A. For pipelines not installed in tunnels or casings, Contractor shall will set 1 stake at 25' intervals, and at angle points and grade breaks.
 1. Station, offset, and cut/fill to flow line will appear on stakes.
- B. Accurately transfer line and grade for facility to trench bottom.
 1. Pavement scoring, cutting, and removal shall be accomplished from this same set of construction stakes.

END OF SECTION

SECTION 01 32 33

CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 Work Included

- A. Administrative and procedural requirements for:
 1. Preconstruction photographs.
 2. Monthly construction photographs (required for contracts > \$1 million)
 3. Final completion construction photographs.
- B. Submit preconstruction photographs or videos to City's Representative before performing Work which has potential to disturb or modify public or private property not owned by City.
 1. Failure to submit preconstruction photographs or videos may be taken by City as evidence subsequent claims by property owners for damage to their property can be rightfully attributed to Contractor's actions.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 73 00: Execution
- F. Section 01 77 00: Closeout Procedures

1.3 Quality Assurance

- A. Use skilled workmen trained and experienced in necessary trades and crafts and familiar with specified requirements and methods for proper performance of Work of this section.

1.4 Submittals

- A. Submittals shall conform to the following:

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Pre-Construction Documentation and Construction Progress Digital Photographs	• Submit pre-construction digital image files before beginning Work. • Date and time stamp photos • Submit digital images in folder(s) named by date of photographs. • Name files to embed date ID letter (A-Z) and subject in ≤32 characters eg. <i>Yy-mm-ddB-road-sawcut</i>	
Key Plan	Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph. • Name of Project. • Name and contact information of photographer. • Name of City and City's Representative. • Name of Contractor. • Date photographs taken. • Description of vantage points, indicating ID key A-Z, location, direction arrow or compass point, and elevation or story of construction.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Monthly Digital Photographs	Submit progress digital image files with each monthly pay request. Document covered Work before covering. • Submit using protocol for mobilization submittal	
CLOSEOUT SUBMITTALS		
Finished Project Photography	Take ≥25 color digital photographs at or near date of Substantial Completion for submission as project record documents. Hire qualified photographer to take construction closeout photographs. Take photographs using maximum range of depth of field.	

SUBMITTAL	DESCRIPTION	
	• Photographs shall be in focus and clearly show Work. • Do not submit photographs with blurry or out-of-focus areas. • City's Representative will inform photographer of desired vantage points. • Do not include date stamp on final completion construction photographs. • Submit completed project photographs on CD with final record drawings submittal	

PART 2 - PRODUCTS

2.1 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Digital images shall be in JPG format, produced by digital camera with minimum sensor size of 8 megapixels, and at image resolution of at least 3200 x 2400 pixels.

PART 3 - EXECUTION

3.1 Preparation

- A. Obtain and transfer copyright usage rights from photographer to City for unlimited reproduction of photographic documentation.

3.2 Photography

- A. Submit digital images exactly as originally recorded in digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 1. Maintain 1 set of images accessible in field office at Project site, available at all times for reference.
 - a. Identify images in same manner as those submitted to City's Representative.

3.3 Preconstruction Photographs

- A. Before beginning Work, excavation, or demolition, carefully and thoroughly document with photographs pre-construction condition of site, including existing neighboring improvements outside City's property which may be damaged during construction.
 1. Provide dated photographs as necessary to resolve disputes that may arise regarding conditions prior to and subsequent to construction.
- B. Take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by City's Representative.
- C. Document pre-construction condition of entire construction area and adjacent properties.
 1. In addition to pre-construction photographic survey, perform periodic photographic survey of site and adjacent areas (at least twice during construction), and then post-construction.
- D. Photographs shall be of sufficient quality and thoroughness to document preexisting damage or wear to photographed property for which Contractor or City might be asked to compensate property owner were it not for photographic evidence of preexisting damage.
- E. Where existing cracks in concrete, masonry or other materials are wider than thickness of a dime, include dime or similar visual standard in photo or video for reference.
- F. Flag excavation areas and construction limits before taking construction photographs.
- G. Take ≥20 photographs to show existing conditions adjacent to property before starting Work.
- H. Take ≥20 photographs of existing buildings either on or adjoining property to record physical conditions at start of construction.

- I. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

3.4 Periodic Construction Photographs

- A. Take 25 photographs weekly, with timing each month adjusted to coincide with cutoff date associated with Applications for Payment.
 1. Select vantage points to show status of construction and progress since last photographs were taken.
- B. Take photographs of Work to be covered or buried prior to covering or burying.
- C. Photographs shall show, where applicable:
 1. Subgrade,
 2. Conduit,
 3. Duct banks,
 4. Utilities,
 5. Steel reinforcement,
 6. Concrete footings, retaining walls, and foundations,
 7. Fasteners,
 8. Embedments
 9. Bare concrete surfaces,
 10. Decking,
 11. Framing,
 12. Piping,
 13. Pipe connections,
 14. Valves and fittings,
 15. Equipment,
 16. Ductwork,
 17. Wiring,
 18. Other items directed by City's Representative.
- D. Where structural members are fabricated off site, provide photographic documentation of fabrication in sufficient detail and quantity to show Work not visible at time of delivery to jobsite.
- E. Where on-site events may result in construction damage or losses, take photographs in advance as needed to document damage or losses.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 Work Included

- A. General procedures and requirements for submittals, initial submittal, submittals required on City's request, progress reports, Working Drawings, Shop Drawings, Product Data and samples, notification of affected residences and businesses, and submittal forms.
- B. Refer to General Conditions §8 "Shop Drawings" and §9 "Submittals" for additional Corona requirements for submittals.

1.2 Related Work

- A. Section 01 32 33: Construction Photographic Documentation
- B. Section 01 40 00: Quality Requirements
- C. Section 01 50 00: Temporary Facilities and Controls
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution

1.1 Definitions

- A. The following definitions apply:
 - 1. Installation Instructions, Application Instructions, or Assembly Instructions: Manufacturer's printed instructions including warranty requirements, clearances required and proper field procedures to deliver, handle, install, and prepare product for use.
 - a. In absence of Manufacturer's published literature, ASTM, AWWA or trade standards for installation will usually be accepted.
 - 2. Operation and Maintenance Instructions: Manufacturer's printed instructions for correct operation and maintenance procedures for product, along with:
 - a. Warranty requirements
 - b. Data which must accompany manual as directed by current regulations of government agency.
 - 3. Product Data: Manufacturer's pre-printed drawings, catalog data, or catalog cut sheets which need not include project name.
 - 4. Shop Drawings: Job-specific drawings showing details of manufactured or assembled products proposed for incorporation in Work.
 - 5. Working Drawings: Job-specific drawings showing details of construction not shown on Plans and required to be designed by Contractor.

1.3 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ANSI AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination

1.4 General

- A. Submit descriptive information, including Shop Drawings, Product Data, Installation or Application Instructions, Operation and Maintenance Instructions, Certificates of Compliance, Engineering Calculations, Foundry and Test Record Transcripts, and other engineering data covering materials, equipment, and/or methods of work, which will enable

City's Representative to advise City whether Contractor's proposed materials, equipment, or methods of work are in general conformance with design concept and in compliance with Contract Documents.

1. Submittals shall become permanent part of Work under this contract.
- B. Contractor shall be responsible for accuracy and completeness of information in each submittal and shall assure material, equipment, or method of work is as described in submittals.
 1. Submittals shall contain required information, including satisfactory identification of items, units, and assemblies in relation to Contract Documents.
- C. Submittals shall be made by Contractor, except where City and Contractor mutually agree in writing on case-by-case basis for City to deal directly with material or equipment supplier.
- D. Verify Work described in each submittal conforms to Contract Documents.
 1. Contractor shall indicate by signed stamp on submittals they have checked submittals and Work shown conforms to Contract requirements and has been checked for dimensions and relationship with Work of other trades involved.
- E. Notify City where Contractor's submittal may affect work of another contractor or owner.
 1. Ensure there is no conflict with other submittals.
 2. Ensure coordination of submittals among related crafts and subcontractors.
- F. Contractor may authorize material or equipment supplier to deal directly with City or City's Representative for submittals on case-by-case basis with City's consent.
 1. Contractor, however, shall be responsible for accuracy and completeness of information contained in submittals.
- G. Number submittals using numbering system as directed by City's Representative.
- H. Use Shop Drawing Transmittal Form included at end of this section unless otherwise directed by City.
 1. Submit separate form for each submittal and assign submittal number.
 2. Form shall be 1st page of each digital submittal.
 3. Submittals without completed Contractor's Transmittal Form as first page will be returned without review as "first submittal" and stamped "REJECTED/RESUBMIT AS SPECIFIED."
- I. Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
- J. Where submittals contain exceptions and departures from Contract Documents, list on Shop Drawing Transmittal Form exceptions or departures being requested.
 1. Highlight and annotate exceptions and departures from Contract Documents along with brief justification for each exception or departure.
- K. Provide space for reviewer's review and acceptance stamp.
- L. Show US units on submittals.
 1. For submittals prepared in foreign countries where Manufacturer's literature is printed solely in metric units, make legible and correct hand annotations to convert to US units.
 2. Submittals not bearing US units will be returned without review.
- M. Submittals bearing text in languages other than English will be returned without review.
- N. Materials submittals shall include:
 1. Brand names and Manufacturers.

2. ID Plate – Product No., etc.
3. Specification section and/or plan drawing number.
4. Intended use of product, locations, etc.

O. Use of contract drawing reproductions for Shop Drawings is subject to rejection.

1.5 Electronic (Digital) Submittals

- A. Submit digital copy of each submittal using 1 of following methods chosen by City:
 1. Email: Send submittal as pdf attachment to City and City's Representative.
 2. Data tracking System (DTS): Upload digital file to server maintained by City's Representative.
 3. CD: Burn CD containing 1 or more submittals and furnish copy of CD to City and City's Representative.
- B. Submittals may be rejected without review if scans or photocopies are of poor quality.
- C. Multiple hard copies of submittals will not be accepted in lieu of digital submittal unless otherwise authorized or directed by City's Representative.
- D. One digital copy of stamped submittal with cover letter will be returned to Contractor by email or DTS as appropriate.
- E. Verify emails sent with large attachments have been successfully received by City and City's Representative.
 1. Do not send files >5 MB in size as attachments to emails due to size restrictions associated with users' email systems.

1.6 Installation, Application, or Assembly Instructions, and Operation and Maintenance Manual Submittals

- A. Installation, Application, or Assembly Instructions: Submit 2 paper copies for review and 4 copies of complete, bound set of assembly and installation manuals for each item of equipment for which manual is required.
 1. Submit digital file in pdf format of final submittal.
- B. Operation and Maintenance Manuals: Submit 2 copies for review and 4 copies of complete, bound set of operation and maintenance manuals for each item of equipment for which manual is required.
 1. Included in binder shall be Shop Drawings plus section for City to add 11"x17" copies of record drawings.
 2. Submit digital file in pdf format of final submittal.

1.7 City's Review of Submittals

- A. City's review or acceptance of submittals shall only constitute acceptance of:
 1. Portions of submittal in compliance with Contract Documents.
 2. Exceptions or departures expressly noted on Contractor's submittal as "exceptions" or "departures" and accepted in writing by City.
 3. Exceptions or departures City or their Representative may by chance discover and acknowledge and accept in writing in City's response to said submittal.
- B. If submittal's exception or departure from Contract Documents is neither noted by Contractor on their submittal nor acknowledged and expressly accepted by City, Contract shall remain unchanged.
 1. Notwithstanding City's acceptance of submittals containing exceptions or departures not brought to City's attention, City's failure to discover said exceptions and departures in

- submittals, shall not relieve Contractor of Contract responsibilities, whether exceptions or departures were intentional or unintentional on Contractor's part,
2. Where exceptions or departures are taken but are not noted on submittals, City may require unauthorized exceptions or departures to be remedied or replaced at Contractor's expense.
 3. Liquidated damages shall also apply.
- C. Resubmittal review will focus on items expressly noted by City or their Representative as requiring correction in prior submittals.
1. Clearly identify changes made on resubmittals.
 2. If resubmittal deviates from prior submittal with respect to items accepted in prior submittal, and Contractor does not note exception or deviation, Contract shall remain unchanged.
 3. City's failure to discover exceptions and departures in resubmittals whether intentional or unintentional on Contractor's part shall in no way relieve Contractor of any Contract responsibilities.
- D. Review of submittals will proceed as follows:
1. Submit specified quantity of complete submittals together with Contractor's submittal forms to City's Representative for review.
 - a. At City's discretion, City may review submittals prior to, parallel with, or after City's Representative has reviewed submittals.
 2. Submittals will be stamped "ACCEPTED", "ACCEPTED AS NOTED", "REVISE AS NOTED/RESUBMIT," "REJECTED/RESUBMIT AS SPECIFIED", "NO ACTION REQUIRED," or "SUBMITTAL NOT REQUESTED, RETURNED WITHOUT REVIEW."
 - a. Three copies with letter of transmittal will be returned to Contractor.
 3. If review indicates material, equipment, or Work method is in general conformance with design concept and complies with Contract Documents, submittal copies will be marked "ACCEPTED." In this event, Contractor may begin to implement Work method or incorporate material or equipment covered by submittal.
 4. If review indicates minor corrections are required, copies will be marked "ACCEPTED AS NOTED." Contractor may begin implementing Work method or incorporating material and equipment covered by submittal in accordance with noted corrections.
 - a. Provide corrected copy where submittal information will be incorporated in Operation and Maintenance Data.
 5. If review reveals submittal is insufficient or contains incorrect data, copies will be marked "REVISE AS NOTED/RESUBMIT."
 - a. Do not undertake Work covered by submittals so marked until submittal has been revised, resubmitted, and returned marked either "ACCEPTED" or "ACCEPTED AS NOTED."
 6. If review indicates material, equipment, or Work methods do not conform to Contract Documents, copies of submittal will be marked "REJECTED/RESUBMIT AS SPECIFIED." Submittals with exceptions and departures not clearly identified may be rejected.
 - a. Do not undertake Work covered by submittals so marked until submittal has been revised, resubmitted, and returned marked either "ACCEPTED" or "ACCEPTED AS NOTED."
 7. If drawing or data is returned stamped "ACCEPTED", "ACCEPTED AS NOTED", "NO ACTION REQUIRED," or "SUBMITTAL NOT REQUESTED, RETURNED WITHOUT REVIEW," no further resubmittals will be required for that item.

8. If drawing or data is stamped "REVISE AS NOTED/RESUBMIT," or REJECTED/RESUBMIT AS SPECIFIED, make necessary corrections and resubmit documents as required in Instruction 1.
 - a. Contractor's submittal form transmitting revised documents shall show that documents comprise a resubmittal.
 - b. Number revisions and re-submittals as Revision #1, Revision #2, or as appropriate.
9. If changes other than those noted by City are made on submittal before resubmittal, note such changes on resubmittal.
10. Revise and resubmit submittals as required, until confirmation of compliance is obtained.
11. Include entire submittal package in resubmittals unless partial resubmittals are accepted in writing by City.
- E. Costs incurred by City for original submittal and first re-submittal will be paid by City.
 1. Costs incurred by City for 2nd and subsequent re-submittals will be deducted from payment due Contractor.
- F. Allow not less than 31 Calendar Days for review and response to submittals.
 1. Review may be delayed if contingent on receipt of other submittals.
 2. Upon timely written request by Contractor, City's Representative will make reasonable efforts to shorten review periods which may fall on Contractor's critical path.
- G. Correct and resubmit rejected submittals within 14 Calendar Days.
 1. Contractor shall have no claim for damages or extension of time due to delays resulting from Contractor having to make submittal revisions required.
- H. Wait to correct and resubmit submittals until reviewed submittal has been returned to Contractor.
 1. Submittals revised and resubmitted prior to Contractor's receipt of review comments for submittal will be returned without review to avoid generating confusion that might arise from having multiple versions of submittals in various stages of review generates confusion and will not be allowed.
- I. Do not order products or begin Work described in required submittals until such submittals have been reviewed and returned by City stamped "ACCEPTED" or "ACCEPTED AS NOTED".
 1. Contractor's acceptance of delivery of products prior to receipt of City's Representative's satisfactory return of applicable submittals shall be at Contractor's risk.
- J. Review of submittals by City's Representative shall extend solely to general type and layout of Work and shall not be construed as relieving Contractor of full responsibility for adequacy and accuracy of submitted designs and details shown in submittals.
- K. City's Representative's review of submittals shall be limited to review of products to be incorporated in Work and to remain in place upon project completion.
 1. Contractor shall have sole responsibility at all times for construction means, methods and jobsite safety.
 2. Retain services of California-licensed civil, structural or traffic engineer, as appropriate, to design and prepare plans for necessary safety equipment required by OSHA, Cal OSHA and other state and local regulatory authorities during construction, and to prepare summary documents for Contractor's use for accomplishing said Work including, but not limited to sheeting, shoring, trench plating, excavation protection, falsework, formwork, scaffolding, barricading, pedestrian safety and traffic control.
 3. Originals of summary documents, signed and sealed by engineer of record who prepared them, shall be submitted solely as proof this requirement has been fulfilled.

4. Since Contractor has sole responsibility for means, methods and jobsite safety, review of said documents will be limited to verifying preparing engineer's registration is current and that engineer of record has no active complaints filed against them with California Board for Professional Engineers and Land Surveyors.

L. Do not ship items to jobsite until applicable submittals have been accepted by City.

1.8 Initial Submittals

- A. Submit the following within 10 hours after Notice of Award.
 1. Names and addresses of Manufacturers furnishing products valued greater than either 4% of contract value or \$40,000, whichever is less.
 - a. State locations of shops at which manufacture will take place.
 - b. State whether products are already designed or in production.
 - c. Include brief description of products proposed, including sizes and catalog numbers.
 2. Letter addressed to City's Representative identifying Contractor's superintendent, safety officer, and traffic control coordinator, including emergency telephone numbers and signature authorization, and listing names, addresses and telephones for subcontractors.
- B. Submit the following within 10 Calendar Days after Notice to Proceed.
 1. Proposed Construction Schedule.
 2. Submittal Log, listing required submittals to be submitted, including required submittals by subcontractors.
 3. No extension of contract time will be granted as result of Contractor's failure to make timely submittals.

1.9 Submittals on City's Request - Supplemental Information

- A. Submit detailed construction schedule updates with monthly pay requests to describe scheduling of elements of construction requiring City's or Contractor's coordination with public, or other private parties or public agencies.
- B. Supplemental information will be requested for "accepted equals" and may be requested when there is a question a Manufacturer's product conforms to Contract Documents.
 1. City reserves right to require submittal of supplemental information as described herein before acceptance of product.
- C. Certification of compliance with listed reference standards shall be submitted by Manufacturers on City's request.
 1. Failure of City to request certification of compliance shall not serve as waiver of Contractor's duty to comply with reference standards.
- D. Transcripts of results of acceptance tests performed at point of manufacture of products furnished shall be submitted by Manufacturers on City's request.
- E. Samples shall be submitted on City's request.
- F. Names and addresses of nearest local service representatives maintaining technical service personnel and complete inventory of spare parts and accessories shall be submitted on City's request.
- G. List of 3 installations in which products comparable in size, capacity and rating with those required in Contract Documents are now in regular operation shall be submitted on City's request.
 1. Include listing of size capacity or rating of each installation.

2. Include name and telephone number of ≥ 1 reference responsible for operations at each installation whom City's Representative may contact.

1.10 Progress Reports

- A. Daily log shall be submitted by Contractor's superintendent on 1-page form provided by City.
 1. These logs shall be detailed with activities that took place during each day.
 2. Submit logs daily to City's Representative by end of following workday.
- B. Schedule updates shall be submitted with monthly pay requests.
 1. If Work falls behind schedule, monthly pay requests shall include revised schedules to demonstrate how Contractor intends to bring Work back on schedule.
- C. Record Drawings, consisting of 1 set of full size annotated hard-copy plans and other drawings forming part of contract, showing installed locations of improvements and changes made during construction shall be available to City for inspection throughout project.
 1. Record deviations from Contract Documents, including accepted change orders, using additional sketches or ink revisions, immediately after installing each portion of Work.
 2. Show locations of underground piping, conduit, sensor lines, valves, capped ends, branch fittings, pull boxes and Work.
 3. Keep 1 current record copy of Contract Documents, Addenda, Supplementary Drawings, Working Drawings, Change Orders and clarifications at site and in good order.
 4. Report changes and deviations promptly to City's Representative.
- D. Partial payment requests may be withheld if daily logs, schedule updates or record drawings are damaged, lost or not kept current to satisfaction of City's Representative.

1.11 Contractor's Notice of Pending Delay Claim

- A. If delay claim is foreseen by Contractor, Contractor shall immediately notify City in writing.
 1. Following said notice, Contractor shall have no more than 7 Calendar Days to furnish follow-up information as required by City to allow City to act judiciously to minimize losses.
 2. At minimum, said information shall consist of letter identifying and substantiating cost of expected claim per day of delay accompanied by schedule showing available float and delay's impact on overall schedule.

1.12 Working Drawings

- A. Prepare Working Drawings to scale wherever possible and show project name on drawing.
- B. Working Drawings shall include:

SECTION	SPECIFICATION TITLE	SUBJECT	PROFESSIONAL ENGINEER STAMP
01 35 26	Governmental Safety Requirements	Shoring Plan	Required
01 73 24	Seismic Restraint	Seismic Restraint System Design	Required
02 41 13	Selective Site Demolition	Demolition Plan	Not Required
05 12 00	Structural Steel Framing	Structural Steel Falsework	Required
31 05 50	Protecting Existing Utilities	Pipe and Utilities Supports at Trench Crossings	Not Required
31 23 19	Dewatering	Dewatering Plan	Required
33 01 30	Sewage Bypassing	Sewage Bypass and Pumping Plan and SPCCP	Not Required

1.13 Shop Drawings

- A. Prepare Shop Drawings to scale wherever possible and show project name on Shop Drawing.

- B. Except where preparation of submittal is contingent upon acceptance of a prior submittal, combine submittals relating to same class or portion of Work into 1 package, regardless of variety of trades or types of equipment required to construct that portion of Work, eg above ground piping, fittings, valves, actuators, pipe stands, couplings, flow meters and appurtenances shall be submitted as 1 package for review.
1. Packages shall clearly reference specification sections and specified submittal requirements therein, showing where in submitted literature each submittal requirement is satisfied.
 2. Packages clearly incomplete will be returned without review.
 3. To facilitate acceptance of critical path items or to facilitate Contractor's communication with multiple suppliers and subcontractors, packages may contain several submittals from several suppliers so long as relevant submittals are contained in package.
 4. Where expedited review of 1 submittal item within package is desired to facilitate critical path items, notify City's Representative in writing to request expedited review of said item.
 5. Contractor's request for expedited review of portion of submittal package shall be taken as full acceptance of responsibility by Contractor for subsequent field modifications or substitutions later necessary to remedy conflicts between expedited submittals and other submittals or to remedy conflicts between expedited submittals and Contract Documents not brought to City's attention at time of submittal.
- C. Shop Drawings for piping shall include:
1. Brand names and Manufacturers.
 2. Specification section and/or plan drawing number.
 3. Intended use and location of product.
 4. Key or index showing locations of spools and fittings.
 5. Order of installation.
 - a. Each spool shall receive unique mark number.
 - b. No other spool or fitting, even on separate pipelines or casings included in Contract, shall have same mark number.
 - c. Sequential order of mark numbers shall correspond to logical order of installation for each pipeline.
 6. Laying lengths, dimensions, clearances and tolerances for spools and fittings.
 7. Clearly legible drawing showing each pipe, duct, or tube fitting and/or spool in plan view and in profile.
 8. Station and invert elevation of grade changes and changes in horizontal alignment
 9. Slopes of pipe not vertical or horizontal.
 10. Horizontal and vertical alignment data for curves, bends, tees and outlets.
 11. Couplings and end types of pipe, spools, fittings, outlets and adjacent valves or pipeline equipment.
 12. Proposed pipeline linings and coatings including thicknesses.
 13. How connections will be made between Work under this contract and existing work or work under other contracts.
 14. Relationship of piping to other Work.
- D. Shop Drawings for valves, pumps, or pipeline equipment shall include:
1. Brand names and Manufacturers.
 2. ID Plate – Product No., etc.
 3. Packager, assembler, or supplier.

4. Specification section and/or plan drawing number.
 5. Intended use and location of product.
 6. Laying lengths and dimensions, clearances, tolerances and end types.
 7. Weight and type of valves, pumps or equipment.
 8. Valve and pump port sizes and tolerances.
 9. Dimensions and orientation of actuators and pilot systems.
 10. Locations of actuator stops.
 11. Valve stem extensions and supports, stem guides.
 12. Proposed linings and coatings.
 13. Performance characteristics.
 14. Special features.
 15. Parts and materials lists and ratings and details of Work, accessories, auxiliary items, and appurtenances to be furnished, along with references to appropriate ASTM, Federal Specifications and other reference standards and grades.
 16. Piping and conduit attachments and sizes.
- E. Shop Drawings for concrete forms and falsework shall include:
1. Detailed drawings of falsework proposed to be used to include
 - a. General layout
 - b. Size of members
 - c. Anticipated stresses
 - d. Grade of materials to be used in falsework
 - e. Means of protecting existing construction which supports falsework
 - f. Typical soil conditions
 2. Form ties and related accessories, including taper plugs, if taper ties are used.
 3. Form gaskets
 4. Proposed locations and type of construction joints, including joints shown on construction drawings and joints required for construction, but not shown on construction drawings
 5. Sequence of forming and concrete placing operations
 6. Engineering calculations signed and sealed by professional Civil or Structural Engineer registered in State of California for both falsework and forming systems and stresses induced on falsework and form systems.
- F. Shop Drawings for replacement items shall include field measurements needed to verify fit in existing spaces.

1.14 Product Data, and Other Submittals

- A. Product Data shall conform to the following.
1. Where multiple products or options are shown on same page, indicate product, model number, and option being furnished.
 - a. Identify optional accessories.
 2. Use black ink to indicate the following on submitted Product Data
 - a. Project name.
 - b. Specification section or plan reference being satisfied.
 3. Provide acknowledgment electrical and other products required to be UL or ETL listed are, in fact, UL or ETL listed or are constructed using UL or ETL recognized components.

- B. Installation Instructions, Application Instructions, or Assembly Instructions shall conform to the following.
1. If no instructions are submitted for installing or applying item of Work, City reserves right to stop Work on subject item, and to retain experts of City's choosing to prepare appropriate instructions to control Contractor's Work.
 2. Installation Instructions shall include recommended bolt torques for assembly and installation of bolted items.
- C. Operation and Maintenance Instructions shall conform to the following.
1. Include operating instructions for each piece of equipment.
 2. Describe equipment function, operating characteristics, limiting conditions, operating instructions, startup procedures, normal and emergency conditions, regulation and control, and shutdown.
 - a. Include preventative maintenance instructions.
 3. List warranty requirements.
 4. Explain and illustrate preventative maintenance tasks.
 5. Include lubrication charts, lists of acceptable lubricants, trouble-shooting instructions, and lists of required maintenance tools and equipment.
 6. List recommended spare parts, their costs, and ordering information for 1 Manufacturer who can supply these parts.
 7. Index instructions for easy reference.
 8. Include information for installed equipment only.
- D. Certificates of Compliance shall mean same thing as "affidavits of compliance" and shall certify materials or procedures have been sampled, tested and found to comply with applicable reference standards.
1. Do not ship items described therein until Certificates of Compliance are accepted by City.
- E. Certificates of Proper Installation shall be signed by Manufacturer and Contractor, certifying material or equipment specified and installed conforms to or exceeds requirements of Contract Documents and has been inspected by Manufacturer's factory-authorized field representative.
- F. Engineering Calculations shall be clearly legible, shall follow recognized engineering principles and shall be sufficiently detailed to permit ready check of procedures used.
1. Where published tables or charts are included in calculations, clearly show design or load variables used to make selection, highlighting applicable columns or rows in tables and highlighting intersecting variables on chart axes.
 2. Engineering calculations shall demonstrate compliance with current state and local codes, applicable standards, and contract requirements.
 3. Calculations shall be sealed by registered engineer licensed in State of California.
 4. Calculations or drawings bearing seals with expired expiration dates will not be accepted.

G.

SUBMITTAL	DESCRIPTION	
Preconstruction Photographs	Refer to Section 01 32 33.	
Daily Construction Reports	Submit daily record showing: 1. Total manpower for each construction trade. 2. Major equipment on site. 3. Comments on daily Work progress and status for each major Work item	

SUBMITTAL	DESCRIPTION	
	4. Other information requested by City's Representative Submit report by 9:00 AM on following Working Day.	
Schedule for Lubrication and Run-in Procedures	Submit 2 weeks before beginning procedures.	
Manufacturer's Written Acceptance of Installation (where "Manufacturer's Statement of Responsibility" is required)	Written acceptance of installation of products shall be certified and submitted by authorized factory representative. This written acceptance shall state factory authorized representative has inspected installation, alignment, lubrication and operation of furnished equipment and found it to fully comply with specified design and warranty requirements and be ready for safe operation.	.
Warranty	Unless otherwise stated, furnish 1-year warranty from date of final acceptance.	

PART 2 - PRODUCTS (not used)**PART 3 - EXECUTION (not used)****END OF SECTION**

SUBMITTAL TRANSMITTAL FORM

FROM: _____ DATE: _____
PROJECT NAME: _____ PROJECT NO.: _____
TO: City of Corona ATTN: _____
400 South Vicentia Avenue
Corona, CA 92882-2187 Construction Manager

SUBMITTAL NO.: _____
☐ THIS IS AN ORIGINAL SUBMITTAL ☐ THIS IS A REVISION OF SUBMITTAL NO. _____
SUBJECT OF SUBMITTAL: _____
SPECIFICATION SECTION(S): _____ PLAN SHEET NUMBER(S): _____

CONTRACTOR'S CERTIFICATION: Check & Complete either (A) or (B) below:
(A) _____ We have reviewed in detail and certify material, equipment or construction procedure(s) contained in this submittal meet all requirements specified in or shown on Contract Documents, Construction Specifications and Construction Plans with no exceptions.
(B) _____ We have reviewed in detail and certify material, equipment or construction procedure(s) contained in this submittal meet all requirements specified in or shown on Contract Documents, Construction Specifications and Construction Plans except for the following deviations:

Contractor's Authorized Signature:

REVIEWER'S COMMENTS

MANUFACTURER'S STATEMENT OF RESPONSIBILITY

Project Name: _____

Specification Section Number: _____

Item: _____

Serial Numbers: _____

City: _____

Contractor: _____

Supplier: _____

1. **We have reviewed applicable sections of the Contract Documents** describing requirements for our product, including Sections entitled "Submittal Procedures," "Quality Requirements," "Product Requirements," "Starting and Adjusting," "Closeout Procedures," "Operating and Maintenance Data," "Demonstration and Training," "Basic Civil Engineering Requirements," and "Painting and Coating."
2. **Before shipping, we promise to review Contractor's submittals from other Manufacturers** who will supply products that interface with our product, and may affect our product's performance. Also, we promise to request and review data concerning quality of water, soils or any other materials which may contact or adversely impact performance of our product.
3. **Should we have cause to believe our product is, for any reason, incompatible** with an interfacing product or material, we will inform City of our concern before shipping our product. In such case, we will not ship our product until our concerns have been satisfactorily resolved.
4. **We further understand that City reserves right to request a factory-authorized representative's written acceptance of installation, application and/or erection of our product** as described in Section of Contract Documents entitled "Starting and Adjusting", before paying Contractor for our product.

Authorized Factory Representative

SECTION 01 35 26

GOVERNMENTAL SAFETY REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Governmentally mandated safety requirements, including compliance with OSHA and Cal OSHA requirements for worker safety.
- B. Refer to General Conditions §36 "Labor/Employment Safety" for additional Corona requirements for safety.
- C. No attempt is made to set out in detail means or methods necessary to satisfy requirements for worker and public safety.
 - 1. Recognition of requirements set forth by law is made to assist Contractor in identifying necessary costs during bid preparation.
 - 2. Contractor shall be solely responsible for conditions on site including safety of all persons and property throughout Work.
 - 3. City's right to conduct construction review or observation of Contractor's performance will not include review or observation of adequacy of Contractor's safety measures in, on, or near Work.
- D. No attempt is made to replicate or interpret existing OSHA and CalOSHA worker safety requirements referenced herein.
 - 1. Contractor's attention is directed to certain critical sections of regulations to allow them to reference and interpret original regulations for themselves.
- E. Hazardous conditions may be encountered performing Work.
 - 1. Fumes from construction materials specified may cause harm or irritation.
 - 2. Advise employees of potential hazards.
 - 3. Supply required protective and safety equipment.
 - 4. Comply with applicable State and Federal safety regulations (OSHA).
- F. Guard machinery and equipment and physical hazards in accordance with safety provisions of Manual of Accident Prevention in Construction of Associated General Contractors of America unless such provisions are incompatible with Laws.
- G. Provide safety vests, eye protection, earplugs, hard hats, steel toed work shoes, appropriate personal protective clothing, gloves, and respirators where required by law for worker safety.
- H. Do not use material containing asbestos.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 50 00: Temporary Facilities and Controls
- D. Section 31 05 50: Protecting Existing Utilities

1.3 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. California Administrative Code, Title 8, Subchapter 4 Cal OSHA "Construction Safety Orders"
 - 2. California Administrative Code, Title 8, "General Industry and Electrical Safety Orders"
 - 3. California Administrative Code, Title 8, "Tunnel Safety Orders"
 - 4. National Safety Council Accident Prevention Manual for Industrial Operations,
 - 5. NFPA 70E Electrical Safety in the Workplace

6. NFPA 241 Safeguarding Construction, Alteration, and Demolition Operations
7. OSHA Regulations

1.4 **Submittals**

A. Furnish the following submittals:

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Construction Safety Plan	Construction Safety Plan shall include submittals required in this table.	
Construction Fire Safety Plan	Construction Fire Safety Plan shall conform to NFPA 241 and include submittals required in this table.	
Designation of "Project Safety Official"	Submit name and phone number to City's Representative at preconstruction meeting.	
Designation of "Project Fire Safety Official"	Submit name and phone number to City's Representative at preconstruction meeting.	
Designation of "Competent Person"	Submit name and phone number to City's Representative at preconstruction meeting.	
Injury and Illness Prevention Program	Submit description of Contractor's procedures and requirements for safety and hygiene.	
California Division of Industrial Safety Excavation Permit	Submit copy of excavation permit from State Division of Industrial Safety prior to start of excavation.	
Applicable Safety Orders	Include in Construction Safety Plan applicable safety orders including Construction Safety Orders, Tunnel Safety Orders and General Industry Safety Orders issued by California Division of Industrial Safety	
Confined Space Entry Program (CSEP)	Submit CSEP meeting requirements of California Code of Regulations Title 8, §5156, 5157, and 5158 addressing confined space procedures including: 1. Training of personnel 2. Purging and cleaning space of materials and residue 3. Potential isolation and control of energy and material inflow 4. Controlled access to spaces 5. Atmospheric testing of spaces 6. Ventilation of spaces 7. Special hazards consideration 8. Personnel protective equipment 9. Rescue plan provisions. Include names and daytime telephone numbers of Contractor's personnel including each Subcontractor's personnel assigned to Work having CSEP responsibilities, their CSEP training, and their specific assignment and responsibility in carrying out CSEP.	
Material Safety Data Sheets	Submit copies of MSDS sheets from chemical manufacturers for all chemical used during construction, startup and testing, or operational activities	
Job Hazard Analysis	Where workers are expected to encounter hazardous materials, submit Job Hazard Analysis documenting: 1. Hazard communications program. 2. Safety precautions for persons who may be exposed to hazardous substances used by Contractor as presented in Construction Safety Plan. 3. Number of people to be involved in Work. 4. Written verification that safety measures will be carried out. 5. Written verification that required safety equipment is available.	
DRAWINGS		
Working Drawings Excavation and Shoring (Shoring Plan)	Submit detailed plan showing design of shoring, bracing, sloping, or other provisions for worker protection from hazard of caving ground during excavation of any trench, pit, or excavation ≥5' deep. Trench shields or boxes will be permitted. for excavations up to 10' deep. Shoring shall conform to requirements of Cal OSHA Construction Safety Orders Article 6 "Excavation"	
	Shoring plan will be rejected if: 1. Plan is based on subsurface conditions more favorable than those shown in Geotechnical Investigation.	

SUBMITTAL	DESCRIPTION	
	2. Plan is not prepared by California-licensed civil or structural engineer. 3. Plan does not address allowable surcharge loads. 4. Plan makes use of horizontal strutting below pipe barrel 5. Plan makes use of pipe as support. 6. Plan does not fully conform to submittal requirements shown herein. If shoring plan varies from shoring system standard drawings, plan shall be prepared by California-registered structural or civil engineer as required by CAL/OSHA Construction Safety Orders and applicable laws.	
	Engineer shoring plan to accommodate surcharge on side of trench of ≥ 300 psf to allow for equipment wheel loads or stockpiling of materials. Plan shall show allowable surcharge loads for nearby embankments and structures, for spoil banks, and for construction equipment and other construction loading. For all trench conditions, shoring plan shall show minimum horizontal distances from side of trench at its top to near side of surcharge loads. Shoring plan shall allow for lateral groundwater pressures. Plan shall show sequence and procedure for installing and removing shoring system components. Shoring plan shall show and accommodate protection of existing underground utilities.	
	Plan shall include note stating registered civil or structural engineer certifies plan conforms to CAL-OSHA Construction Safety Orders, or that registered civil or structural engineer certifies plan is not less effective than shoring, bracing, sloping, or other provisions of Safety Orders.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit affidavit of compliance with California Construction Safety Order requirements prior to beginning excavation on trench or excavation. Affidavit shall certify compliance with shoring, bracing, sloping or other protective system provisions required by California Construction Safety Orders for worker protection from hazard of caving ground during excavation.	

B. Construction safety shall be solely responsibility of Contractor.

1. City review of safety submittals is for general compliance and coordination only.

1.5 Safety and Health Regulations

- A. Contractor shall have full authority over and shall bear full responsibility for jobsite safety and for safeguarding their employees from injury or illness due to construction-related activities.
1. Comply with Safety and Health Regulations for Construction, promulgated by Secretary Standards Act, as set forth in Title 9, CFR.
 2. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue NW, Washington, DC 20013.
 3. Comply with provisions of Federal Occupational Safety and Health Act, as amended, and with applicable State of California, Department of Industrial Relations, Construction Safety Orders (CalOSHA) requirements.
- B. Refer to Paragraph 1.4 entitled "Submittals" for required safety submittals.
- C. Provide safety measures as necessary to protect public and workers within, or in vicinity of Work site.
1. Ensure operations do not create safety hazards.
- D. Provide safety equipment, material, and assistance to City's personnel to facilitate safe and proper inspection of Work phases.
1. Provide first aid kit.
 2. Provide eyeball wash in first aid kit where workers may be exposed to lime, chlorine, or other materials unsafe for eye exposure.
 3. Provide safe and suitable OSHA-compliant ladders as required for safe access to Work.

4. Workers shall wear appropriate clothing including safety vests, eye protection, and hard hats as required by OSHA.
- E. Contractor shall certify they are experienced and qualified to anticipate and meet safety, fire safety, and health requirements of Work and shall require their personnel to observe proper safety and hygienic precautions.
- F. Contractor shall designate in writing "Project Safety Official," who shall:
 1. Be at Work site whenever Work is in progress.
 2. Be thoroughly familiar with Contractor's Injury and Illness Prevention Program (IIPP) and Code of Safe Practices (CSP)
 3. Be available at all times to abate potential safety hazards.
 4. Have access to and authority and responsibility to issue masks, hardhats, or eye protection to personnel on site who fail to furnish their own.
 5. Shut down unsafe operations, if necessary.
- G. Maintain Construction Safety Plan including copies or suitable extracts of Construction Safety Orders, Tunnel Safety Orders, and General Industry Safety Orders issued by California State Division of Industrial Safety at Work site.
- H. Comply with federal, state, and local laws, regulations, and requirements for handling and storage of chemicals.
- I. Monitor for explosive gas levels.
- J. Provide evidence of Contractor's personnel safety orientation practices.

1.6 Confined Space Procedures

- A. Entry into permit-required confined spaces as defined in California Code of Regulations Title 8, §5157 may be required as part of Work.
- B. In accordance with California Code of Regulations Title 8 General Industry Safety Orders, §5157(c)(8), City will provide available information to Contractor for each confined space location.
- C. Confined space work areas include:
 1. Work areas for which entry is expected to be in accordance with California Code of Regulations Title 8 §5157 (c)(5), Non-Permit required Confined Spaces;
 2. Work areas in which hazardous or potentially hazardous atmospheric conditions exist or may exist shall be in accordance with California Code of Regulations Title 8 §5157 (d), (e) and (f) (Permit-Required Confined Space):
 - a. Manholes
 - b. Sewer pipes
 - c. Equipment
 - d. Above grade channels
 - e. Vaults
 - f. UV Structure.
 3. The above enclosed or partially-enclosed spaces shall be considered permit-required confined spaces until pre-entry procedures demonstrate otherwise.
 4. Prior to start of Work, submit Confined Space Entry Program (CSEP).
 - a. Refer to Paragraph 1.4 "Submittals" for required CSEP submittal requirements.
 5. Before performing Work in permit-required confined spaces, implement, administer, and maintain Confined Space Entry Program (CSEP) in accordance with California Code of Regulations Title 8, §5156, 5157, and 5158.
 - a. Retain copy of said regulations on worksite.

6. Copy of permit shall be available for review by Contractor and City's Representative at Work site.
 7. California law and City's policy on confined spaces require 2-week advance notification from Contractor for work within confined spaces, submittal of Contractor's confined space work procedures and rescue plan, compliance with Entry Permit procedures, participation in hazard assessment review of planned precautions and debriefing upon completion of confined space operation.
 - a. Compliance with General Industry Safety Orders remains Contractor's responsibility.
 8. Contractor's is legally obligated to satisfy requirements of Title 8, CCR §5157.
 9. Attention is also directed to "Sewer System Entry", Appendix E to CCR §5157.
 10. Permit-required confined spaces may be reclassified by City Safety staff to non-permit-required confined spaces at Contractor's expense through provisions set forth in §5157 (c)(7), or listed non-permit required Work area may become permit-required confined space work area.
 11. Where continuous flow of sewage and contaminant may occur in confined space, atmosphere may suddenly and unpredictably become lethal.
 - a. Where there is conflict between applicable safety orders, laws and regulations and policies, the more stringent measures shall apply.
- D. Work may expose Contractor's employees to hazardous materials underground and from nearby facilities.
1. Hazardous materials may include asbestos, lead, mercury, petroleum products, propane gas, natural gas, diesel fuel, gasoline, combustion exhaust products, sewer gas, ammonium sulfate, sodium hypochlorite, sodium hydroxide, treatment chemicals, wastewater, primary effluent, secondary effluent, tertiary effluent, wastewater sludge, and other chemicals.

1.7 Hazardous Substance Safety Procedures

- A. Contractor's hazardous substance safety procedures shall address the following:
 1. Contractor shall certify they are experienced and qualified to anticipate and meet safety and health requirements of this Project.
 2. Contractor shall require their personnel to observe proper safety and hygienic precautions.
 3. Contractor shall be solely responsible for storage, usage, handling, and application of hazardous materials encountered or provided as part of Work.
- B. Where asbestos is being removed or cut, requirements of California Code of Regulations Title 8 Division 1, Chapter 4, Subchapter 4 and Subchapter 7 shall be implemented.
- C. Contractor shall be solely responsible for storage, use, and handling of hazardous materials encountered or provided as part of Work.
- D. Job Hazard Analysis:
 1. Comply with provisions of Hazards Communication Act (California Code of Regulations Title 8, §5194).
 2. If hazardous substances are to be used or handled in course of Work, before commencing each task conduct job hazard analysis for City.
 - a. Refer to Paragraph 1.4 "Submittals" for Job Hazard Analysis submittal requirements.

1.8 Fire Safety

- A. Conform to requirements of NFPA 241.
- B. Avoid fire hazards in welding, cutting, and equipment fueling.

- C. Furnish safety devices, fire extinguishers and fire watch personnel required to protect Work and provide for worksite and public safety.
- D. Store flammable materials in accordance with local fire codes, away from open flames, sparks, or temperatures >150°F, and in proximity to Contractor-furnished UL-listed fire extinguishers appropriate for stored materials.
 - 1. Ground metal drums containing flammable materials.
 - 2. Provide NO-SMOKING signs around flammable materials.
 - 3. Do not use spark-producing tools near flammable materials.
 - 4. Promptly dispose of rags used for wiping up resurfacing materials, oils, solvents, and thinners by drenching with water and placing in container with tight-fitting lid.

1.9 Electrical Safety

- A. Provide and maintain electrical safeguards necessary for prevention of accidents and safety of personnel.
- B. Replace covers of energized lighting and power panelboards, removed for work purposes, when left unattended.
- C. Conduct testing and checkout Work in safe manner.
- D. As required by OSHA, provide safety precautions, including:
 - 1. Erect warning signs as necessary.
 - 2. Provide necessary barricades, barriers, and warning signs
 - 3. Maintain voice communications as necessary.
 - 4. Coordinate electrical lockout procedures with City before beginning Work in areas with electrical equipment.
 - 5. De-energize and/or isolate electrical equipment prior to testing.
 - 6. Circuits operating in excess of 600VAC between conductors shall have conductors shorted to ground by suitably designed hot-line grounded device.
 - 7. Station security guards as necessary.
 - 8. Work shall not proceed until Contractor's Project Safety Official has determined it is safe to do so.
- E. Conduct electrical tests within framework of the following procedures:

1.10 Excavation Safety

- A. Contractor's excavation safety procedures shall address the following:
 - 1. Nothing contained in these Contract Documents shall be construed as relieving Contractor of full responsibility for providing shoring, bracing, sloping or other provisions adequate to guarantee worker protection and safety, nor for any liability resulting from failure to do so.
 - 2. Protect open excavations, complying with latest revision of rules, orders and regulations of California State Division of Industrial Safety.
 - 3. Conform to California Labor Code §6500, which includes the following stipulations:
 - a. Do not begin excavating any trench ≥5' deep into which workers will be required to descend, prior to acceptance of Excavation and Shoring Working Drawings required above in Paragraph 1.4 entitled "Submittals".
 - b. Do not begin excavating any trench ≥5' deep into which workers will be required to descend, prior to submitting Excavation Permit from California State Division of Industrial Safety.
 - c. Prior to beginning excavation ≥5' deep into which workers will be required to descend, submit to City's Representative name of "Competent Person" as defined in California Code of Regulations Title 8, §1504.

- d. Competent person shall be at Work site as required by Cal OSHA.
 - e. Protect and support trenches or excavations <5' deep when Competent Person deems hazardous ground movement may be expected.
- 4. If Contractor fails to submit shoring plan or fails to comply with accepted shoring plan, Contractor shall suspend work at affected location(s).
 - a. Such suspended work shall not be basis of claim for Extra Work, and Contractor shall receive no additional compensation or Contract time.
- 5. Pursuant to California Labor Code §6705, submit Excavation and Shoring Working Drawings.
 - a. Refer to Paragraph 1.4 above, entitled "Submittals," for Excavation and Shoring Working Drawings submittal requirements.
 - b. Perform, protect, and support excavations as required for safety and in manner set forth in operation rules, orders, and regulations prescribed by Cal/OSHA Construction Safety Orders.
- 6. City may have made investigations of subsurface conditions in areas where Work is to be performed.
 - a. If so, these investigations are provided for Contractor's use, but not made part of Contract Documents.
 - b. Records of such investigations, if performed, are available for inspection at City's office.
 - c. Refer to Contract General Conditions for more information regarding soils investigations.
- 7. Install and remove shoring and bracing materials required during trenching and excavation.
 - a. Drill vertical supports including steel H-beams and piles into place, except final 4' may be driven.
 - b. Where drilling is impracticable because of rocks or running sand, City's Representative may accept placing of vertical supports by means other than drilling, provided Contractor assumes sole responsibility to protect existing surface and subsurface improvements in place.
 - c. If sheeting is used for trench support, no sheeting shall remain in trench upon project completion except where removal of portions of said sheeting is impracticable in opinion of City's Representative.
- B. Maintain excavations within street right-of-way and easements.
- C. Take appropriate measures when trenching near existing structures, utilities, sewer and water mains, gas lines, storm drain, and conduits to prevent existing utility trench from sloughing into new trench.
 - 1. Wall of new trench may be adjacent to edge of existing trench and therefore may contain loose material.
 - 2. Use shoring or other protective construction measures as required by field conditions to prevent pavement damage outside trench width and prevent trench wall sloughing.
 - a. Minimize sloughing and damage to road surface or other utilities.
 - b. Repair damaged pavement or utilities resulting from such sloughing
 - 3. Do not use shoring systems as forms for cast-in-place concrete.
 - a. Provide adequate space between structure and shoring system for installing and removing forms.
 - 4. Where space between shoring and structure is not sufficient to provide adequate backfill compaction equipment, backfill with 2-sack sand cement slurry.

5. Withdraw sheet piling and timbers in manner to prevent subsequent pipe settlement or additional backflow loading which might overload pipe.

D. Protect open trenches as follows:

1. No trench may be left open overnight unless authorized in writing by City's Authorized Representative.
2. Cover open excavations with steel plates in areas requiring vehicle/truck traffic when not in use.
3. Provide safety fencing around entire area at excavations when not in use.
4. Keep bottoms of excavations dry throughout progress of Work.
5. Provide access ladders within 25' of workers as required by OSHA regulations.
6. Ladders shall project 2' above top of trench.

E. Use of explosives on Work is prohibited.

1.11 Scaffolding, Rigging, and Hoisting Safety Procedures

A. Provide scaffolding, rigging, hoisting, and services needed to safely deliver, support, move and install Work.

1. Remove same from premises when Work is complete.
2. Comply with OSHA requirements and applicable laws, ordinances, rules, regulations, and orders pertaining to construction machinery and equipment, hoists, cranes, scaffolding, staging, materials handling facilities, tools, appliances and other construction aids.
3. Obtain safety bulletins and printed safety instructions from Manufacturers regarding proper operation of their equipment and installation of their products.
4. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
5. Design temporary supports with adequate safety factor to assure adequate load bearing capability.
6. When requested, submit design calculations by professional engineer registered in State of California before applying loads.
 - a. Submitted design calculations are for information and record purposes only.

B. Prepare and implement accident prevention and safety program to include, but not be limited to:

1. Exercise precautions throughout construction for protection of persons and property.
2. Observe safety provisions of applicable laws and regulations.
3. Observe safety provisions recommended by applicable Manufacturers of products, chemicals, and construction equipment.
4. Post safety provisions in conspicuous and logical location accessible to workers on-site for reference.
5. Guard machinery and equipment, and eliminate other hazards.
6. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
7. Before commencing construction Work, take necessary action to comply with provisions for safety and accident prevention.

C. Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers.

1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

- D. On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

1.12 First Aid Information

- A. Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

1.13 Chemical Handling

- A. Obtaining prior acceptance from City for chemical usage.
- B. Obtain MSDS sheets from chemical manufacturers.
 - 1. Post copies on-site in conspicuous location for worker reference.
- C. Provide 4 copies of MSDS sheets to City's Representative for chemicals used during construction or operational activities, prior to bringing them on site, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, fuel, lubricant, or of other classification, which shows acceptance from either US Environmental Protection Agency or US Department of Agriculture.
- D. Use and dispose of residues of such chemicals in strict accordance with printed instructions of Manufacturer.

1.14 Responsibility for Job Site Conditions

- A. Contractor agrees they shall assume sole and complete responsibility for job site conditions during course of Work, including safety of persons and property.
 - 1. This requirement shall apply continuously and not be limited to normal working hours.
 - 2. Contractor shall defend, indemnify and hold City and design consultant harmless from liability except for that arising from sole negligence of City.
- B. Contractor alone shall be responsible for safety of their employees and their protection from construction-related risk.

1.15 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Inspection and testing laboratory qualifications, duties and responsibilities.
 - 1. Contractor's Quality Control Plan and Site Quality Control Plan conforming to ANSI/ASQ E1 for design, procurement, manufacturing, construction, installation and testing activities, ANSI/ASQ E2 for inspection activities related to Work, and ISO 9001 or City-accepted substitute for manufacturing facilities.
 - 2. City's inspection and testing.
 - 3. General quality requirements.
 - 4. Contractor's Quality Control Plan and Site Quality Control Plan shall remain in effect for duration of Work.
- B. Testing and inspecting services are required to verify compliance with requirements shown.
 - 1. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with Contract requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by City, City's Representative, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. Refer to General Conditions §12 "Workers" and §13 "Subcontractors" for additional Corona requirements for submittals.
- D. Refer to Section 31 23 00 / 31 23 33 for soil compaction testing requirements.

1.2 Definitions

- A. The following definitions apply:
 - 1. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of Work to guard against defects and deficiencies and substantiate proposed construction will comply with requirements.
 - 2. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of Work to ensure actual products incorporated into Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by City's Representative.
 - 3. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into Work, to verify performance or compliance with specified criteria.
 - 4. Product Testing: Tests and inspections performed by NRTL, NVLAP, or testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
 - 5. Source Quality-Control Testing: Tests and inspections performed at material source, plant, mill, factory, or shop.
 - 6. Field Quality-Control Testing: Tests and inspections performed on-site for installation of the Work and for completed Work.
 - 7. Testing Agency: Entity engaged to perform tests, inspections, or both.
 - a. Testing laboratory shall mean same as testing agency.

8. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as employee, Subcontractor, or Sub-subcontractor, to perform particular construction operation, including installation, erection, application, and similar operations.
 - a. Use of trade-specific terminology in referring to trade or entity does not require certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
9. Experienced: When used with entity or individual, "experienced" means having successfully completed ≥ 5 previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
10. Qualified: when used with entity or individual, "qualified" means "experienced" plus being in possession of requisite permits, licenses, and certificates documenting qualifications required in Contract Documents, except where City elects to waive a particular requirement.

1.3 **Conflicting Requirements**

- A. Referenced Standards: If specified standards establish conflicting requirements for minimum quantities or quality levels, refer conflicting requirements to City's Representative for resolution before proceeding.
- B. Where conflict arises between standards and/or between Technical Specifications and Design Drawings, more stringent standard or requirement shall govern at discretion of City's Representative.
- C. Quantity or quality level shown or specified shall be minimum provided or performed.
 1. Actual installation may comply exactly with minimum quantity or quality specified or may exceed minimum within reasonable limits.
 2. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for context of requirements.
 3. Refer uncertainties to City's Representative for decision before proceeding.

1.4 **Related Work**

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 61 00: Common Product Requirements
- D. Section 31 23 00: Excavation and Fill
- E. Section 31 23 33: Trenching and Backfilling

1.5 **Reference Standards**

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 1. ANSI/ASQ E1 Quality Program Guidelines for Project Phase of Nonnuclear Power Generation Facilities
 2. ANSI/ASQ E2 Guide to Inspection Planning
 3. ASTM C1077 Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Lab Evaluation
 4. ASTM E329 Agencies Engaged in Construction Inspection, Testing, or Special Inspection
- B. Where reference is made to 3rd-party standards such as ANSI, AWWA or ASTM specifications, or standards or codes adopted or promulgated by public agency, it shall mean latest edition thereof formally adopted and published at time of advertisement for bids.

1.6 **Quality Assurance**

- A. Work shall conform to Federal, State and local building codes, electrical codes, fire codes, mechanical codes, energy codes, green building codes, plumbing codes, and to Occupational Safety and Health Act (OSHA) Regulations.

1. Nothing in Contract Documents shall be interpreted as permission or direction to violate any governing code or ordinance.
- B. Qualifications paragraphs below establish minimum qualification levels required; individual Specification Sections specify additional requirements.
 1. Manufacturer Qualifications: Use firms experienced in manufacturing products or systems similar to those shown and with record of trouble-free and reliable in-service performance, as well as sufficient production capacity to produce required units.
 2. Fabricator Qualifications: Use firms experienced in producing products similar to those shown and with a record of trouble-free and reliable in-service performance, as well as sufficient production capacity to produce required units.
 3. Installer Qualifications: Use firms or individuals experienced in installing, erecting, or assembling Work similar in material, design, and extent to that shown, whose work has resulted in construction with record of trouble-free and reliable in-service performance.
 4. Professional Engineer Qualifications: Use professional engineers legally qualified to practice in California jurisdiction where Work is located having experience in providing engineering services of kind shown.
 - a. Engineering services are defined as professional services performed for installations of system, assembly, or product similar in material, design, and extent to those shown.
 5. Specialists: Certain Specification Sections require specific construction activities be performed by recognized experts in those operations.
 - a. Specialists shall satisfy qualification requirements shown and be engaged for activities shown.
 - b. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
 6. Testing Agency Qualifications: Use NRTL, NVLAP, or independent agencies having experience and capability to conduct testing and inspecting shown, as documented according to ASTM E 329; and with additional qualifications shown in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - a. Testing laboratories shall conform to ASTM C1077 and ASTM E329.
 - b. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - c. NVLAP: Testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
 - d. Testing laboratories shall not be affiliated with Contractor or officers of Contractor's organization.
 - e. Testing agencies shall have ≥5 years' experience in appropriate area of specialty, and shall be listed on "Roster of Approved Testing Agencies" for either City of Los Angeles, or City of San Diego, or shall be accepted by City.
 - f. Where required by these specifications, or where tests occur >50 miles from Work, hire City-accepted independent laboratory to perform testing and certify results.
 7. Deputy Inspectors Qualifications: Deputy inspectors shall meet requirements of ASTM E329, have ≥5 years' experience in appropriate area of specialty and shall be listed on "Roster of Approved Testing Agencies" for either City of Los Angeles, or City of San Diego, or shall be accepted by City.
 8. Manufacturer's Representative Qualifications: Use factory-authorized representative of Manufacturer who is trained and approved by Manufacturer to observe and inspect installation of Manufacturer's products similar in material, design, and extent to those shown.

- C. "Tying" or "Bundling" of manufactured equipment into packages to thwart competition shall be considered in non-conformance to intent of Contract Documents.
 - 1. City is under no obligation to accept any Manufacturer based on such "bundling" arrangements and may elect to reject bundled Manufacturers solely because such bundling, in City's opinion, represents unfair business practice.
- D. Manufacturer's production facilities shall be open for inspection by City or City's Representative throughout production and testing of products furnished under this Contract.
 - 1. Notify City's Representative in writing in advance of manufacture of materials as required to facilitate specified City-provided testing or inspection at source of supply.
 - a. City may elect to witness, at their expense, factory tests and certifications required by Contract Documents by reporting intent to do so to Contractor.
 - 2. Notify City's Representative in writing of time and place of specified factory tests ≥ 14 Calendar Days before they begin.
 - a. Complete manufacturing operations, checks, adjustments and tests before City's factory inspection.
 - b. Perform factory testing and inspections during normal working hours.
 - 3. Notify City's Representative promptly if scheduled test or inspection is cancelled or rescheduled.
 - a. If City has given notice of intent to witness testing, City will back-charge Contractor for costs incurred by City due to Contractor's failure to provide 72-hour notice to City's Representative of rescheduling or cancellation of tests and inspections.
 - 4. Unless otherwise specified, testing equipment shall be calibrated by testing agency acceptable to City at intervals ≤ 12 months or following repair or relocating of test equipment.
- E. Tests of items at place of manufacture during and/or upon completion of manufacture, shall include applicable material tests, hydraulic pressure tests, electric and instrumentation subsystem tests, performance and operating tests and inspections in conformance with relevant industry standards and as detailed in these Specifications.
 - 1. Tests shall satisfy City's Representative that items tested and inspected comply with Contract requirements.
- F. Furnish samples required for testing.
 - 1. Pay cost of material samples to be tested.
 - 2. Cost of testing, sampling and laboratory services shall be paid for by City or Contractor as shown.
 - 3. Samples for testing shall be representative of final Work product.
 - a. Samples to be tested or inspected shall be selected by Testing agency, laboratory or City and not by Contractor.
 - b. Samples treated differently from final Work product will not yield valid test results.
- G. Testing by independent testing agencies shall proceed as follows:
 - 1. Provide labor, products, tools, instruments, water, and power as directed for sampling for required tests.
 - 2. Tests of products shall follow recognized standards of national technical organizations, and specified sampling and testing methods.
 - 3. Contractor shall pay for quality assurance testing unless otherwise shown.
 - 4. Retest costs or other testing costs invoiced to City and specified to be paid by Contractor may be deducted from Contractor's next progress payment in lieu of Contractor's direct payment of invoice.

5. City may test representative samples of each type and size of product furnished using independent testing agency.
 - a. Failure of samples to pass tests will be deemed sufficient cause to reject entire lot delivered.
 - b. Do not delivery materials to Work site which have not satisfactorily passed specified testing and inspection.
- H. Testing by City shall proceed as follows:
 1. Notify City's Representative in writing ≥ 14 Calendar Days before City testing of materials is required.
 2. Written notice shall include name of supplier along with contact information, address and telephone number for material source or Manufacturer.
- I. Test equipment (meters, gauges, torque wrenches, sensors, etc.) supplied or used for taking or recording of qualitative data shall:
 1. Have accuracy equal to or exceeding stated acceptance criteria tolerances for test or Work performed.
 2. Have current calibration with traceability to National Institute of Standards and Technology (NIST).
 - a. Supply calibration records.
 3. Have traceability to national standards in country of use, subject to acceptance by City's Representative, where such equipment is supplied and used in facilities outside United States.
- J. Compute moving averages as follows per SSPWC (Greenbook) §211-5.:
 1. Round moving averages to same number of significant figures as reported for individual test results.
 2. When figure to be dropped ≤ 5 , round down.
 - a. If > 5 , round up.
 3. Moving average shall be continuous for individual material plant or batch plant.
 4. In determining moving average for material properties, use all test results representing material used in Work in calculation.
 5. Enter test results into calculation sequence in chronological order that Work is performed.
 6. First individual test result shall start moving average and shall meet moving average requirements.
 - a. Until > 4 test results are available, moving average shall be numerical average of test results.
 7. When > 4 test results are available, determine moving average by multiplying previous moving average by 4, adding new result to this product, and then dividing sum by 5.
 8. In computing moving average, whenever upper calculation limit-values for individual tests are stated, use upper calculation limit value in calculations in lieu of test results exceeding upper calculation value.
- K. Employ only competent workers on Work.
 1. Employed persons found to be incompetent, intemperate, troublesome, disorderly, or otherwise objectionable or who fail to perform Work properly, acceptably and in accordance with Manufacturers' installation and warranty requirements, shall be immediately removed from Work by Contractor and not reemployed on Work.
 2. Welders shall be AWS certified for type of work they are performing.

- a. Welders on steel pressure piping or tank work shall be AWS certified as boiler and pressure vessel welders per §IX Part A of AWS B2.1 as required by AWWA C200 §3.3.3.1.
- 3. Steel fabricators shall be certified under AISC Quality Certification Program.
- 4. Other fabricators shall have ≥5 years' experience in appropriate area of specialty and shall be listed on "Roster of Licensed Fabricators" for either City of Los Angeles, or City of San Diego, or shall be accepted by City.
- L. Make reasonable efforts to prevent unauthorized personnel or domestic animals from entering Work site.
 - 1. When directed by City, remove unauthorized personnel and domestic animals from City's property.
- M. Upon completion of Contract, Work shall be finished, tested and ready for operation.
 - 1. Work shall fulfill its intended purpose as described in Contract Documents, in submittals, and in Manufacturer's literature.
- N. Form of evidence of satisfactory fulfillment of installed test and inspection requirements shall be, at City's Representative's discretion, either tests or inspections carried out in City's Representative's presence, or by certificates and reports of tests and inspections carried out by accepted persons or organizations.

1.7 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Quality Control Plan	Submit Quality Control Plan for planned and systematic activities to cover Work specified under this Contract. Quality Control Plan shall cover: 1. Quality control team organization chart 2. Procedures for preventing nonconforming Work 3. Contractor's qualifications. 4. Subcontractor qualifications. 5. Material Procurement Control, including sources of materials and procedures regarding traceability of materials. 6. Material testing. 7. Manufacturing schedule. 8. Welding procedures. 9. Individual welder qualification certificates for shop and field welding. 10. Plant QA/QC recordkeeping and means of transmitting records to City. 11. NDE personnel qualifications. 12. NDE Procedures Quality Control record keeping and sign-off forms. 13. Nondestructive Testing. 14. Control and Inspections of fabrication and manufacturing. 15. Shop test and inspection requirements. 16. Packaging and shipping procedures. 17. Storage, handling, erecting and installing instructions. 18. Hold Points (Tests, inspections, and operations requiring City to witness and accept manufacturing operations before further Work may proceed.) 19. Records and Documentation. 20. Material certifications 21. Shop test, NDT, and inspection records. Show accepted test procedure, latest revision, results, date, and name of inspector or tester of examined Work. 22. Engineering calculations 23. Design drawings 24. Warranties 25. Other details regarding adherence to Contract Documents.	
Site Quality Control Plan	Also submit Site Quality Control Plan defining field inspections and tests to ensure work performed on site conforms to Contract Documents and Manufacturers'	

SUBMITTAL	DESCRIPTION	
	Installation Instructions. Site Quality Control Plan shall cover: 1. Quality control team organizational chart 2. Procedures for preventing nonconforming Work 3. Work instructions and procedures for in-process inspections and testing 4. List of inspections and tests to be performed (photocopies of Contract Documents are acceptable) 5. Data sheets for inspection and testing 6. Testing laboratory qualifications. 7. Deputy Inspector qualifications. 8. Field Test and Inspection Requirements 9. Paving quality. 10. Concrete quality. 11. Welding quality • Welding operator qualifications. • Welding Personnel Qualification Records. • Welding Inspector qualifications. • Welding rod control procedures. • Weld Procedure Specifications. • Weld Procedure Qualifications Records. 12. Painting and Coating System quality 13. Mechanical, Plumbing, and HVAC System quality 14. Electrical and Instrumentation System quality 15. Hold Points (Tests, inspections, and operations requiring City to witness and accept manufacturing operations before further Work may proceed.) 16. Records and Documentation • Testing laboratory reports • Contractor's field inspection reports • Data sheets • System demonstration logs • Warranties 17. Record Drawing procedures 18. Final Inspections and Testing	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Test and Inspection Log	Prepare record of tests and inspections. Include: 1. Date test or inspection was conducted. 2. Description of Work tested or inspected. 3. Date test or inspection results were transmitted to City's Representative. 4. Identification of testing agency or special inspector conducting test or inspection. Maintain log at Work site. Post changes and revisions as they occur. Provide access to test and inspection log for City's Representative's reference during normal working hours.	
Certificates of Compliance	Where specified in Contract Documents or on City's Request submit certificates of compliance prior to shipment or use of products.	
	Certificate shall be signed by Manufacturer certifying Work provided conforms to or exceeds requirements of Contract Documents. Attach supporting reference data, affidavits and certifications as appropriate	
	Submit certification letters on Manufacturer's letterhead for powered equipment >5 horsepower.	
Transcripts of Factory Acceptance Test Results	Submit on City's Request as needed to verify quality of manufactured products. Report shall be in English language and describe: 1. Date and time of test 2. Project title and number 3. Identification of product and Specification Section 4. Description of Work and test and inspection method 5. Name, address, and telephone number of testing agency	

SUBMITTAL	DESCRIPTION	
	6. Names of individuals making tests and inspections 7. Test instrumentation 8. Calibrations of measuring equipment 9. Test procedure 10. Pass/Fail criteria 11. Tabulations of measurements taken 12. Sample calculations 13. Test results 14. Final adjustments and settings 15. Guaranteed performance data.	
	Submit transcripts of chemical resistance tests on City's request.	
Field Quality Control Test and Inspection Data Sheets	Submit completed test and inspection data sheets for inspections and tests performed on site to City's Representative no later than start of next-day shift. Data sheets shall show: 1. Date and time of test. 2. Project title and number. 3. Identification of product and Specification Section. 4. Description of Work and test and inspection method 5. Name, address, and telephone number of testing agency. 6. Names of individuals making tests and inspections. 7. Locations of samples and tests or inspections. 8. Record of temperature and weather conditions at time of sample taking, testing and inspecting. 9. Test procedure 10. Pass/Fail criteria 11. Tabulations of results or measurements taken. 12. Interpretation of test results. 13. Comments or professional opinion on whether tested or inspected Work complies with Contract Document requirements. 14. Name and signature of laboratory inspector. 15. Recommendations on retesting and re-inspecting.	
Manufacturer's Field Reports	Prepare written documentation of tests and inspections specified in other Sections. Include the following as applicable: 1. Name, address, and telephone number of representative making report. 2. Statement on condition of substrates and their acceptability for installation of product. 3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken. 4. Results of operational and other tests and a statement of whether observed performance complies with requirements. 5. Other required items shown in individual Specification Sections	
Permits, Licenses and Certificates	For City's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of Work.	
CLOSEOUT SUBMITTALS		
Certificates of Proper Installation	Where specified in Contract Documents, where warranties >1 year are specified, for powered equipment >2 horsepower, or drawing >5 amps at 480VAC, or on City's Request, submit Manufacturer's certificates of proper installation after installation of products.	
	For powered equipment >2 horsepower, or drawing >5 amps at 480VAC, submit Manufacturer's certificate of proper installation stating: 1. Equipment has been factory-checked or field-checked as necessary and is approved for operation. 2. Equipment operates within allowable limits for vibration. 3. Controls, protective devices, instrumentation, and control panels furnished as part of equipment package are properly installed, calibrated, and functioning. 4. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.	

SUBMITTAL	DESCRIPTION	
	5. Equipment has been installed and adjusted in accordance with Manufacturer's requirements and is properly aligned and ready for operation. 6. Equipment has been serviced, lubricated and properly prepared to perform in accordance with intent of Contract Documents. 7. Equipment is ready for operation, and City's Staff is suitably instructed in operation and maintenance of equipment. 8. Specified Manufacturer's warranty will commence, and be in full force from date of final acceptance of project or applicable portion of project by City. 9. Signer has visited site, inspected equipment and installation, and certifies equipment is ready and suitable for full time operation under full-load conditions.	
	Certificate shall be signed by Manufacturer and Contractor, certifying material or equipment specified and installed conforms to or exceeds requirements of Specifications and has been inspected by authorized field representative.	
	Attach supporting reference data, affidavits and certifications as appropriate	
Reports of Installed Test and Inspection Results	Provide and use forms acceptable to City's Representative which show test information, including specified operational parameters.	
Manufacturer's Statement of Responsibility	Furnish where required in Contract Documents.	

1.8 **Contractor's Quality Control**

- A. Develop Quality Control and Quality Assurance Program for all phases of Work in accordance with ANSI/ASQC E1.
1. Quality control requirements apply to Contractor and subcontractors.
 2. To extent possible in Quality Assurance Plan, brevity, lists, and tables are encouraged in lieu of narratives.
 - a. Program documents shall be available for review by City's Representative.
 3. Quality Control Plans shall establish authority and responsibility of those responsible for quality program administration, inspections, tests and plan of execution.
 - a. Include organizational charts showing relationship(s) among Contractor's, subcontractors, management, engineering, purchasing and quality assurance/quality control.
 - b. Maintain Quality Control Plan organizational chart to reflect current organization and lines of authority throughout Contract duration.
 - c. Persons performing quality functions shall be qualified by training, education, or experience and have sufficient and defined authority to enforce quality requirements, to identify, initiate, recommend and provide solutions to quality problems and to verify effectiveness of solutions.
 4. Monitor quality control of suppliers, Manufacturers, material, equipment, services, site conditions and workmanship to produce Work of specified quality.
 - a. Conform to specified standards as minimum quality for Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
 - b. Perform Work using qualified personnel to produce workmanship of specified quality.
 - c. Conform to applicable Manufacturer's instructions and procedures.
 5. City's Representative reserves right to audit Contractor facilities for purpose of verifying compliance with accepted Quality Control Plan.
 - a. Quality program records shall be controlled by Contractor to provide easy access for record retrieval and maintenance.
 - b. Make records available to City's Representative upon request for inspection or City's Representative's use.

- c. City's Representative has right to observe Contractor's Work including design, manufacture, installation, shop or field inspections and tests.
 - d. Coordinate quality activities with City's Representative.
 - e. City's Representative may perform or have performed on its behalf factory inspections during manufacture and testing.
 - f. Provide City's Representative unrestricted access to Contractor's and Subcontractor's shops for such inspections.
 - g. City's exercise of or failure to exercise their right to inspect, witness, test, or audit and subsequent acceptance of Work by City's Representative shall not relieve Contractor of their obligation to comply with terms and conditions of Contract.
- B. Tests and inspections not explicitly assigned to City are Contractor's responsibility.
 - 1. Perform additional quality-control activities required to verify that Work complies with requirements, whether specified or not.
 - 2. Where test services are shown as Contractor's responsibility, engage qualified testing agency to perform quality-control services.
 - 3. Do not employ same entity engaged by City, unless agreed to in writing by City.
 - 4. Notify testing agencies ≥ 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 5. Where quality-control services are shown as Contractor's responsibility, submit certified written report of each quality-control service.
 - 6. Testing and inspecting requested by Contractor and not required by Contract Documents are Contractor's responsibility.
 - 7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Where shown, engage Manufacturer's representative to observe and inspect Work.
 - 1. Manufacturer's representative's services may include examination of substrates and conditions, verification of materials, inspection of completed portions of Work, and submittal of written reports.
- D. Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with Contract Documents.
- E. Notify City's Representative promptly of irregularities or deficiencies observed in Work during performance of its services.
- F. Subject products, material, and equipment furnished to testing programs at place of manufacture and in field.
 - 1. Products, materials, and equipment will be subject to inspection by City's Representative.
 - 2. Complete shop and field inspections and tests in accordance with its "accepted" Quality Control Plan, and requirements herein.
 - a. Record and have involved parties sign off on tests, inspections, and examinations, as well as established results.
 - 3. Provide labor, equipment, calibrated instruments, instrumentation, and other test equipment for testing and commissioning.
 - a. Labor for testing shall include preparation of procedures, wiring and connecting test equipment and instrumentation, test equipment, instrumentation, materials and consumables, supervision of tests, collection and analysis of data and reports and other work necessary for testing.

4. Materials, elements, and devices related to or contemplated for incorporation in equipment during process of manufacture shall be subjected to tests and inspection deemed necessary in City's Representative's opinion to demonstrate compliance with Contract Documents.
 5. Submit test results to City's Representative for acceptance.
 6. Acceptance of assemblies, tests and test procedures and acceptance of pertinent test certificates, inspection or waiving of inspections and tests shall in no way relieve Contractor of their contractual obligations for furnishing Work conforming to Contract Documents.
 - a. Compliance is duty of Contractor, and said duty shall not be avoided by acts or omissions of City's Representative.
 7. Perform checks and tests in accordance with:
 - a. Individual Specification sections.
 - b. Manufacturer's and/or Contractor's standard practices and recommendations.
 - c. Reference and applicable testing standards.
 - d. Mutual agreement of Contractor and City's Representative based on conditions arising in shop or in field.
 8. Evaluate test results and advise City's Representative immediately of discrepancies between test results and test limits or failure of device or system under test.
 - a. Include test limits for acceptability applicable to each test on certified test records.
 9. Furnish, set up, and operate test equipment and facilities.
 - a. If factory testing facilities are unavailable to Manufacturer or Contractor, conduct tests elsewhere or have them performed by independent facility accepted by City's Representative.
 10. Protect material and equipment after testing so subsequent testing of other equipment or systems does not disturb, damage, or interfere with function of previously tested items.
 11. If test results do not fulfill requirements specified or if defects attributable to Contractor are found in test results, repair, adjust or replace, and retest failing Work to satisfaction of City's Representative.
 - a. Repairs shall be subject to acceptance by City's Representative.
- G. Contractor's failure to stop at hold point may be cause for rejection of those items for which notification was not provided, or Contractor may be requested to repeat operation at their expense.
1. Hold Points require written notification in advance of scheduled time of performance as follows:
 - a. 10 working days for domestic Work
 - b. 15 working days for overseas Work.
 2. City's Representative may require activities performed without proper notification to be repeated for City's Representative's observation at Contractor's expense.
- H. Additional specifications and standards for special processes (such as welding, non-destructive testing, etc.) are specified in other sections of Contract Documents.
1. Specifications for special processes located in other sections of Contract Documents are "in addition to" those specified in this section and do not relieve Contractor from compliance with this section.
 2. Should conflicts arise between different or overlapping standards and technical specifications, City's Representative reserves right to determine applicable standard.
- I. Arrange work to be readily accessible and easy to operate and maintain where detail drawings are not included in Contract Documents, supplementary drawings or Shop Drawings and submittals.

- J. Design products for service intended.
 - 1. Provide rugged construction, of ample strength for stresses which may occur during fabrication, transportation, erection and during continuous or intermittent operation, and transient conditions.
- K. Products shall be adequately stayed, braced and anchored and installed in neat and workmanlike manner.
- L. Combinations of manufactured equipment shall be fully compatible and work safely and successfully as a unit.
 - 1. Furnish necessary mountings, couplings and appurtenances with each unit.
- M. Relocations or adjustment of existing facilities noted in Contract Documents shall be done as needed.
 - 1. If existing items are lost or damaged during construction, replace with new items of equal or better quality.
- N. Make field measurements needed to fabricate and install Work before ordering or beginning Work.
 - 1. Make minor changes in alignments and dimensions as needed to remedy or avoid utilities and structural conflicts.
- O. If furnished products differ from those shown and which require changes to enclosures, mounting and support structures, power and control circuitry or other work to accommodate furnished product, provide changes required at no additional cost to City and of same quality as shown.
- P. Nonconforming materials and equipment not meeting Contract standards, criteria, or specifications inadvertently used for this project shall be resolved through price deduction, repair, return to source, scrap, or rework at discretion of City's Representative.
 - 1. Requests for acceptance for deviations or nonconformance to Quality Control Plan shall be made to City's Representative in writing.

1.9 Quality Control Performed by City

- A. Where quality-control services are shown as City's responsibility, City will engage qualified testing agency to perform these services.
 - 1. City will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Schedule times for tests, inspections, obtaining samples, and similar activities by such agencies.
 - 3. Cooperate with parties performing tests, inspections, and quality-control services, and provide reasonable auxiliary services as requested.
 - a. Notify City sufficiently in advance of operations to permit assignment of personnel.
 - 4. Provide access to Work and incidental labor and facilities necessary to facilitate tests and inspections.
 - 5. Provide adequate quantities of representative samples of materials requiring testing and inspecting.
 - 6. Provide preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Assist test agency in obtaining samples, provide facilities for storage and field curing of test samples, and delivery samples to testing agencies as required.
 - 8. Provide Security and protection for samples and for testing and inspecting equipment at Project site.

9. Coordinate sequence of activities to accommodate required quality-assurance and -control services with minimum delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
10. Costs for retesting and re-inspecting construction that replaces or is necessitated by Work that failed to comply with Contract Documents will be charged to Contractor.

1.10 Special Tests and Deputy Inspections

- A. Special Tests and Inspections shall be conducted by qualified deputy inspector as required by authorities having jurisdiction, as shown in individual Specification Sections and Statement of Special Inspections in Contract Documents, and as follows:
 1. Verify Manufacturer maintains detailed fabrication and quality-control procedures and reviews completeness and adequacy of those procedures to perform Work.
 2. Notify City's Representative, and Contractor promptly of irregularities and deficiencies observed in Work during performance of its services.
 3. Submit written report of each test, inspection, and similar quality-control service to City's Representative and to authorities having jurisdiction.
 4. Submit final report of special tests and inspections at Substantial Completion, which includes list of unresolved deficiencies.
 5. Interpret tests and inspections and stating in each report whether tested and inspected work complies with or deviates from Contract Documents.
 6. Retest and re-inspect corrected work.

1.11 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Inspection

- A. Products and Work shall be subject to field and factory inspection and testing in accordance with standards required and defined in Contract Documents.
 1. Waiver by City of their right to inspect shall not relieve Contractor of duties to comply with Contract Documents.
- B. Provide and pay for independent inspection, including CBC-required deputy inspection, and testing services required by Contract Documents.
- C. Additional day-to-day inspection will be provided by City's Representative.
 1. Provide ≥ 2 Working Days' notice to City's Representative in advance of required observations or inspections by City's personnel.
 - a. For inspections by public authorities other than City, promptly inform City of scheduled dates for such inspections.
 - b. Before backfilling or covering Work, request inspection by City's Representative to verify proper installation of buried or covered Work.
 - c. Before finishing, request inspection by City's Representative to verify no surfaces to receive product have defects or errors which could result in poor or potentially defective application or cause latent defects in workmanship.
 2. Inspection shall not be considered as direct control of individual workers and their Work.

- a. Inspections, tests, acceptances, or approvals by City's Representative or others shall not relieve Contractor from their duty to perform Work in accordance with Contract Documents.
- 3. City's Representative will inspect products after delivery and throughout construction process.
 - a. Products will be subject to rejection at any time on account of failure to meet Contract Documents even though samples may have been accepted as satisfactory at place of manufacture.
- 4. Provide City's personnel with safe and proper facilities to access and observe Work and to inspect or perform tests.
- 5. Procure and submit required certificates of inspection, testing or approval to City's Representative.
- 6. If Work is covered contrary to written instructions or work is covered before Contractor requests and receives inspection, uncover it at Contractor's expense, if requested by City's Representative.
 - a. Replace at Contractor's expense.
- 7. If City's Representative considers it advisable covered Work be re-inspected or tested by others, at City's Representative's written request, uncover Work in question, furnishing necessary labor, products, and tools.
 - a. If re-inspected Work is found defective, pay for uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction.
 - b. If, re-inspected Work is not found defective, Contractor will be allowed increase in Contract Price, extension of Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction, and a Change Order will be issued.
- 8. Where shown, City will pay for performance of tests, Contractor shall pay cost of failing tests.
- D. If Contract Documents, permits, laws, ordinances, rules, regulations or orders of public authorities having jurisdiction require Work to be inspected, tested, or accepted by someone other than Contractor, give City's Representative timely notice of readiness.
 - 1. Inspection and testing fees imposed by public agencies other than City shall be paid for by Contractor.
 - 2. Procure and submit required certificates of inspection, testing or approval to City's Representative.
- E. Permit authorized representatives and agents of Federal or State agencies to inspect work, products, and other relevant data and records.

3.2 Installation/Application/Erection

- A. Materials and equipment shall be installed by specialists properly skilled in trades and professions required to assure 1st-class workmanship.
 - 1. Where required by Contract Documents, Contractor shall cause installation of specific equipment items to be accomplished under supervision of factory-trained installation specialists furnished by Manufacturers.
- B. Be prepared to document skills and training of workmen engaged in installation of equipment furnished either by Contractor or City.
- C. Coordinate with Manufacturer when Manufacturer's field services are required.
 - 1. Provide City ≥30 Calendar Days' written notice prior to need for Manufacturer's field services furnished by Contractor.
- D. Install products according to Manufacturer's Installation and Warranty requirements.

- E. Install products according to and at location shown in Plans, Shop Drawings, and submittals.
- F. Unless otherwise shown, install equipment true, plumb, and level using precision gauges and levels.
 - 1. Do not shim between machined surfaces.
 - 2. Install products to tolerances recommended by Manufacturer.
- G. Refer variances between Manufacturer's installation instructions and Contract Documents to City's Representative.
- H. Upon completion of Contract, Work shall be finished, tested and ready for operation.
 - 1. Work shall fulfill its intended purpose as described in Contract Documents, in submittals, and in Manufacturer's literature.

3.3 Field Quality Control

- A. Frequency of sampling and testing shall be as shown, and shall be performed at such other times as necessary to document contract compliance.
 - 1. Inform City's Representative of installation and testing schedules ≥ 7 Calendar Days in advance of field tests.
 - 2. Perform field tests in presence of City's Representative in accordance with accepted Field Test Plan.
- B. Work done beyond lines and grades shown on Plans, or extra Work done without written authority of City's Representative will be considered as unauthorized and no compensation will be made therefor.
- C. Defective Work or unsuitable materials and/or equipment may be rejected, even though such defective items may have been previously overlooked by City's Representative.
- D. Give full cooperation to City's Representative's inspection at Site during installation.
 - 1. During assembly and installation, request City's Representative's observation of in-progress tests, which will be impossible to check if installation proceeds further.
- E. Within 24 hours of completing each in-progress field test, submit test results to City's Representative.
- F. Refer to Section 01 61 00 for field testing requirements for common products.
- G. Repair, correct or replace Work failing tests or inspection.
 - 1. Repeat tests at Contractor's expense, until results satisfy specifications.
 - 2. Repair damage to Work that is not cause for rejection.
- H. Remove rejected work from jobsite.
 - 1. Unless repairs have been made to City's satisfaction, remove Work rejected by City's Representative for failure to comply with Contract Documents within 14 Calendar Days after Written Notice of rejection, whether incorporated in Work or not.
- I. Promptly replace and re-execute removed Work in accordance with Contract Documents and without expense to City.
 - 1. Contractor shall bear cost of making good work of other Contractors destroyed or damaged by such removal or replacement.
- J. If Contractor fails to remedy, remove, replace, or correct Work under provisions of this section within 14 Calendar Days after receipt of Written Notice, City may remove such Work and store products at Contractor's expense.
 - 1. City shall have authority to cause defective Work to be remedied, or removed and replaced, and unauthorized work to be removed by City forces, or otherwise.
 - 2. City shall have authority to deduct costs thereof from monies due or to become due to Contractor, or to bring suit against Contractor and Contractor's sureties for money

damages sustained by City or for specific performance of contractual obligations of Contractor.

- K. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Sections or matching existing substrates and finishes.
 - a. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
 - 2. Protect construction exposed by or for quality-control service activities.
 - 3. Repair and protection are Contractor's responsibility, regardless of assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 Work Included

- A. Mobilization, storage yard, temporary utilities, construction aids, barriers and enclosures, security, fire protection, access roads and parking areas, discharge of waters, and temporary controls.
- B. Refer to General Conditions §20 “Sanitary Facilities”, §21 “Air Pollution Control” §23 “Excessive Noise”, and §29 “Inspector’s Field Office” for additional Corona requirements for temporary facilities and controls.
- C. Refer to the following sections for Work not covered herein.
 - 1. Section 01 32 23 for construction survey staking.
 - 2. Section 01 35 26 for governmental safety requirements.
 - 3. Section 31 05 50 for requirements to protect existing utilities
- D. Provide necessary temporary facilities and controls required for execution of Work, including, but not limited to:
 - 1. Storage yard,
 - 2. Signs,
 - 3. Sheds,
 - 4. Temporary utilities,
 - 5. Temporary controls,
 - 6. Waste disposal,
 - 7. Construction aids,
 - 8. Barriers and enclosures,
 - 9. Security,
 - 10. Fire protection,
 - 11. Parking areas,
 - 12. Traffic regulation,
- E. A field office for City’s use is not required for this project.
- F. Coordinate location of Contractor’s temporary facilities with City to ensure access critical to plant operations is maintained.
- G. No attempt is made to set out in detail means or methods necessary to satisfy requirements.
 - 1. Recognition of requirements is made to assist Contractor in identifying necessary costs.
- H. Maintain support facilities until City’s Representative schedules Substantial Completion inspection.
 - 1. Remove before Substantial Completion.
 - 2. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, with prior consent from City and under conditions acceptable to City

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 32 23: Construction Survey Staking
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 35 26: Governmental Safety Requirements

- E. Section 01 66 00: Product Storage and Handling Requirements
- F. Section 31 05 50: Protecting Existing Utilities

1.3 **References**

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 1. ADA-ABA Accessibility Guidelines California Administrative Code, Title 8, Subchapter 4 Cal OSHA
 2. ASTM E136 Assessing Combustibility of Materials Using Vertical Tube Furnace at 750°C
 3. "Construction Safety Orders"
 4. California Administrative Code, Title 8, "General Industry and Electrical Safety Orders"
 5. California Administrative Code, Title 8, "Tunnel Safety Orders"
 6. ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities
 7. National Safety Council Accident Prevention Manual for Industrial Operations,
 8. NFPA 70 National Electrical Code
 9. NFPA 70E Electrical Safety in the Workplace
 10. NFPA 241 Safeguarding Construction, Alteration, and Demolition Operations
 11. OSHA Regulations

1.4 **Quality Assurance**

- A. Arrange for authorities having jurisdiction to test and inspect each temporary utility before use.
 1. Obtain required certifications and permits.
- B. Comply with applicable provisions in U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- C. Provide noncombustible construction per ASTM E 136 for temporary offices, shops, and sheds located within construction area or within 30' of building lines.
 1. Comply with NFPA 241

1.5 **Submittals**

- A. Furnish the following submittals:

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Storage Yard Description	Submit property owner's written acceptance for use of property used as storage yard for project.	
	Submit description of Contractor's proposed methods for dust and noise control in storage areas	
Construction Facilities and Site Plan	Submit layout, equipment, materials and procedures proposed for construction of temporary power, telephone, lighting, heating, water, sanitation, field offices and sheds, storm water management, security, dewatering, etc.	
California Division of Industrial Safety Excavation Permit	Submit copy of excavation permit from State Division of Industrial Safety prior to start of excavation.	

1.6 **Project Information Signs**

- A. Provide 2 project information signs beginning 2 weeks before start of construction.
 1. City's Representative will determine exact location of project information signs.
 2. Provide adequate sturdy supports for signs as site conditions require.
- B. Provide temporary, directional signs for construction personnel and visitors.
 1. Provide other signs as indicated and as required to inform individuals seeking entrance to Project.
- C. Maintain and touchup signs so they remain legible.
 1. Relocate signs as requested by City.

2. Remove signs once construction is complete.

1.7 Temporary Dry Utilities

- A. Purchase or generate on-site power for Work where existing outlets are not available.
 1. Provide connections and extensions of services as required for construction operations.
 2. Conform to NECA, NEMA, and UL standards and regulations for temporary electric service.
 - a. Install service to conform to NFPA 70
 3. Generators are subject to noise restrictions detailed in this section.
- B. Electric power from City's existing system is available (with prior written Acceptance from City) with payment of use charges.
 1. Coordinate use of power from City's existing system with City.
 2. Power use shall be associated with construction-related activities.
- C. Provide temporary lighting with local switching when Work is performed at night or under deficient daylight conditions to ensure correct performance, to facilitate inspection, and to meet or exceed OSHA and Cal OSHA mandated lighting levels.
 1. Install temporary lighting fulfilling security and protection requirements without operating entire system.
- D. Construction telephone while Work is in progress shall be available at site.
 1. Cellular phones are acceptable.
 2. Do not use City's telephone system for Contractor's work force
 3. Post list of important telephone numbers in project field office.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Engineers' offices.
 - f. City's office.
 - g. Principal subcontractors' field and home offices.
- E. Provide superintendent with cellular telephone for use when away from field office.
- F. Allow other entities to use temporary dry utility services and facilities without cost, including, but not limited to, City's Representative and agents, occupants of Project, testing agencies, and authorities having jurisdiction

1.8 Temporary Wet Utilities

- A. Use of water utility will be under control of City.
 1. Follow requirements and provisions set forth by City regarding use of water.
- B. Do not draw water from fire hydrants, except to extinguish fire, without obtaining written permission from City and abiding by conditions set forth by City.
- C. Connect to potable water utilities using meters and Division of Drinking Water (DDW) - accepted backflow preventers furnished by or acceptable to City.
 1. Obtain City-furnished construction water meters and backflow preventers for use of potable water.
 2. Water meter and backflow preventer deposit will be waived for City capital improvement projects.
 3. Loss or damage to water meter and backflow preventer will be paid by Contractor from project retention up to amounts shown below.

SIZE	MAXIMUM CHARGE FOR METER REPAIR OR LOSS	MAXIMUM CHARGE FOR BACKFLOW PREVENTER REPAIR OR LOSS
3"	\$800	\$2,950
4"	\$2,053	\$3,720
6"	\$3,388	\$5,380
8"	\$5,173	\$9,459

4. Pay for potable water used in prosecution of Work at current Business Construction Water use rate per unit (100 cubic feet or 748 gallons).
 - a. Current potable water rates can be found on City website at <https://www.coronaca.gov/government/departments-divisions/departments-of-water-and-power/customer-care/services/business-water-rates>.
5. Pay monthly potable water readiness to serve fee used in prosecution of Work at current Business Water rates.
 - a. Current readiness to serve water rates can be found on City website at <https://www.coronaca.gov/government/departments-divisions/departments-of-water-and-power/customer-care/services/business-water-rates>.
6. Pay monthly potable water supply backflow program fee used in prosecution of Work at current Water rate of \$6.70.
 - a. Current backflow program fee can be found in Detailed Water Rate Sheet found on City website at <https://www.coronaca.gov/government/departments-divisions/departments-of-water-and-power/customer-care/services/business-water-rates>.
- D. Use potable water for moisture conditioning of backfill in potable water pipeline trenches, and testing, flushing, and commissioning of potable waterlines and untreated water pipelines.
- E. Pay non-refundable installation fee for processing and installation of construction water meters as follows:

SIZE	Non-Refundable Installation Fee
3"	\$100
4"	\$262
6"	\$386
8"	\$631

- F. If permission is granted to take water through fire hydrants, use one 2½-inch connection for construction water.
 1. Reserve remaining outlets for use by fire department.
 2. For construction water meters larger than 3", remove fire hydrant head, install tee on top of fire hydrant riser, and reinstall fire hydrant to maintain hydrant in service for emergencies while using hydrant for construction water.
- G. Contractor shall, at their expense, arrange to develop water sources, and construct temporary piping, valves and appurtenances needed to connect to water utility, and collect, load, transport, and apply water for compaction, testing, concrete work, dust control, and other construction use.
- H. Construction water shall be clean and free from objectionable deleterious amounts of acids, alkalis, salts, or organic materials.
- I. Arrange to develop water sources, construct temporary piping, valves and appurtenances needed to connect to water utility, and collect, load, transport, and apply water as needed for compaction, testing, concrete work, dust control, flushing, chlorination, and other construction use.

1. Construction water shall be clean and free from objectionable deleterious amounts of acids, alkalis, salts, or organic materials.
2. Provide abundant supply of safe drinking water on jobsite.
 - a. Safe drinking water on site during construction shall be bottled water or water furnished in approved metal dispensers.
3. Post notices conspicuously throughout site warning Contractor's personnel that piped water may be contaminated.
4. Post orders against drinking, washing, or bathing in water in vicinity of Work known to be unsafe.
5. Before final acceptance of Work remove temporary water connections and piping installed by Contractor.
 - a. Restore affected improvements to their original condition, or better, to satisfaction of City's Representative.
- J. Provide suitable and conveniently located toilets, sanitation, and hand washing facilities for workers, and comply with rules and regulations of State Board of Health and/or other bodies having jurisdiction.
 1. Toilets at construction job sites shall conform to Subpart D, Section 1926.51 of OSHA Standards for Construction
 2. Leave Contractor-provided toilets and sanitation facilities at site until final inspection has been completed.
 3. Do not use public sanitation facilities without written permission.
 4. Clean toilets at least once per week until project completion.
 - a. Establish adequate and regular collection of sanitary and organic wastes.
 - b. Dispose of wastes and refuse from sanitary facilities provided by Contractor or organic material wastes from other sources related to Contractor's operations in manner satisfactory to City's Representative and in accordance with applicable laws and regulations.
- K. Allow other entities to use temporary wet utility services and facilities without cost, including, but not limited to, City's Representative and agents, occupants of Project, testing agencies, and authorities having jurisdiction.
- L. Do not interrupt water service or wastewater conveyance and disposal without prior written permission from City.
- M. Following final inspection remove temporary sanitation facilities and leave site in neat and sanitary condition.

1.9 Access Roads, Parking Areas, and Materials/Equipment Storage Areas

- A. City will provide access to site.
 1. Do not construct staging areas, haul roads, and access roads without acceptance from City.
- B. When entering or leaving roadways carrying public traffic, Contractor's equipment, whether empty or loaded, shall yield to public traffic.
- C. Do not block access roads or entrances unless otherwise accepted by City's Representative.
 1. Maintain at least 1-way traffic.
 2. Provide signs, traffic cones and other barriers for traffic detours.
- D. Maintain plant emergency access routes shown on Contract Documents.
 1. Do not excavate, store equipment, or otherwise restrict access for emergency vehicles on emergency routes.

2. When Work is required in emergency routes, provide necessary traffic control, including flagmen, to provide emergency access.
 3. Submit plan to City's Representative for review within 14 Calendar Days of Notice to Proceed to maintain emergency access and operator access to operating facilities during construction.
 4. As circumstances and conditions change, submit revised access plans to City's Representative.
 5. Immediately restore and pave emergency routes when Work is finished.
- E. At discretion of Contractor, contact and negotiate agreement(s) directly with private property owner(s) for use of property for materials and equipment storage areas.
1. Park personal vehicles in materials and equipment storage areas and in City-designated parking areas to reduce congestion and traffic impacts on public streets.
 2. Supplemental storing and staging areas (if any) are shown on Plans.
- F. Repair damage to off-site and on-site roads in-kind at no cost to City or property owners.
- G. Immediately remove spillage resulting from hauling operations along or across public right-of-way.
1. Sweep or wash streets along haul routes daily during hauling operations.

1.10 Dust Control

- A. Dust control operations shall be nonpolluting, non-tracking, and prevent construction dust from harming or annoying persons living in or occupying buildings near Work.
1. Use water or dust preventative to control dust.
 2. Cover or wet loads of excavated material, rubbish leaving site, or material being imported to prevent blowing dust.
 3. Employ dust control measures to City's satisfaction throughout project duration.

1.11 Noise Control

- A. Noise Limits are described in County of Riverside Ordinance 847 as amended through 847.1.
1. Capital improvement projects of governmental agencies are exempt from provisions of ordinance.

1.12 Lifts and Hoists

- A. Provide facilities necessary for hoisting materials and personnel.
- B. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

1.13 Stairs

- A. Provide temporary stairs where permanent stairs are shown on Plans and temporary ladders are not adequate.
- B. Use of City's existing stairs will be permitted, provided stairs are cleaned and maintained in condition acceptable to City.
1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and maintain means of egress.
 2. If stairs become damaged, restore damaged areas so no evidence remains of correction work.
 3. At Substantial Completion, restore stairs to condition existing before initial use.
 4. Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion

1.14 Odor Control

- A. Furnish labor, materials, and equipment required to prevent discharge of nuisance odors from Contractor's operation into atmosphere in such quantity as will violate regulations of legally constituted authorities.
- B. Notify City's Representative ≥ 72 hours in advance of potential odor-causing activities scheduled for construction.

1.15 Site Access

- A. Prior to commencing Work, City will supply Contractor with access key or security code for facility front gate.
 - 1. Contractor shall limit number of keys and restrict distribution of keys or security codes to Superintendent and City-authorized personnel employed by Contractor.
 - 2. Contractor in possession of access keys or security code shall be responsible for site security during non-working hours of facility personnel.

1.16 Existing Conditions

- A. Nothing in this section shall relieve Contractor of responsibility to:
 - 1. Fully examine Contract Documents and site where Work is to be performed in accordance with General Conditions
 - 2. Be familiar with local conditions and federal, state, and local laws, rules and regulations that may affect performance of Work
 - 3. Study available surveys and investigative reports about subsurface and latent physical conditions pertaining to worksite
 - 4. Perform such additional surveys and investigations as Contractor deems necessary to complete Work at bid price; and
 - 5. Correlate results of such data with requirements of Contract Documents.
- B. If dispute arises between City and Contractor involving hazardous waste and whether site conditions differ materially from those Contractor could or should have discovered by investigations required by these Contract Documents, Contractor shall not be excused from scheduled completion date provided in Contract Documents and shall proceed with Work in manner and in time required by Contract Documents.

1.17 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS (not used)**PART 3 - EXECUTION****3.01 Protection**

- A. Enforce strict discipline in use of temporary facilities.
 - 1. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintain facilities in good operating condition until removal.
- C. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- D. Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

3.02 Protection from Weather

- B. Protect site and construction from water accumulation.
- C. Keep excavated areas dry.
 - 1. Protect excavated, backfilled, and compacted surfaces from flooding, standing water, or loss of compaction due to water infiltration into soil.
 - 2. If possible, schedule excavation to avoid precipitation.
 - 3. If exposing excavated, backfilled or compacted surfaces to precipitation is unavoidable, provide sandbags, sheeting and other temporary surface measures to minimize impact of runoff on soils.

3.03 Temporary Enclosures, Heating, Ventilation, Cooling, and Humidity Control

- D. Heat and ventilate Work areas to protect Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
- E. Provide temporary enclosures as needed to protect construction, in progress and completed, from exposure, weather, construction operations, and similar activities.
 - 1. Provide temporary weather tight enclosure for building and vault exteriors.

3.04 Protection of Personnel and Existing Improvements

- F. Refer to Section 01 35 26 for procedures for compliance with governmental safety requirements.
- G. In emergency affecting safety of life or of Work or of adjoining property, Contractor, without special instruction or authorization from City's Representative, is authorized to act to prevent such threatened loss or injury.
 - 1. Contractor shall so act, without appeal, if directed by City or City's Representative.
 - 2. Compensation claimed by Contractor on account of emergency work shall be determined by and agreed upon by City and Contractor.
- H. Manage and arrange operations to minimize public inconvenience and danger.
 - 1. Deliver materials to Project site over route designated by City's Representative.
 - 2. Confine Contractor's equipment, materials, and operations to limits required by law, ordinances, permits, or directions of City's Representative.
 - a. Do not unreasonably encumber Work site with Contractor's equipment or materials.
 - 3. Repair damage to existing improvements caused by Contractor's operations.
 - a. At completion of work each day, leave Work site in clean, safe condition.
 - b. Upon completion of Work, restore damaged facilities to condition acceptable to City.
- I. Should damage to persons or property occur due to Work, Contractor shall be responsible for proper investigation, documentation, including video or photography, to memorialize and document what transpired.
 - 1. City shall be entitled to inspect and copy such documentation, video, or photographs.
- J. Prevent damage to property resulting from Contractor's operations.
 - 1. Care for and protect materials delivered and Work performed until Final Acceptance by City.
 - 2. All Work shall be solely at Contractor's risk.
 - 3. Protect adjacent property from settlement or loss of lateral support.
 - 4. Erect and maintain, as required by field conditions and progress of Work, all necessary safeguards, signs, barriers, lights, and watchmen for protection of workers and public.
 - a. Post danger signs warning against hazards created in course of construction.
- K. Prevent injury or damage to existing improvements and property, including:

1. Sidewalks, curbs, gutters, pavements,
 2. Landscaping and groundcovers
 3. Structures, vaults, enclosures, buildings,
 4. Fences, signage, traffic signals, utility poles
 5. Monuments, property corners, benchmarks
 6. Underground pipe and conduit
 7. Precautionary measures shall apply continuously and not be limited to normal working hours.
 8. If such objects, or improvements, are injured or damaged by Contractor's operations, they shall be replaced or restored, at Contractor's expense, to condition at least equal to that prior to mobilization.
- L. Protect landscaping, vegetation, and irrigation facilities as follows:
1. Do not pile excavated material, equipment, construction materials, or anything else on top of branches or against tree trunks.
 2. Protect, or replace in kind, at no additional cost to City, existing irrigation and landscape facilities affected by Work.
 - a. Irrigation system record drawing information is typically missing or incomplete.
 - b. Therefore, Contract Documents do not show details of existing irrigation system.
 - c. Locate irrigation piping, spray heads, control wiring, and controllers and modify components of irrigation system during progress of Work to continue irrigating existing landscaping and vegetation as necessary to maintain health of existing plants, trees, and vegetation.
- M. Refer to Section 31 05 50 for procedures to protect existing utilities.
- N. Refer to Section 01 32 23 for procedures to protect monuments, survey markers, and benchmarks:

3.05 Site Security

- O. Safely guard Work, materials, equipment, vegetation, utilities, and property from loss, theft, damage and vandalism.
1. Contractor's duty to safely guard property shall include protecting City's property and other private property from injury or loss in connection with performance of Contract.
 2. Repair damage to existing facilities not scheduled for demolition.
 3. Provide temporary fencing around construction staging area and partially completed areas of construction.
 - a. Provide 2" grid, 0.148"-thick, galvanized-steel, chain-link fabric fencing; ≥6' high with galvanized-steel pipe posts; ≥2³/₈"-OD line posts and ≥2⁷/₈" OD corner and pull posts.
 - b. Provide 1⁵/₈" OD top and bottom rails.
 - c. Provide galvanized-steel bases for supporting posts.
 - d. Wood enclosure fencing, if used, shall be plywood, 6' high, framed with four 2x4 rails, with preservative-treated wood posts spaced ≤8' apart
 - e. Fence temporary openings when openings are no longer necessary.
 - f. During night hours, weekends, holidays, and other times when no Work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
 - g. Bear responsibility for protecting plant and material on site of Work when openings are not closed.
 - h. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

- i. Lock entrances at end of each workday.
- 4. Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - a. Upon completion of each day's work, leave Work area secure and free of hazards.
- 5. Provide necessary temporary signs, warning devices, chain link fences, and barricades.
- P. Employ security staff as needed to provide required security and prevent unauthorized entry.
 - 1. Contractor shall compensate damage to property of City and others arising from failure to provide adequate security.
- Q. Make no claim against City for damage resulting from trespass.
 - 1. City is not responsible for items lost, damaged, or stolen from construction or storage areas due to unsafe conditions.
 - 2. Party responsible for security shall make good all damage to property of City and others arising from failure to provide adequate security.
- R. Furnish 1 set of keys to City for gates, enclosures or fenced areas constructed by Contractor.
- S. Install and maintain for duration of construction remotely monitored site surveillance system to include video cameras mounted on temporary poles.
 - 1. Install surveillance system to provide full video surveillance of site with connection to monitoring station where police can be notified when unauthorized activity occurs.
 - 2. Remove surveillance system following notice of substantial completion.
- T. Maintain security program throughout construction until City's acceptance and occupancy precludes need for Contractor's security program.
- U. Costs for security as specified in this Section shall be borne by Contractor.

3.06 Vector Control

- A. Provide rodent and pest control as necessary to prevent infestation of construction or storage areas.
 - 1. Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues.
 - 2. Perform control operations lawfully, using environmentally safe materials which will not adversely affect conditions at site or on adjoining properties.

3.07 Fire Protection

- A. Minimize fire danger at and near construction site.
 - 1. Employ every reasonable means to prevent hazard of fire.
 - 2. Develop and supervise fire-prevention and -protection program for personnel at Work site.
 - a. Fire protection program shall conform to OSHA Standards for Construction.
 - b. Comply with NFPA 241.
 - 3. Review needs with local fire department and establish procedures to be followed.
 - a. Instruct personnel in methods and procedures.
 - b. Post warnings and information.
 - 4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 5. Prohibit smoking in construction areas where combustibles are present.

- B. Provide and maintain fire extinguishers and/or temporary hose connections and hose, water casks, chemical equipment or other sufficient means for fighting fires to protect new and existing facilities and temporary facilities against fire damage.
 - 1. Provide portable, UL rated; fire extinguisher(s) with class and extinguishing agent as required by locations and classes of fire exposures.
 - a. Hang hoses with warning sign stating hoses are for fire-protection purposes only and not to be removed.
 - b. Match hose size with outlet size and equip with suitable nozzles.
 - 2. Designate responsible persons and instruct them in operation of such fire apparatus to prevent or minimize fire hazards.
- C. Protect surrounding private property from fire damage resulting from construction operations.

3.08 Waterway Protection

- V. Enforce strict on-site handling rules to keep construction and maintenance materials out of receiving waters, including, but not limited to:
 - 1. Store reserve fuel supplies only within confines of designated construction staging area.
 - 2. Refuel equipment only within designated construction staging area.
 - 3. Regularly inspect construction vehicles for leaks.
- W. Clearly mark and stake on ground construction and staging areas shown on Plans.
 - 1. Heavy equipment use outside this area shall be prohibited.
 - 2. Design construction staging areas to contain contaminants such as oil, grease, and fuel products, so they do not drain toward receiving waters or storm drain inlets.
 - 3. If heavy-duty construction equipment is stored overnight adjacent to potential receiving waters, place drip pans beneath machinery engine block and hydraulic systems.
- X. Construct silt fence around disturbed soil areas and take measures necessary to prevent erosion and transport of sediment into waterway.
- Y. Stockpile excavated material within construction staging area.
 - 1. Cover stockpiles with plastic sheets to prevent erosion.

3.09 Project Closeout

- A. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of permanent facility, or no later than Substantial Completion.
 - 1. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility.
 - 2. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
- B. Materials and facilities that constitute temporary facilities are property of Contractor.
 - 1. City reserves right to take possession of Project identification signs.
- C. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00.

END OF SECTION

SECTION 01 61 00 COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Basic requirements for products used in Work.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 05 05 19 for anchor bolts.
 - 2. Section 05 05 23 for metal fastenings and welds.
 - 3. Section 33 05 31 for pipeline joint materials.
 - 4. Section 33 05 38 for hangers and supports.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 65 00: Product Delivery Requirements
- E. Section 01 66 00: Product Storage and Handling Requirements
- F. Section 01 73 00: Execution
- G. Section 01 73 24: Seismic Restraint
- H. Section 01 73 33: Mechanical Identification
- I. Section 05 14 00: Structural Aluminum Framing
- J. Section 05 05 19: Post-Installed Concrete Anchors
- K. Section 05 05 23: Metal Fastenings and Welds
- L. Section 09 90 00: Painting and Coating
- M. Section 09 92 00: Galvanizing
- N. Section 26 05 10: Common Work Results for Electrical
- O. Section 33 05 31: Pipeline Joint Materials
- P. Section 33 05 38: Hangers and Supports

1.3 Definitions

- A. The following definitions apply:
 - 1. Accepted Equal: Comparable product demonstrated and accepted through submittal process to have reputation for trouble-free and reliable service and to possess indicated qualities related to type, function, dimension, in-service performance, materials, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
 - a. Refer to Section 01 63 00 for Product Substitution Procedures
 - 2. Equipment: Mechanical, electrical, or instrumentation products with 1 or more moving parts, whether motorized, electronically, pneumatically, hydraulically, or manually operated, and products with service connections (wiring, piping, and ductwork).
 - 3. Materials: Products which must be cut, shaped, worked, mixed, finished, refined, fabricated, processed, installed, or applied to form Work.
 - 4. Named Products: Items identified by Manufacturer's product name, including make or model number or other designation shown in Manufacturer's published product literature that is current as of date of the Contract Documents.
 - 5. New Products: Items that have not previously been incorporated into another project or facility.

- a. Products salvaged or recycled from other projects are not considered new products.
- 6. Products: Items for incorporation into Work, whether purchased for project, taken from Contractor's stock of previously purchased products, or replaced or recycled into Work from found materials on site.
- B. Products, materials, and equipment do not include Contractor-furnished machinery and equipment used to prepare, fabricate, convey, and erect Work.
- C. Definitions above shall not negate meanings of other terms used in Contract Documents, including "specialties," "systems," "structures," "finishes," "accessories," "furnishings," "special construction," and similar terms, which are self-explanatory and have recognized meanings in construction industry.

1.4 Quality Assurance

- A. Products shall conform to the following:
 - 1. Products shall be new products of current standard design from Manufacturer regularly engaged in producing type of equipment and materials specified.
 - 2. Products shall conform to governing codes, ordinances, and best current practices.
 - 3. Products shall fit within and through spaces provided.
 - 4. Products or Work for which no technical specifications are set forth shall be of best commercial grade in quality and workmanship obtainable in market from Manufacturers of established good reputation, or, if not ordinarily stocked, shall be 1st-class products of type required for intended use.
 - 5. Products shall be undamaged and free from defects and imperfections that might impede serviceability of products for their intended purpose.
 - 6. Products for each item of Work shall be provided from one source where possible.
 - 7. Similar products shall be products of One Manufacturer.
 - 8. Products and workmanship shall match Contractor's submittals as accepted by City's Representative.
 - 9. Provide products complete with accessories, trim, finish, fasteners, and items needed for complete installation and indicated use and effect.
 - 10. Protect existing products required for reuse and restore to service in condition equal to that existing at start of Contract unless otherwise specified.
 - 11. Work shall conform to best standard of products and construction.
- B. Piping systems and elements shall conform to ASME Codes, and appropriate ASTM, API, AWWA, or NFPA standards.
- C. Equipment with electrical components shall bear Underwriters Laboratories, Inc. (UL) label whenever published standards exist.
 - 1. Otherwise obtain certification from Manufacturer equipment conforms to UL standards
- D. Wiring terminations shall match branch circuit conductor quantities, sizes, and materials shown.
 - 1. Enclose terminal lugs in terminal boxes sized to NFPA 70.
- E. Parts and coatings contacting potable water shall be NSF-listed.
 - 1. NSF-listed coatings shall provide protection for 1 year after final acceptance.
- F. Select options compatible with other products or materials where multiple choices are available for Contractor's selection of products or materials.
- G. Where system of parts, pieces, sub-assemblies, devices, or supporting equipment is necessary for complete and operational system, provide operational system, whether or not

Contract Documents expressly state need for each part, piece, sub-assembly, device, or supporting equipment.

- H. Test products used in conformity with applicable methods prescribed by ASTM, or such other organization as may be specified, and in accordance with best commercial methods.
- I. Perform Work in thorough workmanlike manner, following best practices in design and manufacture.
- J. Perform Work using personnel and operators skilled in related professions.
- K. Stocked material may be used provided evidence is furnished showing such material conforms to specified requirements, in which case tests on stocked material may be waived.
- L. Submit certified material test reports to City's Representative as soon as possible after completing tests.
 - 1. Test certificates shall identify component for which material is used and contain information needed to verify compliance with Contract Documents.
- M. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Plate Steel	Charpy Impact Test	≥25 ft-lb at 30°F per ASTM A370 Where plate material used for principal parts is of type for which experience has shown it consistently meets impact-nil ductility requirements specified herein, impact testing of such plates may be eliminated, subject to Contractor supplying data demonstrating satisfactory evidence thereof.	Longitudinal and transverse impact tests on each heat of steel	Contractor	Contractor
	Bend Test	Conform to specification requirements when tested per ASTM A370 Nil ductility transition temperature shall be temperature at which impact resistance is 25 ft-lb under Charpy impact test	Specimens of major steel castings and forging as directed	Contractor	Contractor
	Tension and Hardness	Conform to specification requirements when tested per ASTM A370		Contractor	Contractor
Welds	Nondestructive Examination	Refer to Section 05 05 23		Contractor	Contractor
Castings and Forgings	Pressure or Load-Bearing Items	Visual Inspection (VT)	100%	Contractor	Contractor
		UT after rough machining PT or MT after final machining Other applicable NDTs to extent necessary to determine soundness	100%	Contractor	Contractor
	Other Items	Visual Inspection (VT) and as required by accepted good practice to ensure soundness	100%	Contractor	Contractor
Equipment	Welds	VT, UT or RT	Spot-check as requested by City	Contractor	Contractor
	Vibration	Factory test and limit vibration to conform to field tests specified in Part 3	As required	Contractor	Contractor
	Noise	Factory test and limit noise to conform to field noise limits specified in Part 3	As required	Contractor	Contractor
	Operation	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test each unit	Contractor	Contractor

N. Allowable stresses shall be as follows:

1. Where specified allowable stresses conflict with Code requirements, the more conservative condition shall govern.
2. Contractor shall be responsible for adequate design based on factors proven in practice and shall use lower working stresses where deemed necessary.
3. Calculated design stresses of new, modified, and rehabilitated pressurized components shall not exceed worst case of seismic or wind criteria, plus maximum stresses resulting from internal hydraulic forces.
4. Compute valve stresses with valves and gates operating at worst-case point from closed to 100% open.
5. Calculated tensile or compressive material stresses in mechanical components shall not exceed lesser of $\frac{1}{3}$ yield strength or 20% of ultimate strength.
6. Resultant shear stress due to either direct or combined loadings in mechanical components shall be $\leq 60\%$ of allowable tensile stress.
7. Under temporary emergency loadings, stresses in mechanical components shall be $\leq \frac{2}{3}$ yield strength and $\leq 40\%$ of ultimate strength.

1.5 References

A. Reference publications listed below and in various sections form part of specification to extent referenced. These are referred to within text by basic designation only.

1. ASME/ANSI B1.20.1 (ANSI B2.1) Pipe Threads – NPT National Pipe Thread Taper
2. ANSI B46.1 Surface Texture
3. ANSI S1.4 General Purpose Sound Level Meters
4. ANSI/NSF 60 Drinking Water Treatment Chemicals – Health Effects
5. ANSI/NSF 61 Drinking Water System Components – Health Effects
6. ASTM A27 Steel Castings, Carbon, for General Application
7. ASTM A36 Carbon Structural Steel
8. ASTM A47 Ferritic Malleable Iron Castings
9. ASTM A48 Gray Iron Castings
10. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
11. ASTM A105 Carbon Steel Forgings for Piping Applications
12. ASTM A106 Seamless Carbon Steel Pipe for High-Temperature Service
13. ASTM A108 Steel Bars, Carbon, Cold-Finished, Standard Quality
14. ASTM A148 Steel Castings, High-Strength, for Structural Purposes
15. ASTM A216 Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
16. ASTM A217 Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
17. ASTM A234 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
18. ASTM A 240 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
19. ASTM A242 High-Strength Low-Alloy Structural Steel
20. ASTM A264 Stainless Chromium-Nickel Steel-Clad Plate, Sheet, and Strip
21. ASTM A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
22. ASTM A276 Stainless Steel Bars and Shapes
23. ASTM A285 Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
24. ASTM A312 Seamless and Welded Austenitic Stainless Steel Pipes
25. ASTM A370 Test Methods and Definitions for Mechanical Testing of Steel Products
26. ASTM A403 Wrought Austenitic Stainless Steel Piping Fittings
27. ASTM A473 Stainless Steel Forgings
28. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
29. ASTM A537 Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
30. ASTM A564 Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
31. ASTM A572 High-Strength Low-Alloy Columbium-Vanadium Structural Steel
32. ASTM A576 Steel Bars, Carbon, Hot-Wrought, Special Quality
33. ASTM A668 Steel Forgings, Carbon and Alloy, for General Industrial Use
34. ASTM A743 Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

35. ASTM A747 Steel Castings, Stainless, Precipitation Hardening
36. ASTM A793 Rolled Floor Plate, Stainless Steel
37. ASTM B16 Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
38. ASTM B21 Naval Brass Rod, Bar, and Shapes
39. ASTM B26 Aluminum-Alloy Sand Castings
40. ASTM B42 Seamless Copper Pipe, Standard Sizes
41. ASTM B88 Seamless Copper Water Tube
42. ASTM B100 Wrought Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Use
43. ASTM B127 Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
44. ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
45. ASTM B455 Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes
46. ASTM B584 Copper Alloy Sand Castings for General Applications
47. ASTM B632 Aluminum Alloy Rolled Tread Plate
48. ASTM B766 Electrodeposited Coatings of Cadmium
49. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
50. ASTM D3951 Commercial Packaging
51. ASTM E165 Liquid Penetrant Examination for General Industry
52. ASTM E433 Reference Photographs for Liquid Penetrant Inspection
53. ASTM E709 Magnetic Particle Testing
54. California Administrative Code, Title 8, "Construction Safety Orders"
55. California Administrative Code, Title 8, "General Industry and Electrical Safety Orders"
56. California Administrative Code, Title 8, "Tunnel Safety Orders"
57. California Building Code (CBC)
58. California Electrical Code (CEC)
59. California Energy Code (CEnc)
60. California Fire Code (CFC)
61. California Green Building Code (CALGreen Code)
62. California Mechanical Code (CMC)
63. California Plumbing Code (CPC)
64. MSS-58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
65. NEMA/ANSI 250 Enclosures for Electrical Equipment
66. NFPA 70 National Electric Code (NEC)

- B. Manufacturers of structural components and systems shall use standards, specifications, recommendations, findings and interpretations of professionally recognized groups such as AISC, AISI, AAMA, AWS, ASTM, MBMA, Federal Specifications, and unpublished research by MBMA as basis for establishing design, drafting, fabrication, and quality criteria, practices, and tolerances.
- C. For convenience, 1 or more reference standards may be referenced in these specifications.
 1. In addition, conform to Manufacturer's design, drafting, fabrication and quality criteria, practices, and tolerances, except where expressly countermanded by Contract Documents.

1.6 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of products.
- C. Manufacturer shall repair or replace equipment or materials damaged in shipment where such damage, in opinion of City's Representative, resulted from improper in-transit handling, packing, and/or crating.
- D. If part of equipment is found to be defective through no fault of Contractor or Manufacturer, Contractor may be required to repair or correct defects.
 1. If it is determined Contractor does not have adequate facilities and personnel for such repair work, City's Representative will require defective equipment be repaired by Manufacturer.

- E. Damage to equipment caused by Contractor's fault or negligence in handling, storage, erection, installation, checkout, startup, commissioning, or testing shall be repaired by equipment Manufacturer or Contractor, as determined by City's Representative, at Contractor's expense.

1.7 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Products of listed acceptable Manufacturers shall meet specifications notwithstanding the fact Manufacturer is "listed".
 - 1. City reserves right to reject submittals and products from "acceptable Manufacturers" if they fail to demonstrate compliance with specifications.
- B. Similar items on project shall be products of 1 Manufacturer.
 - 1. Where 1 Manufacturer offers multiple brands, similar items shall be products of same brand heritage.
 - 2. Where multiple units of same class of material or equipment are required, provide products of 1 generic kind from 1 Manufacturer or source.
 - 3. Where multiple choices are available for Contractor's selection of product, select option compatible with other products, materials, or equipment.
 - 4. Coordinating items which function as interconnected parts of 1 system shall be products of 1 Manufacturer.
 - 5. Where 1 Manufacturer offers multiple brands, similar items shall be products of same brand heritage.
 - 6. Corresponding parts of identical products shall be interchangeable products of 1 Manufacturer.
 - 7. Materials for complete paint or sealant system, including primer, finish coats, thinners, cleaners and drying agents, and other additives shall be end products of 1 Manufacturer to ensure product compatibility and unit responsibility.
- C. Equipment furnished shall operate through its full operating range powered by amperages specified or shown on Plans.
 - 1. Equipment requiring amperage greater than specified or shown is unacceptable absent written statement from City electrical infrastructure and switchgear can support increased amperage.
- D. Provide and install products of recognized Manufacturers regularly engaged in production of latest and best standard design materials and equipment.
- E. Where plans and specifications are silent regarding acceptable Manufacturers, acceptable Manufacturers shall meet requirements outlined in Section 01 63 00 for "accepted equals."
- F. Furnish and install the following products manufactured in United States of America:
 - 1. Ductile Iron Pipe
 - 2. Ductile Iron Pipe Fittings
 - 3. Pipe Restrained Joint Materials – gaskets and mechanical joint restraints
 - 4. Flanged Coupling Adapters
 - 5. Pipe Transition Couplings
 - 6. Tapping Sleeves

7. Stainless Steel Pipe, Tubing, Connections, and Fittings

2.2 **Materials**

- A. Materials and materials sources shall be accepted by City ≥ 3 days before use of materials in Work.
- B. Machining of fits on renewable parts shall be accurate and dimensions specified so replacements made to size shown on Shop Drawings may be readily installed.
1. Manufacture individual parts to standard sizes and gauges so repair parts can be installed in field.
 2. Like parts and spare parts shall be interchangeable.
- C. Where not otherwise shown, use the following list of material specifications, which are acceptable for intended purposes, as referenced for selecting standard, types, and grades of materials used.

MATERIAL GROUP	APPLICATION	SPECIFICATION
CASTINGS		
Carbon Steel	General Purpose	Conform to ASTM A27, Grade 65-35 or better
Carbon Steel	Pressure-Containing Parts and for Welding	Conform to ASTM A216, Grades WCB and WCC
Low-Alloy Steel	High-Strength, Structural Purposes	Conform to ASTM A148, Grade 80-50
Alloy Steel	Pressure-Containing Parts	Conform to ASTM A217, Grades WC4 and WC5
Corrosion-Resistant	General Purpose	Conform to ASTM A743, suitable grade
Alloy Steel	Precipitation Hardening Material	Conform to ASTM A747, Grade CB7-CU1
Aluminum Alloy	General Purpose	Conform to ASTM B26
Bronze "BRNZ"	General Purpose (for Bearings, Wear Plates)	Conform to ASTM B584, Alloy C932 and C937
	General Purpose (for Castings)	Conform to ASTM B584, Alloy C903 or C923
	Leaded Red Brass	Conform to ASTM B584 Alloy 836
	Leaded Semi-Red Brass	Conform to ASTM B584 Alloy 844
	Nickel Silver 20% Leaded nickel Bronze	Conform to ASTM B584 Alloy 976
Gray Iron	General Purpose	Conform to ASTM A48, suitable grade
Malleable Iron	General Purpose	Conform to ASTM A47, suitable grade
SHAPES, PLATES, AND BARS		
	Slotted Channel Framing	Refer to Section 33 05 38
PLATE		
	Abrasive-Surface Floor Plate	Provide abrasive granules rolled into surface or abrasive granules metallically bonded to steel
	Pressure-Containing Parts	Conform to ASTM A516, Grade 60 or better, Impact tested
Carbon-Manganese Silicon Steel	Pressure-Containing parts	Conform to ASTM A537, Class 1, Impact tested
Stainless Clad Carbon Steel	Sealing Surfaces Not Machined	Conform to ASTM A264; with A285, Grade C base material and A240, Type 304L cladding for $\geq 20\%$ of thickness
Stainless Steel	Rolled Floor Plate	Conform to ASTM A793
PLATE, SHEET, AND STRIP		
Corrosion-Resistant Steel "GP-CRES"	General Purpose	Conform to ASTM B766 and ASTM A240
Corrosion-Resistant Steel	Fusion-Welded Pressure-Containing Parts	Conform to ASTM A240, Type 304L
Aluminum Alloy	Rolled Tread Plate	Conform to ASTM B632 Alloy 6061-T6
Phosphor Bronze	Bearing Plates	Conform to ASTM B100, Alloy C51100
Nickel-Copper Alloy	Monel	Conform to ASTM B127
BAR		

MATERIAL GROUP	APPLICATION	SPECIFICATION
Carbon Steel	Pins and Shafts $\leq 4"$ diameter	Conform to ASTM A576, Grade 1020 or 1030
Carbon Steel	General Purpose	Conform to ASTM A108
Corrosion-Resistant Steel "GP-CRES"	General Purpose	Conform to ASTM A276, Series 300 or ASTM A240, Series 300 (Type 316 except where otherwise shown)
Hardened Corrosion-Resistant Steel "Mach-CRES"	Shafts and Pins Wheel Axles	Conform to ASTM A564, Type 630
ROD, BAR, AND SHAPES		
Aluminum	Extruded Aluminum	Refer to Section 05 14 00
Brass	General Purpose Free Machining	Conform to ASTM B16
Bronze	Extruded Architectural Bronze	ASTM B455 Alloy UNS C385
FORGINGS		
Carbon and Alloy Steel	General Purpose	Conform to ASTM A668
Corrosion-Resistant Steel	General Purpose	Conform to ASTM A473
PIPE		
Carbon Steel	General Service Handrails, Special Sizes / Superior Grades / Pressure Vessels	Conform to ASTM A53, Grade A or B, or ASTM A106 Schedule 40 unless otherwise shown.
Austenitic Stainless Steel	Corrosion-Resistant	Conform to ASTM A312
Copper	General Plumbing Water	Conform to ASTM B42
PIPE FITTINGS		
Forged Carbon Steel	Flanges, Fittings, and Valves	Conform to ASTM A105
Wrought Carbon Steel	Elbows, Tees, and Caps	Conform to ASTM A234
Stainless Steel	Elbows, Tees, and Caps	Conform to ASTM A403
TUBE		
Austenitic Stainless Steel	Machinery Component Interconnections	Conform to ASTM A269
Copper	Subject to Cleanliness or Corrosion-Resistant Requirements	Conform to ASTM B88, Type K
BOLTING AND WELDING Refer to Section 05 05 23		
CORROSION PROTECTION		
Fabricated Steel	Corrosive Environments	Refer to Section 09 90 00
	Submerged Environments	Refer to Section 09 90 00
	Other Environments	Galvanized- Refer to Section 09 92 00

- D. Provide materials with smooth, flat, surfaces unless otherwise shown.
- For metal and other fabrications exposed to view in completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- E. Dissimilar metals, when used in conjunction with each other shall have insulation provided between adjoining surfaces to eliminate direct contact and resultant current.
- Materials of construction shall be cathodically compatible to preclude galvanic action.
 - Where dissimilar metals may contact, provide insulation between adjoining surfaces to eliminate direct contact and galvanic action.
 - Electrolytic insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, bushings, washers, or other accepted materials.
- F. Pipe, pipe materials and valves shall conform to US standards and the following:
- Refer to Section 33 05 31 for pipeline joint materials.
 - Do not use all-thread or close nipples.
 - Mating ends of pipe shall match.
 - Mating ends of valves, meters and couplings shall match ends of adjacent pipe.

4. Working pressure of valves, couplings and fittings shall equal or exceed class of pipe to which they are attached or 150 psi, whichever is higher.
5. Mark valves to show name of Manufacturer, year of manufacture, size of valve, maximum working pressure, and arrow to show direction of flow.
 - a. Valves shall close drip tight at rated pressures.
 - b. Valves shall be satisfactory for applications involving valve operation after long periods of inactivity.
- G. Conform to federal, state and local regulations governing VOC content, lead content, percentage solids by volume, and other paint and solvent properties.
- H. Design and fabrication of products shall ensure products withstand stresses and loads occurring during testing, installation, start-up, and normal operation.
- I. Electrical equipment shall be built to NEMA and UL standards for NEC §505 Classifications specified.

2.3 Equipment

- A. Sizes, ratings, capacities, and dimensions of standard equipment items shown, are based on currently available standard products.
 1. Deviations may be allowed to permit supply of standard equipment.
 2. In no case shall capacity furnished be less than specified, unless accepted.
- B. Anti-friction ball and roller bearings and gears shall conform to US standards.
- C. Ensure equipment is complete with fittings, trimmings, and parts necessary for complete operating installations.
- D. Cover and protect installed equipment from damage or contamination by ongoing construction Work and elements.
- E. Stainless steel inscribed nameplates shall be securely fastened in conspicuous locations for equipment.
 1. Show Manufacturer's name, address, year of manufacture, serial number, principal rating data, motor speed in rpm, motor electrical data, and equipment item catalog number.
 2. Nameplates shall be in English and use American measuring units.
 3. Furnish each piece of equipment with 2 identification nameplates.
 4. Nameplates of distributing agents alone will not be accepted.
 5. Mount 1 nameplate at appropriate, prominent location on equipment itself.
 - a. Mount 2nd nameplate at electrical service disconnect for equipment.
 6. For equipment not having separate disconnect, omit 2nd nameplate.
 7. Label pipe and equipment to designate service, direction of flow, pipe size, operating pressures and setpoints, and gate number.
 8. Label hydraulic oil piping HO.
 9. Locate labels near equipment and valves.
 10. Paint valve handwheels and operating levels according to following color schedule to show normal operating position:
 - a. Closed: Red.
 - b. Open: Green.
 - c. Open or Closed: Yellow.
- F. Provide lifting lugs for equipment weighing ≥50 lbm.

- G. Motors shall meet, as minimum requirements, published standards, rules and regulations of NEMA, ANSI and IEEE as to application, manufacture and tests.
1. Motor windings shall be insulated and braced for full voltage operation.
 2. Motors shall develop sufficient torque for required service throughout acceleration range at voltage 10% less than motor nameplate rating.
 3. Motors shall develop sufficient torque when started using reduced voltage starters.
 4. Provide grounding lugs inside conduit boxes for motor frame grounding.
- H. Provide safety devices for equipment as follows:
1. Furnish equipment with guards and safety devices designed to protect personnel against contact with moving parts and hazardous surfaces.
 2. Safety devices shall meet or exceed requirements of federal, state, OSHA, Cal-OSHA, and municipal safety laws.
 3. Fabricate guards of 14-gage (minimum) steel, ½" opening in expanded metal screen to facilitate visual inspection of moving parts without removal of guard.
 4. Galvanize or epoxy-coat guards after fabrication.
 5. Design guards to be readily removable to facilitate maintenance of moving parts.
 6. Provide reinforced holes.
 7. Make provisions to extend lube fittings through guards.
- I. Provide equipment access as follows:
1. Locate motors, valves, control devices, and specialties to provide easy access for operation, repair and maintenance.
 2. Provide concealed access doors.
- J. Grease fittings shall be standard button-head type.
1. Grease fittings shall be serviceable by 1 type of grease gun.
 2. Extend fittings as necessary to provide easy access, or as directed by City's Representative.
 3. Unless otherwise noted, grease lubrication fittings shall be of accepted standard hydraulic type.
 4. Locate oil lubrication fittings within reach from operating surface.
- K. Machine work shall conform to the following:
1. Tolerances, allowances, and gages for metal fits between plain (nonthreaded) cylindrical parts shall conform to ANSI B46.1 for class of fit shown or required.
 2. Provide sufficient machining stock on machined parts to ensure true surfaces of solid material.
 3. Finished contact or bearing surfaces shall be true and exact to secure full contact.
 4. Journal and sliding surfaces shall be polished, and surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operations when assembled.
 5. Use templates to accurately locate drilled holes for bolts intended to match other drilled holes.
 6. No machining shall be done on working surfaces of self-lubricating bronze bushings or washers.
 7. Finished surfaces shall conform to the following:
 - a. Surface finish of machined parts shall be suitable to meet functional requirements.
 - b. Surface finish qualities shall be adequate for intended use, shall be shown on Contractor's Shop Drawings, and shall conform to ANSI B46.1.

- c. Compliance with specified surface will be determined by visual inspection of Work compared to standard roughness specimens, conforming to ANSI B46.1.
 - d. Except as otherwise specified or approved, surface roughness shall be ≤ 32 microinches for surfaces in sliding contact; ≤ 125 microinches for surfaces in permanent contact where tight joint is required; ≤ 250 microinches for surfaces in contact where tight joint is not required; and ≤ 500 microinches for other machined surfaces.
 - e. Contact surfaces of shafts or shaft sleeves, which pass through packing boxes and bearings, and bearings, shall be finished to surface roughness ≤ 32 microinches.
8. Unfinished surfaces shall conform to the following:
- a. So far as practicable, lay out Work out to secure proper matching of adjoining unfinished surfaces.
 - b. Where discrepancies exist between adjoining unfinished surfaces they shall be chipped and ground smooth or machined to secure proper alignment.
 - c. Unfinished surfaces shall be true to lines and dimensions shown and shall be chipped or ground free of projections and rough spots.
 - d. Fill depressions in manner accepted by City.
9. Holes for pins and dowels shall conform to the following:
- a. Perform boring after member is securely fastened in position.
 - b. Bore holes true to gauges, smooth and straight, at right angles to axis of member.
10. Protect machined surfaces as follows:
- a. Thoroughly clean foreign matter from machine-finished surfaces.
 - b. Protect finished surfaces of large parts and other delicate surfaces using wooden pads or other suitable means.
 - c. Oil and wrap unassembled pins and bolts with moisture-resistant paper, or protect by other approved means.
 - d. Wash finished surfaces of ferrous metals to be in bolted contact using rust inhibitor, and provide thin coat of lubricant.
 - e. Do not grease self-lubricating bronze bearings.
 - f. Assemble these bearings dry, according to Manufacturer's instructions.
11. Tolerances shall be selected by Contractor to meet precision required for proper operation of equipment, considering nature and function of part.
- a. Show tolerances on Shop or Working Drawings and submit for review.
 - b. Establish finer shop tolerances, if necessary, to meet specified design or operational requirements or for interchangeability of spare parts.
 - c. Select tolerances with due considerations to nature and function of parts and to corresponding accuracy required to secure proper operation, but do not exceed tolerances specified.
- L. Lubricants shall be of types recommended by applicable equipment Manufacturer.
- 1. Contractor, subject to acceptance from equipment Manufacturer, shall limit lubricants to least number or types required for normal maintenance of equipment.
 - 2. Confer with City to limit number and type of lubricants, to extent practicable, to those presently in use at Project.
 - 3. City shall have final say regarding selection of grease and lubricants.
- M. Factory-paint or coat manufactured equipment as follows:
- 1. Protect steel and iron surfaces by suitable shop-applied coatings.
 - 2. Protect for life of equipment surfaces to be inaccessible after assembly.

3. Finish, smooth, clean, and fill exposed surfaces, as necessary, to provide smooth uniform base for coating.
 4. Coat surfaces to be painted after installation with 1 or more coats primer to protect equipment until finish coats are applied.
 5. Shop-finish electric motors, speed reducers, starters, and other self-contained or enclosed components with oil-resistant epoxy or enamel.
 6. Apply rust preventive compound to machined, polished and nonferrous surfaces not to be painted.
- N. Furnish special tools, wrenches and appliances needed to adjust, lubricate, operate, maintain or repair mechanical equipment supplied.

PART 3 - EXECUTION

3.1 Preparation

- A. Drill holes for equipment mounts as follows:
1. Skilled workmen shall drill holes for mounting devices.
 2. Make holes with rotary drill, or rotary/percussion type drill so no damage or spalling is caused to concrete and/or masonry being drilled.
 3. Do not drill or mount devices to asbestos surfaces or siding.
 4. Do not drill structural steel, reinforcement, or timber work without prior acceptance from City's Representative.
 5. Repair damage to surfaces caused by Contractor during erection without additional payment and subject to City's Representative's acceptance.
- B. Provide equipment bases as follows:
1. Provide foundations, where required by Contract Documents, by Manufacturer's requirements, or by Contractor's design.
 2. Provide concrete equipment base extending 4" above floor unless otherwise required.
 3. Base plan dimension shall be $\geq 2"$ larger in each dimension than steel or cast iron equipment base to be installed.
 4. Allow $\geq 1.0"$ for grout under equipment bases.
 5. Prepare floors and plinths to accept anchor bolts or mounting channels as accepted by City's Representative.
 6. Supply hold-down, alignment and leveling bolts complete with anchor bolts, nuts, washers and packing required to attach items of equipment to new or existing foundations, and bed-plates, frames and other structural parts necessary to transfer loads transmitted by equipment to concrete structures without exceeding design stresses.
 7. Anchor bed plates and machinery to concrete so vertical and horizontal loads are transmitted into foundations by means of direct compressive stress.
 8. Remove shims before grouting.
 9. Unless otherwise accepted, use non-shrinking grout.
 10. Where practicable, place grout through grout holes in base and work outward and under edges of base and across rough top of concrete foundation to peripheral form so constructed to provide suitable chamber around top edge of finished foundation.
- C. Where specified, or recommended by Manufacturer, mount or suspend equipment, including base, using vibration isolators to prevent transmission of vibration and sound to supporting structure.

3.2 **Installation**

- A. Strictly follow Manufacturer's instructions and warranty requirements for installation, application, connection, erection, maintenance, operating, cleaning and conditioning of products.
- B. Provide mounts, guides, bearing plates, flanges, anchor and attachment bolts and screws, saddles, supports, pads and skids necessary to securely mount products and equipment.
 1. Tighten bolts to Manufacturers' specifications using torque wrenches.
 2. Unless otherwise directed, use lubricant such as Copperkote or blue Teflon when making up bolts.
- C. Provide shims, fasteners, grout, grease fittings, lubricants, and fluids necessary for installation and testing procedures.
- D. Lubricate equipment as follows:
 1. Not less than 60 days before date scheduled for field testing of equipment, submit listing of lubricants required for each mechanical equipment item.
 2. Properly lubricate and protect mechanical equipment and appurtenances prior to operation.
 3. Furnish and install oil, grease, and protective fluids required for initial operation.
 4. Provide mechanical equipment with sufficient supply of correct lubricant for starting, testing, and initial 30-day operation period.
 5. Do not grease self-lubricating bronze bearings.
 - a. Assemble dry per Manufacturer's instructions.
 6. Provide lubrication for operation of equipment for starting, testing and initial operation.
 7. Submit chart listing for each piece of equipment, proper type of oil or grease required and recommended frequency of lubrication.
 8. Run in bearings and, after they are run in, drain and flush bearings and refill with new filtered oil charge.
- E. Label excess lubricants and deliver to City's Representative upon completion of Work.
- F. Repair or patch damage to existing walls, ceilings, or floors resulting from anchor installation, coring, or other Work.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
All Work	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
Concrete Flatwork	Grade Conformance	Vertical deviation from plan grades $\leq \frac{3}{4}"$	All Work	City	Contractor
	Rolling and Surface Unevenness	When 10' straightedge is laid on finished surface parallel to centerline, surface shall vary $< \frac{1}{8}"$ in 10'.	As directed	City	Contractor
Steel Work	Welds	Continuous, watertight, and conforming to Structural Welding Code of American Welding Society. Welds shall be free of sharp points or edges	All Work	City	Contractor
Roofing Systems	Leakage	Leak-Free demonstrated by 1-hour hose test	All Roofing	Contractor	Contractor
Exposed	Finishing	Finished in appearance.	All Work	City	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Surfaces		Round or chamfer corners of exposed structural shapes for personal protection.			
Pressure Pipelines and Appurtenances	Hydrostatic Test	Refer to Section 33 08 11, AWWA C600 and AWWA M41	All new pressure pipe	Contractor	Contractor
	Leakage	No visible leaks Joints watertight and airtight	All new piping	City	Contractor
Potable Water Pipe	Disinfection	Refer to Section 33 13 00 and AWWA C651.	All new potable water pipe	Contractor	Contractor
Gravity Pipelines and Electrical Conduits	Horizontal Alignment	Horizontal deviation from plan alignment $\leq 1"$	Mirror each straight section of pipe	Contractor	Contractor
	Vertical Alignment	Vertical deviation from plan grades $\leq 1/4"$	Mirror each straight section of pipe	Contractor	Contractor
	Mandrel Test for Obstructions and Pipe or Conduit Deflections	SSPWC §306-1.2.12 City's Representative reserves right to require mandrel testing to demonstrate compliance before subsequent work such as paving, before charging or commissioning of piping, or before installation of wire within conduit.	1 test per run of pipe	Contractor	Contractor
	Video Inspection	Video entire new alignment. Submit copy of video to City	All new gravity pipe	Contractor	Contractor
Gravity Pipelines	Pressure Test for Leakage and Infiltration	Refer to Section 33 08 31.	1 test per run of pipe	Contractor	Contractor
Motor-Driven Equipment	Motor Current	Record current in each phase of each motor and include in O&M manual. Repair or replace motor or motor-driven equipment if current exceeds motor nameplate FLC value.	Each phase of each motor	Contractor	Contractor
	Vibration	Refer to test procedures below	1 test each equipment item	Contractor	Contractor
	Noise	Refer to test procedures below	1 test each equipment item	Contractor	Contractor
All Work	Field Performance	Demonstrate Work conforms to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Confirm Work conforms to Contract Documents and Manufacturer's printed literature	1 test each equipment item	City	Contractor

- B. Remove rejected or damaged products from site.
- C. Require Manufacturers to furnish factory-authorized technical representative to visit site as needed to provide technical support in resolving field problems associated with Manufacturer's product.

END OF SECTION

SECTION 01 65 00

PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Transportation and delivery of products.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 66 00: Product Storage and Handling Requirements

1.3 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASTM D3951 Commercial Packaging

1.4 Delivery

- A. Before shipping, verify field dimensions, utility locations and electrical compatibility for items of Work which may require relocation, refitting, or different electrical motors and wiring if field dimensions differ from those shown on Plans.
 - 1. If Contractor discovers conflicts during surveying, staking, verification of field dimensions, verification of utility locations or verification of electrical compatibility, they shall bring this matter to City's attention as soon as conflict is discovered and before materials or equipment are shipped.
 - 2. City will adjust Contract requirements needed to accommodate field conditions, and will pay reasonable costs for upgrades or modifications required to be made at place of manufacture prior to shipping to accommodate conflicts discovered.
- B. City will not pay costs of shipping and returning items to place of manufacture unless:
 - 1. City has acted to prevent Contractor from completing surveys, staking, verification of field dimensions, verification of utility locations or verification of electrical compatibility, and Contractor has notified City of this fact in writing before shipping equipment, or
 - 2. Changes required are direct result of buried utility conflicts where said utilities were neither shown on Plans in their approximate location, nor located by Underground Service Alert, nor evident from surface features.
- C. Schedule deliveries and communicate with City as follows:
 - 1. Arrange and pay for shipping and handling equipment from Contractor's shop or factory to Project site, or from Project site to Contractor's shop or factory, as may be required.
 - 2. Do not ship, accept delivery of or store items on site for which applicable submittals have not been accepted.
 - 3. At least 15 Calendar Days before shipping equipment, notify City's Representative as to equipment to be shipped, method of transport, carriers and routing, shipping, delivery dates, and shipping weights.
 - 4. If Contractor fails to provide forgoing information, Contractor shall reimburse City for expenses incurred by City that would not have otherwise occurred.
 - 5. Amount of such expenses may be deducted by City from payments due or to become due Contractor.

6. Before shipping, operate valves, motors, pumps, actuators, and mechanical equipment at factory to ensure products are complete and in working condition.
7. When shipment is made, transmit shipping notices to City's Representative on each shipment, including description of equipment being shipped.
8. Control delivery schedules to minimize long-term storage of products at Site and overcrowding of construction spaces.
9. Ensure coordination to minimize holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

D. Packaging shall conform to the following:

1. Standard commercial packaging in accordance with ASTM D3951 will be acceptable except where other method or standard of packaging is specified.
2. Do not prepare equipment for shipment until it has been inspected and accepted for shipment at origin by City's Representative and/or representative of City, or inspection has been waived in writing.
3. Where necessary, mount heavy machinery parts on skids or in crates.
4. Package mechanical and electrical parts subject to moisture damage in hermetically sealed metal containers, in plastic envelopes or other accepted container within their respective packing cases.
5. Deliver parts of equipment in assembled or sub-assembled units where possible.
6. Deliver large multi-component assemblies in sections facilitating field handling and installation.
7. Use stiffeners where necessary to maintain shapes and provide rigidity.
8. Provide subassemblies with protective pads, supports, and blocking to restrain products and prevent distortion or damage in transit.
9. Prepare for shipment parts >200 lbs so slings for safe handling by crane may be attached to parts while on truck, rail car, or ship deck.
10. Provide desiccant in sealed containers.
11. Ship oil-lubricated gearing, bearings, and other lubricated components with oil-soluble protective coating as described in warranty requirements or recommended by Manufacturer.
12. Loss or damage during shipment, including damage to painted surfaces, shall be Contractor's responsibility, and shall be replaced or repaired without cost to City.

E. Label shipments as follows:

1. Place packing list, listing contents of each container, in moisture-proof envelope and securely fasten to outside of container.
2. Affix to equipment items and valves label or tag in prominent location displaying assigned equipment number.
3. Equipment items and valves lacking numbers shall have similar tag providing unique description of item.
4. Tag or label cases, crates, bundles, packages, containers or single items as needed to identify contents and name of equipment of which contents form a part.
5. Mark cases, crates, bundles, packages, containers or single items with number unique to specification reference covering product.
6. Mark cases, crates, bundles, packages, containers or single items with name and address of installation for which intended.
7. Markers shall be of stainless steel or aluminum, affixed to items with stainless steel fasteners or as otherwise accepted by City.
 - a. Do not use plastic tape labels.

8. Packing lists of equipment shall indicate weights of items >30 lbs.
 9. Show weights of components requiring use of cranes for safe handling.
 10. Mark for identification articles or materials that might be otherwise lost.
 - a. Box, bag, or steel band in bundles such articles or materials.
 11. Accessories and spare parts shall be packed separately in containers marked "ACCESSORIES ONLY," or "SPARE PARTS ONLY."
- F. Transport and handle material and equipment in accordance with Manufacturer's instructions.
1. Deliver products in undamaged condition to jobsite in Manufacturer's original, unbroken, unopened, labeled packaging containers or bundles.
 2. Protect equipment against damage from moisture, dust, handling, or other causes during transport from Manufacturer's premises to site.
 3. Relieve load on motor bearing during transport using jacks or other methods to prevent Brinelling.
 4. Damage to equipment during shipping and handling will be Contractor's responsibility.
 5. Repair or replace equipment or materials damaged in shipment.
- G. Deliver and store Work in accordance with Manufacturer's written recommendations and by methods and means preventing damage, deterioration, and loss including theft.
1. Furnish equipment and personnel to handle material and equipment on site by methods to prevent soiling, disfigurement, or damage.
 2. Deliver, unload, handle, and store equipment at Project site in safe and protected manner.
 3. Uncrate equipment and dispose of packing material properly.
- H. Inspect products delivered to jobsite as follows:
1. Deliver or store only products of accepted Manufacturers at site.
 2. Promptly inspect shipments to assure material and equipment conform to requirements, quantities are correct, and material and equipment are undamaged.
 3. Coordinate with City and equipment supplier/Manufacturer, as necessary, and perform inventory and inspection to include necessary unpacking and repacking operations to examine items delivered.
 4. Record in writing apparent defects, damage, or missing portions and provide copy to City.
 5. Pipes and fittings without openings covered will not be accepted for delivery.
- I. Assist City in inspecting products delivered to jobsite as follows:
1. Remove coverings, containers or crates as directed to permit City's Representative to inspect delivered items.
 2. Should City's Representative find evidence of damage or deficient workmanship, provide necessary documentation or conduct such tests deemed necessary by City's Representative to demonstrate compliance.
- J. For City-furnished products and equipment, City will make good deficiencies noted in inventory and inspection at no cost to Contractor.
1. Once received, Contractor shall be responsible for City-furnished items the same as for Work under the Contract, including insurance coverage, except City will correct subsequently discovered latent or hidden damage or defects in City-furnished items that could not be ascertained at time of delivery and were not caused by Contractor.
- K. Notify City's Representative in writing upon acceptance of shipment.
- L. City's Representatives or personnel will not accept product deliveries for Contractor.

1.4 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Warranty Requirements

- A. Conform to Manufacturer's instructions and warranty requirements for delivery of products.

END OF SECTION

SECTION 01 66 00
PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Handling, storage and protection of products.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
B. Section 01 33 00: Submittal Procedures
C. Section 01 40 00: Quality Requirements
D. Section 01 61 00: Common Product Requirements
E. Section 01 65 00: Product Delivery Requirements

1.3 Storage and Handling

- A. Store products at jobsite as follows:
1. Store and protect products in accordance with Manufacturer's instructions.
 - a. Store products to preserve their quality and fitness for Work.
 - b. Protect products against moisture, weather, temperature extremes, dust, debris, tampering, theft, vandalism, ultraviolet radiation, or damage from improper handling, storage, or exposure.
 - c. Protect exposed metals from moisture, rust and corrosion, even for items which may be sandblasted or cleaned before painting.
 - d. Keep openings in boxes or equipment closed during construction.
 - e. Store products intended for indoor use in clean, dry, indoor locations.
 - f. Store items subject to corrosion under damp conditions in clean, dry, indoor heated locations,
 2. After receipt of material and equipment until Final Acceptance, assume responsibility for loss, damage, breakage, corrosion, soiling, disfigurement, weather damage, and product distortion.
 3. Provide handling provisions for components requiring special access and weight considerations.
 4. Arrange storage of products to facilitate access for maintenance and inspection.
 5. Provide off-site storage and protection when site does not permit on-site storage or protection.
 6. Store products with seals and labels intact and legible.
 7. Store items not designed for outdoor exposure off-ground and under cover.
 - a. Store items with coatings or factory-applied primers off-ground.
 - b. For exterior storage of fabricated material and equipment, place on sloped supports, above ground.
 8. Cover stored material and equipment subject to deterioration with impervious UV-resistant tarpaulin or sheet covering to prevent soiling or exposure to weather.
 - a. Cover plastic items to protect from sun exposure and temperature extremes.
 - b. Fasten coverings to prevent removal by wind
 9. Store aggregate in well-drained area to minimize change in moisture content.
 - a. Prevent contamination by other materials.
 10. Store cementitious materials in weather-tight spaces.
 - a. Keep free from moisture.

- b. Comply with City, County, State and Federal pollution prevention laws and permits.
- 11. Store fasteners and connectors in original unopened containers until used.
- 12. Store flammable products to conform to City, County, State, and Federal safety codes for storage of flammable materials.
- 13. Notify City in writing if delivered or stored product is damaged.
 - a. Exterior surfaces of delivered items shall be in perfect unblemished condition.
- 14. Do not repair damaged products without prior written acceptance.
- 15. Remove corrosion found prior to Final Acceptance or remove and replace product.
- B. Store piping products as follows:
 - 1. Cover, plug, or cap pipe ends, valve ends, and equipment openings with rubber, plastic, or canvas to prevent intrusion or contamination when installation is not in progress.
 - a. These provisions shall apply during Work breaks >40 minutes as well as overnight.
 - b. Covers shall be vermin-proof and constructed in manner to prevent entry by animals and children.
 - c. Plastic covers may be opened temporarily to spray water inside pipe for moisture control.
 - d. Do not permanently remove plastic covers until pipe is ready to be placed in trench.
 - e. During pipe laying operations, do not place tools, clothing, rags, or other materials in pipe.
 - 2. String pipe along right of way in manner not interfering with free passage of vehicles.
 - 3. Do not store pipe on roadway or parkway of residential streets for ≥ 7 Calendar Days, or on business streets for ≥ 3 Calendar Days.
 - 4. Do not use pipeline as drain for removing water that has infiltrated into trench.
 - a. Maintain inside of pipe free from foreign materials and in clean and sanitary condition until final acceptance.
- C. Store temperature- dust- and moisture-sensitive products at jobsite as follows:
 - 1. Between delivery and installation, store equipment to be incorporated into Work in manner to prevent damage or deterioration.
 - a. Store sensitive products in weather-tight, climate-controlled enclosures.
 - b. Provide environmental controls, such as heaters or protective encapsulation, to guard against condensation and moisture damage.
 - c. Store temperature-sensitive products in protected area at temperature between 35°F and 104°F except where Manufacturer's requirements are stricter.
 - d. Maintain temperature and humidity ranges within Manufacturer's recommended tolerances.
 - e. Ventilate products subject to corrosion or moisture damage to prevent condensation.
 - f. To ensure protection of electrical and instrumentation equipment and panels and electric motors, store such equipment in enclosure designed to protect equipment from dust, temperature, and moisture.
 - 2. Maintain storage facilities and stored equipment, providing utilities required.
- D. Inspect, maintain and service products during storage as follows:
 - 1. Periodically inspect stored products on scheduled basis to assure material and equipment are undamaged and maintained in acceptable condition.
 - a. Maintain log of inspections, and make log available on request.
 - 2. Conform to Manufacturer's product storage requirements and recommendations.
 - a. Maintain Manufacturer-required environmental conditions, temperatures and humidities continuously.

3. Ensure surfaces of products exposed to elements are not adversely affected and that weathering of finishes does not occur.
4. For mechanical and electrical equipment, provide copy of Manufacturer's service instructions with each item.
 - a. Exterior of package shall contain notice instructions are included.
5. Service products on regularly scheduled basis.
6. Maintain log of services and submit as Record Document prior to final acceptance by City.

E. Handle products as follows:

1. Handle products with care, using proper equipment according to Manufacturer's recommendations.
2. Provide equipment and personnel to handle products, materials, and equipment by methods to prevent soiling and damage.
3. Provide parts, components, and assemblies heavier than 50 lbm with provisions for handling, such as eyebolts, lugs, hooks, tapped holes for eyebolts, or holes with rounded corners for passing slings.
4. Lift large heavy items only at points designated by Manufacturer.
 - a. Do not drop, drag, bump, bend or handle products in manner that causes abrasions, bruises, cracks, mars, scars, scratches, or other damage.
 - b. Use padded slings and hooks for lifting as needed to prevent damage.
 - c. Improper handling shall be cause to reject mishandled products.
5. Use rubber or canvas belt slings or pneumatic-tired cradles to lift or lower coated pipe, valves and other products.
 - a. Sling width shall equal or exceed pipe or product diameter.
 - b. Do not handle coated products using ropes, hooks, chains, calipers or cables.
 - c. Store coated products on padded skids.
6. Provide protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.
7. Inspect each product item for damage, defects, completeness and correct operation before installing.
 - a. Notify City in writing if delivered or stored product is damaged.
 - b. Do not repair damaged products without prior written acceptance.
8. Before installation, swab joints and interiors of piping materials to remove foreign matter and contaminants.
9. Clean and protect machined surfaces and shafting from corrosion using proper type and amount of coating as described in Manufacturer's warranty requirements to assure protection to 1 year after final acceptance.
10. Maintain records for City's review of deliveries to show Contractor's order number, purchase order number, and equipment number.
 - a. Include labeling or shipping tag in records.

1.4 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 Warranty Requirements

- A. Strictly follow Manufacturer's instructions and warranty requirements for storage and handling of products.

END OF SECTION

SECTION 01 73 00

EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 Work Included

- A. Examination of site before bidding, preparation for construction, and execution of Work.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 32 33: Construction Photographic Documentation
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 40 00: Quality Requirements
- E. Section 01 61 00: Common Product Requirements
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 31 05 50: Protecting Existing Utilities
- I. Section 33 05 31: Pipeline Joint Materials
- J. Section 26 05 10: Common Work Results for Electrical

1.1 Project Conditions

- A. Ascertain suitability of native soil for backfill before submitting bid.
 - 1. If native soil is found to be unsuitable, provide suitable material for meeting compaction requirements at no additional cost to City.
- B. Items furnished shall be capable of fulfilling their intended purpose in environment in which they are installed.
 - 1. Allow for local temperature extremes, climactic conditions and corrosive environments where necessary to ensure proper functioning of furnished products.
- C. The action of beginning installation, application or erection of products shall be deemed sufficient evidence both Contractor and installer accept existing field conditions as acceptable for installation, application or erection of that product, except where written notice is given of Contractor or installer's concerns before starting applicable Work.

1.3 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASME/ANSI B31.3 Process Piping Design
 - 2. AWWA C105 / ANSI A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems

1.4 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Equipment

- A. Furnish special tools, wrenches and appliances needed to adjust, operate, maintain or repair mechanical equipment supplied.

PART 3 - EXECUTION

3.1 Preparation

- A. Contractor represents they have carefully examined Contract Documents and site where Work is to be performed and they have familiarized themselves with local conditions and federal, state, and local laws, ordinances, rules, and regulations that may affect performance of Work.
- B. Refer to Section 01 32 33 for preconstruction and construction photographic and video documentation requirements.
- C. Refer to Section 01 65 00 for requirements to verify field dimensions, utility locations, and electrical compatibility before shipping products.
- D. Carefully lay out work in advance to minimize cutting, channeling, chasing or drilling of structural pads or elements.
 - 1. Review in advance with City's Representative cuts, channeling, drilling, or welding required to accommodate mechanical or electrical equipment.
 - 2. Do not begin such work until notified by City's Representative.
 - 3. Repair damage to structures, piping equipment or finishes using skilled workers of appropriate trades.
- E. Relocations or adjustment of existing facilities to facilitate construction must be accepted in writing by City's Representative.
 - 1. Existing facilities may subsequently be relocated or adjusted by Contractor as directed.
 - 2. Fences, walls, sprinkler systems, substructures or other improvements removed or disturbed by Contractor during construction, and not shown for demolition, shall be replaced and/or repaired within 48 hours at Contractor's expense to satisfaction of City and/or property owner.
- F. Make field measurements needed to fabricate and install Work before ordering or beginning Work.
 - 1. Make minor changes in alignments and dimensions as needed to remedy or avoid utilities and structural conflicts.
- G. Material safety data sheets (MSDS) shall be available and maintained at Project site.

3.2 Installation / Application / Erection

- A. Maintain complete set of Contract Documents, including Shop Drawings and Manufacturer's Installation or Application instructions at jobsite field office or superintendent's truck.
- B. Refer conflicts between Manufacturer's installation instructions and Contract Documents to City's Representative.
 - 1. Additional costs incurred by Contractor resulting from City's Representative's direction in resolving installation instruction conflicts will be reimbursed as Extra Work.
 - 2. Costs incurred by Contractor, through failure to timely notify City's Representative of a conflict, shall be borne by Contractor.
- C. Unless otherwise shown, install equipment on concrete bases $\geq 6"$ high.
 - 1. Anchor baseplates to concrete base with required anchor bolts.
 - 2. For equipment with grouted bases, fill space beneath with grout as specified.
 - 3. Grout equipment base after initial fitting and alignment.
- D. Before welding, abutting joints shall be free of strain.

- E. Prime and paint exposed surfaces of ferrous products, piping, and conduit except for stainless steel or galvanized or sherardized surfaces or unless otherwise shown.
 - 1. Clean painted surfaces and touch up bare or marred spots with finish to match factory finish.
- F. Paint and coat in workmanlike manner to produce even film of uniform thickness.
 - 1. Pay attention to edges, angles, flanges, corners, crevices, and joints to insure they have been thoroughly cleaned and they receive specified thickness of paint or coating.
 - 2. Finished surfaces shall be free from runs, drops, ridges, waves, shiners, laps, brush marks, and variations in color, texture and finish.
 - 3. Hiding shall be so complete that addition of another coat would not increase hiding.
 - 4. Apply coats to produce film of uniform thickness.
- G. Install pipe and conduit as follows:
 - 1. Provide and use proper tools and equipment as recommended by Manufacturer's Installation Instructions to handle, lower and move pipe.
 - 2. Cut and machine pipe in accordance with Manufacturer's Installation Instructions.
 - 3. Do not drop pipe, fittings, or appurtenances into trenches or onto ground.
 - 4. Do not force-fit or spring pipe, conduit or equipment into place.
 - 5. Do not exceed Manufacturers' published tolerance limits for deflections at joints.
 - 6. Prevent water from entering trenches and displacing pipe.
 - 7. Corrective measures for cases of poor alignment shall be accepted in advance by City's Representative.
- H. Install pipe and conduit bends as follows:
 - 1. Pipe bends shall conform to ASME B31.3 and be free from wrinkles, creases or corrugations.
 - 2. Pipe bends shall use accepted AWWA fittings, except API standard fittings may be used for above-ground steel pipe.
 - 3. Mitered piping joints are not permitted.
 - 4. Lower fittings into position using sling, rope, cable, chain, or other accepted means without damaging fitting.
 - a. Attach cable, rope, or other hoisting device around fitting exterior.
 - b. Do not run cables, ropes, chains or other devices through fitting interiors.
 - 5. Secure fittings to adjacent pipe or valves and verify joints are sound and proper.
- I. Cut pipe threads with sharp dies.
 - 1. Ream, deburr, and clean threads before making up joints.
 - 2. Apply NSF 61-compliant thread lubricant to threaded pipe ends before installing fittings, couplings, unions, or joints.
 - 3. Make up joints with accepted thread sealing compound.
 - 4. Threads to be seal-welded shall be made up dry.
 - 5. Do not use Teflon sealers.
- J. Fabricate and install epoxy coated pipe, valves and fittings without cutting, notching or welding.
- K. Install valves and equipment so as to be easy to operate and service.
 - 1. Where geometry of manufactured valves and equipment and field conditions make it difficult or impossible for average worker to operate or service an installed item, notify City's Representative of conflict before installing item.
- L. Unless otherwise shown, encase buried valves and ductile iron pipe in 2 layers of 8-mil polyethylene wrap in accordance with ANSI A21.5/AWWA C105.

3.3 Field Quality Control

- A. Refer to Section 01 40 00 for general field quality control requirements.

END OF SECTION

SECTION 01 73 24

SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 Work Included

- A. Seismic restraint systems for mechanical and electrical equipment other than tanks, vessels, hoppers, freestanding signs, or storage racks.
 - 1. For seismic restraint of the chlorine contact tank stairway, refer to specifications for those sections.
- B. Refer to Section 05 05 23 for requirements for metal fastenings and welds.
- C. Refer to Plans for project-specific seismic design criteria.

1.2 Related Work

- A. Section 01 33 00: Submittal Procedures
- B. Section 01 61 00: Common Product Requirements
- C. Section 05 05 19: Post-Installed Concrete Anchors
- D. Section 05 05 23: Metal Fastenings and Welds
- E. Section 09 90 00: Painting and Coating
- F. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install complete seismic restraint systems, including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building, mechanical, and electrical codes and standards.
- B. Provide restraint systems, hangers, supports, bracing and anchorage in all directions for piping, ductwork, conduits, cable trays, panels, equipment and other items at risk of seismic damage.

1.4 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures Chapter 13 and Chapter 15
 - 2. California Building Code (CBC) Chapter 16 "Structural Design"
 - 3. MSS SP127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
 - 4. SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems

1.5 Submittals

- A. To avoid repetitive submittals, seismic restraint submittals will not be accepted for review until dimensional drawings for supported equipment have been accepted by City and returned to Contractor.
- B. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Working Drawings	Submit for seismic bracing systems per Working Drawing requirements.	
Shop Drawings	Submit per structural Shop Drawing requirements. Show equipment dry weights and locations of centroids Show wet weights using specific gravities of fluids proposed for use Provide loading diagram showing static loads and forces imparted to surrounding pipes and structures. Show auxiliary equipment mounting slides and rails Show snubbers and vibration isolators.	.

SUBMITTAL	DESCRIPTION	
	Show anchorage details and quantity, diameter, load rating, edge distances and penetration depths for anchors.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for pre-manufactured systems per Product Data requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	Submit Engineering Calculations for anchorage of the following Contractor-furnished equipment: For City furnished equipment, submit Engineering Calculations for anchorage of: 1. Chlorine Contact Tank Stairway and landing 2. Static Mixer stairway	
	Submit for seismic anchorage systems and vibration isolators. Refer to California Building Code §16 and ASCE 7 for seismic accelerations. Use full equipment wet weight for calculations.	
	Submit for seismic bracing systems.	
	Compute shear and tension forces that must be developed by anchor bolts to resist calculated lateral forces and overturning moments. Select anchors to resist computed shear and tension forces.	

- C. Refer to Section 01 33 00 for definition of requirements for Working Drawings, Shop Drawings, Product Data, and Engineering Calculations.
- D. Under California Building Code and ASCE 7 §13.1.4, Engineering Calculations are not required for:
1. Seismic restraint of components weighing ≤ 20 pounds.
 2. Seismic restraint of components mounted $\leq 4'$ above floor level weighing ≤ 400 pounds.
 3. Seismic restraint of piping, utility or distribution systems weighing ≤ 5 pounds per lineal foot.
- E. For wall and slab-mounted equipment, requirement for engineering calculations will be waived if Contractor submits unsealed calculations demonstrating to City's satisfaction that:
1. Bolting strength in shear for floor-mounted equipment $>$ weight of equipment.
 - a. For bolt strengths in shear, refer to CBC Table 1911.2 or ICC data for concrete anchors.
 2. Bolting strength in tension for floor-mounted equipment $>$ weight of equipment multiplied by height of equipment divided by twice the width between bolts in narrowest dimension.
 - a. For bolt strengths in tension, refer to CBC Table 1911.2 or ICC data for concrete anchors
 3. Bolting strength in shear for wall-mounted equipment $>$ twice weight of equipment.
 - a. For Bolt strengths in shear, refer to CBC Table 1911.2 or ICC data for concrete anchors
- F. Calculations required for seismic restraint of nonstructural components shall be sealed by California-licensed civil or structural engineer and shall follow ASCE 7 §13.3 where:
1. S_{DS} shall be as shown on Structural Plans or Geotechnical Report.
 - a. If not shown, assume $S_{DS} = \frac{2}{3} S_S$
 2. a_p and R_p shall be as shown in ASCE 7 Table 13.5-1 or Table 13.6-1 as appropriate.
 3. Under ASCE 7, §13.4.2, anchors in concrete and masonry shall be designed for 1.3 times calculated force F_p
 4. Where earthquake lateral design loads for nonstructural components are shown on Plans for Contractor's convenience, typically as multiple of wet weight (W) of furnished item shown on Sheet S1, either this conservative Plan value may be used, or more exact value based on exact elevation of furnished item may be used and substantiated by calculation.

G. When anchoring new structures into existing concrete foundations, seismic design of foundation anchors shall provide lugs for ≥ 2 redundant anchor bolts beyond those required by seismic Engineering Calculations.

1. Place these to accommodate unexpected field conditions, field interferences, pre-existing embedments, or concrete cracking, deterioration, spalling or honeycombing.
2. If field conditions render 1 or 2 anchor bolts ineffective, 1 or 2 redundant bolts may be omitted in field.

H. Site conditions and required equipment environmental ratings are:

VARIABLE		RATED RANGE
SEISMIC DESIGN CRITERIA		
Site Soils Class		D
Seismic Importance Factor	I	1.25
	I_p	1.5
Mapped Spectral Response Accelerations	S_s	2.03g
	S_1	0.76g
Design Seismic Loads for Equipment and Nonstructural Components Excluding Tanks	Horizontal Loads – Floor Mount	1.0W
	Horizontal Loads – Wall Mount	2.3W
	Horizontal Loads – Ceiling or Roof Mount	1.4W
	Vertical Loads	1.0W

I. Less conservative values for items table above will be accepted if supported by sealed Engineering Calculations.

1.6 Unit Prices

A. Payment for Work in this section shall be included as part of lump-sum or unit-price bid amount for which such Work is appurtenant.

PART 2 - PRODUCTS

2.1 Materials

- A. Refer to Section 01 61 00 and Sections 05 05 19 and 05 05 23 for basic requirements for products and materials.
- B. Pack gaps between seismic anchorage lugs and floors or foundations with grout to inhibit corrosion of bolts in space between lug and floor or foundation.
 1. In areas subject to chemical exposure use appropriate chemical-resistant grout.
- C. Provide vibration-isolated equipment with snubbers capable of retaining equipment in its designated location without failure or deformation of snubbers when exposed to vertical or horizontal forces at contact surfaces equal to 100% of operating weight of equipment.
 1. Air gaps between snubber retainer and equipment base shall be $\leq 1/4"$.
- D. Anchor piping with flexible connection and/or expansion joints so intended uses of these joints are maintained in piping system.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install seismic restraint systems before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Design and build replacement retrofit bracing for seismic bracing removed.

1. California-licensed structural engineer shall prepare and seal design calculations and design Working Drawings for seismic bracing.
2. Submit Working Drawings and Engineering Calculations for seismic bracing design for City's acceptance.
3. Seismic bracing design shall facilitate future recoating of tank roof with minimal removal of seismic bracing.
4. Seismic bracing design shall consider roof to be welded to girders.
5. Construct seismic retrofit Work of stainless steel.
6. Construct seismic retrofit system to conform to engineered design accepted by City.

3.2 Installation

- A. Furnish and install seismic restraint systems as required by code and at locations shown on Plans and Submittals.
- B. The following installation standards shall be followed:
 1. Manufacturer's installation and warranty requirements
 2. Applicable OSHA and Cal OSHA regulations
 3. Applicable building, fire, plumbing, mechanical and electrical code requirements
- C. Refer variances between above documents and Contract Documents to City's Representative.
- D. Refer to Section 05 05 19 for concrete anchor system requirements.

END OF SECTION

SECTION 01 73 33

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 Work Included

- A. Materials, and installation of mechanical identification on above-ground pipes, ducts, valves and equipment, for hazardous materials warnings, and for miscellaneous services.
- B. Refer to Section 09 90 00 for painting of valve covers.
- C. Refer to Section 33 05 26 for marking and identification of buried pipes, tanks and equipment.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 22 00: Unit Prices
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 40 00: Quality Requirements
- E. Section 01 61 00: Common Product Requirements
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 03 30 00: Cast-in-Place Concrete
- I. Section 09 90 00: Painting and Coating
- J. Section 26 05 10: Common Work Results for Electrical
- K. Section 33 05 26: Utility Identification

1.3 System Description

- A. Furnish and install mechanical identification on pipe including appurtenant structural and mechanical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASME/ANSI A13.1 Scheme for Identification of Piping Systems
 - 2. ANSI Z535.1 Safety Color Code

1.6 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements.	
SAMPLES		
Material Samples	Submit, showing materials, colors and label sizes and letter sizes to be furnished	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of mechanical identification on pipes.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Labels for Exterior Piping	Calpico, Inc Self-Adhesive Pipe Markers	South San Francisco, CA (650) 588-2241
	Seton Name Plate Corporation Pipe Markers	Branford, CT (855) 772-4204
	WH Brady B-946	Milwaukee, WI (800) 940-0615
	Accepted equal	
Labels for Piping Inside Buildings or Vaults	Calpico, Inc Self-Adhesive Pipe Markers	South San Francisco, CA (650) 588-2241
	Marking Services, Inc.	San Pedro, CA (800) 234-0135
	Seton Name Plate Corporation Pipe Markers	Branford, CT (855) 772-4204
	WH Brady B-500 Vinyl Cloth	Milwaukee, WI (800) 940-0615
	Accepted equal	
Snap-on Type Pipe Markers	Seton Name Plate Corporation Set Mark	Branford, CT (855) 772-4204
	WH Brady B-500 Vinyl Cloth	Milwaukee, WI (800) 940-0615
	Accepted equal	
Tracer Tape and Warning Tap for Buried Piping	Refer to Section 33 05 26	
Labels for Valves	Seton Name Plate Corp Series SVT	Branford, CT (855) 772-4204
	WH Brady B-60	Milwaukee, WI (800) 940-0615
	Accepted equal	
Labels for Mechanical Equipment	Seton Name Plate Corp Style 2065	Branford, CT (855) 772-4204
	WH Brady B-120 Fiber-Shield	Milwaukee, WI (800) 940-0615
	Accepted equal	
Labels for Tanks	Seton Name Plate Corp PSPL	Branford, CT (855) 772-4204
	WH Brady B-946	Milwaukee, WI (800) 940-0615
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Lettering shall conform to OSHA requirements on signage and labels.
- C. Markings shall clearly indicate direction of flow with arrows.
- D. Potable and non-potable water piping shall be identified in conformance with California Plumbing Code §6-1 and Table 6-1 when both are present in same building.
1. Mark non-potable water piping with lettering in black upper-case "CAUTION: NON-POTABLE WATER, DO NOT DRINK."
 2. Message shall occur every 20' and at least once per room.
 3. Background color of piping (if not otherwise specified below for plant piping) shall be green with white lettering for potable water and yellow with black lettering for non-potable water conforming to California Plumbing Code §601.2.

OUTSIDE DIAMETER OF PIPE OR COVERING	MINIMUM LENGTH OF COLOR FIELD	MINIMUM LETTER SIZE
1/2"	8"	1/2"
5/8"	8"	1/2"
3/4"	8"	1/2"
1"	8"	1/2"
1 1/4"	8"	1/2"
1 1/2"	8"	3/4"
2"	8"	3/4"
2 1/2"	12"	1 1/4"
3"	12"	1 1/4"
4"	12"	1 1/4"
6"	12"	1 1/4"
8"	24"	2 1/2"
10"	24"	2 1/2"
12" and larger	32"	3 1/2"

E. Mechanical identification on pipes shall be constructed of the following:

ITEM	MATERIAL	SPECIFICATION
Labels for Piping Exterior	Weather and Ultraviolet-Resistant Acrylic Plastic	
Labels for Piping Inside Buildings or Vaults	Vinyl Cloth	
Labels for Valves	Aluminum or 1/16" Fiberglass Tags	Aluminum tags shall have black-filled letters
Labels for Mechanical Equipment	Aluminum, Brass, or 1/8" -thick Fiberglass Tags	Aluminum tags shall have black-filled letters

F. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Labels for Piping	Label Color	Conform to ANSI A13.1 and Z553.1 See below
	Text	Show full piping system name with no abbreviations
	Text Size	Conform to ANSI A13.1 and Z553.1
	Flow Arrows	Provide flow-directional arrows next to each label
	Design	Pre-printed semi rigid, color-coded, snap-on type pipe markers may be provided. Label shall cover 360° (minimum).
Labels for Valves	Tag Requirement	Tag each valve larger than 1"
	Tag Size	2"x2" square identification tag
	Text	Show valve tag number and full name or designation shown on Plans
Labels for Mechanical Equipment	Tag Requirement	Show tag number and equipment name
	Tag Size	1/2" by 4"
Labels for Instruments and Gauges	Tag Requirement	Show tag number and name of instrument
	Tag Size	1 1/2" by 4"

G. Except where otherwise directed by City, color scheme for piping shall follow 10-States standards and be as follows: (4000-series colors reference numbers are Sherwin-Williams color chips)

PIPING SERVICE	PIPE COLOR	BANDS	LABEL COLOR	LEGEND
WATER PLANT PIPING				
WATER RECLAMATION PLANT PIPING				
Sanitary Sewage	4025 Anchor Gray		Gray	White Text
Backwash Waste	4003 Pallet Tan		Gray	White Text
Sludge	4009 Walnut Brown		Gray	White Text

PIPING SERVICE	PIPE COLOR	BANDS	LABEL COLOR	LEGEND
Secondary Effluent	4048 Mason Brick		Gray	White Text
Raw Sludge	4001 Bolt Brown	4032 Black	Gray	White Text
Sludge Recirculation	4001 Bolt Brown	4084 Safety Yellow	Gray	White Text
Sludge Draw-Off	4001 Bolt Brown	4083 Safety Orange	Gray	White Text
Sludge Recirculation Discharge	4001 Bolt Brown		Gray	White Text
Sludge Gas	4084 International Orange		Safety Yellow	Black Text
Natural Gas	4084 International Orange	4032 Black	Safety Yellow	Black Text
Non-Potable Water	4086 Safety Blue	4032 Black	Safety Green	White Text
Non-Potable Heating Water	4086 Safety Blue	4081 Safety Red	Safety Green	White Text
Potable Water	4086 Safety Blue		Safety Green	White Text
Reclaimed Water	4080 Plumb		Safety Green	White Text
Fire Sprinklers	4081 Safety Red		Safety Red	White Text
Chlorine	4084 Safety Yellow		Safety Orange	Black Text
Sulfur Dioxide	4084 Safety Yellow	4081 Safety Red	Safety Orange	Black Text
Sewage	4026 Slate Gray		Gray	White Text
Compressed Air	4071 Rain Forest		Safety Blue	White Text
CHEMICAL PIPING				
Alum or Primary Coagulant	4083 Safety Orange		Safety Orange	Black Text
Ammonia	White		Safety Orange	Black Text
Brine	4019 Flint Gray		Gray	White Text
Carbon Slurry	Black		Safety Orange	Black Text
Caustic	4084 Safety Yellow	4085 Safety Green	Safety Orange	Black Text
Lime Slurry	4069 Emerald Ice		Safety Orange	Black Text
Ozone	4084 Safety Yellow	4083 Safety Orange	Safety Orange	Black Text
Phosphate Compounds	4069 Emerald Ice	4081 Safety Red	Safety Orange	Black Text
Polymers or Coagulant Aids	4083 Safety Orange	4085 Safety Green	Safety Orange	Black Text
Potassium Permanganate	4080 Plumb		Safety Orange	Black Text
Soda Ash	4069 Emerald Ice	4083 Safety Orange	Safety Orange	Black Text
Sodium Bisulfite	4083 Safety Orange	4084 Safety Yellow	Safety Orange	Black Text
Sodium Hypochlorite	4084 Safety Yellow		Safety Orange	Black Text
Sulfuric Acid	4084 Safety Yellow	4081 Safety Red	Safety Orange	Black Text
Sulfur Dioxide	4069 Emerald Ice	4084 Safety Yellow	Safety Orange	Black Text
OTHER PIPING				
Compressed Air	4071 Rain Forest		Safety Blue	White Text
Vacuum	4069 Emerald Ice		Safety Blue	White Text
Gas	4040 Deck Red		Safety Yellow	Black Text
Other Pipelines	4019 Flint Gray		Conform to ANSI A13.1 and Z553.1	
Hoists, Trolleys	4084 Safety Yellow			
Fire Protection	4081 Safety Red		Safety Red	White Text
Steam	4083 Safety Orange		Flint Gray	Black Text
Oil	4036 Mill Ivory		Safety Yellow	Black Text
BURIED UTILITIES (IDENTIFICATION TAPE COLOR)				
Potable Water	Light Blue		Refer to Section 33 05 26	
Reclaimed Water	Purple			
Non-potable Water	Yellow			
Industrial Water	Yellow with Direction of Flow shown			
Sewage	Light Green			
Natural Gas	Yellow			

PIPING SERVICE	PIPE COLOR	BANDS	LABEL COLOR	LEGEND
Oil				
Steam				
Cable TV and other Communications				
Telephone				
Electrical	Encase in Red Concrete			

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install mechanical identification on pipes before submitting shop drawings or ordering.
1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 Installation

- A. Furnish and install mechanical identification at locations shown on Plans and Submittals.
- B. The following installation standards shall be followed:
1. Manufacturer's installation and warranty requirements
 2. Applicable OSHA and Cal OSHA regulations
 3. Applicable building, fire, plumbing, mechanical and electrical code requirements
- C. Refer variances between above documents and Contract Documents to City's Representative.
- D. In addition to locations shown on Plans and Submittals, provide label and flow arrow at each connection to pumps or other mechanical equipment, at wall boundaries, at tees and crosses, and at 20' centers on straight piping runs.
1. Provide full-band pipe markers, extending 360° around pipe at each location.
- E. Attach labels to valve or piece of equipment with Type 304 or 316 stainless-steel chains or wires.
1. Attach label to valve by tying tag wire or chain around operating shaft or nut.
- F. Attach signs directly to equipment or on adjacent wall as directed by City's Representative.
- G. Install mechanical identification on pipes and equipment true, plumb, and level using precision gauges and levels.

3.3 Field Quality Control

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Mechanical Identification	Installation and Level	Visual inspection of finished installation	1 inspection	City	City
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.1 Work Included

- A. Site, mechanical and electrical demolition outside building envelopes, including:
 - 1. Site improvements
 - 2. Below-Ground Construction
 - 3. Above-ground exterior mechanical piping and equipment:
 - a. Flash Mixer Assembly
 - b. CCT Chemical Feed Piping and electrical panel
 - 4. Above-ground exterior electrical equipment:
 - a. Conduit and wiring
 - b. Transformers
 - c. Switchgear
 - d. Metering equipment and instruments
 - e. Standby power equipment
- B. Facilities may be occupied or operational.
 - 1. Completing Work will require Contractor to plan activities to work around unavoidable obstacles and maintain stability of structures and structural elements.
- C. Work will require restoring existing facilities, utilities, and structures to remain in place if damaged by demolition or removal operations.
- D. Refer to the following sections for Work not covered herein.
 - 1. Section 01 35 44 for procedures for disposing of hazardous materials.
 - a. Concrete structures and foundations
 - b. Masonry structures
 - c. Metal structures
 - d. Wood structures
 - e. Mechanical, plumbing, and HVAC equipment contained within structures and vaults.
 - f. Electrical and instrumentation equipment contained within structures.
 - 2. Section 31 05 50 for protecting existing utilities.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 50 00: Temporary Facilities and Controls
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 74 00: Cleaning and Waste Management
- I. Section 26 05 10: Common Work Results for Electrical
- J. Section 31 05 50: Protecting Existing Utilities
- K. Section 31 23 00: Excavation and Fill

1.3 System Description

- A. The following facilities must remain in operation while demolition is in progress:
 - 1. Secondary equalization basin pump station
 - 2. Influent filters
 - 3. UV channel
 - 4. Chlorine Contact Tank
- B. Facility operators will be working at site during demolition and will require access throughout plant throughout construction.
- C. Remove the following items.
 - 1. Mechanical items including:
 - a. Flash mixer and appurtenances to be replaced
 - b. CCT chemical feed
 - c. Flash Mixer chemical pipe and sample line
 - d. Instrumentation to be replaced
 - 2. Electrical items including:
 - a. CCT Rapid Mixer panel Rapid Mix Panel for chlorine contact tank
 - 3. Electrical conduits and wiring to flash mixer.
- D. Abandon the following items in place:
 - 1. Chemical feed as shown on plans for rerouting.
 - 2. Sample water lines shown on plans for rerouting.
- E. The following items to be removed shall be replaced with new Work in locations shown:
 - 1. Flash Mixer Assembly and chemical feed
- F. Salvage the following items to City.
 - 1. Flash Mixer Pump and motor
- G. Legally dispose of Items not designated for salvage.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods needed for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ANSI/ASSE A10.6 Safety and Health Program Requirements for Demolition Operations
 - 2. California Building Code (CBC)
 - 3. California Fire Code (CFC)
 - 4. California Green Building Code (CGBC)
 - 5. California Mechanical Code (CMC)
 - 6. California Plumbing Code (CPC)
 - 7. ICRI 310.2R Selecting and Specifying Concrete Surface Preparation for Sealers, Concrete Coatings, Polymer Overlays, and Concrete Repair
 - 8. ICRI 310.3R Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods
 - 9. NFPA 70 National Electric Code (NEC)
 - 10. NFPA 241 Safeguarding Construction, Alteration, and Demolition Operations
- A. Hire remediation firm separate from hazardous materials consulting firm to perform appropriate remediation measures.

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Report on Preexisting Damage	Submit inspection report of facility and site itemizing defects and damage or deterioration in place before start of demolition.	
Permits	Submit copies of permits and notices authorizing demolition	
	Submit copies of permits for transport and disposal of debris	
DRAWINGS		
Working Drawings	Submit Working Drawing detailing removal operations and showing methods and sequence of removal and equipment to be used. Include inventory of items to be removed and salvaged.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Receipt for Legal Disposal of Regulated Materials	Submit receipt for acceptable disposal of legally regulated waste materials.	
CLOSEOUT SUBMITTALS		
Certificates of Severance of Utility Services	Submit as required by City's Representative for utilities being disturbed or abandoned.	
	Include drawings documenting locations of service lines and capped utilities	

B. Refer to Section 01 33 00 for definition of requirements for Working Drawings.

1.7 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

1.8 **Unit Prices**

A. Where no bid item is set forth for hazardous materials, the following Work shall be completed under other appropriate bid items:

1. Preparation and submittals of hazardous materials surveys, reports, and environmental documentation as required by law.
2. Remediation and legal disposal of first 50 lbm of asbestos containing construction materials, including gaskets, grout, and other incidental ACCM's.
3. Remediation and legal disposal of first 50 lbm of lead-based paint (LBP) and/or lead containing paint (LCP).
4. Remediation and legal disposal of first 50 lbm of other collective hazardous materials including cadmium-plated bolts, chromium containing paint, mercury switches, mercury ballasts, and PCB's.

B. For quantities of ACCM's, LBP/LCP's, or other hazardous materials >50 lbm, a change order will be negotiated with Contractor for removal and remediation or encapsulation.

PART 2 – PRODUCTS

2.1 **Acceptable Consulting and Remediation Firms**

A. Acceptable hazardous material consulting firms include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Hazardous Materials Consulting Firms	A-Tech Consulting, Inc.	Orange, CA (714) 434-6360
	Ambient Environmental, Inc.	Norco, CA (951) 272-4730
	Citadel Environmental Services, Inc.	Glendale, CA (818) 246-2707
	Pacific Environmental Company	Laguna Niguel, CA (800) 303-6484
	Patriot Environmental Services, Inc.	Wilmington, CA (800) 624-9136
	Accepted equal with ≥5 years experience	

B. Acceptable remediation firms include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Hazardous Materials Removal and Disposal	Advanced Cleanup Technologies, Inc.	Carson, CA (800) 334-2284
	Ocean Blue Environmental	Long Beach, CA (562) 624-4120
	Patriot Environmental Services, Inc.	Wilmington, CA (800) 624-9136
	PSC Industrial Outsourcing	Long Beach, CA (562) 997-6000
	Specialized Environmental	Anaheim, CA (562) 698 9222
	Accepted equal with ≥ 5 years experience	

PART 3 - EXECUTION**3.1 Preparation**

- A. Survey and field-identify structures, improvements, systems and equipment to be demolished before beginning demolition Work.
 - 1. Field-identify conduit, piping, ductwork, equipment, pads, and improvements to be removed with tags or paint.
 - 2. Schedule walkthrough with City's Representative to confirm items to be demolished and items to be protected in place are properly identified
 - 3. Notify utility companies in advance and obtain approval before starting demolition.
- B. Do not begin demolition until after Work to be demolished is tagged.
- C. Arrange and pay for disconnecting, capping and plugging of utility services.
 - 1. Place markers to show location of disconnected services.
 - 2. Ascertain utilities servicing occupied or active portions of surrounding facilities will not be disturbed unless otherwise indicated.
- D. Shut off or disconnect utilities affecting demolition Work.
 - 1. Coordinate and schedule shutdowns with City.
 - 2. Notify City 3 Calendar Days in advance of shutdowns required to perform Work.
 - a. City will open/close valves on piping and electrical disconnects required for shutdowns.
 - 3. Where City cannot facilitate proposed duration of outage (8 hour maximum), phase demolition and retrofit Work to allow system or equipment to be reconnected within City-allotted timeframe or provide temporary power and utility connections as required to maintain service to systems or equipment.
 - 4. Contractor may provide temporary power by portable generator.
- E. Coordinate Work with operation and maintenance of existing facilities.
 - 1. If existing facilities cannot be removed from service, perform demolition Work while facility is in operation, using procedures and equipment that do not jeopardize operation or materially reduce efficiency of that facility.
 - 2. Do not begin Work until permission for activities in each area has been granted by City in writing.
 - 3. Complete Work with minimum delay as quickly as possible.
 - 4. When necessary for proper operation or maintenance of portions of facility, reschedule operations so Work will not conflict with required operations or maintenance.
 - 5. Do not interfere with use of adjacent facilities not subject to Work.
 - a. Maintain free and safe passage to and from such facilities.
 - b. Erect and maintain dustproof partitions where needed to limit dust, noise and dirt migration to neighboring properties and occupied portions of adjacent improvements.
 - c. Use water mist and other suitable methods to limit spread of dust and dirt.

6. Provide, erect, and maintain barricades, lighting, guardrails, and protective devices as required to protect adjoining property, occupants, workers, and public safety.
7. Do not store on-site or sell on-site removed items or materials.
8. Do not close or obstruct roadways without permits.
 - a. Conduct operations to minimize interference to public or private roadways.
- F. Where use of cutting torches is anticipated, clear Work area of flammable materials.
 1. Maintain portable fire suppression devices nearby throughout flame-cutting.
 2. Maintain adequate ventilation throughout flame-cutting
- G. Prevent movement, settlement, or collapse of structures, facilities, utilities, services, sidewalks, driveways, roadways, and trees.
 1. Provide and place shoring and bracing.
 2. Cease operations and notify City's Representative immediately when safety of structures appears to be endangered.
 - a. Take precautions to properly support structure.
 - b. Do not resume operations until safety is restored.
 3. Erect temporary protection including walks, fences, railings, canopies, and covered passageways needed to ensure safety of personnel and equipment in proximity to demolition.
 4. Assume liability for movement, settlement, or collapse.
 - a. Promptly repair damage.
- H. Prior to beginning selective demolition, perform thorough inspection of facility and site.
 1. Report to City's Representative defects and structural damage to or deterioration of existing construction to remain.
- I. Protect existing improvements, improvements, and landscaping to remain.
 1. Erect visible fencing around drip line of trees or groups of trees to remain.
- J. City assumes no responsibility for items scheduled for demolition.

3.2 Demolition

- A. Refer to Section 01 73 00 for basic execution requirements.
- B. Demolish items as shown on Plans.
 1. When a piece of equipment is to be permanently demolished, also remove all ancillary components including wiring, cables, boxes, conduit, solenoids, valves, switches, and instruments.
 2. When a piece of equipment is to be modified or replaced, seal or cap existing conduit, piping, or duct penetrations that will not be reused after existing conduit, piping, or ductwork has been removed.
 3. Remove unused exposed conduit, piping, ductwork and support systems back to point of concealment including abandoned conduit above accessible ceiling finishes.
 4. Remove unused wiring back to source or nearest point of usage.
 5. Seal electrical equipment and enclosures in manner preserving NEMA rating of equipment and enclosures.
 6. Use chutes, hoists, or other devices to convey debris to ground level in controlled descent.
 7. Minimize accumulation of debris in adjacent roadways, walkways, work areas, or Owner-occupied areas except where permission from Owner is obtained.
 8. Do not use explosives for demolition.
 9. Repair adjacent collateral damage to construction and finishes caused by demolition Work.

- C. Protect in place electrical and piping systems passing through demolition areas to serve other portions of premises.
- D. Demolish foundation walls and below-grade construction extending within 5' outside footprint of new Work.
 - 1. Fill voids in soil resulting from demolition with suitable soil materials as specified in Section 31 23 00.
 - 2. Repair damage to adjacent improvements caused by demolition.
- E. Nonstructural items not shown on Plans for demolition but interfering with (or damaged by) installation of new items, may, at Contractor's option, and pending acceptance by City's Representative, be temporarily demolished and replaced following installation of new items subject to the following:
 - 1. Items to be demolished shall not be on a structural load path.
 - 2. Items to be demolished shall not include roofing, decking, trusses, beams, columns, bearing walls, shear diaphragms, connections, or foundations.
 - 3. Non-structural and non-essential items including railings, ladders, supports, piping, conduit, wiring, boxes, lighting fixtures, and other interferences may be removed and shall be replaced with new and similar material pending written permission in advance from City.
- F. The following demolition standards shall be followed:
 - 1. Applicable EPA, OSHA, Cal OSHA, and SCAQMD regulations
 - 2. ANSI/ASSE A10.6 Safety and Health Program Requirements for Demolition Operations
 - 3. NFPA 241 Safeguarding Construction, Alteration, and Demolition Operations
 - 4. Standard Specifications for Public Works Construction §300-1 "Clearing and Grubbing"
 - 5. Other applicable building, fire, plumbing, mechanical and electrical code requirements
- G. Refer variances between above documents and Contract Documents to City's Representative.
- H. Demolished items shown to be removed and disposed of by Contractor shall, upon removal become Contractor's property and shall be disposed of legally.
 - 1. Adhere to CCR Title 8, §1529, including construction safety orders regulating dusts, fumes, mists, vapors, and gases associated with asbestos.
 - 2. Asbestos removal shall be performed by trained and registered personnel.
 - 3. Control measures may include wet methods, encapsulation, or removal with HEPA-filter-equipped vacuums into labeled polyethylene bags.
- I. Remediate lead-based paint (LBP) or lead-containing paint (LCP) according to guidelines set up by EPA, OSHA, CalOSHA, South Coast Air Quality Management District (SCAQMD), and other regulatory agencies. Procedures shall include but not be limited to the following:
 - 1. Lead-based paint removal shall be performed by trained and registered personnel.
 - 2. Notification to California Department of Public Health (CDPH) shall be completed through filing of an Abatement of Lead Hazards Notification CDPH Form 8551.
 - 3. Removal of LBP's or LCP's shall be completed by Certified Lead Supervisor or Certified Lead Works as defined by §35008 and §35009 of LBP Regulations respectively.
 - 4. Work shall conform to procedures specified In Chapter 12 Abatement in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing" published by United States Department of Housing and Urban Development in June 1995.
 - 5. Encapsulate deteriorating lead paint prior to removal.
 - 6. Lead paint that is intact and not delaminating may be disposed of as construction material as long as it is attached to its original substrate.
 - 7. Non-encapsulated paint chips and debris shall be wet-sanded or scraped, collected and disposed of in accordance with local, state and federal regulations.

8. If paints containing Lead or Chromium must be disturbed or made airborne during Work by activities such as abrasive blasting, welding, cutting or torch burning, provide worker protection in accordance with OSHA Lead in Construction Standard and other applicable regulations.
 9. Containment of LBP or LCP shall prevent contamination of non-Work areas with lead-contaminated dust, lead-contaminated soil, or lead-based paint debris.
 10. Removal of LBP or LCP materials shall be conducted in accordance with an Abatement Plan prepared by a Certified Lead Supervisor, Certified Lead Project Monitor, or Certified Lead Project Designer.
 - a. Abatement plan shall encompass requirements specified in §35100(4)(A) of LBP Regulations.
 11. Throughout Work, Certified Lead Supervisor shall maintain records of compliance with LBP regulations for City inspection upon request, including:
 - a. Evidence of notification of CDPH,
 - b. Maintenance of Abatement Plan shall be retained on-site throughout demolition activities for City review upon request,
 12. Demolition activities shall be subject to inspection by CDPH or City to verify compliance with requirements of LBP regulations and Abatement Plan.
 13. Following completion of abatement activities, retain services of a Certified Lead Inspector/Assessor or Certified Lead Project Monitor to conduct clearance inspection in accordance with CCR Title 17 Division 1 Chapter 8 §35000a and §36000(c)(3).
 14. Submit copy of results of clearance inspection to City and to City Planning Division upon completion of abatement and inspection activities.
 15. Legally dispose of paint removed during progress of demolition and Work.
 - a. When paint debris is found to contain >5 ppm lead or hexavalent chromium when tested in accordance with Waste Extraction Test (WET) method of CCR Title 22, it shall be disposed of as hazardous waste.
- J. Following remediation, demolition shall occur as follows:
1. Facilities scheduled for demolition shall be removed, salvaged and disposed of as shown in Contract Documents.
 - a. Remove and dispose of portions of items scheduled for demolition which interfere with project construction.
 2. Backfill and compact site areas disturbed by demolition Work with earth or gravel backfill in accordance with Section 31 23 00.
 3. Protect work not intended to be removed or salvaged.
 - a. If in opinion of City's Representative demolition method used may endanger or damage parts of structure or affect satisfactory operation of facilities, promptly change method upon receipt of notification from City's Representative.
 4. No blasting will be permitted.
 5. Equipment, material and piping, scheduled for demolition and not required to be salvaged to City shall become Contractor's property and shall be removed from project site and disposed of legally.
 6. Do not reuse material salvaged from demolition Work on this project except where permitted by Contract Documents.
- K. Patching and repair shall occur as follows:
1. Patching shall include restoration of surface or item to condition as near as practicable to match existing adjoining surfaces unless otherwise directed.
 2. Where patching involves cleaning, painting, special coating, wall covering or other applied finish, clean and refinish entire surface plane, wall or ceiling unless complete refinishing of entire space is required elsewhere.

3. Repair and restore existing improvements to pre-demolition condition.
- L. Dispose of removed materials legally and off-site in licensed and City-accepted landfill.
- M. Each load for landfill disposal shall be accompanied by manifest verifying hazardous materials were legally disposed of to absolve City of responsibility.
 1. Return completed copy of manifest to City after disposal.

3.3 Salvage and Removal of Existing Equipment

- A. Refer to Paragraph 1.3 above for list of items to be salvaged,
- B. Existing equipment, materials, and appurtenances designated to be demolished or removed, and not to be salvaged, shall become property of Contractor, shall be removed from site, and shall be legally disposed of at Contractor's expense.
- C. Clean and relocate salvaged items to plant area designated by City's Representative.
 1. During construction City's Representative may designate more items to be salvaged whether Contract Documents indicate items are to be salvaged or not.
- D. Furnish tools, equipment, material, and supplies, and perform labor required to remove from service, prepare for storage, inventory, package, mark, and deliver to City equipment and/or materials designated as salvage in Contract Documents.
 1. Prepare and submit listing of equipment identified for salvage.
 2. After equipment is removed, revise and resubmit list to include removal dates, estimated weight, description, and condition of each item.
- E. Disassemble and remove equipment carefully to prevent damage.
 1. Empty fluids from equipment, and plug openings.
 2. Bubble wrap or double box delicate equipment.
 3. Box sizes shall be suitable for item to be packed with cushioning material, but without bulge, and shall be minimum 200-lb. test weight, taped on unmade seams using 2" minimum clear 2-mil minimum industrial tape.
 4. Provide 48" x 48" pallets with minimum 2"x4" main rails and 1" thick (nominal) cross stiles nailed on both sides of main rails.
 5. Bolt larger equipment to wooden pallets.
 6. Wrap equipment with waterproof plastic.
 7. Prepare individual manifests for each equipment container.
 - a. Insert manifest into clear cover envelope and tape to side of container.
- F. Use care in loading and delivering material to prevent damage, splitting and breakage of material. City's Representative will designate receiving party for salvage material at 1 of following locations:
 1. Water Reclamation Facility No. 1

END OF SECTION

SECTION 03 10 00

CONCRETE FORMING

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, erection and removal of concrete formwork including formwork, bracing, shoring, supports, falsework, and appurtenant Work.
- B. Setting of embedded bolts, anchors, pipe sleeves, conduit sleeves, conduit and similar work under direction of respective trades.
- C. Design forms and falsework to resist displacement or damage from internal or external vibration.
- D. Where not otherwise shown, provide construction joints in concrete at $\leq 25'$ spacing and $\leq 20'$ spacing on average.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 31 23 00: Excavation and Fill
- I. Section 03 15 00: Concrete Accessories
- J. Section 03 20 00: Concrete Reinforcing
- K. Section 03 30 00: Cast-in-Place Concrete
- L. Section 03 39 00: Concrete Curing
- M. Section 05 05 19: Post-Installed Concrete Anchors
- N. Section 09 90 00: Painting and Coating

1.3 Definitions

- A. The following definitions apply:
 - 1. Construction Joints: Joints where fresh concrete is placed against a hardened concrete surface.
 - 2. Contraction Joints: Joints similar to construction joints except hardened surface of 1st placement is coated with bond-breaker to prevent bonding with fresh concrete.
 - 3. Expansion Joints: Joints allowing concrete to expand freely by providing gaps between adjacent placements, obtained by placing filler joint material against 1st placement, which acts as form for 2nd placement.
 - 4. Control Joints (Weakened Plane Joints): Joints providing reduced thickness through form inserts or sawcuts at strategic locations to encourage shrinkage and temperature cracks to occur in a planned and orderly fashion.

1.4 System Description

- A. Furnish and install concrete formwork including appurtenant structural, or mechanical mountings or connections required for compliance with applicable building codes and standards.
- B. Design, construct and maintain safe forms, shoring and falsework in accordance with OSHA regulations.

C. Forms, shoring and falsework shall:

1. Confine concrete ingredients including water, sand and cement while placing concrete,
2. Confine concrete to required lines, grades and construction tolerances.
3. Provide safe working environment in accordance with OSHA regulations.
4. Support dead loads and live loads plus superimposed construction loads including equipment, stored materials, personnel, impact loads from falling concrete or other materials, foundation pressures repetitive stress loads from vibrating concrete, and other vertical and lateral loads during construction.
5. Be of sufficient number and area to allow construction to proceed on schedule.
6. Upon removal, leave concrete with nontoxic, clean, dry surface, free from ridges, fins, offsets, deflection marks, or similar defects.
 - a. Surface shall be in condition that can be finished by Contractor as required by Contract Documents.

D. If adequate foundation for shores cannot be secured, provide truss supports.

E. Forms, shoring and falsework failing to provide above functions shall be removed from jobsite immediately at no additional cost to City.

F. Cap protruding reinforcement bars for worker protection in accordance with applicable safety codes.

1.5 **Quality Assurance**

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Design of structures shown on drawings includes no allowance for imposed construction loads.
- C. Provide forms, shoring and falsework of suitable material and of type, size, shape, quality, and strength to withstand dead loads and live loads plus imposed loads during construction.
- D. Formwork shall conform to CCR Title 8 §1717 and ACI 347R, except as exceeded by requirements of other regulatory agencies or as otherwise shown.
- E. Tolerances of formwork shall conform to ACI 117.
 1. Failure of finished concrete work to meet tolerances shall be remedied at Contractor's expense.
- F. Form surfaces shall be smooth and free from irregularities, dents, sags, and holes that might deface finished surfaces.
- G. Forms shall be mortar-tight, and sufficiently rigid to resist deflection during concrete placement.
- H. Thoroughly clean previously used forms of dirt, mortar, and foreign matter before reuse.
 1. Remove dirt, chips, sawdust, nails, laitance, and foreign matter from forms before placing concrete.

1.6 **References**

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 1. ACI 117 Tolerances for Concrete Construction and Materials
 2. ACI 301 Structural Concrete
 3. ACI 318 Building Code Requirements for Reinforced Concrete
 4. ACI 347R Recommended Practice for Concrete Formwork
 5. APA H330G APA Source List
 6. ASTM A36 Structural Steel

7. ASTM C470 Molds for Forming Concrete Test Cylinders Vertically
8. California Building Code (CBC)
9. California Division of Occupational Health and Safety Construction Safety Orders
10. NLMA Design Specifications for Stress-Grade Lumber and its Fastenings
11. U.S. Product Standard PS1 Construction and Industrial Plywood Concrete Forms, Class 1
12. U.S. Product Standard PS20 American Softwood Lumber Standard
13. SSPWC Standard Specifications for Public Works Construction (Greenbook) §303-1 Concrete Structures"
14. WCLIB Standard Grading and Dressing Rules No 16 of West Coast Lumber Inspection Bureau
15. WWPA Standard Grading Rules for Western Lumber

1.7 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Working Drawings - Falsework	At least 30 days before form fabrication, submit Working Drawings bearing stamp of registered professional civil or structural engineer for falsework, formwork, and vertical shoring per Working Drawing requirements.	
	Show size, number, and locations of cleanouts at form bottoms.	
	Show panel sizes and panel joint locations in Class A and Class B forms.	
	Working Drawings for falsework shall coordinate with drawings required by Section 03 30 00.	
	Minimum Design Criteria shall conform to design criteria shown below, taken from SSPWC §303-1.6	
	DESIGN LOADS	
	Tunnel Centering	100% of concrete load where concrete is placed by pneumatic process
	Live Load – Other Structures	30 psf per ft ² horizontal area
	Transverse Loading for Longitudinal Bracing	2% of vertical load
	MINIMUM UNIT STRESSES FOR FALSEWORK (USED MATERIAL)	
	Axial Tension and Bending	1,400 psi
	Compression Perpendicular to Grain	350 psi
	End Grain Bearing	1,300 psi
	Shear Parallel to Grain	125 psi
	Timber Columns	$S_{(psi)} = 1300 (1-L/60d)$ Where d= least dimension of column in inches and d= least dimension of column in inches L = Unbraced length of column $L/d \leq 50$ for bracing $L/d \leq 30$ for main members
	If Contractor furnishes new grade-marked material for falsework, allowable unit stresses shall be those recommended in WWPA Standard Grading Rules increased 25% for short-term loading.	
	Falsework may be bolted or spiked at Contractor's option but use of bolts or spikes shall not be combined in same connection. Refer to NLMA Design Specifications for Stress-Grade Lumber and its Fastenings (increased 25% for short-term loading) for connection strengths of bolts or spikes.	
	Tie ends of columns bearing on wedges in both directions by girts.	
	Show construction and expansion joints placement and for sequence of forming and concrete placing operations per structural Shop Drawing requirements.	
	Show conduit, piping and other wall penetrations per structural Shop Drawing requirements.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for form ties, taper tie plugs (if used), spreaders, corner formers, form coatings, form gaskets related work per Product Data requirements.	
	Submit for traveler forms used for cast-in-place reinforced concrete box (RCB).	

SUBMITTAL	DESCRIPTION	
	Submit for form liners. Include dimensional data and photograph of finished appearance	
SAMPLES		
Material Samples	Submit for textured formliners	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	Submit for falsework, formwork and vertical shoring per Engineering Calculations requirements. Calculations shall include statement from preparing engineer certifying falsework, formwork and vertical shoring design meets or exceeds design requirements of Cal OSHA Construction Safety Orders including Subchapter 4 Article 29 §1717, "Falsework and Vertical Shoring" and design criteria above taken from SSPWC §303-1.6	

B. Refer to Section 01 33 00 for definition of requirements for Working Drawings, Product Data, and Engineering Calculations.

C. Maintain copy of accepted Shop Drawings on site throughout concrete placing operations.

1.8 **Delivery, Storage, and Handling**

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of concrete formwork.

A. Cover and protect forms to prevent surface damage or deterioration which might cause unsatisfactory appearance or condition in finished concrete.

1.9 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
FORM MATERIALS		
Plywood	Use BB-Plyform, Medium Density Overlay(MDO), or High-Density Overlay (HDO) products from APA member-mill Manufacturers listed in APA Source List.	
Reusable and Wash-off Forms for Site Concrete	Labrado – wash off	Dana Point, CA (949) 830-9464
	L M Scofield Company "Lascolite" - reusable	Los Angeles, CA (800) 800-9900
	Accepted equal	
FORM TIE SYSTEMS		
Form Ties	Burke / Edoco (Penta-Tie System)	Long Beach, CA (310) 834-3401
	Dayton Superior Richmond Screw Anchor Company (Snap Tys)	Miamisburg, OH (888) 977-9600
	Dywidag Systems International	Long Beach, CA (562) 529-2109
	Simpson Strong Tie Company	Riverside, CA (714) 871-8373
	Accepted equal	
Tie Hole Filler	Select Products Select Bond GP3000	
	Accepted equal	
Taper Tie Hole Plugs	Dayton Superior A58 "Sure-Plug"	Miamisburg, OH (888) 977-9600
	Sika Concrete Restoration Systems Sika XPlug	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Plug Adhesive	Sika Concrete Restoration Systems SikaDur 35, Hi-Mod LV	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
MATERIALS PLACED AGAINST FORMS		
Form Liners	Fitzgerald Formliners	Santa Ana, CA (714) 547-6710

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	U S Formliner / Reckli	Bogart, GA (706) 549-6787
	Accepted equal	
Bond Breakers	Dayton Superior "Sure-Lift"	Miamisburg, OH (888) 977-9600
	Silcoseal NoxCrete Products	Omaha, NE (402) 341-2080
	Accepted equal	
Concrete Form Release Agents	GCP (Grace Concrete Products) / Applied Technologies "Pieri®"	Cambridge, MA (617) 876-1400
	W R Meadows Sealtight Duogard®	Hampshire, IL (800) 342-5976
	Accepted equal	
Form Coatings	GCP (Grace Concrete Products) / Applied Technologies "Formfilm"	Cambridge, MA (617) 876-1400
	Sika Chemical Corporation "Antisot"	Lyndhurst, NJ (800) 325-9504
	Sonneborn / BASF "Form-Saver"	Shakopee, MN (800) 433-9517
	Accepted equal	

2.2 **Materials**

- A. Unless expressly accepted by City's Representative, lumber brought used for forms, shoring, or bracing shall be new surfaced material of grade shown on accepted Shop Drawings.
- Forms shall have sufficient rigidity to maintain concrete dimensions within permissible tolerances.
 - Form surfaces, other than formliners, shall be smooth, and provide surface at least equal to plywood.
 - Form surfaces shall be non-porous.
 - Do not use badly checked or warped lumber.
- B. City's Representative may permit rejected lumber or plywood to be used on formwork for concrete surfaces to be completely enclosed or buried.
- C. Remove concrete formwork containing arsenic or other toxic materials from jobsite and dispose of off-site.
- D. Materials for formwork shall be:

ITEM	MATERIAL	SPECIFICATION
Forms for Curbs and Coping	Wood	Thickness $\geq 1\frac{1}{2}$ " Width $\geq$ full depth of curb or coping
Class II Forms for Work $\geq 1'$ Below Grade	Metal	Oiled forms.
	Plywood	Oiled forms, free from large or loose knots

ITEM	MATERIAL	SPECIFICATION
	Smooth-Planed Boards	Oiled forms, free from large or loose knots Tongue-and-Groove or Ship-lap joints
All Other Forms	Steel Panels or Tongue-and-Groove Lumber	Design per ACI 347R Provide rubber grommets where ties pass through steel forms to prevent loss of cement paste.
	Plywood	Conform to PS1 Class 1 Exterior B-B Plyform or better Edge-sealed but not mill-oiled Douglas Fir or Southern Yellow Pine plywood manufactured especially for formwork.
		Thickness $\geq \frac{5}{8}$ " with stud spacing ≤ 12 " center-to-center and close enough to prevent deflection marks. Thickness $\leq \frac{5}{8}$ " may only be used with continuous backing of $\frac{3}{4}$ " sheathing.
		Use new forms at start of Work for concrete exposed to view, and replace as directed. Refer to Paragraph 3.3 herein for finish requirements.
		Coat or treat sheathing to prevent chemical deterioration or discoloring of formed concrete surfaces
Form Ties, Clamps or Bolts	Metal Rods or Bolts	Of sufficient strength and quantity to prevent spreading or sagging of forms.
		Terminate embedded rods ≥ 1 " inside formed concrete face.
		Ties for walls in contact with backfill or water shall have waterstop shields ≥ 3 " diameter
		Do not use snap ties which cause spalling of concrete upon form stripping or tie removal.
		Do not use twisted-wire loop ties to hold forms in position.
		Do not use wooden spreaders
Form Ties with Removable Cones	Metal Rods or Bolts Plastic Cones	Plastic removable-cone-type. Do not use snap ties which cause spalling of concrete upon form stripping or tie removal.
		Ties for walls in contact with backfill or water shall have integral waterstop shields ≥ 3 " diameter
		Cone diameter ≤ 1 "
Temporary Anchors	Epoxy-Adhesive-Type	Refer to Section 05 05 19
		Do not use powder-actuated fasteners, expansion bolt anchors, bolts or nails driven into drilled holes, or lead anchors.

E. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Tolerances	Allowable Deviations	Refer to Paragraph 3.3 Field Quality Control
Chamfers and Fillets	Chamfers	Provide $\frac{3}{4}$ " chamfer on exterior corners except where otherwise shown.
	Fillets	Do not provide fillets on reentrant corners except where shown.
Form Ties	Holes	Form ties shall leave holes of regular shape for reaming.
	Design	Provide with plastic cone or other means of forming conical hole to ensure form tie may be broken off back of concrete face.

ITEM	DESCRIPTION	
	Removable Taper Ties	May be used if accepted by City's Representative. Insert preformed neoprene or polyurethane tapered plug (sized to seat at wall center) in hole left by taper tie removal.
Form Liners	Simulated CMU Design Modular Size, Finish and Color	Split-face unless otherwise shown on plans. Color = dark earth tone / sand. Submit sample to City's Representative for confirmation
Form Coating	Acceptable Materials	Non-grainraising, non-staining resin or polymer type coating
	Unacceptable Materials	Coatings leaving residual matter on concrete surface. Coatings adversely affecting concrete bonding to paint, plaster, mortar, protective coatings, waterproofing or other applied materials. Coatings containing mineral oils, paraffins, waxes, or other nondrying ingredients.
	Unacceptable Materials against Surfaces Contacting Potable Water	Any toxic or partially toxic materials
Form Joint Sealers	Design	Resilient foam rubber strips, non-hardening plastic type caulking compound free of oil.
	Alternate Design	Waterproof pressure sensitive plastic tape of minimum 8-mil thickness and 2" width.
	Form Tie Hole Filling	Use rubber plugs, plastic caulking compound or equal

F. Unit stresses for falsework design shall be:

PARAMETER	VALUE
Axial Tension and Bending	1400 psi
Compression Perpendicular to Grain	350 psi
End Grain Bearing	1300 psi
Shear Parallel to Grain	125 psi
Timber Columns (L = unbraced column length, d = least-side column dimension,)	$S_{psi} = 1300 (1-L/60d)$ L/d ≤ 30 for main members L/d ≤ 50 for bracing
Allowable spacings and construction values of bolts or spikes shall conform to NLMA recommendations except additional 25% allowance for temporary use may be added to design values.	

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install concrete formwork before submitting shop drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Install plumb and string lines before placing concrete and maintain throughout concrete placement.
- C. Set pipe stubs, wall sleeves, anchor bolts and other embedded Work in forms where required before placing concrete.
 1. Use templates to maintain anchor bolts in position during concrete placing.
- D. Place embedded items as follows:
 1. Locate embedded items so as not to reduce strength of construction.
 2. Provide inserts and hangers for piping and electrical Work.
 3. Provide sleeves and openings through floors and walls to accommodate piping and conduits.

- a. Sleeves shall be rigidly supported and packed and sealed to prevent ingress of wet concrete.
- b. Provide spacers to prevent movement of embedded sleeves, piping, or conduit.
- c. If inserts, sleeves, hangers or supports are improperly placed or installed, Contractor shall do necessary Work at their expense to rectify misplacement.
4. No embedded item (parallel to surface) shall have outside diameter $> \frac{1}{3}$ of slab or wall thickness.
5. Place embedded items parallel to surface in middle $\frac{1}{3}$ of slab or wall between top or interior reinforcing steel and bottom or exterior reinforcing steel.
6. Embedded items shall not be spaced closer than 3 diameters on center.
 - a. Diameter shall be taken as largest outside diameter of embedded item.
7. Embedded items shall be supported independently from reinforcing steel in manner preventing metallic contact and electrolytic deterioration.
8. Walls or slabs $\leq 4\frac{1}{2}$ " thick shall have no embedded items (parallel to surface) other than conduit.
9. For corrosion protection, place embedded metallic items to provide ≥ 2 " clearance between embedded metallic items and concrete reinforcement.
 - a. Do not secure embedded items in place by wiring or welding to reinforcement.
10. Place supplemental reinforcing around openings as required.
- E. Affix wood grade strips, or V-grooves to forms where shown, to define limits between successive concrete placements.
- F. Do not construct forms continuously, except for battered or sloped surfaces.
 1. Remove and reset forms for each lift.
 2. Sheathing of reset forms shall not overlap previously placed concrete by > 1 ".
 3. Tighten forms against hardened concrete so forms will not spread and permit loss of concrete or cause abrupt irregularities.
 4. Use supplementary bolts and form ties as needed to secure reset forms against hardened concrete.
- G. Build forms for sloped or battered concrete surfaces so sheathing can be placed board-by-board or panel-by-panel immediately ahead of concrete placement to facilitate access for concrete placement, vibration and inspection.
 1. Construct sheathing so sheathing can be removed, board-by-board, from bottom up.
 2. Form surfaces of construction joints and finished surfaces with slopes > 5 horizontal to 1 vertical as required herein.
- H. Clean forms and embedments before placing concrete.
 1. Remove encrusted dirt, concrete, mortar or grout from forms or embedments.
 2. Treat form surfaces with release agents acceptable to City's Representative before using forms.
 3. Remove excess lubricant before placing concrete.
 4. Keep lubricant off surfaces of steel reinforcement and embedded items.
- I. Verify proper placement of forms before and during concrete placement.
 1. Use plumb-bobs, known offsets, and other measurements as needed to detect formwork movement and verify specified tolerances are attained.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install concrete formwork at locations shown on Plans and Submittals.

- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building code requirements
 - 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install concrete formwork to tolerances recommended by Manufacturer and as described below to meet tolerances shown under Paragraph 3.3 "Field Quality Control."
 - 1. Unless otherwise shown, install concrete formwork true, plumb and level using precision gauges and levels.
- F. Construct formwork as follows:
 - 1. Place plywood with grain of outer plies in direction of span.
 - 2. Construct forms so form marks conform to general lines of structure.
 - 3. Place panels in neat, symmetrical pattern with horizontal joints level and continuous.
 - 4. Construct forms so portions may be removed for finishing without disturbing portions of forms to remain in place.
 - 5. Form around construction joints as follows:
 - a. Where construction joints are required, provide pre-molded expansion joint material with edge at appropriate set-back from adjacent finished concrete surface and with lightly tapered, dressed, and oiled wood strip secured or placed at edge during concrete placement.
 - b. Wood strip shall subsequently be removed to form space for joint sealant.
 - c. Fill joints with accepted quick-setting compound and finish flush with form interior
 - d. Where feasible, provide sleeve-type dowels to maintain alignment of adjacent slab or wall elements.
 - e. Refer to Section 03 15 00 for water-stop requirements.
 - 6. Place chamfer strips with $\frac{3}{4}$ " leg dimensions in form corners for exposed exterior corners to produce beveled edges.
 - 7. Do not bevel interior corners and edges at formed joints unless otherwise shown.
 - 8. Forms and form joints shall be tight and shall not leak mortar or paste.
 - a. Use closed-cell rubber or synthetic polymer foam strips under base plates of wall forms.
 - b. Foam strips shall butt against adjacent strips to prevent loss of mortar or paste.
 - c. Foam strips shall be ≥ 4 " wide and $\geq \frac{3}{4}$ " thick.
 - 9. Do not fasten form ties to reinforcing steel or embedded parts.
 - 10. Form coatings shall not contact reinforcing steel or concrete surfaces on which additional concrete or bonded coatings will be placed.
 - 11. Form vertical surfaces except where concrete placement against earth is shown.
 - 12. For members of limited height, where character of ground is such it can be trimmed to required lines and stand securely without caving or sloughing throughout concrete placement, City's Representative may permit placing concrete against earth at Contractor's risk.
 - a. Should ground fail during concrete placement for reasons including weather or natural or manmade causes, remove concrete in areas of earth failure and reconstruct with forms and new concrete.
 - 13. Where concrete is permitted to be placed against trimmed ground in lieu of forms, add ≥ 1 " thickness of additional concrete to face of concrete being formed against earth.

14. Where taper ties are accepted for use, larger end of taper tie shall be on wet side of walls in structures retaining water or groundwater
 15. Secure gaskets at bottom of wall forms before placing concrete.
 16. Provide adequate cleanout holes at bottom of each lift of forms.
 17. Provide form windows where concrete cannot be placed from top of wall in manner that meets contract document requirements.
 18. Quantity and dimensions of cleanout holes and form windows shall be subject to acceptance by City's Representative.
- G. Make Concrete construction joints only where shown on Contract Documents and accepted Shop Drawings or accepted in writing by City's Representative.
1. When 2nd lift is placed on hardened concrete, ensure quantities, locations, and tightness of form ties prevents unsatisfactory effects on finished concrete.
- H. Before placing concrete, treat inside surfaces of forms with accepted form-release agent.
1. Form release agent shall be non-staining and leave no objectionable film on form surface that can be absorbed by concrete.
 2. For steel forms, form release agent shall prevent concrete discoloration due to rust.
 3. Form release agent shall be nontoxic after 30 days.
 4. Do not deposit form-release agent on previously placed concrete.
- I. Contractor shall assume risks involved in form removal.
1. Minimum times shown herein are based on optimum field conditions, temperatures and concrete mixtures.
 2. In no case shall forms be removed on load-bearing members until cylinder tests demonstrate to Contractor's satisfaction concrete has reached sufficient strength to withstand expected dead loads and field loads during construction.
- J. Where admixtures, fly ash, supplementary cementitious materials, or other cement types are used, do not remove forms until concrete cylinder strengths are >3000 psi, or specified values, whichever is less.
- K. Minimum elapsed times prior to formwork and falsework removal shall be:

APPLICATION	LOCATION	CEMENT TYPE	MINIMUM TIME BEFORE FORM REMOVAL
MISCELLANEOUS STRUCTURES			
Miscellaneous Structures	Forms Supporting Direct Loads or Resisting Bending Stress	Type II, II/V, or V	7 days
Curb Forms		Type II, II/V, or V	Remove in time to permit finishing after concrete has set sufficiently to keep its shape
Stairway Forms		Type II, II/V, or V	Remove and complete finish on day concrete is placed. Install stairway treads immediately after placing steps
STANDARD STRUCTURES			
Catch Basins	Outside Forms and Inside Wall Forms not Supporting Top Slab	Type II, II/V, III, or V	16 hours
	Top Slab Forms	Type II, II/V, or V	48 hours
		Type III	24 hours
Transition Structures	Outside Forms and Inside Wall Forms not Supporting Top Slab	Type II, II/V, III, or V	16 hours
	Top Slab Forms		Remove when $f'_c > 20 \times (\text{span length in feet}) + 1000$

- L. Arrange to cure and protect concrete immediately following form removal.
- M. Remove forms not permitted to remain in place and clean concrete surfaces of loose material.

3.3 **Field Quality Control**

- A. Allow City's Representative and special inspectors to inspect formwork before and during concrete placement.
- B. Obtain City's Representative's acceptance of formwork before placing concrete.
- C. Monitor plumb and string line positions continually throughout concrete placement and correct deficiencies immediately.
- D. Special inspection and field testing required by Chapter 17 of CBC (Table 1705.3) shall be completed by ICC-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Concrete Formwork	Shape, Location and Dimensions of Item Being Formed	ACI 318 6.1.1, and paragraph F below	Periodic per CBC Table 1705.3	City	Contractor to reimburse City for costs of first deputy inspector if re-inspection is required

- E. Additional field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Formwork and Finished Concrete	Tolerance of Finished Concrete Work	As described below and ACI 117 Take measurements before formwork removal. Manometer survey may be required for horizontal slabs to demonstrate compliance	Inspection at City's discretion (may occur after concrete is in place except shall occur before removing forms for beams and slabs.)	Contractor	City

- F. Tolerances of finished concrete shall be:

ITEM	TOLERANCE
FOOTINGS	
Variation in Footing Width at Base	+2", - 1/2" for formed footings +3", - 1/2" for footings ≤2'-wide cast against soil +6", - 1/2" for footings >2' and ≤6'-wide cast against soil +12", - 1/2" for footings >6'-wide cast against soil
Variation in Footing Depth at Base	-5% of specified depth No upper limit
Variation in Top of Footing Supporting Masonry	±1/2"
Variation in Top of Footing Not Supporting Masonry	+1/2" -2"
Variation in Relative Alignment of Footing Top or Sides	±1" from level or string line
Variation in Position of Center of Gravity	≤0.02 x width and ≤2"
SLABS	
Variation in Slab Horizontal Dimensions	±1"
Variation in Slab Locations of Sawcuts, Joints, and Weakened Plane Embedments	±1" ±3/4" relative to adjacent columns
Variation from Level or from Grades Shown	±1/4" in 10' ±1/2" in 20' ≤3/4" over entire slab
Variation in Thickness of Slabs	-1/4"

ITEM	TOLERANCE
	$\pm \frac{1}{2}"$
CAST WALLS	
Variation from Plumb Exterior Walls, and Control Joints Exposed to View	$\pm \frac{1}{4}"$ in 10' $\pm \frac{1}{2}"$ in 20'
Variation from Plumb Interior Walls	$\pm \frac{3}{8}"$ in 10' $\pm \frac{1}{2}"$ in 20'
Variation in Thickness of Walls	$-\frac{1}{4}"$ $+\frac{3}{4}"$
STEPS	
Variation in Concrete Step Dimensions	Rise $\pm \frac{1}{8}"$ Run $\pm \frac{1}{4}"$ Total Run (All Steps) $\pm \frac{1}{4}"$
OPENINGS	
Variation in Locations of Other Slab and Wall Openings	$\pm \frac{1}{2}"$
Variation in Sizes of Other Slab and Wall Openings	$\pm \frac{1}{4}"$
OFFSETS FOR ADJACENT PIECES OF FORMWORK	
Walls and Slabs	Class B $\pm \frac{1}{4}"$
APPURTENANCES	
Variation in Locations of Embedded Bolt Settings	$\pm \frac{1}{4}"$ or equipment Manufacturer's tolerance, whichever is stricter

3.4 **Adjusting and Cleaning**

A. Remove forms taking care not to damage concrete.

- Contractor shall remedy damage from improper or premature form removal at their sole expense.
- Do not use stay-in-place formwork.
 - Remove forms.
- No heavy loading on green concrete will be permitted.
- Do not disturb formwork until concrete has hardened, and in no case <24 hours after concrete placement.
- Forms supporting non-load-bearing vertical members, including walls and columns shall remain in place ≥ 2 days.
- Forms supporting roof slabs and above-ground beams or floor slabs shall remain in place for ≥ 14 days and until test cylinders for supported concrete show tested concrete has attained 90% of specified 28-day compressive strength, and meets the other requirements of ACI 301.
- In addition, forms supporting roof slabs and above-ground beams or floor slabs shall remain in place and until test cylinders for slabs, panels, walls, columns, and supporting members adjacent to that item show tested concrete has attained 90% of specified 28-day compressive strength.
- Forms for items of Work not mentioned herein shall remain in place for time periods determined by City's Representative.
- Do not apply construction, equipment or permanent loads on columns, supported slabs or supported beams until concrete in load path to foundation has attained 28-day design compressive strength.
- Time to reach 90% of specified 28-day compressive strength shall be established by City's Representative based on test cylinders taken for this purpose.
- Provide advance notice to City's Representative of Contractor's intent to remove forms.

12. After City's Representative accepts forms for removal, promptly remove them, taking care to prevent concrete damage.
 13. Defective concrete revealed by form removal, or concrete damaged during form removal shall be immediately repaired while concrete is still green.
 14. Refer to Section 03 30 00 for concrete repair procedures.
 15. Immediately after removing forms, wet concrete surfaces and keep surface moist until curing procedures begin.
 16. Refer to Section 03 39 00 for concrete curing requirements.
- B. Remove form ties as follows:
1. No form-tying device or part thereof other than metal shall be left embedded in concrete.
 2. Do not remove ties in such manner as to leave hole extending through interior of concrete members.
 3. Where metal rods extend through concrete to support or strengthen forms, rods shall remain embedded and shall terminate ≥ 1 " back from formed face or faces of concrete,
 4. Where taper ties are removed, ream holes left by removal of form tie cones with suitably toothed reamers.
 - a. Finished surface of holes shall be clean and roughened for bond before being filled with mortar.
 5. A precast neoprene or polyurethane tapered plug shall be placed at wall centerline.
 - a. Hole shall then be completely filled with non-shrink or regular cement grout for above grade walls that are dry on both sides.
 6. Exposed faces of walls and ceilings, and floors shall have outer 2" of exposed face filled with cement grout matching color and texture of surrounding wall surface.
- C. Forms may be reused only if in good condition and if acceptable to City's Representative.
1. Lightly sand form faces between uses to obtain uniform surface texture on exposed concrete surfaces.
 2. Plug or fill residual tie rod holes with metal caps or other methods accepted by City's Representative.
 3. Thoroughly clean form before reuse.

END OF SECTION

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of water-stops and construction joints for concrete and masonry work.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 03 10 00 for requirements for construction joint spacing requirements.
 - 2. Section 03 30 00 for requirements for cold joints.
 - 3. Section 05 05 19 for cast-in-concrete and retrofitted anchor bolts.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 10 00: Concrete Forming
- I. Section 03 20 00: Concrete Reinforcing
- J. Section 03 30 00: Cast-in-Place Concrete
- K. Section 05 05 19: Post-Installed Concrete Anchors
- L.

1.3 System Description

- A. Furnish and install concrete accessories where shown, including water-stop and construction joint materials.
- B. Refer to Section 03 10 00 for definitions of varieties of concrete joints.
 - 1. Provide construction joints in water-bearing or chemical containment structures with water-stop and/or sealant groove of shape indicated.
 - 2. Provide contraction joints in water-bearing or chemical containment structures with water-stop and/or sealant groove of shape indicated.
 - a. Stop slab reinforcement 4½" from contraction joints, which shall be provided with sleeve-type dowels, to allow shrinkage of newly-placed concrete.
 - 3. Provide expansion joints in water bearing members with center-bulb type waterstops.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. City testing of materials may include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Water-Stop	Material properties listed below	See ASTM Standards listed below	as directed	City using sample submitted	Contractor

1.5 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ACI 301 Structural Concrete for Buildings Chapter 8.
2. ACI 318 Building Code Requirements for Reinforced Concrete
3. ASTM D41 Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
4. ASTM D43 Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing
5. ASTM D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
6. ASTM D624 Tear Testing for Rubber and Elastomers
7. ASTM D638 Tensile Properties of Plastics
8. ASTM D746 Brittleness Temperature of Plastics and Elastomers by Impact
9. ASTM D747 Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
10. ASTM D792 Density and Specific Gravity
11. ASTM D1149 Rubber Deterioration—Cracking in an Ozone Controlled Environment
12. ASTM D2240 Rubber Property—Durometer Hardness
13. California Building Code (CBC)
14. NSF/ANSI 61 Drinking Water System Components – Health Effects
15. US Army Corps of Engineers CRD-C572 Polyvinylchloride Water-stop

1.6 Submittals

A. Furnish the following submittals:

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Working Drawings	Show locations of construction joints. For water-bearing or chemical containment structures or on request, submit water-stop placement drawings. Show location and type of joints for each structure.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for water stops and other accessories per Product Data requirements.	
Installation Instructions	Submit for accessories per Installation Instructions requirements. Show methods and equipment proposed for joint cleanup and waste disposal.	
SAMPLES		
Materials Samples	Submit water-stop samples, including extruded or molded sections of each size or shape used. Also submit samples of fabricated mitered cross and tee constructed of each size and shape of material to be fabricated into crosses or tees.	
	City's Representative may randomly select fabricated joint samples for testing.	
	Prepare construction joint sealant adhesion and cohesion test specimens at intervals of 5 working days while sealants are being installed.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	At least 24 hours before placing concrete, submit certification from each trade having embedded items in concrete to be placed stating embedded items for each trade are properly located, placed and braced.	
	Submit current test reports and written certification material to be shipped to job meets physical requirements of CRD-C572 and other requirements listed herein.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. In addition to requirements of ACI, refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, and Certificates of Compliance.

1.7 Delivery, Storage and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery storage and handling requirements.
- B. Strictly follow Manufacturer's instruction and warranty requirements for delivery, storage and handling of concrete accessories.
- C. Storage of materials shall conform to requirements of ACI 301.
- D. Store materials to prevent damage by moisture or breakage.

1. Store water-stops to facilitate circulation of air around water-stop material.

E. Do not use aluminum embedments in concrete.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

1.9 **Unit Prices**

A. Payment for Work in this section shall be included as part of lump-sum or unit-price bid amount for which such Work is appurtenant.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
CRACK CONTROL STRIPS		
Plastic Crack-Control Strips	BoMetals, Inc.	Carrollton, GA (770) 832-2000
	Accepted equal	
WATERSTOPS		
Hydrophilic (Swelling) Water-Stops	CETCO Water-stop-RX®	Hoffman Estates, IL (800) 527-9948
	Durajoint Concrete Accessories	Garrettsville, OH (888) 833-8308
	Sika Greenstreak Swellstop	Lyndhurst, NJ (800) 325-9504
	Sika Greenstreak Hydrotite	Lyndhurst, NJ (800) 325-9504
	Accepted equal	
Hydrophilic Water-Stop Primer Adhesive	Use same Manufacturer as for Hydrophilic Water-stops	
PVC Water-Stops (Flatstrip and Centerbulb Styles)	BoMetals, Inc.	Carrollton, GA (770) 832-2000
	Durajoint Concrete Accessories	Garrettsville, OH (888) 833-8308
	J.P. Specialties, Inc. Earth Shield®	Murietta, CA (800) 821-3859
	Kirkhill Rubber Company	Brea, CA (714) 529-4901
	Progress Unlimited, Inc.	Lynbrook, NY (516) 593-4142
	Sika Greenstreak	Lyndhurst, NJ (800) 325-9504
	Vynlex Corp.	Knoxville, TN (800) 845-1417
	W R Meadows Sealtight®	Hampshire, IL (800) 342-5976
	Accepted equal	
PVC Water-Stops (Multi-Rib Styles)	J.P. Specialties, Inc. Earth Shield®	Murietta, CA (800) 821-3859
	Progress Unlimited, Inc.	Lynbrook, NY (516) 593-4142
	Accepted equal	
TPER Water-Stops for Chemical Containment	Durajoint Concrete Accessories	Garrettsville, OH (888) 833-8308
	J.P. Specialties, Inc.	Murietta, CA (800) 821-3859
	Sika Westec TPE-R®	Lyndhurst, NJ (800) 325-9504
	Accepted equal	
Water-Stops for Retrofit	CETCO Water-stop-RX®	Hoffman Estates, IL (800) 527-9948
	J.P. Specialties, Inc.	Murietta, CA (800) 821-3859
	Sika Hydrotite	Lyndhurst, NJ (800) 325-9504
	Accepted equal	
Water-Stops, Stainless Steel	J.P. Specialties, Inc.	Murietta, CA (800) 821-3859
	Accepted equal	

2.2 **Materials**

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for concrete accessories for facilities not in contact with potable water shall be:

ITEM	MATERIAL	SPECIFICATION
CRACK CONTROL STRIPS		

Plastic Crack-Control Strips (Zip Strips)	Virgin Poly-Vinyl-Chloride Compound	
JOINT SEALANTS		
Asphalt Paint	Asphalt	Conform to ASTM D41 or ASTM D43
Pre-Molded Joint Filler, Sub-Caulking, or Backing Rod for Self-Leveling Sealants	Extruded, Closed-Cell, Polyethylene Foam	Refer to Section 07 92 00.
	Preformed Expansion Joint Filler for Concrete (Bituminous)	Refer to Section 07 92 00.
	Non-Extruding and Resilient Filler (Bituminous)	Refer to Section 07 92 00.
Pre-Molded Joint Filler – Non-Water Holding Structures	Neoprene Sponge or Polyurethane	Refer to Section 07 92 00.
Joint Sealant	Primer	Conform to sealant Manufacturer's recommendations.
	Plane Horizontal Joints Self-Leveling 2-Component Polyurethane	Refer to Section 07 92 00 Joint Sealant - Water-stop Conform to ASTM C920 Class 25 Grade P
	Vertical and Overhead Surfaces Non-Sag 2-Component Polyurethane	Refer to Section 07 92 00 Joint Sealant - Water-stop Conform to ASTM C920 Class 25 Grade NS
WATERSTOPS		
PVC Water-Stops	Virgin Poly-Vinyl-Chloride Sheet Material	Uniform in dimensions, dense, homogeneous, free from porosity conforming to the following:
		Tensile Strength (ASTM D412 or D638 Type IV) $\geq 1,750$ psi
		Accelerated Extraction (CRD C572) Tensile Strength (ASTM D412 or D638 Type IV) $\geq 1,500$ psi
		Finish Water-stop Tensile Strength (ASTM D412 or D638 Type IV) $\geq 1,400$ psi
		Ultimate Elongation (ASTM D412 or D638 Type IV) $\geq 300\%$
		Accelerated Extraction (CRD C572) Ultimate Elongation (ASTM D412 or D638 Type IV) $\geq 300\%$
		Finish Water-stop Ultimate Elongation (ASTM D412 or D638 Type IV) $\geq 280\%$
		Shore A Hardness (ASTM D2240) 75 ± 5
		Specific Gravity (ASTM D792) ≥ 1.30
		Stiffness in Flexure (ASTM D747) ≥ 600 psi
		Tear Resistance (ASTM D624) ≥ 225 pli
		Cold Brittleness (ASTM D746) $\leq -35^{\circ}\text{F}$
		Ozone Resistance (ASTM D1149) Pass
		Water Adsorption – 48 hours (ASTM D570) $\leq 0.150\%$
		Effects of Alkalis – (CRD C572) Change in Weight $+0.25$ to -0.10%
		Effects of Alkalis – (CRD C572) Change in Durometer Shore A Hardness (ASTM D2240) $\leq +5\%$

C. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
CRACK CONTROL STRIPS	

ITEM	DESCRIPTION	
Plastic Crack-Control Strips (Zip Strips)	Design	2-part assembly designed to permit removal of top portion after concrete has hardened, creating clean, neatly defined joint groove for application of caulk or sealant as specified.
	Width	Provide 1", 1½" and 2" strips as applicable.
WATERSTOPS		
PVC Water-Stops	Design for Construction or Contraction Joints	Ribbed without Centerbulb
	Design for Expansion Joints	Ribbed with Centerbulb
	Flatstrip Thickness	≥¾" throughout
	Butt Splices	Provide Teflon-coated thermostatically controlled water-stop splicing irons for field butt splices.
	Corners, Intersections, and Transitions	Provide shop-made corner fittings. Do not splice corners in field.
Hydrophilic Water-stops	Water-stops	Swellable strip-applied

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install concrete accessories before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Before placing concrete within forms, each trade having embedded items, including water-stops within forms and affected by pour shall certify items are properly located, placed and braced.
 - 1. Accuracy of placement of embedded items is Contractor's responsibility.
- C. Construction joints shown on Contract Documents and accepted shop drawings may be made as shown with provision of keys or other locking shapes to secure proper union with subsequent work.

3.2 Installation/Application

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install concrete accessories at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. California Building Code Chapter 19 "Concrete"
 - 3. Other applicable building code requirements
 - 4. ACI 301 Structural Concrete for Buildings Chapter 8.
 - 5. ACI 318 Building Code Requirements for Reinforced Concrete
 - 6. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Prepare vertical surfaces of joints as follows:
 - 1. Construction joints shall have keyed, stepped, or roughened surfaces.
- F. Construction joints shown on Contract Documents and accepted Working Drawings may be made as shown using keys or other locking shapes to secure proper union with subsequent Work.

G. Locate construction joints as follows:

1. Construction joints are defined as planned joints where 2 placements of concrete meet, across which development and maintenance of bond and water tightness are required, and through which reinforcement is not interrupted.
2. Construction joints may be vertical or horizontal.
3. Locate construction joints as shown on Plans or Working Drawings, or as accepted by City's Representative.

H. Prepare construction joints as follows:

1. Perform initial construction joint cleaning at latest practicable time and as last operation before setting forms and installing embedded items.
2. Clean concrete so clean, sound mortar and some coarse aggregate are exposed.
 - a. Methods for cleaning concrete construction joint surfaces may include wet sandblasting, high-pressure water-blasting, or other methods that do not damage bond surface, cause excessive cutting of surface and undercutting of coarse aggregate particles, or poor uniformity of surface treatment as accepted by City's Representative.
3. Perform high-pressure water-blasting with proper equipment that is operated at 6,000 psi or greater.
4. Green cutting, removal of unhardened concrete surfaces by water or air-water jet, will not be permitted.
5. Waste Disposal: Method used in disposing of waste water employed in cutting, washing and rinsing concrete surfaces shall ensure waste water does not stain, discolor, or affect exposed surfaces, or damage environment of project area.
 - a. Disposal method shall be subject to City's acceptance.

I. Prepare vertical surfaces of joints as follows:

1. Clean joint surface of laitance, loose or defective concrete, coatings, sand, curing compound, stains, and foreign matter that may reduce bond or water tightness of joint.
2. Wash, hydro-blast or sandblast surface with clean water.
3. Clean concrete such that clean, sound mortar and some coarse aggregate are exposed.
4. Method of disposing of sand and wastewater used to wash concrete surfaces shall cause no staining, discoloration, or deterioration of exposed surfaces of structures and improvements.
5. Coat joint surface with epoxy-bonding agent unless otherwise shown.
6. Wet joints not coated with bonding agent before placing concrete adjacent to joint.

J. Prepare horizontal surfaces of joints as follows:

1. Roughen horizontal surface with $\geq \frac{1}{4}$ " amplitude profile for good bond.
2. Clean tooled joint surface of laitance, loose or defective concrete, coatings, sand, curing compound, stains, and foreign matter that may reduce bond or water tightness of joint.
3. Wash, hydro-blast or sandblast surface with clean water.
4. Clean concrete such that clean, sound mortar and some coarse aggregate are exposed.
5. Remove ponded water from surface of joints.
6. Method of disposing of sand and wastewater used to wash concrete surfaces shall cause no staining, discoloration, or deterioration of exposed surfaces of structures and improvements.
7. Coat joint surface with epoxy-bonding agent unless otherwise shown.
8. Wet joints not coated with bonding agent before placing concrete adjacent to joint.
9. Cover horizontal joints, except expansion or contraction joints, with 1" layer of Class D mortar (1 part Portland cement – 2½ parts fine aggregate).

- a. Limit water in mortar to that required to produce consistency similar to fresh concrete.
- K. Do not extend steel reinforcement through contraction or expansion joints except where shown on Plans.
- L. Install water-stops as follows:
 1. Install and splice water-stops to form continuous watertight diaphragms in each joint or as shown on Plans.
 - a. Water-stops shall be continuous for extent of joint.
 - b. Center-bulb water-stops shall have bulb centered on joint.
 2. Position water-stops so center of water-stop is centered on joint.
 3. Properly butt-splice water-stops as required for continuity.
 - a. Do not lap water-stops or use adhesives, or solvents.
 - b. Qualified splicers shall make heat-fuse-welded field butt splices, using Manufacturer-approved, Teflon-coated, thermostatically controlled, water-stop splicing irons at approximately 380°F.
 - c. Maintain continuity of water-stop ribs, bulbs and tubular center axis.
 - d. Butt joints of identical non-mitered ends of water-stop sections may be made while material is in forms.
 - e. Make other splices on portable bench provided on-site.
 - f. Use miter guide and portable power saw to cut ends to be joined to ensure proper alignment and contact between joined surfaces.
 - g. Do not damage material during heat-fusing.
 - h. Check joints for strength and pinholes after splicing.
 - i. Splices shall be watertight and strong enough to develop pulling force of 75% of water-stop.
 4. Prefabricate joints requiring >2 ends to be jointed, and joints requiring angle cuts, alignment changes, or joining of 2 dissimilar water-stop sections, before placing water-stops in forms.
 - a. Allow ≥ 24 "-long strips of water-stop material beyond prefabricated joint.
 - b. Following field-inspection of prefabricated joints, install prefabricated joint assemblies in forms and butt-weld ends of 24" strips to straight run portions of water-stops in place in forms.
 - c. Where center-bulb water-stops abut non-center-bulb water-stops, seal ends of center-bulbs using additional PVC material as required.
 - d. Connect ends of radial water-stop in wall footing joints to circumferential water-stop in wall-to-wall-footing joint and to circumferential water-stops in floor to wall-footing joints if they exist.
 5. Water-stop splices will be rejected if:
 - a. Tensile strength < 60% of parent section.
 - b. Water-stops are not symmetrically centered in joints.
 - c. Misalignment of center-bulb, ribs, and end bulbs exceeds 1/16" and misalignment reduces water-stop cross section more than 15%, except these requirements may be altered at City's direction for connecting existing water-stop to new water-stop that is not identical in profile.
 - d. Bond failure at joint creates opening deeper than 1/16" or reduces material thickness $\geq 15\%$.
 - e. Porosity or pinholes are visible in weld.
 - f. Bubbles or inadequate bonding are observed.

- g. Visible signs of splice separation are found when cooled splice is bent by hand at sharp angle.
- h. Charred or burnt material is observed.
- 6. Where preformed expansion joint material is used in conjunction with water-stop, allow for equal water-stop embedment on each side in concrete.
- 7. Support and protect water-stops throughout Work.
 - a. Secure water-stop in place in forms using split forms, hog rings at 12" on-center, end nails, or other accepted method to secure water-stop in correct position and alignment and facilitate placing and tying of water-stops to reinforcing steel forms or form ties.
 - b. Tie off horizontal and vertical water-stops not accessible during concrete placement in 2 directions using light wire ties every 12" to prevent bending or displacement.
 - c. Secure water-stop wire ties to curtain of steel reinforcement.
 - d. When placing flat-strip water-stops, provide means to prevent folding over of flat strip forms by concrete during placement.
 - e. Secure horizontal water-stops with their flat face in vertical plane by tacking top edge of water-stop to continuous supports until concrete is brought to level of water-stop.
 - f. Then place additional concrete over water-stop after which concrete shall be vibrated.
 - g. In vertical wall joints, end water-stop 6" from tops of walls where water-stops will not connect with other water-stops or be connected to future concrete placements.
- 8. Work concrete near water-stops to maximize density and imperviousness of concrete.
 - a. Work concrete below horizontal water-stops by hand to prevent formation of air and rock pockets.
- 9. Where installing water-stops on 1 side of joint while remaining portion of water-stop remains exposed to atmosphere for >2 days, shade and protect exposed portion of direct sunrays until exposed portion of water-stop is embedded in concrete.
- 10. Replace or repair, water-stops punctured or damaged before final acceptance of Work.
- 11. Seal bottom of each vertical water-stop to other cutoff systems.
- 12. Seal joints not requiring water-stop with mastic joint sealer.
 - a. Apply sealant materials in accordance with Manufacturer's recommendations.
- 13. Provide suitable guards to protect exposed projecting edges and ends of partially embedded water-stops from damage after concrete placement is complete.

3.3 Field Quality Control

- A. Provide ≥ 24 hours' notice to City's Representative for scheduling inspections.
- B. Remove and replace field joints exhibiting misalignment, bubbles, voids, inadequate bond, porosity, cracks, offsets and other defects which reduce resistance of Work to water penetration.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of steel reinforcement in concrete and masonry, including reinforcing bar, couplers, concrete inserts, wires, clips, supports, chairs, spacers, epoxy embedment, and other embedded accessories.
- B. Conform to Standard Specifications for Public Works Construction (Greenbook) §201-2.2, §302, and §303, applicable permits, and requirements herein.
- C. Refer to the following sections for Work not covered herein.
 - 1. Section 03 60 00 for requirements for non-shrink grout.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 10 00: Concrete Forming
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 09 90 00: Painting and Coating

1.3 System Description

- A. Furnish and install steel reinforcement including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

- B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Steel Reinforcement	Material Properties	ASTM A615	As required by City	City	Contractor
Steel Reinforcement Welding	Compliance with AWS D1.4	AWS D1.4	As required by City	City	Contractor
	Radiographic Testing	AWS D1.4	As required by City	City	Contractor

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. AASHTO M32 Steel Wire, Plain, for Concrete Reinforcement
 - 2. AASHTO M55 Test for Steel Welded Wire Reinforcement, Plain, for Concrete
 - 3. AASHTO M221 Steel Welded Wire Reinforcement, Deformed, for Concrete

4. ACI 117 Standard Tolerances for Concrete Construction Materials
5. ACI 315 Details and Detailing of Structural Reinforcement
6. ACI 318 Building Code Requirements for Reinforced Concrete
7. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
8. ASTM A497 Steel Welded Wire Reinforcement, Deformed, for Concrete
9. ASTM A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
10. ASTM A706 Low-Alloy Steel Deformed Bars for Concrete Reinforcement
11. ASTM A767 Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
12. ASTM A775 Epoxy-Coated Reinforcing Steel Bars
13. ASTM A934 Epoxy-Coated Prefabricated Steel Reinforcing Bars
14. ASTM A1064 Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
15. ASTM D3963 Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars.
16. AWS D1.4 Structural Welding Code – Reinforcing Steel
17. AWS D12.1 Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction
18. California Building Code (CBC)
19. CRSI MSP1 Concrete Reinforcing Steel Institute Manual of Standard Practice
20. SSPWC Standard Specifications for Public Works Construction (Greenbook) §201-2 “Reinforcement for Concrete”

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Working Drawings Concrete Reinforcing	Submit per Working Drawing requirements.	.
	Show bending diagrams, assembly diagrams, placing lists and drawings of reinforcing steel required per structural Shop Drawing requirements. Conform to ACI 315.	
	Placing diagrams shall show openings for architectural, mechanical, and electrical Work with appropriate reinforcing around openings.	
	Show actual bar lengths to nearest inch measured to intersection of tangent extensions of outside bar surface. Bar placement diagrams shall clearly show dimensions of bar spliced or lapped. Show location of couplers used with details of how they are installed in formwork.	
	Show locations of construction and expansion joints. Show locations of embedded items including anchor bolts, wall sleeves, conduit and piping which may conflict with steel reinforcing	
	After Shop Drawing acceptance, submit weight sheets, indicating pounds of reinforcing steel detailed and furnished with each bar cross-referenced to Working Drawings for payment purposes	
MANUFACTURER'S LITERATURE		
Product Data	Submit for mechanical couplers with ICBO test reports	
Installation Instructions	Submit written welding procedure for each type of rebar weld for each size of bar intended to be spliced by welding. (A mere statement that AWS procedures will be followed is unacceptable.)	
SAMPLES		
Material Samples Steel Reinforcing Bars	Submit from each heat of reinforcing steel 3'-long sample bars for #3-#5 bars and 5'-long sample bars for #6 bars and larger per the following schedule #4 bars – 2 bars per 2 tons delivered #5 bars – 2 bars per 3 tons delivered #6 bars – 2 bars per 4 tons delivered Sample quantities required if requested shall conform to SSPWC (Greenbook) §201-2.4 Submit for each type of welded splice upon City's Representative's request.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	If Contractor-furnished steel area exceeds area shown on Plans by >25%, submit calculations verifying required ductile response is maintained.	

SUBMITTAL	DESCRIPTION	
Test Record Transcripts	For each load of steel reinforcement delivered, submit Manufacturer's certified mill test report of chemical and physical properties of each melt of steel as needed to verify steel materials. Also, submit information needed to determine carbon equivalent of steel to be welded in accordance with AWS D1.4 and per test record transcript requirements.	
	If mill test reports are unavailable and steel quantity exceeds 5 tons, provide laboratory test to prove conformance with specified standards.	
	For epoxy-coated steel reinforcing, submit evidence plant is certified under CRSI Fusion-Bonded Epoxy Coating Applicator Plant Certification Program.	
CBC Chapter 17 Special Inspection Required Contractor Statement of Responsibility	Submit as required in CBC §1704	
Welder Qualification Certificates	Submit as specified in AWS D1.4 for welders performing welding of steel reinforcement. Also submit certifications of procedure qualifications for each welding procedure used.	

- B. Refer to Section 01 33 00 for definition of requirements for Working Drawings, Product Data, Installation Instructions, Test Record Transcripts, and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow CRSI recommendations included in Manual of Standard Practice for delivery, storage and handling of steel reinforcement.
- C. Bundle reinforcement and tag with suitable identification of quantity, grade, and size to facilitate sorting, placing and transport.
1. Tagging and identification requirements shall be identical for both shop- and field-fabricated reinforcing steel.
- D. Bars with kinks or bends not shown on shop drawings shall be removed from site.
- E. Bars with rust, scale, oil or other coatings that would reduce or destroy bond between concrete and steel shall be removed from site.
- F. Store reinforcement on blocks above ground to allow drainage below.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 – PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
REINFORCING BARS		
Steel Reinforcing Bars	Bellis Steel	Northridge, CA (818) 998-7865
	Interstate Rebar, Inc (IRI)	Ventura, CA (805) 643-6892
	R. R. Leonard Company	Santa Fe Springs, CA (562) 941-2288
	Accepted equal	
REINFORCING BAR SUPPORT AND COUPLING SYSTEMS		
Centralizers for Dowels Drilled into Existing Concrete	C&M Manufacturing Company "Duraflex"	Santee, CA (800) 458-6191
	Accepted equal	
	Sika - Greenstreak "Speed Dowel"	Lyndhurst, NJ (800) 325-9504

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Dowel System (alternate to slip dowels)	Accepted equal	
Mechanical Bar Couplers	Bar Splice Products, Inc. / FC Industries "Grip Twist"	Dayton, OH (937) 275-8700
	Dayton Superior "Dowel Bar Splicer System"	Miamisburg, OH (888) 977-9600
	Erico / Pentair "Lenton Form Saver A2"	Solon, OH (440) 349-2630
	Accepted equal	
Rebar Supports	Dayton Superior	Miamisburg, OH (888) 977-9600
	Durajoint Preco® Forming Accessories	Garrettsville, OH (888) 833-8308
	Accepted equal	
EPOXY GEL AND GROUT SYSTEMS		
Epoxy Adhesive Systems for Anchoring Rebar Dowels into Existing Concrete	Burke / Edoco "BurkEpoxy NS"	Long Beach, CA (310) 834-3401
	Concresive® LPL / BASF	Shakopee, MN (800) 433-9517
	Euco Euclid Chemical Co / RPM Epoxy 452	Cleveland, OH (800) 321-7628
	GCP (Grace Concrete Products) / Applied Technologies "Epoxtile 2391"	Cambridge, MA (617) 876-1400
	Hilti USA. "HIT-RE 5800V3	Tulsa, OK (800) 879-8000
	Pecora Corporation "Dynapoxy EP430 Fast"	Harleysville, PA (215) 723-6051
	Powers Fasteners, Inc. "Powers Pure 110+"	Brewster, NY (800) 524-3244
	Sika Corporation "Armatek 110 EpoCem" Epoxy Adhesive	Lyndhurst, NJ (800) 933-7452
	Simpson Strong Tie Co. Set-XP Epoxy-Tie Anchoring Adhesive	Pleasanton, CA (800) 535-5053
	W R Meadows Sealtight Poly-Grip®	Hampshire, IL (800) 342-5976
	Accepted equal	
REINFORCING BAR COATING SYSTEMS		
Epoxy-Coated Rebars	Obtain from plant certified under CRSI Fusion-Bonded Epoxy Coating Applicator Plant Certification Program.	
Rebar Anti-Corrosion Coating	Pecora Corporation	Harleysville, PA (215) 723-6051
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §201-2.2 for materials requirements for steel reinforcing for concrete.
- C. Furnish full-length reinforcement bars to extant practicable.
 1. Make splices as shown on Plans and accepted by City's Representative.
- D. Materials for steel reinforcement shall be:

ITEM	MATERIAL	SPECIFICATION
STEEL REINFORCEMENT		
Steel Bar Reinforcement	Steel	Conform to ASTM A615 Grade 60 Billet Steel Deformed Bars
Steel Bar Reinforcement - Welded	Low Alloy Steel	Conform to ASTM A706 Grade 60 Deformed Bars
Steel Bar Reinforcement - Galvanized	Galvanized Steel	Conform to ASTM A767 Grade 60 Billet Steel Deformed Bars
Steel Bar Reinforcement – Epoxy Coated	Epoxy-Coated Steel	Conform to ASTM A775 or ASTM A934 Grade 60 Color - Green
Steel Wire Reinforcement - Plain	Steel	Conform to ASTM A1064
Steel Wire Reinforcement - Deformed	Steel	Conform to ASTM A497, AASHTO M32, or AASHTO M221
REINFORCING BAR SUPPORT AND COUPLING SYSTEMS		

ITEM	MATERIAL	SPECIFICATION
Centralizers for Dowels Drilled into Existing Concrete	PVC	
Mechanical Couplers	Stainless Steel	
Tie Wire	Black Annealed Steel	16 gauge minimum
EPOXY GEL AND GROUT SYSTEMS		
Grout for Dowels Drilled into Existing Concrete	Non-Shrink Grout	Refer to Section 03 60 00.
	Epoxy Injection Grout	Refer to Section 03 64 23.

- E. Materials for bar supports, chairs or dobies shall conform to CRSI Manual of Standard Practice 1 Chapter 3 and shall be:

ITEM	MATERIAL	SPECIFICATION
Concrete Blocks (Dobies) (Do not use in slabs or walls less than 6" thick, or where architectural finish is to be applied.)	Concrete	Minimum 28-day compressive strength f'_c equal to that of concrete but ≥ 4000 psi. Embed wire ties in concrete block bar supports.
Plastic Bar Supports (Do not use on grade)	Plastic	CRSI Class 1 gray
Wire Bar Supports (Do not use in wastewater environments or environments exposed to continuous moisture, water or corrosion.)	Steel Wire	CRSI Class 1 (with $\frac{1}{8}$ "-thick gray plastic coating)

- F. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Mechanical Couplers	Positive-locking taper thread type Conform to requirements of ACI 318. Provide where shown on accepted Working Drawings. Couplers shall develop 125% of yield strength of reinforcement being spliced. Do not reduce bar cross section to accommodate couplers. Threaded couplers require use of next larger size of reinforcing. Supply all components needed for complete splice.
Welded Splices	Provide where shown on accepted Shop Drawings. Splices shall develop 125% of yield strength of reinforcement being spliced. Provide materials required to meet AWS D1.4.
Bending and Forming Bars	Conform to ACI 315, ACI 318 and CRSI MSP Manual of Standard Practice Fabricate to tolerances shown in ACI 117. Reinforcing for masonry shall be shop fabricated, ready for installation by masons.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install steel reinforcement before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Remove loose rust, mill scale, soil, mortar, oil and other foreign materials which might adversely affect bond with concrete.
- C. Protect reinforcement from moisture until concrete is placed around it.
- D. Coat ends of bars left projecting from concrete for more than one week with heavy coat of neat-cement grout.
- E. Do not place concrete until placing or reinforcing steel has been inspected and accepted.

3.2 **Installation**

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish, accurately position and install steel reinforcement at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. California Building Code Chapter 19 "Concrete" §1907 "Modifications to Reinforcement" and §1908 "Modifications to ACI 318"
 3. Other applicable building code requirements
 4. ACI 315 Details and Detailing of Structural Reinforcement
 5. ACI 318 Building Code Requirements for Reinforced Concrete
 6. ACI 350 Code Requirements for Environmental Engineering Concrete Structures
 7. Manufacturer's installation instructions and warranty requirements
 8. For epoxy-coated rebar, conform to ASTM D3963
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Minimum cover for non-pre-stressed steel reinforcement per ACI 318 and ACI 350 shall be as follows:

LOCATION	BAR SIZE	MINIMUM COVER
Concrete Cast Against and Permanently Exposed to Earth or Rock	#4- #18	3.0"
Formed Concrete Exposed to Weather, Liquid, Earth, or Rock	#3-#5	1.5"
	#6-#18	2.0"
Formed Concrete Not Exposed to Weather, Liquid, or Earth: Beams, Girders or Columns	#4- #18	2.0"
Formed Concrete Not Exposed to Weather, Liquid, or Earth: Slabs, Walls or Joists	#3-#11	0.75"
Concrete Exposed to Water or Wastewater	#4- #18	3.0"
Concrete Exposed to Saltwater	#4- #18	4.0"

- F. Terminate reinforcement 2" from concrete surfaces and expansion joints.
- G. Spacing between parallel bars per ACI 318 shall be $\geq 1.0"$ or 1 bar diameter, whichever is greater.
- H. Clear distance between parallel bars shall be as follows:
 1. Provide the following clear distances except in columns and between multiple layers of bars in beams:
 - a. $\geq$ nominal bar diameter
 - b. $\geq 1\frac{1}{3}$ x maximum coarse aggregate size
 - c. $\geq 1"$
 2. Where beam and column reinforcement is placed in 2 or more layers, clear distance between layers shall be $\geq 1"$.
 3. In columns, provide the following clear distances:
 - a. $\geq 1\frac{1}{2}$ x nominal bar diameter
 - b. $\geq 1\frac{1}{2}$ x maximum coarse aggregate size
 - c. $\geq 1\frac{1}{2}"$
 4. Clear distance between bars shall also apply to distance between contact splice and adjacent splices or bars.
- I. Installation of steel reinforcement bars shall proceed as follows:
 1. Install steel reinforcement to tolerances shown in ACI 117 and ACI 318 §7.5.

2. For environmental structures, install steel reinforcement to tolerances shown in ACI 117, and ACI 350 §7.5.
 3. Do not straighten or re-bend reinforcing steel in manner that might damage material.
 - a. Do not use bars with bends not shown on Plans.
 - b. Bends shall be cold-bent.
 - c. Do not heat bars to bend.
 4. Support and wire together reinforcing at sufficient intervals to prevent displacement during concrete placement and vibration.
 - a. Use annealed iron wire ties or clips at intersections.
 - b. Use concrete, plastic or metal supports, spacers or metal hangers.
 - c. Do not use wooden or aluminum supports.
 - d. Do not place rebars on layers of fresh concrete as Work progresses.
 - e. Do not tack weld reinforcing bars.
 5. Where concrete is placed against earth, use supporting concrete dobies in sufficient numbers to support bars without settlement, but in no case shall support be continuous.
 - a. Tie reinforcing steel to dobies with wire ties embedded in blocks.
 6. Where concrete is placed over formwork, furnish concrete, metal, plastic or other acceptable bar chairs and spacers.
 7. Place and space accessories used to support reinforcing bars such that deflections of supports due to weight of supported bars remains within tolerances specified by ACI 117 and ACI 318.
 8. Bar support methods shall leave no marks or impressions on finished concrete surfaces exposed to view.
 9. Tie bar reinforcement at intersections except where bar spacing is < 12 " in each direction, in which case alternate intersections shall be tied.
 - a. No tie wire shall remain within $1\frac{1}{2}$ " of concrete surface.
 - b. Bend tie wires away from forms to provide specified concrete cover.
 10. Where additional bars are provided by Contractor, they shall be provided at no additional cost to City unless City's preacceptance is evidenced by written Change Order issued prior to placing steel reinforcement.
 11. Move bars as necessary to avoid conflicts with other reinforcement steel, conduits or embedded items.
 12. Provide ≥ 1 " clear distance between steel reinforcement and anchor bolts or embeddings.
 13. If bars are moved by > 1 bar diameter or enough to exceed specified tolerances, secure acceptance from City's Representative before placing concrete.
 14. Provide additional reinforcing bars around sleeves and openings as shown on Drawings.
- J. Splices shall be made as follows:
1. Splicing shall conform to ACI 318 and applicable building codes.
 2. Splice by placing bars in contact and wiring together.
 3. Limit splicing to locations shown on accepted bending lists and Working Drawings.
 4. Stagger splices in adjacent reinforcing bars.
 5. Minimum distance between staggered lap splices or mechanical lap splices shall be same as lap length required for lap splice in longest bar.
 6. Do not provide splices within "No-Splice Zones shown on Plans.

7. Minimum lap length for non-pre-stressed steel reinforcement shall conform to ACI 318 and exceed the following minimums:

LOCATION	BAR SIZE	MINIMUM LAP LENGTH	
		CONCRETE	MASONRY
All Locations	#3	21"	21"
	#4	28"	28"
	#5	35"	35"
	#6	42"	42"
	#7	49"	49"
	#8	56"	56"
	#9	63"	63"
	#10	76"	76"
	#11	93"	93"

8. Minimum lap length for non-pre-stressed epoxy-coated steel reinforcement shall conform to ACI 318 and exceed the following minimums:

LOCATION	BAR SIZE	MINIMUM LAP LENGTH	
		CONCRETE	MASONRY
All Locations	#3	28"	28"
	#4	37"	37"
	#5	46"	46"
	#6	55"	55"
	#7	64"	64"
	#8	77"	77"
	#9	97"	97"
	#10	123"	123"
	#11	151"	151"

9. Minimum lap lengths are based on CRSI worst-case requirements for top-steel bars in 3000 psi concrete with clear distance $\geq 2"$ between splice and nearest bar.
- Contractor may submit alternate proposed lap lengths with Shop Drawings backed up by Engineering Calculations
10. Do not splice bars by lapping where clear distance $\geq 2"$ between splice and nearest bar cannot be provided
11. For bars of different sizes, lap length shall equal or exceed lap lengths specified for smaller bar size, and shall equal or exceed specified embedment lengths for the larger bar size.
12. Do not splice vertical bars in concrete, except at indicated or accepted horizontal construction joints, as detailed on Plans or Shop Drawings or as directed by City's Representative.
13. Do not splice horizontal bars in concrete, except as detailed on Plans or Shop Drawings or as directed by City's Representative.
14. Do not use mechanical couplers, except as detailed on Plans or Shop Drawings or directed by City's Representative.
15. Do not weld reinforcing bars smaller than #14 or #18, except as detailed on Plans or Working Drawings.
16. Welding, when permitted by City's Representative, shall conform to AWS 1.4 and shall be full-penetration butt-groove weld.
17. Welders, welding operators, and tackers shall be prequalified per AWS 1.4.
18. Welds shall use reinforcing bars conforming to ASTM A706.
- K. Drilling and dowelling of rebar into hardened concrete shall proceed as follows:
- Hole diameter shall be as recommended by epoxy Manufacturer but shall be at least double the embedded bar diameter.

2. Depth of hole shall be as recommended by epoxy Manufacturer, but shall not be less than 12 bar diameters, unless noted otherwise or unless required to prevent penetration through opposite surface of existing concrete member.
 3. Drill hole using methods that do not interfere with proper bonding of grout.
 4. Field locate reinforcement in existing concrete before drilling using pachometer or other accepted locator device.
 5. Adjust location of drilled holes to avoid drilling through or nicking existing reinforcing.
 6. Immediately before bar installation, wash drilled holes with air or water jet followed by compressed air jet to remove standing water from holes.
 7. Holes shall be damp but free of drill cuttings, standing water or debris.
 8. Fill hole halfway with epoxy or grout as shown
 9. Insert dowel in hole by rotating it at least one complete turn while tapping it down.
 10. If necessary, add more epoxy or grout to fill hole.
 11. Plug previously cleaned holes when nearby holes are being cleaned.
- L. Dry grouting of rebar into hardened concrete shall proceed as follows:
1. Install dowels and anchors before contamination of hole is possible.
 2. Use centralizers to center entire length of dowel in drilled hole.
 3. Install vertical dowels by filling hole with non-shrink grout, installing dowel and vibrating dowel to compact grout.
 - a. After installing dowels, grout in holes shall extend to concrete surface.
 4. Install horizontal dowels by first installing dowel and then injecting non-shrink grout through bolt, or by using grout tube extending to bottom of hole.
- M. Epoxy grout rebar into hardened concrete as follows:
1. Install dowels and anchors before contamination of hole is possible.
 2. Inject epoxy into hole through tube placed at bottom of hole.
 - a. Withdraw tube as epoxy is placed but keep injection tip immersed to prevent air pockets from forming.
 3. Fill hole to depth that ensures excess material will be expelled from hole during dowel placement.
 4. Twist dowels during insertion into partially filled hole to guarantee full wetting of bar surface with epoxy.
 - a. Insert bar slowly to prevent air pockets from forming.
- N. Treat rebar extending from previously placed concrete into new construction as follows:
1. Clean existing rebar and remove coatings which might reduce, or impair proper bonding with new concrete.
 2. Straighten or bend bars to conform to requirements shown on Plans.
 3. Repair damaged steel to remain in place by welding per AWS D12.1.
 4. Welds shall develop full bar strengths.

3.3 Field Quality Control

- A. Notify City's Representative when installation of steel reinforcement is complete and at least 24 hours prior to placing concrete.
- B. Where formwork will make reinforcement inaccessible for inspection, provide ≥ 24 hours' notice to City's Representative to allow them to inspect reinforcement installation before formwork is erected.
1. Allow City's Representative to inspect and accept reinforcement installation before placement of concrete.

C. Tolerances on placement of concrete reinforcement shall conform to ACI 117.

1. Measure clear distance from outside edge of longitudinal steel or stirrups, whichever is nearest to form.
2. Clear distance tolerance between outside edge of reinforcement and side forms and soffits shall be:

STEEL REINFORCING MEMBER SIZE (lesser of width, depth, or thickness)	TOLERANCE (allowable modification to specified cover)
$\leq 4"$	$+1/4", -3/8"$
$>4"$ and $\leq 12"$	$\pm 3/8"$
$>12"$ and $\leq 24"$	$\pm 1/2"$
$>24"$	$\pm 1"$

3. Reduction in cover at any location shall be $\leq 1/3$ x specified cover.
4. Reduction in cover at any location shall be $\leq 1/4"$ for beam soffits.
5. Distance between unbundled steel reinforcing bars at any location in beams or columns shall be $\geq 1"$ and ≥ 1 bar diameter.
6. Distance between flexural or longitudinal reinforcement at any location shall be within $\pm 1"$ of specified distance and shall not deviate from specified distance by $> \pm 1/4$ x distance specified or shown.
7. Distance between stirrups where used shall be within $\pm 1/12$ the depth of the flexural member.
8. Horizontal distance between flexural reinforcement in walls and slabs shall be within $\pm 3"$ of specified spacing at location.
 - a. Total quantity of bars shall not be less than shown or specified.
9. Bar laps for bars #11 or smaller shall be within $-1"$ of lap lengths specified or shown.
 - a. Bar lap may exceed lengths specified provided no spalling of adjacent concrete results.
10. Embedded bars #11 or smaller shall be embedded to within $-1"$ of embedded length specified or shown.
 - a. Embedment may exceed lengths shown or specified provided no spalling of adjacent concrete occurs.

D. Special inspection requirements for masonry rebar are itemized in Section 04 29 00.

E. Special inspection and field testing required by Chapter 17 of CBC (Table 1705.3) shall be completed by ICC-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Steel Reinforcement	Size Grade and Type	Compliance with Contract Documents	Periodic per CBC Table 1705.3	City	Contractor to reimburse City for costs of first deputy inspector if re- inspection required
	Verification of Weldability (for Steel Other than ASTM A706)	AWS D1.4, & ACI 318 / 350 §3.5.2	Periodic special inspection per CBC Table 1705.3	Contractor	
	Welding	AWS D1.4 & ACI 318 / 350 §3.5.2	Periodic per CBC Table 1705.3		
	Welding for Special Moment Frames, Boundary Elements of Special Reinforced Concrete Shear Walls and Shear Reinforcement	Also inspect for proper dimensions and absence of cracks, undercutting, surface holes or slag inclusions	Continuous per CBC Table 1705.3	Contractor	

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Reinforcement Placement Tolerances	ACI 117, ACI 318 / 350 §3.5, & §7.1-7.7 & CBC 1913.4 and criteria shown above	Periodic per CBC Table 1705.3	City	
	Butt-Weld Splices	Submit results of radiographic examinations with Certificate of Compliance Establish City-accepted radiograph identification and marking system before starting radiographic inspection.	25% of full- penetration butt- welded splices + 1 additional test on random City- selected splice for each defective weld found	Contractor	
Grouted Dowels and Anchors	Non-Shrink Grouted Dowels	CBC §1909	All dowels	Contractor	Contractor
	Epoxy Embedded Dowels	Epoxy Manufacturer's Requirements	All dowels	Contractor	Contractor

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of concrete for buried and above-ground cast-in-place structures, footings, foundations, flatwork, and paving.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 03 10 00 for concrete forming and for construction joint requirements.
 - 2. Section 03 15 00 for concrete accessories, including water-stops, construction joints, and cast-in-concrete anchors.
 - 3. Section 03 20 00 for steel reinforcing.
 - 4. Section 03 35 00 for concrete finishing.
 - 5. Section 03 39 00 for concrete curing.
- C. Refer to the following City of Corona Standard details.
 - 1. Standard Drawing 310 for concrete slope anchors.
- D. Conform to Standard Specifications for Public Works Construction (Greenbook) §203, §302, and §303, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 74 00: Cleaning and Waste Management
- I. Section 03 10 00: Concrete Forming
- J. Section 03 15 00: Concrete Accessories
- K. Section 03 20 00: Concrete Reinforcing
- L. Section 03 32 10: Cement Mortar
- M. Section 03 35 00: Concrete Finishing
- N. Section 03 39 00: Concrete Curing
- O. Section 03 60 00: Grout
- P. Section 05 05 19: Post-Installed Concrete Anchors
- Q. Section 07 92 00: Joint Sealants
- R. Section 09 90 00: Painting and Coating
- S. Section 31 23 00: Excavation and Fill

1.3 Definitions

- A. The following definitions apply:
 - 1. Hydraulic Structure: Environmental engineering concrete structures for containment, treatment, or transmission of water or other fluids.
- B. Refer to Section 03 10 00 for definitions of various types of construction joints in concrete.

1.4 System Description

- A. Furnish and install complete concrete structural system including appurtenant structural, mechanical and/or electrical mountings, embedments, or connections required for compliance with Manufacturer's installation requirements of other trades and compliance with applicable building codes and standards.

1.5 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Proportion mixes either by laboratory trial batch or field experience methods, using specified materials acceptable for each type of concrete required, and conforming to ACI 211.1.
- C. Factory (batch plant) testing of aggregate shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Aggregate	Ratio of Silica Released to Reduction in Alkalinity	ASTM C33	As directed	City	Contractor
	Loss with Sodium Sulfate	ASTM C33	As directed	City	Contractor
	Sieve Analysis	ASTM C136	1 each trial batch	City	Contractor
Coarse Aggregate	Abrasion Loss	ASTM C33	As directed	City	Contractor
Fine Aggregate	Sand Equivalent	ASTM D2419	As directed	City	Contractor
	Organic Impurities	ASTM C40	As directed	City	Contractor
	Color of Supernatant on Washing	ASTM C33	As directed	City	Contractor

- D. Plant testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Concrete	Certification of Mix Design	ACI 301 certified by independent testing laboratory	1 test each mix	Contractor	Contractor
Ready-Mix Concrete Materials	Materials Inspection	Refer to Paragraph in Part 2 below entitled "Materials"	As directed	City	City

1.6 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
1. ACI 117 Standard Tolerances for Concrete Construction Materials
 2. ACI 121 Quality Management System for Concrete Construction
 3. ACI 211.1 Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 4. ACI 211.5R Submittal of Concrete Proportions
 5. ACI 214 Evaluation of Strength Test Results for Concrete
 6. ACI 301 Structural Concrete for Buildings
 7. ACI 302 Concrete Floor and Slab Construction
 8. ACI 304 Measuring, Mixing, Transporting, and Placing Concrete
 9. ACI 305R Hot Weather Concreting
 10. ACI 309R Consolidation of Concrete
 11. ACI 315 Details and Detailing of Concrete Reinforcement
 12. ACI 318 Building Code Requirements for Reinforced Concrete
 13. ACI 350 Code Requirements for Environmental Engineering Concrete Structures

14. ACI SP2 Manual of Concrete Inspection
15. ASTM C31 Making and Curing Concrete Test Specimens in Field
16. ASTM C33 Concrete Aggregates
17. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens
18. ASTM C40 Organic Impurities in Fine Aggregates for Concrete
19. ASTM C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
20. ASTM C78 Flexural Strength of Concrete Using Simple Beam with Third Point Loading
21. ASTM C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
22. ASTM C94 Ready-Mixed Concrete
23. ASTM C117 Materials Finer than 75- μ m (#200) Sieve in Mineral Aggregates by Washing
24. ASTM C127 Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
25. ASTM C128 Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
26. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
27. ASTM C138 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
28. ASTM C143 Slump of Hydraulic Cement Concrete
29. ASTM C150 Portland Cement
30. ASTM C157 Length Change of Hardened Hydraulic Cement Mortar and Concrete
31. ASTM C172 Sampling Freshly Mixed Concrete
32. ASTM C173 Air Content of Freshly Mixed Concrete by Volumetric Method
33. ASTM C192 Making and Curing Concrete Test Specimens in Laboratory
34. ASTM C231 Air Content of Freshly Mixed Concrete by Pressure Method
35. ASTM C289 Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
36. ASTM C470 Molds for Forming Concrete Test Cylinders Vertically
37. ASTM C494 Chemical Admixtures for Concrete
38. ASTM C566 Total Evaporable Moisture Content of Aggregate by Drying
39. ASTM C881 Epoxy-Resin-Base Bonding Systems for Concrete
40. ASTM C932 Surface-Applied Bonding Compounds for Exterior Plastering
41. ASTM C1017 Chemical Admixtures for Use in Producing Flowing Concrete
42. ASTM C1064 Temperature of Freshly Mixed Hydraulic-Cement Concrete
43. ASTM C1077 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
44. ASTM C1602 Mixing Water Used in the Production of Hydraulic Cement Concrete
45. ASTM D75 Sampling Aggregates
46. ASTM D98 Calcium Chloride
47. ASTM D1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
48. ASTM D2419 Sand Equivalent Value of Soils and Fine Aggregate
49. ASTM D4791 Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
50. ASTM E119 Fire Tests of Building Construction and Materials
51. ASTM E1155 Determining FF Floor Flatness and FL Floor Levelness Numbers
52. California Building Code (CBC)
53. California Green Building Standards Code (CALGreen Code)
54. Caltrans Standard Specifications §90 Portland Cement Concrete
55. California Test Method 214 Soundness of Aggregates
56. California Test Method 217 Sand Equivalent
57. California Test Method 227 Cleanness Value
58. California Test Method 229 Durability
59. California Test Method 515 Relative Mortar Strength of Portland Cement Concrete Sand
60. California Test Method 530 Effect of Water-Reducing and Set-Retarding Admixtures on Drying Shrinkage of Concrete
61. CRD C143 Meters for Automatic Indication of Moisture in Fine Aggregate
62. CRD C521 Frequency and Amplitude of Vibrators for Concrete
63. NSF/ANSI 61 Drinking Water System Components – Health Effects
64. National Ready-Mixed Concrete Association (NRMCA) Quality Control Manual §3 Certification of Ready-Mixed Concrete Production Facilities - Plant Certification Check List
65. SSPWC Standard Specifications for Public Works Construction (Greenbook) §201 "Concrete, Mortar, and Related Materials"
66. SSPWC Standard Specifications for Public Works Construction (Greenbook) §302 "Roadway Surfacing"
67. SSPWC Standard Specifications for Public Works Construction (Greenbook) §303 "Concrete and Masonry Construction."
68. Standards for Operation of Truck Mixers and Agitators of the National Ready-Mixed Concrete Association

69. Truck Mixer and Agitator Standards of Truck Mixer Manufacturer's Bureau

1.7 Submittals

A. Furnish the following submittals in accordance with ACI 301 and California Building Code.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Concrete Operations QA/QC Plan	On City's request, submit QA/QC plan for concrete operations, including: 1. Contractor's Quality Assurance / Quality Control plan. 2. Concrete testing laboratory's testing and Quality Control manual describing sampling techniques, curing methods, and testing equipment use and calibration. 3. Sources of cement, SCMs, and aggregates. 4. Sources of electrical power and water. 5. Location of aggregate stockpiles, batching plant, and mixing plant. 6. Method and route for conveying batched concrete under expected weather conditions. 7. Method of conveying concrete within Work site. 8. Contingency plans to replace equipment in event of breakdown. 9. Methods to protect aggregate stockpiles from excessive moisture, or other contamination. 10. Methods to protect fresh concrete from environmental damage during conveyance, placement, and curing. 11. Methods to protect fresh and hardened concrete during hot weather conforming to ACI305R 12. Method and equipment used for consolidation 13. Method and equipment used for finishing, and curing 14. Contractor concrete quality control plan specific to concrete operations and conforming to ACI 121. Quality control plan shall include procedures to identify, investigate, and correct low compressive strength test results. QC measures shall include investigation of ongoing concrete operations, review of concrete materials, batching and mixing operations, and additional concrete compressive strength testing. QA/QC Plan for investigation of low concrete strength shall supplement and conform to procedures within ACI 301.	
DRAWINGS		
Working Drawings	Submit concrete lift drawings showing concrete placements and construction joint locations.	
	Submit 1/4" = 1' scale composite concrete placement drawings for each placement showing size and locations of embedded pipes, conduits, inserts, anchor bolts, openings, recesses, construction joints, and other embedded items.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for admixtures	
Installation Instructions	Submit for admixtures	
SAMPLES		
Product Samples	Provide mock-up for architectural finishes and colored or textured concrete. Construct 5 test panels, ≥6" deep and 2' by 4'. Construct panels using aggregates, cement, SCMs and admixtures to be used in concrete Work. Make first panel with pigment-free and stain-free concrete. Make successive panels with different weights of accepted pigment added, or types of stain applied to best match existing surfaces. Cure panels for 7 days prior to comparison with existing concrete. Place each concrete panel within onsite construction area and photograph to document color differences or similarities between natural or tinted panel and existing surfaces. Submit 3 copies of photos to City's Representative. Meeting will be arranged on-site to determine best color combination for concrete work. City's Representative may direct Contractor to adjust amount of pigment or stain to best match existing concrete.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificates of	Submit plant certification in accordance with NRMCA Quality Control Manual §3.	

SUBMITTAL	DESCRIPTION	
Compliance (Submit 45 days prior to start of structural concrete Work.)	Independent laboratory conforming to ASTM C1077 shall submit certification conforming to ACI 211.5R demonstrating mix designs conform to specifications based on tests using materials from sources used in Work.	
	Submit mill test certification, including fineness for each shipment of cement per ACI 301.	
	Submit cement certification per ASTM C150	
	Submit aggregate gradation and certification per ACI 301.	
	Submit certification aggregate material contains <1% asbestos by weight or volume.	
	Submit admixture certification including chloride ion content per ACI 301.	
Engineering Calculations (Mix Design)	Submit for concrete mix design per engineering calculations requirements sealed by California-licensed Civil Engineer.	
	Mix design shall show: 1. Mix identification number 2. Applicable proportions, weights and quantities of Portland cement, aggregate, water, admixtures, and sand 3. Size and source of concrete aggregates 4. Type and source of Portland cement 5. Brand and designation of chemical admixtures 6. Percent voids 7. Intended type of construction 8. Strength results	
	In addition to original mix design, provide new mix design if change in brand or type of cement or change in source or gradation of aggregates is permitted or if defective concrete occurs.	
Engineering Calculations (Thrust Block Design)	Submit sizing calculations for thrust and anchor block design where not detailed in Contract Documents. 1. Where details are not provided, design thrust blocks with sufficient gross weight and bearing area to withstand specified test pressures. 2. Use recommended bearing pressures in provided in geotechnical report. 3. Where geotechnical report does not stipulate allowable bearing pressure, design thrust blocks for 1500 psf bearing pressure. 4. Unless otherwise shown on Plans, provide bearing surface ≥ 3 times pipe diameter in all directions.	
Brand and Type of Cement/Source of Aggregate	Submit brand and type of cement and source of aggregates to allow sampling and testing by City's Representative.	
CBC Chapter 17 Special Inspection Required Contractor Statement of Responsibility	As required in CBC §1704	
Pre-Placement Inspection Forms	Submit certification from each trade having embedded items in concrete to be placed ≥ 24 hours before placing concrete.	
	Use form similar to that in ACI SP2.	
	Form shall certify preparation of surfaces to receive concrete, formwork, clean-up, and placement of reinforcing steel, electrical conduit, piping or other embedded items has been completed.	
	Work items shall be initialed and dated by each trade foreperson for each placement, stating embedded items for each trade are properly located, placed and braced and equipment pads are properly sized.	
Placement Foreperson's Report	Submit report listing: 1. Date and time of placement 2. Weather conditions 3. Ambient temperature 4. Work item 5. Volume of concrete placed 6. Method of placement 7. Concrete temperature	

SUBMITTAL	DESCRIPTION	
	8. Concrete Class, alternate class or special exposure mix designation,	
Test Results	Submit laboratory test results for fresh or hardened concrete within 1 Working Day following test completion. Verbally notify City's Representative of failing test results and remedial action being taken. Provide weekly written summary of testing and test results.	
Delivery Tickets	Submit for ready-mix concrete as needed to document delivery quantities. In accordance with ASTM C94 §16.1 and §16.2, each ticket shall show 1. Name of ready-mix batch plant, 2. Name of Contractor 3. Serial number of ticket, 4. State certified equipment used in preparing mix, 5. Truck number. 6. Name of purchaser & name & location of job 7. Mix number, 8. Concrete Class, alternate class or special exposure mix designation, 9. Quantities by weight of cement, sand, each class of aggregate, admixtures and water added in batching plant, including water in fine aggregates. Submit computer printout or compact disc showing information in conformance with ASTM C94. 10. Type, brand, and silo bin or storage unit number of cement, 11. Type, brand, and amount of admixtures, 12. Source & identification of aggregates, 13. Amount of water allowed to be added at site for specified mix, 14. Total yield in cubic yards, 15. Date & time of day to nearest minute corresponding to time batch was dispatched, time batch left plant, time batch arrived on site, time unloading began and time unloading was completed. 16. Reading of revolution counter at first addition of water 17. Provide space on certificate so amount of water added at Work site may be indicated. Certificates shall be from public weighmaster. City's Representative will not accept concrete in absence of certificate.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. In addition to requirements of ACI, refer to Section 01 33 00 for definition of requirements for Working Drawings, Product Data, Installation Instructions, Certificates of Compliance, Engineering Calculations, Test Record Transcripts, and Material Samples.

1.8 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of concrete and concrete admixtures.
- C. Handling shall not result in segregation, degradation, or combining of materials resulting in failure of materials to meet specifications.
- D. Storage of materials shall conform to ACI 301 and SSPWC (Greenbook).
- E. Immediately following delivery, store cement, SCMs, and materials in separate dry, weather-tight, ventilated structures designed to protect against moisture and contamination.
1. Properly mark structures to avoid accidental contamination.
- F. Remove contaminated cement or SCMs from site if rejected by City.
- G. Store sacked cement in manner permitting access for inspection and sampling.
- H. Use cement in sequence of receipt of shipments.

- I. Maintain air-entraining and water-reducing admixtures in uniform solution protected from freezing.
- J. Store fine aggregate on accepted base and maintain in manner to prevent inclusion of foreign materials.
 - 1. Do not operate equipment on storage piles.
 - 2. Deposit fine aggregate in storage and remove it in such manner as to increase uniformity of grading as much as possible.
- K. Coarse aggregate with maximum size $>\frac{3}{4}$ " shall be prepared, stored, and handled in 2 or more size groups.
 - 1. When aggregates are proportioned for each batch of concrete, combine the 2 size groups.
- L. Construct coarse aggregate storage piles on accepted base in manner to prevent contamination and to prevent segregation and excessive breakage.
 - 1. Use rock ladders of satisfactory design with conveying and handling systems for aggregate with particles $>1\frac{1}{2}$ " in size.
- M. Do not use aluminum or magnesium alloy materials for handling plastic concrete during mixing, transporting, or pumping.

1.9 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
CEMENT		
Cement – NSF 61-certified for structures holding potable water	CalPortland Company	Colton, CA (626) 852-6200
	Cemex	Ontario, CA (909) 322-7604
	Robertson Ready Mix Concrete	Corona, CA (951) 493-6500
	Superior Ready Mix LP	Escondido, CA (760) 745-0556
	Accepted equal	
BONDING AGENTS		
Epoxy Resin Portland Cement Bonding Agent (Hardened Concrete to Fresh Concrete)	Burke / Edoco "BurkEpoxy MV"	Long Beach, CA (310) 834-3401
	Concresive® LPL / BASF	Shakopee, MN (800) 433-9517
	Euco Euclid Chemical Co / RPM Epoxy 452	Cleveland, OH (800) 321-7628
	GCP (Grace Concrete Products) / Applied Technologies "Epoxitile 2391"	Cambridge, MA (617) 876-1400
	Pecora Corporation "Dynapoxy EP420"	Harleysville, PA (215) 723-6051
	Sika Corporation "Sikadur 32 Hi-Mod" or "Sikadur 32 Hi-Mod (LPL)" Epoxy Adhesive	Lyndhurst, NJ (800) 933-7452
	Sika Corporation "Armatek 110 EpoCem" Epoxy Adhesive	Lyndhurst, NJ (800) 933-7452
	W R Meadows Sealtight Poly-Grip®	Hampshire, IL (800) 342-5976
	Accepted equal	
Epoxy Grout Systems for Bonding Rebar Dowels into Existing Concrete	Refer to Section 03 20 00	

B. Use only 1 brand of cement.

C. Acceptable Manufacturers for admixtures include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
ADMIXTURES		
Admixtures – Dampproofing – Integral Hydrophobic Waterproofing (May be used as alternate to crystalline waterproofing)	BASF Hydrocide 600	Freeport, TX (979) 415-6100
	GCP (Grace Concrete Products) / Applied Technologies Darapel® series	Cambridge, MA (617) 876-1400
	Hycrete Inc. / Broadview Technologies	Carlstadt, NJ (866) 492-7383
	Accepted equal	
Type A Admixtures – Water-Reducing Agents (Normal Range)	Cemex Isoplast 1440	Ontario, CA (909) 322-7604
	Euco Euclid Chemical Co / Eucon WR91	Cleveland, OH (800) 321-7628
	GCP (Grace Concrete Products) / Applied Technologies, Inc "Daracem®"	Cambridge, MA (617) 876-1400
	GCP (Grace Concrete Products) / Applied Technologies, Inc "WRDA64"	Cambridge, MA (617) 876-1400
	GCP (Grace Concrete Products) / Applied Technologies, Inc "Zyla® 625"	Cambridge, MA (617) 876-1400
	Master Builders / BASF "Pozzolith 322-N"	Cleveland, OH (800) 628-9990
	Master Builders / BASF "MasterPozzolith® 700"	Cleveland, OH (800) 628-9990
	Sika Corporation "Plastocrete 161"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Type B Admixtures - Set Retarding Hydration Stabilizing Agents (Use when air temperature exceeds 80°F)	GCP (Grace Concrete Products) / Applied Technologies "Daratard 17"	Cambridge, MA (617) 876-1400
	Euco Euclid Chemical Co / Eucon Retarder	Cleveland, OH (800) 321-7628
	Master Builders / BASF "Pozzolith 300R"	Cleveland, OH (800) 628-9990
	Sika Corporation "Plastocrete"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Type D Admixtures – Water-Reducing and Set Retarding Hydration Stabilizing Agents (Use for large pours and placement)	Cemex Isoplast 1440	Ontario, CA (909) 322-7604
	GCP (Grace Concrete Products) / Applied Technologies, Inc "WRDA64"	Cambridge, MA (617) 876-1400
	GCP (Grace Concrete Products) / Applied Technologies, Inc "Recover"	Cambridge, MA (617) 876-1400

ITEM	MANUFACTURER	MANUFACTURER LOCATION
areas where extra time for finishing is needed)	GCP (Grace Concrete Products) / Applied Technologies, Inc "Zyla® 625"	Cambridge, MA (617) 876-1400
	Master Builders / BASF "MasterPozzolith® 700"	Cleveland, OH (800) 628-9990
	Accepted equal	
Type E Admixtures – Water-Reducing and Set Accelerating Agents	Euco Euclid Chemical Co / Accelguard® DSA	Cleveland, OH (800) 321-7628
	Accepted equal	
Type F or G Admixtures - High-Range Water-Reducing (High Range) (HRWRA) Plasticizers	Euco Euclid Chemical Co / Eucon 1037	Cleveland, OH (800) 321-7628
	GCP (Grace Concrete Products) / Applied Technologies "ADVA®"	Cambridge, MA (617) 876-1400
	Master Builders / BASF "Rheobuild 716 or Rheobuild 1000"	Cleveland, OH (800) 628-9990
	Sika Corporation "Sikament FF or Sikament 86"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Shrinkage Reducing Admixtures	Master Builders / BASF "MasterLife® SRA 035"	Cleveland, OH (800) 628-9990
	Accepted equal	

- D. Admixtures shall be compatible and furnished by 1 Manufacturer capable of providing qualified field service representation.

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Cement shall be clean and free from contaminants.
1. Do not use cement reclaimed from cleaning bags or leaking containers.
 2. Do not use lumpy cement.
- C. Materials for concrete structural systems shall be:

ITEM	MATERIAL	SPECIFICATION
Cement	Standard Brand Portland Cement	Conform to ASTM C150 Type II/V Modified Low Alkali/Sulfate Resisting Type III High Early Strength Type IV Low Heat of Hydration Type V Sulfate Resistant
		Also conform to ASTM C150 Table 2 optional requirements for false set and equivalent alkalis ($\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$ of $\leq 0.60\%$)
		Temperature of cement entering mixer shall be $\leq 160^\circ\text{F}$
		NSF 61-certified for potable water tanks where finished concrete will contact potable water, and NSF 61-certified cement is available within 25-mile radius of project site.
	Gradation	$\geq 85\%$ of cement by weight shall pass #325 screen.
	Source	Cement shall be from single source
Water	Blended Cement with Supplementary Cementitious Materials	Conform to ASTM C595 Type IP(MS) Portland-pozzolan cement and California Green Building Standards Code §A5.405.5 (See below). Conform to ASTM C595 Table 2 optional mortar expansion requirements. SCMs shall not exceed 25% of total weight of cementitious materials.
	Fresh, Clean, Clear Potable Water	Conform to ASTM C1602. $\text{TDS} \leq 1000 \text{ mg/l}$ Water shall not contain impurities causing change in time in setting of Portland cement $>25\%$ nor reduction of $f_c > 10\%$ compared with results obtained using distilled water

ITEM	MATERIAL	SPECIFICATION
Coarse Aggregate	Specification	Conform to ASTM C33 Class Designation 4M unless otherwise specified Nonreactive, clean, hard, durable, washed, uncoated material Gravel, crushed gravel, crushed rock or combination From pits acceptable to City's Representative Aggregate shall be of character to facilitate producing workable concrete mixture within limits of specified water content and slump.
		Rewash each coarse aggregate size range on rinsing screens with spray bars immediately before elevating into batching plant bins. Dewatering portion of rinsing screens shall be of sufficient length to remove excess free water from aggregate to provide coarse aggregate with uniform moisture content when delivered to batching equipment.
	Amount passing #200 Sieve per ASTM C117	≤ 0.5%
	Cleanness Value per California Test Method 227	≥ 75
	Percentage Wear per ASTM C131	Abrasion loss < 15% after 100 revolutions
		Abrasion loss < 52% after 500 revolutions
	Specific Gravity per ASTM C127	≥ 2.58
	% Elongated Particles per ASTM D4791	≤ 20% based on 3:1 dimensional ratio
	Ratio of Silica Released to Reduction in Alkalinity	≤ 1.0
	Reactivity	Nonreactive when tested per ASTM C289 and evaluated per ASTM C33 Appendix X1
	Source	Coarse aggregate shall be from single source for each size range
Fine Aggregate	Specification	Conform to ASTM C33 requirements Nonreactive, clean, hard, durable, washed material From pits acceptable to City's Representative Aggregate shall be of character to facilitate producing workable concrete mixture within limits of specified water content and slump.
	Fineness Modulus	2.75 ± 0.20 per ASTM C136
	Organic Impurities per ASTM C40	Satisfactory Resultant color of testing solution shall not be darker than ASTM C40 standard
	Free Moisture Content	≤ 8% at time of batching
	Mortar Strength Relative to Ottawa Sand per California Test Method 515	≥ 100%
	Sand Equivalent per California Test Method 217	> 75 average for 3 samples > 70 for any 1 sample
	Fineness Modulus	≤ 3.0
	Percent Clay, Silt, Loam per ASTM C117	< 12% passing #200 sieve
	Soundness per California Test Method 214	< 10% Soundness requirement will be waived if durability index D_r > 60 per California Test Method 229.

ITEM	MATERIAL	SPECIFICATION
	Ratio of Silica Released to Reduction in Alkalinity	<1.0
	Specific Gravity	≥2.60 bulk saturated surface-dry basis per ASTM C128 Lightweight sand not permitted
	Reactivity	Nonreactive when tested per ASTM C289 and evaluated per ASTM C33 Appendix X1
	Source	Fine aggregate shall be from single source
Lightweight Aggregate		Conform to ASTM C330 all-lightweight (110 pcf) / sand-lightweight (115 pcf) aggregate
Surface-Applied Bonding Agent	Surface-Applied Bonding Compound	Conform to ASTM C932
Epoxy Bonding Agent	Epoxy Resin	Conform to ASTM C881
Ready-Mix Concrete		Conform to ASTM C94
Curing Materials		Refer to Section 03 39 00

- D. Concrete aggregate gradations designated by letter shall be. (Refer to Standard Specifications for Public Works (Greenbook) Table 201-1.3.2).

PERCENTAGE PASSING SIEVES BY WEIGHT						
SIEVE SIZE	GREENBOOK GRADINGS					
	GRADING A (For concrete street paving not integral with curb)	GRADING B (For concrete channel and box inverts)	GRADING C (For Class AA, A, A2 or B concrete not used for paving or channel or box inverts. May be used for Class C Concrete)	GRADING CSP (For pumped Class AA, A, A2 or B concrete not used for paving or channel or box inverts. May be used for Class C Concrete)	GRADING D (May be used for Class B extruded curbs and gutters or for gunite)	GRADING E (May be used for pumped concrete, trench backfill, slurry and masonry grout.)
2"	100%	100%				
1½"	95-100%	95-100%	100%	100%		
1"	64-80%	80-96%	95-100%	98-100%		
¾"	55-71%	64-80%	77-93%	85-98%	100%	100%
⅝"	37-53%	40-52%	50-70%	67-80%	92-100%	90-100%
#4	32-42%	35-46%	39-51%	46-65%	42-60%	60-80%
#8	25-35%	28-38%	31-41%	38-54%	33-47%	50-70%
#16	18-28%	21-31%	22-32%	27-40%	22-38%	33-53%
#30	10-18%	10-20%	12-22%	15-27%	17-25%	19-35%
#50	3-9%	3-10%	3-15%	3-15%	6-15%	5-15%
#100	0-4%	0-4%	0-5%	0-7%	1-6%	2-7%
#200	0-2%	0-2%	0-2%	0-3%	0-3%	0-4%

- E. Regulate amount of water added at mixer to consider free water in aggregates (total water less water absorbed by aggregate in saturated surface-dry condition).

1. Amount of water shall not exceed amount needed to permit concrete placement and consolidation, nor amount shown below. (Refer to Standard Specifications for Public Works (Greenbook) Table 201-1.3.3).

ALLOWABLE WATER (LBS/CY)					
AGGREGATE GRADING	WORKING LIMIT SLUMP (inches)				
	1"	2"	3"	4"	5"
A	≤270pcf	≤280pcf	≤290pcf	≤300pcf	≤310pcf
B	≤275pcf	≤285pcf	≤295pcf	≤305pcf	≤315pcf
C	≤290pcf	≤300pcf	≤310pcf	≤320pcf	≤330pcf
CSP	≤290pcf	≤300pcf	≤310pcf	≤320pcf	≤330pcf
D	≤320pcf	≤335pcf	≤350pcf	≤365pcf	≤375pcf
E	≤335pcf	≤350pcf	≤365pcf	≤380pcf	≤395pcf

F. City's Representative may direct water quantities be reduced if concrete slump exceeds working limit slump.

1. Concrete consistency shall be uniform from batch to batch.
2. Do not add water to compensate for stiffening of concrete if held too long before placement.

G. Materials for admixtures shall be:

ITEM	MATERIAL	SPECIFICATION
Admixtures	General Requirements	Admixtures shall be compatible with ingredients in concrete mixture. Dispense in liquid form in quantities within $\pm 5\%$ of specified quantities Do not use admixtures to reduce cement requirement Do not use calcium chloride or other chloride-based accelerators in concrete having steel reinforcing or embedments. Shall be free from thiocyanates Chloride ion $< 0.05\%$
Type A Admixtures – Water-Reducing Agents (Normal Range)		Conform to ASTM C494 Type A Dosage shall be maximum recommended by admixture Manufacturer based on weight of cement For concrete encasement around electrical raceways, use liquid-form hydroxylated carboxylic acid to facilitate workability without mechanical vibration. Use only 1 water-reducing admixture per mix.
Type B Admixtures - Set Retarding Hydration Stabilizing Agents (Use when air temperature exceeds 80°F)		Conform to ASTM C494 Type B
Type D Admixtures – Water-Reducing and Set Retarding Hydration Stabilizing Agents (Use for large pours and placement areas where extra time for finishing is needed)		Conform to ASTM C494 Type D Dosage shall be maximum recommended by admixture Manufacturer based on weight of cement. Use only 1 water-reducing admixture per mix.
Type E Admixtures – Water-Reducing and Set Accelerating Agents		Conform to ASTM C494 Type E Use only 1 water-reducing admixture per mix.
Type F or G Admixtures - High-Range Water-Reducing (High Range) (HRWRA) Plasticizers		Conform to ASTM C494 Type F or G Use only 1 water-reducing admixture per mix.
Plasticizing Agents		Conform to ASTM C1017
Type S Admixtures - Specific Performance (SPA)		Conform to ASTM C494 Type S

H. Supplementary Cementitious Materials (SCM's) shall consist of:

ITEM	MATERIAL	SPECIFICATION
Fly Ash and other SCM's (Conform to California Green Building Standards Code §A5.405.5 using supplementary cementitious materials (SCM's))	Class F Fly Ash (Use where sulfate resistant concrete is required.)	Shall not exceed 25% of total weight of cementitious materials / Not permitted
		Conform to ASTM C618 Class F
		Loss of ignition $\leq 4\%$
		SO_3 content $\leq 3\%$
		Moisture content $\leq 1\%$
		$\leq 20\% CaO$
		$\leq 15\%$ of total cementitious material by weight
		Fly ash shall be from single source

ITEM	MATERIAL	SPECIFICATION
	Class C Fly Ash (Do not use where sulfate-resistant concrete is required.)	Conform to ASTM C618 Class C
		Loss of ignition $\leq 2\%$
		SO ₃ content $\leq 4\%$
		Moisture content $\leq 1\%$
		$\leq 30\%$ of total cementitious material by weight
		Fly ash shall be from single source
	Ultra Fine Fly Ash (UFFA)	Conform to ASTM C618
		$\leq 12\%$ of total cementitious material by weight
		Fly ash shall be from single source
	Class N Pozzolan (includes diatomaceous earths, opaline cherts and shales, tuffs and volcanic ashes or pumicites, (calcined and uncalcined), and materials requiring calcination to induce satisfactory properties such as some clays and shales)	Conform to ASTM C618 Table 3 $\leq 20\%$ of total cementitious material by weight
	Slag Cement (GGBFS)	Conform to ASTM C989
	Silica Fume	Conform to ASTM C1240
	Metakaolin	Conform to ASTM C618
	Blended Cement	Conform to ASTM C595 or ASTM C1157
	Mix Design Equation	Use any combination of 1 or more SCM's satisfying equation $F/25 + SL/50 + UF/12 = 1$ where F = % of fly ash or pozzolan in mix, SL = % slag cement in mix and UF = % silica fume, metakaolin or UFFA in mix)

I. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Class AA "Premium" Concrete Greenbook 680-CW-5000 or 680-CFW-5000 (Use for box culverts, vaults and bridge top decks, and for prestressed concrete such as core walls)	f'_c	≥ 5000 psi per ASTM C39 at 28 days
	Portland Cement Content	680-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥ 680 lb cementitious materials per cubic yard (578 lb Portland cement + 102 lb SCMs) but ≤ 700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤ 0.40 by weight
	Aggregate	SSPWC (Greenbook) Grading C
	Maximum Aggregate Size	$\leq 1\frac{1}{2}"$ / $\leq 1"$ for water retaining structures
	Slump Working Limit	$\leq 4"$ average of all tests per ASTM C143
	Slump Rejection Limit	$\leq 5\frac{1}{2}"$ on any test per ASTM C143
	Air Content	4%-7% per ASTM C231 / $\leq 2\%$ per ASTM C231 for water retaining structures
	Water-Reducing Admixture	Required. Dosage shall be maximum recommended by admixture Manufacturer based on total weight of cementitious

ITEM	DESCRIPTION	
Class A "Structural" Concrete Greenbook 600-CW-4000 or 600-CFW-4000 (Use for foundations, footings, ring walls, retaining walls, slabs on grade, beams, columns, walls, roof and floor slabs, and other structural concrete.)		material (cement + SCM's)
	Maximum Transit Time	≤60 minutes (≤250 revolutions)
	f_c	≥4000 psi per ASTM C39 at 28 days
	Portland Cement Content	600-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥600 lb cementitious materials per cubic yard (510 lb Portland cement +90 lb SCMs) but ≤700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤0.45 by weight
	Aggregate	SSPWC (Greenbook) Grading C
	Maximum Aggregate Size	≤1½" / ≤1" for water retaining structures
	Slump Working Limit	≤4" average of all tests per ASTM C143
	Slump Rejection Limit	≤5½" on any test per ASTM C143
	Air Content	4%-7% per ASTM C231 / ≤2% per ASTM C231 for water retaining structures
	Water-Reducing Admixture	Required. Dosage shall be maximum recommended by admixture Manufacturer based on total weight of cementitious material (cement + SCMs)
	Maximum Transit Time	≤60 minutes (≤250 revolutions)
Class AP Pumped "Structural" Concrete Greenbook 600-EW-4000 or 600-EFW-4000 (Use for foundations, footings, ring walls, retaining walls, slabs on grade, beams, columns, walls, roof and floor slabs, and other structural concrete where concrete pumping is accepted by City's Representative.)	f_c	≥4000 psi per ASTM C39 at 28 days
	Portland Cement Content	600-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥600 lb cementitious materials per cubic yard (510 lb Portland cement +90 lb SCMs) but ≤700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤0.55 by weight
	Aggregate	SSPWC (Greenbook) Grading E
	Maximum Aggregate Size	≤1½"
	Slump Working Limit	≤4" average of all tests per ASTM C143
	Slump Rejection Limit	≤5½" on any test per ASTM C143
	Air Content	4%-7% per ASTM C231
	Water-Reducing Admixture	Required. Dosage shall be maximum recommended by admixture Manufacturer based on total weight of cementitious material (cement + SCMs)
	Maximum Transit Time	≤60 minutes (≤250 revolutions)
Class A2 "Structural – No Special Inspection" Concrete Greenbook 600-C-2500, 600-CW-2500 or 600-CFW-2500 (Use for pads and minor structures where City elects to waive CBC Special	f_c	≥2500 psi per ASTM C39 at 28 days
	Portland Cement Content	600-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥600 lb cementitious materials per cubic yard (510 lb Portland cement +90 lb SCMs) but ≤700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum	≤0.45 by weight

ITEM	DESCRIPTION	
Inspection requirements.)	Water/Cement Ratio	
	Aggregate	SSPWC (Greenbook) Grading C
	Maximum Aggregate Size	≤1½"
	Slump Working Limit	≤4" average of all tests per ASTM C143
	Slump Rejection Limit	≤5½" on any test per ASTM C143
	Air Content	4%-7% per ASTM C231
	Water-Reducing Admixture	Optional for 100% Portland Cement Required if SCMs are used
	Maximum Transit Time	≤60 minutes (≤250 revolutions)
Class B3 "Site Paving" Concrete (Use for curbs, gutters, sidewalks, aprons, and non-vehicular paving.) Greenbook 520-C-2500 or 494-CFW-2500	f'_c	≥2500 psi per ASTM C39 at 28 days
	Portland Cement Content	520-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥494 lb cement per cubic yard (420 lb Portland Cement + 74 lb SCMs) but ≤700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤0.55 by weight
	Aggregate	SSPWC (Greenbook) Grading C
	Maximum Aggregate Size	≤2"
	Slump Working Limit	≤4" average of all tests per ASTM C143
	Slump Rejection Limit	≤5½" on any test per ASTM C143
	Air Content	4%-7% per ASTM C231
	Water-Reducing Admixture	Optional
	Maximum Transit Time	≤90 minutes
Class B4 "Site Paving" Concrete (Use for extruded curbs and gutters.) Greenbook 520-D-2500 or 494-DFW-2500	f'_c	≥2500 psi per ASTM C39 at 28 days
	Portland Cement Content	520-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥494 lb cement per cubic yard (420 lb Portland Cement + 74 lb SCMs) but ≤700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤0.55 by weight
	Aggregate	SSPWC (Greenbook) Grading D
	Maximum Aggregate Size	≤¾"
	Slump Working Limit	≤2" average of all tests per ASTM C143
	Slump Rejection Limit	≤3½" on any test per ASTM C143
	Air Content	4%-7% per ASTM C231
	Water-Reducing Admixture	Optional
	Maximum Transit Time	≤90 minutes

ITEM	DESCRIPTION	
	Time	
Class C "Utility" Concrete (Use for encasement, thrust blocks, and fence and guardrail posts.) Greenbook 500-C-2500 or 475-CFW-2500	f_c	≥ 2500 psi per ASTM C39 at 28 days
	Portland Cement Content	500-700 lb cement per cubic yard
	Alternate Cementitious Material Content (15% SCMs)	≥ 475 lb cement per cubic yard (404 lb Portland Cement + 71 lb SCMs) but ≤ 700 lb cementitious materials per cubic yard (595 lb Portland Cement + 105 lb SCMs)
	Maximum Water/Cement Ratio	≤ 0.55 by weight
	Aggregate	SSPWC (Greenbook) Grading C
	Maximum Aggregate Size	$\leq 1\frac{1}{2}"$
	Slump Working Limit	$\leq 5"$ average of all tests per ASTM C143
	Slump Rejection Limit	$\leq 6\frac{1}{2}"$ on any test per ASTM C143
	Air Content	3%-7% per ASTM C231
	Water-Reducing Admixture	Optional
	Maximum Transit Time	≤ 90 minutes
Class D "Slurry Backfill" Concrete (Use for trench backfill.) Greenbook 94-E-100	f_c	≥ 100 psi per ASTM C39 at 28 days
	Portland Cement Content	≥ 94 lb Portland cement per cubic yard
	Maximum Water/Cement Ratio	≤ 0.60 by weight
	Aggregate	$\leq \frac{3}{4}"$
	Maximum Aggregate Size	SSPWC (Greenbook) Grading E
	Slump Working Limit	$\leq 5"$ average of all tests per ASTM C143
	Slump Rejection Limit	$\leq 6\frac{1}{2}"$ on any test per ASTM C143
	Air Content	3%-7% per ASTM C231
	Water-Reducing Admixture	Optional
	Maximum Transit Time	≤ 120 minutes
Reinforcing Steel	f_y	60 ksi Refer to Section 03 20 00.
Additional Requirements for Concrete to which Floor Hardener Is to Be Applied	Slump	$< 4"$, except where ambient temperatures are $< 65^\circ\text{F}$, use slump $< 3"$.
	Air Content	$< 3\%$ per ASTM C231
	Other Requirements	Do not use set-accelerating admixtures containing calcium chloride. Do not use admixtures that increase bleeding.

- J. With addition of high range water reducer, slump shall be 7" +/- 2".
- K. Materials furnished for Work shall conform to ACI 301 §201, §203, and §204 as applicable.
- L. Where adverse conditions affect concrete placement, City's Representative may authorize greater slump, provided cement is increased.
 - 1. Add water at ratio $\leq 32\%$ (by weight) of added cement per cubic yard.
 - 2. Provide additional water and cement at Contractor's expense.
- M. Design concrete mix to meet properties and proportions specified.

1. Design mix to minimize shrinkage, surface flaws, honeycombing and rock pockets around steel reinforcing.
2. Limiting parameters specified are not intended to be mix design.
3. Additional cement or water-reducing agent may be required to achieve workability demanded by Contractor's methods and aggregates.
4. Contractor is responsible for costs associated with furnishing concrete with required workability, density and strength.
5. Percentage of sand of total weight of fine and coarse aggregate shall be $\leq 50\%$.

2.3 Mixes

- A. Proportioning shall conform to ACI 301 Chapter 3 "Proportioning," and the following:
 1. Charge weigh hoppers from bins located directly over them or from conveyor belts. When conveyor belts are used, provide separate belt for each aggregate size.
 - a. Install moisture meter accurate to $\pm 1.0\%$ to indicate moisture in fine aggregate.
 2. Weigh bulk cement in individual hoppers and keep separate from aggregates until ingredients are released for discharge.
 - a. Attach cement hopper to separate scale for individual batch weighing.
 3. Measure amount of water into mixing drum through valve with positive cutoff.
 - a. When water is weighed, weigh water on separate scale.
 4. Add admixtures separately to concrete mixer during batching.
 5. Measure cement and aggregate using direct weighing equipment acceptable and accessible to City's Representative.
 6. Scales shall be springless dial type, multiple-beam type, or solid-state digital strain-gauge transducers.
 7. Scale gradations shall be as follows:
 - a. Aggregate scales ≤ 25 lbs
 - b. Cement scales ≤ 5 lbs
 - c. Water scales ≤ 5 lbs
 8. For multiple-beam scales, provide indicator operated by main beam giving visible evidence of over or under weight.
 - a. Indicator design shall allow operation during addition of last 400 lbs of any weighing.
 - b. Over-travel of indicator hand shall be $\geq \frac{1}{3}$ of loading travel.
 - c. Enclose indicators against moisture and dust.
 9. Insulate weighing equipment against vibration and movement of other operating plant equipment.
 - a. When plant is running, scale reading at cutoff shall not vary from designated weight by $>1\%$ for cement, 1% for water, $1\frac{1}{2}\%$ for any aggregate size, and 1% for total aggregate in any batch.
 10. Tolerances of measurement equipment shall be:
 - a. Cement: Use weighing equipment accurate to $\pm 1\%$ of total weight
 - b. Aggregate: Use weighing equipment accurate to $\pm 3\%$ of total weight
 - c. Admixtures: Use weighing equipment accurate to $\pm 3\%$ of total weight
 - d. Water: Use metering equipment accurate to $\pm 3\%$ of total volume
- B. Water quantity shall be just sufficient to produce workable batches of concrete which can be worked into place without segregation or other flaws and compacted using vibratory methods to provide desired density, impermeability, and smoothness of surface.
 1. Adjust water quantity added if needed to adjust for variations in moisture content of aggregate while providing uniform consistency between batches.

2. Determine consistency of batches by slump testing as described below.
 3. Water feed control mechanism shall be capable of being locked in position to deliver constant flow of water to each batch of concrete.
- C. Apply admixtures according to Manufacturer's installation and warranty requirements.
1. Dispense admixtures in liquid form, ensuring quantity dispensed falls within 5% of specified quantity.
- D. Set-controlling and water-reducing admixtures shall be applied as follows:
1. Use or addition of admixtures shall be at Contractor's option to increase workability and shall result in no increase in cost to City.
 2. Use or addition of admixtures shall be subject to acceptance by City's Representative.
 3. Concrete containing admixture shall be first placed at location determined by City's Representative.
 4. Add high range water-reducing admixtures to concrete on site after all other ingredients have been mixed and initial slump has been verified.
 - a. Do not use > 14 ounces of water reducer per sack of cement.
 - b. Water reducer shall be considered as part of mixing water when calculating water cement ratio.
 5. If high-range water reducer is added to concrete on site, it may be used in conjunction with same water reducer added at batch plant.
 - a. Concrete shall have slump of 3" $\pm 1/2$ " before adding high range water-reducing admixture at job site.
 6. Accurately measure high-range water-reducing admixture and pressure inject into mixer as single dose by experienced technician.
 - a. Provide and test standby system before each day's operation of job site system.
 7. Mix concrete at mixing speed for ≥ 30 mixer revolutions after adding high-range water reducer.
- E. Do not retemper partially hardened concrete.
- F. On-site batching and mixing equipment, if provided, shall conform to the following:
1. Provide automatic, computer controlled system conforming to CPMB 100 and certified by NRMCA.
 2. Batching equipment and scales conform to ASTM C 94.
 3. Batching plant, mixing plant, and concrete handling equipment capacity shall be ≥ 100 cubic yards per hour.
 4. Unless otherwise accepted, mix concrete in stationary mixers.
 5. Equipment shall be capable of combining aggregate, cement, SCMs, admixtures, and water (ice) into uniform mixture within specified time limit, and shall discharge mixtures without segregation.
 6. Plant shall have means of identifying and routing each mix to proper placement without error.
 7. Protect weighing, indicating, recording, printing, and control equipment against exposure to dust and weather.
 8. Batching plant shall be interlocked such that:
 - a. No batching equipment may be started until all batchers are emptied, and batcher discharge gates and valves are closed
 - b. Batchers discharge gate shall not open until correct weights of materials are in batching hoppers and scales are in balance

- c. Batchers discharge gates shall not close until materials are entirely discharged from hopper and scales are back in balance.
 - d. When water is weighed, water valve shall interlock so that discharge valve cannot be opened until filling valve is closed.
 - e. Interlock admixture dispensers to operate with water or fine aggregate batchers.
9. Plant shall include rinsing screens for coarse aggregate and means for handling wash water.
10. Plant shall be capable of ready adjustment to compensate for varying moisture content of aggregates and to change weights of materials being batched.
- a. Provide electric moisture meter conforming to CRD C143 to measure moisture in fine aggregate.
 - b. Arrange sensing element so measurement is made near batcher charging gate of sand bin or in sand batcher.
11. Print batch tickets or store on properly identified CD's (one CD for each production day) for each concrete batch produced for Work.
- a. Batch tickets shall contain information required by ASTM C94 for certification.
 - b. Batch tickets and electronic files shall be City's property.
 - c. City's Representative may require printouts of any batch ticket during concrete production.
12. Suitable facilities shall be provided for obtaining representative samples of each size aggregate, cement, and SCMs, as batched, for testing purposes.
- a. Provide necessary platforms, tools, equipment, and devices for obtaining samples.
13. Mixing plant shall consist of batch type mixers, each with a rated capacity of ≥ 1 cubic yard of mixed concrete.
- a. Equip mixing plant with suitable devices for obtaining representative samples from each mixer and delivering samples to a test area at ground level.
14. Do not charge mixers in excess of capacities recommended by Manufacturer.
- a. Operate mixers at Manufacturer's designated drum or mixing blade speed.
 - b. Maintain mixers in satisfactory operating condition.
 - c. Keep mixer drums free of hardened concrete.
15. Locate plant operator's platform so mixing action in at least 1 mixer and discharge of concrete into receiving hopper from all mixers can be easily observed.
16. Minimum mixing time for each batch, after all solid materials are in mixer drum and with mixing water introduced before $\frac{1}{4}$ of elapsed mixing time, shall be:

MIXER CAPACITY (CUBIC YARDS)	MINIMUM MIXING TIME
<2cy	1½ minutes
2-3cy	2 minutes
3-4cy	2½ minutes
>4cy	1½ minutes for first cubic yard and 15 seconds for each additional cubic yard

17. Perform concrete uniformity tests in accordance with ASTM C94 on each mixer at minimum mixing time.
- a. Contractor may use mixing time less than minimum specified mixing time if uniformity tests at reduced mixing time conform to ASTM C94 Table A1.1.
 - b. Discontinue use of mixers producing unsatisfactory until mixer is repaired or replaced.
18. Equip each mixer with electronic timing and control which will not permit mixer to be discharged until completion of required mixing time.

19. Equip each mixer with consistency meter providing reliable continuous indication of concrete consistency within mixer.
 - a. Sensitivity of consistency meter shall allow $\frac{1}{2}$ " change in slump to be discernable to operator.
 - b. Meter range shall be sufficient to include slumps as low as 1".
20. Batch and mixing plant shall have means for readily wasting materials or concrete that are improperly batched, mixed, or held in mixer too long.
21. Provide facilities at batching and mixing plant for concrete control testing.
 - a. Facilities shall include plant inspector's enclosure or shack and means for obtaining and handling samples of aggregates and plastic concrete.
 - b. Floor shall be 10' x 12' in area, and free of vibration.
 - c. Provide utilities (heat, air conditioning, electricity, air, and water) as required.
- G. Mixing shall conform to of ACI 301 Chapter 7 "Mixing".
- H. Ready mixed concrete shall conform to ASTM C94.
- I. Conveying equipment shall conform to the following:
 1. Conveying equipment shall have sufficient capacity so concrete is kept plastic and free of cold joints while concrete is placed.
 2. Convey concrete from mixer to forms as rapidly as practicable, using methods preventing segregation or loss of ingredients.
 3. Provide telephone or other means of voice communication between mixing plant and concrete forms.
 4. Concrete transferred from 1 conveying device to another shall be passed through conically-shaped hopper and shall not be dropped vertically, in unconfined condition, > 5', except where suitable equipment is provided to prevent segregation and where accepted by City's Representative.
- J. Transit mixing shall conform to ASTM C94 and the following:
 1. Transport and deliver ready-mixed concrete to site using agitating equipment.
 - a. Do not use non-agitating equipment or combination truck and trailer equipment to transport or deliver ready-mixed concrete.
 2. Deliver ready-mixed concrete to site and complete discharge within "maximum travel time" specified above after addition of cement to aggregates.
 - a. Also, deliver mixed concrete to site and complete discharge before drum has been revolved specified maximum number of revolutions.
 3. Transit mixers shall conform to "Standards for Operation of Truck Mixers and Agitators of National Ready-Mixed Concrete Association" and "Truck Mixer and Agitator Standards of Truck Mixer Manufacturer's Bureau."
 4. Transit mixers shall have electrically actuated counters to record number of revolutions of drum or blades.
 - a. Counter shall be resettable recording type, and shall be mounted in driver's cab.
 - b. Counters shall be actuated at time of starting mixers at mixing speeds.
 5. Mixers and agitators in transit mixers shall have metal plate or plates installed by mixer manufacturer in prominent place showing mixer manufacturer's designated drum volume capacity, speed of rotation for agitating, and mixing speeds of mixing drum or blades.
 6. Transit mixers shall have identification number painted on mixer that can be easily read from batching platform.
 7. Volume of concrete introduced into mixer shall not exceed mixer manufacturer's specified mixing capacity.
 8. Empty mixer of previously mixed load or wash water before adding new concrete.

9. Materials, including mixing water shall be in mixer drum before actuating counter to count rotations.
 10. Properly proportion each batch of concrete and mix in transit mixer for 70-100 revolutions of drum or blades at rotation rate designated by equipment manufacturer.
 - a. Additional mixing, if any, shall be at agitating speed designated by equipment manufacturer unless otherwise accepted by City's Representative.
 11. Do not add water to load during transit.
 12. Truck mixers and their operation shall ensure concrete throughout mixed batch is discharged within acceptable limits of uniformity of consistency, mix and grading.
 13. Adequate control of ready-mixed concrete may require addition of water into batch at discharge point, in which case water shall be mixed for ≥ 30 revolutions at equipment manufacturer's designated mixing speed.
 14. Slump tests taken at approximately $\frac{1}{4}$ point and $\frac{3}{4}$ points of load during discharge shall give slumps within 2" of each other.
 - a. Mixers failing to meet this requirement shall not be used on job until causing condition is corrected and satisfactory performance is verified on-site using additional slump tests.
 - b. Mechanical parts of failing mixer, including water measurement and discharge apparatus, blades, rotation speed, and drum clearances shall be serviced and checked before further attempt to use equipment.
 15. Each delivery of ready-mixed concrete shall be accompanied by delivery ticket furnished to City's Representative as described in Paragraph 1.6 above.
- K. Paving and stationary mixing shall proceed as follows:
1. Equip paving and stationary mixers with accurate automatic timing device designed and constructed to lock discharge lever.
 - a. Regulation setting of this device shall be accepted by City's Representative.
 2. Provide water control equipment with each mixer.
 3. Proportion aggregate, cement, and water for each concrete batch into mixer and mix for ≥ 1 minute ($1\frac{1}{2}$ minutes for reinforced concrete).
 4. Mixer rotating speed shall conform to mixer manufacturer's recommendation.
 5. Total material volume in mixer shall not exceed water level capacity of mixer or mixer manufacturer's specified capacity of mixer.
- L. Concrete conveyance through non-agitating equipment shall proceed as follows:
1. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation and equipped with gates to permit positive control of concrete discharge and to facilitate handling low-slump concrete with specified nominal aggregate gradation.
 2. Bucket interior hopper slopes shall be $\geq 58^\circ$ from horizontal.
 - a. Clear bucket gate opening shall be ≥ 5 times nominal maximum-size aggregate, and area of bucket gate opening shall be $\geq 2\text{ft}^2$.
 - b. Maximum dimension of bucket gate opening shall not exceed twice minimum dimension.
 - c. Bucket gates shall be grout tight when closed and may be manually, pneumatically, or hydraulically operated except buckets > 2 cubic yards shall not be manually operated.
 - d. Design of bucket shall provide means for positive regulation of amount and rate of deposit of concrete in each dumping position.

3. Non-agitating transfer hoppers used for concrete transfer to other conveying devices. shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features.
 - a. Machine shall be equipped with hydraulically operated gate with means of external vibration to facilitate discharge.
 - b. Do not hold concrete in non-agitating transfer hoppers for > 30 minutes.
- M. Belt conveyors, when accepted by City's Representative, shall proceed as follows:
 1. Conveyors shall be designed and operated to assure uniform flow of concrete without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of concrete at transfer points and at point of discharge.
 2. If concrete is to be placed through installed horizontal or sloping reinforcing bars, conveyor shall discharge concrete into pipe or elephant trunk long enough to extend through reinforcing bars.
 - a. In no case shall concrete be discharged to free fall through reinforcing bars.
- N. Chutes shall be used as follows:
 1. When concrete can be placed directly from truck mixers, agitators, or non-agitating equipment, chutes attached to this equipment may be used.
 2. Slope chutes to permit concrete of consistency required to flow without segregation.
 3. Use discharge deflector when required by City's Representative.
 4. Separate chutes and other similar equipment will not be permitted for conveying concrete except when accepted by City's Representative.
- O. Pump placement, when accepted by City's Representative, shall proceed as follows:
 1. Pumping equipment shall be piston or squeeze pressure type.
 2. For redundancy, provide standby pump on-site or provide pumping equipment with 2 cylinders, designed to operate with 1 cylinder only.
 3. Pipeline shall be rigid steel pipe or heavy-duty flexible hose.
 4. Do not use aluminum conduits to convey concrete.
 5. Pipe inside diameter shall conform to ACI 304 and be ≥ 3 times nominal maximum size coarse aggregate in concrete mix being pumped and ≥ 5 ".
 6. Maximum size coarse aggregate shall not be reduced to accommodate pumping.
 7. Distance to be pumped shall not exceed limits recommended by pump manufacturer.
 8. Test concrete samples for slump, air content and test cylinders at placement (discharge) end of line.
 9. Supply concrete to concrete pump continuously.
 10. When pumping is completed, eject concrete remaining in pipeline without contaminating concrete in place.
 11. Replace pumping equipment or hoses that fail to function properly.
 12. After each operation, thoroughly clean equipment.
 13. Waste flushing water outside of forms and in compliance with environmental requirements.
 14. Pumping of concrete will only be permitted if satisfactory end results are obtained.
- P. Provide machine mixing except where it is obviously impractical, in which case City's Representative may accept hand-mixing.
- Q. Hand-mixing will be accepted when <1 cy concrete is required.
 1. Do not use hand-mixing methods which allow loss of mixing water.
 2. Hand-mix concrete on water-tight platform or in mortar box in batches not to exceed $\frac{1}{3}$ cubic yard each.

3. Spread aggregates in uniform layer.
 4. Evenly distribute required quantity of cement over aggregates.
 5. Turn entire batch with shovels until ingredients are thoroughly blended before adding water.
 6. After adding proper amount of water, turn batch with shovels again until uniform consistency is obtained.
- R. Compartments of trucks or other equipment used to transport dry aggregate and cement, or mixed concrete shall be constructed to prevent loss or leakage of contents during charging, transit, or discharging.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install Concrete structural systems before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Schedule concrete placements so newly placed concrete will not be damaged by blasting or other operations.
- C. Provide walkways and platforms for personnel and equipment at levels convenient for Work and to permit performance of operations necessary for concrete placement, consolidation, finishing, and curing.
- D. Prepare earth foundations to receive concrete as follows:
 1. Ensure earth foundations are clean, damp, and free from standing or running water, and loose particles or foreign matter.
 2. Compact earth foundations in accordance with Section 31 23 00.
 3. Maintain groundwater levels below subgrade until concrete has set.
 4. Wet dry earth surfaces by sprinkling before placing concrete to minimize moisture absorbed from fresh concrete.
 5. During concrete placement, ground surface shall be moist, but free from standing water, mud and debris.
- E. Prepare sand, gravel, or crushed rock foundations to receive concrete as follows:
 1. Place geotextile filter above sand, gravel or crushed rock.
 2. Keep aggregate base or sand filler or drain material dewatered to prevent concrete materials from being deposited in water.
 3. Place steel reinforcement and concrete as quickly as possible after placing geotextiles.
- F. Before placing concrete, provide dewatering, runoff diversion, upstream debris containment systems and protection as needed to ensure proper and water-free environment suitable for concrete hardening and curing.
 1. Do not place concrete if 15-day weather forecast indicates chance of rain.
 2. Do not place concrete underwater or in spaces where standing water is present.
- G. Concrete placement will not be permitted when, in City's Representative's opinion, jobsite conditions preclude proper placement, control, consolidation, and finishing.
- H. Protect uncured concrete from exposure to rain, runoff or groundwater.
- I. Prosecute Work so construction joints occur at locations shown on Plans and Working Drawings.
 1. Construct concrete between joints in 1 continuous placing operation.

2. Refer to Section 03 15 00 for requirements for construction joints and expansion joints.
- J. Cold joints shall be deemed to occur when concrete placement is interrupted so new concrete is neither incorporated integrally with previously placed concrete in opinion of City's Representative nor keyed into place with preformed construction joints shown on Contract Documents or accepted Working Drawings.
 1. Minimize cold joints.
 2. Form and place vertical joints as construction joints wherever possible.
- K. Prepare vertical surfaces of cold joints as follows:
 1. Clean tooled joint surface of laitance, loose or defective concrete, and foreign matter by hydroblasting or sandblasting to expose aggregate.
 2. Wash hydro-blast or sandblast surface with clean water.
 3. Method of disposing of wastewater used to wash concrete surfaces shall cause no staining, discoloration, or deterioration of exposed surfaces of structures and improvements.
 4. Coat joint surface with epoxy-bonding agent unless otherwise shown.
 5. Wet joints not coated with bonding agent before placing concrete adjacent to joint.
- L. Prepare horizontal surfaces of cold joints as follows:
 1. Roughen horizontal surface with minimum ¼" amplitude profile for good bond.
 2. Clean tooled joint surface of laitance, loose or defective concrete, and foreign matter by hydroblasting or sandblasting to expose aggregate.
 3. Wash hydro-blast or sandblast surface with clean water.
 4. Remove ponded water from surface of joints.
 5. Method of disposing of wastewater used to wash concrete surfaces shall cause no staining, discoloration, or deterioration of exposed surfaces of structures and improvements.
 6. Coat joint surface with epoxy-bonding agent unless otherwise shown.
 7. Wet joints not coated with bonding agent before placing concrete adjacent to joint.
 8. Cover horizontal joints, except expansion or contraction joints, with 1" layer of Class D mortar (1 part Portland cement – 2½ parts fine aggregate).
 9. Limit water in mortar to that required to produce consistency similar to fresh concrete.
- M. Notify City's Representative in writing ≥ 24 hours before placing concrete.
 1. Do not place concrete except when City's Representative or their duly authorized representative is present.
- N. Secure inspection of steel reinforcement and obtain acceptance by City's Representative ≥4 hours before placing concrete,.
- O. Before placing concrete, verify location of embedded items with affected trades.
 1. Each trade having embedded items, including water stops within forms and affected by pour shall certify items are properly located, placed and braced.
 2. Verify embedded items are firmly and securely fastened in place.
 3. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint and scale.
 4. Accuracy of placement of embedded items is Contractor's responsibility.
 5. Do not embed wood into concrete unless accepted in writing by City's Representative.
 6. Temporarily fill voids in sleeves, inserts, and anchor slots using removable materials to prevent concrete entry into voids.

7. Before placing concrete, provide written notice to City's Representative and submit Pre-placement checkout form similar to that in ACI SP2 described under "Submittals."
 8. Equipment needed to place and consolidate concrete shall be at placement site and in good operating condition.
 - a. Spare vibrators shall be available throughout concrete placement.
 9. Do not use aluminum pipes, chutes, troughs, spouts or tremies for pumping, conveying or placing concrete.
 10. Order of placement of concrete shall be acceptable to City's Representative.
 11. To minimize shrinkage effects, place concrete in units bounded by construction joints shown in Working Drawings.
 12. Placement shall occur such that each unit shall cure ≥ 3 days before contiguous units are placed, except corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have ≥ 7 days.
 13. Moisten surfaces against which concrete will be placed with water immediately before placing concrete.
 - a. Remove ponded or excess water to leave surfaces moist but not flooded.
- P. Concrete not placed within 10 minutes from time of leaving mixer shall be remixed before placing.
1. Concrete not placed within 15 minutes after mixing shall be removed from Work site and legally disposed of.
- Q. Provide sufficient illumination in interior of forms so concrete at places of deposit is visible from deck or runway.
- R. Do not place concrete when weather conditions prevent proper placement and consolidation.
- S. Maintain temperature of concrete within the following ranges immediately before placement.
1. Concrete $< 12"$ thick: 55°F to 90°F
 2. All other concrete: 50°F to 90°F
 3. When concrete temperature exceeds 80°F, only set-retarding hydration stabilizing admixtures shall be used.
 4. When concrete temperature exceeds 85°F, time between introducing cement to aggregates and discharge shall not exceed 45 minutes.
 5. No additional compensation will be made to contractor for measures used to maintain concrete temperature within specified limits.
- T. Schedule concrete placement during evening or morning hours, and provide ice, refrigerated mixing water, pre-cooled aggregate, shading, sprinkling and other means needed to conform to maximum temperature limits.
1. If ice is used, store ice at temperatures low enough to prevent forming lumps by refreezing particles.
 2. Size of ice particles shall ensure ice completely melts before end of mixing time for each batch.
 - a. Do not use liquid nitrogen cooling.
- U. Hot weather placement shall proceed as follows:
1. Comply with ACI 305R.
 2. Do not mix or place concrete when atmospheric temperatures are $\geq 115^\circ\text{F}$, unless means are employed to cool aggregate and water and protect Work
 3. If evaporation rate surface moisture, determined by nomograph in ACI 305R, may be expected to exceed 0.2 lbm per square feet per hour such as to cause plastic shrinkage

cracking, provide windbreaks, shading, fog spraying, or wet covering with light colored material in advance of concrete placement.

4. From initial placement through curing, protect concrete from adverse effects of high temperature, low humidity and wind.
5. Cool steel forms and reinforcement prior to concrete placement when steel temperatures exceed 120°F.
6. Cool conveying and placing equipment if necessary to maintain proper concrete placing temperature.
7. Shading of placing area shall be used if required.

V. Stop concrete placement when rainfall is sufficient to damage Work.

W. Prevent cold joints when placing concrete.

1. Concrete placing rate shall ensure each concrete batch is placed while previously placed underlying or adjacent batches of concrete are still plastic so both can be made monolithic by normal use of immersion vibrators.
2. If equipment breaks down or unavoidable prolonged interruptions of continuous placing causes unconsolidated concrete to harden to extent later vibration cannot fully consolidate concrete, immediately consolidate concrete to stable and uniform slope.
3. If delay of placement is then short enough to permit penetration of operating vibrator into concrete, resume placement, taking care to penetrate and re-vibrate concrete placed before delay.
4. If concrete cannot be penetrated with operating vibrator, stop placement and treat cold joint as construction joint if design requirements are such that construction joint is practical.
5. If construction joint will impair structural integrity, as determined by City's Representative, repair concrete placed before delay as directed by City's Representative.
6. Repairs in some instances will include removal of concrete placed before delay at Contractor's expense.

X. Arrange ends of chutes, hopper gates, and other points of concrete discharge so concrete passing from them flows continuously into receiving vessel without separation.

1. Conveyor belts, if used, shall be wiped clean by device operated so mortar adhering to belt is not wasted and shall be of type acceptable to City's Representative.
2. Chutes shall be ≤ 50' long.
3. Slopes of chutes shall permit free and continuous flow of concrete being placed.

3.2 Installation

A. Refer to Section 01 73 00 for basic execution and installation requirements.

B. Furnish and install concrete at locations shown on Plans and Submittals.

C. The following installation standards shall be followed:

1. Applicable OSHA and Cal OSHA regulations
2. California Building Code Chapter 19 "Concrete"
3. Other applicable building and CalGreen code requirements
4. ACI 301 Structural Concrete for Buildings Chapter 8.
5. ACI 318 Building Code Requirements for Reinforced Concrete
6. ACI 350 Code Requirements for Environmental Concrete Structures
7. Standard Specifications for Public Works Construction (Greenbook) §203, §302, and §303
8. City of Corona Standard Drawings:

- a. Standard Drawing 310 for concrete slope anchors.
- 9. Manufacturer's installation and warranty requirements
- 10. Standard Specifications for Public Works Construction (Greenbook) §303 "Concrete and Masonry Construction."
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Where concrete is to be deposited against hardened concrete at horizontal construction joints, begin placing operations by conveying grout mixture through placing system and equipment and depositing mixture on joint.
 - 1. Grout mixture shall be non-shrink grout class 1 as defined in Section 03 60 00.
 - 2. Aggregate shall be Class E as defined herein.
 - 3. Use consolidation techniques to assure proper bond at joint.
- F. Deposit concrete into forms as follows:
 - 1. Provide equipment adequate to handle and place concrete with specified aggregate and slump.
 - 2. Keep construction joint surfaces continuously wet for first 12 hours during 24-hour period before placing concrete.
 - 3. Treat cold joints as specified for concrete construction joints in Section 03 15 00.
 - 4. Remove free water before placing concrete.
 - 5. To avoid segregation, deposit concrete as near to its final position as possible.
 - a. Do not use vibrators for extensive shifting of mass of concrete.
 - b. Do not place partially hardened or retempered concrete or concrete contaminated by foreign material into structure.
 - 6. Place concrete in horizontal layers insofar as practical.
 - 7. Begin placing at low point and proceed up grade.
 - 8. Place concrete in continuous operation between construction joints.
 - 9. Once placement of concrete has begun in a location, do not interrupt placement by diverting placing equipment to other locations unless authorized.
 - 10. Terminate placement with square ends and level tops unless otherwise shown.
 - 11. Place concrete within time limit specified herein and in ASTM C94.
 - 12. Concrete deliveries will be rejected if specified elapsed time from batching to placing is exceeded.
 - 13. Provide sufficient placing capacity so concrete placement is kept plastic and free of cold joints while concrete is placed.
 - 14. Vertical free fall drop shall be $\leq 4'$ below ends of ducts, tremies, chutes or buggies except where suitable equipment is provided to prevent segregation, and where specifically accepted.
 - 15. Tremies shall be $\geq 6"$ diameter or equivalent cross-section area for rectangular sections.
 - 16. Do not place concrete in horizontal members or sections until concrete in supporting vertical members has been consolidated and 2 hours have elapsed to permit shrinkage to occur.
 - 17. In no case shall concrete be displaced horizontally in forms by $>6'$ after depositing.
 - 18. Do not drop concrete through reinforcing steel or into deep forms, nor place concrete in forms in manner permitting accumulation of mortar on surfaces above placed concrete.
 - 19. If necessary, use hoppers or vertical ducts of canvas, rubber or metal to convey concrete to place of final deposit without separation or splashing.

20. Depth of concrete deposited in each location shall be that which can be fully consolidated in uniform horizontal layers not exceeding 24" in thickness.
21. Place slabs 24" thick or less in 1 course.
22. Avoid inclined layers or inclined construction joints except where required for sloping members.
23. Place each layer while previous layer is still soft.
24. Rate of placement in forms shall be $\leq 5'$ vertical rise per hour.
25. Time between successive lifts shall be defined as time elapsing from completion of 1 lift to start of placing next lift.
 - a. Unless otherwise accepted, time between successive lifts shall be ≥ 72 hours.
- G. Concrete in ramps and sloping slabs shall be placed uniformly from bottom to top for full width of placement.
 1. As Work progresses, vibrate concrete and work it around reinforcement.
 2. Screed ramp surface in up-slope direction.
- H. Consolidate encasement concrete around duct banks by hand puddling.
 1. Do not use mechanical vibration around electrical raceways.
- I. Settle, compact and consolidate concrete in forms or excavations throughout depth of concrete layer being placed to produce surface of uniform texture free of rock pockets and excessive voids.
 1. Immediately after placement, consolidate each concrete layer using internal vibrating equipment.
 2. Do not use vibrators to transport or move concrete within forms.
 - a. If necessary, use hand spading with internal vibrating along formed surfaces permanently exposed to view.
 3. Do not use form or surface vibrators unless specifically accepted.
 4. Consolidate concrete into dense, homogeneous mass.
 - a. Work concrete into form corners and angles of forms and around reinforcement and embedded items, eliminating rock pockets without causing concrete materials to segregate, while bringing only a slight excess of water to exposed concrete surface during placement.
 5. Use power vibrators of immersion type in sufficient number to accomplish specified results within 15 minutes after concrete is deposited.
 6. Vibration shall be accomplished by vertically inserting vibrator into fresh concrete at uniform spacing over full placement area.
 7. Distance between insertions shall be approximately $1\frac{1}{2}$ times radius of action of vibrator and overlap adjacent, just vibrated areas by a few inches.
 8. Vibrators shall penetrate rapidly to bottom of layer, and slightly into layer below, when fresh.
 9. Hold vibrators stationary momentarily, then withdraw slowly so concrete consolidates from bottom upward as entrapped air is removed.
 10. Use 2 or more units simultaneously when placing >25 CY.
 - a. Backup vibrator shall be onsite for each in use.
 11. Vibrators for structural concrete shall be Group 3 (2"-3 $\frac{1}{2}$ " head, 8,000-12,000Hz, 0.025-0.05" amplitude) per ACI 309R.
 12. Group 2 (1 $\frac{1}{4}$ "-2 $\frac{1}{2}$ " 8,500-12,500Hz, 0.02"-0.04" amplitude) vibrators may be used only at specific locations when accepted by City's Representative.
 13. When placing concrete around waterstops, carefully rod and vibrate concrete to eliminate air and rock pockets.

- a. Where flat-strip waterstops are placed horizontally, work concrete under waterstops by hand.
- b. Concrete surrounding waterstops shall receive additional vibration over and above that used for adjacent concrete to assure full embedment of waterstops in concrete.
- 14. Internally vibrate concrete in walls and columns and at same time, ram, stir, or work with suitable appliances, tamping bars, shovels, or forked tools until it completely fills forms or excavations and closes snugly against surfaces.
 - a. Do not place subsequent layers of concrete until previously placed layers have been worked thoroughly.
 - b. Keep vibrating head from contact with form surfaces.
- 15. Do not vibrate concrete excessively or work it in any manner causing segregation of constituents.
- 16. Perform vibration at each required pour window opening in form walls.
- 17. Accepted external vibrators will be permitted when concrete is inaccessible to internal vibration.
- J. Horizontal surfaces of concrete shall be level whenever run of concrete is stopped.
 - 1. To ensure level, straight joint on exposed surfaces of walls, tack wood strip $\geq \frac{3}{4}$ " thick to forms on these surfaces.
 - 2. Carry concrete about $\frac{1}{2}$ " above underside of strip.
 - 3. One hour after concrete is placed, remove wood strip.
 - 4. Using trowel, remove irregularities in edge formed by strip, and remove laitance.
- K. Do not backfill against walls until concrete has obtained 100% of specified 28-day compressive strength.

3.3 **Field Quality Control**

- A. Refer to the following sections for additional field testing and inspection requirements:
 - 1. Section 03 10 00 for field testing and inspection of formwork and finish dimensions
 - 2. Section 03 15 00 for field testing and inspection of concrete accessories, waterstops and joints.
 - 3. Section 03 20 00 for field testing and inspection of steel reinforcement.
 - 4. Section 03 35 00 for field testing and inspection of concrete finishing.
 - 5. Section 03 39 00 for field testing and inspection of curing.
 - 6. Section 05 12 00 for field testing and inspection of embedded steel bolts.
- B. CBC Chapter 17 special inspection shall only be required for Class AA "premium" concrete, Class A "structural" concrete and concrete having specified compressive strength $f'_c > 2500$ psi.
- C. Maintain placing record on-site showing time and date of placement of concrete having specified compressive strength $f'_c > 2500$ psi as required in CBC §1705.3.2.
- D. Special inspection and field testing of Class AA and Class A concrete required by Chapter 17 of CBC (Table 1705.3) shall be completed by ICC-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Class AA Concrete, Class A Concrete and Concrete	Design Mix Verification	ACI 318, Ch 19 & §26.4.3 & 26.4.4	Periodic per CBC Table 1705.3	City	Contractor to reimburse City for costs of
	Slump	ACI 318 §26.4.5, §26.12, ASTM C31, ASTM C172 Slump per ASTM C143	Continuous per CBC Table 1705.3 taken at at		

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
having f_c >2500 psi	Air Content	ACI 318 §26.4.5, §26.12, ASTM C31, ASTM C172 Air content per ASTM C173 or C231	$\frac{1}{4}$ point and $\frac{3}{4}$ point of batch and at time fresh concrete is sampled to fabricate cylinders for strength tests		first deputy inspector if re-inspection required
	Temperature	ACI 318 §5.6& 5.8, ASTM C31, ASTM C172, ASTM C1064			
	Proper Placement of Concrete	ACI 318 §26.4.5	Continuous per CBC Table 1705.3		
	Verification of in-situ Concrete Strength Prior to Removal of Shores and Forms	ACI 318, §6.10.2 See below for concrete strength test requirements	Periodic per CBC Table 1705.3		
Precast Concrete Members	Erection	Contract Documents, ACI 318, Ch. 16	Periodic per CBC Table 1705.3		

E. Additional field testing of concrete shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Concrete Materials (Concrete Production on Site)	Coarse and Fine Aggregate Gradation	Sampling per ASTM D75. Sieve analysis and fineness modulus per ASTM C136	1 test during each shift in which concrete is produced on site.	Contractor	Contractor
	Coarse and Fine Aggregate Moisture Content	ASTM C566	1 morning test per day.	Contractor	Contractor
	Coarse and Fine Aggregate Specific Gravity and Absorption (SSD)	ASTM C127 (Coarse) ASTM C128 (Fine)	1 test per week	Contractor	Contractor
	Coarse and Fine Aggregate Deleterious Substances	ASTM C33	1 test per week	Contractor	Contractor
	Coarse Aggregate Flat and Elongated Particles	ASTM D4791	1 test per week	Contractor	Contractor
	Fine Aggregate Sand Equivalent Value	ASTM C2419	1 test per week	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Batch-Plant Control	Monitor and control proportioning of cement, SCMs, each size aggregate, water, and admixtures .Adjust aggregate weights and amount of added water to compensate for free moisture in aggregates. Adjust water content to produce specified slump. Adjust air-entraining admixture to maintain air content within specified limits.	Continuous	Contractor	Contractor
	Weighing Equipment Accuracy	ASTM C94	1 test per 6 months or whenever variations in properties of fresh concrete are detected	Contractor	Contractor
Concrete	Air Content and Unit Weight	ASTM C138 or ASTM C231	1 morning test per day or every 250cy increment whichever is stricter.	Contractor	Contractor
	Slump	ASTM C143 No test shall exceed specified rejection limit. Average value of all tests shall be ≤ specified working limit.	1 morning test per day or every 250cy increment whichever is stricter.	Contractor	Contractor
	Air and Concrete Temperature	ASTM C1064,	Concurrent with slump tests and as directed	Contractor	Contractor
Concrete Compressive Strength f_c	Trial Batch Sample Preparation	1 st 5 cylinder tests at 7 days 2 nd 5 cylinder tests at 28 days	3 drying shrinkage samples and 10 compression test cylinders for each class or mix of concrete used	Contractor	Contractor
	Cylinder Sampling	ASTM C172	Sample each 100 cy concrete and each separate mix design placed on any day	Contractor	Contractor
	Trial-Batch and Field-Trial Cylinder Testing of Compressive Strength f_c	Field Cylinders per ASTM C31 §9.2	Make ten 6" diameter x 12" high cylinders 1 st tests (2 cylinders) at 7 days 2 nd test (2 cylinders) at 28 days	Contractor	Contractor
		Laboratory Cylinders per ASTM C192			
		Testing per ASTM C39 Conform to table below			
		Evaluation per ACI 214 & ACI 318 Chapter 5 "Concrete Quality"			
	Field Cylinder Testing of	Make Field Cylinders per ASTM C31 §9.2	Make ≥ ten 6" diameter x 12"	City	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Compressive Strength f_c	Test per ASTM C39 Average of 2 cylinders	high cylinders per 250 cy concrete and separate mix design placed on any day 1 st tests (2 cylinders) at 7 days 2 nd test (2 cylinders) at 28 days Save remaining cylinders to verify test results as directed.		
		Evaluation per ACI 214 & ACI 318 Chapter 5 "Concrete Quality"			
		Standard deviation of test results from same mix and duration shall be ≤ 640 psi.			
		Average of any 3 consecutive tests shall be $\geq$ specified 28-day strength			
		$\geq 90\%$ of tests shall be $\geq$ specified 28-day strength			
		No test shall be $< 85\%$ of specified 28-day strength			
	Test Core Testing of Compressive Strength f_c	Take test cores per ASTM C42 if minimum strengths fall below those specified.	3 cores per test as directed	Contractor	Contractor
		Concrete tested by coring shall be acceptable if average f_c of 3 cores $\geq 85\%$ of specified f_c and no single core strength $< 75\%$ of specified f_c .			
		Penalty clauses may be assessed as described under Unit Prices for concrete failing to meet full specified strength.			
Concrete	Flexural Strength	ASTM C78	As directed	Contractor	Contractor
	Unit Weight Yield	ASTM C138	As directed	Contractor	Contractor
	Drying Shrinkage	California Test 530	As directed	Contractor	Contractor
Finished Concrete	Dimensional Tolerance,	Refer to Section 03 35 00	Inspection at City's discretion	City	City
	Footing Dimensional Tolerance	ACI 117	Inspection at City's discretion	City	City
	Surface Defects	Refer to Section 03 35 00	Inspection at City's discretion	City	City
	Cracking in Flatwork and Non-Water- bearing Structures	Refer to Section 03 35 00	Inspection at City's discretion	City	City
Concrete	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

F. Refer to Section 03 10 00 for tolerances of finished concrete.

G. Trial-batch testing and field-trial testing of concrete cylinders shall proceed as follows:

1. Before placing concrete, testing laboratory designated by City's Representative shall prepare trial batch of each class of "structural" or "premium" concrete based on preliminary concrete mixes submitted by Contractor and using aggregates, cement and admixtures proposed.

2. During trial-batch, testing laboratory may adjust aggregate proportions to obtain required properties.
 - a. Such adjustments shall be considered refinements to mix design and shall not justify extra compensation to Contractor.
3. All concrete shall meet specified requirements whether aggregate proportions are from Contractor's preliminary mix design, or whether proportions have been adjusted during trial batch process.
4. Trial-batch materials shall be sufficient to yield 3 drying shrinkage and 10 compression test specimens from each batch.
5. Test 5 cylinders at 7 days to establish 7-day average compressive strength.
6. Test remaining 5 cylinders ≤ 28 days after molding.
7. Required average compressive strengths shall be:

SPECIFIED COMPRESSIVE STRENGTH (f_c)	28-DAY LABORATORY TRIAL-BATCH COMPRESSIVE STRENGTH MINIMUM TEST RESULTS		28-DAY FIELD-TRIAL TEST COMPRESSIVE STRENGTH MINIMUM TEST RESULTS	
	5-CYLINDER AVERAGE	ANY SINGLE TEST	5-CYLINDER AVERAGE	ANY SINGLE TEST
$0 < f_c < 3000$ psi	$f_c + 1000$ psi	f_c	$f_c + 600$ psi	f_c
$3000 \text{ psi} \leq f_c < 5000$ psi	$f_c + 1200$ psi	f_c	$f_c + 600$ psi	f_c
$5000 \leq f_c$	$f_c + 1400$ psi	f_c	$f_c + 600$ psi	f_c

8. Do not place "structural" or "premium" concrete until mix design has been qualified under test criteria above.
 - a. Should source of materials or established procedures change, City will require new trial batch testing.
 9. Field trial batches may be placed in Work at designated locations accepted by City's Representative where concrete of lower quality is required.
 - a. For payment purposes, concrete so placed will be considered to be type of concrete specified at that location.
 10. Furnish concrete samples for batch testing in steel drums at no cost to City.
 11. In lieu of trial-batch testing, Contractor may submit previously designed, tested and successfully used concrete mixes using materials similar to those intended for Work, together with ≥ 3 certified test reports of 28-day strength of proposed concrete mix.
- H. Specified frequency of tests may be increased at City's Representative's discretion where excessive variation in concrete properties is observed during construction.
- I. Contractor-hired personnel sampling and testing concrete and concrete constituents shall have ACI certification for Concrete Field Testing Technician Grade I.
- J. Laboratory used for field testing shall conform to ASTM C1077.
 1. If directed by City's Representative, remove from Work and replace laboratory equipment not acceptably maintained.
- K. Contractor shall provide concrete for testing at no charge to City, and shall assist City's Representative and laboratory personnel in obtaining samples, and disposal and cleanup of excess material.
- L. Statistical analysis of compression test results will be performed according to ACI 214.
 1. Standard deviation of test results shall not exceed 640 psi when ordered at equivalent water content as estimated by slump.
 2. When said standard deviation > 640 psi, increase average strength for which mix is designed as needed to satisfy statistical requirement that:
 - a. Probability of any test being > 500 psi below specified strength $< 1\%$.

- b. Probability of average of 3 consecutive tests being below specified strength <1%.
 - c. Required average strength shall be calculated using Criterion Number 3 of ACI 214 using actual standard deviation.
- M. Concrete which fails to meet ACI requirements and these Specifications is subject to removal and replacement at no cost to City and shall be disposed of as required by law.
- N. In lieu of removing and replacing slightly deficient concrete having 85% or more of specified strength, City may, at their sole discretion, elect to reduce payment due to Contractor for substandard concrete as described in Caltrans Standard Specification §90-9 "Compressive Strength."

3.4 Cleaning

- A. Wash out chutes, shovels, finishing trowels and other equipment that has been in contact with wet concrete at a designated concrete washout area.
- B. Do not discharge or deposit wet concrete, debris, or other concrete washout effluent on bare ground, on area tributary to storm drain or natural channel or into storm drain facility.
- C. Dispose of concrete and concrete waste in accordance with pollution prevention laws and regulations.
- D. Refer to Section 01 74 00 for cleanup and disposal requirements.

3.5 Protection

- A. Protect concrete against injury until final acceptance by City.
- B. Protect fresh concrete from damage due to impact, overstress, vandalism and weather, including precipitation or extremes in temperature or humidity until final acceptance.
- C. New concrete not complying with these specifications shall be repaired or removed and replaced prior to final acceptance except where City agrees to reduce payment as described above.

END OF SECTION

SECTION 03 32 10 CEMENT MORTAR

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of cement mortar.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 03 30 00 for cast-in-place concrete.
 - 2. Section 04 05 00 for masonry mortaring and grouting.
- C. Conform to Standard Specifications for Public Works Construction (Greenbook) §201-5, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 31 23 00: Excavation and Fill

1.3 System Description

- A. Furnish and install cement mortar in compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Mortar Mix	Compressive Strength, Consistency, Mortar Aggregate Ratio, Water Content, Air Content, Splitting Tensile Strength and Slump	ASTM C780	1 each batch	Contractor	Contractor

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASTM C33 Concrete Aggregates
 - 2. ASTM C40 Organic Impurities in Fine Aggregates for Concrete
 - 3. ASTM C109 Compressive Strength of Hydraulic Cement Mortars

4. ASTM C150 Portland Cement
5. ASTM C191 Time of Setting of Hydraulic Cement by Vicat Needle
6. ASTM C266 Time of Setting of Hydraulic Cement Paste by Gillmore Needlesaw
7. ASTM C289 Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
8. ASTM C780 Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
9. California Building Code (CBC)
10. California Fire Code (CFC)
11. California Green Building Code (CALGreen Code)
12. California Test Method 229 Durability
13. California Test Method 515 Relative Mortar Strength of Portland Cement Concrete Sand
14. NSF/ANSI 61 Drinking Water System Components – Health Effects
15. SSPWC Standard Specifications for Public Works Construction (Greenbook) §201-5 "Cement Mortar"

1.6 **Submittals**

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Submit per Installation or Application Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
Test Record Transcripts	Submit for factory tests per test record transcript requirements.	
Delivery Tickets	Submit as required for payment.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance.	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, Certificates of Compliance, and Test Record Transcripts.

1.7 **Delivery, Storage and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instruction and warranty requirements for delivery, storage and handling of cement mortar.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §201-5 for materials requirements for cement mortar.

C. Cement mortar shall be constructed of:

ITEM	MATERIAL	SPECIFICATION
Cement	Standard Brand Portland Cement	Conform to ASTM C150 including optional requirements of Table 2 for maximum equivalent alkalis ($\text{Na}_2\text{O}+0.658\text{K}_2\text{O}$ of 0.60% Type II Modified Low Alkali Type II/V Modified Low Alkali/Sulfate Resisting Type III High Early Strength Type IV Low Heat of Hydration Type V Sulfate Resistant Also conform to Table 2 optional requirements At least 85% of cement by weight shall pass 325 screen.
Sand	Specification	Conform to ASTM C33 Nonreactive clean, hard durable washed material From pits acceptable to City's Representative Aggregate shall be of character to facilitate producing workable concrete mixture within limits of specified water content and slump.
	Organic Impurities per ASTM C40	Satisfactory Resultant color of testing solution shall not be darker than ASTM C40 standard
	Free Moisture Content	$\leq 8\%$ at time of batching
	Mortar Strength Relative to Ottawa Sand per California Test Method 515	$\geq 100\%$
	Sand Equivalent	$> 75\%$ average for 3 samples $> 70\%$ for any 1 sample
	Percent Clay, Silt, Loam per ASTM C117	$< 3\%$
	Soundness per California Test Method 214	$< 10\%$ Soundness requirement will be waived if durability index $D_i > 60$ per California Test Method 229.
	Ratio of silica released to reduction in alkalinity	< 1.0
	Weight	Lightweight sand not permitted
	Reactivity	Nonreactive when tested per ASTM C289 and evaluated per ASTM C33 Appendix X1
Water	Clean, Clear Potable Water	TDS ≤ 1000 mg/l
Admixtures		Do not use admixtures unless accepted by City's Representative.

D. Mortar sand shall conform to gradation below. (Refer to Standard Specifications for Public Works (Greenbook) Table 200-1.5.5).

PERCENTAGE PASSING SIEVES BY WEIGHT	
SIEVE SIZE	ASPHALT CONCRETE SAND GRADATION
#4	100%
#8	95-100%
#16	70-95%
#30	35-70%
#50	5-35%
#100	0-10%
#200	0-5%

E. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Mortar	2-Component Cement Based Product	Low shrinkage.
		Designed for repairing damaged concrete surfaces.
		Use medium slump repair mortar on horizontal surfaces.
		Use non-sag low-slump repair mortar on vertical or overhead surfaces.
	Class A Mortar	1 part Portland cement – 1 part fine aggregate
	Class B Mortar	1 part Portland cement – 1½ parts fine aggregate
	Class C Mortar	1 part Portland cement – 2 parts fine aggregate
	Class D Mortar	1 part Portland cement – 2½ parts fine aggregate
	Class E Mortar	1 part Portland cement – 3 parts fine aggregate
	Class F Mortar	1 part Portland cement – 3½ parts fine aggregate
	Concrete Repair Mortar	Class C with Atlas white Portland cement added as needed so patch matches finish.
Water		Add precise amount of water needed to produce required strength and workability

PART 3 - EXECUTION**3.1 Preparation**

- A. Make field measurements needed to install cement mortar before ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Examine areas and conditions under which Work of this section will be performed.
 - 1. Correct conditions detrimental to timely and proper completion of Work.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install cement mortar at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. California Building Code
 - 3. Other applicable building, fire, plumbing, mechanical and electrical code requirements
 - 4. Manufacturer's installation and warranty requirements
 - 5. Standard Specifications for Public Works Construction Section 201-5 "Cement Mortar"
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install cement mortar to tolerances recommended by Manufacturer.
 - 1. Unless otherwise shown, install cement mortar true, plumb, and level using precision gauges and levels.
- F. Installation of cement mortar shall pay particular attention to the following:
 - 1. Use mortar as soon as possible after mixing.
 - 2. Mortar shall show no visible signs of setting prior to use.
 - 3. Do not re-temper mortar.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cement Mortar	Installation	Visual inspection of finished installation	1 inspection	City	City
	Setting of Mortar	ASTM C191 or C266	As directed	Contractor	Contractor
	Mortar Cube Test	California Test 515	As directed	Contractor	Contractor
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 03 39 00

CONCRETE CURING

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and curing of concrete.
- B. Refer to the following sections for Work not covered herein.
 - 1. Refer to Section 03 30 00 for cast-in-place concrete.
- C. Conform to Standard Specifications for Public Works Construction (Greenbook) §201-4, 303-1.10, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 30 00: Cast-in-Place Concrete
- I. Section 03 60 00: Grouting
- J. Section 09 90 00: Painting and Coating
- K. Section 31 05 23: Cement and Concrete Conforming to Greenbook Specifications

1.3 System Description

- A. Furnish and install pigmented curing compound which when applied to fresh concrete will form continuous membrane over exposed surface.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. AASHTO M182 Burlap Cloth Made from Jute or Kenaf and Cotton Mats
 - 2. ASTM C31 Making and Curing Concrete Test Specimens in Field
 - 3. ASTM C156 Water Retention by Concrete Curing Materials
 - 4. ASTM C171 Sheet Materials for Curing Concrete
 - 5. ASTM C192 Making and Curing Concrete Test Specimens in Laboratory
 - 6. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 7. California Building Code (CBC)
 - 8. California Green Building Standards Code (CALGreen Code)
 - 9. Fed Spec UU-B-790A Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellent and Fire Resistant
 - 10. NSF/ANSI 61 Drinking Water System Components – Health Effects
 - 11. SSPWC Standard Specifications for Public Works Construction (Greenbook) §201-4 "Concrete Curing Materials
 - 12. SSPWC Standard Specifications for Public Works Construction (Greenbook) §303-1.10 "Curing."

1.6 Submittals

- A. Furnish the following submittals in accordance with ACI 301 and California Building Code.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit for curing compounds per Product Data requirements.	
Installation Instructions	Submit materials and methods for curing per Installation Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	For impervious sheet curing materials, submit Certificate of Compliance with ASTM C171.	
	For curing compounds, submit Certificate of Compliance with ASTM C309.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. In addition to requirements of ACI, refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, and Certificates of Compliance.

1.7 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow ASTM C309 and Manufacturer's instructions and warranty requirements for delivery, storage, and handling of curing compounds.
- C. At time of use, maintain pigmented curing compounds in thoroughly mixed condition.
- D. Store materials in air-tight containers when not in use.

1.8 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Curing Blankets	Reef Industries	Houston, TX (800) 231-6074
	Sika Corporation	Lyndhurst, NJ (800) 325-9504
	Accepted equal	
Curing Compounds (Water-Based Resin Type) Use where air quality regulations prohibit use of solvent based compounds	Edoco "Aqua Resincure"	Long Beach, CA (310) 834-3401
	Euco Euclid Chemical Co / RPM "Aqua-Cure" VOX	Cleveland, OH (800) 321-7628
	L M Scofield Company "Cureseal W®"	Los Angeles, CA (800) 800-9900
	Master Builders / BASF "Masterkure-WB"	Beachwood, OH (800) 228-3318
	W R Meadows SealTight VoComp®20	Hampshire, IL (800) 342-5976
	Accepted equal	
Evaporation Retardant for Curing	Euco Euclid Chemical Co / RPM "Eucobarl"	Cleveland, OH (800) 321-7628
	Master Builders / BASF (Confilm)	Beachwood, OH (800) 228-3318
	Accepted equal	

- B. Curing compounds shall be compatible and supplied by 1 Manufacturer capable of providing qualified field service representation.

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §201-4 for materials requirements for concrete curing materials.

C. Materials for concrete curing shall be:

ITEM	MATERIAL	SPECIFICATION
Curing Compounds		Conform to ASTM C309 Class B (Resin-type only) Liquid shall form continuous membrane over exposed concrete surfaces when applied to fresh concrete. Do not use sodium silicate compounds. Water loss $\leq 0.15\text{kg/m}^2$ in 24 hours per ASTM C156 Water loss $\leq 0.45\text{kg/m}^2$ in 72 hours per ASTM C156 SSPWC (Greenbook) §204-1 Type 1D clear or translucent with fugitive dye
Sheet Curing Materials	Type 1 Waterproof Paper	Conform to ASTM C171 With white polyethylene sheeting 2- mil nominal PE thickness Permanently bond to waterproof paper per Fed Spec UU-B-790A Loss of moisture per ASTM C156 $<0.055\text{ grams/cm}^2$
	Type 2 Polyethylene Film	White opaque 10-mil nominal PE thickness Loss of moisture per ASTM C156 $<0.055\text{ grams/cm}^2$
	Type 3 White-Burlap Polyethylene Sheet	Conform to AASHTO M182 White opaque polyethylene film impregnated or extruded onto 1 side of burlap 4-mil nominal PE thickness Burlap weight 9oz/yd ² Loss of moisture per ASTM C156 $<0.055\text{ grams/cm}^2$
	Type 4 Burlap	Weight $\geq 10\text{ oz/yard}$ 40" wide
Curing Mats	Heavy Shag Rugs, Carpets or Cotton Mats Quilted at 4" on center	Dry weight $\geq 12\text{ oz/sy}$
Curing Water		Shall not contain substances that stain or injure concrete.

D. Materials furnished for Work shall conform to requirements of ACI 301 §201, §203, and §204 as applicable.

PART 3 - EXECUTION**3.1 Preparation**

- A. Materials and equipment needed for curing and protection shall be on- site prior to start of concrete placement.
- B. Protect uncured concrete from exposure to rain for 12 hours.
 1. Protect uncured concrete from exposure to runoff or groundwater for 14 days.
- C. When recorded peak ambient temperature $>85^\circ\text{F}$ and is forecast to reach 85°F on consecutive days, shield concrete from direct sunlight for 3 days.
- D. Do not expose uncured concrete to fire or excessive heat
- E. Surface defect repairs that cannot be made within 2 hours following form removal shall be delayed until after curing compound has been applied.
- F. Cover and protect construction joints, shear planes, reinforcing steel and surfaces requiring bond as needed to prevent deposits or overspray of curing compound.

3.2 Installation/Application

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations

2. California Building Code Chapter 19 "Concrete"
 3. Other applicable building and CalGreen code requirements
 4. ACI 301 Structural Concrete for Buildings Chapter 8.
 5. ACI 305R Hot Weather Concreting
 6. ACI 318 Building Code Requirements for Reinforced Concrete
 7. ACI 350 Code Requirements for Environmental Concrete Structures
 8. Manufacturer's installation and warranty requirements
 9. Standard Specifications for Public Works Construction §303-1.10 "Curing."
- C. Refer variances between above documents and Contract Documents to City's Representative.
- D. Cure finished surfaces using methods and duration similar to that for adjacent concrete.
- E. If fresh concrete may check or crack prior to commencement of curing due to weather, materials used, or other reasons, keep concrete damp but not wet using indirect fine water spray until it is unlikely checking or cracking will occur, or until curing commences.
- F. Concrete curing shall proceed as follows:

SURFACE	DESCRIPTION
Unstripped Forms	Method 1: Wet wood forms completely after concrete has been placed, and keep wet with water until forms are removed. For steel forms, keep exposed concrete surfaces continuously wet until forms are removed. If forms are removed within 14 days of placing concrete, continue curing as described for surfaces with forms removed
Construction Joints between Footings & Walls	Method 2 (Moist Curing): Cover surface with at least 2 layers burlap or cotton mats. Wet mats with water for duration of 14-day curing period until concrete in walls has been placed. Horizontal non-architectural flatwork, including roadways, slabs, curbs, and walks may also be water-cured by ponding or by covering with 2" of saturated sand in lieu of burlap or cotton mats. Do not apply curing compound to joint surfaces.
Encasement Concrete	Method 3: Cover surface with moist earth 4 to 24 hours after concrete is placed. Earthwork operations that may damage concrete shall not begin until ≥ 7 days after concrete is placed.
Concrete Surfaces not Described Elsewhere	Method 2 (Moist Curing) (described above) Method 4 (Curing Compounds): As soon as concrete hardens enough to prevent marring on unformed surfaces, and within 2 hours after form removal, spray surface with 2 coats liquid curing compound at minimum 75-psi pressure and uniform coverage of $\leq 400\text{ft}^2/\text{gallon}$ each coat. Apply first coat as soon as finished concrete surface reaches uniformly damp appearance with no free water on surface. Allow first coat to dry up to 4 hours, then apply 2 nd coat perpendicular to 1 st coat. Respray concrete surfaces subjected to rainfall within 3 hours after curing compound application by method and at coverage specified. Protect concrete surfaces to which curing compound is applied for duration of curing period from pedestrian and vehicular traffic or causes that will disrupt continuity of curing membrane. Do not damage seal during curing. If seal is damaged or broken, reapply curing compound over damaged portion. Where curing compound is accidentally applied to surfaces against which concrete is to be subsequently placed, remove curing compound by wet sandblasting just before placing new concrete. Where concrete is placed adjacent to panel coated with curing compound, apply curing compound to previously coated panel areas within 6' of joint and apply to other locations where curing membrane is disturbed. Following curing, remove visible traces of curing compound without damaging surface finish. Appearance is a primary consideration for concrete surfaces exposed to view. Apply curing compound evenly on these surfaces. Repair variations in shade, color or tint, resulting from uneven application of curing compound.
Floor Slabs on Grade	Method 5 (Curing Blankets): Before curing medium is applied, keep entire surface damp using nozzles that atomize flow so surface is not marred or washed. Apply curing material using Method 4 (Curing Compounds) described above.

SURFACE	DESCRIPTION
	After 1 hour but not more than 4 hours after applying curing material, wet surface with water delivered through fog nozzle. Place concrete curing blankets on slab, with edges butted together and with joints between strips sealed with 2" wide strips of sealing tape or with edges lapped at least 3" and fastened with waterproof cement to form continuous watertight joint. During first 3 days of curing, do not permit traffic or depositing of materials on curing blankets. After 3 days, traffic or material deposits shall only occur on top of 5/8" minimum plywood sheets laid over curing blankets. Leave curing blankets in place for ≥ 14 days. Add water under curing blanket as necessary to maintain damp concrete surfaces. Do not remove curing blankets until concrete for adjacent Work has been placed. Should curing blankets tear or become damaged, replace damaged sections.

G. Dispose of excess curing water in manner that avoids damage to Work.

H. Hot-weather curing shall proceed as follows:

1. If surface moisture evaporation rate as determined by nomograph in ACI 305R, is expected to be >0.2 psf per hour such as to cause plastic shrinkage cracking, make provision for windbreaks, shading, fog spraying, or wet covering with light colored material in advance of placement.
2. Take such protective measures as quickly as finishing operations allow.

I. Allow concrete to cure ≥ 14 days before applying architectural finishes.

3.3 **Field Quality Control**

A. Refer to Section 03 30 00 for field testing and inspection of concrete.

B. Special inspection and field testing of Class AA and Class A concrete required by Chapter 17 of CBC (Table 1705.3) shall be completed by ICBO-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Class AA Concrete, Class A Concrete and Concrete having f_c exceeding 2500 psi	Curing Temperature and Techniques	ACI 318 §26.4.7-26.4.9	Periodic per CBC Table 1705.3	City	Contractor to reimburse City for costs of first deputy inspector if re-inspection is required
Curing Compound	Mixing Verification	Verify curing compound has been mixed before spraying	As directed	City	City
	Local Application Rate	Within 50ft ² per gallon of specified rate per California Test 535	As directed	Contractor	Contractor
	Average Application Rate	Within 25ft ² per gallon of specified rate per California Test 535	As directed	Contractor	Contractor
Curing Period	Moist Curing	Record surface moisture conditions in daily log	1 inspection per day	Contractor	Contractor
	Impervious- Sheet Curing	Record condition of covering and tightness of laps and tapes in daily log	1 inspection per day	Contractor	Contractor
	Hot-Weather Protection	Record temperature in daily log	1 inspection per day and hourly for 1 st 24 hours upon removal of protection	Contractor	Contractor

3.4 Protection

- A. Protect concrete against injury until final acceptance by City.

END OF SECTION

SECTION 03 60 00**GROUTING****PART 1 - GENERAL****1.1 Work Included**

- A. Materials, testing, and installation of cement grout, quick-setting grout, dry-pack grout, non-shrink grout, topping grout, structural repair grout, and pressure grouting other than for masonry.
- B. Use quick setting grouts for setting posts and anchors in concrete or masonry.
- C. Use non-shrink grout for setting bearing plates.
- D. In places of high temperature or fire hazard, use non-shrink grout Class I, and not Class II.
- E. Conform to Standard Specifications for Public Works Construction (Greenbook) §201-7, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 03 39 00: Concrete Curing
- K. Section 05 05 19: Post-Installed Concrete Anchors
- L. Section 09 90 00: Painting and Coating

1.3 System Description

- A. Furnish and install complete grouted system with applicable embedments, including appurtenant structural, mechanical, and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Plant testing of aggregate shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Aggregate	Sieve Analysis	ASTM C136	1 each trial batch	City	Contractor
	Amount passing #200 sieve	ASTM C117	1 each trial batch	City	Contractor
Fine Aggregate	Sand Equivalent	ASTM D2419	As directed	City	Contractor
	Organic Impurities	ASTM C40	As directed	City	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Soundness	ASTM C88	As directed	City	Contractor

C. Plant testing of grout shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Grout	Certification of Mix Design	ACI 301 certified by independent testing laboratory	1 per mix	Contractor	Contractor
	Strength Requirements	Applicable specified ASTM Standards tested at 28 days	1 per product type	Contractor	Contractor
Grout Materials	Materials Inspection	Refer to Paragraph 2.2 below	As directed	City	City

1.5 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM C33 Concrete Aggregate.
2. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens
3. ASTM C40 Organic Impurities in Sand for Concrete.
4. ASTM C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
5. ASTM C109 Compressive Strength of Hydraulic Cement Mortars (Using 2" Cube Specimens)
6. ASTM C117 Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing.
7. ASTM C136 Sieve or Screen Analysis of Fine and Course Aggregates.
8. ASTM C150 Portland Cement.
9. ASTM C494 Chemical Admixtures for Concrete.
10. ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens.
11. ASTM C531 Linear Shrinkage and Cioefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concrete
12. ASTM C579 Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
13. ASTM C580 Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
14. ASTM C827 Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
15. ASTM C939 Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
16. ASTM 1090 Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout
17. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).
18. ASTM C1116 Fiber-Reinforced Concrete
19. ASTM D695 Compressive Properties of Rigid Plastics.
20. California Test No. 217 Sand Equivalent
21. California Building Code (CBC)
22. CRD-C 621 Corps of Engineers Specification for Non-Shrink Grout
23. International Concrete Repair Institute (ICRI) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Product Data required for bonding compounds, non-shrink grout, repair grout, topping grout, and water reducing retardant per Product Data requirements.	
Installation Instructions	Submit per Installation or Application instruction requirements for each type of manufactured grout.	
SAMPLES		
Material Samples	Submit color samples for grout mortar on request. Mortar color shall match adjacent Work.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		

SUBMITTAL	DESCRIPTION	
Certificate of Compliance	Submit mill test certification including fineness for each shipment of cement per ACI 301.	
	Submit aggregate gradation and certification per ACI 301.	
	Submit admixture certification including chloride ion content per ACI 301.	
	Submit Manufacturer's certification grouts contain no chlorides or corrosive chemicals.	
	Submit Manufacturer's certification non-shrink grout contains no aluminum, zinc, or magnesium powders as method of expansion.	
	Submit Manufacturer's certification non-shrink grout does not rely on gas production or gypsum expansion.	
	Submit certification grout conforms to specified strength requirements	
Test Record Transcripts	Submit for factory tests per Test Record Transcript requirements.	
Delivery Tickets	Submit as required for payment.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance Submit name and telephone number of grout Manufacturer's representative who will provide on-site service. Representative shall have at least one year of experience with specified grouts.	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, Certificates of Compliance, and Test Record Transcripts.
- C. When sources of aggregate are changed, submit new certification for new materials prior to its use.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of grout.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Bonding Agent (Noncorrosive)	Concresive Div BASF	Shakopee, MN (800) 433-9517
	Edoco / Dayton Superior	Kansas City, KS (877) 266-7732
	Master Builders / BASF	Beachwood, OH (800) 228-3318
	Sika Corporation "Armatec 110 EpoCem"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Lubricant for Cement Pressure Grouting	Intrusion Prepakt Intrusion Aid	Nanaimo, BC (604) 618-2304
	Sika Corporation Intraplast	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Non-Shrink Epoxy Grout	BASF Construction Chemicals "Masterflow 648"	Beachwood, OH (800) 228-3318
	Five Star Products "Five Star Epoxy Grout"	Shelton, CT (800) 243-2206
	L&M Construction Chemicals / Laticrete "EpogROUT"	Bethany, CT (800) 362-3331
	Accepted equal	
Non-Shrink Grout Class I	BASF Construction Chemicals "Masterflow 713"	Beachwood, OH (800) 228-3318
	Euco Euclid Chemical Co "High Glow Grout"	Cleveland, OH (800) 321-7628
	Five Star Products "Five Star Grout"	Shelton, CT (800) 243-2206

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Gifford-Hill American, Inc.	Dallas, TX (214) 262-3600
	Hilti "CG 200PC"	Tulsa, OK (800) 879-8000
	L&M Construction Chemicals / Laticrete "Duragrout"	Bethany, CT(800) 362-3331
	Master Builders / BASF. Embeco 636	Beachwood, OH (800) 228-3318
	Master Builders / BASF MasterFlow 928	Beachwood, OH (800) 228-3318
	Sika Corporation "Sikagrout 212"	Lyndhurst, NJ (800) 933-7452
	Tremcrete Systems, Incorporated	Woodland, CA
	Accepted equal	
Non-Shrink Grout Class II	BASF Construction Chemicals "Masterflow 928"	Beachwood, OH (800) 228-3318
	Five Star Products "Fluid Grout 100"	Shelton, CT (800) 243-2206
	L&M Construction Chemicals / Laticrete "Crystex"	Bethany, CT(800) 362-3331
	Accepted equal	
Structural Repair Grout	BASF Construction Chemicals "Emaco S88CI"	Beachwood, OH (800) 228-3318
	Five Star Products "Structural Concrete ES"	Shelton, CT (800) 243-2206
	Sika Corporation "Sikarepair 224"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	
Water Reducing Retarder	Sika Corporation Plastocrete "161MR"	Lyndhurst, NJ (800) 933-7452
	Sika Corporation "Plastiment"	Lyndhurst, NJ (800) 933-7452
	Accepted equal	

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §201-7 for materials requirements for non-masonry grout.
- C. Provide the following grouts for the applications listed:

APPLICATION	TYPE OF GROUT
Anchor bolts, anchor rods and reinforcing steel required to be set in grout in which average working or operating temperature >100°F or in high fire risk areas.	Non-Shrink - Class I
Storage tanks and non-motorized equipment and machinery <30 horsepower	Non-Shrink - Class I
Pumps ≤1000 horsepower, unless indicated otherwise	Non-Shrink - Class I
Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time >20 min.)
Surface repairs	Cement Grout
Repair of small (largest dimension <12") holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I or Non-Shrink - Class II or Structural Repair Grout
Repair of small (largest dimension <12") holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II or Structural Repair Grout
Repair of large (largest dimension >12") holes and defects in concrete members.	Structural Repair Grout
Applications not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise

- D. Materials for grout shall be:

ITEM	MATERIAL	SPECIFICATION
Cement	Portland Cement	Conform to ASTM C150 Type II/V Modified Low Alkali/Sulfate Resisting, including Table 2 optional requirements Low Alkali containing ≤0.60% alkalis
	Gradation	≥85% of cement by weight shall pass #325 screen.
Water	Clean, Clear Potable Water	TDS<1000 mg/l
Aggregate	All Aggregate	Conform to ASTM C33 Nonreactive clean hard durable washed material From pits acceptable to City's Representative Ratio of silica released to reduction in alkalinity <1.0 Ratio of fine aggregate to total aggregate shall be <41% for hydraulic structures

ITEM	MATERIAL	SPECIFICATION	
		and <50% for all other structures.	
	Fine Aggregate	Natural sand, manufactured sand or combination Sand Equivalent $\geq 75\%$ average for 3 samples or $\geq 70\%$ for any 1 sample. Gradation – well graded per ASTM C33 100% passing #8 sieve 45% or more passing #40 sieve 3% max passing #200 sieve Variation will be accepted if average of 3 consecutive tests falls within limits and variation does not exceed the following: Sieves #30 or coarser: $\leq 2.0\%$ variation Sieves #50 or finer: $\leq 0.5\%$ variation Soundness $\leq 10\%$ loss with sodium sulfate Fineness modulus < 3.00	
Admixtures	All Admixtures	Compatible with grout Conform to ASTM C494 Do not use admixtures containing calcium chloride Use admixtures in accordance with Manufacturer's recommendations Add admixtures separately to grout mix	
	Water Reducing Retarder	Conform to ASTM C494 Type D	
Bonding Agent		Epoxy resin with anti-corrosive properties	
Grout	Dry-Pack Grout	Proportions (parts by volume)	1 part cement 2 parts fine aggregate Water reducing retarder Sufficient water to make stiff workable mix.
	Cement Grout	f_c	≥ 4000 psi within 28 days
		Proportions (parts by volume)	1 part cement 2 / 3 parts fine aggregate Pressure grouting admixture Minimum amount of water to make stiff workable mix.
		Coloring Additive	Blend white Portland cement with regular cement as needed to match adjacent concrete color
	Quick-Setting Grout	f_c	≥ 2500 psi within 24 hours
		Set time	≤ 90 minutes at 70°F to initial set
		Color	Non-staining
	Non-Shrink Epoxy Grout	f_c	≥ 5000 psi at 24 hours $\geq 10,000$ psi at 24 hours
		Minimum Working Life	≥ 45 minutes at 75°F
		Pourable. Non-shrink 100% solids system, pre-measured and pre-packaged Chemical formulation recommended by Manufacturer for application	
	Non-Shrink Grout Class I	f_c	≥ 6000 psi per ASTM C39 at 28 days
		Tensile Splitting Strength	≥ 500 psi per ASTM C496 at 28 days
		Flexural Strength	≥ 500 psi per ASTM C580 at 28 days
		Bond Strength (Concrete to Grout)	≥ 1900 psi per ASTM C882 at 28 days
		Early-Age Height Change	$\leq 4.0\%$ per ASTM C827
		Shrinkage	0.0% per ASTM C827 and ASTM C1090
		Expansion	$\leq 0.3\%$ per ASTM C1090
		Slump Rejection Limit	$\leq 4"$ on any test per ASTM C143
		Conform to ASTM C1107 Grade B or C when mixed to fluid, flowable, and plastic consistencies.	
		Prepackaged, inorganic, fluid, non-staining, noncorrosive, non-gas-liberating, non-metallic, free-flowing, cement-based grout requiring only addition of potable water. Grout, when tested, shall not bleed or segregate and maximum allowed water. Do not use cement from kilns burning metal-rich hazardous waste fuel. Grout shall be free of chlorides or corrosive additives.	

ITEM	MATERIAL	SPECIFICATION	
	Non-Shrink Grout Class II	Formulate grout for use at any consistency from fluid to plastic. Manufacturer's application instruction shall be printed on container, bag, or packaging.	
		f_c	≥7500 psi per ASTM C39 at 28 days
		Tensile Splitting Strength	≥500 psi per ASTM C496 at 28 days
		Flexural Strength	≥500 psi per ASTM C580 at 28 days
		Bond Strength (Concrete to Grout)	≥1900 psi per ASTM C882 at 28 days
		Slump Rejection Limit	≤4" on any test per ASTM C143
		Conform to ASTM C1107 Grade B or C when tested using amount of water needed to achieve fluid consistency per ASTM C939	
		Prepackaged, inorganic, fluid, non-staining, noncorrosive, non-gas-liberating, non-metallic, free-flowing, cement-based grout requiring only addition of potable water. Grout, when tested, shall not bleed or segregate and maximum allowed water. Do not use cement from kilns burning metal-rich hazardous waste fuel. Grout shall be free of chlorides or corrosive additives. Grout shall have extended working time of ≥30 minutes when mixed to fluid consistency as defined in ASTM C827 at temperature extremes of 45-90°F in accordance with ASTM C1107. Formulate grout for use at any consistency from fluid to plastic. Manufacturer's application instruction shall be printed on container, bag, or packaging.	
	Structural Repair Grout	f_c	≥6000 psi per ASTM C109 at 7 days
		Bond Strength (Concrete to Grout)	≥2000 psi at 1 day per ASTM C882
		Slump Rejection Limit	≤4" on any test per ASTM C143
		Extended-set pre-packaged cement-based mortar requiring only addition of potable water. Grout shall be free of chlorides or lime other than that contained within hydraulic cement composition. For repairs >2 ft ³ , structural repair grout may be extended by adding clean, damp, coarse aggregate per Manufacturer's recommendations.	
Curing Materials		Refer to Section 03 39 00 and Manufacturer's recommendations.	

2.3 Mixes

A. Measure grouts as follows:

1. Measure cement grout accurately by volume using containers.
 - a. Do not use shovel measurements.
2. For prepackaged grouts, measure ingredients by means recommended by Manufacturer.

B. Mix grouts as follows:

1. Mix grouts to consistency needed to fill grouted space for each application.
2. Mix grout for ≥1 minute.
 - a. Agitate diluted grout to keep ingredients mixed.
3. "Dry-pack" consistency shall mean plastic and moldable grout that will not flow.
4. Adjust slump for concrete/grout fill to match placement and finishing conditions but do not exceed specified maximum.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install grout before ordering.
 - 1. Make minor changes in dimensions as needed to avoid utilities or structural conflicts.
- B. At least 10 Working Days before grouting, conduct pre-installation meeting to review requirements for surface preparation, mixing, placing, and curing for each proposed product.
 - 1. Notify all parties involved with grouting including City's Representative.
 - 2. Provide services of field technician from grout Manufacturer to attend pre-installation meeting, observe initial installation of each grout type, and correct installation problems.
- C. Prepare for grouting beneath equipment base plates as follows:
 - 1. Size concrete equipment pads for equipment bases to be grouted so when equipment base is fully grouted, grout is stopped ≥ 1.0 " from pad edge.
 - 2. Block out original concrete or finish concrete off sufficient distance below equipment mounting plates to provide ≥ 1 " grout thickness or other thickness shown.
 - 3. Complete mechanical, electrical, and finish work prior to placing topping or concrete/grout fill.
- D. Prepare for non-shrink grouting to cement dowels and adhesive anchors in place as follows:
 - 1. Install drilled anchors in concrete having age ≥ 21 days at time of anchor installation.
 - 2. Identify position of reinforcing steel and other embedded items prior to drilling holes.
 - 3. Unless otherwise shown, when non-shrink-grout anchors are used to resist tensile forces in structural applications, embedment depth shall equal or exceed development length (l_d) determined in accordance with ACI 318 for cast in place reinforcing bars of same diameter and grade, unless it can be shown by calculation anchor spacing and edge distance is sufficient to develop tensile strength of anchor using lesser depth of embedment.
 - a. Submit calculations.
 - 4. Exercise care in drilling to avoid damaging existing reinforcing or embedded items.
 - a. Avoid damaging prestressing tendons, electrical and communications conduit, and piping.
 - 5. Adjust locations of drilled holes to avoid damage to reinforcing bars or embedded items.
 - 6. Relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of Work and provided at no additional cost to City.
 - 7. Notify City's Representative if reinforcing steel or other embedded items are encountered during drilling.
 - 8. Do not core drill holes, unless separately accepted.
 - 9. Clean holes with water under pressure prior to grout and anchor installation.
 - 10. Drill, brush, and clean holes in accordance with Manufacturer's instructions.
- E. Do not place grout until base concrete or masonry has attained its design strength.
- F. Contact grout Manufacturer's representative for assistance on hot- and cold-weather grouting techniques and precautions if applicable.
- G. When cementitious grouts are used on concrete surfaces, saturate concrete surface with water for 24 hours prior to placement.
 - 1. Upon completion of saturation period, remove excess water with clean, oil-free compressed air prior to grouting.
- H. Surface preparation, curing, and protection of cement grout shall conform to Section 03 30 00.
- I. Holes required for grouting shall be blown clean.

1. Drill horizontal holes for grouting at slight downward angle to facilitate holding grout until setting is complete.
2. Slightly bend bolts or reinforcing steel installed in horizontal grout holes accordingly.
- J. Surfaces to contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- K. Wash concrete surfaces clean and keep moist for ≥ 24 hours before placing non-shrink cementitious or cement grout.
 1. Achieve saturation by covering concrete with saturated burlap bags, use of soaker hoses, or flooding.
 2. Upon completion of 24-hour pre-soak, remove visible water from surface before grouting.
- L. Shade Work from sunlight for at least 24 hours before and 48 hours after grouting.
- M. Apply bonding agent to existing surfaces before applying grout or mortar.

3.2 Installation

- A. Refer to 01 73 00 for basic execution and installation requirements.
- B. Furnish and install grout at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. Applicable building code requirements
 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install grout to tolerances recommended by Manufacturer.
 1. Unless otherwise shown, install grout true and level using precision gauges and levels.
- F. Install dry-pack grout as follows:
 1. Use dry-pack grout for built-up surfaces, setting miscellaneous metal items and minor repairs.
 2. Roughen surfaces required to be built up with dry-pack grout by brushing, cleaning, and coating with bonding agent specified in this section before applying grout.
 3. Apply dry-pack grout immediately after applying bonding compound.
 - a. Apply grout in bands or strips to form smooth covering of required thickness.
 4. Slope construction joints in grout.
 - a. Clean and wet construction joints before resuming application.
 5. Cure dry-pack grout in accordance with Section 03 30 00,
- G. Install cement grout as follows:
 1. Cement grout may be used for filling nonbearing portions of equipment pads and pressure grouting.
 2. Except for specialized equipment for pressure grouting, mixing and placing apparatus shall be similar to that used for cast-in-place concrete.
- H. Install non-shrink grout as follows:
 1. Use non-shrink grout for bearing surfaces of machinery and equipment bases, and bearing plates, and for setting bolts and reinforcing steel in holes for grouting.
 2. Place non-shrink grout in accordance with grout Manufacturer's instructions.
 3. Grout structural, equipment, tank, and piping support bases, unless otherwise shown.

4. When anchor bolt or anchor rod diameter is $\leq 1"$, hole diameter shall be $\geq 2"$.
 - a. When anchor bolt/rod diameter is $> 1"$, hole diameter shall be $\geq 2 \times$ anchor bolt/rod diameter.
 5. Place non-shrink grout in holes in non-sag (trowelable) consistency.
 - a. Place grout in holes before anchor bolt/rod and then insert anchor bolt/rod and vibrate to ensure proper coverage.
 6. Grout forms for grouting beneath equipment base plates shall be tight against retaining surfaces.
 - a. Seal joints liquid-tight as recommended by grout Manufacturer.
 7. Coat forms as recommended by grout Manufacturer for easy form release.
 8. After base plate is set in position at proper elevation by steel wedges or double nuts on anchor bolts, fill space between bottom of plate and original concrete pour with non-shrink-type grout through headbox of appropriate size.
 9. For grouting beneath base plates, pour mixture of fluid consistency continuously into space between plate and base concrete.
 10. Ensure grout space is filled.
 11. Where this method of placement is not practical or where required by City's Representative, submit alternate grouting methods for acceptance by City's Representative.
- I. Install pressure grout as follows:
1. Pressure grouting equipment shall include mixer and holdover agitator tanks and shall be designed to place grout at pressures up to 50 psi.
 - a. Provide gages to indicate pressure used.
 - b. Provide mixer with meter capable of indicating grout volume used to $\pm 0.10 \text{ ft}^3$.
 2. Prior to grouting, wash systems and holes to be grouted.
 - a. Washing is not required for grouting soil voids outside pipe cylinders or casing pipes.
 3. Complete grouting without stoppage once grouting commences.
 - a. If equipment breaks down, wash out grouting system sufficiently to ensure fresh grout and adequate bond and penetration occur upon restarting grouting.
 4. Maintain grout pressure until grout has set.
- J. Refer to Section 03 39 00 for curing procedures.
- K. Finish of grout surface shall match adjacent concrete unless otherwise shown.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cement Grout Mix	Material Properties	ASTM C1019	2 samples per day	Contractor	Contractor
	Non-Shrink Grout Compressive Strength	ASTM C1107	3 samples per batch (7-day test) + 3 samples per batch (28-day test) from first placement of each grout type and at intervals directed by City's Representative	Contractor	Contractor
	Construction Tolerance	Refer to Section 03 30 00.			
	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

B. Provide services of factory-authorized representative on-site within 72 hours of request as part of Work to provide:

1. Installation technical assistance, inspection.
2. Field testing and adjustment.
3. Instruction of City's personnel in operation and maintenance.

END OF SECTION

SECTION 05 05 19

POST-INSTALLED CONCRETE ANCHORS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of post-installed concrete anchor bolts.
- B. Refer to Section 05 05 23 for cast-in-place embedded anchor bolts and for structural steel connections, including bolting and welding.
- C. Conform to Standard Specifications for Public Works Construction (Greenbook) §206, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 03 15 00: Concrete Accessories
- J. Section 03 30 00: Cast-in-Place Concrete
- K. Section 03 32 10: Cement Mortar
- L. Section 03 60 00: Grouting
- M. Section 05 05 23: Metal Fastenings and Welds
- N. Section 05 50 00: Metal Fabrications
- O. Section 05 52 00: Railings
- P. Section 09 92 00: Galvanizing
- Q. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install concrete anchors where shown including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Post-installed anchors shall be capable, under laboratory conditions described in ASTM E488, of sustaining the following loads:

SUBSTRATE	LOAD RESISTANCE AT FAILURE
Concrete	≥4 x imposed load
Masonry	≥6 x imposed load

- C. Shop quality control documentation shall be available in fabricator's shop for City's review.

1.5 References

- A. Reference publications listed below and in various sections form part of specification to extent referenced. These are referred to within text by basic designation only.
 1. AISC 316 Manual of Steel Construction ASD
 2. AISC 317 Manual of Steel Construction Volume II Connections

3. AISC S326 Design Fabrication and Erection of Structural Steel for Buildings
4. ASME/ANSI B1.1 Unified Inch Screw Threads
5. ASME/ANSI B18.21.1 Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
6. ASTM A36 Carbon Structural Steel
7. ASTM A167 Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip
8. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
9. ASTM A194 Carbon and Alloy Steel Nuts for High-Pressure and High-Temperature Service
10. ASTM A240 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
11. ASTM A307 Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
12. ASTM A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
13. ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
14. ASTM C881 Epoxy-Resin-Base Bonding Systems for Concrete
15. ASTM E10 Brinell Hardness of Metallic Materials
16. ASTM E488 Strength of Anchors in Concrete Elements
17. ASTM F436 Hardened Steel Washers
18. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
19. ASTM F594 Stainless Steel Nuts
20. ASTM F1554 Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
21. ASTM F3125 High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength
22. California Building Code (CBC)
23. MIL A907E Anti-seize Thread Compound, High-Temperature
24. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 206 "Miscellaneous Metal Items"
25. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 304 "Metal Fabrication and Construction"

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit for manufactured products per Product Data requirements. Include ICC test reports verifying strength per ASTM E488 and material equivalency for embedded anchors. Include temperature at which load capacity reduces to 90% of that determined at 75°F.	
Installation Instructions	Submit per Installation Instructions requirements for embedded anchors.	
SAMPLES		
Material Samples	Submit upon request	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
	Submit ICC-ES or IAPMO-UES report for epoxy anchor grouts for adhesive anchors.	
Foundry or Test Record Transcripts	Submit for factory tests upon request per Foundry or Test Record transcript requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, Certificates of Compliance, Foundry or Test Records, and Material Samples.

1.7 Delivery, Storage, and Handling

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of concrete anchor products.

- C. Store materials above ground on platforms, skids, or other supports and protect from rain, dirt, grease, foreign matter, and corrosion.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
EPOXY-BASED CONCRETE ANCHOR SYSTEMS, FASTENERS AND CONNECTIONS		
Concrete Anchors – Capsule Epoxy Adhesive Anchor Systems	Hilti USA. "HVU"	Tulsa, OK (800) 879-8000
	ITW Ramset / Redhead "Epcon"	Glendale Heights, IL (800) 348-3231
	MKT Fastening LLC "Liquid Roc"	Lonoke, AR (501) 676-2222
	Powers Fasteners, Inc. "Powers Pure 110+"	Brewster, NY (800) 524-3244
	Simpson Strong Tie Co. "Epoxy-Tie"	Riverside, CA (714) 871-8373
	Accepted Equal	
Concrete Anchors – Injectable Epoxy Adhesive Anchor Systems	Hilti USA. "HIT"	Tulsa, OK (800) 879-8000
	Accepted Equal	
Epoxy Grout for Anchor Bolts	Five Star Products "DP Epoxy Grout"	Shelton, CT (800) 243-2206
	Hilti USA. "HIT"	Tulsa, OK (800) 879-8000
	Epoxy grout recommended by anchor Manufacturer	
	Accepted Equal	
MECHANICAL CONCRETE ANCHOR SYSTEMS, FASTENERS AND CONNECTIONS		
Wall Anchors	Powers Fasteners, Inc.	Brewster, NY (800) 524-3244
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Provide adequately sized anchor bolts for equipment loads and in no case less than size recommended by equipment Manufacturer.
1. Provide embedded sleeve or epoxy-adhesive type anchors whenever possible.
 2. Anchor bolt assembly shall consist of anchor bolt, surrounding pipe sleeve, bottom plate, leveling nut, nut and washer.
 3. Assembly shall permit reasonable lateral movement of bolts to facilitate matching of bolts to equipment.
 4. If stainless steel anchor bolts are not provided, galvanize anchor bolts and anchor bolt assemblies after fabrication.
 5. Size anchors per Section 01 73 24 for seismic accelerations shown in Contract Documents.
- C. Refer to Section 05 05 23 for structural bolting.
- D. Materials for bolts, anchors and welds shall be:

ITEM	MATERIAL	SPECIFICATION
ANCHOR SYSTEMS		
Concrete Anchors – Epoxy Adhesive Anchor Systems	Embedded Stainless Steel Threaded Rod "CRES" (Use for corrosion resistant applications,	Conform to one of the following: ASTM A193 Grade B8M Class 1 SAE Type 316 bolts (F _y =30ksi, F _u =75ksi, E=29000ksi)

ITEM	MATERIAL	SPECIFICATION
	buried, or submersible locations, fasteners for equipment, fasteners for aluminum, nickel silver, and stainless steel, and in chemical handling areas or underground structures	ASTM A193 Grade B8M Class 2 SAE Type 316 bolts (F _y ≥50ksi, F _u ≥90ksi, E=29000ksi) ASTM F593 Condition AF Type 316 bolts with (F _y ≥20ksi, F _u ≥65ksi, E=29000ksi) ASTM F593 Condition A SAE Type 316 bolts 1/8"-1/4" shall project through tightened nut. Weldable
	Stainless Steel Threaded Nuts	Conform to one of the following: ASTM A194 Grade 8M Class 1 SAE Type 316 (F _y =30ksi, F _u =75ksi, E=29000ksi) ASTM A194 Grade 8M Class 2 SAE Type 316 (F _y ≥50ksi, F _u ≥90ksi, E=29000ksi) ASTM F594 Condition AF SAE Type 316 (F _y ≥20ksi, F _u ≥65ksi, E=29000ksi) ASTM F594 SAE Condition A Type 316 (F _y ≥30ksi, F _u ≥75ksi, E=29000ksi) Free-cutting steel capable of developing full strength of bolts
	Stainless Steel Threaded Washers	Conform to ASTM A240 and ANSI B18.21.1 Type A Plain
	Anchor System	Conform to ASTM C881 Type IV Grade 3, Classes A, B, and C with exception of gel time and epoxy content
	Epoxy Adhesive	2- or 3-component non-shrink non-sag paste, Moisture insensitive when cured Rated for cracked and uncracked concrete Tested per ICC-ES AC308 and IBC requirements
	Epoxy-Grout Aggregate	As furnished prepackaged by epoxy grout Manufacturer
Embedded Anchor Bolts 1/2"-4"		Refer to Section 05 05 23

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install concrete anchors before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Clean surfaces of metalwork to be in contact with concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
- C. Embedded anchors shall be secured accurately in position when concrete is placed to prevent displacement or undue vibration during or after placement of concrete.
- D. Concrete anchors not cast in place shall be installed in holes drilled or cored to dimensions shown in anchor Manufacturer's installation instructions.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for execution and installation requirements.
- B. Furnish and install concrete anchors at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations.
 2. California Building Code Chapter 19 "Concrete."
 3. California Building Code Chapter 22 "Steel."
 4. AISC 316 and 317 Manual of Steel Construction
 5. AISC 360 Structural Steel Buildings

6. Other applicable building and fire code requirements.
 7. Manufacturer's installation and warranty requirements.
 8. SSPWC Standard Specifications for Public Works Construction (Greenbook) §304 "Metal Fabrication and Construction."
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Drill and install epoxy adhesive anchor systems as follows:
1. Do not install drilled anchors until concrete has reached required 28-day compressive strength.
 2. Drill holes perpendicular to exposed face of concrete and place within tolerances accepted within AISC documents.
 3. Drill holes to permit embedments and spacings required by Manufacturer to develop full anchor strength and to conform with CBC Table 1911.2.
 4. Roughen holes with clean and dry brush mounted on power drill.
 5. Do not load adhesive anchors until adhesive has reached its indicated strength in accordance with Manufacturer's instructions.
- F. Unless expressly shown otherwise or supported by Contractor-submitted and City-accepted shop drawings and engineering calculations, install bolts with embedments, edge distances and spacings per CBC Table 1911.2 including the following requirements:

BOLT DIAMETER	MINIMUM EMBEDMENT	MINIMUM EDGE DISTANCE	MINIMUM SPACING
1/4"	2 1/2"	1 1/2"	3"
3/8"	3"	2 1/4"	4 1/2"
1/2"	4"	3"	6"
5/8"	4 1/2"	3 3/4"	7 1/2"
3/4"	5"	4 1/2"	9"
7/8"	6"	5 1/4"	10 1/2"
1"	7"	6"	12"
1 1/8"	8"	6 3/4"	13 1/2"
1 1/4"	9"	7 1/2"	15"

- G. Conceal fastenings whenever possible.

3.3 **Field Quality Control**

- A. Special inspection and field testing required by Chapter 17 of CBC (Table 1704.3 and 1704.4) shall be completed by an ICC-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Anchor Bolts	Embedded Bolts in Concrete and Masonry	CBC Table 1704.4, CBC 1911.5	Continuous per CBC Table 1704.3	Contractor	Contractor
	Edge Distances and Spacings	Visual inspection and measurement per CBC Table 1911.2	All bolts	City	City
	Bolt Placement Error Within Same Group	≤ 1/8" and fit within pre-drilled base	All bolts	City	City
	Bolt Placement Error Between Adjacent Bolt Groups	≤ 1/4" and fit within pre-drilled base	All bolts	City	City
	Elevation of Anchor Bolt Tops	± 1/2"	All bolts	City	City

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Bolt Variation from Perpendicular to Concrete Surface	0° (no tolerance)	All bolts	City	City
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	All bolts	City	Contractor

END OF SECTION

SECTION 05 05 23

METAL FASTENINGS AND WELDS

PART 1 - GENERAL

1.1 Work Included

- A. Basic requirements for metal fastenings and welds.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 05 05 19 for post-installed anchor bolts.
 - 2. Section 33 05 31 for pipeline joint materials.
 - 3. Section 33 05 38 for hangers and supports.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 63 00: Product Substitution Procedures
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 01 73 00: Execution
- I. Section 01 73 24: Seismic Restraint
- J. Section 01 73 33: Mechanical Identification
- K. Section 03 60 00: Grouting
- L. Section 05 05 19: Post-Installed Concrete Anchors
- M. Section 05 50 00: Metal Fabrications
- N. Section 33 05 31: Pipeline Joint Materials
- O. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Use the following fasteners to fasten the metal materials shown:

METAL BEING FASTENED	FASTENERS
Aluminum	Stainless Steel "CRES"
Cast or Ductile Iron	Stainless Steel "CRES"
Non-Structural Steel	Low-Carbon Steel
Structural Steel	High-Strength Alloy Galvanized Steel
Stainless Steel	Stainless Steel "CRES"

1.4 Quality Assurance

- A. Employ only competent workers on Work.
 - 1. Employed persons found to be incompetent, intemperate, troublesome, disorderly, or otherwise objectionable or who fail to perform Work properly, acceptably and in accordance with Manufacturers' installation and warranty requirements, shall be immediately removed from Work by Contractor and not reemployed on Work.
 - 2. Welders shall be AWS certified for type of work they are performing.
- B. Construction equipment requirements shall include:

CONSTRUCTION EQUIPMENT ITEM	FEATURE	REQUIREMENTS
Welding	General	Of reputable make and maintained in such condition as to enable qualified welders,

Equipment		welding operators, and tack welders to follow qualified welding procedures.
		Provide consumable material including electrodes. Store and handle other welding consumables per Manufacturer's recommendations.
	SMAW Electrodes	Use only low-hydrogen electrodes for SMAW Handle, store, and condition SMAW electrodes as described in AWS D1.1 or applicable procedure
Filler Metals		Choose filler metals to suit base metal and process used per above referenced standards

C. Structural steel welding in off-site fabrication shops shall be continuously inspected by governing jurisdiction's Certified Special Inspector.

1. For fabrication performed in shop of licensed Fabricator accepted by governing Building Official and certified by ICC, only field welding and high-strength bolting of structural steel assemblies will be required to be performed under continuous inspection by ICC-certified Special Inspector.
2. City's Representative reserves right to inspect fabricated material or steel at Fabricator's shop to verify materials used conform to mill tests, affidavits of test reports, and that fabrication and welding procedures meet specifications.
3. Notify City's Representative and supply City's Representative with test reports ≥ 2 Working Days in advance of fabrication to allow shop inspection of steel to occur at City's option.
4. If City's Representative identifies faulty materials or workmanship in fabricated material at Fabricator's shop, pay City's reasonable costs for subsequent retests or inspections.

D. Unless otherwise indicated, nondestructive tests shall conform to applicable sections of ASTM Standards, Part 11, "Metallography; Nondestructive Tests."

1. Unless otherwise noted, determine standard for nondestructive testing applicable to material and manufacturing method used.
2. Extent of examination and basis for acceptance shall be agreed upon between City's Representative and Contractor.
3. Contractor's Shop Drawings submitted for review shall define areas, extent, and type of nondestructive examination.
4. Weld inspection and acceptance criteria shall conform to AWS D1.1 and ASME Boiler and Pressure Vessel Code requirements.
5. Certify personnel performing and interpreting nondestructive examinations have been qualified as Level II or III examiners in accordance with ASNT SNT-TC-1A.

E. Factory testing of factory welds shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
METAL FASTENINGS					
Bolts	Chemical and Physical Properties	Use applicable ASTM standards (varies with steel)	Submit Certificate of Compliance for each lot	Contractor	Contractor
Fabricated Steel	Inspection of High-Strength Bolted Connections	ASTM F3125	At City's Discretion during City instigated shop inspection	City	Contractor
WELDS					
Fabricated	Off-jobsite	ICC-Certified Special Inspector	Continuous	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Steel	Welding Special Inspection	selected by Building Official			
	Welding Procedures	AWS D1.1	Continuous	City	Contractor
NONDESTRUCTIVE WELD TESTING					
Weld Examination Before and After Stress- Relieving	Welds	Visual Inspection (VT)	100% of total length	Contractor	Contractor
	Pressure Vessels	PT, MT, UT and/or RT, as specified above, unless otherwise accepted by City's Representative	100% of total length	Contractor	Contractor
	Plate Edge Preparation Prior to Pressure Vessel or Thick Plate Welding	Liquid penetrant (PT)	100% of total length	Contractor	Contractor
	Fillet Welds between Main Components	Magnetic particle (MT) or liquid penetrant (PT) examination	100% of total length	Contractor	Contractor
	Fillet Welds Including Welds between Stiffeners and Main Beam Members	Magnetic particle (MT) or liquid penetrant (PT) examination	25% of total length selected at random	Contractor	Contractor
	Partial Penetration Welds	Magnetic particle (MT), liquid penetrant (PT), or ultrasonic (UT) examination	25% of total length selected at random	Contractor	Contractor
	Full-Penetration Welds other than Butt Welds	Ultrasonic (UT) examination followed by radiographic examination (RT if results are not clear, or by MT or PT if RT is not feasible.	100% of total length	Contractor	Contractor
	Butt Welds	RT and PT or MT, or UT followed by PT or MT and PT, if RT is not feasible	100% of total length	Contractor	Contractor
	Back-Gouging Full Penetration or Butt Welds	PT or MT for pressure vessels. As agreed upon between Contractor and City for other mechanical equipment	100% of total length	Contractor	Contractor
Equipment	Welds	VT, UT or RT	Spot-check as requested by City	Contractor	Contractor

- F. At time of assembling, bolting, or welding, contacting steel surfaces shall be free of rust, loose mill scale, dirt, grease, or other material foreign to steel.
1. Do not apply paint to contact surfaces before bolting, or welding.
- G. Holes for shop bolts shall be sub-punched or sub-drilled at fabricator's option ¼" less in diameter than that of finished holes, and reamed to size with parts assembled with the following exceptions:
1. Do not punch holes in material $>\frac{7}{8}$ " thick.
 2. At fabricator's option, holes in material $>\frac{7}{8}$ " thick may be sub-drilled to diameter specified for sub-punching or may be drilled full size with parts assembled, provided parts are adequately bolted or clamped together.

3. Holes in rolled beams and plate girders, including stiffeners and active fillers at bearing points may be sub-punched $\frac{1}{8}$ " less in diameter than that of finished holes, and reamed to size after assembly if material is not thicker than nominal diameter of bolt less $\frac{1}{8}$ ".
4. Holes in material $\leq \frac{7}{8}$ " thick for bolts which do not transfer stress caused by external vertical loading may be punched full size or, at fabricator's option, may be sub-punched $\frac{1}{8}$ " less in diameter than that of finished holes and reamed to size after assembly.
 - a. This applies to holes for stitch bolts, lateral, longitudinal, or sway bracing and their connecting material, lacing, stay plates, diaphragms which do not transfer shear or stress, inactive fillers, and stiffeners at bearing points.
 - b. However, holes through assembled material shall not pass through both reamed plies and plies punched full-size unless reamed holes have been sub-punched for fabricator's convenience, or assembled material is >5 plies thick, of which main material consists of ≤ 3 plies.

H. Repair defective factory welds.

1. Defective factory welds found after stress-relieving may require additional stress-relieving after weld repairs and re-examination of welds, as agreed upon between Contractor and City's Representative

1.5 References

A. Reference publications listed below and in various sections form part of specification to extent referenced. These are referred to within text by basic designation only.

1. AISC M011 Manual of Steel Construction for Shop and Field Welding
2. AISC 316 Manual of Steel Construction ASD
3. AISC 317 Manual of Steel Construction Volume II Connections
4. AISC S326 Design Fabrication and Erection of Structural Steel for Buildings
5. Aluminum Association Inc. Specifications for Aluminum Structures
6. ASME/ANSI B1.1 Unified Inch Screw Threads
7. ASME/ANSI B18.2.1 Square and Hex Bolts and Screws (Inch Series)
8. ASME/ANSI B18.2.2 Square and Hex Nuts (Inch Series)
9. ASME/ANSI B18.15 Forged Eyebolts
10. ASME/ANSI B18.21.1 Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
11. ASME/ANSI B31.1 Power Piping
12. ASME Boiler and Pressure Vessel Code
13. ASNT SNT-TC-1A Recommended Practice
14. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
15. ASTM A194 Carbon and Alloy-Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or both.
16. ASTM A307 Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
17. ASTM A489 Carbon Steel Lifting Eyes
18. ASTM E165 Liquid Penetrant Examination for General Industry
19. ASTM E433 Reference Photographs for Liquid Penetrant Inspection
20. ASTM E709 Magnetic Particle Testing
21. ASTM F436 Hardened Steel Washers
22. ASTM F541 Alloy-Steel Eyebolts
23. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
24. ASTM F594 Stainless Steel Nuts
25. ASTM F1554 Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
26. ASTM F3125 High-Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa)
27. AWS QC1 Qualification and Certification of Welding Inspectors
28. AWS/ANSI A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination
29. AWS/ANSI A2.3 Standard Welding Terms and Definitions
30. AWS/ANSI A5.5 Low-Alloy Steel-Covered Arc-Welding Electrodes
31. AWS/ANSI S B3.0 Welding Procedures and Performance Qualifications
32. AWS/ANSI D1.1 Structural Welding Code – Steel
33. AWS/ANSI D1.2 Structural Welding Code – Aluminum
34. AWS/ANSI D1.3 Structural Welding Code – Sheet Steel

35. AWS/ANSI D1.4 Structural Welding Code – Reinforcing Steel
36. AWS/ANSI D1.6 Structural Welding Code – Stainless Steel
37. AWS/ANSI D1.7 Strengthening and Repairing Existing Structures
38. AWS/ANSI D1.8 Seismic Supplement
39. AWS/ANSI D1.9 Structural Welding Code – Titanium
40. AWS QC1 Qualification and Certification of Welding Inspectors
41. AWS/ANSI W1 Welding Metallurgy
42. California Administrative Code, Title 8, “Construction Safety Orders”
43. California Building Code (CBC)
44. MIL-E-18038 Welding Medium- and High-Tensile Steels
45. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 206 “Miscellaneous Metal Items”
46. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 304 “Metal Fabrication and Construction”

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Welder and Weld Qualifications	Required for welders performing work on this project. Submit welding operator qualification records. Submit welding inspector qualifications. Submit welding rod control procedures.	
MANUFACTURER'S LITERATURE		
Shop Drawings	Submit for bolts $\geq 1"$ per structural Shop Drawing requirements Show welds on applicable Shop Drawings Show weld type using AWS symbols. Show weld procedure to be employed. Show examination procedures to be applied.	
Installation Instructions – Welding Procedures	Submit destructive and nondestructive test results, and welding bead profiles.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR)	Submit written WPSs and PQRs for each welding procedure used unless requirement is waived by City's Representative.	
Welder Procedure Qualification (WPQ) Certificates	Prior to start of Work for factory or field fabrication, submit written WPQs using sample forms in AWS D1.1 or similar forms unless requirement is waived by City's Representative. Submit for welders performing Work on this project. Also submit certifications of procedure qualifications for each welding procedure used.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance.	

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of products.
- C. Store low-hydrogen electrodes in accepted low-hydrogen oven at 300°F-400°F to control moisture in electrode coating.
 1. Restore low-hydrogen electrodes not packaged in moisture-proof container by rebaking for ≥ 2 hours at 450°F-500°F in accepted oven.
 2. After rebaking, store low-hydrogen electrodes in low-hydrogen oven at 300°F-400°F.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
BOLTS AND NUTS		
Bolts and Nuts	A&G Engineering Company	Anaheim, CA (714) 630-7400
	Birmingham Fastener Supply (BF)	Birmingham, AL (800) 695-3511
	Copper State Bolt & Nut	Phoenix, AZ (800) 603-6887
	Industrial Threaded Products, Inc. (wholesaler)	Brea, CA (800) 976-2658
	Le Jeune Bolt Co. (L)	Burnsville, MN (952) 890-4482
	Nucor Fasteners (n)	Saint Joe, IN (260) 337-1600
	Ocean State Stainless, Inc. (wholesaler)	Huntington Beach, CA (714) 898-0404
	Pacific Coast Bolt (wholesaler)	Santa Fe Springs, CA (562) 944-9549
	Portland Bolt Co. (PB)	Portland, OR (800) 547-6758
	Robbins Mfg. Co., Inc.(R)	Fall River, MA (508) 675-2555
	ShurSeal Industries (wholesaler)	Edmonton, AB (780) 435-3771
	Silo Fastener, Inc. (S)	Kansas City, MO (816) 231-6750
	St Louis Screw & Bolt Co. (SL)	Saint Louis, MO (314) 389-7500
	Texas Bolt Company (TB)	Houston, TX (713) 869-7111
	Tripac Fasteners (wholesaler)	Corona, CA (951) 280-4488
	Unytite, Inc. (UNY)	Peru, IL (815) 224-2221
	Vegas Fastener Manufacturing (VFM)	Las Vegas, NV (702) 651-9222
	Vulcan Rivet & Bolt Corp (V)	Birmingham, AL (205) 841-2711
	Western Pacific Products (wholesaler)	Chino, CA (909) 591-2410
	Accepted Equal	Phoenix, AZ (800) 603-6887
Anchor Bolts	Portland Bolt & Manufacturing Company	Portland, OR (800) 547-6758
	Steel City Bolt	Birmingham, AL (800) 522-2658
	Accepted Equal	
Studs	Nelson Stud Welding Div. (N)	Walnut, CA (909) 468-2105
	Stud Welding Associates (+)	Elyria, OH (440) 324-3042
	Accepted Equal	
EPOXY-BASED FASTENERS AND CONNECTORS		
Metal-to-Metal Epoxy	J-B Weld Company	Sulfur Springs, TX (903) 885-7696
	Accepted Equal	
COATINGS		
Anti-Seize Compound for Stainless Steel Bolts and Nuts	Anti-Seize Technology "Pure White"	Franklin Park, IL (800) 991-1106
	Bostik Never Seez	Wauwatosa, WI (800) 726-7845
	Dixon Ticonderoga Company "AS470"	Lakehurst, NJ (732) 657-2255
	Husk-Itt Husky Lube O-Seal	Norco, CA (951) 340-4000
	Loctite	Dusseldorf, DEU (800) 624-7767
	Permatex	Hartford, CT (877) 376-2839
	Ramco Specialty Products Anti-seize	Huntington Beach, CA (800) 334-7071
	Ramco Specialty Products TRX-Synlube	Huntington Beach, CA (800) 334-7071
	T Christy Enterprises, Inc. Anti-seize	Anaheim, CA (714) 507-3300
	Accepted Equal	
Galvanized Touch Up Material	Refer to Section 09 92 00	

2.2 Materials

A. Where not otherwise shown, use the following list of material specifications, which are acceptable for intended purposes, as referenced, for selecting standard types and grades of materials used.

ITEM	MATERIAL	SPECIFICATION
FASTENERS, AND CONNECTIONS		
Bolts and Nuts – High-Strength Alloy Galvanized Steel (Use for connection bolts and anchor bolts for structural members outside corrosive areas)	High-Strength Alloy Carbon Steel – Galvanized	Conform to one of the following: ASTM F3125 Grade 120ksi (F _y =92ksi, F _u =120ksi, E=29000ksi) ASTM F3125 Grade 150ksi (F _y =130ksi, F _u ≥150ksi, E=29000ksi) 1/8"-1/4" shall project through tightened nut. Heavy hexagon series
	Nuts	Free-cutting steel capable of developing full strength of bolts Use self-locking nuts or lock-washers and plain nuts Shape of nuts shall match bolt heads
	Threads	Conform to ANSI/ASME B18.2.1 for Bolts Conform to ANSI/ASME B18.2.1 for Nuts Coarse thread series Use taps and dies so bolts retain normal clearance after hot-dip galvanizing
	Galvanized Coating	Refer to Section 09 92 00
Bolts and Nuts - Stainless Steel "CRES" (Use for corrosion resistant applications, buried, or submersible locations, fasteners for equipment, fasteners for aluminum, nickel silver, and stainless steel, and in chemical handling areas or underground structures)	Stainless Steel – Corrosion-Resistant	Conform to one of the following: ASTM A193 Grade B8M Class 1 SAE Type 316 bolts with ASTM A194 Grade 8M Class 1 SAE Type 316 nuts (F _y =30ksi, F _u =75ksi, E=29000ksi) ASTM A193 Grade B8M Class 2 SAE Type 316 bolts with ASTM A194 Grade 8M Class 2 SAE Type 316 nuts (F _y ≥50ksi, F _u ≥90ksi, E=29000ksi) ASTM F593 Condition AF Type 316 bolts with ASTM F594 SAE Type 316 nuts (F _y ≥20ksi, F _u ≥65ksi, E=29000ksi) ASTM F593 Condition A SAE Type 316 bolts with ASTM F594 SAE Type 316 nuts (F _y ≥30ksi, F _u ≥75ksi, E=29000ksi) 1/8"-1/4" shall project through tightened nut. Heavy hexagon series
	Nuts	Free-cutting steel capable of developing full strength of bolts Use self-locking nuts or lock-washers and plain nuts Shape of nuts shall match bolt heads
	Threads	Conform to ANSI/ASME B18.2.1 for Bolts Conform to ANSI/ASME B18.2.1 for Nuts Coarse thread series Threads may be either cut or cold-formed
	Anti-Seize Lubricant	Conform to MIL A907E
Bolts – Embedded Eyebolts and Lifting Eyebolts	Stainless Steel	Conform to ASTM F541 SAE Type 316 Dimensions per ANSI/ASME B18.15 Welded eye type
Bolts – Naval Brass (Use for corrosion resistant applications and for fastening bronze)	Naval Brass	Conform to ASTM B21
Washers (Galvanized)	Carbon Steel – Galvanized	Square or rectangular smooth beveled washers, tapered in thickness Hardened washers for high-strength bolts shall conform to AISC specification
	Galvanized Coating	Refer to Section 09 92 00
Washers (Stainless Steel)	Stainless Steel	SAE Type 316 Square or rectangular smooth beveled washers, tapered in thickness
Lock Washers	Same Material as Nuts	Provide where shown.
Screws	Stainless Steel	Do not use slotted-head screws.

ITEM	MATERIAL	SPECIFICATION
WELDING ELECTRODES		
Welding Electrode - Steel	Steel Electrodes	Conform to AWS D1.1 Conform to AWS A5.5 E70xx, except E7024 rods or electrodes shall not be used
	Low-Hydrogen Electrodes	Conform to MIL-E-18038m (Ships)
Welding Electrode – Stainless Steel	Stainless Steel Electrodes	Type 347 electrode
Welding Electrode – Aluminum	Aluminum	Conform to AWS D1.2 Use type 4043 filler material
ANCHOR SYSTEMS		
Embedded Anchor Bolts ½”-4” Stainless Steel “CRES” (Use for corrosion resistant applications, buried, or submersible locations, fasteners for equipment, fasteners for aluminum, nickel silver, and stainless steel, and in chemical handling areas or underground structures)	Stainless Steel Threaded Rod	Conform to one of the following: ASTM A193 Grade B8M Class 1 SAE Type 316 bolts (F _y =30ksi, F _u =75ksi, E=29000ksi) ASTM A193 Grade B8M Class 2 SAE Type 316 bolts (F _y ≥50ksi, F _u ≥90ksi, E=29000ksi) ASTM F593 Condition AF Type 316 bolts with (F _y ≥20ksi, F _u ≥65ksi, E=29000ksi) ASTM F593 Condition A SAE Type 316 bolts ⅛”-¼” shall project through tightened nut. Weldable
	Stainless Steel Threaded Nuts	Conform to one of the following: ASTM A194 Grade 8M Class 1 SAE Type 316 (F _y =30ksi, F _u =75ksi, E=29000ksi) ASTM A194 Grade 8M Class 2 SAE Type 316 (F _y ≥50ksi, F _u ≥90ksi, E=29000ksi) ASTM F594 Condition AF SAE Type 316 (F _y ≥20ksi, F _u ≥65ksi, E=29000ksi) ASTM F594 SAE Condition A Type 316 (F _y ≥30ksi, F _u ≥75ksi, E=29000ksi) Free-cutting steel capable of developing full strength of bolts
	Stainless Steel Threaded Washers	Conform to ASTM A240 and ANSI B18.21.1 Type A Plain
	Grout	Refer to Section 03 60 00
	Galvanized High-Strength Alloy Carbon Steel Threaded Rod	Conform to one of the following: ASTM F3125 Grade 120ksi (F _y =92ksi, F _u =120ksi, E=29000ksi) ASTM F3125 Grade 150ksi (F _y =130ksi, F _u ≥150ksi, E=29000ksi) ⅛”-¼” shall project through tightened nut.
Embedded Anchor Bolts – High-Strength Alloy Galvanized Steel (Use for anchor bolts for structural members outside corrosive areas)	Galvanized High-Strength Alloy Threaded Nuts	Free-cutting steel capable of developing full strength of bolts Use self-locking nuts or lock-washers and plain nuts
	Threads	Coarse thread series Use taps and dies so bolts retain normal clearance after hot-dip galvanizing
	Galvanized Steel Washers	Conform to ASTM F436 Type 1 and ANSI B18.21.1 Type A Plain
	Galvanized Coating	Refer to Section 09 92 00
	Grout	Refer to Section 03 60 00
	Post-Installed Concrete Anchors	Refer to Section 05 05 19

B. Fasteners, bolts, nuts, screws, and threads, shall conform to US standards and the following.

1. Screw threads for screws, bolts, nuts, and other threaded hardware shall conform to ANSI B1.1.

2. Connections, fasteners, and mountings required to install products shall conform to connections and mountings shown in Contract Documents and Submittals on location-specific basis.
 3. Unless otherwise shown, furnish and install Type 316 stainless steel nuts, bolts, and washers on bolted connections.
 4. Nuts shall be symmetrically formed with hole centered and perpendicular to face.
 - a. Tap nuts to fit corresponding thread on bolt such that nut can be run entire length of thread by fingers without forcing, and without play or rocking.
 5. Liberally apply anti-seize thread lubricant to threaded portion of stainless steel bolts during assembly.
 6. Do not assume acceptance of connections, fasteners, or mountings at 1 location constitutes acceptance of same at all locations.
 7. Screws, bolts, and nuts shall be provided with locking devices.
 8. Selection of locking means shall consider service conditions and the following:
 - a. On parts subject to vibration and on connections requiring repeated adjustment or which are not accessible (such as bolts or nuts inside hydraulic cylinders), provide positive reusable locking device on bolts, such as castellated nuts with cotter pins or soft copper lock plate or washer bent over nut and fixed point on structure.
 - b. On other parts, use positive reusable locking devices or spring steel lock washers on bolts.
 - c. Use lock washers in combination with chemical thread-locking compound when required.
 - d. Chemical locking compound shall be manufactured for purpose of locking threaded connections, such as Loctite as manufactured by Loctite Corporation, or equal.
 - e. Selection of chemical locking compound shall consider requirements for disassembly and maintenance.
- C. Install anchor bolts, nuts, and washers as follows:
1. Anchor bolts, nuts, and washers, and plates shall be adequate for intended use.
 2. Anchor bolts shall be either headed bolts, installed with or without pipe sleeves, or swage bolts installed in drilled holes as shown.
 3. Install anchor bolts to facilitate true positioning of bearing assemblies.
 4. Install anchor bolts perpendicular to concrete surfaces and place within tolerances accepted within AISC documents.
 5. Furnish anchor bolts as part of each piece of equipment.
 6. Anchor bolts shall be complete with required flat washers, lock washers, and nuts.
 7. Refer to Section 01 73 24 for requirements for seismic design of anchor bolts.
 8. Where anchor bolts are installed in pipe sleeves, fill pipes with grout at time grout pads are constructed or at time bearing assemblies or masonry plates are placed.
 9. Grout to be placed in anchor bolt sleeves shall be Class E (1-part cement to 3-part sand) mortar.
 10. Swage bolts installed in holes shall be either sulfured in or grouted in as shown.
- D. Unless expressly shown otherwise or supported by Contractor-submitted and City-accepted Shop Drawings and Engineering Calculations, install bolts with embedments, edge distances and spacings per CBC Table 1911.2 including the following requirements:

BOLT DIAMETER	MINIMUM EMBEDMENT	MINIMUM EDGE DISTANCE	MINIMUM SPACING
$\frac{1}{4}"$	$2\frac{1}{2}"$	$1\frac{1}{2}"$	3"
$\frac{3}{8}"$	3"	$2\frac{1}{4}"$	$4\frac{1}{2}"$

BOLT DIAMETER	MINIMUM EMBEDMENT	MINIMUM EDGE DISTANCE	MINIMUM SPACING
$\frac{1}{2}$ "	4"	3"	6"
$\frac{5}{8}$ "	$4\frac{1}{2}$ "	$3\frac{3}{4}$ "	$7\frac{1}{2}$ "
$\frac{3}{4}$ "	5"	$4\frac{1}{2}$ "	9"
$\frac{7}{8}$ "	6"	$5\frac{1}{4}$ "	$10\frac{1}{2}$ "
1"	7"	6"	12"
$1\frac{1}{8}$ "	8"	$6\frac{3}{4}$ "	$13\frac{1}{2}$ "
$1\frac{1}{4}$ "	9"	$7\frac{1}{2}$ "	15"

- E. Welding, welded steel joints and structures fabricated by welding shall conform to the following.
1. Selection of welding processes and development of weld procedures is part of design process established by Contractor and shall consider stress levels and use of each component.
 - a. Use materials and methods minimizing distortion and developing strength and corrosion resistance of base metals.
 - b. Fuse metal at welded joints without undercut or overlap.
 2. Ensure weld joints are designed and sized in accordance with current engineering standards and practices for each class of equipment.
 3. Design, produce, qualify, inspect, and repair structural and non-structural steel welds in accordance with AWS D1.1.
 4. Design, produce, qualify, inspect, and repair pipe and pipe related welds in accordance with ASME B31.1.
 5. Design, produce, qualify, inspect, and repair welds for pressure vessels or pressure containing parts to accepted welding rules of ASME §VIII and §IX.
 6. Remove welding flux immediately.
 7. Welded components and assemblies, to be machined, shall be stress-relieved prior to final machining.
 - a. Perform stress-relief in accordance with AWS D1.1 and applicable welding specifications referenced above.
 8. Welds shall be continuous, unless otherwise noted or approved.
 - a. Welds shall be even, with no contact gaps, or crevices left between members or unfilled re-entrant corners that would harbor moisture or dirt and prevent satisfactory application and retention of corrosion protective system.
 - b. At exposed connections, finish, smooth, and blend exposed welds and surfaces so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 9. Ensure suppliers and subcontractors comply with these requirements as they apply to manufactured equipment.
- F. Welding, welded aluminum joints and structures fabricated by welding shall conform to the following.
1. Select welding processes and develop weld procedures as part of design process established by Contractor.
 - a. Consider stress levels and use of each component.
 2. Ensure weld joints are designed and sized in accordance with current engineering standards and practices for each class of equipment.
 3. Design, produce, qualify, inspect, and repair structural and non-structural steel welds in accordance with AWS D1.2.
 4. Welds shall be continuous, unless otherwise noted or approved.

- a. Welds shall be even, with no contact gaps, or crevices left between members or unfilled re-entrant corners that would harbor moisture or dirt and prevent satisfactory application and retention of corrosion protective system.
 - 5. Ensure suppliers and subcontractors comply with these requirements as they apply to manufactured equipment.
- G. Welding, welded stainless steel joints and structures fabricated by welding shall conform to the following.
 - 1. Select welding processes and develop weld procedures as part of design process established by Contractor.
 - a. Consider stress levels and use of each component.
 - 2. Ensure weld joints are designed and sized in accordance with current engineering standards and practices for each class of equipment.
 - 3. Design, produce, qualify, inspect, and repair structural and non-structural steel welds in accordance with AWS D1.6.
 - 4. Welds shall be continuous, unless otherwise noted or approved.
 - a. Welds shall be even, with no contact gaps, or crevices left between members or unfilled re-entrant corners that would harbor moisture or dirt and prevent satisfactory application and retention of corrosion protective system.
 - 5. Ensure suppliers and subcontractors comply with these requirements as they apply to manufactured equipment.
- H. Welding procedures shall be as follows.
 - 1. Perform welding by electric-arc method, by process at least equal to that required by Standard Qualification Procedure of American Welding Society.
 - 2. Welding Procedure Specifications (WPSs) for welds shall be qualified per applicable Codes.
 - 3. WPS submittals shall be accepted by City's Representative prior to use for fabrication.
 - 4. Ensure accepted WPSs are in presence of welding personnel prior to production welding.
 - 5. Ensure contents of WPS are being followed.
 - 6. Acceptance and repair of mill-induced discontinuities shall be handled as described in applicable AWS or ASME code sections.
 - 7. Arc strikes and temporary welds in critical locations shall be completely removed, inspected and repaired per AWS D1.1 or applicable procedure.
 - 8. Welding shall only be done on materials above 50°F on dry surfaces.
 - 9. Short-circuiting arc GMAW is prohibited.
 - 10. Electroslag and electrogas welding is prohibited.
- I. Qualification of welders shall be as follows.
 - 1. Welding Performance Qualification (WPQs) records for welding personnel shall conform to AWS D1.1 or applicable procedure.
 - 2. Welding operators shall submit documentary evidence of having been qualified by tests as prescribed by AWS D1.1 §5 and AWS W1 §7, to perform type of welding indicated.
 - 3. Test welders and welding operators in accordance with these Codes.
 - 4. Welders and welding operators shall have in their possession, valid qualification records for welding positions and welding processes used.
 - 5. Maintain welder qualification test records and keep current for duration of Work.
 - 6. When cause exists to question a welder's ability to make welds in accordance with these requirements, City may request welder in question be retested.

7. Retrain or replace welders who cannot maintain quality level as specified to satisfaction of City's Representative.
8. Furnish proof welding operators and welders possess requisite qualifications.
 - a. Allow City's Representative to witness shop radiography.
 - b. Free access shall be allowed to radiographic film records.
 - c. Furnish necessary copies of test reports, together with copies of supplier's test reports on welding rod.
- J. Dissimilar metals, when used in conjunction with each other shall have insulation provided between adjoining surfaces to eliminate direct contact and resultant current.
 1. Materials of construction shall be cathodically compatible to preclude galvanic action.
 2. Where dissimilar metals may contact, provide insulation between adjoining surfaces to eliminate direct contact and galvanic action.
 3. Electrolytic insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, bushings, washers, or other accepted materials.
- K. For purposes of chemical compatibility, use the following materials for bolts unless otherwise recommended by Manufacturer and accepted by City:

ENVIRONMENTAL OR CHEMICAL EXPOSURE	STRENGTH	ACCEPTABLE BOLTING METALS
INORGANIC CHEMICALS		
Ammonium Sulfate (NH ₄) ₂ SO ₄		316SS
Sodium Hypochlorite (NaClO)	15%	316SS Titanium
ENVIRONMENTS		
Recycled Water	n/a	316SS
Wastewater	n/a	316SS

PART 3 - EXECUTION

3.1 Preparation

- A. Holes for bolts shall be full size, punched and reamed, or drilled.
 1. Measure bolt locations in field before drilling companion holes in structural steel beam or assembly.
 2. Finished hole shall be 1/16" larger than nominal bolt diameter.
 3. Holes punched full size shall have burrs and sharp edges removed.
 4. Diameter of die shall not exceed diameter of punch by > 3/32"
- B. Holes for field bolts shall be sub-punched or sub-drilled at fabricator's option, 1/4" less in diameter than that of finished holes and shall be reamed to size through steel templates with hardened steel bushings, with the following exceptions:
 1. Holes required to be sub-drilled and reamed may be sub-drilled 1/8" less in diameter than finished hole provided offset of any hole in any ply measured from outer ply after hole is finished ≤ 1/32", and ≤ 20% of holes provide 1/32" offset.
 2. Field splices in plate girders and in truss chords shall be reamed with members assembled.
 - a. Other field connections may be reamed with members assembled at fabricator's option.
 - b. Chord splices in truss members shall, in all cases, be reamed or drilled with at least 3 abutting sections assembled and with milled ends of compression chords in full bearing.
 3. Assemblies such as floor systems to girders, complete trusses, rolled beam spans connected by diaphragms, and portals to trusses shall be reamed with members assembled if so shown.

4. Field connections of lateral, longitudinal, or sway bracing shall conform to requirements of holes for shop bolts.
5. Holes in material thicker than $\frac{7}{8}$ " shall not be punched, but shall be sub-drilled to diameter specified for sub-punching, or drilled full size with parts assembled.
- C. Accuracy of punching shall be such that for any group of holes when assembled, 75% shall admit rod equal to diameter of bolt at right angles to plane of connection.
 1. Otherwise holes shall be reamed.
 2. When extent of reaming is such that holes cannot be properly filled or accurately adjusted after reaming, faulty member shall be discarded and replaced.
 3. Do not correct mis-punched members without acceptance by City's Representative.
- D. Reaming shall be done after pieces forming member are assembled and bolted together so surfaces are in contact.
 1. Remove burrs and sharp edges of reamed hole under or bolt and nut using countersinking tool making $\frac{1}{16}$ " fillets.
 2. Take pieces apart before bolting, if necessary and remove shavings.
 3. If it is necessary to disassemble members for shipping or handling, pieces reamed together shall be so marked that they may be reassembled in same position.
 4. Do not interchange reamed parts.
- E. Drilled holes shall be $\frac{1}{16}$ " larger than nominal diameter of bolt.
 1. Remove burrs and sharp edges of reamed hole under or bolt and nut using countersinking tool making $\frac{1}{16}$ " fillets.
 2. Remove burrs on outside edges.
 3. If members are drilled while assembled, secure parts together during drilling.
 4. Drill drilled holes to finish size while all thicknesses of metal are assembled, or sub-drilled and reamed as required for punched and reamed holes.
 5. Holes shall be clean-cut, without torn or ragged edges.
 6. Holes that must be enlarged to admit bolts shall be reamed.
 7. Drilling shall be done accurately.
- F. Prepare surfaces for welding as follows
 1. Cut members and sections to be joined by welding accurately to size, with edges sheared, flame-cut or machined to suit required type of welding and to allow full penetration.
 2. Surfaces of members or sections to be welded shall be free from rust, grease, and other foreign matters for at least 2" back from weld edge.
 3. Accurately cut plates to be joined by welding to size.
 4. Roll by pressure to proper curvature, which shall be continuous from edge.
 5. Do not flatten curvature along edges with correction by blows.
 6. Dimensions and shape of edges to be joined shall allow thorough fusion and penetration.
 7. Plate edges shall be properly formed to accommodate welding conditions.
 8. If tack welds are used in weld groove, remove each tack before welding operation.
 9. Accurately align butt joints and retain in position during welding operations so at finished joint projection of 1 plate beyond its adjoining plate is $\leq \frac{1}{16}$ ".
 10. Throat gap for butt joints shall be $\leq \frac{1}{8}$ ".
 11. Where possible, design joints so welding may be done in down-hand, vertical or horizontal position.

12. Backing plates or other reinforcement on both faces of weld on butt joints shall be chipped and ground flush with surrounding plate.
13. When welding plates, of which one or both >1" thickness, preheat contiguous areas of plates around welding operation to $\geq 300^{\circ}\text{F}$ to prevent distortion of weld cracking.
 - a. Keep at uniform temperature throughout process.
 - b. Preheating to temperature 400°F is not required.
14. Measure temperature using Tempilstiks or other accepted means.
15. Use low hydrogen electrodes where necessary.
16. Edges of surfaces (up to thickness of metal) to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations, and free from rust, oil, grease, and other foreign matter.
17. Supply welding rods in sufficient quantities to complete welding requirements of materials supplied under this Contract plus 25% surplus.
 - a. Welding electrodes shall conform to AWS Filler Metal Specification A5 or ASME Boiler and Pressure Vessel Code, §II, Part C.
 - b. Supply welding machines and welding equipment required for erection at Site.
 - c. Provide suitable meters to show welding current and arc voltage.
 - d. Welding rods shall be plastic-wrapped against moisture and shipped in hermetically sealed metal containers.
 - e. Do not use welding rods, which absorb moisture in coating.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for basic execution and installation requirements.
- B. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. California Building Code Chapter 22 "Steel"
 3. Other applicable building code requirements
 4. Manufacturer's installation and warranty requirements
 5. AWS B3.0 Welding Procedures and Performance Qualifications
 6. AWS D1.1 Structural Welding Code – Steel
 7. AWS D1.2 Structural Welding Code – Aluminum
 8. AWS D1.3 Structural Welding Code - Sheet Steel
 9. AWS D1.4 Structural Welding Code – Reinforcing Steel
 10. AWS D1.6 Structural Welding Code – Stainless Steel
 11. AISC 316 and 317 Manual of Steel Construction
 12. AISC 360 Structural Steel Buildings
 13. AISC M011 Manual of Steel Construction for Shop and Field Welding
 14. AISC S326 Design Fabrication and Erection of Structural Steel for Buildings
 15. Standard Specifications for Public Works Construction (Greenbook) §304-1 "Structural Steel"
 16. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 304 "Metal Fabrication and Construction"
- C. Refer variances between above documents and Contract Documents to City's Representative.
- D. Protect dissimilar metals from galvanic corrosion using pressure tapes, coatings, or isolators.

- E. Provide mounts, guides, bearing plates, flanges, anchor and attachment bolts and screws, saddles, supports, pads and skids necessary to securely mount products and equipment.
1. Tighten bolts to Manufacturers' specifications using torque wrenches.
 2. Unless otherwise directed, use lubricant such as Copperkote or blue Teflon when making up bolts.
- F. Perform bolting as follows:
1. Bolts shall be unfinished bolts, or high-strength steel bolts as shown.
 2. Unfinished bolts in shear shall have no more than 1 thread within grip.
 3. Bolts shall extend entirely through nut but not more than specified distance beyond outside face of nut.
 4. Unfinished structural bolts in tension shall have 2 nuts.
 5. Diameter of unfinished bolts shall be $\leq 1/32$ " smaller than hole diameter.
 6. Bolted connections using high-strength steel bolts shall conform to ASTM A3125.
 7. Bolts shall not be permitted to drift
 8. Holes shall not be enlarged to correct misalignment.
 9. If mismatching of holes occurs, provide new materials.
 10. Drive bolts accurately into holes without damaging thread.
 11. Protect boltheads from damage during driving, and replace if damaged.
 12. Boltheads and nuts shall rest squarely against metal.
 13. Draw boltheads and nuts tight against work using suitable wrench ≥ 15 " long or torque wrench set to provide similar torque.
 14. Tap bolt heads with hammer while nut is being tightened.
 15. After being tightened, nuts shall be locked.
 16. Bolts used on beveled surfaces having slopes $>1:20$ with plane normal to bolt axis shall be provided with beveled washers to provide full bearing of boltheads and nuts.
 17. Where self-locking nuts are not furnished, bolt threads shall be upset to prevent nuts from backing off.
- G. Perform welding as follows:
1. Welding and weld reinforcement shall conform to AWS D1.1 and AWS D1.3,
 2. Welders, welding operators, and tackers shall be qualified in accordance with applicable AWS standards.
 3. Welded components subject to vibration and fatigue shall be fabricated with fully penetrated welds.
 4. Use metal-arc, submerged arc or gas-shield arc process as described in AWS "Welding Handbook" as supplemented by other pertinent AWS standards.
 5. Weld sizes between members shall not be less than those specified in AWS D1.1, Structural Welding Code, or ASME §VIII, Division I.
 6. In assembly and during welding, clamp, support, and restrain component parts to control dimensions and minimize distortion.
 7. Use electrodes intended for grade of steel or metal being joined.
 - a. Use materials and methods that minimize distortion and preserve strength and corrosion resistance of base metals.
 8. Obtain fusion without undercut or overlap.
 9. Remove welding flux immediately.
 10. Provide 2 passes for metal $3/16$ " thick plus one additional pass for each additional $1/8$ " in metal thickness.

- a. Fillet welds shall be $\geq 1/4$ ";
 - b. Make fillet welds $\geq 5/16$ " shall be with 2 or more passes.
 - c. Make fillet welds with full throat, and with each leg of uniform length of indicated size in accordance with Contract Documents and Shop Drawings
 11. Butt welds shall be fully penetrated and slightly convex of uniform height.
 - a. In plates $>5/16$ " thick use double-welded type joints.
 12. Peening of multiple pass welds to control distortion or to minimize residual stresses may be carried out with light blows from power hammer, using elongated round-nosed tool.
 - a. Peen immediately after depositing and cleaning.
 - b. Exercise care to prevent scaling, flaking or rupturing of weld and base metal from overpeening.
 - c. Neither first nor last pass of multiple weld shall be peened.
 13. Welds shall be uniform in width and size throughout their length with each layer of weld smooth, free of slag, cracks, pinholes and undercutting, and completely fused to adjacent base metal and weld beads.
 - a. Avoid coarse ripples, irregular surfaces, non-uniform bead patterns, high crowns, deep ridges or valleys between beads.
 14. At exposed connections, finish exposed welds so surfaces are smooth and blended.
 15. Stainless-type weld, for protection against pitting or corrosion, shall be of chromium nickel steel.
 - a. Type, chemical composition and ASTM class of welding rods used for this purpose shall meet with acceptance from City's Representative.
 16. Upon completing weld, remove temporary bracing and attachments.
 - a. Exercise care that base metal to which bracing is attached is not adversely affected.
 - b. Chip projecting welds remaining after this operation and grind flush.
 - c. Weld tears in base metal and grind flush.
 - d. If temporary bracing or attachments are welded to plates <1 " thick, preheat requirements may be waived; however, upon removing these attachments, base metal shall be ground flush and inspected for cracks.
 17. Test plates for automatic welding on longitudinal seams shall be attached to sections to be welded if requested by City's Representative.
- B. Finish welding as follows
1. Remove weld splatter, flux, slag and burrs.
 2. Grind sharp corners of material to be painted or coated to at least $1/32$ " on the flat.
 3. Dress welds to display good appearance and provide surface suitable for painting.
 4. Grind and blend structural welds to avoid stress raisers.
 5. Dress welds requiring nondestructive examinations by chipping and grinding as required for good interpretation by selected weld examination methods.
 6. Erection bolts required for welded splices or connections may be left in place.
 - a. Burn off ends of erection bolts which project beyond nut flush with face of nut.
 - b. Where bolt does not project, tack weld end of bolt and nut to prevent loosening of nut.
 - c. Complete burning off of bolt ends or tack welding before painting.
- C. Repair welding as follows
1. Repair welds to produce workmanlike appearance, with uniform weld contours and dimensions.

2. Unacceptable defects in welds shall be chipped out to sound metal and such areas shall be checked by Contractor as directed by City's Representative to ensure defect has been completely removed before repair welding.

3.3 **Field Quality Control**

- A. Special inspection and field testing required by Chapter 17 of CBC (Table 1704.3 and 1704.4) shall be completed by an ICC-certified special inspector selected by City and shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Metal Fastenings and Welds	Welding Materials	AISC §A3.5 and CBC §1708.4	Periodic per CBC Table 1704.3	Contractor	Contractor
	Weld Procedure Qualification	AWS QC1	One each procedure in presence of City's Representative		
	Welding	AISC 341, AWS D1.1, D1.3, CBC 1704.3.1, and CBC Table 1704.3. Also inspect for proper dimensions and absence of cracks, undercutting, surface holes or slag inclusions	Periodic per CBC Table 1704.3 for single-pass fillet welds 5/16" or smaller or floor and roof deck welding		
		AISC 341, AWS D1.1 CBC 1704.3.1, and CBC Table 1704.3	Continuous per CBC Table 1704.3 for all other welds		
	Nondestructive Weld Testing	Magnetic particle testing (MT), dye penetrant (PT), radiography (RT) or ultrasonic (UT)	1 inspection each weld		
	Welding Gas Pockets, Slag, and Oxide Inclusions	No defects >1/16" in any dimension Sum of all defects in any square inch shall be $\leq \frac{3}{8}$ "	Periodic		
	Brinnell Hardness	$\geq$ (Parent metal minimum specified tensile strength in psi) / 500 $\leq$ (Parent metal minimum specified tensile strength in psi +50 psi) / 500	Periodic		
	Joint Details	CBC 1704.3.2	Periodic per CBC Table 1704.3		
	High-Strength Bolting	AISC 360 §M2.5 and CBC 1704.3.3	Periodic per CBC Table 1704.3		
			Continuous for slip-critical bolting per CBC Table 1704.3		
	11-month Warranty Inspection	Confirm Work conforms to Contract Documents and Manufacturer's printed literature	1 test each equipment item	City	Contractor
Anchor Bolts	Installation	Refer to Section 05 05 19	All bolts	City	Contractor

- B. Unless otherwise indicated, nondestructive tests shall conform to applicable sections of ASTM Standards, Part 11, "Metallography; Nondestructive Tests."

1. Unless otherwise noted, determine standard for nondestructive testing applicable to material and manufacturing method used.

2. Extent of examination and basis for acceptance shall be agreed upon between City's Representative and Contractor.
 3. Contractor's Shop Drawings submitted for review shall define areas, extent, and type of nondestructive examination.
 4. Weld inspection and acceptance criteria shall conform to AWS D1.1 and ASME Boiler and Pressure Vessel Code requirements.
 5. Certify personnel performing and interpreting nondestructive examinations have been qualified as Level II or III examiners in accordance with ASNT SNT-TC-1A.
- C. Prior to Special Inspection of steel welding, verify seam welds and puddle welds are made in accordance with Contract Documents.
1. Inspection shall ensure proper electrodes, current, travel and speed are used and that no cracks, serious undercutting, overlap, surface holes, or slag inclusions occur.
- D. Provide copies of special inspection reports to City's Representative and applicable Building Official.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of metal fabrications, including formed metal fabrications.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 05 05 19 for post-installed concrete and masonry anchors
 - 2. Section 05 05 23 for structural steel connections, including bolting and welding.
 - 3. Section 05 14 00 for structural aluminum framing.
 - 4. Section 05 51 00 for stairs, ladders, and platforms.
 - 5. Section 05 52 00 for railings.
 - 6. Section 05 53 00 for gratings and floor plates.
 - 7. Section 09 92 00 for galvanizing.
 - 8. Section 33 05 31 for piping joint materials and bolting
- C. Conform to Standard Specifications for Public Works Construction (Greenbook) §206, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 03 15 00: Concrete Accessories
- J. Section 03 30 00: Cast-in-Place Concrete
- K. Section 03 32 10: Cement Mortar
- L. Section 03 60 00: Grouting
- M. Section 05 05 19: Post-Installed Concrete Anchors
- N. Section 05 05 23: Metal Fastenings and Welds
- O. Section 05 14 00: Structural Aluminum Framing
- P. Section 05 51 00: Stairs, Ladders, and Platforms
- Q. Section 05 52 00: Railings
- R. Section 05 53 00: Gratings and Floor Plates
- S. Section 09 90 00: Painting and Coating
- T. Section 09 92 00: Galvanizing
- U. Section 33 05 31: Piping Joint Materials
- V. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install metal fabrications where shown including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 **Quality Assurance**

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Form metal fabrications true to detail with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength or durability.
- C. Shop quality control documentation shall be available in fabricator's shop for City's review.

1.5 **References**

- A. Reference publications listed below and in various sections form part of specification to extent referenced. These are referred to within text by basic designation only.
 - 1. AISC 316 Manual of Steel Construction ASD
 - 2. AISC 317 Manual of Steel Construction Volume II Connections
 - 3. ASME/ANSI B1.1 Unified Inch Screw Threads
 - 4. ANSI/ASME B18.15 Forged Eyebolts
 - 5. ANSI AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination
 - 6. API 9A Wire Rope
 - 7. ASSE 1060 Outdoor Enclosures for Backflow Prevention Devices
 - 8. ASTM A36 Carbon Structural Steel
 - 9. ASTM A167 Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip
 - 10. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - 11. ASTM A194 Carbon and Alloy Steel Nuts for High-Pressure and High-Temperature Service
 - 12. ASTM A240 Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 13. ASTM A276 Stainless Steel Bars and Shapes
 - 14. ASTM A283 Low and Intermediate Tensile Strength Carbon Steel Plates
 - 15. ASTM A307 Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
 - 16. ASTM A413 Carbon Steel Chain
 - 17. ASTM A489 Carbon Steel Lifting Eyes
 - 18. ASTM A786 Hot-Rolled Carbon, Low Alloy, High-Strength Low Alloy, and Alloy Steel Floor Plates
 - 19. ASTM A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
 - 20. ASTM B26 Aluminum Alloy Sand Castings
 - 21. ASTM B455 Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes
 - 22. ASTM B584 Copper Alloy Sand Castings
 - 23. ASTM C881 Epoxy-Resin-Base Bonding Systems for Concrete
 - 24. ASTM E10 Brinell Hardness of Metallic Materials
 - 25. ASTM F541 Alloy Steel Eyebolts
 - 26. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
 - 27. ASTM F594 Stainless Steel Nuts
 - 28. ASTM F3125 High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength
 - 29. ASTM F1267 Metal, Expanded, Steel
 - 30. AWS Welding Handbook
 - 31. AWS A5.5 Low-Alloy Steel-Covered Arc-Welding Electrodes
 - 32. AWS D1.1 Structural Welding Code – Steel
 - 33. AWS QC1 Qualification and Certification of Welding Inspectors
 - 34. California Building Code (CBC)
 - 35. MIL A907E Antiseize Thread Compound, High-Temperature
 - 36. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 206 "Miscellaneous Metal Items"
 - 37. SSPWC Standard Specifications for Public Works Construction (Greenbook) Section 304 "Metal Fabrication and Construction"

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit for formed metal fabrications per structural Shop Drawing requirements	.
MANUFACTURER'S LITERATURE		
Product Data	Submit for manufactured products per Product Data requirements.	
Installation Instructions	Submit per Installation Instructions requirements.	
SAMPLES		
Material Samples	Submit upon request	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
Foundry or Test Record Transcripts	Submit for factory tests upon request per Foundry or Test Record transcript requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, Foundry or Test Records, and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of metal fabrications.
- C. Store materials above ground on platforms, skids, or other supports and protect from rain, dirt, grease, foreign matter, and corrosion.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
METAL FABRICATIONS		
Fabricated Metalwork	Desert Iron and Machine Works, Inc	Thermal, CA (310) 773-0589
	Accepted Equal	
Stair Treads	Harsco Industrial / IKG Aluminum Grating Stair Tread with Mebac Nosing	Channelview, TX (800) 324-8417
	McNichols Company Type A-Standard with Corrugated Angle Nosing	Tampa, FL (877) 884-4653
	Nystrom Building Products	Brooklyn Park, MN (800) 547-2635
	SlipNOT Div. W S Molnar Co	Detroit, MI (800) 754-7668
	Accepted Equal	
METAL PRODUCTS		
Perforated Metal and Expanded Metal	AMICO Div. Gibraltar Industries	Birmingham, AL (800) 326-8842
	Bobco Metals	Los Angeles, CA (888) 304-5927
	McNichols Company	Tampa, FL (877) 884-4653
	Metalex	Libertyville, IL (888) 639-6382
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §206-1 for materials requirements for metal fabrications.
- C. Structural steel shall conform to requirements of Section 05 12 00.
- D. Structural aluminum shall conform to requirements of Section 05 14 00.
- E. Materials for bolts, anchors and welds shall be:

ITEM	MATERIAL	SPECIFICATION
FASTENERS, AND CONNECTIONS		
Post-Installed Concrete Anchors	Refer to Section 05 05 19	
Nuts, Bolts, Washers, and Screws	Refer to Section 05 05 23	
Welds and Electrodes	Refer to Section 05 05 23	
ANCHOR SYSTEMS		
Concrete Anchors	Refer to Section 05 05 19	
METAL FABRICATIONS		
Pipe Guards	Steel	Fabricate from 3/8" thick x 12" wide steel plate, bent to fit against wall or column at both ends and to fit around pipe with 2" clearance between pipe and pipe guard. Drill each end for 3/4" anchor bolts.
	Finish	Refer to Section 09 90 00.
METAL PRODUCTS		
Chain	Stainless Steel	SAE Type 316 Length sufficient to provide 6" sag at center of opening spanned.
Steel Forgings	Steel	Conform to ASTM F3125 Class C forgings ≥0.35% carbon content, annealed Brinell hardness 1.30-1.90 per ASTM E10
Washers (Stainless Steel)	Stainless Steel	SAE Type 316
Washers (Galvanized)	Carbon Steel – Galvanized	Square or rectangular smooth beveled washers, tapered in thickness
	Galvanized Coating	Refer to Section 09 92 00

- F. Materials for metal shapes and members shall be:

ITEM	MATERIAL	SPECIFICATION
Hardware – Steel Including Castings, Rolled, Pressed and Forged Articles	Steel Hardware	Conform to ASTM A36
	Galvanized Coating	Refer to Section 09 92 00
Aluminum Castings	Aluminum	Conform to ASTM B26 Alloy 443.0F
Perforated Metal and Expanded Metal	Stainless Steel	SAE Type 316 Gauge as shown on Plans – Thickness ≥16 gauge
	Steel	Conform to ASTM F1267 Gauge as shown on Plans – Thickness ≥16 gauge
	Galvanized Coating	Refer to Section 09 92 00
Plate and Sheet – Stainless Steel	Stainless Steel	Conform to ASTM A167 or ASTM A240 SAE Type 316
Structural Members – Stainless Steel	Stainless Steel	SAE Type 316

- G. The following product design criteria, options and accessories are required for metal products:

ITEM	DESCRIPTION	
Boat Snap	Design	Swivel Eye, Size to match attached chain

ITEM	DESCRIPTION	
Chain – ASTM Grade 43 High Test	Size and Nominal Strength	3/8" chain 5400-lb rated
		1/2" chain 9200-lb rated
Eyebolt	Size and Diameter	3/8" eyebolt (1"ID / 1-21/32"OD)
		1/2" eyebolt (1-3/16"ID / 2-1/16"OD)
		5/8" eyebolt (1 1/8"ID / 2 1/2"OD)
		3/4" eyebolt (1 1/2"ID / 2-13/16"OD)
		7/8" eyebolt (1-11/16" ID / 3 1/4"OD)
		1" eyebolt (1-13/16"ID / 3-9/16"OD)

H. Wall thicknesses shall be:

GAUGE	THICKNESS RANGE	NOMINAL VALUE
20	0.0329"-0.0389"	0.0359"
18	0.0438"-0.0518"	0.0478"
16	0.0548"-0.0648"	0.0598"
14	0.0697"-0.0797"	0.0747"
12	0.0986"-0.1106"	0.1046"
10	0.1285"-0.1405"	0.1345"
9	0.140"-0.150"	0.1495"
8	0.157"-0.167"	0.1644"
7	0.175"-0.185"	0.1793"
6		0.1943"
5		0.2092"
4		0.2242"
3		0.2391"
n/a		0.25"
2		0.2656"
1		0.2813"
0		0.3125"
00		0.3438"
000		0.3750"
0000		0.4063"
00000		0.4375"
000000		0.4688"
0000000		0.5000"

- I. Before leaving shop, steel not shown or specified to be galvanized or stainless shall receive coat of pigmented primer recommended by Manufacturer of final paint system.
1. Parts inaccessible after assembly shall receive 2nd coat of same primer.
 2. Final painting shall conform to Section 09 90 00.
 3. Galvanizing shall conform to Section 09 92 00.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install metal fabrications before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Preassemble items in shop to greatest extent possible.
 1. Use connections maintaining structural value of joined pieces.
- C. Equip items to be cast into concrete or built into masonry with integrally welded steel strap anchors ≤8" from ends or corners and ≤24" on center.
- D. Perform cutting, drilling, and fitting required to install metal fabrications.

1. Fit exposed connections accurately together to form hairline joints.
 2. Weld connections that are not to be left exposed but cannot be shop welded because of shipping size limitations.
 3. Do not weld, cut, or abrade galvanized joining surfaces intended for bolted or screwed field connections.
 4. Set fabrications accurately in location, alignment, and elevation, with edges and surfaces level, plumb, true, and free of rack and measured from established lines and levels.
- E. Clean surfaces of metalwork to contact concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
1. On City's request, coat steel surfaces (excluding nuts and bolts) to contact exposed concrete with protective sealant coating of accepted heavy bitumastic troweling mastic applied per Manufacturer's application instructions before installing metalwork.
 2. Coat aluminum surfaces to contact concrete with heavy alkali-resistant bituminous paint or 1 coat of zinc chromate.
 3. Insulate aluminum surfaces from contact with dissimilar metals using neoprene gaskets or washers.
- F. Where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03 32 10.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for execution and installation requirements.
- B. Furnish and install metal fabrications at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
1. Applicable OSHA and Cal OSHA regulations
 2. California Building Code Chapter 20 "Aluminum"
 3. California Building Code Chapter 22 "Steel"
 4. Other applicable building and fire code requirements
 5. Manufacturer's installation and warranty requirements
 6. SSPWC Standard Specifications for Public Works Construction (Greenbook) §304 "Metal Fabrication and Construction"
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install metal fabrications to tolerances recommended by Manufacturer.
1. Unless otherwise shown, install metal fabrications true, plumb, and level using precision gauges and levels.
 2. Cut, drill, and punch metals cleanly and accurately.
 3. Remove burrs and ease edges.
 4. Remove sharp or rough edges on exposed surfaces.
 5. Joints shall have close fit with corner joints coped or mitered and in true alignment.
- F. Where needed to complete and support Work, provide steel framing and supports as needed.
1. Fabricate support structures in sizes, shapes, and profiles necessary to support Work.
 2. Use steel shapes, plates, and bars of welded construction conforming to Sections 05 12 00. and 05 05 23.
 3. Fabricate steel pipe columns for supporting wood frame or other Work from steel pipe with steel baseplates and top plates.

4. Drill or punch baseplates.
 5. Add top plates for anchor and connection bolts and weld to pipe with fillet welds all around.
 6. Make fillet welds same size as pipe wall thickness.
 7. Fabricate shelf angles from steel angles of sizes shown for attachment to concrete or masonry.
 8. Provide horizontally slotted holes to receive $\frac{3}{4}$ " bolts spaced ≤ 6 " from ends and ≤ 24 " on center unless otherwise shown.
 9. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
 10. Galvanize shelf angles located in exterior walls.
 11. Prime shelf angles located in exterior walls with primer specified in Section 09 90 00.
 12. Refer to Section 05 05 19 for post-installed concrete anchor requirements.
- G. Fabricate seams and connections to be exposed to weather in manner excluding water.
1. Provide weep holes where water may accumulate.
- H. Repair or recondition existing metal fabrications, where shown, as follows:
1. Disassemble Work as deemed necessary by City for proper repair or reconditioning.
 2. Remove existing coatings.
 3. Clean and prepare surfaces.
 4. Perform visual inspection of metal.
 5. Notify City's Representative of major damage
 6. Supplement with further NDE (MT, PT, UT) if necessary.
 7. Repair minor damage.
 8. Replace damaged anchors, hardware, and appurtenances.
 9. Refurbish Work.
 10. Recoat per Section 09 90 00
 11. Repair galvanizing per Section 09 92 00.
 12. Reassemble Work.
- I. Refer to Section 05 05 19 for post-installed concrete anchors.
- J. Form exposed connections with hairline joints, flush and smooth.
1. Locate joints where least conspicuous.
 2. Conceal fastenings whenever possible.
- K. Bolting for piping shall conform to Section 33 05 31.
- L. Built-up parts shall be free of warp.
- M. Exposed ends and edges of metal shall be slightly rounded.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Metal Fabrications	No Bends, Twists or Open Joints No Projecting Edges or Corners at Intersections	Visual inspection	All metalwork	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 05 51 00

STAIRS, LADDERS, AND PLATFORMS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of stairs, ladders, and platforms.
- B. OSHA Standard 29 CFR 1926.1053 (a) requires fall protection be provided where length of climb on fixed ladders $\geq 24'$ or where top of fixed ladder $>24'$ above lower levels.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 32 10: Cement Mortar
- I. Section 05 05 19: Post-Installed Concrete Anchors
- J. Section 05 05 23: Metal Fastenings and Welds
- K. Section 05 14 00: Structural Aluminum Framing
- L. Section 05 50 00: Metal Fabrications
- M. Section 09 90 00: Painting and Coating
- N. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install complete stairs and ladders where shown including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Workmanship and finish shall conform to requirements of American Welding Society and Aluminum Association, as applicable.
- C. Connections and accessories shall safely withstand stresses and strains to which they will be subjected.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. Aluminum Association Inc. Aluminum Construction Manual
 - 2. Aluminum Association Inc. Specifications
 - 3. ANSI / ASC A14.3 Ladders - Fixed - Safety Requirements
 - 4. ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products
 - 5. ASTM A36 Carbon Structural Steel
 - 6. ASTM A276 Stainless Steel Bars and Shapes
 - 7. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate
 - 8. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - 9. ASTM B241 Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
 - 10. ASTM B308 Aluminum-Alloy 6061-T6 Standard Structural Shapes

11. ASTM D962 Standard Specification for Aluminum Pigments, Powder, and Paste
12. AWS A2.4 - Standard Symbols for Welding, Brazing and Non-destructive Examination
13. AWS A5.10 - Specification for Aluminum and Aluminum-Alloy Arc-Welding Electrodes
14. AWS D1.2 - Structural Welding Code - Aluminum
15. California Building Code (CBC)
16. California Mechanical Code (CMC) §904.10
17. OSHA Standard 29 CFR1910.24 Fixed Industrial Stairs
18. OSHA Standard 29 CFR1910.27 Fixed Ladders
19. OSHA Standard 29 CFR 1926.1053 Ladders

1.6 **Submittals**

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit for fabricated stairs and ladders per structural Shop Drawing requirements Show dimensions, sizes, thickness, gauges, materials, finishes, joint attachment and erection procedure. Shop drawings shall be stamped and signed by California-licensed civil or structural engineer.	.
MANUFACTURER'S LITERATURE		
Product Data	Submit for manufactured products per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
Foundry or Test Record Transcripts	Submit for factory tests upon request per Foundry or Test Record transcript requirements.	
Welder Qualification Certificates	Submit for welders performing Work. Also submit certifications of procedure qualifications for each welding procedure used.	
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, Foundry or Test Records and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of stairs and ladders.
- C. Store materials above ground on platforms, skids, or other supports and protect from rain, dirt, grease, foreign matter, and corrosion.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
LADDERS		
Ladders – Aluminum	Alaco Ladder Co.	Chino, CA (909) 591-7561
	City Tool Works, Inc.	Ontario, CA (909) 923-8080
	WernerCo. Inc.	Greenville, PA (888) 229-7727
	Accepted equal	
Ladders – Fiberglass	WernerCo. Inc.	Greenville, PA (888) 229-7727
	Ultra Fiberglass Systems	Milwaukee, WI (414) 461-5051
	Accepted equal	
Ladders – Stainless Steel	City Tool Works, Inc.	Ontario, CA (909) 923-8080
	Inwesco Inc.	Azusa, CA (626) 334-9304
	Pipeline Products VL100	San Marcos, CA (800) 998-1079
	Remco Machining and Fabrication	Bloomington, CA (909) 877-3530
	Accepted equal	
FABRICATED STRUCTURES		
Fabricated Aluminum Structures	CST Industries, Inc.	Conroe, TX (913) 621-3700 Gardena, CA (310) 353-5100
	RPS Engineering, Incorporated	Elburn, IL (847) 931-1950 Irwindale, CA (626) 856-5656
	Ultraflote Corporation	Houston, TX (713) 461-2100
	Accepted Equal	
STAIRS		
FRP Ship Ladders	Ultra Fiberglass Systems	Milwaukee, WI (414) 461-5051
	Accepted equal	
Stair Treads and Platforms	Hoertig, Inc.	Fountain Valley, CA (714) 545-1575
	Keene Building Products / Metalex	Libertyville, IL (888) 639-6382
	Lapeyre Stair	New Orleans, LA (866) 433-5518
	McNichols Company	Tampa, FL (877) 884-4653
	SlipNOT Div. W S Molnar Co.	Detroit, MI (800) 754-7668
	Accepted equal	
Stairways - Fiberglass	Structural Fiberglass, Inc.	Bedford, PA (814) 623-0458
	Accepted equal	

2.2 Materials

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for stairs and platforms shall be:

ITEM	MATERIAL	SPECIFICATION	
Interior and Exterior Stairs - Aluminum	Aluminum	Materials	Aluminum
		Dimensions	Conform to Plans and OSHA Std CFR1910.24
		Minimum Width	≥22" required by OSHA Std CFR1910.24
		Allowable Slope	30° to 50° above horizontal required by OSHA Std CFR1910.24
		Tread	≥8" deep slip-resistant tread required by OSHA Std CFR1910.24
		Vertical Clearance	≥7' required by OSHA Std CFR1910.24
		Platforms or Landings	≥30" on 1 side required by OSHA Std CFR1910.24
		Railings	30"-34" high required by OSHA Std CFR1910.24

- C. Before leaving shop, steel not shown or specified to be galvanized or stainless shall receive 1 coat of pigmented primer recommended by Manufacturer of final paint system.
1. Parts inaccessible after assembly shall receive 2nd coat of same primer.
 2. Final painting shall conform to Section 09 90 00.
- D. The following design criteria are required for equipment specified in this section:

ITEM	DESCRIPTION	
Platforms and Stair Treads	Live Load	100 psf or concentrated 300-lbf load at mid span whichever creates higher stress or deflection
	Allowable Live Load Deflection	$<L/360$ per CBC Table 1604.3 and $\leq 1/4"$,
	Allowable Total Load Deflection	$<L/240$ per CBC Table 1604.3 and $\leq 1/4"$,
	Stair Tread Nosing	Integral non-slip

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install stairs and ladders before submitting Shop Drawings or ordering.
1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Clean surfaces of work to be in contact with concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
- C. Coat aluminum surfaces to contact concrete with heavy alkali-resistant bituminous paint or one coat of zinc chromate.
- D. Insulate aluminum surfaces from contact with dissimilar metals using neoprene gaskets or washers.
- E. Secure embedded metalwork accurately in position when concrete is placed to prevent displacement or undue vibration during or after placement of concrete.
- F. Where Work is to be installed in recesses in formed concrete, said recesses shall be made, Work installed, and recesses filled with dry-pack mortar in conformance with Section 03 32 10.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install stairs and ladders at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
1. Applicable OSHA and Cal OSHA regulations.
 2. Applicable building and fire code requirements
 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to Owner's Representative.
- E. Install stairs and ladders to tolerances recommended by Manufacturer.
1. Unless otherwise shown, install stairs and ladders true, plumb and level using precision gauges and levels.
- F. Welding shall comply with Section 05 05 23.
1. Continuously weld permanent connections along entire area of contact.

- G. Bolting shall comply with Section 05 05 23.
1. Conceal fastenings whenever possible.
- H. Joints shall have a close fit with corner joints coped or mitered and in true alignment.
- I. Built-up parts shall be free of warp.
- J. Exposed ends and edges of work shall be slightly rounded.
- K. Mount ladders so clearance from back of ladder to wall behind ladder exceeds 7".

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Stairs and Ladders	No bends, twists or open joints No projecting edges or corners at intersections	Visual inspection	All work	Owner	Owner
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Owner	Contractor

END OF SECTION

SECTION 05 52 00**RAILINGS****PART 1 - GENERAL****1.1 Work Included**

- A. Materials, testing, and installation of railings and handrails.
- B. Refer to Section 05 05 19 for post-installed anchor bolts.
- C. Refer to Section 05 05 23 for metal fastenings and welds.
- D. Unless otherwise noted, refer to APWA Southern California Chapter Standard Plans for Public Works Construction Standard Drawing 606 for requirements for metal hand railings.
- E. Conform to Standard Specifications for Public Works Construction (Greenbook) §206-5, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 30 00: Cast-in-Place Concrete
- I. Section 03 32 10: Cement Mortar
- J. Section 05 05 19: Post-Installed Concrete Anchors
- K. Section 05 05 23: Metal Fastenings and Welds
- L. Section 05 50 00: Metal Fabrications
- M. Section 05 51 00: Stairs, Ladders, and Platforms
- N. Section 09 90 00: Painting and Coating
- O. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install complete handrails and railings where shown including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in the necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. Aluminum Association Standard 1 – Aluminum Standards and Data
 - 2. Aluminum Association Standard for Anodized Architectural Aluminum
 - 3. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 4. ASTM B26 Aluminum-Alloy Sand Castings
 - 5. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate
 - 6. ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - 7. ASTM B241 Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
 - 8. ASTM B429 Aluminum-Alloy Extruded Structural Pipe and Tube
 - 9. ASTM B487 Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

10. ASTM F880 Stainless Steel Socket, Square Head, and Slotted Headless-Set Screws
11. ASTM F912 Alloy Steel Socket Set Screws
12. AWS/ANSI D1.1 Structural Welding Code – Steel
13. AWS/ANSI D1.2 Structural Welding Code – Aluminum
14. AWS/ANSI D1.6 Structural Welding Code – Stainless Steel
15. California Building Code (CBC)
16. OSHA Standard 29 CFR 1926.502b “Guardrail Systems”
17. OSHA Standard 29 CFR 1926.502b “Guardrail Systems”

1.6 **Submittals**

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit for fabricated and formed handrails and railings per structural Shop Drawing requirements	.
MANUFACTURER'S LITERATURE		
Product Data	Submit for manufactured products per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements	
SAMPLES		
Material Samples	Submit upon request	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
Engineering Calculations	Required for submitted handrail systems <2" diameter or < Schedule 80 per Engineering Calculations requirements.	
Foundry or Test Record Transcripts	Submit for factory tests upon request per Foundry or Test Record Transcript requirements.	
Welder Qualification Certificates	Submit for welders performing Work on this project. Also submit certifications of procedure qualifications for each welding procedure used.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, Engineering Calculations, Foundry or Test Record Transcripts and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of handrails and railings.
- C. Store materials above ground on platforms, skids, or other supports and protect from rain, dirt, grease, foreign matter, and corrosion.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
HANDRAIL		
Handrail - Aluminum	Alumarail Manufacturing, Inc.	Woodbridge, ON (877) 258-6288
	Golden Railings, Inc.	Broomfield, CO (303) 279-5807
	Hanson Architectural Systems / C.R. Laurence Co.	Hillsboro, OR (800) 599-2965
	Hollaender Manufacturing Company "Interna-Rail"	Cincinnati, OH (800) 772-8800

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Hollaender Manufacturing Company "Speed-Rail"	Cincinnati, OH (800) 772-8800
	Idealshield	Detroit, MI (866) 825-8659
	Accepted Equal	
ACCESSORIES		
Perforated Metal and Expanded Metal	McNichols Company	Tampa, FL (877) 884-4653
	Accepted Equal	

2.2 **Materials**

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for aluminum handrails shall be:

ITEM	MATERIAL	SPECIFICATION	
Handrails – Aluminum	Aluminum Base Metal	Anodized Aluminum	Conform to ASTM B241 Alloy 6005-T5, 6061-T6, or 6063-T6 $f_y \geq 25\text{ksi}$
	Pipe and Tubing	Aluminum Alloy	Conform to ASTM B241 or ASTM B429
	Slip-on or Bolt-on Fittings	Aluminum Alloy	Conform to ASTM B26
	Plates and Sheets	Aluminum Alloy	Conform to ASTM B209
	Rods, Bars, or Shapes	Aluminum Alloy	Conform to ASTM B221
	Dimensions	Conform to Plans, CBC Chapter 10 and OSHA Std CFR1926.502	
	Top Bar Height Guardrails	Conform to CBC §1013	42" above base $\pm 3"$ for guard rails
	Top Bar Height Staircase and Ramp Handrails	Conform to CBC §1012	34-38" above stair tread nosings or ramp slope
	Intermediate Bars	Conform to CBC §1013	As required to prevent passage of 21"-diameter sphere
	Bar Diameter	Conform to CBC §1607A.7	2" except where Engineering Calculations are submitted to document 1½" pipe will resist 200-lbf horizontal load applied to top rail
	Tube Wall Thickness	Conform to CBC §1607A.7	Schedule 80 except where Engineering Calculations are submitted to document Schedule 40 pipe will resist 200-lbf horizontal load applied to top rail
	Finish (Refer to and conform to Aluminum Association Standard 1)	Mechanical Finish	M10 Unspecified
		Chemical Finish	C22 Medium matte sodium hydroxide etch
		Anodic Coating	Conform to Aluminum Association Standard for Anodized Architectural Aluminum Class I Anodic Coating, AA-C22 A41 0.7-mil thick clear coating
	Set Screws	Steel	Conform to ASTM F912 Plate per ASTM B633 followed by trivalent conversion & JS600 topcoat $\geq 6 \mu\text{m}$ thick measured per ASTM B487
		Stainless Steel	Conform to ASTM F880 SAE Type 302
	Stainless Steel Hardware		SAE Type 316
Handrail Safety Chain	Stainless Steel Type 316	Type of Chain	Straight link chain 3/16" diameter
		Links per Foot	12 links minimum per foot
		Chain Length	4" longer than access opening

ITEM	MATERIAL	SPECIFICATION	
		Chains Required	2 each opening
		Mounting Height – top chain	42" above floor
		Mounting Height – lower chain	24" above floor
		Snaphooks	boat snap at each end
Guardrail - Aluminum Free-Standing	Anodized Aluminum Pipe or Alloy 6005-T5, 6061-T6 or 6063-T6	Conform to ASTM B241 Clear satin anodized finish 0.7 mil AA-M10-C22-A41	
	Dimensions	Conform to Plans, CBC Chapter 10 and OSHA Std CFR1926.502	
	Top Bar Height Guardrails	Conform to CBC §1013	42" above base ± 3" for guard rails
	Top Bar Height Staircase and Ramp Handrails	Conform to CBC §1012	34-38" above stair tread nosings or ramp slope
	Intermediate Bars	Conform to CBC §1013	As required to prevent passage of / 21"-diameter sphere
	Bar Diameter	Conform to CBC §1607A.7	1½" or 2" as required to resist 200-lbf horizontal load applied to top rail
	Stainless Steel Hardware		SAE Type 316

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install handrails and railings before submitting shop drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Clean surfaces of metalwork to be in contact with concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
- C. Aluminum surfaces to contact concrete shall be coated with heavy alkali-resistant bituminous paint or one coat of zinc chromate.
- D. Aluminum surfaces to contact dissimilar metals shall be insulated from dissimilar metals using neoprene gaskets or washers.
- E. All embedded metalwork shall be secured accurately in position when concrete is placed to prevent displacement or undue vibration during or after placement of concrete.
- F. Where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with Section 03 32 10.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install handrails and railings at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. Applicable building code requirements
 3. AWS D1.2 Structural Welding Code – Aluminum
 4. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.

- E. Install handrails and railings to tolerances recommended by Manufacturer.
1. Unless otherwise shown, install handrails and railings true, plumb, and level using precision gauges and levels.
 2. Do not erect railings on structures until concrete to which it attaches is completed and falsework supporting concrete is released.
 3. For structures on horizontal or vertical curves, railing shall conform to curvature of structure using series of short chords.
 - a. Lengths of chords shall be distance center-to-center of rail posts.
 4. Erect vertical rails on anchor bolts or in holes formed by inserts provided in concrete railing base to receive railing posts.
 - a. Remove sheet metal inserts before erecting railing.
 5. Carefully erect railing true to line and grade.
 - a. Misalignment at any joint between two panels shall be $\leq 1/16"$.
 - b. Deviation of posts or balusters from vertical shall be $\leq 1/8"$
 - c. Joints shall be matchmarked.
 - d. Joints shall have close fit with corner joints coped or mitered and in true alignment.
 6. Built-up parts shall be free of warp.
 7. After erecting railing, repair abrasions in exposed metal.
- F. Welding shall comply with Section 05 05 23.
1. Continuously weld permanent connections along entire contact area.
 2. Grind welds flush with adjacent surfaces.
- G. Bolting shall comply with Section 05 05 23.
1. Conceal fastenings whenever possible.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Handrails and Railings	No bends, twists or open joints No projecting edges or corners at intersections	Visual inspection	All metalwork	City	City
	Alignment	Maximum variation of adjacent railing panels within 1/16"	All joints	City	City
		Posts and balusters vertical with maximum 1/8" deviation from vertical	All posts	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 05 53 00

GRATINGS AND FLOOR PLATES

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of metal gratings, metal floor plates.
- B. Materials, testing, and installation of metal frames and supports for gratings.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 03 32 10: Cement Mortar
- I. Section 05 05 19: Post-Installed Concrete Anchors
- J. Section 05 05 23: Metal Fastenings and Welds
- K. Section 05 50 00: Metal Fabrications
- L. Section 09 90 00: Painting and Coating
- M. Section 09 92 00: Galvanizing
- N. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Design gratings, floor plates, and supports to incorporate design criteria and performance requirements shown.
- B. Furnish and install complete grating and/or floor plate system where shown, including mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Conform to NAAMM MBG 531 and NAAMM MBG 532.
 - 1. Form gratings from materials of size, thickness, and shapes shown, but not less than required to support indicated loads.
 - 2. Fit exposed connections accurately together to form hairline joints.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products
 - 2. ANSI/ASME B18.15 Forged Eyebolts
 - 3. ASTM A36 Carbon Structural Steel
 - 4. ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 5. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 6. ASTM A167 Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet, and Strip
 - 7. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - 8. ASTM A194 Carbon and Alloy Steel Nuts for High-Pressure and High Temperature Service
 - 9. ASTM A276 Stainless Steel Bars and Shapes

10. ASTM A325 Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
11. ASTM A489 Carbon Steel Lifting Eyes
12. ASTM A490 Heat-Treated Steel Structural Bolts 150ksi Minimum Strength
13. ASTM A510 Wire Rods and Coarse Round Wire, Carbon Steel
14. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
15. ASTM A666 Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, And Flat Bar
16. ASTM A793 Rolled Floor Plate, Stainless Steel
17. ASTM A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution-Hardened, and Bake-Hardenable
18. ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
19. ASTM A1018 Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
20. ASTM B6 Zinc
21. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate
22. ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
23. ASTM B241 Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
24. ASTM B308 Aluminum-Alloy 6061-T6 Standard Structural Shapes
25. ASTM B633 Electrodeposited Coatings of Zinc on Iron and Steel
26. ASTM E84 Surface Burning Characteristics of Building Materials
27. ASTM F541 Alloy Steel Eyebolts
28. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
29. ASTM F594 Stainless Steel Nuts
30. AWS D1.1 Structural Welding Code – Steel
31. MIL-G-18015 A (Ships) Aluminum Planks. (6063-T6)
32. NAAMM MBG 531 Metal Bar Grating Manual
33. NAAMM MBG 532 Heavy-Duty Metal Bar Grating Manual

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit for fabricated gratings, floor plates and cover plates per structural Shop Drawing requirements	.
	Submit layout drawings for grating, showing direction of span, type and depth of gratings, size and shape of grating panels, seat angle details, and details of grating hold-down fasteners.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for gratings per Product Data requirements.	
	Submit load and deflection tables for each style and depth of grating used.	
	Submit data for clips and anchorage devices.	
	Submit data on shop-applied coatings.	
Installation Instructions	Submit per Installation Instructions requirements. Include Manufacturer's recommendations for reinforcing cut openings.	
SAMPLES		
Material Samples	Submit on request	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	Submit for grating and grating support systems, including seismic anchorage calculations. Grading and grating support calculations may be omitted for grating frames embedded in concrete.	
Foundry or Test Record Transcripts	Submit for factory tests upon request per Foundry or Test Record transcript requirements.	
Welder Qualification Certificates	Submit for welders performing work on this project. Also submit certifications of procedure qualifications for each welding procedure used.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, Foundry or Test Records and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of gratings and floor plates.
- C. Store materials above ground on platforms, skids, or other supports and protect from rain, dirt, grease, foreign matter, and corrosion.
1. Protect composite gratings from UV exposure.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
GRATING SYSTEMS		
Grating - Aluminum	Grating Pacific, Inc.	Los Alamitos, CA (562) 598-4314
	Harsco Industrial / IKG	Channelview, TX (800) 324-8417
	McNichols Company	Tampa, FL (877) 884-4653
	SlipNOT Div. W S Molnar Co.	Detroit, MI (800) 754-7668
	Accepted Equal	
Grating – Fiberglass Reinforced Polymers (FRP)	Aetna Plastics Corporation "Chemgrate®: or "Fibergate®"	Valley View, OH (800) 634-3074
	American Grating "Gridwalk SuperSpan"	Henderson, NV (702) 567-0303
	Bedford PROGrid® and PROGrate®	Bedford, PA (800) 377-3280
	Delta Composites, LLC (HS)	Houston, TX (713) 225-3225
	Enduro Composites	Houston, TX (281) 921-9002
	Fibergate Composite Structures, Inc.	Stephenville, TX (254) 965-3148
	Grating Pacific, Inc.	Los Alamitos, CA (562) 598-4314
	Harsco Industrial IKG	Channelview, TX (281) 452-6637
	International Grating, Inc.	Houston, TX (713) 633-0982
	Grating Pacific, Inc.	Los Alamitos, CA (562) 598-4314
	McNichols Company	Tampa, FL (877) 884-4653
	Seasafe, Inc.	Lafayette, LA (337) 406-2345
	SlipNOT Div. W S Molnar Co.	Detroit, MI (800) 754-7668
	Strongwell Corporation "Duradek"	Chatfield, MN (276) 645-8054
	Ultra Fiberglass Systems	Milwaukee, WI (414) 461-5051
	Accepted Equal	
Grating – Cast Iron	Alhambra Foundry Company Ltd.	Alhambra, CA (626) 289-4294
	Long Beach Iron Works, Inc.	Long Beach, CA (562) 432-5451
	Neenah Foundry	Ontario, CA (626) 602-6796
	South Bay Foundry	Santee, CA (619) 956-2780
	U S Foundry and Manufacturing Corp	Medley, FL (305) 885-0301
	Accepted Equal	
Grating – Steel	Grating Pacific, Inc.	Los Alamitos, CA (562) 598-4314
	Inwesco Inc.	Azusa, CA (626) 334-9304
	McNichols Company	Tampa, FL (877) 884-4653
	SlipNOT Div. W S Molnar Co.	Detroit, MI (800) 754-7668
	Accepted Equal	
GRATING PLANKS AND TRENCH COVERS		
Grating Planks -	Harsco Industrial / IKG	Channelview, TX (800) 324-8417

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Aluminum	Accepted Equal	
Safety Grating Planks - Steel	Harsco Industrial / IKG "Deck Span"	Channelview, TX (800) 324-8417
	Cooper B-Line / Eaton "Grip Strut"	Highland, IL (800) 851-7415
	Accepted Equal	
GRATING ACCESSORIES		
Grating Anchor Systems	Struct-Fast® Grate-Fast	Easton, MD (800) 327-6719
	Accepted Equal	
Grating Pedestals - Fiberglass	Grating Pacific, Inc.	Los Alamitos, CA (562) 598-4314
	Ultra Fiberglass Systems	Milwaukee, WI (414) 461-5051
	Accepted Equal	
Lifting Eyebolts	Cleveland City Forge	Wellington, OH (440) 647-5400
	Sierra Pacific Engineering and Products	Long Beach, CA (800) 433-5554
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Materials for gratings, floor plates and cover plates shall be:

ITEM	MATERIAL	SPECIFICATION
Cover Plates – Checkered Aluminum	Aluminum	Conform to one of the following: ASTM B308 Alloy 6061 T6 temper (F _y =35ksi, f _u =38ksi E=10,000ksi) Thickness 3/16"
	Lug Pattern	Shall have raised lug pattern on top face and smooth bottom face. Provide lugs ≥1" long raised at least ½" above surface. Lug pattern shall orient lugs at 90° from adjacent lugs in 2 orthogonal directions. Orient rows of lugs 45° from plate edges.
	Thickness	As required to limit total-load deflection to <L/240 per CBC Table 1604.3 or ¼", whichever is less
	Frame	Miter and weld corners of embedded angle frames and grind welds smooth.
	Abrasive Surface	For abrasive-surface floor plate roll abrasive granules into surface or bond abrasive material metallically to steel
	Lifting Handles	Provide each removable section with U-bolt lifting handles located at opposite ends.
	Angle Supports	Aluminum to match floor plate material
Cover Plates – Checkered Steel	Welded Mild Carbon Structural Steel	Conform to ASTM A789 for dimensions and fabrication Conform to one of the following for steel properties ASTM A36 (F _y =36ksi, F _u =58ksi, E=29000ksi) ASTM A283 Grade C (F _y =30ksi, F _u =55ksi, E=29000ksi) ASTM A283 Grade D (F _y =33ksi, F _u =60ksi, E=29000ksi) Thickness 3/16"
	Galvanized Coating	Refer to Section 09 92 00.
	Lug Pattern	Shall have raised lug pattern on top face and smooth bottom face. Provide lugs ≥1" long raised at least ½" above surface. Lug pattern shall orient lugs at 90° from adjacent lugs in 2 orthogonal directions. Orient rows of lugs 45° from plate edges.
	Thickness	As required to limit total-load deflection to <L/240 per CBC Table 1604.3 or ¼", whichever is less
	Frame	Miter and weld corners of embedded angle frames and grind welds smooth.
	Abrasive Surface	For abrasive-surface floor plate roll abrasive granules into surface or bond abrasive material metallically to steel
	Lifting Handles	Provide each removable section with U-bolt lifting handles located at opposite ends.
	Angle Supports	Steel to match floor plate material

ITEM	MATERIAL	SPECIFICATION
Cover Plates – Checkered Stainless Steel	Welded Stainless Steel	Conform to the following for materials, dimensions and fabrication SAE Type 316/316L ASTM A793 (F _y =31ksi, F _u =73ksi, E=29000ksi Thickness 3/16"
	Lug Pattern	Shall have raised lug pattern on top face and smooth bottom face. Provide lugs ≥1" long raised at least ½" above surface. Lug pattern shall orient lugs at 90° from adjacent lugs in 2 orthogonal directions. Orient rows of lugs 45° from plate edges.
	Thickness	As required to limit total-load deflection to <L/240 per CBC Table 1604.3 or ¼", whichever is less
	Frame	Miter and weld corners of embedded angle frames and grind welds smooth.
	Abrasive Surface	For abrasive-surface floor plate roll abrasive granules into surface or bond abrasive material metallically to steel
	Lifting Handles	Provide each removable section with U-bolt lifting handles located at opposite ends.
	Angle Supports	Stainless steel to match floor plate material
Grating – Pressure- Locked Aluminum I-Bar	Aluminum	Conform to the following: ASTM B221 Alloy 6063 T42 temper (F _y =11ksi, F _u =23ksi E=9,900ksi) Size – Refer to Plans
	Aluminum Frame	Conform to the following: ASTM B221 Alloy 6063 T42 temper (F _y =11ksi, F _u =23ksi E=9,900ksi) Miter and weld corners of embedded angle frames and grind welds smooth.
Grating – Fiberglass	Fiberglass	Size – Refer to Plans Molded fiber-reinforced polymer (FRP) composite (yellow)
	Core	Unidirectionally aligned glass fibers
	Mat	Standard corrosion liner
	Veil	Standard corrosion liner
	Ultraviolet Stabilizer	Add to exterior surfaces in type and amount recommended by resin manufacturer.
	Color	As selected by City's Representative
	Skid-Resistant Coating	Anti-slip permanently-bonded grit coating of selected color.
	Flame Spread	≤25 per ASTM E84
	Clips, Saddles, and Fastener Components	Stainless Steel SAE Type 316
	Stainless Steel Frame	SAE Type 316 Miter and weld corners of embedded angle frames and grind welds smooth.
Grating – Steel	Welded Steel Bars	Conform to one of the following: ASTM A36 (F _y =36ksi, F _u =58ksi, E=29000ksi) ASTM A1011 Grade 36 Type 2 (F _y =36ksi, F _u =58.3ksi, E=29000ksi) ASTM A1018 Grade 50 (F _y =50ksi, F _u =65.3ksi, E=29000ksi) Size – Refer to Plans
	Wire Rod for Grating Crossbars	Conform to ASTM A510
	Steel Frame	Conform to one of the following: ASTM A36 (F _y =36ksi, F _u =58ksi, E=29000ksi) ASTM A1011 Grade 36 Type 2 (F _y =36ksi, F _u =58.3ksi, E=29000ksi) ASTM A1018 Grade 50 (F _y =50ksi, F _u =65.3ksi, E=29000ksi) Frame – Miter and weld corners of embedded angle frames and grind welds smooth.
	Galvanized Coating	Refer to Section 09 92 00.
Grating Planks - Aluminum	Aluminum	Conform to the following: ASTM B221 Alloy 6063 T42 temper (F _y =11ksi, F _u =23ksi E=9,900ksi)

ITEM	MATERIAL	SPECIFICATION
		Conform to MIL-G-18015 Type II or IV Extruded in 6" widths with integral I-bar bearing bars at $\leq 6"$ on center. Top surface solid with raised ribs unless otherwise shown. Depth – $\frac{3}{4}"$ / $1"$ / $1\frac{1}{4}"$ / $1\frac{1}{2}"$ / $1\frac{3}{4}"$ / $2"$ / $2\frac{1}{4}"$ / $2\frac{1}{2}"$
		Planks shall have continuous tongue-and-groove interlock at each side, except interlocking planks shall be arranged so any 4' wide section may be removed independently from neighboring grating sections
		Top Surface Pattern – Unpunched, / Rectangular pattern of 3" by $19/32"$ rectangular openings spaced 4" on center / $13/16"$ holes spaced $1\frac{1}{2}"$ on-center / 1" holes spaced 2" on-center
	Aluminum Frame	Conform to the following: ASTM B221 Alloy 6063 T42 temper ($F_y=11\text{ksi}$, $F_u=23\text{ksi}$ $E=9,900\text{ksi}$) Miter and weld corners of embedded angle frames and grind welds smooth.
Safety Grating Planks - Steel	Sheet Steel	Punched into $1\frac{1}{8}"$ by $11/16"$ open serrated diamond-shape pattern formed into plank sections.
	Galvanized Coating	Refer to Section 09 92 00.
Bolts – Embedded Eyebolts and Lifting Eyebolts	Stainless Steel	Conform to ASTM F541 SAE Type 316 Dimensions per ANSI/ASME B18.15 Welded eye type

C. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Gratings	Grating shall be fully banded including cutouts for penetrations $\geq 1.0"$ before galvanizing or installation.
	Design Live Load Rating (Outdoor Paved Areas) AASHTO H-25 Loading
	Design Live Uniform Load Rating (Indoors or Areas Above Pavement Elevation) Refer to Structural Load Sheet S1 for Floor Loads / 300 / 200 / 100 / 60 psf or 1000 / 300 / 250 / 300-lbf concentrated load at midspan, whichever produces greater stress or deflection
	Span Refer to Plans / XX ft
	Allowable Live Load Deflection $< L/360$ per CBC Table 1604.3 or $\frac{1}{4}"$, whichever is less
	Allowable Total Load Deflection $< L/240$ per CBC Table 1604.3 or $\frac{1}{4}"$, whichever is less
	Maximum Weight of any Piece or Leaf 80 lbs
	Minimum Depth (Steel) See plans / $\geq 1"$ / $1\frac{1}{4}"$ / $1\frac{1}{2}"$ / $1\frac{3}{4}"$ / $2"$ / $2\frac{1}{4}"$ / $2\frac{1}{2}"$ / $3"$ / $3\frac{1}{2}"$ / $4"$ / $5"$ / $6"$ / $7"$
	Minimum Depth (Aluminum) See plans / $\geq 1"$ / $1\frac{1}{4}"$ / $1\frac{1}{2}"$ / $1\frac{3}{4}"$ / $2"$ / $2\frac{1}{4}"$ / $2\frac{1}{2}"$ / $3"$ / $3\frac{1}{2}"$ / $4"$ / $5"$ / $6"$ / $7"$
	Bearing Bar Size or Flange Width $\geq \frac{1}{4}"$ / $5/16"$ / $\frac{3}{8}"$ / $\frac{1}{2}"$
	Bearing Bar Spacing (Steel) $\leq 15/16"$ / $1-3/16"$ / $1\frac{3}{8}"$ / $1\frac{1}{8}"$ / $2\frac{3}{8}"$
	Bearing Bar Spacing (Aluminum) $\leq 15/16"$ / $1-3/16"$ / $1\frac{3}{8}"$ / $1\frac{1}{8}"$ / $2\frac{3}{8}"$
	Minimum Moment of Inertia (I_{min}) Refer to plans / XXX in ⁴ /ft
	Minimum Section Modulus (S_{min}) Refer to plans / XXX in ³ /ft
	Substitutions in bar width and spacing may be proposed if section modulus is not compromised.
	Traffic Surface Abrasive Grit Coating
	Spans Fabricate single sections for each span. Do not clamp 2 or more grating sections together within spans.

ITEM	DESCRIPTION	
	Cross Bars (Steel)	Size $\geq \frac{3}{8}$ " @ 6" on center Weld or mechanically lock bars into position so no movement occurs between bearing and cross bars.
	Cross Bars (Aluminum)	Size $\geq \frac{3}{8}$ " @ 4" on center Weld or mechanically lock bars into position so no movement occurs between bearing and cross bars.
	Cutouts	Provide where required for equipment access or penetrations, including valve operators, stems, and gate frames.
		Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
	Banding	Fully band grating perimeters. Fully band cutouts or openings interrupting 4 or more bearing bars with bars of same size and material as bearing bars before galvanizing or installation Fully band other cutouts for penetrations ≥ 1.0 " before galvanizing or installation.
		Weld banding to each cut bearing bar.
		Banding shall use same material and cross section as bearing bars.
	Clearances	Provide $\leq \frac{1}{8}$ " clearance between grating ends and inside face of vertical support angles.
	Finish (Aluminum)	Class I clear anodized finish
Toeplates		Fabricate toeplates for attaching in field.
Lifting Eyebolts	Size and Diameter	$\frac{3}{8}$ " eyebolt (1"ID / 1-21/32"OD) $\frac{1}{2}$ " eyebolt (1-3/16"ID / 2-1/16" OD) $\frac{5}{8}$ " eyebolt (1-1/2" ID / 2-1/2"OD) $\frac{3}{4}$ " eyebolt (1-1/2"ID / 2-13/16"OD) $\frac{7}{8}$ " eyebolt (1-11/16"ID / 3-1/4"OD) 1" eyebolt (1-13/16"ID / 3-9/16"OD)
Fastenings		Fasten grating pieces in 2 locations to each support.
Non-Slip Nosings at Stairway Tops		Grating edges forming top riser for stairways shall have integral non-slip nosing of width equal to stairway.
Support Angles	Support Around Openings	Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles needed to receive gratings. Miter and weld connections for perimeter angle frames. Provide support angles matching grating material around openings.
		Support angles in concrete shall be embedded.
		Miter and weld angles at corners
Floor Plates and Cover Plates	Thickness	$\frac{1}{4}$ " / $\frac{1}{2}$ " / $\frac{3}{4}$ " / 1"

- D. Cut, drill, tap, and punch materials to receive hardware cleanly and accurately.
1. Remove burrs and ease edges to approximate 1/32" radius.
 2. Remove sharp or rough areas on exposed surfaces.
- E. Refer to Section 09 92 00 for galvanizing.
- F. Before leaving shop, carbon steel not shown or specified to be galvanized or in contact with concrete shall receive one coat of pigmented primer recommended by Manufacturer of final paint system. Parts inaccessible after assembly shall be given second coat of same primer.
- G. Final painting shall conform to Section 09 90 00.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install gratings and floor plates before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Clean surfaces of metalwork to be in contact with concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
- C. Aluminum surfaces to contact concrete shall be coated with heavy alkali-resistant bituminous paint or one coat of zinc chromate.
- D. Aluminum surfaces to contact dissimilar metals shall be insulated from dissimilar metals using neoprene gaskets or washers.
- E. Secure embedded metalwork accurately in position when concrete is placed to prevent displacement or undue vibration during or after placement of concrete.
- F. Where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar in conformance with specifications in Section 03 32 10.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install gratings and floor plates at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations.
 - 2. Applicable building code requirements.
 - 3. Manufacturer's installation and warranty requirements.
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install channels, angle seats, gratings and floor plates to tolerances and installation clearances recommended by Manufacturer.
 - 1. Install channels, angle seats, gratings and floor plates true and level using precision gauges and levels.
 - 2. Do not notch bearing bars at supports to maintain elevation.
 - 3. Attach removable units to supporting members using type and size of clips and fasteners shown, or if not shown, as recommended by Manufacturer for type of installation conditions shown.
 - 4. Attach nonremovable units to supporting members by welding where both materials are same.
 - 5. Attach dissimilar materials by bolting as indicated above.
- F. Attach fasteners and connections as follows:
 - 1. Welding shall conform to Section 05 05 23.
 - a. Continuously weld permanent connections along entire area of contact.
 - 2. Bolting shall conform to Section 05 05 23.
 - a. Conceal fastenings where possible.
 - 3. Attach clips or saddles to bearing bars only.

- G. Built-up parts shall be free of warp.
- H. Exposed ends and edges of metal shall be slightly rounded.
- I. Preassemble items in shop to extent possible.
 - 1. With written permission of City's Representative, minor or unforeseen access openings and banding of grating may be made in field.
 - 2. Reinforce field-cut openings in accordance with Manufacturer's instructions.
- J. Set seat angles for grating flush with finished floor.
- K. Maintain gratings and checker plates flush with finished floor.
- L. Attach toeplates to gratings by welding at indicated locations.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Gratings and Floor Plates	No Bends, Twists or Open Joints No Projecting Edges or Corners at Intersections	Visual Inspection	All gratings and floor plates	City	City
	Tolerances	$\leq \frac{1}{8}"$ in 3' deviation from vertical $\leq \frac{1}{4}"$ in 20' deviation from horizontal $\leq \frac{1}{4}"$ in 20' deviation from Plan location	All gratings and floor plates	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-Month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING
IN SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

PART 1 - GENERAL

1.1 Work Included

- A. Furnish labor, materials and equipment required for satisfactory preparation of surfaces and subsequent application of protective coatings.
- B. Unless otherwise specified or directed by City's Representative, paint all surfaces except:
 - 1. Nameplates, Manufacturer's data plates, UL labels, and stamping and instruction labels.
 - 2. Grease fittings.
 - 3. Threads of threaded fittings.
 - 4. Mating, contacting, or rotating machined surfaces, operators, shafts, gears, linkages, bearings, packing glands, and sensing elements.
 - 5. Platform gratings, stair treads, thresholds, and other walk surfaces.
 - 6. Maintenance hole covers, and valve lids,
 - 7. Aluminum or anodized aluminum items not in contact with concrete.
 - 8. Stainless steel items.
 - 9. Galvanized items.
 - 10. Items embedded in concrete except aluminum.
 - 11. Submerged brass or copper tubing.
 - 12. Flexible items including flexible conduit, rubber items, and flexible or fabric connections to fans or ducts.
 - 13. Buried pipe exteriors.
 - 14. Pipe interiors.
 - 15. Mortar-coated pipe and fittings.
 - 16. Electrical conduit
 - 17. Electrical wiring and insulation.
 - 18. Factory-coated items having a complete factory finish, including control panels, and motors,
- C. Protect surfaces not to be painted.
 - 1. Prevent abrasive, solvent, surface preparation, or paint materials from falling on or marring adjacent surfaces.
 - 2. Remove, mask, or use plastic or drop cloths to cover surfaces to be protected.
 - 3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
 - 4. Mask openings in motors and machinery to prevent paint, dust, and other materials from entering.
 - 5. Remove masking materials and clean surfaces at completion of painting operations.
- D. Coat contacting metal surfaces of structures to be bolted together as follows:
 - 1. When bolted contact is to exist between mating surfaces of ferrous or metal parts of identical chemical composition, such surfaces need not be painted, but resulting crevices shall be watertight and filled or sealed with paint.
 - 2. Protect such surfaces during shipping and handling.
 - a. Apply rust-resistant oil or coating to be removed before surfaces are mated.
 - 3. Do not paint contacting metal surfaces formed by high-strength bolts in friction-type or flanged connections.
 - 4. Where nonmetal surface is in bolted contact with metal surface, clean contacting metal

surfaces and coat metal with 3 coats of specified primer.

- E. Structural steel, and metal floor decking which will not be exposed in final construction shall have no finish other than 1 coat of shop primer.
- F. Shop primers on surfaces to be coated shall be treated as temporary coatings intended to prevent ferrous or other surfaces from oxidizing during shipment.
 - 1. Shop primers shall be chemically compatible with field primers and topcoats of this section.
 - 2. Shop primers shall conform to MPI#79 and be universal modified-alkyd primers, fast curing, and lead- and chromate-free.
 - 3. Shop primers not conforming to MPI#79 shall be accepted in writing by topcoat manufacturer.
 - 4. Shop primers shall contain pigments to make them easily distinguishable from specified zinc-rich field primers.
 - 5. Bituminous primers over metal are incompatible with coating systems specified herein and shall be field-removed by sandblasting prior to primer application.
 - 6. Specified field primers may cover non-bituminous shop primers provided finish coating system Manufacturer deems them compatible with coating system Manufacturer's painting system.
 - 7. Thicknesses of shop primers will not be counted toward thicknesses of field primers.
- G. Conform to Standard Specifications for Public Works Construction (Greenbook) §210-1, §310, applicable permits, and requirements herein.

1.2 **Related Work**

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 63 00: Product Substitutions
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 01 73 00: Execution
- I. Section 01 73 33: Mechanical Identification
- J. Section 01 74 00: Cleaning and Waste Management
- K. Section 09 92 00: Galvanizing

1.3 **Definitions**

- A. The following definitions apply:
 - 1. Coating: Refer to definition of "paint" herein.
 - 2. Dry Film Thickness (DFT): Thickness of fully cured coat of paint measured in mils (1/1000").
 - 3. Finish: Refer to definition of "paint" herein.
 - 4. Paint: Surface treatments, emulsions, enamels, paints, epoxy resins and protective coatings other than anodizing or galvanizing, whether used as pretreatment, primer, intermediate coat, or finish coat

1.4 **System Description**

- A. Furnish and install complete functional coating system for specified surface in compliance with applicable local air quality management regulations.
 - 1. Comply with Manufacturer's application requirements and applicable codes, standards, and South Coast Air Quality Management District regulations, including Rule 1107 for shop coating and Rule 1113 for field coating.

1.5 **Quality Assurance**

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Equipment and its use shall conform to the following:
1. Use only good, clean brushes and equipment.
 - a. Clean brushes, buckets, and spraying equipment shall be cleaned immediately at end of each painting period.
 2. Maintain Contractor's painting and coating equipment in first-class working condition.
 - a. Compressors shall have suitable traps and filters to remove water and oils from air.
 - b. Perform blotter test at each start-up period and as deemed necessary by City's Representative.
 3. Steel wire brushes shall have sufficient rigidity to clean surface, shall be kept free of excess foreign matter, and shall be discarded when they are no longer effective.
 4. Hand scrapers shall be made of suitable material and kept sharp enough to be effective.
 5. Brushes shall have sufficient body and bristle length to spread paint in uniform coat.
 6. Rollers shall be of type that do not leave stippled texture in paint film.
 7. On surfaces inaccessible for brushing, apply paint by spray or by sheepskin daubers especially made for this purpose.
 8. Spraying shall be done by experienced operators.
 - a. Provide water trap acceptable to City's Representative on spray painting equipment.
 9. Use mechanical mixers to mix paint sufficient length of time before use to mix pigment and vehicle.
 - a. To keep pigment in suspension, keep paint mixed while being applied.
 10. Use application equipment, tools, pressure settings and techniques in accordance with Manufacturer's application instructions.
- C. Paint shall be homogenous, free of contaminants, and of consistency suitable for intended use.
1. Pigment shall be finely ground and properly dispersed in vehicle such that pigment does not settle, cake, or thicken in container, or become granular or curdled.
- D. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Painting and Coating Materials	Compliance with Contract Requirements	Federal Standard 141	Test representative sample	Contractor	Contractor
Paint from Proposed "equals"	Spectrographic and Durability Tests	Federal Standard 141 and applicable ASTM standards	As directed	Contractor	Contractor
Valve, Pump, Hydrant, Meter and Pipeline Appurtenance Interiors	Holidays	ASTM D5162 Certify as holiday free using low voltage (22.5- 80V with approximately 80,000Ω resistance) holiday detector and sponge saturated with 0.5% sodium chloride solution	Each lined item	Contractor	Contractor
	Lining Thickness	Verify thickness with magnetic-type dry film thickness gauge.	Each lined item	Contractor	Contractor

- E. Surface preparation and priming operations accomplished offsite for prefabricated structural members will be monitored 100% by City-selected quality control inspector at City's option.

1. Where factory Work is performed >50 miles from jobsite, costs incurred by offsite inspection shall be borne by Contractor.
 2. Refer to Section 01 40 00 for off-site inspection and reimbursement requirements.
- F. Submit schedule of shop activities as specified below under "Submittals."
- G. If shop Work is not scheduled on consecutive basis to facilitate scheduling of offsite inspector, expenses incurred by multiple trips to shop will be borne by Contractor.
- H. Failure by City to exercise option for shop inspection shall in no way relieve Contractor of their duty to meet Contract requirements.

1.6 **References**

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
1. ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment
 2. ANSI Z535 American National Standard for Safety Colors
 3. ASTM D16 Terminology Relating to Paint, Varnish, Lacquer and Related Products
 4. ASTM D449 Asphalt Used in Dampproofing and Waterproofing
 5. ASTM D1187 Asphalt-Base Emulsions for Use as Protective Coatings for Metal
 6. ASTM D4138 Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means
 7. ASTM D5162 Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
 8. ASTM D6386 Surface Preparation of Galvanized Surfaces
 9. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
 10. California Green Building Standards Code (CALGreen Code)
 11. Federal Specification TT-P-19 Paint, Latex (Acrylic Emulsion, Exterior Wood and Masonry)
 12. Federal Specification TT-S-230 Sealing Compound, Synthetic Rubber Base, Single Component Chemically Curing
 13. Federal Standard 141 Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing
 14. MPI#79 Primer, Alkyd, Anti-Corrosive for Metal
 15. NACE 6D-173 Manual for Painter Safety
 16. NACE RP0188 Discontinuity (Holiday) Testing of Protective Coatings
 17. NSF/ANSI 61 Drinking Water System Components – Health Effects
 18. NSF/ANSI 600 Health Effects Evaluation and Criteria for Chemicals in Drinking Water
 19. SSPC Guide 12 Guide for Illumination of Industrial Painting Projects
 20. SSPC PA1 Shop, Field and Maintenance Painting
 21. SSPC PA2 Measurement of Dry Paint Thickness with Magnetic Gauges
 22. SSPC PA3 Safety in Paint Applications
 23. SSPC SP1 Solvent Cleaning
 24. SSPC SP2 Hand Tool Cleaning
 25. SSPC SP3 Power Tool Cleaning
 26. SSPC SP5/NACE 1 White Metal Blast Cleaning
 27. SSPC SP6/NACE 3 Commercial Blast Cleaning
 28. SSPC SP7 Brush-off Blast Cleaning
 29. SSPC SP10/NACE 2 Near White Blast Cleaning
 30. SSPC SP11 Power Tool Cleaning to Bare Metal
 31. SSPC SP13/NACE 6 Surface Preparation of Concrete
 32. SSPC SP15 Commercial-Grade Power Tool Cleaning
 33. SSPC Vis1 Pictorial Surface Preparation Standards for Painting Steel Surfaces
 34. SSPWC Standard Specifications for Public Works Construction (Greenbook) §210-1 "Paint"
 35. SSPWC Standard Specifications for Public Works Construction (Greenbook) §310 "Painting"

1.7 **Submittals**

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Applicator's Quality Assurance	Submit list of ≥5 completed projects of similar size and complexity. Include product name and location, name of owner, name of contractor, name of City's representative, name of coating Manufacturer, approximate area of coatings applied and date of completion	
Applicator's Quality Assurance for Submerged or	In addition to above, submit letter from coating system Manufacturer on their stationery stating application Contractor is factory-authorized and trained to apply their product and that coating system Manufacturer will honor specified warranty of	

SUBMITTAL	DESCRIPTION	
Severe-Service Coating Systems	systems applied by applicator.	
Paint, Color, and Finish Schedule	Submit finish schedule showing the following for each surface type. 1. Surface description 2. Manufacturer of proposed system 3. Proposed Surface preparation 4. Proposed primer product and thickness 5. Proposed intermediate coat and thickness 6. Proposed finish coat and thickness 7. Proposed color 8. Proposed finish (flat, eggshell, satin, semi-gloss or high gloss)	
	Identify proposed exceptions or departures from Contract Documents in submitted finish schedule along with reason for proposed exception or departure (eg Specified product no longer marketed in Southern California.	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements. Include VOC data.	
Application Instructions	Submit for each paint and coating per Application Instruction requirements. Include: 1. Surface Preparation Requirements. 2. MSDS sheets identifying flammability, toxicity, allergenic properties and other characteristics requiring field precautions. 3. Safety practices. 4. Minimum and maximum recommended dry-film thicknesses per coat for prime, intermediate, and finish coats. 5. % solids by volume. 6. Recommended thinners. 7. Statement verifying selected prime coat is recommended by Manufacturer for use with selected intermediate and finish coats. 8. Recommended application, equipment, humidity, and temperature limitations. 9. Curing requirements and instructions. 10. Patching, repair, and touch-up instructions.	
SAMPLES		
Material and Color Samples	Submit current Manufacturer's color samples showing full range of available standard colors. On City's request, field-apply up to 3 coating samples at no extra cost for review. City will select colors.	
	After City-selects color, submit 2 sets of color samples for each color and finish type. Show color formula on back of each color sample. Include color samples with formulas in O&M instructions.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	1. With each delivery of paint and coating materials, Manufacturer shall certify materials conform to Contract Documents. 2. Submit certification that coatings conform to applicable local Air Quality Management District rules and regulations for products and application 3. Submit coating system and application certification that coatings conform to specified requirements and are suitable for intended application per certificate of compliance requirements.	
Inspection Reports	1. Submit inspection reports and data collection sheets for surface preparation and profile checks, coating thickness measurements for each coat, holiday tests, ambient conditions, and other pertinent records. 2. Submit written 3 rd -party report from accepted testing agency describing inspections made and actions taken to correct nonconforming Work. 3. Report nonconforming Work not corrected.	
CLOSEOUT SUBMITTALS		

SUBMITTAL	DESCRIPTION	
O & M & Cleaning Instructions	Submit per Operation and Maintenance Instruction requirements.	
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Application Instructions, O&M Instructions, Certificates of Compliance, and Material Samples.

1.8 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of painting and coating products.
- C. Labels on coating system containers shall show:
1. Coating or material name, formula, or specification number
 2. Generic type of material
 3. Manufacturer
 4. Color name and number
 5. Batch or lot number
 6. Date of manufacture
 7. Shelf-life date
 8. Mixing and thinning instructions
 9. Hazards connected with use of coating system and precautions, if any, required to prevent injury.
- D. Deliver materials to Project Site in original, unopened containers bearing label information specified above.
- E. Store paint and coating materials used on job in 1 place designated by City's Representative.
1. Store materials in clean dry area within temperature range stipulated by Manufacturer.
 2. Store paint materials in area $\geq 50^{\circ}\text{F}$
 3. Store flammable materials in accordance with local building codes.
 4. Separate flammable materials and store in suitable area.
- F. Keep containers sealed until ready for use.
1. Do not open or use painting and coating system materials until City's Representative has inspected containers and has obtained necessary data from information shown on containers and labels.
 2. Do not use paint until ≥ 7 days have elapsed since date of manufacture.
 3. Do not use materials beyond Manufacturer's shelf-life or pot-life limits.
 4. Do not use mixed materials beyond pot life limits.
 5. Do not apply new coatings to surfaces beyond Manufacturer's specified recoat limits.
- G. Protect materials from damage or contamination.
1. Keep containers closed when not in use.
- H. Deliver, store and handle shop-primed steel and shop-coated items as follows:
1. Upon completing blasting and priming, primer on steel shall be cured sufficiently to minimize damage during handling.
 2. When transporting structural steel, use spacers and protective devices to eliminate scuffing during unloading.
 3. If wood spacers are used, remove wood splinters and particles from shop-primed surfaces after separation.
 4. Use padded chains or ribbon binders to secure loaded items and minimize damage to shop-coated surfaces during shipping.

5. Handle shop-coated items with care during loading/unloading, installation, and erection to minimize damage.
6. Prevent abrasion damage during loading, unloading, storage and erection.
 - a. Do not slide steel across another plate or member except to fit sheets into position during fabrication.
7. Fully cover shop-primed or shop-coated items with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.
8. Do not place or store shop-coated items on ground or on top of other Work unless ground or Work is covered with protective covering or tarpaulin.
9. Steel may be elevated above ground level or other steel members using accepted spacers.
10. Place shop-coated items above ground upon platforms, skids, or other supports.

1.9 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Materials shall be of current manufacture and shall conform to applicable regulations for application and intended service.
 1. Materials shall conform to applicable Federal, state and local regulations, including South Coast Air Quality Management District Regulations.
 2. Coats of coating systems shall come from 1 Manufacturer and shall be accepted by Manufacturer for intended service.
 3. Should product specified herein no longer be manufactured or not meet current regulations, substitute currently manufactured product of at least equal performance meeting applicable regulations subject to City's Representative's acceptance, at no additional cost.
- B. Materials specified are those that have been evaluated for the specific service.
 1. Listed products establish a standard of quality.
 2. Standard products of Manufacturers other than those listed will be accepted when it is proved to satisfaction of City's Representative that they are equal to or better than specified materials in the following properties:
 - a. Quality
 - b. Composition
 - c. Utility
 - d. Durability
 - e. Resistance to abrasion and physical damage
 - f. Life expectancy
 - g. Ability to recoat in future
 - h. Solids content by volume
 - i. Dry film thickness per coat
 - j. Compatibility with other coatings
 - k. Suitability for intended service
 - l. Resistance to chemical attack
 - m. Temperature limitations in service and during application
 - n. Type and quality of recommended undercoats and topcoats
 - o. Ease and convenience of application
 - p. Ease and convenience of repairing damaged areas

- q. Stability of colors
- C. Paints and coatings used on Work shall comply with VOC limits set forth in CALGreen Code §5.504.4.3.
- D. Products listed were in general use in 2018.
1. If changes in air quality, water quality or other regulations render listed product obsolete, substitute equivalent product shown in Manufacturer's literature as being formulated and appropriate for surface to be coated.
- E. Factory-applied base coatings to specific products may differ slightly from those listed below where primers are factory-applied by Manufacturers.
- F. Base-coat substitutions for convenience of Contractor are subject to the following.
1. Surface preparation shall meet or exceed surface preparations specified below.
 2. Primer or base coat shall be that recommended and normally used by Manufacturer for condition and exposure of finished installation.
 3. Chemical composition of factory-applied base coats shall be similar to chemical composition specified below.
 4. If different coating system is recommended by Manufacturer to meet performance specifications of other sections, Manufacturer shall notify Contractor in writing and said notice shall be forwarded to City's Representative.
 5. Verify compatibility of adjacent coats with coating Manufacturers.
 6. If necessary, apply barrier coat between prime coat and subsequent field coats to ensure compatibility.
 7. Total DFT shall be $\geq$ DFT specified.
 8. Finish coat shall be as specified.
 9. In event of paint system failure, repair paint system in failed area to specifications of this section.
- G. Acceptable Manufacturers for pretreatment and shop coats include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Aluminum Pretreatment	Henkel North America Bonderite C-IC 33	Madison Heights, MI (248) 583-9300
	International AWL Grip Alumiprep 33	Amsterdam NED (800) 589-1267
	Accepted equal	
Steel Pretreatment	Henkel North America Galvaprep 5	Madison Heights, MI (248) 583-9300
	Accepted equal	
Surface Cleaners and Degreasers	AkzoNobel / Devoe – Devprep 88	Amsterdam NED (800) 589-1267
	Carboline Company Surface Cleaner No 3	St Louis, MO (888) 227-2654
	Sherwin-Williams Co Clean and Etch	Cleveland, OH (800) 524-5979 Ontario, CA (909) 717-3064
	Accepted equal	
MPI#79 Universal Shop Primer		
	AkzoNobel - Ameritone - Devoe - Sinclair - Dulux - Glidden	Amsterdam NED (800) 589-1267
	Benjamin Moore and Company – Vista Paints	Montvale, NJ (201) 573-9600
	Carboline Company	St Louis, MO (888) 227-2654
	Chemcoat	
	PPG Protective & Marine Coating Amercoat	Pittsburgh, PA (412) 434-3131 Yorba Linda CA (714) 777-0300
	Primetime Manufacture	
	Rust-Oleum International LLC / RPM	Vernon Hills, IL(877) 385-8155
	Sherwin-Williams Company	Cleveland, OH (800) 524-5979 Ontario, CA (909) 717-3064
	Tnemec Company, Inc.	Kansas City, KS (800) 863-6321 Compton, CA (310) 804-2326

H. Acceptable Manufacturers for industrial and architectural applications include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Industrial Coating Systems	3M	Saint Paul, MN (888) 364-3577
	AkzoNobel - Ameritone - Devoe - Sinclair - Dulux - Glidden	Amsterdam NED (800) 589-1267
	Ameron Corrosion Control Division	Brea, CA (714) 256-7755
	Carboline Company	St Louis, MO (888) 227-2654
	Dampney Company, Inc.	Everett, MA (800) 537-7023
	Dudick, Inc., Streetsboro, OH	Streetsboro, OH (330) 562-1970
	E I DuPont de Nemours & Company	Wilmington, DE (302) 774-1000
	GET Global Eco Technologies	Pittsburg, CA (925) 473-9250
	Henkel North America	Madison Heights, MI (248) 583-9300
	IET Integrated Environmental Technologies	Santa Barbara, CA (805) 969-2292
	PPG Protective & Marine Coating Amercoat	Pittsburgh, PA (412) 434-3131 Yorba Linda CA (714) 777-0300
	Rust-Oleum International LLC / RPM	Vernon Hills, IL (877) 385-8155
	Sanchem, Inc.	Chicago, IL (312) 733-6100
	Sherwin-Williams Company	Cleveland, OH (800) 524-5979 Ontario, CA (909) 717-3064
	Superior Environmental Products, Inc.	Addison TX (972) 490-0566
	Tnemec Company, Inc.	Kansas City, KS (800) 863-6321 Compton, CA (310) 804-2326
	Wasser Corporation	Auburn, WA (800) 627-2968
	ZRC Worldwide	Marshfield, MA (781) 319-0400
	Accepted equal	

I. Substitutions will be considered providing the following minimum conditions are met.

1. Request for substitution shall be accepted in writing per Section 01 63 00.
2. Proposed coating system dry film thickness shall equal or exceed specified system thickness.
3. Proposed coating system shall employ an equal or greater number of separate coats.
4. Proposed coating system shall employ coatings or paints of same generic type.
5. Requests for substitution shall include full descriptive literature and required for submittal above including generic coating type, non-volatile content by volume and list of 10 similar projects ≥3 years old where coatings or paints have been applied to similar exposure.
6. City's Representative may also require submittal of laboratory data sheets certified by independent testing laboratory satisfactory to City's Representative, showing results of complete spectrographic and durability tests on proposed substitute.
7. City's Representative shall be sole and final judge of acceptability of substitutions.

J. In addition to requirements stated elsewhere, acceptable manufacturers shall demonstrate ≥10 years' domestic experience in manufacture of coating systems similar to those furnished.

K. In addition to requirements stated elsewhere, painting, coating, and coating application accessories shall be products of 1 manufacturer.

L. Thinners, cleaners, driers, and additives shall conform to Manufacturer's application instructions.

2.2 Materials - General

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Surface preparation, prime coatings, and finish coats for various systems are specified herein.

1. Intermediate and finish coats shall be of slightly contrasting shades of specified color.
2. Coating alternates specified shall serve as general guide for type of coating desired.

C. Painting and coating materials shall be specially adapted for use around surface to be coated in its expected environment.

1. Primer coats shall be used as recommended by Manufacturer for these conditions and shall be applied at rates and thicknesses recommended by Manufacturer.

D. Materials schedules below list competing products of 2 or 3 manufacturers to establish general standard of quality required.

1. Other listed manufacturers shall furnish products of equivalent chemistry, thickness and product life where their products are not itemized.

E. The following colors are required:

ITEM	FINISH COLOR TREATMENT PLANTS	FINISH COLOR PUMPS, WELLS, AND ENCLOSED PIPING	FINISH COLOR (AT GRADE or EXPOSED)
RECYCLED WATER SYSTEM IMPROVEMENTS			
Air and Vacuum Relief Valve Assemblies	Brown	Purple	Purple
Air and Vacuum Relief Valve Covers	Purple		Purple
Piping	Brown	Purple	Purple
Pressure Vessels	Brown	Purple	Purple
Pump and Pump Bases (excluding motor)	Brown	Purple	Purple
Valves (all types)	Brown	Purple	Purple
Valve Can Lids	Purple	Purple	Purple
Vault Hatch Lids	Factory Finish	Factory Finish	Factory Finish
Fire Hydrants	Purple		Purple
SITE AND BUILDING IMPROVEMENTS			
Safety Markings	Safety Yellow	Safety Yellow	Safety Yellow
Electrical Equipment, Controls, Panels	ANSI safety white	ANSI safety white	ANSI safety white
Electrical Motors (Do not field coat)	ANSI 61 light grey	ANSI 61 light grey	ANSI 61 light grey
Instruments	ANSI 61 light grey	ANSI 61 light grey	ANSI 61 light grey
Plant Process Wastewater Piping	Refer to Section 01 73 33	Refer to Section 01 73 33	Refer to Section 01 73 33
Other Plant Piping	Refer to Section 01 73 33	Refer to Section 01 73 33	Refer to Section 01 73 33
Valve Interiors	White	White	White

F. Color definitions shall be as follows:

COLOR	PANTONE ID # (CLOSEST MATCH IN SUNLIGHT)	COMMERCIAL COLOR NAME		
		PPG/PMC	Sherwin Williams	Tnemec
ANSI Safety Green	Pantone 335C		Safety Green 4085 - 384U	
ANSI Safety Red	Pantone 186C		Safety Red 4081 - 485C 2X	
ANSI Safety Orange	Pantone 151C		Safety Orange 4083 - 021C	
ANSI Safety Yellow	Pantone 109C	Flirtatious 1212-7	Safety Yellow 4084 - U2X	89HT
ANSI Safety Purple	Pantone 259C			
ANSI Safety White		White	High-Reflective White 7757	White 00WH
ANSI Safety Gray				
ANSI Safety Brown				
ANSI Safety Blue	Pantone 285C			
ANSI 24 Gray	ANSI 24			
ANSI 33 Gray	ANSI 33			
ANSI 45 Gray	ANSI 45			
ANSI 49 Medium Light Gray	ANSI 49			
ANSI 61 Light Gray	ANSI 61			
Flint Gray			Flint Gray 4019	
Light Blue	Pantone 2925C			
Dark Blue	Pantone 2766C	Blue Tang 1160-7	Honorable Blue 6811	Old Glory Blue 78BL
Purple	Pantone 512C			
Reclaimed Water Purple	Pantone 522	Grape Arbor 1247-5	Berry Frappé 9068	Reclaimed Water Purple 16SF

Green		Royal Hunter Green 1133-7	Derbyshire 6741	Garden 35GN
Olive-lite	Pantone 451C			
Safety Orange		Field Poppy 1195-7	Invigorate 6886	79HT
Safety Red		Rum Punch 1190-7	Positive Red 6871	69HT
Desert Sand		Desert Camel 12-16	Ligonier Tan 7717	Desert Sands 04BR
Brown		Fudge 1073-7	Rugged Brown 6062	Safety Brown 15SF

G. Color trade names are provided for reference and do not indicate preference for Manufacturer.

1. Alternative Manufacturers may be furnished, provided colors can be matched

H. Final colors will be selected by City from submitted color samples.

I. Color pigments shall be pure, non-fading, types to suit substrates and intended service shown.

1. Lead content shall not exceed amounts permitted by federal, state and local government regulations.
2. Paints applied to submerged concrete or metal contacting potable water shall be approved by the California State Department of Health Services

2.3 **Materials – Painting and Coating of Valves, Pumps, Flow Meters, Pipe Supports, Exposed Piping, and Pipeline Appurtenances**

A. Coating shall occur as follows:

1. Shop prime exteriors at place of manufacture.
2. Prepare the following surfaces to conform to SSPC-SP6/NACE3 “Commercial Blast Cleaning” before shop priming:
 - a. Exterior items
 - b. Items to receive zinc-rich primer
 - c. Items to receive high-performance coatings
3. Prepare other surfaces to conform to SSPC-SP3 “Power Tool Cleaning” before shop priming.
4. Shop prime to conform to applicable sections of SSPC PA1 “Shop, Field and Maintenance Painting”
5. Coat buried metal valves, above ground metal valves, flow meters, and pumps at place of manufacture unless otherwise directed.
6. Apply other primer, intermediate, and finish coats to exterior of pipe supports, exposed piping, and pipeline appurtenances in field unless otherwise directed.
7. Finish coat on exposed pipe, valves, and appurtenances shall match color and sheen of adjacent piping.
 - a. Where factory coat does not match color and sheen of adjacent piping, apply additional finish coat to match adjacent piping.
8. Coat hand-wheels, pipe supports, and floor stands same as valves.
9. For pipe areas employing grooved or shouldered couplings, limit coating thickness in groove or shoulder area to ≤10 mils.

B. Coat non-buried piping and piping appurtenance exteriors with this coating system:

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Valve, Pump, , Flow Meter, Pipe Support, Piping, or Pipeline Appurtenance Exterior Coating	Polyamidoamine Epoxy / Aliphatic Acrylic Urethane	Total DFT 8.0-15.0 mils		
Surface Preparation		SSPC-SP6/NACE 3 Commercial blast cleaning 1.5-3.0-mil surface angular blast anchor profile		
Base Coat (Shop- Applied)	Polyamidomine Epoxy	Tnemec	Sherwin Williams Macropoxy 646-100	PPG/PMC Amerlock 2 VOC

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
		Series L69 Epoxoline DFT 3.0-5.0 mils	DFT 3.0-5.0 mils	DFT 3.0-5.0 mils
Intermediate Coat	Polyamidomine Epoxy	Tnemec Series L69 Epoxoline DFT 3.0-5.0 mils	Sherwin Williams Macropoxy 646-100 DFT 3.0-5.0 mils	PPG/PMC Amerlock 2 VOC DFT 3.0-5.0 mils
Finish Coat	Aliphatic or Acrylic Urethane or Polysiloxane	Tnemec Endura-Shield II Series 1095 DFT 2.0-3.0 mils	Sherwin Williams Sher-Loxane-800 DFT 2.0-4.0 mils	PPG/PMC Amershield VOC Polyurethane DFT 2.0-4.0 mils

- C. Coating systems for buried valve, flow meter, pipeline and pipeline appurtenance exteriors shall meet requirements for buried metal specified elsewhere in this section.
- D. Apply interior lining of valves 3" and larger as follows:
1. Coat interior metal surfaces excluding seating areas and bronze and stainless-steel pieces.
 - a. Remove protuberances which may produce pinholes in lining.
 - b. Round sharp edges to be coated.
 - c. Remove contaminants which may prevent bonding of lining.
- E. Apply interior lining of valves 3" and larger per AWWA C550.

2.4 **Metal, Interior and Exterior, Normal Exposure**

- A. Coat exposed non-galvanized steelwork, non-galvanized handrails, exposed pipework, fittings, mechanical equipment, pumps, machinery, doors, door frames and window sash with this coating system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Normal-Exposure Steel	Polyamidoamine Epoxy / Aliphatic Acrylic Urethane	Total DFT 8.0-15.0 mils		
Surface Preparation		SSPC-SP6/NACE 3 Commercial blast cleaning 1.5-3.0-mil surface angular blast anchor profile (Where blast cleaning is not possible, provide SSPC SP-15 Commercial-Grade Power Tool cleaning.)		
Base Coat (Shop-Applied)	Polyamidoamine Epoxy	Tnemec Series L69 Epoxoline DFT 3.0-5.0 mils	Sherwin Williams Macropoxy 646-100 DFT 3.0-5.0 mils	PPG/PMC Amerlock 2 VOC DFT 3.0-5.0 mils
Intermediate Coat (Field-Applied)	Polyamidomine Epoxy	Tnemec Series L69 Epoxoline DFT 3.0-5.0 mils	Sherwin Williams Macropoxy 646-100 DFT 3.0-5.0 mils	PPG/PMC Amerlock 2 VOC DFT 3.0-5.0 mils
Finish Coat (Field-Applied)	Aliphatic or Acrylic Urethane or Polysiloxane	Tnemec Endura-Shield II Series 1095 DFT 2.0-3.0 mils	Sherwin Williams Sher-Loxane-800 DFT 2.0-4.0 mils	PPG/PMC Amershield VOC Polyurethane DFT 2.0-4.0 mils

- B. Metalwork previously given shop prime coat accepted by City's Representative shall be touched up as required in field with Tnemec Series 27 WB Typoxy or equal.

2.5 **Metal, Severe Exposure to Moisture or Chemical Fumes**

- A. Coat exterior non-submerged metal with severe exposure to moisture or chemical fumes with this coating system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Metal Exposed to Moisture or Chemical Fumes	Aromatic Urethane Zinc-Rich Primer / Modified Polyamine	Total DFT 8.5-14.5 mils		

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
	Epoxy / Aliphatic Acrylic Urethane			
Surface Preparation		SSPC-SP10/NACE 2 Near-white metal blast cleaning 2.0-3.0-mil surface angular blast anchor profile		
Base Coat	Aromatic Urethane Zinc Rich Primer	Tnemec Series 94 H2O Tneme-zinc DFT 2.5-3.5 mils Gray Green	Sherwin Williams Corethane Galvapac 2K100 DFT 2.5-3.5 mils Gray Green	PPG/PMC Dimetcote 21-5 DFT 2.0-5.0 mils Gray
Intermediate Coat	Modified Polyamine Epoxy	Tnemec Series L69 Epoxy DFT 4.0-5.0 mils,	Sherwin Williams Macropoxy 646-100 DFT 4.0-6.0 mils	PPG/PMC Amerlock 2VOC DFT 4.0-6.0 mils
Finish Coat	Aliphatic or Acrylic Urethane or Polysiloxane	Tnemec Series 1095 2.0-3.0 mils DFT	Sherwin Williams Sher-Loxane-800 DFT 2.0-4.0 mils	PPG/PMC Amershield VOC Polyurethane DFT 2.0-4.0 mils

- B. Coat interior non-submerged metal with severe exposure to hydrogen sulfide fumes with this coating system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Interior Metal Exposed to High Hydrogen sulfide fumes	Modified Polyamine Epoxy	Total DFT 30.0-40.0 mils		
Surface Preparation		SSPC-SP10/NACE 2 Near-white metal blast cleaning ≥3.0-mil surface angular blast anchor profile		
Base Coat	Modified Polyamine Epoxy	Tnemec Series 435 Perma Shield DFT 15-20 mils	Sherwin Williams Duraplate 6100 DFT: 15-20 mils	PPG/PMC Novaguard 810 Phenolic novolac epoxy DFT 15-20 mils
Finish Coat	Modified Polyamine Epoxy	Tnemec Series 435 Perma Shield DFT 15-20 mils	Sherwin Williams Duraplate 6100 DFT: 15-20 mils	PPG/PMC Novaguard 810 Phenolic novolac epoxy DFT 15-20 mils

2.6 **Nonferrous Metal, Galvanized Steel, Stainless Steel, Aluminum, Copper, or Brass**

- A. Copper, bronze, chromium plate, nickel, stainless steel, aluminum, nonferrous, and factory-finished materials and surfaces shall not be painted except as otherwise specified.
1. Nameplates painted over shall be replaced in kind.
 2. Grease fittings painted over shall be replaced in kind.
 3. Galvanized finish will not be considered factory finish.
- B. Coat aluminum embedded in or in contact with concrete to prevent electrolysis.
- C. Coat galvanized metal, aluminum, copper or brass with this coating system where coating is required.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Galvanized Metal, Aluminum, Copper or Brass	Hydrophobic Acrylic Primer / HDP Acrylic Polymer Finish	Total DFT 4.0-10.0 mils		
Surface Preparation		SSPC-SP1 Solvent Cleaning followed by SSPC-SP2 Hand Tool Cleaning Prepare and scarify galvanized surfaces in accordance with ASTM D6386		
Base Coat	Etch	Chemically etch in accordance with Tnemec Technical Memo #10-78 and in	Chemically etch in accordance with Manufacturer's recommendations	Prepare surface in accordance with Manufacturer's recommendations

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
		accordance with ASTM D6386		
Intermediate Coat	Hydrophobic Acrylic	Tnemec Series V115 Uni Bond DF DFT 2.0-3.0 mils	Sherwin Williams Macropoxy 646-100 DFT 3.0-5.0 mils	PPG/PMC Amerlock 2VOC DFT 3.0-5.0 mils
Finish Coat	HDP Acrylic Polymer or Polysiloxane	Tnemec Series 1029 Enduratone DFT 2.0-3.0 mils	Sherwin Williams Sher-Loxane-800 DFT 2.0-4.0 mils	PPG/PMC Amershield VOC DFT 2.0-4.0 mils

2.7 Metal, Buried

- A. Coat buried metal which includes valves, bolts, nuts, structural steel and fittings with this system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Buried Metal	Hybrid Inorganic Water-Based Epoxy	Total DFT 12.0-24.0 mils	Total DFT 16.0-24.0 mils	Total DFT 16.0-24.0 mils
Surface Preparation		SSPC-SP6/NACE 3 Commercial blast cleaning 1.5-3.0-mil surface angular blast anchor profile ≥1.5-mil surface angular blast anchor profile		
Base Coat	Hybrid Inorganic Water-Based Epoxy	Tnemec Series 27 WB Typoxy DFT 6.0-12.0 mils	Sherwin Williams Sherglass FF Low VOC DFT: 8.0-12.0 mils	PPG/PMC Amerlock 2VOC DFT 8.0-12.0 mils
Finish Coat	Hybrid Inorganic Water-Based Epoxy	Tnemec Series 27 WB Typoxy DFT 6.0-12.0 mils	Sherwin Williams Sherglass FF Low VOC DFT: 8.0-12.0 mils	PPG/PMC Amerlock 2VOC DFT 8.0-12.0 mils

2.8 Materials – Painting and Coating of PVC, CPVC and FRP

- A. Coat PVC, CPVC and FRP items with this system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
PVC, CPVC and FRP pipe	Modified Polyamine Epoxy / Pigmented Aliphatic Acrylic Urethane	Total DFT 4.0-8.0 mils		
Surface Preparation		SSPC-SP1 Solvent cleaning followed by thorough and uniform abrasion with medium grain sandpaper		
Base Coat	Modified Polyamine Epoxy	Tnemec Series L69 Epoxy DFT 2.0-3.0 mils	Sherwin Williams Macropoxy 646-100 DFT 2.0-3.0 mils	PPG/PMC Amerlock 2VOC DFT 2.0-4.0 mils
Finish Coat	Pigmented Aliphatic Acrylic Urethane or Polysiloxane	Tnemec Endura-Shield II Series 1095 DFT 2.0-3.0 mils,	Sherwin Williams Sher-Loxane-800 DFT 2.0-4.0 mils	PPG/PMC Amershield VOC Polyurethane DFT 2.0-4.0 mils

- B. Coat PVC, CPVC and FRP where such pipe is above grade and exposed to sunlight, or where required in vaults and buildings for color coding of pipes, or to match adjacent finishes.

2.9 Masonry, Exterior, Normal Exposure

- A. Where Contract Documents require masonry to be painted, paint exterior masonry surfaces subject to normal exposure with this system.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Coating for Exterior Masonry Surfaces	Modified Waterborne Acrylate	Total DFT 8.0-16.0 mils		
Surface Preparation		Remove dirt, dust, grease, laitance or other deleterious matter.		
Filler	Filler	Fill cracks and voids with suitable caulking material compatible with specified coating.		
Base Coat	Modified Waterborne Acrylate	Tnemec Series 156 Envirocrete DFT 4.0-8.0 mils	Sherwin Williams Loxon Block Surfer DFT 8.0-12.0 mils	PPG Paints Perma-Crete 4-100 DFT 9.3 – 11.6 mils
Finish Coat	Modified Waterborne Acrylate	Tnemec Series 156 Envirocrete DFT 4.0-8.0 mils	Sherwin Williams Pro Industrial Acrylic DFT 2.0-4.0 mils	PPG Paints Pitt-Tech Plus DFT 2.0 – 4.0 mils

PART 3 - EXECUTION

3.1 Preparation

- A. Pre-application meeting shall be held 1 to 2 weeks before start of coating system application for products covering > 100 ft².
 1. Meeting shall be attended by Contractor, applicator, Manufacturer's representative and City's Representative and shall cover:
 - a. Environmental requirements set by Manufacturer for their product
 - b. Protection of surfaces not scheduled to be coated
 - c. Stormwater pollution prevention requirements
 - d. Surface preparation
 - e. Application
 - f. Repair
 - g. Field quality control
 - h. Dust control
 - i. Cleaning
 - j. Protection of coating systems
 - k. 11-month inspection
 - l. Coordination with other work
- B. Notify City's Representative ≥3 days before start of field surface preparation Work.
- C. Surfaces to be coated or painted shall be in proper condition to receive material specified before coating or painting is done.
 1. Do not apply painting materials to wet, damp, dusty, dirty, fingermarked, rough, unfinished, or defective surfaces.
 2. Prepare concrete, iron, steel, and wood surfaces in accordance with applicable Manufacturer's instructions and SSPC standards.
- D. Solvent cleaning shall conform to SSPC SP1 and the following:
 1. Oil, grease, soil, drawing and cutting compounds, contaminants, and salts shall be removed by solvent cleaning, emulsions, cleaning compounds, steam cleaning, or other methods which may not involve solvent action before hand cleaning or power tool cleaning.
 2. Cleaning with solutions of alkaline cleaners shall be followed by fresh-water rinse.
 - a. When recommended by paint Manufacturer or specified, follow fresh-water rinse with passivating dichromate or dilute chromic acid wash.

3. Remove oil or grease by 1 of the following methods:
 - a. Wiping or scrubbing surface with rags or brushes wetted with solvent.
 - b. (Final wiping shall use clean solvent and clean rags or brushes.)
 - c. Spraying surface with solvent.
 - d. (Final spraying shall use clean solvent.)
 - e. Complete immersion in tank or tanks of solvent.
 - f. (Solvent for last immersion shall not contain detrimental amounts of contaminant.)
 - g. Emulsion cleaners may be used provided surface treated is subsequently washed to remove detrimental residues.
 - h. Steam cleaning may be used, using detergents or cleaners provided surface is steamed or washed to remove detrimental residues.
 4. If chemical paint strippers are used to remove paint, use suitable solvent to remove wax from stripper remaining on surface.
 - a. Remove alkaline residues from paint strippers by washing surface with fresh water.
 - b. Remove all detrimental paint residue or stripping agent.
 5. Regardless of solvent-cleaning method, no detrimental residue shall remain following cleaning.
- E. Hand cleaning shall conform to SSPC SP2 and the following:
1. Remove loose mill scale, loose rust, dirt, and loose or non-adherent paint by hand brushing, hand sanding, hand scraping, hand chipping, hand impact tools, or combination of these methods.
 - a. Although not all mill scale, rust, and paint need be removed, loose mill scale, rust, paint and other detrimental foreign matter shall be removed.
 - b. Remove stratified rust (rust scale) by hand hammering, hand chipping, hand impact tools or combination of these methods.
 - c. Remove loose mill scale and loose or non-adherent rust by hand wire brushing, hand sanding, hand scraping, or combination of these methods.
 2. Rust and mill scale are classified as "loose mill scale" and "loose or non-adherent rust" if they can be removed from steel surface by vigorous hand brushing with new, commercially available wire brush of suitable type at rate of 2 ft² per minute.
 - a. This test shall be conducted on area not previously brushed, scraped, or sanded, but from which all detrimental stratified rust (rust scale), oil, and grease (if present) have been removed.
 - b. This test establishes standard for surface preparation and shall and shall not be considered as establishing production rate by cleaning.
 - c. Regardless of methods used for cleaning, clean surface at least as well as surface resulting from this test.
 3. Operate hand tools in such manner no burrs or sharp edges are left on surface and no sharp cuts are made into steel.
 4. After removing loose or non-adherent paint, feather edges of remaining old paint so repainted surface will have smooth appearance.
 - a. Remaining old paint shall have sufficient adhesion so it cannot be lifted as layer by inserting blade of putty knife beneath it.
 5. Remove accessible weld flux and spatter by hand scraping or hand impact tools, followed by wire brushing.
 6. Clean accessible portions of all partially enclosed steel members.
 - a. Before assembly, clean new Work areas which will be inaccessible after assembly.
 7. Properly clean rivets, welds, corners, joints, and openings.
 8. After completing hand cleaning, remove dust and other loose matter from surface.

- a. If detrimental amounts of grease or oil are still present, spot clean these areas with solvent.
- F. Power-tool cleaning shall conform to SSPC SP3 and the following:
 - 1. Remove loose mill scale, loose rust, and loose paint with power wire brushes, power impact tools, power grinders, power sanders, or combination of these methods.
 - a. Although not all mill scale, rust, and paint need be removed, loose mill scale, rust, paint and other detrimental foreign matter shall be removed.
 - b. Remove stratified rust (rust scale) by power impact tools or, if minor quantities are present, by hand.
 - c. Large areas of tight or well-adhered paint, even if removable, shall only be removed where specified.
 - 2. Acceptable power-tool cleaning methods include:
 - a. Power wire brushing, using rotary, radial, or cup brushes of suitable size, entering all accessible openings, angles, joints, and corners.
 - b. (Steel wire of such brushes shall have sufficient rigidity to clean surface, shall be kept free of excess foreign matter, and shall be discarded when no longer effective.
 - c. (Clean surface, but do not burnish to detrimental degree.)
 - d. Power impact tool cleaning, using power-driven chipping or scaling hammers, rotary scalers, single- or multiple-piston scalers, or similar impact cleaning tools.
 - e. (Maintain cutting edges of such tools in effective condition.)
 - f. Power grinding, using abrasive wheels or power sanding using abrasive materials.
 - g. (Discard sanding or abrasive materials when they become ineffective.)
 - 3. Rust and mill scale are classified as "loose mill scale," "loose or non-adherent rust," and "loose or removable paint," if they can be removed from steel surface by power wire brushing using commercial electric or air wire-brushing machine operated at speed under load of 3,450 rpm and equipped with 6" diameter cup brush of double-row, knotted construction, made of No.20-gage music wire.
 - a. Hold brush against steel surface with force of 16 lbf.
 - b. Rate of cleaning shall be $\geq 2 \text{ ft}^2$ per minute
 - c. This test shall be conducted on area not previously brushed, scraped, or sanded, but from which all detrimental stratified rust (rust scale), oil, and grease (if present) have been removed.
 - d. This test establishes standard for surface preparation and shall and shall not be considered as establishing production rate by cleaning.
 - e. Clean surface at least as well as surface resulting from this test.
 - 4. After removing loose or non-adherent paint, feather edges of remaining old paint so repainted surface will have smooth appearance.
 - a. Remaining old paint shall have sufficient adhesion so it cannot be lifted as layer by inserting blade of putty knife beneath it.
 - 5. Remove accessible weld flux and spatter by hand scraping or hand impact tools, followed by wire brushing.
 - 6. Clean accessible portions of all partially enclosed steel members.
 - a. Before assembly, clean new Work areas which will be inaccessible after assembly.
 - 7. Properly clean rivets, welds, corners, joints, and openings, using power wire brushing, sharp chisels used in chipping, scaling hammers, rotary grinders, sanders, or combination of these methods.
 - 8. After completing hand cleaning, remove dust and other loose matter from surface.
 - a. If detrimental amounts of grease or oil are still present, spot clean these areas with solvent.
- G. Power-tool cleaning to bare metal, where specified, shall conform to SSPC SP11.

H. Abrasive blast cleaning (sandblasting) shall be completed as follows:

1. Abrasive blast cleaning is defined as removing mill scale, rust, rust scale, oxide, paint, contamination, and foreign matter from surfaces, using fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh propelled through nozzles or centrifugal wheels..
2. Metal surface may be cleaned by 1 of the following methods:
 - a. Dry sandblasting, using compressed air blast nozzles and dry sand of particle size no larger than that passing #18 mesh screen, US sieve series.
 - b. Wet or water vapor sandblasting, using compressed air blast nozzles, water, and sand of particle size no larger than that passing #18 mesh screen, US sieve series.
 - c. Grit blasting using compressed air blast nozzles and crushed grit made of cast iron, malleable iron, steel, or synthetic grits other than sand.
 - d. (Largest commercial grade of metal grit permitted shall be SAE Grit #G25 abrasive material.)
 - e. Shot blasting, using compressed air nozzles and cast iron, malleable iron, steel, or synthetic shot.
 - f. (Largest commercial grade shot permitted shall be SAE Shot #S330.)
 - g. Closed, re-circulating nozzle blasting using compressed air, vacuum, and any of the preceding abrasives,
 - h. Grit blasting using centrifugal wheels and crushed grit made of cast iron, malleable iron, steel, or synthetic grits.
 - i. (Largest commercial grade grit permitted shall be SAE Shot #330.)
3. Compressed air used for nozzle blasting shall be free of detrimental amounts of condensed water, or oil.
 - a. Provide adequate separators or traps.
4. Do not use abrasives that have become contaminated in automatic equipment.
 - a. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.
 - b. Abrasives used in blast cleaning shall be new, washed, graded and free of contaminants which might interfere with adhesion of coatings and paints.
 - c. Do not reuse abrasive unless accepted by City's Representative.
 - d. Particle size of abrasives used in blast cleaning shall produce specified surface profile in per recommendations of Manufacturer of paint or coating system, subject to acceptance by City's Representative.
5. Implement debris containment systems for surfaces subject to abrasive blast cleaning, regardless of whether LBP/LCP materials are present.
 - a. Mask openings in motors and machinery to prevent paint and abrasive materials from entering.
 - b. Place drop cloths or apply masking tape where required to prevent spatter, dripping and overspray from contact with floors, surfaces and equipment not scheduled to receive paint or coatings.
 - c. Protect surrounding areas and surfaces not scheduled to be blasted and/or coated from damage or coloration during surface preparation and coating application.
 - d. Perform blast cleaning operations in manner such that no damage is done to partially or fully completed Work.
6. Remove weld spatter, sharp edges, burrs, and weld slag from metal surfaces.
 - a. Grind smooth rough welds, beads, peaked corners, sharp edges, erection lugs and protrusions in accordance with SSPC SP-2 and SSPC SP-3.
 - b. Neutralize welds with chemical solvent compatible with specified coating materials.
 - c. Use clean cloths and chemical solvent.
 - d. Wipe dry with clean cloths.
 - e. Do not leave residue on cleaned surfaces.

7. Remove oil and grease from metal surfaces in accordance with SSPC SP-1.
 - a. Use clean cloths and cleaning solvents and wipe dry with clean cloths.
 - b. Do not leave film or greasy residue on cleaned surfaces before sandblasting.
8. Do not sandblast or prepare more surface than can be coated or painted in same working day.
 - a. Sandblasting shall be done not more than 8 hours ahead of painting, subject to humidity and weather conditions between time of sandblasting and painting operations.
9. Complete abrasive blast cleaning using dry or water vapor methods unless otherwise directed.
 - a. Maintain dust emissions within legal levels and within levels which will not create nuisance.
10. Equip abrasive blasting nozzles with "deadman" emergency shutoff nozzles.
 - a. Blast nozzle pressure shall be ≥ 95 psi and shall be verified using accepted nozzle pressure gauge at each start-up period or as directed by City's Representative.
 - b. Nozzles used during blast cleaning operations shall be sufficient to ensure timely completion of Work on schedule.
11. Blast cleaning from rolling scaffolds shall only be done within confines of interior perimeter of scaffold.
 - a. Reaching beyond limits of perimeter will be allowed only if blast nozzle is maintained in position which will produce profile acceptable to City's Representative.
12. Keep Work areas clean, and do not allow blasting particles to accumulate and constitute nuisance or hazard.
 - a. Remove spent abrasives and other debris at Contractor's expense.
 - b. If waste is determined to be hazardous, dispose of waste as required by law.
13. During abrasive blast cleaning, prevent damage to adjacent coatings.
 - a. Schedule blast cleaning and coating such that dust, dirt, blast particles, old coatings, rust, or mill scale will not damage or fall upon wet or newly coated surfaces.
14. After blast cleaning and prior to applying coating, dry clean substrates by dusting, sweeping, and vacuuming to remove residue from blasting.
15. If rusting or discoloration of sandblasted surfaces occurs before painting, remove such rusting or discoloration by additional sandblasting.
16. Clean dry sandblasted and coated/painted surfaces before applying paint or coating systems by combination of blowing with clean dry air, brushing/brooming with clean brushes of hair, bristle, or fiber, and/or vacuuming as directed by City's Representative.
 - a. Air hose for blowing shall be $\geq \frac{1}{2}$ " diameter and equipped with shut-off device.
 - b. Remove loose traces of blast products from surface, and remove abrasive from pockets and corners.
17. Clean wet sandblasted surfaces before applying paint or coating systems by rinsing with fresh water to which sufficient corrosion inhibitor has been added to prevent rusting, or with fresh water followed immediately by inhibition treatment.
 - a. Supplement cleaning by brushing or vacuuming to remove residues.
18. Sandblasted surfaces shall not be left overnight before painting.
19. Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface.
 - a. Do not leave blast-cleaned surfaces uncoated for > 8 hours.
 - b. Cleaned areas not receiving base coat within 8-hour period shall be recleaned prior to application of base coat.
- I. White metal blast cleaning shall conform to SSPC SP5/NACE 1, and the following:
 1. White metal blast-cleaned surface is defined as surface with gray-white, uniform metallic color, slightly roughened to form suitable anchor pattern for coatings.

- a. Surface when viewed without magnification shall be free from oil, grease, dirt, visible mill scale, rust, corrosion products, oxides, paint or foreign matter.
 - b. Color of clean surface may be affected by abrasive medium used.
- J. Near-white metal blast cleaning shall conform to SSPC SP10/NACE 2, and the following:
 - 1. Near-white blast-cleaned surface is defined as 1 from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint, or foreign matter have been removed from surface except for very light shadows, very light streaks, or slight discoloration caused by rust, stain, mill scale, oxides, or slight, tight residues of paint or coating that may remain.
 - a. At least 95% of each square inch of surface shall be free of visible residues, and remainder shall be limited to light discoloration mentioned above.
- K. Commercial blast cleaning shall conform to SSPC SP6/NACE 3, and the following:
 - 1. Commercial blast-cleaned surface is defined as 1 from which all oil, grease, dirt, rust scale, and foreign matter have been removed from surface and rust, mill scale, and old paint have been removed except for slight shadows, streaks, or discoloration caused by rust, stain, mill scale, oxides, or slight, tight residues of paint or coating that may remain.
 - a. If surface is pitted, slight residues of rust or paint may be found in bottom of pits.
 - b. At least $\frac{2}{3}$ of every square inch of surface area shall be free of visible residues, and remainder shall be limited to light discoloration, slight staining or light residues mentioned above.
- L. Brush-off blast cleaning shall conform to SSPC SP7, and the following:
 - 1. Brush-off blast cleaned surface is defined as 1 from which all oil, grease, dirt, rust scale, loose mill scale, loose rust, and loose paint or coatings are removed, but tight mill scale and tight-adhered rust, paint, and coating are permitted to remain provided all mill scale and rust have been exposed to abrasive blast pattern sufficient to expose numerous flecks of underlying metal fairly uniformly distributed over entire surface.
 - a. Heavy oil and grease deposits shall be removed by solvent cleaning.
 - b. Small quantities of oil or grease may be removed by blast cleaning.
 - c. Excessive rust scale shall be removed by impact tools and hand cleaning.
- M. Prepare galvanized surfaces as follows:
 - 1. Hand clean to remove concrete spatter, heavy grease, and foreign matter by hand scraping or wire brushing.
 - 2. After hand cleaning, clean galvanized surfaces by solvent cleaning to remove oil, grease, and detrimental foreign matter.
 - 3. After washing, roughen areas by abrasive blasting using abrasive no larger than #30 mesh.
 - 4. Abrasive blasting shall not remove galvanizing.
- N. Prepare wood surfaces as follows:
 - 1. Remove cracked or peeled paint, loose chalky paint, dirt, and foreign matter by wire brushing, scraping, sanding, or other accepted means immediately prior to painting.
 - 2. Wipe or dry brush surfaces to remove dust or chalky residue remaining from cleaning.
 - 3. Allow wood surface to dry before painting.
- O. Before application, examine areas and conditions under which coating systems are to be applied.
 - 1. Concrete and masonry surfaces shall cure 30 days prior to coating or painting.
 - 2. Ensure surfaces to receive coatings are dry and free from visible oil, grease, dirt, dust, laitance, mill scale, rust, paint oxides, corrosion products, blisters, loose paint, moisture, and other foreign matter in accordance with specified SSPC standards.
 - 3. Neutralize spots showing effects of alkali.
 - 4. Neutralize welds with suitable chemical compatible with specified paint or coating system.

5. Notify City's Representative of areas or conditions which are not acceptable to receive coatings.
 - a. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.
- P. Prior to application of paint or coating, notify City's Representative to inspect and accept prepared surfaces to receive paint or coating.
 1. Surface preparation inspection for metals shall be based on comparison with SSPC-Vis1 "Surface Preparation Standards for Painting Steel Surfaces"
 2. Prepare and submit report of surface preparation inspections.
 - a. Failure to provide inspections and reports shall be cause for rejection of applied coating if there is reasonable doubt, as determined solely by City's Representative, that specified surface preparation or paint application procedures were not followed.
- Q. Touch up shop-primed surfaces to cover scratches or abraded areas, using primer similar to and compatible with shop-primer and specified finish coat.
- R. Using brush, stripe paint critical locations such as welds, corners, edges, roof lap seams, nuts, bolts, ends, rafter flanges and other areas identified by City's Representative using specified primer.
- S. Where surfaces are joined so closely that proper surface preparation and paint application is not possible, prepare and paint such surfaces prior to assembly or installation.

3.2 Application

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install paint and coating systems at locations shown on Plans and Submittals.
- C. Unless otherwise specified, ferrous surfaces except for stainless steel or galvanized iron or steel surfaces shall be painted or coated, including top surfaces of steel roof support framing and underside of steel roof plates bearing on roof supports.
- D. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. SSPC PA3 Guide to Safety in Paint Application
 3. NACE 6D-173 Manual for Painter Safety
 4. Applicable building, fire, plumbing, mechanical and electrical code requirements
 5. Manufacturer's installation and warranty requirements
 6. SSPC-PA1 "Shop, Field and Maintenance Painting"
- E. Refer variances between above documents and Contract Documents to City's Representative.
- F. Do not apply coatings when environmental conditions are not appropriate or jeopardize appearance or quality of coating.
 1. This includes but is not limited to the following unsatisfactory environmental conditions.
 - a. When air temperature is <50°F or >125°F or is outside limits recommended by Manufacturer for satisfactory application.
 - b. When it is expected air temperature will drop to <40°F or rise to >125°F within 8 hours after application of coating.
 - c. When surface temperature is <5°F (3°C) above dew point or is outside limits recommended by Manufacturer for satisfactory application.
 - d. When relative humidity is outside limits recommended by Manufacturer for satisfactory application.
 - e. When surfaces are exposed to fog or condensation.
 - f. During precipitation including rain, sleet, snow, fog or mist.

- g. When wind velocity is outside limits recommended by Manufacturer for satisfactory application.
 - h. In dust or smoke-laden atmospheres.
 - i. When above conditions are prevalent, postpone paint or coating application until conditions are favorable.
 - j. Complete daily paint or coating application in time to permit film sufficient drying and curing time before damage by atmospheric conditions.
- G. Mixing shall be done as follows:
 - 1. Mixing shall occur in enclosed areas designated by City's Representative where materials are protected from direct sunlight, inclement weather, or freezing.
 - 2. Protect surfaces of City's paving, structures, and improvements from material spillage within mixing area.
 - 3. Remove surface film, and if necessary, strain paint material before mixing.
 - 4. Mix thoroughly using slow-speed power mixer until components are thoroughly combined and are of smooth consistency.
 - a. Use exact proportions specified by Manufacturer.
 - b. Mix only components specified and furnished by Manufacturer.
 - c. Do not intermix additional components for reasons of color or otherwise, even within same generic type of coating.
 - d. Exercise care to ensure all material is removed from containers during mixing and metering.
 - e. Do not use partial batches.
 - 5. Do not use multiple-component coatings that have been mixed beyond their pot life.
 - 6. Provide small quantity kits for touch-up painting and for painting other small areas.
 - 7. When power mixing multiple components, do not introduce moisture or air into product.
 - 8. Do not dispose of coating and coating-system washdown materials using floor drains, dikes, channels, or storm drains.
- H. Thinning shall only be permitted within limits set by applicable regulatory agencies and as permitted by Manufacturer and accepted by City's Representative.
 - 1. Perform thinning in presence of City's Representative.
 - 2. If thinning is accepted, do not exceed maximum allowable amount of thinner per gallon of coating material.
 - 3. Stir coating materials when adding thinner.
 - 4. Do not flood coating material surface with thinner prior to mixing.
 - 5. Do not reduce coating materials more than necessary to obtain proper application characteristics and to obtain specified dry-film thicknesses.
 - 6. If paint becomes thick in cool weather, it may be heated by immersing container in hot water.
- I. Coating applications shall conform to the following:
 - 1. Painting of structures shall occur after erection or assembly.
 - a. Requests to do painting other than undercoats before erection or assembly shall be submitted to and accepted by City's Representative in writing before proceeding with coating.
 - b. Surfaces exposed to atmosphere which would be inaccessible for painting after erection or assembly shall receive full number of coats before erection or assembly.
 - c. Caulk open seams at contact surfaces of stiffeners and built-up members which would retain moisture with non-sag polysulfide material conforming to Federal Specification TT-S-230, Type 2 or other accepted material before applying second coat of primer.
 - d. Emulsion and alkyd paints shall contain mildewcide, and both paint and mildewcide shall conform to Federal Specification TT-P-19

- e. Do not use finish coats containing lead.
 - f. Do not paint stainless steel surfaces.
 - g. Except for anchor bolt assemblies, steel surfaces embedded in concrete need not be painted.
2. Schedule coating Work to avoid excessive dust and airborne contaminants.
 - a. Protect Work from dust and airborne contaminants during coating application and curing.
 3. Work is subject to intermittent shutdown if, in opinion of City's Representative, cleaning, coating and painting operations are creating localized condition detrimental to ongoing facility activities, personnel or adjacent property.
 - a. In event of emergency shutdown by City's Representative, immediately correct deficiencies.
 - b. Additional costs created by shutdown shall be borne by Contractor.
 4. Remove dust, blast particles, and other debris from blast-cleaned surfaces by dusting, sweeping, and vacuuming.
 - a. Allow ventilator fans to clean airborne dust to provide good visibility of working area prior to coating applications.
 - b. Remove dust from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.
 5. Previous paint coats shall be dry and fully cured and surface of paint coat being covered shall be free from moisture, dust, grease, and deleterious material which would prevent bond of succeeding paint coats.
 - a. In spot coating old paint which lifts after application of first spot coat shall be removed by scraping and the area repainted before applying second coat.
 6. Conform to Manufacturer's Application Instructions, completing Work within over-coating timeframe of prime or intermediate coat.
 - a. Follow recommendations of Manufacturer including selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
 - b. Do not paint under adverse ambient conditions that may affect life or appearance of coating.
 - c. Do not apply coatings over damp or moist surfaces.
 7. Prepare undercoats and intermediate coats to differ noticeably in coloration to each other on succeeding coating applications to ensure even coverage by shading or tinting, as appropriate, for paint material and color.
 - a. Shading or tinting shall be done by Manufacturer.
 8. Uniformly apply coatings at spreading rate required to achieve specified DFT.
 - a. Application shall be by airless spray method, except brush and roller application may be required for exterior surfaces if environmental and neighborhood conditions preclude spray application.
 - b. Apply coatings to be free of film characteristics such as runs or blisters that might adversely affect performance or appearance of coating systems.
 9. Spraying shall be done by cross-lap method of spraying, stroking first in 1 direction and shortly later, spraying across this section at right angles to first set of passes.
 - a. Exercise care during spraying to hold nozzle perpendicular and sufficiently close to receiving surface to avoid excessive evaporation of volatile components or loss of material to air or bridging of cracks and crevices.
 - b. Runs, sags, thin areas in paint coat, or skips and holidays shall be considered as evidence Work is unsatisfactory, and Contractor may be required to apply remaining paint by brush.
 10. When finished and dried, brush strokes shall appear in 1 direction only.
 - a. There shall be no curved brush strokes showing.

- b. Primary brush movement shall be such as to fill surface irregularities, after which coating shall be smoothed by series of parallel strokes.
 - c. Paint shall be evenly spread and brushed out.
 - d. Paint will be considered improperly applied if an inordinate amount of residual brush marks remain.
11. Immediately remove spills, oversprays and coatings that fall on surrounding areas and surfaces not scheduled to receive specified coating.
12. After completing each coat application, request inspection by City's Representative before applying next coat.
 - a. Work performed in absence of inspection by City's Representative may be required to be removed and replaced with proper inspection.
 - b. Entire cost of removal and replacement, including cost of materials which may be furnished by City and used in removed Work shall be borne by Contractor regardless of whether Work removed is found to be defective or not.
 - c. Do not apply finish coats until total film thickness of paint undercoats is obtained.
 - d. Work covered up without authority of City's Representative shall, upon order of City's Representative, be uncovered to extent required, and Contractor shall similarly bear entire cost of performing Work and furnishing materials necessary for removal of covering and its subsequent replacement as directed and accepted by City's Representative.
13. Pinholes and holidays detected during testing shall be marked, repaired in accordance with Manufacturer's printed instructions and retested.
 - a. No pinholes or other irregularities will be permitted in final coating.
14. Coats that do not hide undercoat shall be given another coat.
15. Protect finished surfaces between coats.
 - a. For subsequent coats, remove dust, dirt, oil, grease and foreign matter which will affect adhesion or durability of finish by washing with clean rags dipped in commercial cleaning solvent approved by paint and coating system Manufacturer.
 - b. Surface shall then be rinsed with clean water and wiped dry with clean rags.
16. Cure coats in accordance with Manufacturer's Application Instructions.
 - a. Allow ≥ 24 hours between coats of paint for curing.
17. Strictly observe drying and curing time between coats stated in Manufacturer's application instructions.
18. Upon completion, remove masking and other temporary coverings and protection of surrounding areas and surfaces.
19. Allow City's Representative to examine each coat of paint, enamel, stain, shellac, and varnish before next coat is applied.
 - a. Notify City's Representative such Work is ready for inspection.
- J. Apply prime coats to steel or concrete as follows:
 1. Apply prime coats in accordance with Manufacturer's Application Instructions.
 - a. Follow Manufacturer's recommendations, including selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
 2. Surfaces of metal and steel not embedded in concrete, and surfaces of unprimed plain sheet metalwork shall be primed promptly upon delivery to project site.
 3. Galvanized metalwork shall be primed immediately after erection.
 4. Reclean surfaces by blast cleaning that have surface colored or become moist prior to coating application.
 5. Do not apply prime coat over damp or moist surfaces.
 6. Prime prepared ferrous surfaces immediately after completing surface preparation and before surface rusting or accumulation of dust, dirt, or foreign matter occurs.

7. Apply brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces prior to application of primer and finish coat.
 - a. Brush coat shall be done prior to and in conjunction with spray coat application.
 - b. Apply spray coat over brush coat.
 8. For galvanized metalwork, clean oil, grease and foreign materials from surfaces.
 - a. Apply vinyl wash pretreatment coating.
 - b. Follow manufacturer's instructions for drying time, then prime with 1 coat of metal primer.
 9. For unprimed iron, steel, and uncoated metals specified to be painted, prime with 1 coat of metal primer.
 10. Apply zinc-rich primer by spray methods.
 - a. On areas inaccessible to spray application, apply paint by brush or daubers.
 - b. Use mechanical mixers to mix primer.
 - c. After mixing, strain primer through metal #30 to #60 mesh screen or double layer of cheesecloth immediately prior to or during pour into spray pot.
 - d. Use agitating spray pot for spray application of primer.
 - e. Agitator or stirrer shall reach within 2" of bottom of spray pot and shall be in motion at all times during primer application.
 - f. Motion shall be sufficient to keep primer mixed.
 - g. If painting is interrupted, expel primer remaining in fluid hose.
 - h. Primer shall be free from dust, dirt, salt, or deleterious deposits and thoroughly dry before applying pre-treatment vinyl wash primer.
 - i. Apply wash primer ≤ 72 hours before applying finish coats.
 - j. Apply vinyl wash primer by spraying to produce uniform wet film completely coating underlying surface.
 11. For shop-primed metal items, touch up bare and abraded areas with metal primer prior to applying 2nd and 3rd coats.
 12. Apply coats evenly and with full coverage so finished surfaces are free of sags, runs and imperfections.
 13. Prime coats incompatible with finish coats or applied to improperly prepared surfaces shall be removed and appropriate prime coat applied at no additional cost to City.
 14. Cure prime coats in accordance with Manufacturer's written specifications and instructions.
- K. Apply intermediate coats as follows:
1. Apply intermediate coats in accordance with Manufacturer's Application Instructions, and within over-coating timeframe of prime coat.
 2. Follow recommendations of Manufacturer including selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.
 - a. Do not paint under adverse ambient conditions that may affect life or appearance of coating.
 3. After applying prime coat, apply by brush, 1 stripe coat of intermediate coat epoxy, thinned 15% (or as recommended by Manufacturer), to welds, edges and corners, rivets, fasteners, and/or other difficult to reach areas.
- L. Apply finish coats as follows:
1. Conform to requirements of SSPC PA-1, Shop, Field and Maintenance Painting.
 2. Stir, strain, and keep coating materials at uniform consistency during application.
 - a. Apply each coating evenly, free of brush marks, sags, runs, and other evidence of poor workmanship.

3. Apply coating systems to specified minimum dry-film thicknesses as measured from above peaks of surface profile.
 4. Finished surfaces shall be free from holidays, pinholes, bubbles, runs, drops, ridges, waves, laps, excessive or unsightly brush marks, and variations in color, texture, and gloss.
 - a. Verify absence of holidays and flaws by appropriate testing.
 - b. Recoat and retest areas failing these tests.
 - c. City may require >1 finish coat if required to provide uniform color and texture.
 5. Finish coats found to be incompatible with prime or intermediate coats or applied to improperly prepared surfaces shall be removed and appropriate finish coat applied at no additional cost to City.
- M. Following application and testing, protect surfaces of coating systems from damage during construction.

3.3 Field Quality Control

- A. Contractor shall hold current C-33 Painting and Decorating Contractor's license and have ≥5 years practical experience and successful history in applying specified products to surfaces of steel standpipes, reservoirs, vessels and elevated tanks for water storage.
 1. Upon request, they shall substantiate this requirement by furnishing list of references.
- B. Employees working on project shall be skilled craftsmen, trained for application of specified coatings and qualified to perform required Work.
 1. Work shall be done in manner comparable with best standards of practice found in that trade.
 2. Apply materials evenly so as to be free from sags, runs, crawls, brush marks, wrinkles, skips, holidays or other application defects, blemishes or evidence of poor workmanship.
 3. Coats shall be of proper consistency.
 4. Repair skips, holidays, thin areas, and deficiencies in each paint coat before proceeding to next coat.
 5. Cut lines shall be sharply cut to lines.
- C. Repair or replace damaged or colored materials and surfaces not scheduled to be coated.
- D. Touch up or repair damaged coatings shall be acceptable if result is not visibly different from adjacent surfaces.
 1. Recoat entire surface where touch-up result is visibly different, either in sheen, texture or color.
- E. Remove and clean up paint drips, spills, oversprays, and splashes from areas not being painted.
 1. Remove rubbish, waste and surplus material and clean woodwork, hardware, floors and other adjacent Work.
 2. Remove paint, varnish and brush marks from glazing material and, upon completion of painting Work, wash and polish glazing material both sides.
 3. Remove and replace damaged glazing material with new material at no cost to City.
 4. Clean hardware and other unpainted metal surfaces with accepted cleaner.
 5. Do not use abrasives or edged tools.
- F. Repair in accordance with Manufacturer's instructions coatings showing film characteristics or defects that might adversely affect their performance or appearance.
 1. Clean and recoat surfaces with specified paint material to obtain specified color and coverage, if surfaces have improper finish color, or insufficient film thickness.
 2. Sandblast or power-sand visible areas of chipped, peeled, or abraded paint, feathering edges.
 3. Prime and finish coat in accordance with Manufacturer's Application Instructions.

4. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

G. Manufacturer's representative shall provide technical assistance and guidance as needed for proper surface preparation and coating system application.

H. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Surface Preparation	Visual Inspection	SSPC Vis 1, ASTM D2200, NACE Std TM01-70	As directed	City	City
	Contaminants	Chemical or ultraviolet tests	City's option	City	Contractor
	Anchor Profile	As specified or Manufacturer's requirement to be verified by nondestructive instrument such as Keane-Tator Surface Profile Comparator or Testex Press-O Film System	As directed	Contractor	Contractor
Compressor	Verify Absence of Water and Oil	Blotter test	1 each startup	Contractor	Contractor
Atmospheric Conditions	Dewpoint	Sling Psychrometer and US Dept of Commerce Weather Bureau Psychrometric Tables	As directed	Contractor	Contractor
Each Coating System	Visual Inspection	No runs, orange-peels, fisheyes, bridges, shiners, laps, or other imperfections.	City's option	City	City
Each Coat	Holidays	NACE RP0188 Nondestructive holiday tester such as K-D Bird Dog or Tinker-Rasor Model AP or AP-W (22.5-80V with approximate 80,000 Ω resistance) Use sponge saturated with 0.5% sodium chloride solution. Coating shall be holiday-free. Contractor to submit written reports from accepted testing agency on prime, intermediate, and finish coating inspections.	100% of surface of each coating	Contractor	Contractor
	Dry-Film Thickness (Ferrous Surfaces)	SSPC-PA2 Nondestructive magnetic-type dry- film thickness gauge such as "Elcometer", "Inspector", ElectroPhysik USA MiniTest", "Mikrotest Digital", or "Positest" Average of measurements shall exceed specified DFT. No spot measurement shall be <80% or >140% of specified DFT Submit written report from accepted testing agency on reinspection	Allow 8 hours to elapse after application. Then take ≥ 5 spot measurements in each area. Check each coat for DFT	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	Dry-Film Thickness (Non-magnetic Surfaces)	ASTM D4138 Use Tooke Gage or similar instrument. Average of measurements shall exceed specified DFT. No spot measurement shall be <80% or >140% of specified DFT Repair coating at locations where coupons are removed Submit written report from accepted testing agency on reinspection	Allow 8 hours to elapse after application. Then take ≥5 spot measurements in each area. Check each coat for DFT	Contractor	Contractor
	Holidays in Coatings ≤20 mils (except zinc primers and galvanizing)	Nondestructive holiday tester such as K-D Bird Dog or Tinker-Rasor Model AP or AP-W (22.5-80V with approximate 80,000Ω resistance) Use sponge saturated with 0.5% sodium chloride solution. Coating shall be holiday-free. Submit written reports from accepted testing agency on prime, intermediate, and finish coating inspections.	100% of surface of each dried coating	Contractor	Contractor
Finished Coating System	11-Month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturers printed literature as described below. Repair identified deficiencies.	1 inspection attended by City, Contractor, City's Representative and Manufacturer's representative	City and Contractor's respective duties are itemized below	Contractor

- I. Furnish inspection devices in good working condition for detection of holidays and measurement of dry-film thickness of paints and coatings.
 1. Also furnish US Department of Commerce, National Bureau of Standards certified thickness calibration plates to test accuracy of thickness gauges.
 2. Dry film thickness gauges and holiday detectors shall be available until final acceptance of application.
 3. Inspection devices shall be operated by, or in presence of City's Representative with location and frequency basis determined by City's Representative.
 4. City's Representative is not precluded from furnishing their own inspection devices and rendering their opinion based solely on their tests.
- J. Work having improper finish color, insufficient film thickness, holidays, or visual flaws shall be cleaned and top-coated with specified system to obtain specified color and coverage.
 1. Sand by hand or power sand nonconforming areas.
 2. Feather edges.
 3. Prime areas.
 4. Apply specified finish coat free of runs, bridges, shiners, laps, or flaws.
- K. City's Representative shall have right to reject unsatisfactory material or Work and to replace it at Contractor's expense if deficiencies are found in quality of installed coating.
- L. Upon completion of Work, remove staging, scaffolding, drop cloths, rags, brushes, and containers from project site.
 1. Remove paint brushed, splattered, spilled or splashed on surfaces not specified to be painted.

2. Remove temporary protective wrappings and tape after completing painting operations.
 3. Clean and polish glass surfaces.
 4. Clean site to satisfaction of City's Representative.
- M. Warranty Inspection shall be conducted during 11th month following completion of coating and painting Work.
1. Repair defective Work in strict accordance with Contract Documents and to satisfaction of City's Representative.
 2. City will establish inspection date and will notify Contractor ≥ 30 days in advance.
 - a. City will uncover or expose surfaces to be inspected.
 3. Contractor shall provide at their expense suitable lighting and ventilation for inspection.
 - a. Provide other necessary inspection equipment to City's satisfaction.
 4. Coating system shall be visually inspected.
 5. City's Representative will prepare Warranty Inspection Report and deliver to Contractor.
 - a. Report will set forth number and type of failures observed, percentage of surface area where failure has occurred, and names of persons making inspection.
 - b. Upon completion of inspection and receipt of Inspection Report, City will establish date for Contractor to proceed with remedial Work.
 6. Remedial Work shall occur at locations where paint or coating have peeled, scaled, flaked, bubbled, or cracked and at locations where rusting is evident.
 - a. Such locations shall be considered failures.
 7. Repair defective coatings and damaged or rusting spots.
 - a. Then test repaired areas as specified herein.
 - b. Repeat repair/testing procedure until surface meets specified requirements.
 - c. Repairs shall proceed promptly.
 - d. Delay on part of Contractor to proceed with remedial Work on schedule shall constitute breach of this Contract.
 - e. In such case, City may remedy defects as outlined in Contract Documents.
 8. Make repairs at points where failures are observed by removing deteriorated coating or paint, sandpapering, cleaning surface, and repainting or recoating with same system.
 - a. If area of failure $>25\%$ of specific coated or painted surface, entire paint or coating system shall, at City's option, be removed and recoated or repainted in accordance with original Contract Documents.
 9. Contractor shall include appropriate amount for testing and repair in their bid.
 - a. No additional allowance will be paid by City for Warranty Inspection and repairs.

3.4 Protection

- A. Abate dust nuisance to protect wet paint film.
1. Dampen adjacent roadbeds and shoulders with water on each side of locations where painting is in progress.
 2. Furnish and post "DRIVE SLOWLY" signs and other precautions necessary to prevent dust and dirt from accumulating on freshly painted surfaces.
- B. Provide "WET PAINT" signs to protect freshly painted surfaces.

END OF SECTION

SECTION 09 92 00

GALVANIZING

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and application of galvanizing by hot-dip or electro-depositing process.
- B. Steel metalwork, other than stainless steel, shall be galvanized after fabrication, except for:
 - 1. Stainless steel items.
 - 2. Teflon® (PTFE)-coated items.
 - 3. Epoxy-coated items.
 - 4. Items to be mortar-coated or embedded in concrete.
 - 5. Items specified to be painted.
 - 6. Items not to be painted or galvanized as directed by City's Representative
- C. Refer to the following sections for Work not covered herein.
 - 1. Section 05 12 00 for galvanizing structural steel framing
 - 2. Section 33 05 38 for galvanizing of hangers and supports.
- D. Conform to Standard Specifications for Public Works Construction (Greenbook) §210-3, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 05 50 00: Metal Fabrications
- I. Section 09 90 00: Painting and Coating
- J. Section 26 05 10: Common Work Results for Electrical
- K. Section 33 05 31: Pipeline Joint Materials
- L. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install galvanizing required for compliance with Manufacturer's installation requirements and applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workers trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Complete machine Work, die Work, cutting, punching, bending, welding, drilling, thread-cutting, straightening and other fabrication Work before galvanizing.
- C. Galvanize items after fabrication in largest sections possible.
- D. Galvanize applicable fasteners before assembling structural units.
- E. Zinc coating shall adhere tenaciously to base metal surface.

1. Coatings shall be even, smooth, and uniform, free from blisters and excess zinc deposits.

F. Warped or distorted products shall be replaced.

G. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Galvanizing	Test Coupon Preparation	Wire coupon to material being galvanized before immersion to represent coating deposited.	1 coupon each unit galvanized weighing over 1 lb or where requested by City's Representative	Contractor	Contractor
Galvanizing	Thickness	ASTM E376	1 test each coupon	Contractor	Contractor

1.5 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM A116 Metallic-Coated, Steel-Woven Wire Fence Fabric
2. ASTM A121 Zinc-Coated (Galvanized) Steel Barbed Wire
3. ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A239 Locating Thinnest Spot on a Zinc (Galvanized) Coating on Iron or Steel Articles
6. ASTM A392 Zinc-Coated Steel Chain Link Fence Fabric
7. ASTM A525 Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products
8. ASTM A767 Galvanizing Steel Bars for Concrete Reinforcement
9. ASTM A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
10. ASTM A929 Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
11. ASTM B6 Zinc
12. ASTM B633 Electrodeposited Coatings of Zinc on Iron and Steel
13. ASTM B695 Coatings of Zinc Mechanically Deposited on Iron and Steel
14. ASTM E376 Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods
15. ASTM F1083 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded for Fence Structures
16. ASTM F1941 Electrodeposited Coatings on Mechanical Fasteners
17. SSPC Paint 20 Zinc-Rich Primer
18. SSPC SP1 Solvent Cleaning
19. SSPC SP6/NACE 3 Commercial Blast Cleaning
20. SSPC SP7 Brush-off Blast Cleaning
21. SSPWC Standard Specifications for Public Works Construction (Greenbook) §210-3 "Galvanizing"

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit galvanizing certificate of compliance with listed ASTM specifications per Certificate of Compliance requirements. Certificate shall identify ASTM standard complied with.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance.	

B. Refer to Section 01 33 00 for definition of requirements for Certificates of Compliance.

1.7 **Delivery, Storage, and Handling**

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of galvanized materials.

1.8 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Galvanized Touch Up Material	American Solder and Flux Company (Drygalv)	Paoli, PA (610) 647-3575
	Carboline International "Galvanox"	St Louis, MO (888) 227-2654
	Cominco, Ltd "Galva-Guard"	San Diego, CA (619) 233-4763
	Glidden ICI Dulux Paints Div PPG Industries (GlidZinc Organic 5526/5527/5528)	Strongsville, OH (440) 816-9021
	Koppers Industries (CarboZinc 11)	Pittsburgh, PA (412) 227-2001
	Lanco Manufacturing "Galvacon"	San Lorenzo, PR (787) 736-6745
	Metalloy Products Co (Galvalloy)	Los Angeles, CA
	Rust-Oleum Corp (2185 Cold Galvanizing Compound)	Vernon Hills, IL (877) 385-8155
	Sherwin Williams (ZincClad I Low VOC B69AW9)	Cleveland OH (800) 524-5979
	Tnemec Co Inc (90-97)	Kansas City, MO (800) 863-6321
	Zaclon, LLC "Galvanizing Repair Rod"	Cleveland, OH (216) 271-1601
	ZRC Worldwide Cold Galvanizing Compound	Marshfield, MA (781) 319-0400
	Accepted lead-free equal	

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Standard Specifications for Public Works Construction (Greenbook) §210-3 for materials requirements for galvanizing.
- C. Materials for galvanizing shall be:

ITEM	MATERIAL	SPECIFICATION
Galvanizing	Zinc	Conform to ASTM B6 Prime Western
Steel Products, Structural Shapes, Tie-Rods, Handrails, Manhole Steps, Castings, and Metal Fabrications	Galvanized Coating	Conform to ASTM A123, ASTM A153, ASTM B633 or ASTM B695 Thickness ≥ 3.4 mil - 2.00 oz/ft ²
Galvanized Steel Rebars	Galvanized Coating	Conform to ASTM A767 Thickness as shown in Table 1 or ASTM A767
Structural Steel Bolts, Nuts, and Washers (Connection Bolts and Anchor Bolts)	Galvanized Coating	Conform to ASTM A153, ASTM B633, ASTM B695, or ASTM F1941 Class Fe/Zn 5 Thickness as shown in Table 1 of ASTM A153
Steel or Iron Sheets	Galvanized Coating	Conform to ASTM A525
Hangers and Supports	Galvanized Coating	Refer to Section 33 05 38
Galvanizing Repair Paint	Zinc-Rich Primer	Conform to SSPC Paint 20
Hot-Stick Galvanizing Rod	50% Zinc, 50% Tin	Do not use products containing lead.

- D. Shop prime iron and steel Work not shown to be galvanized with exceptions below:
1. Refer to Section 09 90 00 for requirements for shop priming.
 2. Do not galvanize or shop prime stainless steel.
 3. Do not galvanize or shop prime items to be embedded in concrete, masonry, or sprayed on fireproofing.
 4. Provide clean surface for bonding to concrete.

PART 3 - EXECUTION

3.1 Preparation

- A. Examine areas and conditions under which Work of this section will be performed.
 - 1. Correct conditions detrimental to timely and proper completion of Work.
 - 2. Avoid unsuitable marking paints.
 - 3. Remove welding slag, splatter, anti-splatter compounds, and burrs before galvanizing.
 - 4. Consult with galvanizer about removal of grease, oil, paint, and other deleterious material prior to fabrication.
 - 5. Remove surface contaminants not removable by normal chemical cleaning process of galvanizing operation.
 - 6. Use blast cleaning where chemical cleaning is not sufficient.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish galvanizing at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations.
 - 2. Other applicable building, fire, plumbing, mechanical and electrical code requirements
 - 3. Manufacturer's installation and warranty requirements
 - 4. Standard Specifications for Public Works Construction §210-3 "Galvanizing"
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Apply galvanizing as follows:
 - 1. Clean steel of rust and scale.
 - 2. Galvanize steel plates, shapes, bars, and fabricated assemblies in accordance with ASTM A123.
 - 3. Galvanize bolts, anchor bolts, nuts, and threaded fasteners in accordance with ASTM A153.
 - 4. Straighten galvanized parts that become warped during galvanizing operation.
- F. Repair zinc coatings which have been field or shop cut, burned by welding, abraded or otherwise damaged to such extent as to expose base metal.
- G. Shop repairs may be made by stripping and cleaning damaged areas and re-applying a zinc coating by hot-dip process as follows:
 - 1. Prepare surface, removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush off blast cleaning (SSPC SP7).
 - 2. Blasted area shall lap undamaged zinc coating $\geq \frac{1}{2}$ ".
 - 3. Make metalizing repairs using zinc wire containing $\geq 99.98\%$ zinc..
 - 4. Apply zinc coating per ASTM A780 Annex A3.
 - 5. Use metalizing gun to apply ≥ 5 mils zinc on damaged areas.
 - 6. Repair coating shall taper to zero thickness at edge of blasted undamaged section.
- H. Field repairs to field welded and damaged galvanizing may be made by applying a zinc-dust paint coating as follows:
 - 1. Prepare surface, removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush off blast cleaning (SSPC SP7).
 - 2. Blasted area shall lap undamaged zinc coating $\geq \frac{1}{2}$ ".

3. Field repair using acceptable galvanizing touch-up material.
 4. Paint cleaned area with 2 coats un-thinned zinc paint to apply ≥ 5 mils zinc on damaged areas.
 5. Apply repair compound per ASTM A780 Annex A3 and paint Manufacturer's Application Instructions, except coating shall have $\geq 90\%$ dry film zinc content by weight.
- I. Field repairs to field welded and damaged galvanizing may be made by applying zinc-alloy solder coating or a hot stick galvanizing repair rod zinc coating as follows:
1. Prepare surface, removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush off blast cleaning (SSPC SP7).
 2. Blasted area shall lap undamaged zinc coating $\geq \frac{1}{2}$ ".
 3. Deposit solder to apply ≥ 5 mils zinc-alloy solder on damaged areas or make repairs using specified hot stick galvanizing repair rod.
 4. Apply repair compound per ASTM A780 Annex A3 and repair rod Manufacturer's Application Instructions.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Galvanizing	Visual Inspection	Conform to ASTM A123 (steel sections), A153 (fasteners), or A767 (rebar) as applicable	1 inspection	City	City
	Zinc Coating Thickness	Conform to ASTM A123 (steel sections), A153 (fasteners), or A767 (rebar) as applicable	1 test	Contractor	Contractor
	Field Performance	Demonstrate Work conforms to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Confirm Work conforms to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 09 96 56

EPOXY LININGS AND COATINGS

PART 1 - GENERAL

1.1 Work Included

- A. Requirements for surface preparation, application and testing of fusion-bonded epoxy lining and coating systems for ferrous surfaces of valves, hydrants, flow meters, pumps, , pipelines, fittings, or pipeline appurtenances.
- B. Do not apply fusion-bonded epoxy systems to aluminum, brass, bronze, copper, plastic, rubber, or stainless steel surfaces.
- C. Where City deems fusion-bonded epoxy coatings to be impractical, or for plug valve lining systems, liquid epoxy lining systems may be substituted as described herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 09 90 00: Painting and Coating

1.3 Definitions

- A. The following definitions apply:
 - 1. Dry Film Thickness (DFT): Thickness of fully cured coat of paint measured in mils (1/1000").

1.4 System Description

- A. Furnish and install complete functional coating system for specified surface in compliance with applicable local air quality management regulations and NSF requirements for use with potable water where applicable.
 - 1. Conformance to NSF 61 shall require concurrent conformance with NSF standards referenced by NSF 61, including NSF 600.
 - 2. Comply with Manufacturer's application requirements and applicable codes, standards, and South Coast Air Quality Management District regulations, including Rule 1107 for shop coating and Rule 1113 for field coating.

1.5 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Cured lining or coating shall be smooth and glossy with no graininess or roughness.
 - 1. Lining or coating shall have no blisters, cracks, bubbles, under-film voids, mechanical damage, discontinuities or holidays.

C. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Offsite Surface Preparation and Priming	Offsite Inspection of Priming Operation	Applicable standards	As directed	Contractor	Contractor
Paint from Proposed "Equals"	Spectrographic and Durability Tests	Applicable ASTM standards	As directed	Contractor	Contractor
Valve, Hydrant, Flow Meter, Pump, Pipe, Fitting, or Pipeline Appurtenance Interior Lining or Coating	Visual Inspection	AWWA C116 §5.2 Pipe or items will be rejected due to: 1 Sizeable protrusions in lining obviously caused by lining over foreign material. 2 Defects indicating double flow or fold in lining. 3 Chuck marks or gouges extending to bare metal. 4 Bubbles or area which appears to be unbonded to underlying metal surface	Each lined pipe spool or item	Contractor	Contractor
	Holidays	ASTM D5162 and AWWA C116 §5.3 or AWWA C213 §5.3.3. If number of holidays or pinholes for items ≤12" is ≤5 per item, repair per coating Manufacturer's recommendation and retest. If more holidays are found, sandblast, recoat and retest entire item.	Each lined Valve, Hydrant, Flow Meter, Pump, Pipe, Fitting, or Pipeline Appurtenance	Contractor	Contractor
		AWWA C116 §5.3 or AWWA C213 §5.3.3 If <1 holiday per 10ft ² of pipe surface is found, repair per coating Manufacturer's recommendation and retest. If more holidays are found, sandblast, recoat and retest entire pipe spool. Also check weld seam centerlines to verify no porous blisters, craters or pimples lie along peak of weld crown.	Each lined Valve, Flow Meter, Pump, Pipe Spool, Fitting, or Pipeline Appurtenance ≥16"	Contractor	Contractor
	Lining Thickness	AWWA C116 §5.2 Verify thickness with magnetic-type dry film thickness gauge. Average shall exceed minimum thickness, No thickness measurement shall be >2 mils below or >3 mils above specified minimum thickness. Items not meeting these criteria shall be sandblasted, recoated and retested.	Each lined Valve, Hydrant, Flow Meter, Pump, Pipe, Fitting, or Pipeline Appurtenance at 3 locations per item	Contractor	Contractor

1.6 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM D1002 Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
2. ASTM D1044 Resistance of Transparent Plastics to Surface Abrasion
3. ASTM D2370 Tensile Properties of Organic Coatings

4. ASTM D2583 Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
5. ASTM D5162 Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
6. ASTM G17 Penetration Resistance of Pipeline Coatings
7. AWWA C116/ANSI A21.16 Protective Fusion-Bonded Epoxy Coatings for Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
8. AWWA C210 Liquid Epoxy Coatings and Linings for Steel Water Pipe and Fittings
9. AWWA C213 Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
10. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
11. AWWA C620 Spray-Applied In-Place Epoxy Lining of Water Pipelines 3" and Larger
12. California Green Building Standards Code (CALGreen Code)
13. MSS SP98 Protective Coatings for Interior of Valves, Hydrants, and Fittings
14. NSF/ANSI 61 Drinking Water System Components – Health Effects
15. NSF/ANSI 600 Health Effects Evaluation and Criteria for Chemicals in Drinking Water
16. SSPC PA1 Shop, Field and Maintenance Painting
17. SSPC PA2 Measurement of Dry Paint Thickness with Magnetic Gauges
18. SSPC SP5/NACE 1 White Metal Blast Cleaning
19. SSPC SP10/NACE 2 Near White Blast Cleaning
20. SSPC Vis1 Pictorial Surface Preparation Standards for Painting Steel Surfaces

1.7 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit product data sheets per Product Data requirements.	
Application Instructions	Required for each paint and coating per Application Instruction requirements. Include: 1. Surface Preparation Requirements. 2. MSDS sheets identifying flammability, toxicity, allergenic properties and other characteristics requiring field precautions. 3. Minimum and maximum recommended dry-film thicknesses per coat for prime, intermediate, and finish coats. 4. Percent solids by volume. 5. Statement verifying selected prime coat is recommended by Manufacturer for use with selected intermediate and finish coats. 6. Application and curing requirements and instructions.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	1. For Work done in California, submit certification coatings conform to applicable local Air Quality Management District rules and regulations for products and application 2. Submit coating system and application certification coatings comply with specified requirements and are suitable for intended application per Certificate of Compliance requirements. 3. Submit description of repair procedures used if any.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Product Data, Application Instructions, and Certificates of Compliance.

1.8 **Delivery, Storage, and Handling**

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

1.9 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Materials shall be of current manufacture and shall meet applicable regulations for their application and intended service.
1. Materials shall meet applicable Federal, state and local regulations, including Air Quality Management District Regulations.
 2. Coats of coating system shall be of same Manufacturer and shall be accepted by Manufacturer for intended service.
 3. If product specified herein is no longer manufactured or does not meet current regulations, provide substitute, currently manufactured product of at least equal performance which meets applicable regulations subject to City's Representative's approval, at no additional cost.
- B. Linings and coatings used on Work shall comply with VOC limits set forth in CALGreen Code §5.504.4.3.
- C. Factory-applied base coatings to a specific product may differ slightly from those listed below where primers are factory-applied by Manufacturers.
1. Such base-coat substitutions for Contractor's convenience are subject to the following:
 - a. Surface preparation shall meet or exceed surface preparations specified below.
 - b. Primer or base coat shall be that recommended and normally used by Manufacturer for condition and exposure of finished installation.
 - c. Chemical composition of factory-applied base coats shall be similar to chemical composition specified below.
 - d. If different coating system is recommended by Manufacturer to meet performance specifications of other sections, Manufacturer shall notify Contractor in writing and said notice shall be forwarded to City's Representative.
 - e. Verify compatibility of adjacent coats with coating Manufacturers.
 - f. Total DFT shall equal or exceed DFT specified below.
 - g. Finish coat shall be as stipulated below.
 - h. If paint system fails, repair paint system in failed area to specifications of this section.

D. Acceptable Manufacturers for NSF-61 approved fusion-bonded epoxy include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
NSF-Approved Fusion-Bonded Epoxy Linings and Coatings	3M Scotchkote 134W, 206N or 6233	Saint Paul, MN (888) 364-3577
	AkzoNobel Resicoat® R4	Reutlingen DEU (615) 259-2430
	Lilly Powder Coatings / Valspar "Pipe Clad" 1500 Red	Kansas City, MO (816) 421-7400
	Accepted equal	

E. Acceptable Manufacturers for fusion-bonded epoxy where NSF approval is not required include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Fusion-Bonded Epoxy Linings and Coatings	3M Scotchkote 134, 135, 203, 206, 206N or 6233	Saint Paul, MN (888) 364-3577
	Axalta Coating Systems	Philadelphia, PA (855) 547-1461
	AkzoNobel Devoe - Sinclair - Dulux - Glidden	Amsterdam NED (800) 589-1267
	Lilly Powder Coatings / Valspar "Pipe Clad" 1500 Red	Kansas City, MO (816) 421-7400
	Northtown Keysite 740	Huntington Beach, CA (714) 897-0700
	Rohm & Haas / Dow Chemical	Philadelphia, PA (215) 537-4000
	Sherwin Williams	Cleveland, OH (800) 524-5979
	Accepted equal	

F. Acceptable Manufacturers for field-applied epoxy coating for patching include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Field-Applied Liquid	3M Scotchkote 306	Saint Paul, MN (888) 364-3577

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Epoxy Linings and Coatings for Patching	Accepted equal	

- G. Acceptable Manufacturers for field-applied epoxy coating for patching of welded steel pipe joint interiors include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Field-Applied Liquid Epoxy Linings and Coatings for Patching Welded Steel Pipe	3M Scotchkote 302	Saint Paul, MN (888) 364-3577
	Accepted equal	

- H. Refer to City of Corona List of Sole-Source Equipment for Water Facilities for acceptable Manufacturers for high-build-epoxy liner.

- I. Acceptable Manufacturers for NSF-61 approved liquid epoxy where permitted include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
NSF-Approved Liquid Epoxy Linings and Coatings	3M Scotchkote 323	Saint Paul, MN (888) 364-3577
	AkzoNobel Devoe - Sinclair - Dulux - Glidden	Amsterdam NED (800) 589-1267
	Carboline / RPM Plasite® 4500	Saint Louis, MO (800) 848-4645
	PPG Industries Amercoat 370	Cheswick, PA (888) 774-4332
	PPG Industries Amerlock®2 Sigmacover™2	Cheswick, PA (888) 774-4332
	Raven AquataPoxy A6 or A61	Broken Arrow, OK (800) 324-2810
	Tnemec Pota-Pox L140	Kansas City, KS (800) 863-6321
	Tnemec Epoxoline Series 141	Kansas City, KS (800) 863-6321
	Accepted equal	

- J. Acceptable Manufacturers for liquid epoxy where NSF 61 approval is not required include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Liquid Epoxy Linings and Coatings where NSF 61 Approval is Not Required	3M Scotchkote 312 or 314	Saint Paul, MN (888) 364-3577
	AkzoNobel Devoe - Sinclair - Dulux - Glidden	Amsterdam NED (800) 589-1267
	PPG Industries Amercoat 370	Cheswick, PA (888) 774-4332
	Tnemec Pota-Pox L140 (For nonpotable water use Tnemec Series L69)	Kansas City, KS (800) 863-6321
	Accepted equal	

- K. Acceptable Applicators for liquid catalyst epoxy include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Liquid Catalyst Epoxy Linings and Coatings	Soc-Co Plastic Coating Company	Rancho Cucamonga, CA (909) 987-4753
	Accepted equal	

- L. Acceptable Applicators for dry powder fusion-bonded epoxy include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Dry-Powder Fusion-Bonded Epoxy Linings and Coatings	3M	Saint Paul, MN (888) 364-3577
	Armstrong Products	Lancaster, PA (877) 276-7876
	Fusecoat Company, Inc.	South El Monte, CA (626) 443-6760
	Accepted equal	

2.2 **Materials - General**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Interior lining of valves and hydrants 3" and larger for use with potable or reclaimed water shall meet requirements of AWWA C550.

C. Liquid epoxy lining systems for plug valve, interiors shall conform to the following.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION*
Plug Valve Interior Lining or Coating	Liquid Epoxy	AWWA C213 for steel AWWA C116 for ductile iron 100% solids powdered thermosetting epoxy per AWWA C550 Hardness per ASTM D2583: Barcol 17 Hardness on "M" Scale: Rockwell 50 Abrasion Resistance per ASTM D1044 with Tabor CS17 wheel 1000-gram wheel, 1000 cycles: 0.05 gram removed / 5000 cycles 0.115 gram removed Adhesion 3,000 psi (Elcometer) Tensile Strength per ASTM D2370: 7300 psi Penetration per ASTM G17: 0 mil Adhesion Overlap Shear, 1/8" steel panel, 0.010 glue line per ASTM D1002: 4300 psi Impact (100 in-lb minimum (Gardner 5/8" diameter tip) Total DFT 16.0 mils Total DFT 5.0-16.0 mils on ring grooves and flange faces	
Surface Preparation		SSPC-SP5/NACE 1 White metal blast cleaning	
Base Coat (Apply at Place of Manufacture)	Polyamide Epoxy	3M Company Epoxy Primer DFT 5.0-6.0 mils,	
Finish Coat (Apply at Place of Manufacture)	Polyamide Epoxy	3M Scotchkote 323	Tnemec Pota-Pox L140

D. Fusion-bonded epoxy lining systems for other valve, hydrant, flow meter, pump, pipe, column, pipe fitting, or interiors shall conform to the following.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION*
Valve, Hydrant, Flow Meter, Pump, Pipe, , Lining or Coating	Fusion-Bonded Epoxy	AWWA C213 for steel AWWA C116 for ductile iron ANSI/NSF 61 certified for use with potable water. 100% solids powdered thermosetting epoxy per AWWA C550 Hardness per ASTM D2583: Barcol 17 Hardness on "M" Scale: Rockwell 50 Abrasion Resistance per ASTM D1044 with Tabor CS17 wheel 1000-gram wheel, 1000 cycles: 0.05 gram removed / 5000 cycles 0.115 gram removed Adhesion 3,000 psi (Elcometer) Tensile Strength per ASTM D2370: 7300 psi Penetration per ASTM G17: 0 mil Adhesion Overlap Shear, 1/8" steel panel, 0.010 glue line per ASTM D1002: 4300 psi Impact (100 in-lb minimum (Gardner 5/8" diameter tip) Total DFT 12.0 mils Total DFT 5.0-16.0 mils on ring grooves and flange faces	
Surface Preparation		SSPC-SP5/NACE 1 White metal blast cleaning	
Base Coat (Apply at Place of Manufacture)	Polyamide Epoxy	3M Company Epoxy Primer DFT 5.0-6.0 mils,	
Finish Coat (Apply at Place of Manufacture)	Polyamide Epoxy	3M Scotchkote 134, 206N, or 6233	Lilly / Valspar "Pipe Clad" 1500 Red

E. Field-applied epoxy coating for patching shall conform to the following.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION*
Valve, Hydrant, Flow Meter, Pump, Pipe, , Pipe Fitting, or Pipeline Appurtenance Interior Lining or Coating	Liquid Epoxy	ANSI/NSF 61 certified for use with potable water. 80% solids liquid resin Total DFT 12.0 mils	
Patching Compound	Polyamide Epoxy	Scotchkote 306 or 323	

- F. Liquid epoxy lining systems for valve, hydrant, flow meter, pump, pipe, column, pipe fitting, or pipeline appurtenance interiors shall be used only when City deems fusion-bonded epoxy coating to be impractical.

1. Liquid epoxy lining systems for valve, hydrant and appurtenance interiors shall meet the following requirements.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION	ALTERNATE SPECIFICATION
Valve, Hydrant, Flow Meter, Pump, Pipe, Column Pipe, Pipe Fitting, or Pipeline Appurtenance Interior Lining or Coating	Epoxy	ANSI/NSF 61 certified for use with potable water. Total MDFT 16.0 mils		
Surface Preparation		SSPC-SP5/NACE 1 White metal blast cleaning		
Base Coat (Apply at Place of Manufacture)	Polyamide Epoxy	Tnemec Pota-Pox L140 (For nonpotable water use Tnemec Series L69) DFT 4.0-5.0 mils,	3M Company Epoxy Primer DFT 4.0-5.0 mils,	ICI Devoe Bar-Rust 233V DFT 5.0-6.0 mils
Intermediate Coat (Apply at Place of Manufacture)	Polyamide Epoxy	Tnemec Pota-Pox L140 (For nonpotable water use Tnemec Series L69) DFT 4.0-5.0 mils,	3M Skotchkote 312 or 314 DFT 4.0-5.0 mils,	ICI Devoe Bar-Rust 233V DFT 4.0-5.0 mils,
Finish Coat (Apply at Place of Manufacture)	Polyamide Epoxy	Tnemec Pota-Pox L140 (For nonpotable water use Tnemec Series L69) DFT 4.0-5.0 mils,	3M Skotchkote 312 or 314 DFT 4.0-5.0 mils,	ICI Devoe Bar-Rust 233V DFT 4.0-5.0 mils,

*Powdered thermosetting epoxy or two coats of polyamide epoxy may be substituted.

- G. Epoxy lining shall meet current Volatile Organic Compound (VOC) content regulations.

1. Epoxy lining for potable water valves and hydrants shall also be listed by National Sanitation Foundation (NSF) for contact with potable water and shall contain no perchloroethylene, lead, chromium or zinc.

- H. Powdered thermosetting epoxy coating systems for steel architectural surfaces shall meet the following requirements.

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION*
Architectural Exterior Powder-Epoxy Coating	Powdered Thermosetting Epoxy	ANSI/NSF 61 certified for use with potable water. 100% solids powdered thermosetting epoxy per AWWA C550 Hardness per ASTM D2583: Barcol 17 Hardness on "M" Scale: Rockwell 50 Abrasion Resistance per ASTM D1044 with Tabor CS17 wheel 1000-gram wheel, 1000 cycles: 0.05 gram removed / 5000 cycles 0.115 gram removed Adhesion 3,000 psi (Elcometer) Tensile Strength per ASTM D2370: 7300 psi Penetration per ASTM G17: 0 mil Adhesion Overlap Shear, 1/8" steel panel, 0.010 glue line per ASTM D1002: 4300 psi Impact (100 in-lb minimum (Gardner 5/8" diameter tip) Total DFT 12.0 mils	
Surface Preparation		SSPC-SP5/NACE 1 White metal blast cleaning	
Base Coat (Apply at Place of Manufacture)	Polyamide Epoxy	3M Company Epoxy Primer DFT 5.0-6.0 mils,	

ITEM	MATERIAL	SPECIFICATION	ALTERNATE SPECIFICATION*
Finish Coat (Apply at Place of Manufacture)	Polyamide Epoxy	Scotchkote 134 or 206N	

PART 3 - EXECUTION

3.1 Preparation

- A. Surfaces to be coated or painted shall be in proper condition to receive material specified before coating or painting is done.
- B. Prepare iron or steel surfaces in accordance with applicable Manufacturer's instructions and SSPC standards.
- C. Grind surface irregularities, welds, and weld spatter smooth before applying epoxy.
 1. Remove protuberances including slivers, scales, burrs and gouges which may produce pinholes in lining.
 2. Grind $\geq 0.020"$ off weld caps on pipe weld seams before beginning surface preparation and heating of pipe.
 3. Coat round sharp edges.
- D. Allowable grind area shall be $\leq 0.5 \text{ ft}^2$ per location and maximum grind area shall be $\leq 2 \text{ ft}^2$ per item or piece of equipment.
 1. Do not use items, pipes or pieces of equipment not meeting these requirements.
- E. Ensure surfaces to receive coatings are dry and free from visible oil, grease, dirt, dust, mill scale, rust, paint oxides, corrosion products and other foreign matter in accordance with specified SSPC standards.
- F. Preheat pipe, item or piece of equipment prior to blast cleaning to remove surface moisture.
 1. Preheat shall ensure surface temperature is $\geq 5^\circ\text{F}$ above dew point temperature during blast cleaning and inspection.
- G. Sandblast surfaces as specified, protecting beveled pipe ends from abrasive blast cleaning.
- H. After sandblasting, apply 5% (by weight) phosphoric acid solution wash to pipe, item or piece of equipment.
 1. Average temperature measured in three different locations shall be between 80°F and 130°F during acid wash procedure.
 2. Duration of acid contact with surface shall be:

TEMPERATURE	CONTACT TIME
80°F	52 seconds
85°F	45 seconds
90°F	36 seconds
95°F	33 seconds
100°F	28 seconds
105°F	24 seconds
110°F	21 seconds
130°F	10 seconds

- I. After completing acid wash, remove acid with demineralized water having maximum conductivity of 5 micromhos/cm at nozzle pressure of $\geq 2500 \text{ psi}$.

3.2 Application

- A. Refer to Section 01 73 00 for basic execution and application requirements.
- B. Furnish and install fusion-bonded epoxy linings and coatings at locations shown on Plans
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations

2. Manufacturer's installation and warranty requirements including minimum and maximum drying time between required coats, except as modified herein
 3. AWWA C116 Fusion-Bonded Epoxy Coatings for Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
 4. AWWA C213 Fusion-Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines
- D. Refer variances between above documents and Contract Documents to City's Representative.
 - E. Coat interior metal surfaces excluding seating areas and bronze and stainless-steel pieces.
 - F. Uniformly apply coatings at spreading rate required to achieve specified DFT.
 - G. Apply coatings to be free of film characteristics such as runs or blisters that would adversely affect performance or appearance of coating systems.
 - H. Apply lining and coating by electrostatic spray or fluidized bed process.
 1. Heat and cure per epoxy Manufacturer's recommendations.
 2. Heat source shall not leave residue or contaminant on metal surface.
 3. Do not allow surfaces to oxidize or flash rust prior to coating.
 - I. Pinholes and holidays detected during testing shall be marked, repaired in accordance with Manufacturer's printed instructions and retested.
 1. No pinholes or other irregularities will be permitted in final coating.
 - J. Protect finished surfaces between coats.
 1. For subsequent coats, remove dust, dirt, oil, grease, and foreign matter which will affect adhesion or durability of finish by washing with clean rags dipped in commercial cleaning solvent approved by paint and coating system Manufacturer.
 2. Surface shall then be rinsed with clean water and wiped dry with clean rags.
 - K. Coats shall be thoroughly dry and cured according to Manufacturer's recommendations before next coat is applied.
 - L. Upon completion, remove masking and other temporary coverings and protection of surrounding areas and surfaces.
 - M. Following application and testing, protect surfaces of coating systems from damage during construction.

3.3 Field Quality Control

- A. Repair or replace damaged or colored materials and surfaces not scheduled to be coated.
- B. Repair in accordance with Manufacturer's instructions coatings that exhibit film characteristics or defects that might adversely affect performance or appearance of coating systems.
 1. Wire brush or sandblast damaged areas per SSPC SP10.
 2. Lightly abrade or sandblast lining and coating on sides of damaged area before applying liquid repair coating specified above.
 3. Patched areas shall overlap parent or base coating $\geq \frac{1}{2}$ ".
 4. If damaged area $> 20 \text{ in}^2$, remove entire lining and coating and recoat and retest entire item.

C. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Finished Lining or Coating	Holidays	Nondestructive holiday tester such as Tinker-Razor Model AP or AP-W Contractor to submit written report from approved testing agency on re-inspection	City's option	City	Contractor
	Dry Film Thickness	SSPC-PA2 Nondestructive magnetic-type thickness gauge such as "Inspector" or "Positest." Coated items failing inspection will be subject to rejection.	City's option	City	Contractor
	Film Characteristics and Defects	Visual inspection. Contractor to submit written report from approved testing agency on reinspection	As directed	City	Contractor
Finished Coating System	11-Month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature as described below. Repair identified deficiencies.	1 inspection attended by City, Contractor, City's Representative and Manufacturer's representative	City	Contractor

- D. Furnish inspection devices in good working condition for detection of holidays and measurement of dry-film thickness of paints and coatings.
- Also furnish US Department of Commerce, National Bureau of Standards certified thickness calibration plates to test accuracy of thickness gauges.
 - Dry film thickness gauges and holiday detectors shall be available until final acceptance of application.
 - Inspection devices shall be operated by, or in presence of City's Representative with location and frequency basis determined by City's Representative.
 - City's Representative is not precluded from furnish his own inspection devices and rendering their opinion based solely on their tests.
- E. City's Representative shall have right to reject unsatisfactory material or Work and to replace it at Contractor's expense if deficiencies are found in quality of installed coating.
- F. Upon completion of Work, remove staging, scaffolding and containers from Work site.
- Clean site to satisfaction of City's Representative.
- G. Warranty Inspection shall be conducted between 11th month following completion of coating and painting Work.
- City will establish inspection date and will notify Contractor ≥ 30 days in advance.
 - City will uncover or otherwise expose surfaces to be inspected.
 - Contractor shall provide at their expense suitable lighting and ventilation for inspection.
 - Provide other necessary inspection equipment to City's satisfaction.
 - Entire interior coating system shall be visually inspected.
 - Defective coatings as well as damaged or rusting spots shall be satisfactorily repaired by and at sole expense of Contractor.
 - Repaired areas shall then be tested as specified herein and repair/testing procedure repeated until surface meets specified requirements.

3. Entire exterior paint system shall be visually inspected.
 - a. Defective, damaged or rusting areas shall be satisfactorily repaired by and at Contractor's sole expense.
4. Warranty Inspection Report will be prepared by City's Representative and delivered to Contractor.
 - a. It will set forth number and type of failures observed, percentage of surface area where failure has occurred, and names of persons making inspection.
5. Repairs shall proceed promptly.
 - a. Upon completion of inspection and receipt of Inspection Report, City will establish date for Contractor to proceed with remedial Work.
 - b. Repair defective Work in strict accordance with Contract Documents and to satisfaction of City's Representative.
 - c. Delay on part of Contractor to proceed with remedial Work on schedule shall constitute breach of this Contract.
 - d. In such case, City may proceed to have defects remedied as outlined in Contract Documents.
6. Remedial Work shall occur at locations where paint or coating has peeled, bubbled, or cracked and at locations where rusting is evident.
 - a. Such locations shall be considered failures.
 - b. Make repairs at points where failures are observed by removing deteriorated coating or paint, cleaning surface and repainting or recoating with same system.
 - c. If area of failure exceeds 25% of coated or painted surface, entire paint or coating system shall, at City's option, be required to be removed and recoated or repainted in accordance with original Contract Documents.
7. Costs of warranty inspection and repair shall be borne by Contractor, who shall include an appropriate amount for testing and repair in their bid.
 - a. No additional allowance will be paid by City for Warranty Inspection and repairs.

END OF SECTION

SECTION 26 05 10

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 Work Included

- A. Materials, tools, equipment, supplies, installation, and testing of electrical Work.
- B. The following systems and equipment are typical, but not inclusive, for materials furnished in accordance with this section:
 - 1. Control and alarm systems.
 - 2. Raceways and fittings.
 - 3. Wires and cables.
 - 4. Lighting systems.
 - 5. Underground conduit systems.
 - 6. Grounding systems.
 - 7. Instrumentation systems.
 - 8. Pumping power and control systems.
 - 9. Temporary electricity, lighting, and telephone as required during construction operations.
 - 10. Conduit, wire, and control equipment as required for motors and equipment.
- C. Refer to the following sections for Work not covered herein.
 - 1. Section 26 05 26 for grounding and bonding requirements.
 - 2. Section 26 08 00 for requirements for commissioning electrical systems.
 - 3. Section 31 05 50 for requirements for protecting existing utilities.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 32 00: Construction Progress Documentation
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 35 26: Governmental Safety Requirements
- E. Section 01 40 00: Quality Requirements
- F. Section 01 61 00: Common Product Requirements
- G. Section 01 65 00: Product Delivery Requirements
- H. Section 01 66 00: Product Storage and Handling Requirements
- I. Section 01 73 00: Execution
- J. Section 01 73 24: Seismic Restraint
- K. Section 09 90 00: Painting and Coating
- L. Section 26 05 19: Low-Voltage Electrical Power Conductors and Cables
- M. Section 26 05 26: Grounding and Bonding for Electrical Systems
- N. Section 26 05 33: Raceway and Boxes for Electrical Systems
- O. Section 26 08 00: Commissioning of Electrical Systems
- P. Section 31 05 50: Protecting Existing Utilities
- Q. Section 31 23 00: Excavation and Fill

1.3 Definitions

- A. The following definitions apply:
 - 1. Corrosive Locations: Chlorination building interiors, chemical storage rooms, and other spaces so identified on Plans or classified by NEC Article 505.
 - 2. General Purpose (Indoor Dry) Locations: Indoor areas not defined below as wet, damp, hazardous, or corrosive locations.
 - 3. Hazardous Locations: Spaces Classified as Class I, II, or III by NEC Article 505.

4. Outdoor or Wet Locations: Locations exposed to weather, whether under a roof or not, including below grade structures, handholes vaults unless otherwise designated on Plans.
5. Shop-Fabricated: Manufactured or assembled equipment for which no UL test procedure has been established.

1.4 System Description

- A. Furnish and install complete operating electrical system including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building, fire, and electrical codes and standards.
- B. Plans indicate connections for typical equipment only.
 1. If equipment furnished differs from that shown, provide modifications necessary for safe and properly operating installation in accordance with Manufacturer's recommendations.
- C. Use equipment, materials, and wiring methods suitable for types of locations in which they are located as defined below.

1.5 Quality Assurance

- A. Electrical Work shall conform to applicable codes and standards.
 1. Conform to Cal/OSHA Safety Orders (Title 8 CCR)
 2. Conform to California Electrical Code
 3. Conform to applicable local codes and regulations.
 4. Equipment and materials shall bear UL or ETL labels to indicate manufacturing conforms to specified standards or equal.
 - a. UL label or listing is required for electrical products and assemblies, except where UL- or ETL- listed products meeting Contract requirements are not manufactured.
 - b. In such case, submittals shall state products or assemblies are not UL- or ETL-listed and no UL- or ETL-listed products are available.
 - c. Where UL-or ETL-listed products are not manufactured, Work shall conform to independent testing laboratory acceptable to City.
 - d. Where generic UL label does not apply to an assembly, serialized UL label shall be affixed to assembly by City-accepted inspector and serial number shall appear on assembly Record Drawings.
 5. Where 2 codes or standards are at variance, conform to more restrictive requirements:
- B. Electrical materials and equipment shall be subject to factory inspection by City's Representative or City-designated testing agency representatives.
- C. Use appropriate conduit and conductor entry fittings with enclosures which maintain specified enclosure environmental capability after proper installation.
- D. Use adequate number of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- E. Refer to Sections 01 75 00 and 26 08 00 for commissioning and testing requirements.

1.6 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 1. Certified Ballast Manufacturers.
 2. ANSI/IEEE C2 National Electrical Safety Code
 3. ANSI/IEEE C57.109 Guide for Transformer Through-Fault-Current Duration
 4. ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys.

5. ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment
6. ANSI Z244-1 Personnel Protection
7. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California, Cal-OSHA Low Voltage Electrical Safety Orders
8. California Building Code (CBC)
9. California Electrical Code (CEC)
10. California Energy Code (CEnC)
11. California Fire Code (CFC)
12. City, County and District Electrical Codes.
13. ETL Electrical Testing Laboratories standards
14. IEEE C2 National Electric Safety Code (NESC)
15. IEEE 45 Testing Insulation Resistance of Rotating Machinery
16. IEEE 86 Airborne Sound Measurement on Rotating Electric Machinery
17. IEEE 112 Test Procedure for Polyphase Induction Motors and Generators
18. IEEE 115 Test Procedure for Synchronous Machines
19. IEEE 241 Electric Power Systems in Commercial Buildings
20. IEEE 242 Protection and Coordination of Industrial and Commercial Power Systems
21. IEEE 1584 Performing Arc-Flash Hazard Calculations
22. Illuminating Engineering Society (IES) Standards.
23. Insulated Cable Engineers Association (ICEA) Standards.
24. National Electrical Manufacturers Association (NEMA) Standards.
25. National Electrical Safety Code.
26. NECA Standard of Installation
27. NEMA WD-1-1.10 General Requirements for Wiring Devices.
28. NEMA AB1 Molded Case Circuit Breakers.
29. NEMA KS1 Enclosed Switches.
30. NETA ATS Acceptance Testing Specifications for Electrical Power Equipment and Systems
31. NFPA 70 National Electric Code (NEC)
32. NFPA 70B Electrical Equipment Maintenance
33. NFPA 70E Electrical Safety Requirements for Employer Workplaces
34. NFPA 78 Lighting Protection Code
35. NFPA 101 Life Safety Code
36. NEMA/ANSI 250 Enclosures for Electrical Equipment
37. NEMA MG1 Motor s and Generators
38. NEMA MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
39. NEMA MG10 Energy Management Guide for Selection and Use of Polyphase Motors
40. OSHA CFR 1910 Occupational Safety and Health Standards
41. OSHA CFR 1926 Occupational Safety and Health Standards
42. Public Utilities Service Requirements.
43. Underwriter's Laboratories Inc.(UL) Standards.

1.7 **Submittals**

1. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
QA/QC Plan	On City's request, submit QA/QC procedures for composite fabrication, including: 1. Qualifications of plant staff directly involved in Work, 2. Current and anticipated plant workload. 3. State how other Work will impact hoist fabrication schedule for this contract. 4. Plant QA/QC recordkeeping and means for transmitting records to City. 5. Shop Drawing submittal process. 6. Materials sources. 7. Plant QA/QC procedures regarding sources of materials. 8. Fabrication schedule. 9. Procedures for materials handling and storage at plant. 10. Fabrication process.	

DRAWINGS AND PART SCHEDULES		
Shop Drawings	Submit under electrically-controlled equipment Shop Drawing requirements.	
SUBMITTAL	DESCRIPTION	
	Dimensional Outlines Show front, side, and rear elevations, footprints, and top views of panels, enclosures, and electrically powered equipment.	
	Single Line Diagrams and Metering Diagrams Show local and remote devices associated with each installation.	
	Wiring and Control Diagrams, 1. Schematic wiring diagrams 2. Connection diagrams 3. Terminal diagrams showing numbering of terminal blocks 4. Conductor wire numbers, sizes and types 5. Grounding diagrams 6. Logic diagrams for programmable controllers or relays. 7. Drawings shall reference instrument tag numbers shown on Plans	
	List of Nameplates and Identification Tags 1. Starters 2. Relays 3. Conductors 4. Push buttons 5. Switches 6. Indicating lights 7. Show nameplate material, height of letters, number of lines, inscriptions and dimensions	
Materials and Equipment Schedule	Materials and Equipment List 1. Manufacturers, 2. Brand names, 3. Catalog, model, or part numbers 4. Sizes, and other information needed to identify manufactured items proposed for use. 5. Show instrument tag numbers applicable.	
	Environmental Ratings Including temperature, humidity, and elevation ratings	
	Electrical Ratings 1. Voltage, continuous current, and wattage ratings. 2. Conduit entry restrictions, 3. Enclosure types and dimensions 4. UL or ETL listing or identification of non UL- or ETL-Listed Products	
	Finish Information	
	Information on Dielectric Connections and materials used to isolate dissimilar metals	
MANUFACTURER'S LITERATURE		
Product Data	Submit the following for items of standard manufacture:	
	Product name or identification in sufficient detail to facilitate reordering.	
	List of parts and construction materials referenced by ANSI, NEMA, ASTM, SAE or CDA specification and grade.	
	Standard test reports for mass-produced equipment.	
Motor Data	Submit in tabular form for each motor:	
	General 1. Equipment driven and specification number of driven machine 2. Motor Manufacturer 3. Nominal horsepower 4. Service factor 5. Lists of special features being provided as specified	

	Enclosure and Frame 1. Frame size 2. Motor type or model, and dimension drawing 3. Net motor weight 4. Type of enclosure 5. Motor housing material and winding material.	

SUBMITTAL	DESCRIPTION	
	Electrical 1. Voltage, phase, and frequency rating 2. Motor locked rotor current at rated voltage 3. Motor no-load current at rated voltage 4. Motor full load current at rated horsepower for rated voltage 5. Motor full-load current at 110% voltage 6. NEMA design letter 7. Starting code letter or locked rotor kVA or current 8. Winding insulation class and treatment 9. Special winding configuration such as part-winding, star-delta. 10. Include winding diagram. Submit mounting details and templates where required for proper motor installation.	
Installation Instructions	Submit per Installation Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations – Seismic Restraint	Refer to Section 01 73 24.	
System Demonstration Plan	Submit written plan for demonstrating each equipment item provided under Division 26 meets specified operational requirements. Plan shall detail procedures to be used in final operation testing of entire systems including description of each system, test methods and materials, testing instruments and recorders, and list of equipment involved with functional parameters to be recorded on each item. Submit written notice to City's Representative for each motor verifying phasing has been checked and corrected if necessary.	
	Testing and check-out forms 1. List procedures with instructions for checking and testing of each electrical component of each system. 2. Include job safety rules in test procedures. 3. Provide list of qualified personnel for testing and checkout documentation. 4. Submit test results for specified testing.	
CLOSEOUT SUBMITTALS		
Record Drawings	Submit per Section 01 78 39.	
O & M Instructions	Submittal shall include: Product Data, drawings, descriptions, and schematic drawings. Include name, address, and telephone number for nearest distributor of each piece of equipment. Theory of operation. Expanded parts drawings of electrical parts. Parts list and part changeout instructions. List of recommended spare parts. Specifications and part numbers for replacement parts Name, address, and phone number for nearest distributor of each equipment item. Preventative maintenance schedules. Troubleshooting checklists.	
Warranty	Unless otherwise stated, furnish 1-year warranty from date of final acceptance	

8. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, O&M Instructions, and Test Record Transcripts.
9. Standard test reports for mass-produced equipment shall be submitted along with Shop Drawings for such equipment.

1.8 **Delivery, Storage, and Handling**

- A. Refer to Section 01 32 00 for requirements for scheduling.
- B. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- C. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of electrical products.

- D. After completing shop assembly, factory test, and approval, pack equipment, cabinets, panels, and consoles in protective crates and enclose in heavy duty polyethylene envelopes or secured sheeting to protect from damage, dust, and moisture.
 - 1. Skid-mount equipment for final transport.
 - 2. Provide external continuous lifting angles for moving heavy equipment without removing protective covering.
 - a. Lifting rings may be used for items <48" in all horizontal dimensions
 - b. Lifting eyelets are not acceptable
 - 3. Show boxed weight on shipping tags, with instructions for unloading, transporting, and handling at site.
 - 4. Do not drop or knock over electrical equipment and assemblies.
- E. Tag each component to identify location, instrument tag number and function in system.
 - 1. Provide permanent stainless steel tag secured and etched with instrument tag number shown in tabulation.
 - 2. Prominently display identification on exterior of shipment packaging.
- F. Ensure electrical equipment will pass through building doorways and openings to reach Plan locations.
 - 1. Coordinate shipping splits with Manufacturer to facilitate safe handling and passage through doorways and openings.
 - 2. Ship, handle, and if necessary, assemble equipment at job site in accordance with Manufacturer's requirements to maintain functional integrity.
- G. Keep electrical equipment upright during storage and handling.
 - 1. When equipment must be tilted to pass through openings or restrictions, brace equipment to ensure tilting does not impair functional integrity of equipment.
- H. Cover and protect materials and equipment to ensure no finished surfaces are damaged, marred, or splattered with water, foam, plaster, or paint.
 - 1. Protect nameplates to prevent defacing.
- I. Protect electrical equipment against loss, weather, or mechanical and moisture damage.
 - 1. Do not store electrical equipment outdoors.
 - 2. Store electrical equipment in clean, dry, indoor, shelters or locations.
 - 3. Store products containing electrical insulation such as transformers, conductors, motors, and controls in clean, dry, indoor heated locations.
 - 4. Keep rotating and moving parts clean and dry.
- J. Provide temporary heating, sufficient to prevent condensation, in transformers, switchgear, switchboards, motors, and motor control centers which do not have space heaters.
- K. Replace Work evidencing moisture or other damage.

1.9 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Electrical equipment Manufacturers shall have manufactured similar electrical equipment for ≥5 years.

1. On City's Representative's request, provide acceptable list of installations with similar equipment to verify compliance.

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Furnished electrical system shall be complete and functional.
 1. Furnish material incidental to Work of this section.
- C. Equipment motors furnished shall operate through their full operating range powered by amperages specified or shown on Plans.
 1. Equipment requiring larger amperage than specified or shown is unacceptable absent written statement from City electrical infrastructure and switchgear can support increased amperage.
- D. Electrical equipment and panels shall be factory finished with Manufacturer's standard primer and enamel topcoats, unless stated otherwise in individual equipment specifications.
- E. The following product design criteria, options and accessories are required for nameplates:

ITEM	DESCRIPTION	
	Dimensions	$\geq 1/16"$ thick x $\geq 3/4"$ high x $\geq 2 1/2"$ long
	Lettering	Provide nameplates with engraved lettering $\geq 1/4"$ high, legible from reasonable angles of observation to distances of at least 10'
	Color	Use black-engraved-to-white-core laminated plastic (so letters will be white with black background)
	Mounting	Secure with ≥ 2 stainless steel panhead sheet metal screws, escutcheon pins, or rivets. Do not use adhesives. Do not use embossed plastic adhesive tape. Where equipment does not have suitable space or surface for mounting nameplate, mount nameplate to adjacent mounting surface.
Nameplates on Motors and Equipment	Stainless Steel	SAE Type 316
		Permanently attached to motor frame with information impressed, engraved or embossed into plate
		Show information required by NEMA MG1-10.39 through 39, Manufacturer's name, model and serial number, year of manufacture, rpm, horsepower, voltage, phase, full load current, locked-rotor kVA code, motor type, frame, insulation class, centigrade degree rise and motor connection diagram. Also show bearing numbers for both bearings, efficiency, power factor at full load, and maximum recommended kVAR of power capacitors to result in a 90% power factor.

PART 3 - EXECUTION

3.1 **Preparation**

- A. Provide supervision on-site to lay out, check, coordinate, and supervise electrical Work.
 1. Plan installation of electrical Work, considering Work of other trades to minimize interference.
- B. Lay out Work in advance.
 1. Plans were developed from Record Drawings and information received from City.
 - a. Plans diagrammatically show desired locations and arrangements of panelboards, pull boxes, lighting, outlets, conduit runs, equipment, and other items.
 - b. Where apparatus and equipment, switchboards and transformers, are shown on Plans, dimensions have been taken from typical equipment of class shown.

- c. Plans diagrammatically show desired location and arrangement of outlets, conduit runs, equipment, and other items.
- 2. Make field measurements needed to install electrical system and components before submitting Shop Drawings or ordering.
 - a. Determine exact locations in field based on size and arrangement of equipment, finished elevations, required NEC Article 110-26 clearances and other obstructions.
 - b. Adhere as closely as possible to Plan locations.
 - c. Verify equipment contemplated for installation will fit through openings and into spaces provided.
 - d. Verify exact rough-in location and dimensions for connection to electrified equipment provided by others.
- 3. Field determine and verify exact location based on physical size and arrangement of equipment, finished elevations, and obstructions, and submit such location for acceptance by City's Representative prior to installation.
 - a. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
 - b. Minor adjustment entails changes of $\leq 5'$ in any direction.
 - c. Install electrical equipment, including pull or junction boxes $\geq 6"$ from process gas, air, water, wastewater, or drainage piping and equipment.
 - d. Do not use equipment exceeding dimensions shown or reducing clearances to less than those shown on Plans or required by NEC Article 110-26.
- 4. Where necessary to adjust Plan locations of electrical equipment the following adjustments may be made without securing City's acceptance provided NEC Article 110-26 mandated code clearances are maintained.:
 - a. Adjustments $\leq 12"$ at grade, floor and roof level in any direction in horizontal plane.
 - b. Adjustments $\leq 12"$ for non-lighting equipment at ceiling level in any direction in horizontal plane.
 - c. Adjustments $\leq 12"$ for lighting fixtures at ceiling level in any direction in horizontal plane.
 - d. Adjustments $\leq 12"$ on walls in horizontal direction within vertical plane.
 - e. Obtain acceptance form City's Representative for changes in location outside the above limits.
- C. Install conduit and equipment to avoid obstructions, preserve head room, and keep openings and passageways clear.
 - 1. Where equipment installed without City's direction must be moved, it shall be moved at Contractor's expense.
- D. Confer with City's Representative to verify location of existing underground utilities at each area of construction activity
 - 1. Protect existing underground utilities throughout construction.
- E. Complete Work involving shutdown of existing services to equipment now functioning or tie-in of equipment to existing system at such time as to minimize downtime and inconvenience to City.
 - 1. Do such work when directed by City's Representative.
- F. Do not start Work involving existing electrical system without first obtaining and completing coordination forms required by facility.
 - 1. Submit coordination forms with drawings and procedures showing information about what, where, why, and how Work will be done.

- G. Do not cut, notch, or weld to structural members or building surfaces without acceptance from City's Representative.
 - 1. Sawcut, channel, chase, or core-drill floors, walls, partitions, ceilings, paving, or other surfaces as required for installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment.
 - 2. Following such Work, repair, patch and restore surfaces to original condition.
- H. Contract Documents show circuiting to electrical loads and distribution equipment.
 - 1. Balance electrical load between phases as nearly as possible on switchboards, panelboards and motor control centers.
- I. Provide scaffolding, rigging, hoisting, and erection equipment necessary for electrical Work.
 - 1. Remove same from premises when no longer required.
- J. Maintain continuity of electric service to functioning portions of process or buildings during hours they are normally in use.
 - 1. Temporary outages will be permitted during cutover Work at such times and places as can be prearranged with City's Representative and electric utility company providing service to facility.
 - 2. Minimize outages and their duration.
 - 3. Make no outages without prior written authorization of City's Representative.
 - 4. Include costs for temporary wiring and overtime Work required in Contract price.
 - a. Remove temporary wiring at completion of Work.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for basic execution and installation requirements.
- B. Install and wire all electrical equipment, including pre-purchased equipment.
 - 1. Perform tests as necessary to assure compliance with Contract Documents and ensure Work is ready and safe for energizing.
- C. Refer to Section 31 23 00 for open trench requirements.
- D. Conform to NECA Standard of Installation unless otherwise specified.
- E. Make connections to equipment as required and in accordance with accepted Shop Drawings.
- F. Analyze systems components, identify terminals, and prepare plans or wiring tables necessary for component interconnection.
 - 1. Furnish and install component interconnections.
- G. Conform to the following installation standards:
 - 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 - 2. Other applicable OSHA and Cal OSHA regulations
 - 3. IEEE C2 National Electric Safety Code (NESC)
 - 4. California Electrical Code (CEC)
 - 5. NFPA 70 National Electric Code (NEC)
 - 6. Applicable building and fire code requirements
 - 7. Servicing electrical utility requirements
 - 8. Manufacturer's installation and warranty requirements
- H. Refer variances between above documents and Contract Documents to City's Representative.

- I. Plans indicate connections for typical equipment only.
 - 1. If equipment furnished differs from that shown, provide modifications necessary for safe and properly operating installation in accordance with equipment Manufacturer's recommendations.
- J. Plans indicate diagrammatically desired locations and arrangement of outlets, conduit runs, equipment, and other items.
 - 1. Field determine exact location based on physical size and arrangement of equipment, finished elevations, and obstructions.
 - 2. Work or equipment not indicated or specified but needed for proper operation of electrical systems shall be brought to attention of City prior to installation.
 - 3. Do not mount safety switches or other equipment to equipment enclosures unless enclosure mounting surface is properly braced to accept mounting of external equipment.
- K. Install electrical system components to tolerances recommended by Manufacturer.
 - 1. Unless otherwise shown, install components true, plumb, and level using precision gauges and levels.
- L. Install equipment to be accessible for operation and maintenance
 - 1. Electrical equipment shall not be blocked or concealed, nor interfere with normal operating and maintenance requirements of other equipment.
- M. Accomplish Work required to seal penetrations of waterproofing after part penetrating waterproofing is set in place.
 - 1. Seal and make watertight openings made for this purpose.
 - 2. Seal weather-tight equipment or components exposed to weather.
- N. In damp, wet, or below-grade areas, provide corrosion-resistant spacers to maintain ¼" separation between metallic equipment and metallic equipment supports and mounting surfaces.
 - 1. Do not place equipment fabricated from aluminum in direct contact with earth, concrete, or steel.
 - 2. Do not use materials that may cause building walls, ceilings, or roofing to discolor or rust.
- O. Screen or seal openings into outdoor-mounted equipment to prevent entrance of rodents, birds, and insects.
- P. Provide foreign power circuit isolation devices including protection of independently powered PLC input/output circuits located in equipment enclosures.
 - 1. Circuits which are sources of foreign power shall pass through isolation device where wiring penetrates equipment enclosures including control cabinets, and MCC buckets.
 - a. Provide easily accessible isolation point for foreign power sources for circuits in enclosure.
 - b. Clearly label isolation devices.
 - 2. Manufacturers shall supply isolation devices integral with their equipment whenever possible, such as isolation switches integral with disconnect handles on MCC buckets.
 - 3. Devices shall allow for operation of equipment with doors open to allow for testing and/or maintenance.
- Q. Mark circuit breakers, disconnect switches, timer, relays, and contactors to identify each item with its respective service or function and unique identification number as shown on Plans.
 - 1. Provide device tags for all receptacles and switches whether shown on Plans or not.

2. Provide nameplates with engraved lettering not less than height specified.
3. Use black-on-white laminated plastic, attached with sheet metal screws or self-adhesive backs.
4. Minimum label lettering heights as follows:
 - a. Main panel identification: $\geq \frac{3}{8}$ ".
 - b. Panel compartments with hinged doors, and MCC buckets: $\geq \frac{1}{4}$ ".
 - c. Device tags: $\geq \frac{1}{8}$ "
- R. Show homerun indicating panelboard name and circuit number adjacent to additional devices such as light fixtures and receptacles on same circuit.
- S. Repair affected surfaces to conform to type, quality, and finish of surrounding surface in neat and workmanlike manner.
- T. Upon completion of Work, remove materials, scraps, and debris from premises and from interior and exterior of devices and equipment.
 1. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes closely matching type, color, consistency, and type of surface of original finish.
 2. If damage is done to equipment paint surfaces, refinish entire equipment in manner that provides finish equal to or better than factory finish, that meets requirements of Contract Documents, and is acceptable to City's Representative.
- U. Where existing materials and equipment are removed or relocated, remove materials no longer used including studs, straps, conduits, and wires.
 1. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to ≥ 12 " below final finished surface and ≥ 24 " below ground surface.
 2. Coordinate such removal with City's Representative.

3.3 Field Quality Control

- A. Refer to Section 26 08 00 for field testing and commissioning requirements.
- B. Schedule tests and inspections as job progresses.
 1. Ensure inspections required by permitting agencies and servicing utilities are coordinated, conducted, and documented.
 2. Allow City's Representative to inspect materials, equipment, and workmanship.
 3. After each electrical system installation is complete, perform tests to verify system is in proper working order and in accordance with Contract Documents, Manufacturer's Installation Instructions, and applicable codes.
 4. Conduct tests in presence of City's Representative.
 - a. Notify City's Representative ≥ 7 days in advance of tests scheduled to be performed.
 5. Perform insulation and ground resistance tests before operating tests.
 6. Where motors ≥ 10 hp are part of packaged equipment such as pumps, qualified motor Manufacturer's representative shall supervise unpacking, installation and field testing.

3.4 Protection

- A. Protect Work against corrosion, physical damage, and effects of moisture on insulation until Final Acceptance.
 1. If partial dismantling of equipment is required for installation, box or wrap removed parts until reinstalled.
 2. Cover materials and equipment, both in storage and during construction, so no finished surfaces are damaged, marred, or splattered with water, foam, plaster, or paint.
 3. Protect factory-painted surfaces from impact, abrasion, discoloration, and other damage.

4. Protect Work from corrosion, and effects of moisture on insulation.
5. Cap conduit runs and equipment outlets during construction with manufactured seals, plugs, or caps where Work at these locations is not in progress.
 - a. Keep openings in boxes or equipment closed during construction.
6. Keep electrical equipment, materials, and insulation dry.
 - a. Maintain heaters in equipment connected and operating until equipment is placed in operation.
7. Repair or replace damaged Work as directed.
 - a. Repair stainless steel components using zinc-rich paint.
 - b. Repair painted components using touch-up paint provided by or approved by equipment Manufacturer.
 - c. Repair PVC-coated components using patching compound of same material as coating, provided by Manufacturer of component.
 - d. Replaced damaged nameplates.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas subject to dampness, moisture, dirt, or adverse atmosphere until completion of construction, provide protection from these atmospheres.
 1. Provide temporary heating, sufficient to prevent condensation, in transformers, switchgear, switchboards, motors, and motor control centers which do not have space heaters.
 2. Energize space heaters furnished with equipment.
 3. Keep moving parts clean and dry.
- C. Replace or have Manufacturer refinish damaged or marred materials or equipment, including face plates of panels and switchboard sections.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of building wire, power cable, control cable, instrumentation cable, wire connectors, insulating tape, and pulling lubricant for conductors and cables rated 600VAC and less.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 26 05 26: Grounding and Bonding for Electrical Systems
- I. Section 26 05 10: Common Work Results for Electrical
- J. Section 26 05 33: Raceway and Boxes for Electrical Systems
- K. Section 26 08 00: Commissioning of Electrical Systems

1.3 Definitions

- A. The following definitions apply:
 - 1. Building Wire: Single conductor, insulated, with or without outer jacket depending on type.
 - 2. Cable: Multi-conductor, insulated assemblies with outer sheath containing either building wire or instrumentation wire.
 - 3. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires #14AWG, #12AWG, or #10AWG.
 - 4. Instrumentation Cable: Multi-conductor insulated, twisted or untwisted, with outer sheath including:
 - a. Analog Signal Cable used to transmit low current (4-20mA DC) or low voltage (0-10VDC) signals using $\leq$ #16AWG conductors.
 - b. Common types include twisted shielded pairs (TSP) or twisted shielded triads (TST)
 - c. Digital Signal Cable: Used for transmission of digital signals between computers, PLC's, and RTU's.
 - 5. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire $\geq$ #8AWG.

1.4 System Description

- A. Furnish and install conductors and cables as shown on Plans and as required by NEC to power equipment furnished.
 - 1. Include appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable codes and standards.

1.5 Quality Assurance

- A. Use adequate number of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

- B. Conductors and cables shall be UL-listed and bear UL label.
- C. Where Manufacturer's, Electrical Utility or Contract Documents require larger conductor sizes than specified minimum sizes below, larger conductor size shall govern.
- D. Wire diameters shall be $\geq 98\%$ of specified AWG diameter.

1.6 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 1. ANSI C119.1 Electric Connectors-Sealed Insulated Underground Connector Systems Rated 600 Volts
 2. ANSI/TIA/EIA568B.2: Commercial Building Telecommunications Cabling Standards
 3. ASTM B1 Hard-Drawn Copper Wire
 4. ASTM B3 Soft or Annealed Copper Wire
 5. ASTM B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
 6. ASTM B33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
 7. ASTM B189 Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
 8. ASTM D2219 Poly(Vinyl Chloride) Insulation for Wire and Cable, 60°C Operation
 9. ASTM D2220 Poly(Vinyl Chloride) Insulation for Wire and Cable, 75°C Operation
 10. ASTM D2301 Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
 11. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 12. California Building Code (CBC)
 13. California Electrical Code (CEC)
 14. California Fire Code (CFC)
 15. ICEA S19 Rubber - Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 16. ICEA S58-679 Standard for Control Cable Conductor Identification
 17. ICEA S61-402/NEMA WC5 Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 18. IEEE 400 Field Testing and Evaluation of Insulation of Shielded Power Cable Systems
 19. IEEE 1202 Flame-Propagation Testing of Wire and Cable
 20. LAEC Los Angeles Electrical Code Article 725
 21. NEMA ICS4 Industrial Control and Systems: Terminal Blocks
 22. NEMA WC55 Instrumentation Cables and Thermocouple Wire
 23. NEMA WC57 Control Cables
 24. NEMA WC70 Non-Shielded Power Cables Rated 2000 Volts or Less for Distribution of Electrical Energy
 25. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
 26. NFPA 70 National Electric Code (NEC)
 27. NFPA 262 Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
 28. TIA/EIA/ANSI 568 Commercial Building Telecommunications Cabling Standard
 29. UL 44 Thermoset-Insulated Wires and Cables
 30. UL 62 Flexible Cords and Cables
 31. UL83 Thermoplastic-Insulated Wires and Cables
 32. UL444 Communications Cables
 33. UL 467 Grounding and Bonding Equipment
 34. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
 35. UL 486C Splicing Wire Connections
 36. UL 486D Sealed Wire Connector Systems
 37. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
 38. UL 969 Labels
 39. UL 1277 Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
 40. UL1581 Electrical Wires, Cables, and Flexible Cords
 41. UL 2250 Instrumentation Tray Cable

1.7 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION
DRAWINGS AND PART SCHEDULES Refer to Section 26 05 10	
MANUFACTURER'S LITERATURE	

Product Data	Submit the following for items of standard manufacture	
SUBMITTAL	DESCRIPTION	
	Product Data for each type of conductor.	
	Product Data is not required for wire connectors, insulating tape, or cable lubricant.	
Material List	Submit material list for each conductor type.	
	Show insulation material, conductor material, voltage rating, Manufacturer, and other pertinent data such as type shielding, number of pairs, and applicable standards.	
Installation Instructions	Submit per Installation Instruction requirements. Describe recommended splicing, testing, and installation procedures.	
SAMPLES		
Material Samples	Submit for fireproofing tape materials.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	Submit cable pulling calculations for cables sized 4/0 and larger per Engineering Calculations requirements to ascertain cable will not overstrain.	
	If cable diameters exceed diameters shown, submit calculations verifying larger cables fit within raceways shown in conformance to NEC requirements.	
Certificate of Compliance	Submit evidence of UL listing for products not bearing UL label.	
Test Record Transcripts	Submit for factory tests per Test Record Transcript requirements.	
	At least 30 days prior to system demonstration, submit transcript for field tests using City-accepted test forms for cable tests, Hi-Pot, and Megger tests.	
	Field test data. Show equipment used and time of test.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, Engineering Calculations, and Test Record Transcripts.

1.8 Delivery, Storage and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage and handling of conductors and cables.

1.9 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
CONDUCTOR WIRES		
Insulated Conductor Wire	Aetna Insulated Wire / Marmon / Berkshire Hathaway	Virginia Beach, VA (800) 423-6505
	Alpha Wire	Elizabeth, NJ (800) 522-5742
	American Insulated Wire Corporation	Mansfield, MA (440) 235-1140
	Belden, Inc.	St Louis, MO (800) 235-3361
	CerroWire SLiP-Wire® / Marmon / Berkshire Hathaway	Chicago, IL (800) 523-3869
	Encore Wire Corporation	McKinney, TX (800) 962-9473
	General Cable	Highland Heights, KY (859) 572-8000
	Kris-Tech Wire	Norwalk, CA (315) 339-5268
	The Okonite Company	Ramsey, NJ (201) 825-0300
	Omni Cable LLC	West Chester, PA (888) 292-6664
	Pro-Line Safety Products Company	West Chicago, IL (800) 554-3424

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Rome Cable Corporation	Rome, NY (315) 337-3000
	Southwire Company "SimPULL"	Carrollton, GA (770) 832-4000
	USA Wire and Cable, Inc.	Austin, TX (800) 880-9473
	Accepted equal	
INSTRUMENTATION CABLES		
Control and Logic Multiconductor Cable	Aetna Insulated Wire / Marmon / Berkshire Hathaway	Virginia Beach, VA (800) 423-6505
	Alpha Wire	Elizabeth, NJ (800) 522-5742
	Belden, Inc.	St Louis, MO (800) 235-3361
	Encore Wire Corporation	McKinney, TX (800) 962-9473
	General Cable	Highland Heights, KY (859) 572-8000
	Mohawk LAN-Trak	Leominster, MA (800) 422-9961
	The Okonite Company	Ramsey, NJ (201) 825-0300
	Omni Cable LLC	West Chester, PA (888) 292-6664
	Rome Cable Corporation	Rome, NY (315) 337-3000
	Southwire Company "Tappan"	Blauvelt, NY (800) 947-3911
	Accepted equal	
Twisted, Shielded Pair (TSP) and Twisted, Shielded Triad (TST) Instrumentation Cable	Aetna Insulated Wire / Marmon / Berkshire Hathaway	Virginia Beach, VA (800) 423-6505
	Alpha Wire	Elizabeth, NJ (800) 522-5742
	Belden, Inc.	St Louis, MO (800) 235-3361
	Encore Wire Corporation	McKinney, TX (800) 962-9473
	General Cable	Highland Heights, KY (859) 572-8000
	Mohawk LAN-Trak	Leominster, MA (800) 422-9961
	The Okonite Company	Ramsey, NJ (201) 825-0300
	Omni Cable LLC	West Chester, PA (800) 292-6664
	Rome Cable Corporation	Rome, NY (315) 337-3000
	Southwire Company "Tappan"	Blauvelt, NY (800) 947-3911
	Accepted equal	
Multi-Twisted Shielded Pairs with Common Overall Shield Instrumentation Cable Type TC	Alpha Wire	Elizabeth, NJ (800) 522-5742
	Belden, Inc.	St Louis, MO (800) 235-3361
	The Okonite Company	Ramsey, NJ (201) 825-0300
	Rome Cable Corporation	Rome, NY (315) 337-3000
	Omni Cable LLC	West Chester, PA (800) 292-6664
	Southwire Company "Tappan"	Blauvelt, NY (800) 947-3911
	Accepted equal	
CABLE AND WIRE MARKERS		
Conductor Sleeve or Tag Markers	Grafoplast Wire Markers	Denver, CO (800) 864-3874
	Floy Tag & Manufacturing, Inc Type FT200C	Seattle, WA (206) 524-2700
	Floy Tag & Manufacturing, Inc Type FT200S	Seattle, WA (206) 524-2700
	Panduit Corporation	Tinley Park, IL (800) 344-4539
	Phoenix Contact	Middletown, PA (800) 888-7388
	Thomas & Betts / ABB TY-RAP TY54M Series	Memphis, TN (800) 816-7809
	W H Brady Type B500	Milwaukee, WI (800) 940-0615
	Accepted equal	
Conductor Tags (Embossed Fiber Floater Markers for Use in Small Junction Boxes)	Floy Tag & Manufacturing, Inc Type FT205	Seattle, WA (206) 524-2700
	Accepted equal	
Insulating and Color-Coded Tape	3M "Scotch"	St Paul, MN (888) 364-3577
	Plymouth Bishop Tapes / Plymouth Rubber	Canton, MA (800) 458-0336
	Red Seal Electric Company	Cleveland, OH (216) 941-3900
	Accepted equal	
OTHER		
Pulling Lubricant	Ideal Aqua-Gel	Sycamore, IL (815) 895-5181

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Polywater	Stillwater, MN (651) 430-2270
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Conductors shall conform to NEC Article 200.
- C. Cables shall conform to NEC Article 340
- D. Materials for conductors and cables shall be:

ITEM	MATERIAL	SPECIFICATION			
BUILDING AND INDUSTRIAL CONDUCTOR WIRES					
Low-Voltage Building Wire #8AWG and Smaller (600-VAC Rated)	Conductors except #10AWG or #12AWG branch power or lighting circuits	Coated silt-drawn or annealed stranded copper Conform to ASTM B33 and ASTM B189 Stranding shall conform to ASTM B8 Class B			
	Conductors - #10AWG or #12AWG designated for branch circuit power wiring to lighting and receptacle circuits	Coated silt-drawn or annealed stranded copper Conform to ASTM B33 and ASTM B189 Stranding shall conform to ASTM B8 Class B			
	Size	Size as shown on Plans and as required per NEC			
	Minimum Size (where wire size not shown)	≥#12AWG for power and lighting circuits			
	Insulation	Rated for 600VAC Conform to ASTM D2220 for 75°C PVC Rated for continuous operation at 75°C (167°F) / 90°C (194°F) in dry locations, 75°C (167°F) / 90°C (194°F) in wet locations			
		Location		Permitted Insulation	Standard
		Architectural and Non-Architectural Finished Areas		Type XHHW-2,	Flame-retardant XLPE Conform to NEMA WC70 and UL 44
				THHN/THWN or THHN/THWN-2	Thermoplastic PVC with nylon jacket Conform to NEMA WC70 and UL 83
		Below Grade		Type XHHW-2	Flame-retardant XLPE Conform to NEMA WC70 and UL 44
		Wire Size	THWN Insulation Thickness	PVC Insulation Thickness	Clear Nylon Jacket Thickness
		#14AWG	≥12 mils	≥16 mils	≥4 / 5 mils
		#12 AWG	≥14 mils	≥19 mils	≥4 / 5 mils
		#10AWG	≥16 mils	≥22 mils	≥4 / 5 mils
	≥#8AWG			≥4 / 5 mils	
Jacket	≥4 / 5-mil nylon jacket on THHW and THWN cables Moisture, sunlight, oil-and-heat-resistant, flame-retardant cross-linked polyolefin outer jacket on multi-conductor XHHW-2 cables No jacket required for single conductor XHHW-2 cables				
Labeling	Permanently imprint along length of each conductor 1. Manufacturer Name or Trademark 2. Insulation Type Letter Designation				

ITEM	MATERIAL	SPECIFICATION		
		3. Voltage Rating 4. Wire Size 5. UL Label		
Control Cable (600-VAC Rated) Type TC	Conductors	Conform to NFPA 70 (NEC) Type TC Coated sift-drawn or annealed stranded copper Conform to ASTM B33 and ASTM B189 Stranding shall conform to ASTM B8 Class B		
	Size	Size as shown on Plans and as required per NEC		
	Minimum Size (where wire size not shown)	≥#14AWG for control circuits, provided fuse or circuit breaker sized at ≤15A protects circuit		
	Number of Conductors	As required, provided with or without bare ground conductor of same AWG size. When bare ground conductor is not provided, provide additional insulated conductor for ground conductor		
	Insulation	Rated for 600VAC Flame-retardant cross-linked thermoplastic PVC with nylon jacket (THHN/THWN and THHN/THWN-2) conforming to NEMA WC57 and UL83 and UL 1277 Type XHHW-2 for below-grade runs Type XHHW-2, THHN, or THWN for above-grade runs Rated for continuous operation at 90°C (194°F) in dry locations, 90°C (194°F) in wet locations		
		Location	Permitted Insulation	Standard
		Architectural and Non-Architectural Finished Areas	Type XHHW-2,	Flame-retardant XLPE Conform to NEMA WC70 and UL 44
			THHN/THWN or THHN/THWN-2	Thermoplastic PVC with nylon jacket Conform to NEMA WC57, UL 83, and UL 1277
		Below Grade	Type XHHW-2	Flame-retardant XLPE Conform to NEMA WC70 and UL 44
	Individual Conductor Color Coding	Conform to ICEA S58-679 Method 1, Table E2 where not otherwise shown		
	Jacket	≥4-mil nylon jacket on THHW and THWN cables Moisture, sunlight, oil-and-heat-resistant, flame-retardant cross-linked polyolefin outer jacket on multi-conductor XHHW-2 cables No jacket required for single conductor XHHW-2 cables		
	Labeling	Permanently imprint along length of each conductor 1. Manufacturer Name or Trademark 2. Insulation Type Letter Designation 3. Voltage Rating 4. Wire Size 5. UL Label		
Grounding Conductors	Conductor	Stranded soft-drawn copper Required in multi-conductor power cables.		
	Size – Alternating Current System Ground	As shown on Plans and sized per NEC Table 250.66		
	Size – Equipment Ground	As shown on Plans and sized per NEC Table 250.122		
	Minimum Size of Ground Conductors (Use where wire size not shown)	≥#12AWG		
	Insulation	Insulation material shall match that used for phase conductors		

ITEM	MATERIAL	SPECIFICATION		
		Color – Green or Green with yellow stripes per NEC 250.119		
	Jacket	≥4-mil nylon jacket on THHW and THWN cables Moisture, sunlight, oil-and-heat-resistant, flame-retardant cross-linked polyolefin outer jacket on multi-conductor XHHW-2 cables No jacket required for single conductor XHHW-2 cables		
	Labeling	Permanently imprint along length of each conductor 1. Manufacturer 2. Insulation Type Letter Designation 3. Voltage Rating 4. Conductor Size 5. UL Label		
Direct-Buried Grounding Conductors	Conductors #10AWG or smaller	Soft or annealed copper wire Conform to ASTM B3		
	Conductors - 8AWG – 500kcmil	Bare stranded soft-temper high-conductivity copper grounding cable Conform to ASTM B8 Class B Identify ground conductor with green electrical tape spiral-wound around conductor for exposed lengths in boxes, enclosures, or where emerging from protective raceways.		
	Size – Alternating Current System Ground	As shown on Plans and as required per NEC Table 250.66		
Fixture Wires	Conductor	Copper Conform to NEC Article 402 Type AVA		
	Minimum Size (where wire size not shown)	≥#14 AWG		
	Insulation	Rated for 600VAC		
Flexible Cords and Cables	Conductor	Copper Conform to NEC Article 400 Type SO or SJO		
	Insulation	Rated for 600VAC		
INSTRUMENTATION CABLES				
Digital Control and Logic Cables (for Control Logic, PLC Outputs and Inputs) Type TC	Conductor	Conform to NFPA 70 (NEC) Article 336 Type TC Copper UL-listed multi-conductor cable with ground Conform to NFPA 262 As recommended by PLC, RTU, or digital equipment Manufacturer		
	Ground	Include 1 full-size green equipment grounding conductor		
	Minimum Size (where wire size not shown)	≥#14AWG 7-strand		
	Insulation	Rated for 600VAC Conform to ASTM D2220 for 75°C PVC 15-mil PVC+4-mil nylon jacket insulated wires UL listed as Type THHN/THWN Color code to ICEA S61-402 Appendix K, Method 1 Table K2 Rated for continuous operation at 90°C (194°F) in dry locations, 90°C (194°F) in wet locations Flame-retardant		
	Shield	Bind conductor groups with spiral wrap of barrier tape.		
	Outer Jacket	PVC Flame-retardant, sunlight, abrasion, moisture and oil-resistant and suitable for wet or dry locations		
	Dimension	4-pair	OD ≤0.50"	45-mil nominal jacket thickness
		8-pair	OD ≤0.68"	60-mil nominal jacket thickness
12-pair		OD ≤0.82"	60-mil nominal jacket thickness	

ITEM	MATERIAL	SPECIFICATION		
		16-pair	OD ≤0.95"	80-mil nominal jacket thickness
		20-pair	OD ≤1.05"	80-mil nominal jacket thickness
		24-pair	OD ≤1.16"	80-mil nominal jacket thickness
		36-pair	OD ≤1.33"	80-mil nominal jacket thickness
		50-pair	OD ≤1.56"	80-mil nominal jacket thickness
	Labeling	1. Manufacturer Name or Trademark 2. Maximum Working Voltage (Rating) for which cable was tested 3. Type of Cable 4. UL Label 5. Verified performance level		
Instrument Analog Cable – Single Pair Type TC (UL 62 and UL 1277 or UL 1581)	Horizontal Voice and Data Cable	Category 6 per TIA/EIA/ANSI 568 Label-verified ≥#24AWG solid untinned copper conductors Rated CMP per NFPA 70 Use where recommended by PLC or RTU manufacturer		
	Service	Multi-conductor control circuit interconnection cable with ground Suitable for installing in cable trays, conduit or other accepted raceways Passes vertical tray flame test		
	Conductor	Conform to NFPA 70 (NEC) Article 336 Type TC Conform to UL2250 Conform to UL1581 for cable tray use Conform to UL1277 for direct burial or sunlight exposure Bare soft annealed stranded tinned copper Class B 7-strand ≥ 6 twists per foot Concentric conforming to ASTM B8		
	Drain Wire	Pair drain wire #20AWG 7-strand tinned copper Increase wire size for runs >1000'		
	Minimum Size (where wire size not shown)	Two or 3 ≥#18AWG for runs <1000' Two or 3 ≥#16AWG for runs >1000'		
	Insulation	Rated for 600VAC 15-mil PVC+4-mil nylon jacket-insulated twisted-pair wires Color code to ANSI/ICEA standards Rated for continuous operation at 90°C (194°F) in dry locations, 90°C (194°F) in wet locations Flame-retardant Pair conductors integrally pigmented black and red.		
	Individual Conductor Color Coding	Conform to ICEA S58-679 Method 1, Table E2 where not otherwise shown		
	Shield	Spiral-wound 1.35-mil aluminum/mylar metal-foil tape Overlap to provide 100% coverage		
	Jacket	45-mil PVC Flame-retardant, sunlight, abrasion, moisture and oil-resistant and suitable for wet or dry locations		
	Dimension	Nominal OD – 0.31"		
Instrument Analog Cable – Single Triad Type TC (UL 62 and UL 1277 or UL 1581)	Service	Instrument cable designed for noise rejection for process control, computer, or data log applications Suitable for installing in cable trays, conduit or other accepted raceways		
	Conductor	Conform to NFPA 70 (NEC) Article 336 Type TC Conform to UL2250 Conform to UL 1581 for cable tray use Conform to UL 1277 for direct burial or sunlight exposure Bare soft annealed stranded tinned copper Class B 7-strand ≥ 6 twists per foot Concentric conforming to ASTM B8		
	Drain Wire	Triad drain wire #20AWG 7-strand tinned copper		

ITEM	MATERIAL	SPECIFICATION	
		Increase wire size for runs >1000'	
	Minimum Size (where wire size not shown)	Two or 3 $\geq$ #18AWG for runs <1000' Two or 3 $\geq$ #16AWG for runs >1000'	
	Insulation	Rated for 600VAC 15-mil PVC+4-mil nylon jacket-insulated twisted-triad wires Color code to ANSI/ICEA standards Rated for continuous operation at 90°C (194°F) in dry locations, 90°C (194°F) in wet locations Flame-retardant Triad conductors integrally pigmented black, red, and blue	
	Individual Conductor Color Coding	Conform to ICEA S58-679 Method 1, Table E2 where not otherwise shown	
	Shield	Spiral-wound 1.35-mil aluminum/mylar metal-foil tape Overlap to provide 100% coverage	
	Jacket	45-mil PVC Flame-retardant, sunlight, abrasion, moisture and oil-resistant and suitable for wet or dry locations.	
	Dimension	Nominal OD – 0.32"	
	Service	Instrument cable designed for noise rejection for process control, computer, or data log applications Suitable for installing in cable trays, conduit or other accepted raceways	
Instrument Analog Cable – #18AWG Multi-Twisted Shielded Pairs with Common Overall Shield Type TC (UL 62 and UL 1277 or UL 1581)	Conductor	Conform to NFPA 70 (NEC) Article 336 Type TC Conform to UL2250 Conform to UL 1581 for cable tray use Conform to UL 1277 for direct burial or sunlight exposure Bare soft annealed stranded tinned copper Class B 7-strand ≥ 6 twists per foot Concentric conforming to ASTM B8	
	Drain Wire	Pair drain wire #20AWG tinned copper Group drain wire #18AWG tinned copper Increase wire size for runs >1000'	
	Minimum Size (where wire size not shown)	Two or 3 $\geq$ #22AWG for runs <1000' Two or 3 $\geq$ #20AWG for runs >1000'	
	Insulation	Rated for 600VAC 15-mil PVC+4-mil nylon jacket-insulated wires twisted together Color code to ANSI/ICEA standards Rated for continuous operation at 90°C (194°F) in dry locations, 90°C (194°F) in wet locations Flame-retardant Twisted-pair conductors integrally pigmented black and red with red conductor numerically printed for group identification	
	Individual Conductor Color Coding	Conform to ICEA S58-679 Method 1, Table E2 where not otherwise shown	
	Shield	Spiral-wound 1.35-mil aluminum/mylar metal-foil tape Group shield 2.35-mil aluminum/mylar metal-foil tape Overlap to provide 100% coverage	
	Jacket	45-mil PVC Flame-retardant, sunlight, abrasion, moisture and oil-resistant and suitable for wet or dry locations.	
	Dimension	4-pair	OD $\leq 0.50"$ 45-mil nominal jacket thickness
		8-pair	OD $\leq 0.68"$ 60-mil nominal jacket thickness
		12-pair	OD $\leq 0.82"$ 60-mil nominal jacket thickness
		16-pair	OD $\leq 0.95"$ 80-mil nominal jacket thickness
		20-pair	OD $\leq 1.05"$ 80-mil nominal jacket thickness

ITEM	MATERIAL	SPECIFICATION		
		24-pair	OD ≤ 1.16"	80-mil nominal jacket thickness
		36-pair	OD ≤ 1.33"	80-mil nominal jacket thickness
		50-pair	OD ≤ 1.56"	80-mil nominal jacket thickness
	Service	Instrumentation, process control, and computer cable suitable for installing in cable trays, conduit or other accepted raceways.		
Network Cables – Ethernet Cable				
TERMINALS AND CONNECTIONS				
Twist / Screw-on Type Wire Connectors	Copper	600VAC-rated For phase and neutral conductors, conform to UL 486C For ground conductors, conform to UL 486C and/or UL 467 as required by local codes.		
Compression and Mechanical Screw Type Wire Connectors	Copper – Electro-Tin-Plated	600VAC-rated For phase and neutral conductors conform to UL 486A For ground conductors, conform to UL 467		
Terminal Block-Type Wire Connectors	Copper – Electro-Tin-Plated	High-density, screw-post barrier-type with white center marking strip 600VAC-rated for power circuits 600VAC 20-Amp-rated for control circuits 600VAC 15-Amp-rated for instrumentation circuits Conform to NEMA ICS4 and UL486A		
Terminals - ≥#6AWG	Copper – Electro-Tin-Plated	UL-listed, solderless, compression type.		
Terminals - ≤#8AWG	Copper – Electro-Tin-Plated	UL-listed, solderless, compression type connectors, or mechanical seamless tubular ring tongue terminals.		
Terminals – Control and Instrumentation Cable	Copper – Electro-Tin-Plated	Ring tongue terminals. Terminal barrel shall be internally serrated and covered with color-coded PVC insulation sleeve.		
Terminals – For Terminations on Screw-Type Terminal Strips Supplied Integral to Devices	Copper – Tin-Plated	Ring-tongue, nylon- or vinyl-insulated copper crimp terminals and ferrules with insulating sleeves for terminal blocks, except for light switches and receptacles.		
Taps in Wires #6AWG and Larger	Copper	Mechanical tap with preformed insulating cover.		
Taps - ≤#8AWG	Copper	Make "pigtail" or connections with compression connection with thermoplastic insulating cover.		
CABLE AND WIRE MARKERS				
Labeling System	Label Stock, Laminating Adhesive and Ink	Conform to UL969		
Cable Markers	Nylon Identification Ties	Hot-stamp with black letters ≥5/32" high		
Wire Markers	Hot-Stamped PVC Sleeves	White with black lettering for uniform appearance Hold sleeve length to uniform length at each terminal board Where hot-stamped sleeve is unavailable, mark wire with clip sleeve covered with transparent heat-shrink tubing.		
	Heat-Shrink Polyolefin	White with black lettering for uniform appearance Hold sleeve length to uniform length at each terminal board		

ITEM	MATERIAL	SPECIFICATION
	Sleeves	
OTHER		
Wire and Cable Supports		Baskets, grips, clamps, wedge assemblies and other devices designed for cable support Heavy-duty split-lace
Pulling Lubricant		Cable Manufacturer's standard containing no petroleum or other products which deteriorate insulation.

E. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Wire Color	Phase Conductors #8AWG and smaller	Factory color coding with integrally pigmented solid color insulation along full length Do not use on-site coloring of conductor ends or apply colored plastic adhesives in lieu of factory color-coding.
	Ground Conductors	Factory color coding with integrally pigmented solid green color insulation along full length, or Stripping insulation from entire exposed length, or Covering entire exposed length with green tape.
	Purple-Colored Wiring	Use to identify wires connecting to PLC input/output circuits. Use white or purple with white stripe for PLC neutral throughout Work. This requirement is a worker safety precaution to identify foreign power sources in equipment and applies to internal wiring in PLC enclosure cabinet, interconnecting wiring to devices and equipment, and internal equipment wiring.

F. Color-code low-voltage building and power wire as follows:

PHASE	240/120 VOLTS	208/120 VOLTS	240 VOLTS
Phase A	Black	Black	Black
Phase B	Red	Red	Red (Orange for high leg of Delta system)
Phase C	---	Blue	Blue
Neutral	White	White	White
Ground	Green	Green	Green
OTHER WIRING			
Control	Red (and see below)		
PLC (Field)	Purple		
PLC (Neutral)	White or Purple w/ White Stripe		
+24VDC	Blue		
-24VDC	Blue w/ White Stripe		
Instrument Signal Wiring	+White		
	-Black		
Wires energized by sources external to control panels	Yellow		

1. Phases A, B, and C denote direction of positive phase rotation.

G. Control wires shall have colored insulation.

1. Provide separate color codes for each wire in each conduit that has ≤ 7 wires.
2. Conduits with >7 wires shall have ≥ 7 types of colored insulation.

H. Refer to individual cable type specifications for color coding of multiconductor control and instrumentation cable.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install conductors and cables before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install conductors and cables at locations shown on Plans and Submittals.
- C. Conform to the following installation standards:
 - 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 - 2. Other applicable OSHA and Cal OSHA regulations
 - 3. California Electrical Code Article 300 "Wiring Methods"
 - 4. California Electrical Code Article 310 "Conductors for General Wiring"
 - 5. California Electrical Code Article 320 "Armored Cable: Type AC"
 - 6. California Electrical Code Article 334 "Nonmetallic Sheathed Cable: Types NM, NMC, and NMS"
 - 7. California Electrical Code Article 336 "Power and Control Tray Cable: Type TC"
 - 8. California Electrical Code Article 340 "Underground Feeder and Branch-Circuit Cable: Type UF"
 - 9. California Electrical Code Article 400 "Flexible Cords and Cables"
 - 10. California Electrical Code Article 402 "Fixture Wires"
 - 11. Other applicable building, fire and electrical code requirements
 - 12. NETA (National Electrical Testing Association) ATS standards
 - a. NETA ATS 7.3.2 for low-voltage cable inspections and tests.
 - 13. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Tag control wires and instrument cables at terminations and visible and accessible locations in maintenance holes, hand-holes, panels, switchboards, pull boxes, terminal boxes, and at control device.
 - 1. Tag power wires in pull boxes or similar structures where there is more than 1 circuit.
- F. Tags shall conform to the following:
 - 1. Tag wires within $\leq 2"$ of termination at each device and terminal board.
 - 2. Tag both ends of wires $\geq 12"$ long.
 - 3. Do not use tags relying on adhesives or taped-on markers.
 - 4. Provide conductor tags for conductors $\leq \#12\text{AWG}$ with legible permanent sleeve of yellow or white PVC with machine printed black marking.
 - 5. Provide tags for cables, and for conductors $\geq \#10\text{AWG}$, consisting of permanent nylon marker plates with legible designations hot stamped on plate.
 - a. Attach these marker plates to conductors and cables with nylon tie cord.
 - 6. Position wire markers to be readily visible for inspection.

G. Assign tag numbers as follows:

1. Identify power and control conductors at each termination and at all accessible locations including maintenance holes, handholes, panels, switchboards, pull boxes and terminal boxes.
2. Tag numbers for conductors shall follow 3-segment numbering scheme, defining origin of conductor, function of conductor, and destination of conductor.
 - a. For example: MCCA-P-MCCB shows MCCA is origin, P is function identification (P=power, L=lighting or receptacle, C=control, S=signal, etc.), and MCCB is destination.
3. Where Plans, Shop Drawings, or interconnection diagrams show circuit numbers or where conductors have multiple destinations, append circuit numbers or identifiers to letters showing function of conductor, eg PA, PB.
4. Make origin and destination identification the specific names of equipment or instruments used on Plans

H. Install Conductor Arc and Fireproofing Tapes as Follows:

1. Wrap together single conductors and cables in maintenance holes, handholes, vaults, cable trays, and other indicated locations using arc and fireproofing tapes.
 - a. Wrap all conductors entering from each conduit together as 1 cable.
2. Follow tape Manufacturer's Installation Instructions.
3. Throughout their exposed length, bundle and secure arc and fireproofing tape at intervals $\leq 18"$ on centers with nylon, self-locking, releasable, cable ties or bands of specified glass cloth electrical tape.
 - a. Make each band of ≥ 2 wraps of tape directly over each other.
4. Wrap together as far as possible, conductors carrying phases A, B, and C of same feeder.
 - a. Do not wrap together conductors carrying only 2 of 3 phases.
5. Train cables as closely as possible to their final positions.
6. Clean cables of oil, grease, and cable pulling compounds, using suitable solvents and cleaners non-injurious to cable, and then wipe dry.
7. Cover projecting surfaces such as fittings, ground connectors or bonding connections with insulating compound to present smooth continuous surface for taping.
8. Fireproofing tape shall be 3" width half-lapped and extend $\geq 6"$ into raceway.
 - a. Use $\frac{3}{4}"$ glass tape at 3' intervals to hold tape in place.

I. Install wiring within raceways unless otherwise shown.

1. Do not combine feeder, branch, control, and instrumentation circuits in same raceway, cable tray, junction or pull box, except:
 - a. Where shown in Contract Documents
 - b. Where field conditions dictate and where written acceptance is obtained from City's Representative.
2. Isolate control circuits from feeder and branch power circuits and from instrumentation circuits.
 - a. 12VDC, 24VDC, and 48VDC control circuits may be combined.
 - b. Isolate AC control circuits from DC control circuits.
 - c. Isolate 125 VDC control circuits from all other AC and DC circuits.
3. Isolate instrumentation circuits from feeder and branch power circuits and from control circuits.
 - a. Isolate analog and digital instrumentation circuits.
 - b. Analog instrumentation signal circuits may be combined.

- c. Digital instrumentation signal circuits may be combined.
- 4. Multiple branch circuits for lighting, receptacle, and other 120VAC circuits may be combined into a common raceway.
 - a. If circuits are combined, upsize raceway as required by NEC for size and quantity of conductors.
 - b. If circuits are combined, upsize conductor sizes as required by NEC for ampacity deratings for number of conductors in raceway.
 - c. Neutral conductors may not be shared.
- J. Pull cables and conductors into place as follows:
 - 1. Do not install conductors or cables in conduits, ducts or trays until raceway system is completed.
 - 2. Size raceways to accommodate number and size of cables shown in accordance with NEC Article 300.
 - 3. Immediately prior to placement of each cable or cable group, inspect raceway route to be followed and verify installation is complete and free of materials detrimental to cable or its placement.
 - a. Brush, scrape, or swab embedded or buried conduits and ducts before pulling in conductors.
 - 4. Do not damage conductors or insulation.
 - a. Handle conductors carefully to avoid kinks or insulation damage.
 - b. Do not pull cables tight against bushings nor press cables heavily against enclosures.
 - 5. If during Work progress, raceways appear inadequate to accommodate assigned cable, notify City's Representative and discontinue further Work within questionable raceway until advised by City's Representative on how to proceed.
 - 6. Group cables assigned to each conduit and pull in simultaneously, using cable grips and UL-accepted lubricants compatible with insulation.
 - 7. Check size and length of cables before pulling into conduits.
 - 8. Install shielded instrumentation wire from terminal to terminal with no splicing at intermediate points.
 - a. Remove cable pulled into wrong conduit or cut too short and replace at no additional cost to City.
 - b. Do not reuse cable removed from 1 conduit or duct without permission from City's Representative.
 - 9. Where pulling compound is used, use UL-listed compound acceptable to cable Manufacturer and compatible with cable outer jacket or insulation and with raceway involved.
 - 10. Accomplish fishing and pulling with flexible round metal or non-metallic tape, carbon dioxide or forced air propelled polyethylene cord, nylon rope, or manila rope.
 - a. Use woven wire cable grips to pull single conductor cable, #2/0AWG and larger, and multiconductor cable.
 - b. Use pulling loops to pull single conductor cable smaller than #2/0AWG.
 - c. Use only those pulling mechanisms of both manual and power types with rated capacity in tons clearly marked on mechanism.
 - d. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
 - e. Do not use vehicles to pull conductors.

- f. If pulling mechanism capacity exceeds recommended pulling tension of cable as given by cable Manufacturer, provide dynamometer to monitor cable tension, and observe indicator throughout pulling.
 - g. If excessive strain develops, stop pulling operation, determine difficulty, and make corrections.
 - h. When cable grip is used for pulling, cut off area of cable covered by grip plus 6" and discard.
- 11. Leave spare conductors at their maximum length for possible use as replacements.
 - a. Coil each spare conductor neatly and then tape to conductors being used.
- K. Install low-voltage (600VAC) building wire and power wire as follows:
 - 1. Install wiring and cable in conduit and terminate unless otherwise noted.
 - 2. To reduce pulling tension in long runs, coat wires and cables with pulling compound recommended by wire or cable Manufacturer before pulling into conduits.
 - 3. Remove debris and moisture from conduits, boxes, and cabinets prior to wire or cable installation.
 - 4. Install wires and cables in each voltage classification in separate raceways and completely isolate at cable and wire terminations.
 - 5. Group conductors #1/0 AWG and smaller in panelboards, cabinets, pull boxes, and switchboard wireways.
 - a. Tie with plastic ties, and fan out to terminals.
 - 6. Do not insulate soldered mechanical joints with tape.
 - 7. Vinyl plastic insulating tape for wire and cable splices and terminations and for color coding shall be flame retardant, rated for $\geq 90^{\circ}\text{C}$, conforming to UL510.
 - a. Use tape ≥ 7 -mil thick for $\leq \#8\text{AWG}$ size wire.
 - b. Use tape ≥ 8.5 -mil thick for outdoor or cold-weather applications for $\leq \#8\text{AWG}$ size wire
 - c. Use tape ≥ 10 -mil thick for $\geq \#6\text{AWG}$ size wire.
 - 8. Arrange wiring in cabinets, panels, and motor control centers neatly, cut to proper length, remove surplus wire, and bridle and secure in acceptable manner.
 - a. Identify circuits entering motor control centers or other control cabinets in accordance with conductor identification system specified.
 - 9. Cap spare conductors and conductors not terminated with UL-listed end caps.
 - 10. Where conductors pass through holes or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect conductors.
 - 11. For conductors to be connected by others, provide $\geq 6'$ spare conductor in freestanding panels and $\geq 2'$ spare in other assemblies.
 - a. Provide more spare conductor in assemblies where it is obvious more conductor will be needed to reach termination point.

L. Splice low-voltage (600VAC) cable and building wire as follows:

1. Splices shall be as follows using connectors listed under Acceptable Manufacturers.

FEEDER AND POWER BRANCH CIRCUITS		
Location	Wire Size	Type of Splice or Termination
Device Outlet Boxes	≤#10AWG	Use twist/screw-on-type connectors or crimp connectors with tools by same Manufacturer or UL listed for connector
	≤#8AWG	Use twist/screw-on-type connectors
Junction and Pull Boxes and Wireways	≤#10AWG	Use twist/screw-on-type connectors or crimp connectors with tools by same Manufacturer or UL listed for connector
	≤#8AWG	Use twist/screw-on-type connectors
	≥#6AWG	Use compression sleeve, mechanical screw or terminal block, or terminal strip-type connectors. Stagger sleeves to minimize completed splice diameter Cover sleeves with Thermofit insulation sleeve, extending ≥3 wire diameters beyond each end of compression sleeve after shrinking. Heat source and shrinking techniques shall conform to Manufacturer's Installation instructions.
Motor Terminal Boxes	≤#10AWG	Use twist/screw-on-type connectors or crimp connectors with tools by same Manufacturer or UL listed for connector
	≥#8AWG	Use insulated mechanical screw-type connectors
Manholes or Handholes	≤#8AWG	Use twist/screw-on-type connectors pre-filled with epoxy
	≥#6AWG	Use watertight compression sleeve or mechanical screw-type connectors
CONTROL CIRCUITS		
Junction and Pull Boxes	≤#8AWG	Use terminal-block-type connector
Manholes or Handholes	≤#8AWG	Use twist/screw-on-type connectors pre-filled with epoxy
Control Panels or Motor Control Centers	≤#8AWG	Use terminal block or strips provided within equipment or field-installed within equipment by Contractor.
INSTRUMENTATION CIRCUITS		
May be spliced where field conditions dictate and written permission is obtained from City's Representative. Maintain electrical continuity of shields when splicing twisted shielded conductors.		
Junction and Pull Boxes	≤#10AWG	Use terminal-block-type connector
Control Panels or Motor Control Centers	≤#10AWG	Use terminal block or strips provided within equipment or field-installed within equipment by Contractor.

2. Retighten bolt-type connectors 24-48 hours after initial installation and before taping.
- a. Tape connections made with non-insulated-type connectors with rubber-type tape, 1½ times thickness of conductor insulation, then cover with Scotch 33 tape.
3. Do not splice wires in underground handholes or pull boxes unless shown on Plans.
- a. Seal splices in underground handholes and pull boxes and in light poles with individual sealing packs of Scotchcast Brand 400 Resin or equal.

M. Terminate low-voltage (600VAC) wires as follows:

1. Terminate wires and cables at each end.
2. Do not splice feeders without written acceptance from City's Representative.
3. Provide terminals and connectors acceptable for material type used.
4. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal Manufacturer's Installation Instructions.
 - a. Where terminals provided will accept such lugs, terminate control and instrumentation wiring (except solid thermocouple leads) with insulated, locking-fork compression lugs
5. Install compression-type lugs or connectors with specially-designed hydraulic or mechanical tool conforming to Manufacturer's Installation Instructions to ensure permanent, secure, high-conductivity joint.
 - a. Tooling shall provide complete, controlled crimp where tool will not release until crimp is complete.

- b. Do not use plier-type crimpers.
 - 6. Provide color-coded system on terminal and die sets to provide correct number and location of crimps.
 - a. Permanent die index number shall be embossed on completed crimp for inspection purposes.
 - 7. For terminals designed to accept only bare wire compression terminations, use only stranded wire.
 - a. Terminate only 1 wire per terminal.
 - b. Tighten terminal screws with torque screwdriver to recommended torque values.
 - 8. Tighten screws and terminal bolts using torque-type wrenches and/or drivers to tighten to inch-pound requirements of Manufacturer, NEC, and UL.
 - 9. Lace control leads between conduit ends and terminal blocks located in control panels, cabinets and similar locations neatly together with non-releasing nylon ties.
- N. Install instrument cables as follows:
- 1. Do not splice instrument cables without permission of City's Representative.
 - a. Cables shall be continuous from device to RTU unless shown otherwise on Plans.
 - 2. Cable splices shall be made by qualified cable splicers following Manufacturer's recommendations.
 - 3. Locate splices, when permitted, only in readily accessible cabinets or junction boxes using terminal strips.
 - a. Splices will only be permitted where proven necessary by accepted pulling tension calculations.
 - 4. Where connections of cables are to be made for instrumentation and control cables, leave pigtails of adequate length for neat, bundled type connections.
 - 5. Maintain integrity of shielding of instrumentation cables.
 - a. Ensure grounds do not occur because of damage to jacket over shield.
 - 6. Seal cables entering maintenance holes, hand-holes or vaults using accepted expanding foam product.
 - 7. Ground drain wire of shielded instrumentation cables at source terminal strip end only.
 - a. Preferred grounding location is at load (eg control panel), not at source (eg field-mounted instrument).
 - 8. Use small piece of heat-shrink tube or signal wiring to cover area where outer cable jacket is cut to expose inner conductors.

3.3 Field Quality Control

- A. Refer to Section 26 08 00 for field testing requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of grounding and bonding conforming to CEC and NEC Article 250.
- B. Refer to Section 26 05 19 for wiring requirements.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 26 05 10: Common Work Results for Electrical
- I. Section 26 05 19: Low-Voltage Electrical Power Conductors and Cables
- J. Section 26 05 33: Raceway and Boxes for Electrical Systems
- K. Section 26 08 00: Commissioning of Electrical Systems
- L. Section 31 23 00: Excavation and Fill

1.3 System Description

- A. Furnish and install complete operating grounding and bonding including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.
- B. System shall bond and ground exposed non-energized metal surfaces containing energized devices, parts, or conductors, building steel, other metals, metallic electrical raceways, and neutrals of transformers and generators.
 - 1. Assure ground continuity is continuous throughout Work.

1.4 Quality Assurance

- A. Use adequate number of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Furnished equipment shall be UL listed and labeled.
- C. Work shall conform to applicable requirements of NEC and Cal OSHA Title 8.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 - 2. California Building Code (CBC)
 - 3. California Electrical Code (CEC)
 - 4. California Plumbing Code (CPC)
 - 5. IEEE 81 Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of Ground System
 - 6. IEEE 142 Grounding of Industrial and Commercial Power Systems
 - 7. IEEE 837 Qualifying Permanent Connections Used in Substation Grounding
 - 8. NEMA/ANSI GR1 Ground Rod Electrodes and Ground Rod Electrode Couplings

9. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
10. NFPA 70 National Electric Code (NEC)
11. UL 467 Safety Standard for Grounding and Bonding Equipment

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS AND PART SCHEDULES		
Shop Drawings	Submit per equipment Shop Drawing requirements.	.
Material List	Submit list of grounding materials and equipment. Show size, material and manufacturer.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for the following per Product Data requirements: 1. Exothermic welding materials 2. Terminal lugs and clamps 3. Copper grounding cable 4. Ground rods 5. Ground connection hardware	
Installation Instructions	Submit per Installation Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Field Test Procedures	Include list of test equipment to be used.	
CLOSEOUT SUBMITTALS		
Field Test Record Transcripts	Indicate overall resistance to ground, resistance of each electrode, and plot of resistance vs distance from grid.	
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, and Test Record Transcripts.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of grounding and bonding equipment.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Concrete Grounding Wire Boxes and Cover	Brooks Products	Ontario, CA (909) 947-7470
	Eisel Enterprises, Inc.	Placentia, CA (714) 993-1706
	J&R Concrete Products #10-R	Perris, CA (951) 943-5855
	Accepted equal	
Grounding Rods and Connectors	Burndy® Corporation	Manchester, NH (800) 346-4175
	Erico/ Pentair "Eritech"	Solon, OH (440) 349-2630
	Harger Lighting and Grounding	Grayslake, IL (800) 842-7437
	Henry Brothers	Springville, NY (716) 941-6141
	Jocelyn Forge, Inc.	Bulacan, PHI (632) 984-8582
	Lyncole Grounding Solutions/ VFC XIT®	Torrance, CA (310) 214-4000
	Robbins Lightning Protection	Maryville, MO (800) 426-3792
	Thomas & Betts (Blackburn) / ABB	Memphis, TN (800) 888-0211
	Thompson Lightning Protection, Inc.	Saint Paul, MN (800) 777-1230
	Accepted equal	

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Exothermic Weld Equipment	Erico / Pentair Cadweld Electrical Products	Solon, OH (440) 349-2630
	Furseweld	Torrance, CA (310) 214-4000
	Harger Lighting and Grounding Ultraweld	Grayslake, IL (847) 548-8700
	ThermOweld / Continental Industries	Tulsa, OK (800) 558-1373
	Accepted equal	

- B. Molds, cartridges, powder, and accessories for exothermic welds shall be furnished by same Manufacturer.

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.

- B. Materials for grounding and bonding shall be:

ITEM	MATERIAL	SPECIFICATION
Grounding Conductors	Insulated Copper	Refer to Section 26 05 19. Color-coded to code requirements.
Conduit		Refer to Section 26 05 33.
Bonding Jumpers	Multiple-Circuit Lighting Systems	#6AWG Cross-sectional areas of jumper shall match cross-sectional area of conductors in circuit
	Series and Other Lighting Systems	#8AWG or larger Cross-sectional areas of jumper shall match cross-sectional area of conductors in circuit
Main Ground Conductor Loop when Exposed within Buildings	Copper	Minimum ¼" x 1" rectangular bar ground bus supported with suitable spacers at ½"-1" from structure
Grounding System Bond to Piping	Copper	Connect to 1 st pipe flange inside structure on either suction or discharge pipe using copper bar or strap and drilling and tapping flange to provide bolted connection
Ground Connection Hardware, Bolts, and Nuts	High-Strength High-Conductivity Copper Alloy	
Ground Rods	Copper-Clad Steel	UL listed Conform to ANSI/NEMA GR1 ¾" diameter nominal ≥10' long ≥80,000 psi tensile strength ≥10 mil Cu plating With hardened steel points Provide heavy uniform coating of electrolytic copper molecularly bonded to rigid steel core. Hard drawn for scar-resistant surface.
Connections – Ground Clamps or Lugs, Connectors and Terminals – Mechanical Type	Copper	Conform to UL 467
Connections – Ground Clamps, Connectors and Terminals – Compression Type Suitable for Direct Burial in Earth or Concrete	Bronze	High Copper Alloy Content Conform to UL 467 Conform to IEEE 837 Non-Reversible
Connections – Ground Clamps, Connectors and Terminals – Compression Type for Interior Locations	Bronze	High Copper Alloy Content Conform to UL 467 Non-Reversible Provide 2 bolt holes for terminals for connection to bus bars
Connections – Ground Clamps, Connectors and Terminals – Compression Type Suitable for Direct Burial in Earth or Concrete	Bronze	High Copper Alloy Content Conform to UL 467 Conform to IEEE 837 Non-Reversible
Exothermic Weld Connections	Copper oxide	Properly size molds for application.

ITEM	MATERIAL	SPECIFICATION
	reduction by aluminum process	
Above-Grade Outdoor Connectors	Exothermic Weld, Compression, or Brazed Type	Of proper size for conductors and ground rods specified
Below-Grade Connectors	Exothermic Weld Type	Of proper size for conductors and ground rods specified.
Bare Copper Conductor and Bus Splice Protection	Heat-Shrink Tape or Sleeve	
Grounding Wire Boxes	Precast Concrete	H25-rated
Grounding Wire Box Cover	Cast Iron	13-lbm minimum Embossed "GROUND"

C. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
	Noncurrent-Carrying Metal Parts	25Ω
	All other Grounds	25Ω

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install grounding and bonding before submitting shop drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Examine areas and conditions under which Work of this section will be performed.
 1. Correct conditions detrimental to timely and proper completion of Work.
- C. Coordinate installation of embedded ground cables with concrete Work.
- D. Remove paint, rust, or other nonconducting material from contact surfaces before making ground connections.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Refer to Section 31 23 00 for open trench requirements.
- C. Furnish and install grounding and bonding at locations shown on Plans and Submittals.
- D. Install grounds in presence of City's Representative.
- E. Conform to the following installation standards:
 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders.
 2. Other applicable OSHA and Cal OSHA regulations.
 3. California Electrical Code Article 250 "Grounding and Bonding".
 4. NFPA 70 National Electric Code (NEC)
 5. Other applicable building, fire, plumbing, mechanical and electrical code requirements.
 6. NETA (National Electrical Testing Association) ATS standards
 - a. NETA ATS 7.13 for grounding inspections and tests.
 - b. NETA ATS 7.14 for ground fault protection inspections and tests.
 7. Manufacturer's installation and warranty requirements.
- F. Refer variances between above documents and Contract Documents to City's Representative.

G. The following shall be grounded:

1. Handhole and maintenance hole exposed metal covers
2. Handrails
3. Motors
4. Pumps
5. Casings
6. Magnetic flow meters
7. Process equipment with exposed metal parts
8. Exposed non-current-carrying metallic parts of electrical equipment.
9. Raceways and neutral of wiring systems.
10. Neutrals of transformers.
11. Metal sheathing and exposed metal vertical structural elements of buildings.
12. Metal fences enclosing electrical equipment.
13. Metal equipment platforms supporting electrical equipment. (Bond platform to equipment.)
14. Bond metal frames and railings supporting pushbutton stations, receptacles, instrument cabinets to raceways carrying circuits to these devices.
15. Exposed metallic equipment that may contact electrical equipment due to close proximity.

H. Ground both ends of conduit where possible.

I. Install ground electrode as follows:

1. Construct grounding system at each structure where panels or other electrical equipment are installed.
2. Install ground rods and grounding conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and ground conductors.
3. Drive ground rods and install grounding conductors prior to constructing concrete slabs and duct banks.
 - a. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.

J. Bond and ground raceways as follows:

1. Install metallic conduit so it is electrically continuous.
2. Conduits shall contain grounding conductor with insulation identical to phase conductors, unless otherwise shown.
3. NEC-required grounding bushings shall be of insulating type.
4. Provide double locknuts at panels.
5. Bond conduit, at entrance and exit of equipment, to equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make metallic raceway fittings and ground clamps tight to ensure equipment grounding system operates continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.
8. Ground raceways and non-current carrying parts of electrical equipment in accordance with NEC Article 250.

K. Connect conductors to grounding rod as follows:

1. Exothermic T or H splices will be permitted at ground rods and where required.
 - a. Splices shall be inspected by City's Representative.

2. Provide exothermic welds or compression type connectors between grounding cable installed for building ground grid and each ground electrode in ground grid system.
 - a. Do not use exothermic welding if it will damage structure grounding conductor is being welded to.
3. Install grounding cable near base of structures in undisturbed, firm earth and as far from structure as excavation permits and $\geq 18"$.
4. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
5. Extend pigtail conductors at structures or risers 6' above finished grade.
6. Protect pigtail conductors from damage by coiling, tying, and bagging in 10-mil polyethylene.
7. Backfill excavation completely, tamping to provide contact between backfill materials and ground rods and conductors.
8. Extend grounding conductors through concrete foundations or building walls within 3' below finish grade
 - a. Where ground conductors penetrate floor slabs or building walls provide non-metallic water-stop sleeves.
9. Extend grounding conductors within structures to accessible points for grounding equipment and electrical enclosures.
10. For isolated well sites, construct bare copper ground wire from MCC ground bus to well casing as shown.
11. Construct concrete-encased bare ground conductor in each duct bank.
 - a. Run grounding electrode system conductors continuously in duct banks, through maintenance holes, handholes, raceway boxes and cable tray exteriors.
 - b. Connect conductors to structure ground ring or grounding system to provide continuous grounding electrode system.
 - c. Bond to metal lid or cover.
12. Bond electrical enclosures, pedestals, and support racks, including metallic raceways, panels, switchboards and other similar metallic panels, cases, and devices associated with power, instrumentation, and control systems to grounding electrode system.
 - a. Connect using $\geq \#6$ AWG bare copper conductor to ground
 - b. Connect metal light or utility poles to ground rod using $\geq \#6$ AWG bare copper conductor.
13. Extend both ends of loop to ground bus within main service switchboard or motor control centers as appropriate.
14. Buried or concealed joints or terminations are not permitted.
15. Protect wires with rigid steel conduit or Schedule 40 PVC conduit where exposed wires stub up through slab at switchboard or motor control centers.
- L. Where grounding conductors are shown, bond wires to metallic enclosures at each end and to intermediate metallic enclosures.
 1. Provide ground rod, when shown or when needed in each electrical maintenance hole and handhole with exposed metal parts.
 - a. Expose $\geq 4"$ of rod above floor for field connections to rod.
 - b. Connect exposed metal parts including conduits and cable racks to ground rod.
 2. Bond ground cables in underground circuits with main ground cables in each electrical maintenance hole and handhole.
 3. Ground maintenance hole hardware and cover.
 4. Connect grounding conductors to all grounding bushings on raceways.

5. Run ground conductors inside conduits enclosing power conductors.
 6. Buried or concealed joints or terminations are not permitted.
 7. Protect wires with rigid steel conduit where wires stub up through slab at switchboard or motor control centers.
 8. Protect exposed splices and connections for bare copper conductors and buses by wrapping with heat-shrink tape or covering.
- M. Make connections to enclosures not provided with ground buses or ground terminals using clamp type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures other than explosion proof, or by grounding locknuts or bushings.
1. Do not connect ground cables to anchor bolts, against gaskets, paint, or varnish, or to bolts holding removable access covers.
- N. Ground shields of shielded power cable at each splice or termination in accordance with recommendations of splice or termination Manufacturer.
- O. Ground shields of control cables in accordance with details shown.
- P. Ground equipment as follows:
1. Connect ground buses of lighting panels, distribution panels, switchboards, motor control centers and switchgear to common ground bus with grounding conductor.
 2. Use metallic conduit system for equipment and enclosure grounding.
 - a. Grounding through conduit system shall be in excess of ground conductors shown in Plans.
 3. Provide liquid-tight flexible conduits with separate equipment grounding conductors sized per NEC.
 4. Where equipment contains ground bus, extend and connect grounding conductors to that bus.
 5. Form equipment ground conductors to contour of equipment and firmly support.
 6. Run ground conductors to equipment neatly along face of concrete surfaces or structural steel.
 - a. Support and secure ground conductors with cable fasteners at $\leq 5'$ intervals.
 7. Bond equipment grounding conductor to approved grounding bushing and terminal lug.
 - a. Install grounding conductor outside conduit if required size is $> \#10$.
 8. Connect equipment enclosure containing ground bus to that bus.
 9. Construct grounding bushings at both ends of rigid conduit runs.
 - a. Bond grounding bushings to grounding system.
 10. Run conductors to equipment neatly along face of concrete surfaces or structural steel.
 11. Support and secure conductors with cable fasteners at $\leq 5'$ intervals.
- Q. Install ground test well as follows:
1. Provide handhole and ground rod as detailed on Plans to aid in performing ground testing and connecting additional ground rods if required by test results.
 2. Connect ground wire from ground rod to main service switchboard or motor control center ground bus as shown on Plans.
- R. Obtain City's written approval of each below-grade connection before backfilling.
1. After installation and inspection, backfill trench with earth and other low resistivity materials.
 2. Exclude stones, gravel, or crushed rock.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Grounding and Bonding	Installation	Visual inspection and testing of finished grounding installation per NETA ATS 7.13 Notify City's Representative 24 hours before below-grade connections are ready for inspection.	1 inspection	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of conduit, raceway, boxes and fittings to contain conductors for electrical power, communications, control circuits and feeders for Work outside public right-of-way.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 01 73 33 for identification procedures for above-ground raceways.
 - 2. Section 03 30 00 for procedures for concrete encasement.
 - 3. Section 31 23 00 for trenching procedures.
 - 4. Section 33 05 26 for identification procedures for buried raceways.
 - 5. Section 33 05 38 for requirements for hangers and supports.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 33: Mechanical Identification
- I. Section 03 15 00: Concrete Accessories
- J. Section 03 30 00: Cast-in-Place Concrete
- K. Section 09 90 00: Painting and Coating
- L. Section 26 05 10: Common Work Results for Electrical
- M. Section 26 05 19: Low-Voltage Electrical Power Conductors and Cables
- N. Section 26 05 26: Grounding and Bonding for Electrical Systems
- O. Section 26 08 00: Commissioning of Electrical Systems
- P. Section 31 23 00: Excavation and Fill
- Q. Section 33 05 26: Utility Identification
- R. Section 33 05 38: Hangers and Supports

1.3 System Description

- A. Furnish and install raceway and boxes as shown on Plans and as required by CEC to deliver power to equipment furnished.
 - 1. Include appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable codes and standards.

1.4 Quality Assurance

- A. Use adequate number of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Raceway, Conduit, Fittings and Boxes	NEMA Compliance	NEMA Standards	All products furnished	Contractor	Contractor
	UL Compliance	Products shall be UL listed and UL labeled	All products furnished	Contractor	Contractor

1.5 References**A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.**

1. AASHTO Standard Specifications for Highway Bridges
2. ANSI C33.84 Safety Standards for Outlet Boxes and Fittings
3. ANSI 61
4. ANSI C80.1/UL6 Electrical Rigid Steel Conduit (ERSC)
5. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
6. ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
7. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
8. ASTM A536 Ductile Iron Castings
9. ASTM A1008 Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
10. ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength ASTM B63 Electrodeposited Coatings of Zinc on Iron and Steel
11. ASTM D1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
12. ASTM D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping
13. ASTM D2855 Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
14. ASTM F512 Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
15. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
16. California Building Code (CBC)
17. California Electrical Code (CEC)
18. California Fire Code (CFC)
19. California Plumbing Code (CPC)
20. Federal Specification WW-C-581E Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple,
21. IEEE C2 National Electric Safety Code (NESC)
22. NEMA 5-19-1986
23. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
24. NEMA FB1 Conduit Fitting, Cables Fittings and Accessories
25. NEMA/ANSI OS1 Sheet-Steel Outlet Boxes, Devices, Covers, and Box Supports
26. NEMA RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
27. NEMA TC2 Electrical Polyvinyl Chloride (PVC) Conduit
28. NEMA TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
29. NEMA TC6 and TC8 Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
30. NEMA VE1 Ventilated Cable Tray
31. NFPA 70 National Electric Code (NEC)
32. Society of Cable Telecommunications Engineers SCTE 77 Underground Enclosure Integrity
33. UL 1 Flexible Metal Conduit
34. UL 6/ANSI C80.1 Electrical Rigid Metal Conduit – Steel (ERSC)
35. UL 6A Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
36. UL 35-L4
37. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations
38. UL 360 Liquid-Tight Flexible Steel Conduit
39. UL 467 Grounding and Bonding Equipment
40. UL 514A Metallic Outlet Boxes
41. UL 514B Conduit, Tubing, and Cable Fittings
42. UL 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
43. UL 651 Schedule 40 and 80 Rigid PVC Conduit

- 44. UL 651A Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit
- 45. UL 870 Wireways, Auxiliary Gutters, and Associated Fittings
- 46. UL 884 Underfloor Raceways and Fittings
- 47. UL 886 Outlet Boxes and Fittings for use in Hazardous (Classified Locations)

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS AND PART SCHEDULES		
Shop Drawings	Submit conduit layout and installation drawings	
	Show individual conduit numbers, proposed routing, conduit sizes, circuit numbers contained in each conduit, and size of wires in each conduit.	
	Show dimensional size of pull and junction boxes to be used.	
	Verify conduit sizes meet NEC requirements.	
	City's review of layout drawings will be solely for aesthetics and Operator access.	
MANUFACTURER'S LITERATURE		
Product Data	Submit the following for items of standard manufacture:	
	Product Data for each type of conduit, fittings and boxes.	
	List of conduits, fittings, boxes, conduit boxes, mounting hardware, and accessories.	
	Product data is not required for conduit fittings or support systems	
QUALITY ASSURANCE AND CONTROL SUBMITTALS Refer to Section 26 05 10		
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, and Product Data.

1.7 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of raceway and boxes.
- C. Ship conduit with thread protectors.

1.8 Project Site Conditions

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers for conduit and raceways include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
CONDUIT FITTINGS		
Conduit Bodies	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton Form 8	Syracuse, NY (866) 764-5454
	Killark / Hubbell	Saint Louis, MO (314) 531-0460
	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506
	Thomas & Betts / ABB Ocal® (Occidental Coating Company)	Memphis, TN (800) 816-7809
	Accepted equal	
Conduit Fittings (Metal)	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Hubbell-Raco	South Bend, IN (800) 992-7030
	Killark / Hubbell	Saint Louis, MO (314) 531-0460
	Osburn Associates, Inc.	Saint Petersburg, FL (888) 672-8767
	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Robroy Industries	Gilmer, TX (903) 843-6562
	Steel City / ABB	Memphis, TN (800) 816-7809
	Thomas & Betts / ABB Ocal® (Occidental Coating Company)	Memphis, TN (800) 816-7809
	Accepted equal	
Conduit Fittings (PVC)	Atkore International (Allied Tube and Conduit)	Harvey, IL (800) 882-5543
	Carlson / Lamson & Session Co "PV-Duit"	Cleveland, OH (800) 346-2646
	Cantex Inc.	Fort Worth, TX (817) 215-7000
	SAF-T-CO Supply	Santa Ana, CA (714) 547-9975
	Accepted equal	
Conduit Hubs	Atkore International (Allied Tube and Conduit)	Harvey, IL (800) 882-5543
	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton Myers™	Syracuse, NY (866) 764-5454
	Hubbell-Raco	South Bend, IN (800) 992-7030
	Killark / Hubbell	Saint Louis, MO (314) 531-0460
	Thomas & Betts / ABB Ocal® Bullet Type	Memphis, TN (800) 816-7809
	Accepted equal	
Conduit Unions	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Thomas & Betts / ABB Ocal® Erickson Type	Memphis, TN (800) 816-7809
	Accepted equal	
Conduit Expansion-Deflection Couplings	Appleton / Emerson Type DF	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton Type XD	Syracuse, NY (866) 764-5454
	O-Z Gedney / Emerson Type AXDX	Rosemont, IL (800) 621-1506
	Accepted equal	
Flexible Couplings	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Killark / Hubbell	Saint Louis, MO (314) 531-0460
	Accepted equal	
CONDUIT ACCESSORIES		
Conduit Automatic Drains	Crouse Hinds / Eaton ECD	Syracuse, NY (866) 764-5454
	Accepted equal	
Conduit Clamps	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506
	Accepted equal	
Conduit Seals for Sealing Around Pipe or Conduit	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton "EYS" and "EYD"	Syracuse, NY (866) 764-5454
	O-Z Gedney / Emerson CSMI Type	Rosemont, IL (800) 621-1506
	Accepted equal	
Conduit Seal Bushings for Sealing Around Cables in Conduit	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	O-Z Gedney / Emerson CSB Type factory-prepared for each cable applicaiton	Rosemont, IL (800) 621-1506
	Accepted equal	
Locknuts	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506
	Accepted equal	
Bushings	Bridgeport Fittings, Inc.	Stratford, CT (203) 377-5944
	O-Z Gedney / Emerson Type B	Rosemont, IL (800) 621-1506
	Accepted equal	
Grounding Bushings	Bridgeport Fittings, Inc.	Stratford, CT (203) 377-5944
	O-Z Gedney / Emerson Type BLG	Rosemont, IL (800) 621-1506
	Accepted equal	
Phenolic Bushings for Protecting Cables Penetrating Metal Partitions or Barriers	O-Z Gedney / Emerson Type ABB	Rosemont, IL (800) 621-1506
	Accepted equal	
NEC TYPE RMC RIGID METAL CONDUIT (PVC-COATED)		

ITEM	MANUFACTURER	MANUFACTURER LOCATION
PVC-Coated NEC Type RMC Electrical Rigid Steel Conduit (PVC-ERSC) ½"-6"	Robroy Industries "KorKap"	Gilmer, TX (903) 843-6562
	Robroy Industries "Perma-Cote"	Gilmer, TX (903) 843-4388
	Thomas & Betts / ABB Ocal® (Occidental Coating Company)	Memphis, TN (800) 816-7809
	Accepted equal	
PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) and Fitting Coating Repair Material	Robroy Industries "Plastibond"	Gilmer, TX (903) 843-6562
	Accepted equal	
Electrical Rigid Steel Conduit (ERSC) Expansion Fittings for Exposed Locations	O-Z Gedney / Emerson Type "AX" with jumper	Rosemont, IL (800) 621-1506
	Accepted equal	
Electrical Rigid Steel Conduit (ERSC) Expansion Fittings at Structural Expansion Joints	Spring City Electrical Manufacturing Company Type "D"	Spring City, PA (610) 948-4000
	Accepted equal	
NEC TYPE PVC RIGID NONMETALLIC CONDUIT		
NEC Type PVC Rigid Nonmetallic Conduit (RNC) (PVC) and Fittings	Atkore International (Allied Tube and Conduit)	Harvey, IL (800) 882-5543
	Carlson / Lamson & Session Co "PV-Duit"	Cleveland, OH (800) 346-2646
	CertainTeed Corporation / Saint-Gobain	Corona, CA (951) 272-1300
	Cantex Inc	Fort Worth, TX (817) 215-7000
	Condux International	Rancho Cucamonga, CA (909) 989-4377
	Heritage Plastics	Carrollton, OH (330) 627-8002
	Highland Plastics, Inc.	Shepherd, MI (800) 866-8208
	JM Eagle Inc	Los Angeles, CA (310) 693-8200
	Kraloy® Products Co., Inc.	London, ON (800) 265-1815
	Osburn Associates, Inc	Saint Petersburg, FL (888) 672-8767
	PW Eagle	Eugene, OR (800) 347-0200
	Triangle Conduit & Cable	New Brunswick, NJ (412) 920-7190
	Accepted equal	
NEC TYPE LFMC AND TYPE LFNC LIQUIDTIGHT FLEXIBLE CONDUIT		
NEC Type LFMC Liquid-Tight Flexible Metal Conduit	AFC (American Flexible Conduit) Cable Systems® / Atkore International (Allied Tube and Conduit)	Harvey, IL (800) 882-5543
	Anamet Electrical Sealtite® / Anaconda	Mattoon, IL (800) 230-3718
	Electri-Flex Company Liqueatite® Type LA	Roselle, IL (800) 323-6174
	Flexible Metal Inc (FMI) / Hyspan	Tucker, GA (770) 493-1100
	General Electric Company	Fairfield, CT (203) 373-2211
	International Metal Hose Company	Bellevue, OH (419) 483-7690
	LTV Steel Company	Cleveland, OH (216) 622-5000
	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506
	Southwire Company "Titan®"	Carrollton, GA (770) 832-4000
	Thomas & Betts / ABB	Memphis, TN (800) 816-7809
	Triangle Industries PWC Line	New Brunswick, NJ (412) 920-7190
	Universal Hose & Braid.	South Holland, IL (888) 277-9927
	Accepted equal	
Liquid-Tight Flexible Metal Conduit Fittings	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Thomas & Betts / ABB sealing rings (5262 = ½" 5263 = ¾" 5264 = 1" or "Jake"	Memphis, TN (800) 816-7809
	Thomas & Betts / ABB Ocal® (Occidental Coating Company) Liquidtight	Memphis, TN (800) 816-7809
	Accepted equal	
Liquid-Tight Flexible Metallic Conduit	Appleton / Emerson "Series ST" or Jake Type "BC"	Rosemont, IL (800) 621-1506

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Connectors	Pyle-National / Hillcrest Enterprises Series "CT"	Ashland, VA (800) 848-3106
	Accepted equal	
NEC Type LFNC Liquid-Tight Flexible Non-Metallic Conduit	Ultratite® / Southwire Company	Carrollton, GA (770) 832-4000
	Accepted equal	
CONDUIT AND RACEWAY ACCESSORIES		
Plastic Wire Duct and Spiral Binding	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Accepted equal	
Wireway	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Accepted equal	
Conduit Hangers and Supports	Refer to Section 33 05 38.	
Duct Spacers and Supports	Atkore International (Allied Tube and Conduit)	Harvey, IL (800) 882-5543
	Carlson / Lamson & Session Co	Cleveland, OH (800) 346-2646
	George Fischer Sloane, Inc.	Little Rock, AR (501) 490-7777
	Queen City Plastics	Fort Mill, SC (803) 548-0685
	Accepted equal	
Conduit Through-Wall Seals	O-Z Gedney / Emerson Type "WDK"	Rosemont, IL (800) 621-1506
	Accepted equal	
Cable-Lubricating Compounds	CRC Industries Powerlube with Teflon	Horsham, PA (800) 556-5074
	Accepted equal	

B. Acceptable Manufacturers for boxes include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
OUTLET AND DEVICE BOXES		
Cast Steel (CS) Outlet and Device Boxes	Appleton / Emerson Type FD or FS	Rosemont, IL (800) 621-1506
	Bell Outdoor / Hubbell	South Bend, IN (574) 234-7151
	Crouse Hinds / Eaton / B-Line Condulet® Type FD or FS	Syracuse, NY (866) 764-5454
	Eaton / B-Line Circle AW	Highland, IL (800) 851-7415
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Hubbell Wiegmann	Santa Fe Springs, CA (714) 620-6300
	Killark / Hubbell	Saint Louis, MO (314) 531-0460
	Thomas & Betts / ABB	Memphis, TN (800) 816-7809
	Accepted equal	
Nonmetallic (NM) Outlet and Device Boxes	Carlson / Lamson & Session Co	Cleveland, OH (800) 346-2646
	George Fischer Sloane, Inc.	Little Rock, AR (501) 490-7777
	Accepted equal	
Galvanized Pressed Sheet Steel Switch and Outlet Boxes	Adalet / Scott Fetzer	Westlake, OH (440) 892-3000
	Hubbell-Raco	South Bend, IN (800) 992-7030
	O-Z Gedney / Emerson	Rosemont, IL (800) 621-1506
	Accepted equal	
Galvanized Sheet Steel Outlet Boxes	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Accepted equal	
JUNCTION AND PULL BOXES		
Cast Steel Embedded Pull Boxes Above Grade	Crouse Hinds / Eaton Series W	Syracuse, NY (866) 764-5454
	O-Z Gedney / Emerson Series Y	Rosemont, IL (800) 621-1506
	Accepted equal	
Cast Steel Embedded Pull Boxes Below Grade	Crouse Hinds / Eaton Type WJBF	Syracuse, NY (866) 764-5454
	O-Z Gedney / Emerson Series YR	Rosemont, IL (800) 621-1506
	Accepted equal	
Nonmetallic Pull Boxes	Crouse Hinds / Eaton Type NJB	Syracuse, NY (866) 764-5454
	Accepted equal	
Fasteners	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Accepted equal	
Fiberglass and	Armorcast Products Company	Ontario, CA (909) 390-1365

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Composite Polymer-Concrete Hand-Holes	Carson Industries H Series	Glendora, CA (909) 592-6272
	J & R Concrete Products	Perris, CA (951) 943-5855
	Accepted Equal	
Precast Concrete Hand-Holes	Brooks Products 3½T	Ontario, CA (909) 947-7470
	Eisel Enterprises, Inc.	Placentia, CA (714) 993-1706
	Ford Meter Box Co.	Wabash, IN (260) 563-3171
	Jensen Precast	Sparks, NV (775) 352-2700
	J & R Concrete Products	Perris, CA (951) 943-5855
	Oldcastle Precast (formerly Utility Vault Company)	Fontana, CA (800) 626-3860
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Do not use aluminum conduits, fittings, elbows, supports or boxes.
- C. Mark raceway products to show:
 1. Nominal trade size.
 2. Name or trademark of Manufacturer.
- D. Materials for NEC Type RMC PVC-coated Electrical Rigid Steel Conduit (PVC-ERSC) and fittings shall be:

ITEM	MATERIAL	SPECIFICATION
PVC-COATED ELECTRICAL RIGID STEEL CONDUIT (PVC-ERSC)		
PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) and Fittings	Hot-Dipped Galvanized Steel	Conform to UL6/ANSI C80.1 Conform to NEMA RN1 Conform to CEC Article 344
Finish	Zinc with Epoxy Primer and PVC Coating	Conduit shall be bendable without coating damage. See below for PVC final coating and urethane final lining
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153 Conduits shall be hot-dipped galvanized after threading Treat zinc surface to enhance metal-plastic bond
	Epoxy-Acrylic Primer	Provide 0.5-mil thick coating over steel surface to ensure bond between steel exterior and PVC coating Apply exterior coat by dipping in liquid plastisol or equal method producing finished product conforming to NEMA 5-19
Exterior Coating	PVC	40-mil thick for full conduit length except threads. Bond between PVC and conduit surface shall exceed tensile strength of plastic. Provide 2-mil clear urethane coating to threads.
Interior Lining	Urethane	≥2-mil thick on conduit and fittings Sufficiently flexible to permit conduit bending without coating cracking or flaking.
	PVC Sleeve on Female Opening	40-mil PVC coat extending 1 conduit diameter or 2" beyond opening, whichever is less. Sleeve interior diameter shall be same as conduit OD before coating.
CONDUIT FITTINGS		
Conduit Bodies (Ells and Tees)	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Provide types, shapes, and sizes to suit individual applications. Oblong Provide threaded hubs.
		Standard and Mogul type When fittings are used with #2AWG or larger multi-conductor cables, fittings shall be Mogul type
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Conduit Body Covers (Ells and	Same Material as	Form 8 secured with ≥2 captive stainless steel screws

ITEM	MATERIAL	SPECIFICATION
Tees)	Conduit Bodies	With tongue-in-groove (V-seal) gasket to seal out corrosive elements.
Conduit Bodies (Round)	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Provide types, shapes, and sizes to suit individual applications. Oblong Provide threaded hubs.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Conduit Body Covers (Round)	Same Material as Conduit Bodies	Form 8 secured with ≥2 captive stainless steel screws
		With tongue-in-groove (V-seal) gasket to seal out corrosive elements.
Conduit Fittings and Elbows – Indoor Dry Non-Corrosive Locations	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Conform to UL 514B and NEMA FB1 Standard threaded
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Conduit Fittings and Elbows – Outdoor, or Wet or Corrosive Locations shown on Plans	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Provide wedge nut covers (Form 8) weathertight
	Galvanizing	2.0 oz/sf conforming to ASTM A123 or A153
Conduit Fittings and Elbows – Outdoor, or Wet or Corrosive Locations shown on Plans	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Provide wedge nut covers (Form 8) weathertight Listed for use in Class I Groups C and D locations Conform to UL886
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Fittings, FS and FD Boxes, Condulets and Accessories		Conform to UL 514A ≥40-mil PVC coat similar to conduits. ≥2-mil urethane liner similar to conduit Otherwise same as specified for Electrical Rigid Steel Conduit (PVC-ERSC) Screws on Form 8 fittings shall be stainless steel with encapsulated plastic heads Encapsulate screw heads on condulets with corrosion-resistant material recommended by Manufacturer.
Service Entrance Heads	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Provide insulated knockout cover for use with variety of sizes and number of conductors
Sealing Fittings	Hot-Dipped Galvanized Malleable Iron	Provide threaded hubs with PVC oversize sleeve Standard and mogul size With or without drain and breather
	Fiber and Sealing Compound	UL listed for use with sealing fitting.
Expansion Couplings	Hot-Dipped Galvanized Steel with Insulating Bushing	Allow ≥2" expansion or contraction
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
	Gasketing	Gasketed for wet locations
	Grounding	Internally or externally grounded
Expansion-Deflection Couplings	Hot-Dipped Galvanized Steel	Allow ≥¾" expansion and ≥30° deflection from relaxed position.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
	Outer Jacket	Neoprene
	Jacket Clamps	Stainless Steel
	Gasketing	Watertight, raintight and concrete-tight
End Caps		Internally or externally grounded
		Protect threads using color-coded end caps to provide quick trade size identification.

ITEM	MATERIAL	SPECIFICATION
Long Radius Elbows	¾"-1¼"	≥12" radius
	1½"-2½"	≥15" radius
Conduit Hubs	Plated Steel or Malleable Iron	Threaded type Insulated and gasketed for raintight connection Shall have PVC sleeves equal to those on couplings.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Box Connectors for Damp and Wet Locations		Provide watertight threaded hub on enclosure consisting of sealing fitting with tapered conduit thread, neoprene O-ring, and 105°C rated insulating throat with grounding and bonding lug. Sealing locknuts are allowed but are not a substitute for threaded watertight hubs or sealing fittings.
Conduit Unions	Threaded Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Do not use running threads. Required for connections
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Couplings	Hot-Dipped Galvanized Steel	IPS-threaded, Hot-dipped after fabrication. Provide ribbed loose coupling with each conduit length Bond PVC coating to coupling outer surface. PVC sleeve equal to OD of uncoated conduit shall extend 1 pipe diameter or 2" (whichever is smaller) beyond both ends of coupling. Sleeve's wall thickness shall be same as plastic coating on pipe. PVC coating on coupling shall be ribbed to enhance installation.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
ACCESSORIES		
Fasteners	Stainless Steel	SAE Type 316
	PVC-Coated Steel	
Screws, Bolts, Nuts, Washers, and Hardware	Stainless Steel	SAE Type 316
Locknuts	Stainless Steel	SAE Type 316
	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Threaded, gasketed, insulated Bonding type with sharp edges for digging into metal enclosure wall Grounding or non-grounding type
Bushings	Hot-Dipped Galvanized Steel or Galvanized Malleable Iron	Threaded type with 105°C-rated plastic insulated throat and grounding and bonding lug Plastic bushings with 105°C temperature rating may be used for conduits 1" and smaller where hubs are not required and circuit conductors are supplying less than 480V
		Grounding or non-grounding type
Grounding Bushings	Plated Steel or Malleable Iron with Insulating Molded Phenolic or Nylon Dielectric Collar Insert	Threaded type Provide 105°C-rated plastic insulated throat and grounding and bonding lug Do not use all-metal or all-plastic bushings. Plastic bushings with 105°C temperature rating may be used for conduits ≤1" where hubs are not required and circuit conductors are supplying <480V
		Grounding type Conform to UL467
U-bolts and RA Clamps	Stainless Steel	Size to fit conduit Encapsulate nuts in plastic.
Conduit Mounting Strut	Stainless Steel	SAE Type 316

E. Materials for NEC Type PVC rigid nonmetallic conduit (PVC) and fittings shall be:

ITEM	MATERIAL	SPECIFICATION
PVC RIGID NONMETALLIC CONDUIT (PVC)		
NEC Type PVC Rigid Nonmetallic Conduit (PVC)	PVC	Conform to ASTM D1785, NEMA TC2 Type EC40 and UL651 Conform to CEC Article 352 Schedule 40 Type EB for concrete encased conduit $\geq 2"$ UL labeled for above-ground and underground use Rated for direct sunlight exposure Fire retardant and low smoke emission 90°C rise rating – marked "maximum 90 Deg C" Type 1 (normal impact) Grade 1 (high chemical resistance) Add inert modifiers to improve weatherability and heat distribution
Buried Rigid Nonmetallic Conduit (PVC)	PVC	Conform to ASTM F512, NEMA TC6 and TC8 and UL651A UL labeled for above-ground and underground use Schedule 40 90°C rise rating
CONDUIT FITTINGS		
Rigid Nonmetallic Conduit (PVC), Connectors, and Fittings	PVC	Conform to UL 514C and NEMA TC3 Schedule 40 Same thickness and construction as adjacent conduit Homogeneous plastic free from cracks, nicks, holes, blisters, foreign inclusions or imperfections which could damage conductors As recommended by conduit Manufacturer.
Elbows (90°)	PVC	Schedule 80 Same dimension as specified for Electrical Rigid Steel Conduit (PVC-ERSC)
Couplings, Adapters, Expansion Couplings, Elbows and 30° turns	PVC	Factory-made Conform to NEMA TC2 and TC3
Couplings	PVC	Socket-type for use with solvent weld cement
		Provide bell-end fitting upon termination in maintenance holes, hand holes, or pull boxes.
ACCESSORIES		
Joint Cement		As recommended and furnished by conduit Manufacturer for climate Furnished with instructions to achieve watertight joints. Conform to ASTM D2564.
Fasteners	PVC-Coated Steel or Nonmetallic	
Conduit Mounting Strut	Stainless Steel	SAE Type 316

F. Materials for NEC Type LFMC liquid-tight flexible metal conduit and fittings shall be:

ITEM	MATERIAL	SPECIFICATION
LIQUID-TIGHT FLEXIBLE CONDUIT (LFMC)		
NEC Type LFMC Liquid-Tight Flexible Metal Conduit and Fittings (FLEX)	Hot-Dipped Galvanized Steel	Conform to UL1 Conform to CEC Article 350 Size $\geq \frac{3}{4}"$.
	Galvanizing	≥ 2.0 oz/sf conforming to ASTM A123 or A153 Hot-dip galvanized on all 4 sides before conduit fabrication
NEC Type LFMC Liquid-Tight Flexible Metal Conduit and Fittings (FLEX-LT)	Hot-Dipped Galvanized Steel	Conform to UL360 Conform to CEC Article 350 Core of continuous, spiral wound, steel strip with interlocking convolutions. Liquid- and vapor-tight
	Galvanizing	≥ 2.0 oz/sf conforming to ASTM A123 or A153 Hot-dip galvanized on all 4 sides before conduit fabrication
	Jacketing	Extruded PVC positively locked to steel core

ITEM	MATERIAL	SPECIFICATION
NEC Type LFMC Liquid-Tight Flexible Metal Conduit and Fittings (HAZ-FLEX)	Bronze (Use in dry, damp, or wet areas)	Conform to CEC Article 350 Liquid-tight and arc-resistant Electrically conductive so no bonding jumper is required Provide bronze braided covering over flexible brass core, bronze end fittings, and hot-dipped galvanized steel or malleable iron unions and nipples
	Stainless Steel (Use in corrosive areas)	Conform to CEC Article 350 Liquid-tight and arc-resistant Electrically conductive so no bonding jumper is required Provide stainless steel braided covering over flexible stainless steel core, stainless steel end fittings, and aluminum unions and nipples.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153 Hot-dip galvanized on all 4 sides before conduit fabrication
CONDUIT FITTINGS		
Fittings NEC Type LFMC Liquid-Tight Flexible Metal Conduit and Fittings (FLEX)	Hot-Dipped Galvanized Steel or Zinc-Plated Malleable Iron Insulated Type	Conform to UL 514B and NEMA FB1 Conform to ANSI C33.84 UL listed for use with conduit Provide Steel or plastic compression rings and glands for tightening. Provide 105°C rated insulated throats.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
	Grounding	Provide threaded grounding cones or grounding and bonding lugs. For sizes ≤1¼", UL listed for grounding For fittings ≥1½" trade size, provide external grounding lugs.
Fittings NEC Type LFMC Liquid-Tight Flexible Metal Conduit and Fittings (FLEX-LT)	Hot-Dipped Galvanized Steel or Zinc-Plated Malleable Iron Insulated Type	UL 514B and NEMA FB1 Conform to ANSI C33.84 UL listed for use with conduit Straight or angle type Liquid-tight Provide steel construction, insulated and gasketed with locknut, grounding ferrule, and gland compression nut Provide 105°C rated insulated throats.
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
	Grounding	Conform to UL 467 Provide threaded grounding cones or grounding and bonding lugs. For sizes ≤1¼", UL listed for grounding For fittings ≥1½" trade size, provide external grounding lugs.
Conduit Fittings and Elbows – Outdoor, or Wet or Corrosive Locations shown on Plans	Hot-Dipped Galvanized Steel	Provide captive-screw covers (Form 8) weathertight Do not use setscrew connectors
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
ACCESSORIES		
Bushings	Hot-Dipped Galvanized Steel	Compression type
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Integral Copper Bonding Conductor	Copper	Required on conduit 1¼" and smaller Wind spirally in space between each convolution on conduit interior Conform to UL360
Jacket	Gray PVC Vinyl	Extend around and into helical grooves of core.
Conduit Mounting Strut	Stainless Steel	SAE Type 316

G. Materials for conduit identification tags shall be:

ITEM	MATERIAL	SPECIFICATION
ACCESSORIES		
Conduit Identification Tags	Stainless Steel	19-gauge With ½" stamped letters and numbers as shown on Plans

H. Materials for duct spacers and supports shall be:

ITEM	MATERIAL	SPECIFICATION
Duct Spacers and Supports	High-Density Polyethylene (HDPE) or High-Impact Polystyrene	Interlocking Provide ≥3" spacing between parallel conduits Provide 1" clearance between perpendicular conduits or conduits and pipes.
Spacers for Wall-Mount Boxes and Cabinets	Hot-Dipped Galvanized Steel	If spacers are cut from galvanized stock, coat cut surfaces with 2 coats cold galvanizing compound
	Galvanizing	≥2.0 oz/sf conforming to ASTM A123 or A153
Accessories		Provide hold down bars Provide duct-bank strapping

I. Materials for wireways shall be:

ITEM	MATERIAL	SPECIFICATION
Bodies and Covers	Stainless Steel	SAE Type 316 ≥14-gauge without knockouts ≥10-gauge SS flanges Conform to CEC Article 376 Gasketed cover held in place with captive clamp type latches
	Cast Rustproof Metal where required by NEC or Plans	Gasketed with bolted flanges Provide hinged covers, except where removable covers are shown.

J. Materials for outlet, junction and pull-boxes shall be:

ITEM	MATERIAL	SPECIFICATION
OUTLET AND DEVICE BOXES		
Cast Outlet Boxes	Cast Steel (CS) Outlet and Device Boxes	May be used in exterior or interior wet or dry locations with the following raceway systems 1. PVC-coated electric rigid steel conduit (PVC-ERSC) 2. Liquid-tight flexible steel conduit 3. PVC rigid nonmetallic conduit (RNC) 4. Concealed raceway systems 5. Concrete-encased raceways Use where required by NEC or Plans
		Conform to UL 50, UL 514A, and NEMA/ANSI OS1 Hot-dipped galvanized cast steel box Provide cast mounting lugs where required Zinc-plated cast steel cover, watertight and gasketed Fabricate bodies without holes or knockouts Provide threaded cast hubs for connections Provide removable gasketed screw-cover in accessible location. Use stainless steel fasteners.
Sheet Steel Outlet Boxes	Sheet Steel (SS) Outlet and Device Boxes	May be used in interior dry locations with the following raceway systems 1. PVC-coated electric rigid steel conduit (PVC-ERSC) 2. Liquid-tight flexible steel conduit 3. PVC rigid nonmetallic conduit (RNC) 4. Exposed or concealed raceways >4' above floor 5. Ceiling portion of lighting circuits Use in NEMA 1 areas where required by NEC or Plans
		Conform to UL 50 and UL 514A Hot-dipped galvanized of 1-piece drawn carbon steel sheet ≥14-gauge thick body ≥12-gauge thick cover

ITEM	MATERIAL	SPECIFICATION
		Continuously welded seams Shop fabricate when nonstandard size boxes are shown Provide removable gasketed screw-cover in accessible location. Use stainless steel fasteners.
	Stainless Steel (SS) Outlet and Device Boxes	May be used in exterior or interior wet or dry locations with the following raceway systems 1. PVC-coated electric rigid steel conduit (PVC-ERSC) 2. Liquid-tight flexible steel conduit 3. PVC rigid nonmetallic conduit (RNC) 4. Exposed or concealed raceways >4' above floor 5. Ceiling portion of lighting circuits Use for NEMA 4X enclosures Use where required by NEC or Plans
		1-piece drawn stainless steel sheet ≥14-gauge thick body ≥12-gauge thick cover Continuously welded seams Conform to UL 50 and UL 514A Shop fabricate when nonstandard size boxes are shown Provide removable gasketed screw-cover in accessible location. Use stainless steel fasteners.
Nonmetallic Outlet Boxes	Nonmetallic (NM) Outlet and Device Boxes	May be used in exposed, concealed, or concrete-encased exterior or interior locations with the following raceway systems 1. PVC Rigid Nonmetallic Conduit (RNC) Use where required by NEC or Plans
		Conform to UL 50 and UL 514A PVC box Provide mounting lugs where required PVC cover, watertight and gasketed Fabricate without holes or knockouts Provide threaded hubs for connections Use stainless steel fasteners.
Outlet and Device Box Dimensions		Factory-made standard sizes ≥1½" deep Use ≥4"x4"x1½" boxes for switches and receptacles. Use ≥4" octagonal boxes for ceiling outlets. For hollow masonry construction, provide boxes of depth to allow hubs to be in masonry void space. Where field conditions or fixture requirements mandate use of smaller box dimensions than specified, obtain acceptance from City's Representative before ordering boxes.
Outlet Box Extensions	Prohibited	Do not use box extensions to provide NEC-required wiring space.
Concealed and Flush-Mounted Boxes (Use with concealed conduits)	Galvanized Steel	Gang sizes as required by code Do not use sectional boxes for multi-gang applications. Use square cornered tile-type rings for exposed masonry wall construction Use square corner tile-type covers with ribs or extensions for casting in concrete Use stainless steel fasteners.
	Type	Type FS or FD
	Grounding Screw	Required
	Coating	≥40-mil PVC exterior coating ≥2-mil urethane interior coating
Exposed and Surface-Mounted Outlet Boxes (Use with exposed conduits)	Cast Iron with Threaded Hubs	Provide boxes with mounting flanges Conduit bodies may be used instead of boxes except where boxes contain devices.

ITEM	MATERIAL	SPECIFICATION
		Outlet boxes connecting to PVC-coated rigid conduit shall be of same material and coating as conduit, with metal threaded hubs. Provide gasketed covers secured with ≥2 stainless steel capture screws.
	Type	Type FS or FD
	Grounding Screw	Required
	Coating	≥40-mil PVC exterior coating ≥2-mil urethane interior coating
	PVC-Coated Steel	≥40-mil PVC exterior coating ≥2-mil urethane interior coating
Outlet Boxes Encased in Concrete	Cast or Sheet Metal as required by NEC or Plans	Moisture-proof and concrete-tight boxes designed for concrete encasement
JUNCTION AND PULL BOXES		
Outlet and Device Boxes	See above	Use outlet boxes as junction boxes and pull boxes where possible and allowed by applicable codes
Cast Steel Boxes	Cast Steel	May be used for above-grade or below-grade conduit
		Hot-dipped galvanized cast steel box Neoprene gasketed watertight Hinged cast steel full access screw-mounted covers. Drilled and tapped conduit entrances. Use stainless steel fasteners and hinges Size ≥8"x8"x6"
Sheet Steel Boxes	Galvanized Steel	Code gauge with gasketed full-access screw covers Use stainless steel fasteners
Stainless Steel Boxes	Stainless Steel	May be used for above-grade or below-grade conduit Use for NEMA 4X enclosures
		Code gauge with gasketed full-access screw covers Use stainless steel fasteners
Nonmetallic Boxes	Fiberglass-Reinforced Polyester	May be used for above-grade or below-grade conduit
		Corrosion resistant FRP with stability to high heat Gasketed watertight Hinged full-access screw-mounted FRP cover Provide mounting lugs where required Provide threaded hubs for connections Use stainless steel fasteners and hinges Size ≥7"x10"x6½"
Concrete Boxes	Reinforced Cast Concrete	May be used for below-grade conduit
		Interior Size ≥10"x17" Cast Iron Cover Mark" ELECTRICAL"
NEMA-RATED JUNCTION AND PULL BOXES		
NEMA 4X Watertight Metallic Corrosion-Resistant Boxes (Use for pull and junction boxes in outdoor, wet, damp, or corrosive areas)	Stainless Steel	≥14 gauge wall thickness SAE Type 316
	Seams	Continuously welded and ground smooth
	Mounting Flanges	External
	Knockouts	Prohibited
	Cover	Hinged cover secured with stainless steel screws and clamps
	Gaskets	Provide oil-resistant gaskets
NEMA 4X Watertight Nonmetallic Corrosion-Resistant Boxes (Use for pull and junction boxes in outdoor, wet, damp, or corrosive areas)	Fiberglass	Ultraviolet light-protected fiberglass-reinforced polyester
	Mounting Flanges	External
	Knockouts	Prohibited
	Cover	Hinged door with quick-release latches and padlocking hasp
	Gaskets	Provide oil-resistant gaskets on door
NEMA 12 Industrial Use Boxes (Use for indoor pull and junction boxes in dry areas)	Hot-Dip Galvanized Code Gauge Steel	≥14 gauge wall thickness Hot-dipped galvanized after fabrication
	Seams	Continuously welded and ground smooth

ITEM	MATERIAL	SPECIFICATION
	Mounting Flanges	External
	Knockouts	Prohibited
	Cover	Flat Continuous hinged cover with 3-point latch or SS bolts and clamps
	Gaskets	Provide oil-resistant gaskets on door
	Finish	1 coat rust-inhibiting primer + 1 coat primer seal inside and out Factory paint with ANSI 61 gray exterior finish and white interior finish
Accessories	Handles	Provide rigid handles for covers ≥ 9 sf or ≥ 25 lbm. Provide split covers when > 25 lbm.
	Weldnuts	Provide weldnuts for mounting optional panels and terminal kits.
	Terminal Blocks	Provide screw-post barrier-type terminal blocks rated ≥ 600 VAC and ≥ 20 A

K. Materials for conduit sealant shall be:

ITEM	MATERIAL	SPECIFICATION
Moisture Barrier Types	Water-Tight Material	Nontoxic, nonshrink, nonhardening, putty-type, hand-applied material providing effective barrier under submerged conditions
Fire-Retardant Types	Fire-Stop Material	Reusable, nontoxic, asbestos-free, expanding, putty-type material with 3-hour rating in accordance with UL35L4.

L. Materials for tape coating system shall be:

ITEM	MATERIAL	SPECIFICATION
Tape Coating System	Water-Tight PVC Tape	Conform to AWWA / ANSI C209 and C214 Provide protection against moisture, acids, alkalis, salts and sewage. Suitable for direct burial.
	Primer	Hot Dip Galvanized ≥ 2.0 oz/sf conforming to ASTM A123 or A153
	Inner Layer Tape (Corrosion Protection)	≥ 30 mils thickness
	Outer Layer Tape (Mechanical Protection)	≥ 30 mils thickness
	Complete System	≥ 60 mils thickness

M. Materials for pull cord shall be:

ITEM	MATERIAL	SPECIFICATION
Cord, Pull Tape, or Rope	Polypropylene or Nylon	$\frac{1}{4}$ " diameter 1800-lbf-rated
	Polyester Tape	Flat, woven, lubricated, soft-fiber polyester 1800-lbf-rated With painted sequential measurement markings each 3'

N. Materials for concrete hand-holes shall be:

ITEM	MATERIAL	SPECIFICATION
Hand-Holes	Steel-Reinforced Concrete	Weatherproof concrete with pull-in irons
	Fiberglass-Reinforced Polymer-Concrete	
Cable Racks	Galvanized Steel with Porcelain Blocks	≥ 2.0 oz/sf conforming to ASTM A123 or A153
Cover and Frame	Ductile Iron	Traffic-rated 20-lb Lid and Lid Ring ELECT shall be cast into lid in 1" letters

6. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Pre-Cast Concrete Hand-Hole Sections	Base	Solid bottom with 12"x12" or 12" diameter opening to French drain beneath hand-hole.
	Sections	Mating edges shall be tongue-and-groove-type
	Top Slab	Gasketed removable top slab with lifting eyes and cast-in iron frame and cover. Provide cover extension rings as required.
	Design Surcharge and Lateral Earth Pressure	AASHTO H25 Loading
	28-day Compressive Strength f_c	≥ 4500 psi
	Steel Reinforcing Yield Strength f_y	60 ksi
	Size	As shown on Plans or as required for number and size of entering conduits.
Openings	Knockouts	Full round openings with thin walls Diameter = pipe penetration OD + 4"

7. Install the following types of conduits and fittings in locations listed, unless otherwise shown on Plans.

- Definitions and requirements of NEC apply unless modified below.
- Installation of buried or concealed conduit Work shall be witnessed and accepted by City's Representative or inspector.

EXPOSURE	ALLOWABLE SIZE RANGE	ALLOWABLE MATERIALS
Indoor Exposed Dry, Wet and Damp Noncorrosive Locations	$\frac{3}{4}" - 4"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
		In wet locations provide watertight joints.
Indoor, Concealed, Dry or Damp Locations	$\frac{3}{4}" - 4"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
Outdoor Exposed Dry Locations	$\frac{3}{4}" - 4"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
Underground Vault Interiors	$\geq \frac{3}{4}"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
Corrosive Locations Indoor and Outdoor	$\geq \frac{3}{4}"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
Embedded in Concrete Slabs and Masonry Walls	$\geq 1"$	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC)
Underground, Including Below Concrete Slabs	$\geq 1"$	Rigid Non-Metallic Conduit (Schedule 40 PVC) or PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) $\geq 24"$ cover Provide red-colored concrete encasement Watertight
	Stub-ups into Equipment Pads or Floor	Provide PVC Schedule 80 elbows and stub-ups Extend exposed stub-ups $\geq 6"$ above grade or finish floor
	Stub-ups into Exposed Areas	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) Conduit Connect underground Non-Metallic Conduit to PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) with 90° PVC-Coated Rigid Steel elbows before emergence. Extend $\geq 6"$ above grade or finish floor. Apply corrosion-resistant coating consisting of heavy coat of coal-tar paint or 3 wraps of 10-mil pipe wrap tape extending 1" on each side of turn-out point.
	Stub-ups to be Embedded in Walls	PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) Conduit. Connect underground Non-Metallic Conduit to PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) Conduit with 90°

		PVC-Coated Rigid Steel long-radius elbows before emergence. Extend $\geq 12"$ above and below grade or finish floor. Apply corrosion-resistant coating consisting of heavy coat of coal-tar paint or 3 wraps of 10-mil pipe wrap tape extending 1" on each side of turn-out point.
	Long sweeping bends $>15^\circ$ and $\geq 2"$	Electrical Rigid Steel Conduit (PVC-ERSC)
Final Connections to Lighting Fixtures and Appliances	$\geq \frac{1}{2}"$	Liquid-Tight Flexible Steel Conduit $\leq 3'$ long unless otherwise authorized by City
Final Connections to Motors, Solenoids, Transformers, Vibrating Equipment, Appliances, or Instruments	$\frac{1}{2}"$ - $2\frac{1}{2}"$	Liquid-Tight Flexible Steel Conduit $\leq 3'$ long unless otherwise authorized by City
	$\geq 3"$	Liquid-Tight Flexible Steel Conduit $\leq 5'$ long unless otherwise authorized by City
Direct-Buried Conduit for Telemetry Cable	$\geq 2"$	
Underground Duct Banks	$\geq 2"$	Rigid Non-Metallic Conduit (Schedule 40 PVC) or PVC-Coated Electrical Rigid Steel Conduit (PVC-ERSC) Watertight Provide red-colored concrete encasement.

8. The following electrical design criteria are required for equipment specified in this section:

ITEM	DESCRIPTION	
Electrical Work	NEC Article 505 Classification	Conform to NFPA 820 Nonhazardous
Enclosures – Outdoor or Wet Locations	NEMA 250 Enclosure Rating	NEMA 4X – Watertight, Corrosion-Resistant, Stainless steel
All Enclosures	Construction	Lockable With powdercoat epoxy finish on steel surfaces

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install raceway and boxes before submitting Shop Drawings or ordering.
 1. Locations shown are approximate.
 2. Study Plans in relation to spaces and equipment around outlets and devices.
 3. Make minor changes in dimensions and alignments as needed to avoid utilities or mechanical or structural conflicts.
- B. Determine conduit routing conforming to installation requirements set forth in Contract Documents and Raceway and Cable Schedules.
 1. Not all conduit routing is shown on Contract Documents.
 2. Route conduit to City's satisfaction, including those shown on:
 - a. Control block diagrams
 - b. Home runs shown on Plans
 - c. Manufacturer's equipment installation instructions.
 3. Install conduit runs for lighting and receptacle circuits whether or not shown on Plans for circuits and circuit numbers shown.
 4. Conduit routings and stub-up locations shown are approximate.
 - a. Coordinate stub-up locations with conduit entries of furnished equipment.
 - b. Modify stub-up locations as required to accommodate equipment furnished and field conditions.

5. Where circuits are indicated as "home-runs," provide necessary fittings and boxes for complete raceway installation.
 6. Use conduit and conductor sizes shown for entire branch circuit.
 7. Supports, pull-boxes, junction boxes, and other ancillary equipment are not usually shown.
 - a. Provide pull-boxes and junction boxes where shown.
 - b. Provide pull-boxes and junction boxes as required by NEC.
 8. Provide additional pull boxes and junction boxes required to permit pulling wires without damage to conductors or insulation.
 - a. Bends shall total $\leq 270^\circ$ total deflection between pull points.
 - b. Conduit runs shall total $\leq 100'$ between pull points.
 - c. Provide boxes where necessary to terminate, tap-off, or redirect multiple conduit runs
 9. Coordinate motor terminal box locations with motor branch circuit conduit and wiring.
- C. Verify with City's Representative exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

- D. Set and mount outlet and device box locations as follows:

DEVICE	TYPE	HEIGHT TO CENTERLINE
Wall Switches	All	48" above floor
Thermostats	All	48" above floor
Receptacles	Near Floor	12" above floor

1. Where above heights are inappropriate for construction or finish, locate boxes as directed by City's Representative.
 2. Locate light switches on lock side of doors.
 3. Locate light fixture and utility outlets in symmetrical pattern according to room or vault layout.
- E. Support surface mounted panel boxes, junction boxes, and conduit with spacers to provide clearance between walls, equipment, and parallel or perpendicular pipe or conduit crossings.
- F. Provide and place sleeves for conduits penetrating floors, walls, and partitions.
 1. Locate necessary slots for electrical Work and form before concrete is poured.
- G. Seal openings, sleeves, penetration, and slots.

3.2 **Installation**

- A. Refer to Sections 01 73 00, 01 73 24, and 01 73 33 for basic execution and installation requirements.
- B. Refer to Section 33 05 26 for identification procedures for buried raceways.
- C. Refer to Section 33 05 38 for installation procedures for hangers and supports.
- D. Furnish and install raceway and boxes at locations shown on Plans and Submittals.
- E. Conform to the following installation standards:
 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 2. Other applicable OSHA and Cal OSHA regulations
 3. California Electrical Code Article 312 "Cabinets, Cutout Boxes, and Meter Socket Enclosures"
 4. California Electrical Code Article 314 "Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures"
 5. California Electrical Code Article 344 "Rigid Metal Conduit: Type RMC"

6. California Electrical Code Article 350 "Liquidtight Flexible Metal Conduit: Type LFMC"
 7. California Electrical Code Article 352 "Rigid Polyvinyl Chloride Conduit: Type PVC"
 8. California Electrical Code Article 366 "Auxiliary Gutters"
 9. California Electrical Code Article 376 "Metal Wireways"
 10. California Electrical Code Article 378 "Nonmetallic Wireways"
 11. California Electrical Code Article 386 "Surface Metal Raceways"
 12. Other applicable building, fire, and electrical code requirements
 13. Manufacturer's installation and warranty requirements
- F. Refer variances between above documents and Contract Documents to City's Representative.
- G. Size raceways as follows:
1. Raceway sizes are shown on Plans.
 2. If not shown on Drawings, size in accordance with NFPA 70.
 3. For runs not sized on drawings, compute maximum conduit fill using NEC (NFPA 70) requirements for Type THW conductors (larger if applicable), although actual wiring may be with conductor types having smaller cross sections.
 4. For multi-conductor cables, size conduit to $\leq 40\%$ fill considering overall outside diameter of multi-conductor cable.
 5. Unless shown otherwise, conduit size shall be $\geq \frac{3}{4}$ " for exposed conduit and ≥ 1 " for buried conduit.
 - a. Use 1", 2", 4" and 5" conduit only.
 6. Wireway size shall be ≥ 4 " x 4"
- H. Construct raceway system to provide firm mechanical assemblies with electrical conductivity throughout.
- I. Install raceway and boxes to tolerances recommended by Manufacturer.
1. Unless otherwise shown, install raceway and boxes true, plumb, and level using precision gauges and levels.
 2. Do not use diagonal runs except when expressly shown on Plans.
- J. Install outlet and device boxes as follows:
1. Metallic outlet boxes may be used for:
 - a. Housing wiring devices.
 - b. Pull or junction boxes above gypsum board or acoustical tile ceilings.
 - c. Pull or junction box $\geq 10'$ above floor in architecturally finished area with no ceiling.
 2. Recess metallic outlet and device boxes:
 - a. In stud-framed walls and ceilings using appropriate stud wall support brackets or adjustable bar hangers to mount boxes flush with wall face.
 - b. In poured concrete walls of architectural finished areas and exterior building walls.
 - c. In ungrouted cells of concrete block in architectural finished areas and exterior building walls, with bottom box edge flush with bottom edge of block.
 3. Cast outlet boxes may be used for:
 - a. Housing wiring devices surface-mounted in non-architecturally finished areas.
 - b. Pull or junction boxes surface-mounted in architecturally finished area with no ceiling.
 4. Mount outlet and device boxes at locations and elevations shown on Plans.
 - a. Set outlet and device boxes plumb and vertical to floor.
 5. Mount box edges flush with finished surface.

- a. Provide proper type extension rings or plaster covers for this purpose.
 - b. For flush-mounted boxes, make holes in surrounding surface no larger than required to receive box.
6. Mount boxes in secure, substantial manner supported independently of conduit by attachment to building structure or structural member.
 - a. Fasten boxes with bolts and expansion shields on concrete toggle bolts on hollow masonry units, and machine screws or welded, threaded studs on steelwork.
 - b. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
 - c. Boxes embedded in concrete or masonry need not be additionally supported.
7. Provide flush or recessed lighting fixtures with separate junction boxes when required by fixture terminal temperature.
 - a. Where boxes support fixtures, provide proper means of attachment with adequate strength.
8. Outlet boxes connected to PVC-coated conduit shall also be PVC-coated.
9. Open no more knockouts in sheet steel boxes than are required.
 - a. Seal used openings in boxes with insert plugs.
- K. Install junction and pull boxes as follows:
 1. Make boxes and covers accessible.
 2. Do not install boxes in finished areas until surfaces receiving boxes are accepted by City's Representative.
 3. Mount boxes plumb and level.
 4. Use flush mounted boxes with concealed conduits.
 - a. Make edges of boxes flush with final surface.
 5. Mount boxes in secure, substantial manner, supported independently of conduit by attachment to building structure or structural member.
 - a. Fasten boxes with bolts and expansion shields on concrete toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.
 - b. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
 - c. Boxes embedded in concrete or masonry need not be additionally supported.
 6. Install boxes for conduits under grade flush with finished grade in locations outside paved areas, roadways, or walkways.
 7. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - a. If it is found desirable to locate boxes in paved areas, roadways, or walkways, obtain City's Representative's written acceptance.
 - b. Use boxes and covers suitable for traffic loadings to which they may be subjected.
 8. Support pull boxes independently of raceways, walls, and partitions.
 - a. Securely mount surface boxes, cabinets and apparatus.
 - b. Unless otherwise specified, space wall-mounted boxes, cabinets and apparatus enclosures out from walls $\geq \frac{1}{2}$ ".
 - c. Equip NEMA 4 and NEMA 4X boxes and boxes located in wet locations with automatic drain.
 - d. Install flush-mounted wall or ceiling boxes with raised covers so front face of raised cover is flush with surface.
 - e. Install surface-mounted wall or ceiling boxes with surface-style flat or raised covers.

L. Route conduits and raceways as follows:

1. Construct conduit and fittings as required to provide complete system with neat appearance conforming to applicable codes.
2. Run raceways concealed except where otherwise shown.
 - a. Install conduit in walls or slabs which have reinforcement in both faces between reinforcing steel mats.
 - b. In slabs, with only 1 layer of reinforcing steel, install conduit under reinforcement.
 - c. Install PVC conduits not embedded in slabs $\geq 6"$ thick under bottom of concrete slab floors.
3. Run conduits parallel and perpendicular to building lines, walls, surfaces or exposed structural members.
 - a. Follow surface contours as much as practicable to provide neat appearance.
 - b. Unless otherwise shown, keep legs of bends in same plane and straight legs of offsets parallel.
4. Do not route conduits:
 - a. Through areas of high ambient temperature or radiant heat.
 - b. In suspended concrete slabs.
5. Install rigid conduits exposed with the following exceptions:
 - a. Embedded in ground-level floor slabs or buried under floor where accepted by City's Representative.
6. Conduit shall not interfere with or prevent access to piping, valves, ductwork, or equipment for operation, maintenance, or repair.
7. Maintain spacing between parallel conduit and piping runs for runs $>30'$ as follows:

ITEMS	REQUIRED SEPARATION
SEPARATION FROM FLUES, HOT WATER PIPES, STEAM PIPES, HEATING APPLIANCES AND HEAT SOURCES	
All conduit	$\geq 12"$ wall-to-wall
SEPARATION FROM PROCESS, GAS, AIR, AND WATER PIPES AND DUCTS	
All conduit	$\geq 6"$ wall-to-wall
SEPARATION FROM AC POWER CONDUCTORS, $>600\text{VAC}$	
Instrumentation or Telecommunication	$\geq 12"$ wall-to-wall
AC Power Conductors $\leq 600\text{VAC}$	$\geq 2"$ wall-to-wall
DC Power Conductors $\leq 125\text{VAC}$	$\geq 2"$ wall-to-wall
SEPARATION FROM AC POWER CONDUCTORS, $\leq 600\text{VAC}$	
Instrumentation or Telecommunication	$\geq 6"$ wall-to-wall
DC Power Conductors $\leq 125\text{VAC}$	$\geq 2"$ wall-to-wall
SEPARATION FROM DC POWER CONDUCTORS $\leq 125\text{VDC}$	
Instrumentation or Telecommunication	$\geq 2"$ wall-to-wall
SEPARATION FROM INSTRUMENTATION CABLE OR CONDUIT	
Telecommunication	$\geq 1"$ wall-to-wall

8. Provide $\geq 1"$ wall-to-wall separation at crossings.
9. Slope horizontal outdoor and indoor runs exposed to moisture to low point or to downturned elbow to drain internal moisture.
 - a. Equip low points with automatic drains.
10. Where space exists within housing of roof- or floor-mounted equipment, stub up conduit within housings.
11. Route exposed conduit to preserve headroom, access space, and work space.
12. Construct conduit runs to avoid interference with both proper and safe equipment operation, and ingress or egress including equipment removal hatches.
13. Install exposed, parallel, or banked conduits together.
 - a. Make bends in parallel or banked runs from same centerline so bends are parallel.

- b. Factory elbows may be used in banked runs only where they can be installed parallel.

14. Buried conduits shall penetrate surfaces at 90°

M. Install conduits as follows:

1. Conduits shall be continuous from outlets to cabinets, pull or junction boxes and secured to boxes with locknuts and insulated bushings such that each system is electrically continuous throughout.
2. Cut conduit joints square so ends butt together for full circumference of cut.
 - a. Ream ends of conduit smooth, interior and exterior, whether shop-cut or field-cut, to remove burrs and rough edges.
 - b. Degrease threads after threading.
 - c. Thread, and draw up tight.
3. Before installing fittings, paint male threads of field-threaded galvanized rigid-steel conduit with:
 - a. Zinc-rich paint or
 - b. Homogenized blend of colloidal copper and rust corrosion inhibitor joint pre-treating pipe compound from acceptable Manufacturer.
4. For PVC-coated rigid conduits, use Manufacturer's recommended style threading and installation tools.
5. Before installing fittings, coat male threads of conduit with electrically conductive anti-seize compound.
6. Make threaded connections wrench-tight.
7. Anchor conduits in place at ≤10' intervals, at elbows, and within 24" of outlet boxes or cabinets.
 - a. Provide hangers, supports, channel strut systems, fastenings, or clamps at elbows and at ends of straight runs terminating at boxes or cabinets.
 - b. Do not use perforated metal or "plumber's tape."
 - c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
8. Space out raceways and conduits run on building surfaces from surface ≥¼" using clamp backs and nest backs.
 - a. Do not use offset bends at boxes or cabinets except where accepted by City's Representative.
9. Make connections from metallic to non-metallic conduits with accepted fittings.
 - a. Limit use of threadless couplings to applications joining new conduit to existing conduit when existing conduit is not threaded and it is not possible to cut threads on existing conduit with pipe threader.

N. Bend conduits as follows:

1. Make offsets and right-angle bends in conduit runs with hub-type conduit fittings, or standard or long-radius elbows.
2. To make field bends and cuts, use tools, equipment, benders or hickies recommended by conduit Manufacturer and designed for bending or cutting conduit material.
 - a. Use Electrical Rigid Steel Conduit (PVC-ERSC) for bends
 - b. Make bends and offsets so inside diameter of conduit is not reduced.
 - c. Prepare tools and equipment to prevent damage to PVC coatings.
 - d. Make bends to radii not less than those specified for standard or long-radius elbows depending on wire pull conditions.
3. Number of bends shall not exceed NEC limitations.

- O. Install PVC-coated Electrical Rigid Steel Conduit (PVC-ERSC) as follows:
1. Use Manufacturer's recommended installation tools and recommendations.
 2. Manufacturer shall certify installer before installation proceeds.
 3. Provide expansion fittings where conduit crosses expansion joint in structure
 - a. Provide expansion fittings with #8AWG copper bonding jumper.
 4. Bend rigid metallic conduit without crimping or flattening with radius of $\geq 6 \times$ conduit inside diameter.
 5. Fittings shall be galvanized steel.
 6. Securely tighten couplings to provide electrical and mechanical connection throughout conduit run length.
 7. When standard coupling cannot be used, use UL or ETL listed threaded union coupling accepted by City's Representative.
 8. Where rigid metallic conduit is capped and caps are removed, provide ends of conduit with conduit bushings.
- P. Install Rigid Nonmetallic (PVC) Conduit as follows:
1. Conform to installation provisions of NEMA TC2, except as modified below.
 2. Install rigid PVC for underground portions of conduit for power, control, communication and instrumentation cables.
 3. Provide rigid PVC conduit for underground portions of telephone conduit unless otherwise required by telephone utility.
 - a. Conduits shall have end bells where terminated at walls.
 4. Provide specified cover and concrete encasement for buried conduit.
 5. Conduits shall have end bells where terminated at walls, or adapters for steel conduit continuations where required.
 - a. Solvent weld PVC conduit joints per Manufacturer's recommendations.
 - b. Immediately after installing PVC conduit and fitting, rotate fitting or conduit 90° to provide uniform contact while drawing joint up tight to shoulder.
 - c. Cementing and joining operation take ≤ 20 seconds.
 - d. Do not disturb joint for 5 minutes, longer (up to 10 minutes) at lower temperatures.
 - e. Make joints watertight.
 - f. Joining procedure shall conform to ASTM D2855.
 6. Provide ground wire with power wiring and increase conduit size as required.
 7. Make cuts with fine tooth handsaw.
 - a. For sizes 2" and larger, use miter box or similar saw guide to assure square cut.
 8. Use factory-made couplings for joining conduit.
 9. Ream square-cut ends smooth, and wipe clean.
 10. Provide expansion fittings as follows:
 - a. Provide expansion fittings when conduit is left exposed in trenches for time period during which conduit's temperature may vary by $>2^{\circ}\text{F}$.
 - b. Provide near fixed end of runs and 100' on center.
 - c. Provide where shown on Plans.
 11. Install expansion/deflection fittings as follows:
 - a. Provide where conduits enter structures other than electrical manholes and handholes except where ductbank is tied to structure with rebar.
 - b. Provide where conduits span structural expansion joints.
 - c. Provide where shown on Plans.

12. Convert to steel conduit through adaptors when entering buildings and for risers.
13. For direct buried conduit transition from PVC to PVC-ERSC, provide half-lapped 5-mil plastic protective tape-coating over PVC-ERSC.

Q. Install flexible metallic conduit as follows:

1. Provide separate insulated stranded copper equipment ground conductor in areas exposed to weather, damp locations, and connections to transformer enclosures regardless of location.
2. Connect ground conductor to enclosure or raceway at each end.

R. Seal conduit entries with silicone conduit sealant when conduit:

1. Exits areas identified as corrosive.
2. Exits underground structures.

S. Provide grounding in accordance with Section 26 05 26.

1. Use grounding bushings for conduits carrying grounding conductor or not installed into threaded hubs.
2. Maintain grounding continuity of interrupted metallic raceways with ground conductor, and in flexible conduit for feeders and motor terminal connections.
3. In exposed, damp, or wet locations, provide equipment grounding conductor with raceway or in liquid-tight flexible conduit.
4. Size grounding conductors according to NEC §250.

T. Install raceway embedded in concrete and below slabs as follows:

1. Perform trenching and backfill in accordance with Section 31 23 00.
2. Perform cutting and patching of curbs and pavements required for proper installation of electrical Work.
 - a. Use patching of same material, workmanship and finish as existing surface and matching surrounding work to City's satisfaction.
3. Use PVC-ERSC for bends.
4. Install half-lapped 5-mil plastic protective tape-coating system on buried PVC-ERSC conduits.
5. Install conduits and sleeves passing through slabs, walls, or beams so as not to impair strength of construction.
 - a. Secure conduit to prevent sagging or shifting during concrete placement.
6. Provide ≥ 1 " concrete cover over embedded conduit.
7. Conduits $> 1\frac{1}{2}$ " diameter may be embedded in concrete only after submittal and review of location and reinforcement details.
 - a. Conduits and sleeves may be installed without specific permission, provided they are $\leq 1\frac{1}{2}$ " in diameter and are spaced ≥ 3 diameters on centers.
8. Install conduits in slabs other than slabs-on-grade as close to slab center as practical without disturbing steel reinforcement.
 - a. Conduit outside diameters shall not exceed $\frac{1}{3}$ x slab thickness.
9. Do not space parallel runs of conduit ≤ 3 diameters on centers, except at cabinet and outlet box locations.
10. Install conduit deep enough for elbows to penetrate perpendicular to slab.
11. Concrete encasement of conduits installed below concrete slabs shall be continuous with concrete floor or slab where practical.
 - a. Otherwise, install below floor slab, under curing or damp-proofing membranes, and under sand blankets.

12. Locate conduit stub-ups below cabinets and boxes within conduit entry area identified in equipment Manufacturer's shop drawings.
 - a. Brace conduits prior to concrete placement to prevent shifting of conduits during placement.
13. Keep raceways clear of motor and equipment foundations.
14. Transition from PVC to steel underground 5' prior to riser.

U. Install underground raceway as follows:

1. For high-voltage and service entrance conduits, provide burial depth, bedding, and backfill per Electrical Utility service requirements, and provide concrete encasement.
2. Provide cover as follows:
 - a. Provide $\geq 30"$ cover for direct-burial cable.
 - b. Provide $\geq 24"$ cover where PVC or PVC-coated rigid steel conduit is installed underground in locations other than under concrete slab.
 - c. Unless otherwise shown, provide other underground conduits and conduit banks with $\geq 24"$ earth cover.
3. Underground conduit bend radius shall be $\geq 24"$ at vertical risers and $\geq 36"$ elsewhere.
 - a. Requirement for $\geq 36"$ radius may be relaxed by City's Representative where deemed necessary to facilitate and simplify operation.
4. Maintain separations as follows.
 - a. Maintain $\geq 12"$ vertical separation between buried raceways and other systems at crossings.
 - b. Maintain $\geq 12"$ horizontal separation between buried raceways and other utility piping systems in parallel runs.
5. Pitch and slope conduit to drain away from buildings to manholes or pull-boxes.
6. Isolate telephone and communication cables, raceways, conduits, boxes, manholes, and hand-holes from those of other circuits.
7. Isolate communication and instrument cables from power wiring raceways, conduits, boxes, manholes, and hand-holes.
 - a. Route these cables through manholes and hand-holes in liquid-tight flexible metal conduit.
8. Where other utility piping systems are encountered or being installed along raceway route, refer conflicts to City's Representative before proceeding.
 - a. Do not place raceways over buried valves, couplings or appurtenances.
9. Provide concrete encasement for underground conduit duct banks unless shown otherwise on Plans.
 - a. Where conduits are concrete- or slurry-encased, provide $\geq 2"$ wall-to-wall separation between conduits, $\geq 1"$ wall to edge separation between conduit and reinforcing, and $\geq 3"$ cover over reinforcing or conduit
 - b. Provide $\geq 3"$ sand-cement slurry with red color additive on all sides of buried conduits.
 - c. Continue concrete encasement on exposed outdoor conduit risers to 3" above grade, with top crowned and edges chamfered.
10. Where conduit and concrete encasement terminate underground, terminate steel conduit flush at bulkhead with coupling and screw plug.
 - a. Protect threads with screw-in plastic cap.
 - b. Form $\geq 1\frac{3}{4}" \times 3\frac{3}{4}"$ deep horizontal shear key in concrete encasement above and below embedded conduits.
 - c. After concrete placement, clean conduit and bar connector ends and coat with 2 coats of thixotropic coal tar.

11. Refer to Section 33 05 26 for installation of detectable warning tape above conduits, or, if under slabs, directly beneath concrete subgrade.
12. Isolate low-voltage cable raceways from raceways, conduits, boxes, manholes and hand-holes for other circuits.
13. Separate communication and instrumentation cables from power wiring in raceways, boxes, manholes, and hand-holes.
14. Transitions from PVC to steel conduit shall occur underground.

V. Construct building wall or foundation penetrations as follows:

1. Underground conduit banks through building walls or footings shall be cast in place or concreted into box-outs with water stops on all sides of box-out.
2. Water stops shall conform to Section 03 15 00 Concrete Accessories.
3. Conduits not encased in concrete and passing through walls which have 1 side in contact with earth shall be sealed watertight with special rubber-gasketed sleeve-and-joint assemblies or with sleeves and modular rubber sealing elements.
4. Maintain integrity of damp-proofing and waterproofing membranes penetrated by conduits and boxes.
5. Buried conduit shall penetrate surface at 90°.
6. Seal between raceway and building where raceway passes through exterior wall or rated firewall as follows:
 - a. Concrete Construction: Cast conduit in wall or core drill wall and pack around conduit with, dry-pack, fire stop putty or equivalent method accepted by City's Representative.
 - b. Frame Construction: Seal with fire-stop rated material compatible with building material through which raceway passes, as accepted by City's Representative.
 - c. Provide flashing for conduits installed through roofs or metal walls and seal watertight.
7. Fill openings in walls, floors, and ceilings and finish flush with surface.

W. Construct conduit terminations into enclosures as follows:

ENCLOSURE TYPE	CONNECTING CONDUIT	TERMINATION
Metallic Outlet Boxes	PVC-ERSC	Provide conduit hub and locknut. Provide insulated bushing and 2 locknuts. Use grounding type locknut or bushing when required by NEC.
Stubups Through Floors into Floor-Mount Equipment		Provide insulated grounding bushing on metallic conduits. Provide end bells on nonmetallic conduits.
NEMA 1 Enclosures	PVC-ERSC	Provide conduit hub and locknut. Provide insulated bushing and 2 locknuts. Use grounding type locknut or bushing when required by NEC.
NEMA 4 and 4X Enclosures		Provide watertight, insulated, and gasketed hub and locknut.
NEMA 12 Enclosures		Provide watertight, insulated, and gasketed hub and locknut. Use grounding type locknut or bushing when required by NEC.

1. Terminate conduits in manner ensuring each system is electrically continuous throughout.
2. Terminate conduits entering enclosures using fittings ensuring NEMA rating of enclosure is not compromised.
3. Terminate conduits with locknuts and bushings except where threaded hubs are specified.
4. Terminate rigid steel conduits with Meyers-type hubs with bushings.
5. Install conduits squarely to box and provide 1 locknut outside box and 1 locknut and bushing inside box.

6. Install locknuts with dished side against box.
 7. When terminating in threaded conduit hubs, screw conduit or fitting tight into hub so end bears against fire protection shoulder.
 8. When chase nipples are used, install conduits and coupling square to box.
 - a. Tighten chase nipple leaving no exposed threads.
 9. Cap conduits during construction to prevent entrance of dirt, trash, and water.
 10. Ream and taper thread termination and connections of rigid steel conduit.
 11. Terminate all sizes with conduit bushings.
 12. Terminate concealed conduits for future use within equipment or by galvanized couplings plugged flush with structural surfaces or installed $\geq 6"$ from surface if so directed.
 13. Terminate exposed conduit stubs for future use with galvanized pipe caps.
 14. Space rigid steel conduit stubouts $\geq 6"$ apart.
 15. Connect underground nonmetallic conduit which turns out of concrete, masonry, or earth to metallic conduit before emergence, with 90° elbows of electrical rigid steel conduit (PVC-ERSC).
 - a. Ensure conduit risers are vertically plumb.
 16. Apply corrosion-resistant coating to conduits that turn out of concrete, masonry, or earth.
 - a. Provide coating which consists of heavy coat of thixotropic coal tar paint extending 1" on each side of point of turn-out.
- X. Clean and protect constructed conduit as follows:
1. Maintain protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories.
 2. Install conduit systems complete with insulated, grounding bushing before pulling in conductors.
 3. Cap or plug open ends of conduit with tapered wood plugs or plastic inserts immediately after installation to prevent entrance of foreign matter until wire is pulled.
 4. Clean and ensure conduit runs are not crushed or creased.
 - a. After concrete (if any) has set, pull mandrel with diameter nominally $\frac{1}{4}"$ smaller than raceway interior through raceway to remove obstructions.
 - b. Then pull bristle brush through raceways to remove debris.
 - c. Swab conduit by pulling clean, tight-fitting rag through conduit.
 - d. Verify no foreign objects or obstructions are present in conduit prior to installing conductors.
 - e. Remove moisture and debris from conduit before pulling wire into place.
 5. After completing installation of $\geq 2"$ conduit runs, snake conduits with conduit cleaner equipped with cylindrical mandrel of diameter $\geq 85\%$ of nominal diameter of conduit.
 - a. Remove and replace conduits through which mandrel will not pass.
 6. Where portions of raceways are subject to different temperatures and where condensation is known to be a problem, as where passing from interior to exterior of buildings, seal raceway to prevent circulation of warm air to colder section of raceway.
- Y. Install general purpose sheet steel pull-boxes in dry interior locations only.
1. Install cast metal or concrete pull-boxes in exterior locations where boxes are subject to mechanical injury.
- Z. Repair damaged conduit as follows:
1. Replace conduit damaged during or after installation.

2. Replace crushed or clogged conduit or any conduit whose inner surface is damaged or not smooth.
3. Prior to installation, repair surfaces which will be inaccessible after installation.
4. Repair cuts, nicks, or abrasions in zinc coating of galvanized conduit with:
 - a. Galvanizing repair stick or
 - b. Zinc-rich paint.
5. Repair painted components using touch up paint provided by or approved by Manufacturer.
6. Repair cuts, nicks, or abrasions in PVC coatings with PVC material.
 - a. Manufacturer's furnished or recommended PVC patching compound of same thickness, and color as coating, or
 - b. Self-adhesive, conformable, cross-linked silicone composition strip, followed by protective coating of vinyl tape.
7. Use patching described above for small areas only.
 - a. Items with significant damage may require replacement at City's Representative's discretion.

AA. Install empty conduit as follows:

1. Provide ≥ 200 -lbf strength pull cord, tape, or rope in empty conduits, with $\geq 4'$ knotted and coiled at each end.
2. Provide waterproof label on each end of pull-cords to indicate destination of other end.
3. Show coordinate dimensions of stub-outs on record drawings.
 - a. Place 1"x12"x12" concrete marker over stub-outs, and engrave with words "Electrical Conduit."
4. Cap spare PVC conduit stub-outs and stub-ups.
 - a. Provide #10 THHN green wire below threaded cap.
 - b. Provide $\geq 6"$ of spare wire beyond conduit end to allow future splicing of grounding conductor extension.
 - c. Secure green wire to conduit interior with suitable tape or adhesive.
5. Provide bonded bushing and bond wire for metallic conduit terminating in equipment enclosures or pull boxes.
 - a. Provide $\geq \#10$ AWG bond wire.

BB. Install outlets for general wiring as follows:

1. Use multi-gang boxes and device plates where several devices are located in same general area.
 - a. Do not use sectional boxes.
 - b. Obtain back box requirements for systems provided under other sections and provide them per those requirements.
2. Mount outlets for different conduit systems shown in same wall area $\leq 6"$ on center.
3. Rigidly support boxes for wall and ceiling outlets and finish flush and straight.
 - a. Front edge shall be within $\frac{1}{8}"$ of finished surface and plumb within $\frac{1}{8}"$
4. Install outlets and boxes securely and support them substantially.
 - a. Anchor boxes into masonry construction with 1 or more integral flanges.

CC. Seal conduits as follows:

1. Upon completion of installation of conduits and boxes, inspect interiors of conduits and boxes; clear blockages; and remove burrs, dirt, and construction debris.

2. After cable has been installed and connected, seal conduit ends by non-hardening duct sealing compound forced into conduits to depth $\geq$ conduit diameter.
 - a. This shall apply for conduits at hand-holes, manholes, and building entrance junction boxes, and for 1" and larger conduit connections to equipment.

DD. Provide conduit identification as follows:

1. Provide conduit identification tags in manholes, hand-holes, building entrance pull boxes, junction boxes, and equipment.
2. Attach identification tags shall be attached to conduits with nylon tie wraps.
3. Position tags to be visible for inspection.
4. Labels shall designate conduit destination.

3.3 **Field Quality Control**

A. Install conduit exposed unless specifically noted otherwise.

1. Concealed and underground conduits shall be inspected by City's Representative prior to concealment.

B. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Raceway and Boxes	Installation, & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Cleanliness	Snake conduits with conduit cleaner equipped with cylindrical mandrel of diameter $\geq 85\%$ of nominal diameter of conduit.	1 each conduit $\geq 2"$	Contractor	Contractor
	Continuity	Test resistance of feeder conduits from service to point of final distribution using 1 conductor return. Resistance shall be $\leq 25\Omega$	1 each conduit	Contractor	Contractor
	11-month Warranty Inspection	Confirm Work conforms to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 26 05 47

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of cabinets and enclosures.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 05 05 19: Post-Installed Concrete Anchors
- J. Section 26 05 10: Common Work Results for Electrical
- K. Section 26 05 26: Grounding and Bonding for Electrical Systems
- L. Section 26 05 33: Raceway and Boxes for Electrical Systems
- M. Section 26 08 00: Commissioning of Electrical Systems

1.3 System Description

- A. Furnish and install cabinets and enclosures, including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and applicable building codes and standards.
- B. Cabinets and enclosures shall protect enclosed electrical and instrumentation equipment from high or low ambient temperature, freezing, airborne dust, wind, humidity, wet weather, corrosive, and hazardous environments.
 - 1. If equipment enclosed by cabinetry does not incorporate derating and necessary oversizing to meet Manufacturer's warranty requirements and specified performance criteria at design conditions shown in Section 01 10 01, provide heating, cooling, ventilation, dehumidifying, filtering, or other devices needed to maintain cabinet interior environmental conditions within electrical equipment Manufacturer's limits and warranty requirements.
 - 2. Size cabinet-mounted HVAC equipment to maintain cabinet interior environmental conditions within Manufacturer's limits under worst conditions shown in Section 01 10 01.
 - a. Provide air filters to protect against dust in outside air used to cool enclosure interiors.
 - b. Sizing of cabinet-mounted HVAC equipment shall be supported by Engineering Calculations and include a margin of safety of $\geq 3^{\circ}\text{F}$ for refrigeration equipment and 10% of airflow for ventilation equipment.
 - 3. Provide conduit, wiring, and overcurrent protection required to power and control HVAC equipment furnished.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment
2. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
3. California Building Code (CBC)
4. California Energy Code (CEnc)
5. California Fire Code (CFC)
6. NEMA/ANSI 250 Enclosures for Electrical Equipment
7. NFPA 70 National Electric Code (NEC)
8. UL50 Enclosures for Electrical Equipment Non-Environmental Considerations

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit per equipment Shop Drawing requirements.	.
	Submit information on proposed ventilation or HVAC equipment required to protect furnished equipment. Include tabulation of Manufacturers' acceptable cabinet temperatures and humidity's for control equipment furnished. Include equipment Manufacturer's recommendations for venting, forced air ventilation, or refrigeration required to provide enforceable warranties for their equipment.	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Engineering Calculations	Submit for sizing of cabinet-mounted HVAC systems.	
	Submit for seismic anchorage per Section 01 73 24.	
Certificate of Compliance	Submit coating system and application certification per Certificate of Compliance requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, and Certificates of Compliance.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of cabinets and enclosures.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
NEMA 1 – General Purpose Enclosures	Adalet / ScottFetzer Genlo Series	Cleveland, OH (216) 267-9000
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Integra Enclosures / Winncom	Solon, OH (888) 946-6266
	Accepted equal	
NEMA 2 – Drip-proof Enclosures	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Integra Enclosures / Winncom	Solon, OH (888) 946-6266

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Accepted equal	
NEMA 3R – Rainproof, Sleet-Resistant Enclosures	Adalet / ScottFetzer Genlo Victory Series	Cleveland, OH (216) 267-9000
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Hubbell Wiegmann	Santa Fe Springs, CA (714) 620-6300
	Integra Enclosures / Winncom	Solon, OH (888) 946-6266
	Accepted equal	
NEMA 4X – Stainless Steel Watertight, Corrosion-Resistant Enclosures	Adalet / ScottFetzer Genlo Victory Series	Cleveland, OH (216) 267-9000
	Hammond Manufacturing Company, Inc.	Cheektowaga, NY (716)630-7030
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Hubbell Wiegmann	Santa Fe Springs, CA (714) 620-6300
	Accepted equal	
NEMA 4X – Fiberglass Watertight, Corrosion-Resistant Enclosures	Adalet / ScottFetzer Genlo Series	Cleveland, OH (216) 267-9000
	Carlson / Lamson & Session Co	Cleveland, OH (800) 346-2646
	Hammond Manufacturing Company, Inc.	Cheektowaga, NY (716)630-7030
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Hubbell Wiegmann	Santa Fe Springs, CA (714) 620-6300
	Accepted equal	
NEMA 7 – Explosion Proof Enclosures Rated for Class I Locations	Adalet / ScottFetzer Hazlo Series	Cleveland, OH (216) 267-9000
	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Accepted equal	
NEMA 9 – Explosion Proof Enclosures Rated for Class II Locations	Adalet / ScottFetzer Hazlo Series	Cleveland, OH (216) 267-9000
	Appleton / Emerson	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	Accepted equal	
NEMA 12 – Industrial Use Enclosures	Adalet / ScottFetzer Genlo Victory Series	Cleveland, OH (216) 267-9000
	Hammond Manufacturing Company, Inc.	Cheektowaga, NY (716)630-7030
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Hubbell Wiegmann	Santa Fe Springs, CA (714) 620-6300
	Integra Enclosures / Winncom	Solon, OH (888) 946-6266
	Accepted equal	
NEMA 13 – Oil-Tight, Dust-Tight Enclosures	Adalet / ScottFetzer Genlo Victory Series	Cleveland, OH (216) 267-9000
	Hoffman-Panduit / Pentair	Anoka, MN (763) 545-1730
	Integra Enclosures / Winncom	Solon, OH (888) 946-6266
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Cabinets and enclosures shall meet selection requirements of NEC Table 110.20.
- C. Materials for cabinets shall be:

ITEM	MATERIAL	SPECIFICATION
NEMA 1 – General Purpose Enclosures	Steel	NEMA 1 Thickness ≥14-gauge Conform to UL50
NEMA 2 Damp-Proof Enclosures	Steel	NEMA 2 Thickness ≥14-gauge Conform to UL50
NEMA 3 – Dust-Tight, Rain-Tight Enclosures	Steel	NEMA 3 Thickness ≥14-gauge Conform to UL50
NEMA 3R – Rainproof, Sleet-Resistant Enclosures	Steel	NEMA 3R Thickness ≥14-gauge Conform to UL50
NEMA 4 – Watertight Enclosures	Steel	NEMA 4 Thickness ≥14-gauge Conform to UL50

ITEM	MATERIAL	SPECIFICATION
NEMA 4X – Watertight, Corrosion-Resistant Enclosures	Stainless Steel	NEMA 4X Thickness ≥ 14 -gauge Gasketed Conform to UL50
NEMA 4X – Watertight, Corrosion-Resistant Enclosures	Fiberglass-Reinforced Polyester	NEMA 4X Shall contain >25% fiberglass by weight
NEMA 4X – Watertight, Corrosion-Resistant Enclosure Transparent Covers	Polycarbonate	
NEMA 7 – Explosion Proof Enclosures Rated for Class I Locations	Steel	NEMA 7 Thickness ≥ 14 -gauge
NEMA 9 – Explosion Proof Enclosures Rated for Class II Locations	Steel	NEMA 9 Thickness ≥ 14 -gauge
NEMA 12 – Industrial Use Enclosures	Steel	NEMA 12 Thickness ≥ 14 -gauge Gasketed Conform to UL50
NEMA 13 – Oil-Tight, Dust-Tight Enclosures	Steel	NEMA 13 Thickness ≥ 14 -gauge Conform to UL50

D. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
All Cabinets and Enclosures	Construction	Galvanized sheet steel, stainless sheet steel, fiberglass, or polycarbonate as required for NEMA ratings. Flush- or surface-mounted boxes as shown Metal frames shall use reinforced code-gauge metal
	Doors	Provide separate hinged doors for each starter, feeder, panel, controller, or other unit. Door size shall permit $\geq 110^\circ$ door swing within dimensional constraints of equipment room. Doors shall be key-lockable. Key door locks alike per City's requirements.
	Dimensions	Size to conform with NEC.
	Nameplates	Refer to Section 26 05 10.
	Ventilation	Provide adequate ventilation for enclosed equipment
	Exterior Finish	For steel provide rust-inhibiting primer and then Manufacturer's factory-baked enamel Refer to Section 09 90 00 Color ANSI 49 Medium-light gray / ANSI 61 Gray / White / selected by City's Representative. Plate unpainted parts for corrosion resistance
		For stainless steel, do not paint. Grind door front smooth
		For plastic or FRP, do not paint
	Interior Finish	For steel provide rust-inhibiting primer and then Manufacturer's factory-baked enamel on interior panels and directory frame print pockets. Refer to Section 09 90 00 Color ANSI 49 Medium-light gray / ANSI 61 Gray / White / selected by City's Representative
		For stainless steel, do not paint. Grind door front smooth
		For plastic or FRP, do not paint
	Print Pocket	Provide with index card holders and cards mounted behind heavy transparent plastic on backside of cabinet doors
	Directory Frame	Provide interior directory metal frame, heavy transparent

ITEM	DESCRIPTION	
		plastic cover and enclosed directory card on backside of panel doors
Wall-Mount Cabinets	Construction	Conform to NEMA type shown
	Back Panel	Provide removable steel back panels for mounting equipment. Equip cabinet back panels with ground bus bar.
	Knockouts	Provide appropriate size and quantity of knock-outs for conduit entry.
Floor-Mount Vertical Cabinets	Construction	Conform to NEMA type shown Free-standing, floor-mounted preassembled type Provide 19" EIA adjustable mounting rails for front and rear equipment mounting. Group cabinets side by side with side panels on each section.
	Rear Doors	Vented except as otherwise shown
	Front Doors	Vented top and bottom except as otherwise shown.
	Side Panels	Thickness $\geq$ 18-gauge
	Top Panel	Plain
	Exterior Dimensions	Overall Width 20"
		Overall Height 87" nominal / As shown on Plans
		Overall Depth 20" / 25" nominal
	Interior Dimensions	Panel Width 19"
		Panel Height 78 $\frac{3}{4}$ "
	Compartment Dimensions	Unit Spaces Divide each vertical standard section into 12 usable 6.5"-high unit spaces
		Space Factors 2 unit spaces = 13" = 1 space factor Do not provide fractional space factor compartments except where shown on Plans.
	Empty Panel Spaces	Provide 19"-wide panels of color matching cabinet for unused vertical mounting units. Filler panel height shall be $\leq$ 10 $\frac{1}{2}$ "
Pedestals	Construction	Conform to NEMA type shown for outdoor or wet locations. Continuously welded seams. Secure panel with security screws. Pre-drill pedestal for mounting of equipment such as intercom stations and loop detectors
	Access Panel	Provide gasketed panel to access enclosed equipment.
	Dimensions	As shown
	Exterior Finish	For steel, refer to Section 09 90 00 Color ANSI 61 Gray / selected by City's Representative.
		For stainless steel, do not paint. Grind door front smooth
	Interior Finish	Use Manufacturer's enamel on directory frame print pockets and interior panels. Color ANSI 61 Gray / White / selected by City's Representative
Power Strips	General	Provide plug-in or hardwired outlet strips as required to support installed equipment.
	Case	Metallic
	Plug-In Power Strips	Provide with locking plug and use only with compatible locking-type receptacle
NEMA 3R Rainproof Sleet-Resistant Steel Enclosures Wrapped around NEMA 1 Gasketed Enclosure Rainproof Sleet-Resistant Steel Enclosures	Construction	Provide NEMA 1 enclosure inside NEMA3R enclosure
	Enclosure	Continuously welded seams Provide rolled lip around sides of door and around sides of enclosure opening.
	Door	Provide full-length piano hinges with door removable by pulling stainless-steel hinge pin.

ITEM	DESCRIPTION	
	Gasket	Attach with oil-resistant adhesive. Secure with steel retaining strips
	Hardware	Provide clamps, screws, hinge pins, hasp, and staple for padlocking
NEMA 4X – Watertight, Corrosion-Resistant Stainless Steel Enclosures	Enclosure	Continuously welded seams Provide rolled lip around sides of door and around sides of enclosure opening.
	Door	Provide full-length piano hinges with door removable by pulling stainless-steel hinge pin.
	Gasket	Attach with oil-resistant adhesive. Secure with steel retaining strips
	Hardware	Provide clamps, screws, hinge pins, hasp, and staple for padlocking
NEMA 4X – Watertight, Corrosion-Resistant Fiberglass Enclosures	Enclosure	Heavy-duty hot compression molded
	Door	Cover hinges manufactured from nonmetallic materials
	Gasket	Neoprene cemented into molded labyrinth on cover
	Hardware	Provide nonmetallic latches suitable for padlocking
NEMA 12 – Industrial Use Enclosures	Enclosure	Continuously welded seams Provide rolled lip around sides of door and around sides of enclosure opening.
	Door	Provide full-length piano hinges with door removable by pulling stainless-steel hinge pin.
	Gasket	Attach with oil-resistant adhesive and secure with steel retaining strips
	Hardware	Provide clamps, screws, hinge pins, hasp, and staple for padlocking
	Lighting and Utility Circuitry (PLC enclosures)	For PLC enclosures, provide 120VAC 15-amp duplex output and single-pole 120VAC 15-amp circuit breaker. Provide fluorescent lamp in panel.

E. The following electrical design criteria are required for equipment specified in this section:

ITEM	DESCRIPTION	
Electrical Work	NEC Article 505 Classification	Nonhazardous Class I Division 1 (wet well) Class I Division 2 (dry well)
Enclosures – Indoor Dry Locations	NEMA 250 Enclosure Rating	NEMA 12 – Industrial Use NEMA 1 – General Purpose As shown on plans
Enclosures – Indoor or Vault-Enclosed Damp Locations	NEMA 250 Enclosure Rating	NEMA 12 – Industrial Use NEMA 2 – Drip-tight As shown on plans NEMA 4 – Watertight NEMA 4X – Watertight, Corrosion-Resistant, Stainless steel
Enclosures – Outdoor or Wet Locations	NEMA 250 Enclosure Rating	NEMA 4X – Watertight, Corrosion-Resistant, Stainless steel NEMA 3 – Dust-tight, Rain-tight NEMA 3R – Rainproof, Sleet-Resistant NEMA 4 – Watertight As shown on plans Mount enclosures $\geq \frac{1}{4}$ " from walls to provide air space. Enclosure entrances shall be threaded.
Enclosures – Class I Division 1 Wet Well Locations	NEMA 250 Enclosure Rating	NEMA 7 – Explosion Proof, Rated for Class I Locations As shown on plans
Enclosures – Class I Division 2 Dry Well Locations	NEMA 250 Enclosure Rating	NEMA 7 – Explosion Proof, Rated for Class I Locations

ITEM	DESCRIPTION	
		As shown on plans
All Enclosures	Construction	Lockable With powdercoat epoxy finish on steel surfaces
	IEC 60529 Enclosure Rating for Underground Equipment	IP 65 dust-tight + low-pressure water jet
Enclosure or Instrument Mounting	Local Mount	Panel-mount Surface-mount on wall / instrument board Pipe-mount Skid-mount See plans
	Remote Mount	MCC Telemetry cabinet See plans

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install cabinets and enclosures before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Examine areas and conditions under which Work of this section will be performed.
 - 1. Correct conditions detrimental to timely and proper completion of Work.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for basic execution and installation requirements.
- B. Furnish and install cabinets and enclosures at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 - 2. Other applicable OSHA and Cal OSHA regulations
 - 3. California Electrical Code Article 312 "Cabinets, Cutout Boxes, and Meter Socket Enclosures"
 - 4. California Electrical Code Chapter 4 "Equipment for General Use"
 - 5. Other applicable building, fire, and electrical code requirements
 - 6. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install cabinets and enclosures to tolerances recommended by Manufacturer.
 - 1. Unless otherwise shown, install cabinets and enclosures true, plumb, and level using precision gauges and levels.
- F. Provide pedestals conforming to NEC as required for proper equipment installation.
 - 1. Install pedestal in accessible locations.
 - 2. Coordinate installed conduit locations so conduit is stubbed up inside pedestal enclosure.
 - 3. Provide working clearances meeting NEC requirements for electrical equipment.
 - 4. Secure to concrete with Type 304 SS anchor bolts, self-drilling anchors, or expansion anchors per Section 05 05 19.
 - a. Do not use powder-actuated fasteners.

- b. Locate anchors so they are only accessible from inside enclosure.
- G. Provide cabinets conforming to NEC as required for proper equipment installation.
 - 1. Install cabinets and enclosures in accessible locations.
 - 2. Provide working clearances meeting NEC requirements for electrical equipment.
 - 3. Pedestal cabinets shall be large enough and equipment shall be spaced to provide room for airflow and maintenance.
 - 4. Secure to concrete with Type 304 SS anchor bolts, self-drilling anchors, or expansion anchors per Section 05 05 19.
 - a. Do not use powder-actuated fasteners.
 - 5. Close unused cabinet openings to provide protection equal to that of cabinet walls.
- H. Provide venting, ventilation, heating, air conditioning, and dehumidification as shown, and as required to:
 - 1. Conform to electrical equipment warranty requirements.
 - 2. Prevent condensation from damaging enclosed electrical equipment.
 - 3. Maintain interior cabinet temperatures at $\leq 95^{\circ}\text{F}$.
 - a. Locate heat-producing equipment including power supplies near top of cabinets.
 - 4. Where forced air cooling is required, provide ventilation fans, vents, and filters.
 - a. For cabinets with forced ventilation, doors and side panels shall be solid with no louvers.
 - 5. Construct top-mounted air-conditioning units to prevent condensation from damaging electrical equipment or enclosure.
 - 6. Maintain temperatures inside cabinet to within recommended Manufacturer's limits for equipment mounted in cabinet, and $\leq 14^{\circ}\text{F}$ (8°C) above ambient.
 - 7. Submit calculations to City for approval prior to manufacturing.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cabinets and Enclosures	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Condensation	No visible condensation from top-mounted AC units	1 inspection	City	City
	NEC Clearances	Meet NEC §110.26 clearance requirements	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed Literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed Literature	1 test	City	Contractor

3.4 Protection

- A. Dress cables neatly within cabinets and enclosures.
 - 1. Trim and dispose of excess cable.
- B. After equipment is installed, touch up scratches and marks incurred during shipment or installation.
 - 1. If required by City's Representative due to excessive scratching, repaint entire assemblies.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Work Included

- A. Testing, commissioning and startup of electrical system equipment, components, materials, wiring, and grounding.
- B. Provide services of City-accepted third-party Electrical Testing Agency (ETA) to provide the following acceptance tests and inspections in accordance with applicable sections of NETA ATS, Contract Documents, and Manufacturer's recommendations:
 - 1. Field tests for electrical power conductors and cables
 - 2. Field tests of grounding and bonding systems
 - a. Refer to Section 26 05 26 for field tests of grounding and bonding systems.
 - 3. Tests identified as optional in NETA ATS are only required where specified.
- C. Refer to sections for individual equipment items for additional testing and commissioning requirements.
- D. Testing, commissioning and startup of the following electrical Work will be performed by others and are excluded from the scope of this section
 - 1. Testing of instrumentation and controls systems

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 73 00: Execution
- F. Section 26 05 10: Common Work Results for Electrical
- G. Section 26 05 19: Low-Voltage Electrical Power Conductors and Cables
- H. Section 26 05 26: Grounding and Bonding for Electrical Systems

1.3 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Perform factory tests required by applicable industry standards or NRTL before shipping equipment.
- C. Factory tests will not be accepted as substitute for specified field accepted tests.

1.4 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 - 2. California Electrical Code (CEC)
 - 3. IEEE 400 Field Testing and Evaluation of Insulation of Shielded Power Cable Systems
 - 4. IEEE 400.3 Partial Discharge Testing of Power Cable Systems in Field Environment
 - 5. NETA ATS Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
 - 6. NFPA 70 National Electric Code (NEC)
 - 7. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance (ANSI)
 - 8. NFPA 70E Electrical Safety Requirements for Employer Workplaces

9. NRTL Nationally Recognized Testing Laboratory

10. TIA/EIA/ANSI 455-78-B Optical Fibres Part 1-40 Measurement Methods and Test Procedures - Attenuation

1.5 Submittals

A. Furnish the following submittals with bid or within 72 hours following bid opening.

1. Failure to submit required information on time may cause City to determine and assign City-accepted testing company to be employed by Contractor at no cost to City.

SUBMITTAL	DESCRIPTION	
PREMOBILIZATION SUBMITTALS		
Electrical Test Agency Qualifications	Submit name and qualifications of ETA	
	Submit documentary evidence ETA has been in business in California for ≥5 years	
	Submit name and qualifications of lead engineer or engineering technician performing required testing services along with documentary evidence proposed onsite foreman has worked in such capacity in employ of subcontractor ≥3 years and has completed ≥3 installations of product. Include reference names and telephone numbers	
	Submit ETA's quality assurance program	
	Submit ETA's instrument calibration and equipment testing program	
	Submit ETA's electrical safety program.	

B. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Pre-Test Submittals	Submit equipment Manufacturer's instructions for testing manufactured products	.
	Submit phasing diagrams showing coordinated phasing for 3 ϕ power showing coordinated phase rotations with generators and motors through transformers.	
	Submit photocopies of continuity tests before energizing equipment.	
	Submit test data forms	
CLOSEOUT SUBMITTALS		
Post-Test Submittals	Submit summary of testing for Work including date and time of tests	
	Submit information from pre-energization testing.	
	Submit description of equipment tested	
	Submit description of tests and test procedures At least 45 days prior to planned testing, submit acceptance and system functions test plan for each equipment item or system to be field tested Include applicable procedures, forms, and lists of test equipment. Do not perform testing until test plan and procedures have been accepted.	
	Submit tabulated data for each piece of equipment tested, including circuit number, equipment or motor name and tag number (where applicable), nameplate full-ampere rating, motor service factor, motor ambient temperature rating, overload relay rating, measured full load current, and measured discharge pressures (where applicable)	
	Submit certified copies of inspection reports, test reports, and system function tests. Reports shall include certification of compliance with specified requirements including test instrument calibration, identification of deficiencies, and recommendation of corrective action when appropriate. Type and neatly bind test reports to form part of final record.	
	Submit conclusions and recommendations	
	Submit completed test forms in appendix, including witness's signatures.	
	Submit list of test equipment in appendix including calibration documents	
	Submit test report ≤10 days after each test is completed	
	Refer to Section 26 08 13 for short circuit and coordination report submittal requirements.	
	Refer to Section 26 08 16 for arc-flash hazard analysis and report submittal requirements.	
Deviations from Contract Documents	Note or indicate wiring deviations from Contract Documents on Project Record Documents.	

C. Refer to Section 01 33 00 for definition of requirements for submittals.

D. Include the following minimum information in each data record:

1. Identification of ETA.
2. Equipment identification: Equipment ID code based on Drawings
 - a. Where applicable, include building number, and system identifier.
3. Humidity, temperature, and other conditions that may affect results of tests or calibration of test equipment.
4. Date inspection, test, or function test was performed.
5. Identification and signature of testing technician.
6. Description of inspections, tests, maintenance, and function tests performed and recorded.
7. Test equipment used and references to calibration records.
8. Indication of as-found condition and as-left results.

E. Include the following information in final test report:

1. Summary of project.
2. Description of equipment inspected and tested.
3. Description of inspections and tests.
4. Data record resulting from each inspection and test.
5. Results of system function tests.
6. Analysis of tests, identification of deficiencies, and recommendations for corrective action.

F. Refer to Part 3 below for schedule of required field tests.

1.6 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Testing Firms**

- A. Retain qualified engineering appraisal and testing firm to perform inspections, tests, and evaluation to determine equipment designated herein is installed and adjusted for successful energization and operation.
- B. Testing firm shall meet Federal OSHA criteria for accrediting testing laboratories, Title 29, Part 1910.7, and have work history and qualifications acceptable to City.
 1. Appraisal and testing firm shall have ≥ 2 years of experience in appraising and testing equipment of nature to be tested.
 2. Managing or supervising representatives of appraisal and testing firm shall have extensive knowledge of products involved and ≥ 2 years hands-on experience conducting appraisals and tests.
 3. Conduct testing under supervision of managing or supervising representatives.
 4. Testing technicians shall be trained and experienced in type of testing to be performed.
- C. ETA shall be independent testing organization which shall function as unbiased testing authority, independent of Manufacturers, suppliers, and installers of equipment or systems evaluated.
 1. ETA shall be regularly engaged in testing of electrical equipment devices, installations, and systems.
 2. ETA shall have documented quality assurance program, documented inspection and test and procedures, and documented electrical safety program.

3. ETA shall have completed ≥ 10 acceptance testing, inspection and calibration projects of similar scope to this project.
 4. ETA shall have a calibration program
 - a. Test instruments used shall be calibrated per NETA ATS.
 5. ETA technicians performing testing, inspection, calibration, and adjustments shall be “qualified persons” as defined by NFPA 70E and NEC.
 6. Technicians performing electrical tests and inspections shall be trained and experienced concerning apparatus and systems being evaluated.
 7. Technicians shall be capable of conducting tests in safe manner with knowledge of hazards involved and appropriate safety-related work practices.
 8. Technicians shall be qualified to evaluate test data and make judgment on serviceability of specific equipment.
 9. Testing, inspection, calibration, and adjustments shall be performed or supervised on Project site by ETA employee with following minimum qualifications:
 - a. Personnel shall have ≥ 5 years’ experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices, and
 - b. Personnel shall have 1 of the following certifications/registrations:
 - c. Certification to at least Level III per ANSI/NETA ETT Standard for Certification of Electrical Testing Technicians (ANSI), or
 - d. Certification to at least NICET ET-grade in Electrical Testing Engineering Technology.
 10. Responsible ETA employee shall coordinate with City’s system integrators and operators.
- D. As an alternative, ETA testing firms and technicians may be certified by electrical equipment Manufacturers and accepted by City for types of tests required on their equipment.
- E. Testing firm shall use comprehensive report forms to document engineering appraisal and test results on equipment and products tested.
1. Upon testing completion, managing or supervising engineering representative shall sign forms prior to inclusion in final report.
- F. Obtain written acceptance from City of testing firm prior to beginning testing.
1. Testing service or personnel may be accepted or rejected based on, but not limited to testing equipment intended to be used, qualifications of firm, completeness of testing forms, and experience and reputation of personnel.

PART 3 - EXECUTION

3.1 Preparation

- A. Examine areas and conditions under which Work of this section will be performed.
 1. Correct conditions detrimental to timely and proper completion of Work.
- B. Verify correct phase rotation of equipment before making connections at service entrance, transformers, or motors permanent.
 1. Coordinate with Servicing Electrical Utility for phase rotations and Phase A, B, and C markings.
 2. Create phasing diagram showing coordinated phase rotations with generators and motors through transformers.
 3. Coordinate motor phasing inspections with City’s Representative.
 4. Submit written report to City’s Representative for each motor verifying phasing has been checked and corrected.

5. Install and insulate these connections temporarily while determining proper rotation.
 6. Make permanent connections after rotation has been established and subsequent to completion of component insulation resistance and dielectric tests.
- C. Schedule project to allow adequate time for electrical acceptance testing before electrical Work is energized.
1. Notify ETA when equipment becomes available for acceptance inspections and tests.
 2. Coordinate Work to expedite inspections and tests.
- D. Notify City's Representative ≥ 7 Calendar Days before tests to allow City to witness testing.
1. Notify City again 24 hours before start of testing.
 2. City will arrange for witnessing of tests and inspections by appropriate personnel when required by submitted Test and Inspection Plan, applicable codes and consensus standards, or when City deems appropriate.
- E. Supply 1 set of following to ETA prior to final testing:
1. Preliminary short-circuit analysis
 2. Preliminary coordination study and protective device setting table
 3. Complete set of electrical Contract Documents plus pertinent Change Orders
 4. Accepted construction submittal documents.
 5. Site specific hazard notification and safety training.
 6. Other information necessary for safe and accurate test and inspection of system.
- F. Perform installation insulation-resistance, continuity, and rotation tests for electrical Work prior to tests performed by ETA.
- G. Provide suitable and stable electrical power, and adequate lighting as required at each test site for ETA to perform specified acceptance testing.

3.2 Field Quality Control

- A. Refer to Section 01 73 00 for basic execution requirements.
- B. Conform to the following testing standards:
1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 2. Other applicable OSHA and Cal OSHA regulations
 3. California Electrical Code
 4. NETA (National Electrical Testing Association) ATS standards
 - a. NETA ATS 7.3.2 for low-voltage cable inspections and tests.
 - b. NETA ATS 7.6.1.1 for low-voltage molded-case circuit breaker tests.
 - c. NETA ATS 7.10 for instrument transformer inspections.
 - d. NETA ATS 7.13 for grounding inspections and tests.
 5. Manufacturer's installation and warranty requirements
 6. Other applicable ANSI, ASTM, and NEMA standards.
- C. Refer variances between above documents and Contract Documents to City's Representative.
- D. Test electrical equipment in 3 phases.
1. Pre-energization testing.
 2. Equipment energized with no load.
 3. Equipment energized under load.

- E. Perform calibration and setting checks with calibrated test instruments of at least twice that of accuracy of equipment, device, relay or meter under test.
 - 1. Dated calibration labels shall be visible on test equipment.
 - 2. Calibrations > 6 months old are not acceptable on field test instruments.
 - a. Inspect test instruments for proper operation prior to testing.
 - 3. Record serial and model numbers of instruments used on test forms.
- F. Testing of installed equipment shall result in acceptable test results.
 - 1. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, will be deemed as not meeting Contract Requirements.
- G. Repair or replace items not passing tests.
- H. Do not place equipment into service until required tests have been completed, test results have been evaluated and accepted, and recommended or required adjustments have been completed.
- I. Provide supervision, labor materials, tools, test instruments, and equipment or services required to test, adjust, set, calibrate, and operationally check Work and components of various electrical systems and circuitry.
 - 1. During checkout and startup of plant systems, provide skilled workers for checkout and troubleshooting as required by City's Representative.
 - a. Since coordination with other crafts and contractors may be required, make workers assigned to checkout available outside normal working hours when necessary.
 - 2. Provide services of factory-authorized representative on-site as needed to provide:
 - a. Installation assistance, inspection and startup of complete electrical system.
 - b. Field testing and adjustment.
 - c. Instruction of City's personnel in operation and maintenance.
- J. Tests shall:
 - 1. Provide initial equipment/system acceptance,
 - 2. Provide recorded data for future maintenance and troubleshooting, and
 - 3. Provide assurance each system component is installed satisfactorily and can be expected to perform and continue to perform its function with reasonable reliability.
- K. Schedule tests and inspections as job progresses.
 - 1. Allow City's Representative to inspect materials, equipment, and workmanship.
 - 2. After each electrical system installation is complete, perform tests to verify system is in proper working order and in accordance with Contract Documents, Manufacturer's Installation Instructions, and applicable codes.
 - 3. Conduct tests in presence of City's Representative.
 - a. Notify City's Representative 7 days in advance of tests scheduled to be performed.
 - 4. Perform insulation and ground resistance tests before operating tests.
- L. Perform specified tests in presence of City's Representative.
 - 1. Furnish testing equipment and pay costs of tests, including replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation.
 - 2. Correct test failures in manner satisfactory to City's Representative.
- M. Perform insulation tests on electrical equipment at the following times and conditions:
 - 1. Prior to energizing and/or placing into service.
 - 2. When damage to insulation is suspected.
 - 3. After repairs or modifications to equipment affecting insulation.

4. When necessary to evaluate condition of equipment insulation, especially in high ambient moisture conditions, and to determine need for drying, cleaning, or other maintenance work or protection of such equipment.
 5. Where lightning or other surge conditions are known to have passed through circuit.
- N. Make openings in circuits for test instruments and place and connect instruments, equipment, and devices, required for tests.
1. Upon completion of tests, remove instruments and instrument connections and restore circuits to permanent condition.
- O. Pay for tests, including expenses incident to retests occasioned by defects or failures of equipment to conform to Contract Documents.
- P. Do not void equipment warranties or guarantees by testing.
1. Checks and tests shall be supplemental to and compatible with Manufacturer's Installation Instructions and warranty requirements.
 2. Where deviations are warranted, obtain Manufacturer's written acceptance prior to testing.
 3. Where repairs, modifications, adjustments, or tests are to be made, notify City's Representative and make such repairs, modifications, adjustments and tests in accordance with Manufacturer's recommendations.
- Q. Report to City's Representative electrical equipment or systems determined to be damaged, or faulty.
1. Report to City, within 3 Working Days, Work or construction found defective based on acceptance tests or inspections by ETA.
 2. Obtain acceptance from City's Representative for corrective action and retesting.
 3. Within 21 Calendar Days of direction from City, rework, repair or replace Work found defective based on acceptance tests or inspections.
 - a. Replace wiring and equipment found defective.
 4. Retest Work failing acceptance tests or inspections.
- R. Coordinate Work to expedite project schedule.
- S. Field inspection and testing shall conform to NETA ATS and include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
FIELD TESTS AND INSPECTIONS					
Conductors and Cables Section 26 05 19	Installation Examination	Verify correctness of wiring by visually comparing conductor connections with connection diagrams.	1 inspection	Contractor	Contractor
		Inspect for physical damage and correct connections	1 inspection	Contractor	Contractor
		Inspect for damage to insulation and jackets	1 inspection	Contractor	Contractor
		Inspect connections for high resistance	1 inspection	Contractor	Contractor
		Inspect compression-applied connections for correct cable match and indentation	1 inspection	Contractor	Contractor
	Low Voltage Cable	Refer to NETA ATS 7.3.2	1 inspection	Contractor	Contractor
	Field Tag Verification	Verify proper identification numbering and/or color coding for cables and wiring during continuity testing.	1 test each phase of each circuit	Contractor	Contractor
	Continuity	Make individual circuit continuity checks using electrical circuit testers.	1 test each phase of each	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
			circuit		
	High Resistance	Test connections for high resistance using low resistance ohmmeter	1 test each phase of each circuit	Contractor	Contractor
	High-Potential Test	Conduct tests at 1000VDC for 2 minutes Wire and cable shall withstand test high voltage without breakdown and have steady or decreasing leakage during test	1 test each phase of each circuit ≤600VAC	Contractor	Contractor
	Insulation Resistance (Megger Test) Conductors ≤600VAC	Conduct tests at 1000VDC for 2 minutes to measure insulation resistance. Resistance between conductors and between each conductor and ground shall be >10 megΩ and recommendations of cable Manufacturer Measure insulation resistance for motor feeders after disconnecting motors and other equipment that might be damaged. Measuring from load side of conductors or circuit breakers.	1 test each phase of each circuit ≤600VAC before energizing	Contractor	Contractor
	Uniform Resistance	On circuits ≥#6AWG, verify uniform resistance of parallel conductors.			
Motors	Motor Inspection and Tests	NETA ATS 7.15	All motors ≥¾hp	Contractor	Contractor
	Motor Operating Test – Insulation Resistance, Continuity, Rotation	Perform routine insulation resistance, continuity and rotation tests for distribution and utilization equipment including motors >¾Hp before and in addition to tests performed by test laboratory. Supply suitable and stable test power source to test laboratory at each test site. Test laboratory shall specify requirements. Notify test laboratory when equipment becomes available for acceptance tests. Perform testing in presence of City's Representative. Test laboratory shall implement final settings and adjustments on protective devices and tap changes. Test laboratory shall record test results and upon completion, assemble and certify final test report	All motors ≥¾hp	Contractor	Contractor
	Motor Operating Test - Current	Record current in each phase of each motor ≥¾-hp and include in O&M manual. Repair or replace motor or motor-driven equipment if current > motor nameplate FLC value.	Each phase of each motor ≥¾hp	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
SYSTEM DEMONSTRATION					
	System Demonstration	Refer to Section 26 08 00.	All electrical systems	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 26 27 26**WIRING DEVICES****PART 1 - GENERAL****1.1 Work Included**

- A. Materials, testing, and installation of switches, receptacles, and other wiring devices.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
 B. Section 01 33 00: Submittal Procedures
 C. Section 01 40 00: Quality Requirements
 D. Section 01 61 00: Common Product Requirements
 E. Section 01 65 00: Product Delivery Requirements
 F. Section 01 66 00: Product Storage and Handling Requirements
 G. Section 01 73 00: Execution
 H. Section 26 05 10: Common Work Results for Electrical
 I. Section 26 05 19: Low-Voltage Electrical Power Conductors and Cables
 J. Section 26 05 26: Grounding and Bonding for Electrical Systems
 K. Section 26 28 00: Low-Voltage Circuit-Protective Devices

1.3 System Description

- A. Furnish and install wiring devices including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building and electrical codes and standards.

1.4 Quality Assurance

- A. Use adequate number of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Switches and Receptacles	UL Listing	UL Standards	All wiring devices	Contractor	Contractor

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 2. California Building Code (CBC)
 3. California Electrical Code (CEC)
 4. California Fire Code (CFC)
 5. California Mechanical Code (CMC)
 6. Fed Spec W-C-596 Connector, Receptacle, Electrical, General Purpose, Duplex, General Grade and Hospital Grade, Grounding, 2-Pole, 3-Wire, 20 Amperes 125Volts, 50/60 Hertz, Box-Mount and Snap-In Mount
 7. Fed Spec W-S-896E Switches, Toggle and Lock., Flush-Mounted (AC)
 8. Fed Spec W-S-896F (1P-ZP-3W) Switch, Toggle, Single Unit with Wall Plates for Switches and Receptacles.
 9. NEMA/ANSI 250 Enclosures for Electrical Equipment
 10. NEMA KS1 Enclosed Switches
 11. NEMA WD1 General Purpose Wiring Devices.
 12. NEMA WD6 Wiring Device Configurations.

13. NFPA 70 National Electric Code (NEC)
14. UL 20 General Use Snap Switches
15. UL 943 Ground Fault Circuit Interrupters
16. UL 2682 Switch-Rated Plugs and Receptacles

1.6 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Material List	Submit material list for each type of switch, receptacle, and cover plate.	
	Submit material list for each additional type of wiring device listed herein.	
	Indicate type, voltage rating, continuous current rating, conduit entry restrictions, enclosure type, dimensions, material, color, and Manufacturer.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit evidence of UL listing	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, and Certificates of Compliance.

1.7 Delivery, Storage and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage and handling of wiring devices.

1.8 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers for basic wiring devices include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
20-AMP 125VAC RECEPTACLES		
Receptacles NEMA 5-20 20A-125VAC Straight-Blade GFCI Ground Fault Current Interrupter Duplex - Outlet	3M "GFI-2701"	St Paul, MN (888) 364-3577
	Arrow-Hart / Eaton GF5342 Series	Beachwood, OH (216) 523-5000
	Hubbell / Bryant GF5362 Series	Shelton, CT (800) 288-6000
	Leviton Manufacturing Co "6398-HGI"	Melville, NY (800) 323-8920
	Pass & Seymour / Legrand 2091-F Series	West Hartford, CT (877) 295-3472
	Schneider Electric Square D	Andover, MA (888) 778-2733
	Accepted equal	
RECEPTACLE PLATES		
Receptacle Plates – "While-in-Use" Outdoor Weatherproof (WP)	Crouse Hinds / Eaton	Syracuse, NY (866) 764-5454
	General Electric	Fairfield, CT (800) 626-2000
	Hubbell / Bell	Shelton, CT (800) 288-6000
	Hubbell / Bryant RB5000 Series	Shelton, CT (800) 288-6000
	Pass & Seymour / Legrand	West Hartford, CT (877) 295-3472
	Sierra Electric Corporation	San Francisco, CA (415) 752-2850
	Accepted equal	
SWITCHES		
Wall Switches SPST	Arrow-Hart / Eaton 1991 Series	Beachwood, OH (216) 523-5000
	General Electric GE5951-G Series	Fairfield, CT (800) 626-2000
	Hubbell / Bryant 1221 Series	Shelton, CT (800) 288-6000
	Leviton Manufacturing Co "Lev-Spec" 1221-2I Series	Melville, NY (800) 323-8920

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Pass & Seymour / Legrand 20AC1 Series	West Hartford, CT (877) 295-3472
	Accepted equal	
Wall Switches DPST	Arrow-Hart / Eaton 1992 Series	Beachwood, OH (216) 523-5000
	General Electric GE5952-G Series	Fairfield, CT (800) 626-2000
	Hubbell / Bryant 1222 Series	Shelton, CT (800) 288-6000
	Leviton Manufacturing Co "Lev-Spec" 1222-2I Series	Melville, NY (800) 323-8920
	Pass & Seymour / Legrand 20AC2 Series	West Hartford, CT (877) 295-3472
	Accepted equal	
Momentary Contact Switches 20A 120/277VAC	Arrow-Hart / Eaton 1995 Series	Beachwood, OH (216) 523-5000
	General Electric GE5935-G Series	Fairfield, CT (800) 626-2000
	Hubbell / Bryant 1557 Series	Shelton, CT (800) 288-6000
	Leviton Manufacturing Co "Lev-Spec" 1257-I Series	Melville, NY (800) 323-8920
	Pass & Seymour / Legrand 1250 Series	West Hartford, CT (877) 295-3472
	Accepted equal	
SWITCH PLATES		
Switch Plates – Outdoor Weatherproof (WP)	Appleton / Emerson "FSK-1VTS" or "FSK-1VS"	Rosemont, IL (800) 621-1506
	Crouse Hinds / Eaton "DS-181" or "DS185"	Syracuse, NY (866) 764-5454
	Hubbell / Bryant 7420 Series	Milford, CT (800) 288-6000
	Accepted equal	

B. Acceptable Manufacturers for other wiring devices include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
PUSH BUTTONS, HAND SWITCHES, AND INDICATING LAMPS		
Push Buttons – Outdoor and Damp Locations	Allen-Bradley / Rockwell Automation Bulletin 800H	Milwaukee, WI (414) 382-2000
	Schneider Electric Square D Class 9001 Type SK	Andover, MA (888) 778-2733
	Accepted equal	
Selector Switches	Schneider Electric Square D Class 9001 Type K	Andover, MA (888) 778-2733
	Accepted equal	
Indicating Lights 120V	Allen-Bradley / Rockwell Automation Type PSB120	Milwaukee, WI (414) 382-2000
	General Electric "CR104PLT22"	Fairfield, CT (800) 626-2000
	Schneider Electric Square D Class 9001 Type K	Andover, MA (888) 778-2733
	Accepted equal	
RELAYS		
Control Relays 24V DPDT	Allen-Bradley / Rockwell Automation 700-HA32Z24 Relay 700 HN 125, 10A, 300V Relay Base	Milwaukee, WI (414) 382-2000
	Accepted equal	
Control Relays 24V TPDT	Allen-Bradley / Rockwell Automation 700-HA33Z24 Relay 700-HN126, 10A, 300V Relay Base	Milwaukee, WI (414) 382-2000
	Accepted equal	
Timing Control Relays 24V DPDT	Allen-Bradley / Rockwell Automation 700-HR52TZ24 Relay 700 HN 101, 10A, 300V Relay Base 700-HN131 Retainer Clip	Milwaukee, WI (414) 382-2000
	Accepted equal	
Control Relays 120V DPDT	Allen-Bradley / Rockwell Automation 700-HA32A1 Relay 700 HN125, 10A, 300V Relay Base	Milwaukee, WI (414) 382-2000
	Schneider Electric Square D Class 8501 Type KP NR51	Andover, MA (888) 778-2733
	Accepted equal	
Control Relays 120V TPDT	Allen-Bradley / Rockwell Automation 700-HA33A1 Relay 700-HN126, 10A, 300V Relay Base	Milwaukee, WI (414) 382-2000
	Accepted equal	
Timing Control Relays 120V	Allen-Bradley / Rockwell Automation 700-HR52TA17 Relay 700-HN126, 10A, 300V Relay Base 700-HN131 Retainer Clip	Milwaukee, WI (414) 382-2000
	Schneider Electric Square D Class 9050 Type JCK with socket	Andover, MA (888) 778-2733

ITEM	MANUFACTURER	MANUFACTURER LOCATION
	Accepted equal	
Time-of-Use Override Switches	Eaton Cutler-Hammer 1025016H Switch 2 NO 10250T2 Contact Block 10250T15112H501 #501CH Key	Cleveland, OH (800) 386-1911
	No exceptions	
Intrinsically Safe Barrier 24VDC Contacts and Relays	Ingram Micro / HNA Two Channel Relay with Intrinsically Safe Inputs, "ISR2-24V-10K"	Irvine, CA (714) 566-1000
	No exceptions	
Intrinsically Safe Barrier 120VAC Contacts and Relays	Warrick / Gems Sensors, Inc Series 27A1DO	Plainville, CT (855) 877-9666
	No exceptions	
TERMINAL BLOCKS		
Control Wiring Terminal Blocks 120V DIN Rail Mounted	Phoenix Contact USK-4 or USK-10 with mounting rack	Middletown, PA (800) 888-7388
	No exceptions	
Control Wiring Terminal Blocks DIN Rail Mounted	Phoenix Contact UK5N (for power and general terminations)	Middletown, PA (800) 888-7388
	Phoenix Contact UKK 5TG (for discrete I/O terminations)	Middletown, PA (800) 888-7388
	Phoenix Contact DOKD 1.5TG (for analog terminations)	Middletown, PA (800) 888-7388
	Phoenix Contact ST-SILED 24-UK 4 (for fuse-plug terminations with indicator)	Middletown, PA (800) 888-7388
	Phoenix Contact USLKG 5 (for ground terminations)	Middletown, PA (800) 888-7388
	No exceptions	
Terminal Blocks 600V	Electrovert / Wieland	Oakville, ON (905) 829-8414
	Ideal Industries, Inc.	Sycamore, IL (815) 895-5181
	Weidmuller USA	Richmond, VA (800) 849-9343
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Materials for basic wiring devices shall be:

ITEM	MATERIAL	SPECIFICATION
Receptacle Bases	Polycarbonate	High-strength
	Color	Brown
Switch Plate Type	varies	Toggle switch cover
Mounting Hardware	Mounting Holes	Countersunk
	Mounting Screws	Oval-head stainless steel screws of color matching plate
Device Plates for Receptacles and Switches	General	Plates shall fit snugly to box to which they are mounted. On surface-mounted boxes, plates shall not extend beyond sides of box unless plates are free of sharp corners or edges.
	Plate Type	Refer to table below
	Location	Plate Type
	Interior	Metal (M)
	Exterior (WP Designation)	Weatherproof (WP)
	Flush-Mounted Boxes	Metal (M)
	Surface-Mounted Cast Metal Boxes	Cast Metal (CM)
	Surface-Mounted Sheet Metal Boxes	Metal (M)
	Corrosive or Wet Areas or Areas Subject to Hosedown	Polycarbonate
WEATHERPROOF (WP) PLATES (Use for outdoor applications)		
Receptacle Plates	Stainless Steel	Provide soft-gasketed "while-in-use" cover plates ≥ 0.040 " thick

ITEM	MATERIAL	SPECIFICATION
		Provide individual spring-loaded cap over each receptacle opening. Stainless steel springs shall hold caps closed when receptacle is not in use.
Switch Plates	Stainless Steel	Provide gasketed plates ≥ 0.040 " thick Provide provisions for padlocking switches "ON" and "OFF" Incorporate external operator for internal switch

C. Materials for other wiring devices shall be:

ITEM	MATERIAL	SPECIFICATION
Push Button Enclosures	Glass Polyester	Individually gasketed
	Stainless Steel	SAE Type 430 with satin finish Individually gasketed
Terminal Blocks 120V Control Circuits	Molded Plastic	

D. Unless otherwise shown, the following electrical design criteria are required for equipment specified in this section:

ITEM	DESCRIPTION	
Electrical Work	NEC Article 505 Classification	Nonhazardous
Enclosures – Outdoor or Wet Locations	NEMA 250 Enclosure Rating	NEMA 4X – Watertight, Corrosion-Resistant, Stainless steel
Enclosures	Construction	Lockable
	IEC 60529 Enclosure Rating for Underground Equipment	IP 65 water jet

E. The following product design criteria, options and accessories are required for basic wiring devices:

ITEM	DESCRIPTION	
Receptacles		
	Ground Fault Interrupter (GFI) Duplex Receptacles	Conform to NEC Article 406 Conform to UL943, Class A Molded composition encased specification grade receptacles fitting within standard size outlet box and accepting standard device plates. Duplex receptacles for 120VAC – 1 ϕ 3-wire circuit to be rated 125VAC, 20A NEMA Configuration 5-20R UL Class A sensitivity - Trip at 5 milliamps after 0.025 seconds Rated and capable of interrupting 1000A without damage Provide #12AWG copper TW-insulated pigtails Parallel-blade grounding type for general-duty applications. Provide front-mount test feature for periodic testing of GFCI circuit Use standard model where ground fault protection is required at individual location. Use feed-thru model where ground fault protection is specified for "downstream" conventional receptacles.
	Special-Purpose Receptacles	Provide receptacles of type, rating, and number of poles shown or required for anticipated purpose. Furnish matching plugs with cord-grip features for each special purpose receptacle.
Wall Switches	General	Conform to NEMA WD 1 and Fed Spec W-S-896E Conform to NEC Article 404 Molded specification grade for flush device boxes or surface-mount FD or FS cast outlet boxes Totally enclose in composition case with insulated mounting yoke and

ITEM	DESCRIPTION	
		side-wired, binding screw-type terminals. Single pole, 2-pole, 3-way and 4-way as shown Capable of control of 100% tungsten filament and fluorescent lamp loads.
	120VAC or 277VAC Lighting Switches	20A rating 120/277VAC Quiet-operation toggle type
	Weatherproof Switches	Mount in cast metal box with gasketed weatherproof device plate.
Switch-Rated Plugs and Receptacles	Design	Conform to UL 2682

- F. The following product design criteria, options and accessories are required for other wiring devices:

ITEM	DESCRIPTION	
Push Buttons	Type	Conform to NEMA ICS2 Provide contacts with NEMA designation rating A600 Heavy-duty oil-tight
	Push-Buttons	30mm diameter round ON or START pushbuttons colored black OFF or STOP pushbuttons colored red
	Enclosure: Nonhazardous Indoor Dry Locations, including MCC's, control panels, and control stations	NEMA 12 to match panel in which mounted
	Enclosure: Nonhazardous Outdoor or Wet Locations	NEMA 4X – Watertight, Corrosion-Resistant, SAE Type 316 stainless steel to match panel in which mounted Provide required special gasketing to make complete station watertight
	Nameplate	Provide extra-large laminated plastic nameplate or legend plate on enclosure front conforming to Section 26 05 10, showing function
	Lockout Provisions	Provide for locking pushbuttons in OFF position where lockout provisions are shown.
Indicating (Pilot) Lights	Type	Conform to NEMA ICS2 Heavy-duty of same type and rating High-visibility LED type long-life ($\geq 20,000$ hours) Replaceable from panel front Color caps shall be interchangeable
	Lamps	120VAC Indicating lights shall be push-to-test type
	Enclosure: Nonhazardous Indoor Dry Locations, including MCC's, control panels, and control stations	NEMA 12 to match panel in which mounted
	Enclosure: Nonhazardous Outdoor or Wet Locations	NEMA 4X – Watertight, Corrosion-Resistant, SAE Type 316 stainless steel to match panel in which mounted Provide required special gasketing to make complete station watertight

ITEM	DESCRIPTION	
	Nameplate	Provide extra-large laminated plastic nameplate or legend plate on enclosure front conforming to Section 26 05 10, showing function
Selector Switches	Type	Conform to NEMA ICS2 Heavy-duty
	Key-operated Switches	Key switches alike Coordinate key type with City.
	Operating Levers	Standard
	Enclosure: Nonhazardous Indoor Dry Locations, including MCC's, control panels, and control stations	NEMA 4/13 Watertight-Oiltight.
	Enclosure: Nonhazardous Outdoor or Wet Locations	NEMA 4X – Watertight, Corrosion-Resistant, SAE Type 316 stainless steel to match panel in which mounted Provide required special gasketing to make complete station watertight
	Nameplate	Provide extra-large laminated plastic nameplate on enclosure front conforming to Section 26 05 10, showing function
Relay Sockets	Type	Mounted via DIN rail and related hardware Terminal screws of "pressure screw" type
	Rating	Rated for 5A
Control Relays	Type	Conform to NEMA ICS2 Indicating type Magnetic industrial control type with pilot light and 1 spare contact
	NEMA Class	NEMA Class A300 (300VAC, rated for 10A inductive load continuous, 7200VA make, 720VA break)
	Voltage	24VDC or 120VAC coils as shown. Number of poles and pole arrangement as shown. Contacts rated for circuit application shown
	Contacts	Multiple-contact, field-convertible plug-in type with dust cover and sockets. If additional contacts are required, they shall be ganged.
	Time Delay Relays	Magnetic type with socket Timer attachment adjustable over range shown
	Latching (Mechanically-Held) Relays or Thermal-Detector Relays	Magnetic type with mechanical latch attachment and unlatching coil and coil clearing contacts. Use attachment allowing easy latching and unlatching.
Terminal Blocks 600VAC and less for 120VAC Control Circuits	Design	UL Listed CSA certified Dead-front barrier type Size to allow insertion of necessary wire sizes and types
	Location	Provide for termination of control circuits entering or leaving equipment panels or boxes
	Rating	25A at 600VAC
	Yoke	Provide yoke to guide wire strands into terminal Construct of high-strength, high-conductivity metal
	Current Bar	Shall provide dependable vibration-proof connection. Shall provide direct contact with wire between compression screw and yoke. Construct of high-strength, high-conductivity metal.
	Terminals	DIN rail-mounted screw-clamp compression box lug type allowing connection of wire with no special preparation other than stripping. Provide terminals constructed so jumpers may be installed with no loss of space on terminal or rail. Construct of high-strength, high-conductivity metal
	Marking Strips	Secure to molded sections.

ITEM	DESCRIPTION	
		Mark wire numbers or circuit identifications with pre-printed tags or permanent marking fluid
	Spare Terminals	Provide blocks with 25% spare termination points for City's use following completion of installation
Intrusion Override Switches	Switch	2-Position Key Operator, key removal left and right positions
	Contact Block	1 NC, 1 NO
Time-of-Use Override Switches	Switch	2-Position Key Operator, key removal left position only
	Contact Block	2 NO
Intrinsically Safe Barrier 24VDC Contacts and Relays		Two Channel Relay with intrinsically safe inputs
Intrinsically Safe Barrier 120VDC Contacts and Relays		Required

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install wiring devices before submitting Shop Drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Examine areas and conditions under which Work of this section will be performed.
 1. Correct conditions detrimental to timely and proper completion of Work.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install wiring devices at locations shown on Plans and Submittals.
- C. Conform to the following installation standards:
 1. California Administrative Code (CCR) Title 8 §5 Division of Industrial Safety, State of California Cal-OSHA Low Voltage Electrical Safety Orders
 2. Other applicable OSHA and Cal OSHA regulations
 3. California Electrical Code Article 404 "Switches"
 4. California Electrical Code Article 406 "Receptacles, Cord Connectors, and Attachment Plugs"
 5. Other applicable building, fire, and electrical code requirements
 6. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install wiring devices to tolerances recommended by Manufacturer.
 1. Unless otherwise shown, install wiring devices true and level using precision gauges and levels.
- F. Mount devices as follows:
 1. Secure wiring devices, as shown, avoiding interference with other equipment.
 2. Secure nameplates using screws, bolts, or rivets centered under or on device.

3. Mount wiring devices as follows:

DEVICE	MOUNTING DISTANCE	FROM/TO	NOTES
SWITCHES			
Wall Switches	40" / 48"	Finish floor or grade to center	Set for switch operation in vertical position unless otherwise shown.
Safety Switches	54"	Finish floor to center of operating handle	
Separately-Mounted Motor Starter Switches	54"	Finish floor to center of operating handle	
Push-Button or Selector Switch Control Station	48"	Finish floor or grade to center	
RECEPTACLES			
Outdoor	18"	Finish floor or grade to center of outlet	Set duplex receptacles vertically unless otherwise shown Mount with grounding slots down except where horizontal mounting is required, in which case mount with neutral slot down

4. Do not mount devices outside limits stipulated in California Building Code §1136A
 5. Mount weatherproof receptacles with hinge for protective cover above (not at side or below) receptacle opening.
 6. Locate special-purpose receptacles where shown, installing and mounting per Manufacturer's Installation Instructions and applicable codes.
 7. Mount multi-outlet surface raceway systems where shown in accordance with Manufacturer's Installation Instructions.
- G. Ground devices, including switches and receptacles in accordance with NEC Article 250.
1. Ground switches and metal plates through switch mounting yoke, outlet box, and raceway system.
 2. Ground flush receptacles and metal plates through positive ground connection to outlet box and grounding system.
 3. Provide bonding jumper between grounded outlet box and receptacle ground terminal.
 - a. Do not rely on yoke or screw contact for grounding.
 4. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw, or by grounding jumper, both making positive connection to outlet box and grounding system.
- H. Mount device plates as follows:
1. Secure device plates to appropriate switch or receptacle.
 2. Install to alignment tolerance of $\pm 1/16"$
 3. Do not use sectional type device plates.
 4. Install device plates over flush-mounted boxes so all 4 edges contact finished wall surface without use of mats, plaster or spackle fillings, or similar materials.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Wiring Devices	Installation	Visual inspection of finished installation	1 inspection	City	City
	Switch Operation	Operate each switch and verify load turns on and off.	1 test each switch	Contractor	Contractor
	Receptacles	Test with circuit tester checking voltage, polarity and grounded conditions.	1 test each receptacle	Contractor	Contractor
	GFI Receptacles	Test with circuits energized using portable GFI receptacle tester capable of circulating 7.5 mA current between "hot" line and ground when plugged in to produce tripping of receptacle	2 tests each GFI receptacle	Contractor	Contractor
	Ground Fault Protective Equipment	1. NEC 230.95C, 2. Use 3rd-party tester qualified for such testing. 3. Submit written report of test. 4. Include copy of Manufacturer's instructions for test 5. Include statement service grounding connections are properly installed for ground fault system. 6. Include statement neutral conductors in distribution system have been tested and found to be ungrounded 7. Include description of testing method. 8. Include statement ground fault equipment functioned properly when tested. 9. Document actual settings and trip times. 10. Provide label on panel above device with certification and values. 11. Record current pickup level and time-delay settings to which equipment was finally adjusted. 12. Measure and record relay pickup current and relay time-delay at 2 values above pickup. 13. Test for correct system operation at 57% rated voltage. 14. If relay pickup current is not within 5% of Manufacturer's calibration marks or fixed setting or relay timing does not conform with Manufacturer's published time-current characteristic curves, repair or replace equipment and repeat test.	1 test before energizing	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed Literature	1 test	City	Contractor

END OF SECTION

SECTION 31 05 50

PROTECTING EXISTING UTILITIES

PART 1 - GENERAL

1.1 Work Included

- A. Materials and procedures to protect existing underground utilities.
- B. Refer to General Conditions §5 "Existence of Utilities at Worksite" for additional Corona requirements for protecting existing utilities.
- C. Utilities shall include but not be limited to the following, irrespective of ownership:
 - 1. Pipelines (including irrigation lines),
 - 2. Conduits
 - 3. Transmission lines and overhead wires
 - 4. Pipelines, conduits, and appurtenances of "Public Utilities" (as defined in Public Utilities Act of State of California),
 - 5. Pipelines, conduits, and appurtenances of private industry, business, or individuals solely for their own use or their tenants,
 - 6. Storm drains,
 - 7. Sanitary sewers,
 - 8. Culverts
 - 9. Street lighting,
 - 10. Traffic signal systems,
 - 11. Duct banks,
 - 12. Telephone cables,
 - 13. Power lines,
 - 14. Cable television,
 - 15. Fiber optic lines,
 - 16. Gas lines,
 - 17. Petroleum lines,
 - 18. Transmission cables,
 - 19. Completely buried structures.
- D. Take necessary measures to protect existing service laterals shown or not shown on Plans.
 - 1. Assume each property contains a service lateral, whether shown or not shown on Plans.
 - 2. Maintain laterals in service throughout construction.
 - 3. Notify City of Corona Fire Department prior to shutdown of existing water main resulting in fire water service or potable water service interruption.
- E. Refer to the following City of Corona standard details:
 - 1. Standard Drawing 407 for water main crossing beneath existing utility.
 - 2. Standard Drawing 407R for recycled water main crossing beneath existing utility.
 - 3. Standard Drawing 419 for utility separation requirements.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 73 00: Execution
- D. Section 26 05 10: Common Work Results for Electrical

E. Section 33 01 19: Connecting to Existing Pressure Pipelines

1.3 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASCE 38 Standard Guidelines for Collection and Depiction of Existing Subsurface Data
2. ASTM C143 Slump of Hydraulic Cement Concrete
3. ASTM C425 Compression Joints for Vitrified Clay Pipe and Fittings
4. ASTM C700 Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated
5. California Administrative Code Title 22 §64572
6. California Government Code §4215-4216
7. SSPWC Standard Specifications for Public Works Construction (Greenbook) §402 "Utilities"

1.4 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Potholing Results	Submit subsurface installation location data before starting Work at each location. Notify City's Representative in writing immediately after identifying potential physical conflicts between existing subsurface installations and Work. Written notification shall include: 1. Date of notification 2. Method of locating 3. Type, size, material, and condition of subsurface installation 4. Horizontal location 5. Elevation (or depth from existing pavement or ground surface) of top and bottom of subsurface installation 6. Presumed owner	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Working Drawings for Pipe and Utilities	Required when utilities to be supported exceed 16" diameter or any transverse dimension.	
Supports at Trench Crossings	Required when requested in writing by City's Representative	
Engineering Calculations	Submit for pipe supports for existing utilities ≥ 24 " in any dimension. If concrete beams are used as supports, calculations shall take into account concrete strength based on Calendar Days elapsing between placing concrete and trenching beneath concrete beams. Do not use 28-day strength unless concrete will be ≥ 28 days old when beam is placed in service.	

B. Immediately notify City and Utility in writing if Contractor discovers:

1. Utility facilities not shown on Plans
2. Utility facilities in field locations different than shown on Plans.

C. Refer to Section 01 33 00 for definition of requirements for Working Drawings and Engineering Calculations.

1.5 Project Conditions

A. Design Engineer has attempted to show approximate location of buried utilities on drawings pursuant to Utility Quality Level B (QLC) as defined in ASCE 38.

1. These approximate locations are based on:
 - a. Record maps requested and received during design from utilities identified through an inquiry to Underground Service Alert and utilities.
 - b. Comments received from Utilities after their review of preliminary plans showing record drawing information.

- c. Field surveying and plotting of locations of readily visible surface features including manhole covers, valve covers, utility boxes, marking posts, pavement repair strips, and culvert end sections which might indicate presence of buried utilities.
 - d. Field surveying and plotting of locations of utilities and buried structures marked on ground using ground penetrating radar and/or electromagnetic induction methods.
 - e. Design Engineer's professional judgment in correlating record map information to surveyed surface features
- B. Where potholing has been done at spot locations to measure utility depths at those locations, pothole location and elevation is noted on Plans and shall be construed as accurate to $\pm 0.5'$ at point of potholing.
- C. Utility locations on Plans are based solely on the above.
 - 1. Plotted locations may not accurately reflect subsurface conditions.
- D. Where Plans show underground utilities, assume every property parcel will be served by service connection for each utility type.
- E. Prior to excavation, and prior to submittal of cut sheets for pre-engineered pipe, pothole and determine precise locations of all utilities which are:
 - 1. Shown on plans
 - 2. Identified by Underground Service Alert
 - 3. Evident from readily visible surface features including manhole covers, valve covers, utility boxes, marking posts, pavement repair strips, and culvert end sections which might indicate presence of buried utilities.
 - 4. Identified by Contractor by walking alignment using a reliable electronic pipe finder.
 - 1. Hand dig foundations until clear of obstructions.
- F. Power trench excavating equipment may only be used when and where all the following conditions exist.
 - 1. Contractor has notified Underground Service Alert, and all known Utility Owners at least 2 Working Days before excavating.
 - 2. A USA ticket number is available at construction site.
 - 3. Contractor has thoroughly searched entire excavation route using a reliable electronic pipe finder and has pre-marked horizontal locations of conflicts.
 - 4. Utilities shown on Plans have been potholed 1,300' in advance of excavation as needed to verify locations.
 - 5. No pipelines carrying gas, petroleum, explosives, hazardous materials, or other regulated contaminants are believed to be within 5' of area to be excavated.
 - 6. City's Representative is continuously present during excavation.
- G. Power equipment specifically designed and manufactured for potholing existing utilities is exempt from above restrictions.
- H. Hand excavation shall be used
 - 1. In areas where buried gas, petroleum, explosives or hazardous material piping is known to be present
 - 2. In areas where electrical, fiber optic or communications conduit is known to be present.
 - 3. In first 5' below existing grade where drilling or auguring equipment is used.
- I. Pursuant to California Government Code §4215:
 - 1. City will be responsible *"for timely removal, relocation, or protection of existing main or trunk line utility facilities located on the site"* if such utilities are not identified by City in Contract Documents.

2. City will compensate Contractor for documented *“costs of locating, repairing damage not due to the failure of the Contractor to exercise reasonable care, and removing or relocating such utility facilities not indicated in the plans and specifications with reasonable accuracy, and for equipment on the project necessarily idled during such work.”*
 3. *“Contractor shall not be assessed liquidated damages for delay in completion of the project when such delay was caused by the failure of the public agency or the owner of the utility to provide for removal or relocation of such utility facilities.”*
- J. Pursuant to California Government Code §4216, City’s liability shall be limited to reimbursement of costs due to utility facilities either not shown on Contract Documents, or shown on Contract Documents at locations $\geq 2'$ vertically or $\geq 5'$ horizontally in error from field locations, except where location of said utilities are evident from surface features or staked correctly by Underground Service Alert.
- K. City will not indicate presence of existing service laterals or appurtenances when presence of utilities on Project site can be inferred from presence of other visible facilities, such as buildings, meters and junction boxes, on or adjacent to Work site.
1. City will identify main or trunk lines on Contract Documents.
- L. Contractor shall make their own investigations, including exploratory investigations, to determine or verify locations and type of existing service laterals or appurtenances when their presence can be inferred from presence of other visible facilities.
- M. Damage to underground utilities, pipelines or other facilities shown on Plans or identified by field staking or markings shall be immediately brought to attention of City’s Representative and affected Utility and repaired at Contractor’s expense.
1. Exact determination of location of these utilities, pipelines or other facilities shall be Contractor’s responsibility.
 2. Contractor shall be solely and directly responsible for damage, injury, expense, loss, inconvenience, delay, suits, actions or damage that may result from Contractor’s failure to verify or locate utilities whose existence is indicated.
 3. Costs incurred for protection of these lines or costs incurred due to presence of lines, whether or not they lie within trench prism, shall be borne in full by Contractor.
- N. Costs, and Work to be done by Contractor in locating, removing, relocating, protecting or temporarily maintaining utility facilities not shown on Plans shall be covered by written Change Order conforming to provisions herein pertaining to changes in Work.
1. City may make changes in alignment and grade of Work to obviate need to remove, relocate, protect or temporarily maintain utility facilities or to reduce costs of Work involved in removing, relocating, protecting or temporarily maintaining such utility facilities.
 2. Changes in alignment and grade will be ordered in accordance with provisions pertaining to changes in Work.
- O. When it is necessary to remove, relocate, protect or temporarily maintain a utility other than
1. existing mains or trunk-line facilities not originally shown on Plans with sufficient accuracy to allow Work to proceed according to Contract Documents or;
 2. existing service laterals or appurtenances whose presence cannot be inferred from presence of other visible facilities, such as buildings, meters and junction boxes, on or adjacent to Work site;
 - a. Contractor shall bear all expenses incidental to Work on utility or damage thereto.
- P. Work on utility shall be done in manner satisfactory to Utility Owner.
1. Utility Owner will have option of doing such Work with their own forces or permitting Work to be done by Contractor.

- Q. When pipe alignment or grade is obstructed by existing utility structures including conduits, ducts, pipe, or laterals, permanently support obstruction, or relocate, remove, or reconstruct in cooperation with Utility Owner.
- R. No representations are made that obligations to remove, relocate, protect or temporarily maintain a utility and to pay cost thereof is not required to be borne by utility.
 - 1. Contractor shall investigate, to find out whether or not said cost is required to be borne by Utility Owner.
- S. Liquidated damages will not be assessed for damages in delay in completion of Work, when such delay was caused by failure of City, City's Representative, Design Engineer and Utility Owner to provide for removal or relocation of utility facilities.
 - 1. Right is reserved to governmental agencies and to Utility Owners to enter at any time upon any street, alley, right of way or easement for purpose of making changes in their property made necessary by Work and to maintain and make repairs to their property.

1.6 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

1.7 Unit Prices

- A. Work necessitated to protect utilities not shown on Contract Documents other than service connections whose existence may be inferred from shown utilities will be paid for as Extra Work.

PART 2 - PRODUCTS - NOT USED

PART 3 – EXECUTION

3.1 Preparation

- A. California Government Code §4216 states Contractors *“planning to conduct any excavation shall contact the appropriate regional notification center at least two Working Days but not more than 14 Calendar Days, prior to commencing excavation.”*
- B. In Southern California, appropriate regional notification center is Underground Service Alert of Southern California (DigAlert) (1-800-422-4133) or 811.
- C. Underground Service Alert ticket numbers shall be available at construction site.
- D. Contractor shall be responsible for damage done to public or private property shown on Plans or marked or staked in field.
- E. Construction Plans will be provided to Utilities by City.
- F. Provide construction schedule to Utilities before beginning trenching or excavation.
 - 1. Coordinate construction schedule with Utility Owner's requirements.
- G. Notify Utility Owner ≥10 Calendar Days in advance of shutdown of existing mains or services.
- H. Notify Utility Owner ≥ 72 hours in advance of utility crossing construction.
 - 1. Coordinate construction schedule with utility service requirements.
- I. Before starting Work, make exploratory excavations to determine vertical and horizontal location, alignment, depth, material type, and size of utilities, service connections, and buried structures within 24” of Work.

1. Conduct exploratory excavations at tie-in locations and at least 1,300' ahead of pipe trench heading at least 5 Working Days in advance of planned construction to provide lead-time to:
 - a. Resolve utility conflicts,
 - b. Allow for adjustment in alignment or grade line,
 - c. Verify pipe and utility location and depths, types materials, conditions and sizes for ordering proper transition and/or tie-in fittings,
 - d. Allow City's Representative to verify no buried utilities interfere with proposed construction.
 2. Where potholing or exposure is not done, repair or replacement of damaged utilities and necessary horizontal and vertical realignments shall be paid for entirely by Contractor.
- J. Electrical utilities may maintain energized underground electrical power lines in immediate vicinity of Work.
1. These power lines represent an extreme hazard from electrical shock to construction personnel or equipment coming in contact with them.
 2. State law requires parties planning excavations in public right of way to contact Utilities for locations of their underground facilities.
 3. Contractors, their employees, and other personnel working near underground power lines must be warned to take adequate protective measures.
 - a. (See: OSHA Std 1926-651(A)).
 4. Notify electrical Utility to arrange, if possible, to have these lines de-energized when Work reaches their immediate vicinity.
 5. Cost of such temporary arrangements shall be borne by Contractor.
- K. Electrical utility companies may maintain energized aerial electrical power lines in immediate vicinity of Work.
1. Do not consider these lines to be insulated.
 2. Construction personnel working near these lines are exposed to an extreme hazard from electrical shock.
 3. Contractors, their employees and construction personnel working on this project must be warned of danger and instructed to take adequate protective measures, including maintaining at least 10' clearance between lines and construction equipment and personnel.
 - a. (See OSHA Std 1926.550(A)15).
 4. Notify electrical utility company to arrange, if possible, to have these lines de-energized or relocated when Work reaches their immediate vicinity.
 5. Cost of such temporary arrangements shall be borne by Contractor.
- L. Neither City nor their Representative shall be responsible for verifying need for electrical Utility shutdowns, nor for verifying shutdowns have taken place.

3.2 Protection

- A. Protect existing active services and utilities in place against damage from construction.
- B. Protect existing utilities running parallel to proposed pipelines, sewers, conduits, structures and other improvements in place.
 1. This includes protection in place of backfill above utility and pipe bedding.
- C. The following installation standards shall be followed:
 1. City of Corona Standard Drawings
 - a. Standard Drawing 407 for water main crossing beneath existing utility.
 - b. Standard Drawing 407R for recycled water main crossing beneath existing utility.

- c. Standard Drawing 419 for utility separation requirements.
- D. Maintain existing services and utilities in service.
 - 1. Do not interrupt or shut down active services or utilities except where previous written authorization has been obtained from City's Representative and Utility.
 - 2. Do not disturb support of utilities without authorization from Utility Owner.
 - 3. Where protection is required to ensure support of utilities, furnish and place necessary protection, pipe and duct supports as needed.
 - 4. Maintain valves, switches, vaults, and meters readily accessible for emergency shutoff.
 - 5. Notify Utilities in writing ≥ 3 Working Days before authorized shutdown.
 - 6. Unauthorized shutdowns shall only be made where necessary, as emergency measure, to protect property or human life until proper authorization can be obtained.
- E. Governmental agencies and Utility Owners of utilities reserve right to enter at any time upon any street, alley, right-of-way, or easement for purpose of making changes in their facilities and for purpose of maintaining and making repairs.
 - 1. If Contractor hits utility, take prompt action to make sure employees and public are not endangered.
 - a. If water line is hit, evacuate trench immediately.
 - 2. If oil or gas line is hit, evacuate employees and public from immediate vicinity.
 - 3. Treat conduits as though they are high-voltage or high-current electrical conduits.
 - 4. Do not tamper with conduits until conduit owner is called and power shut off.
 - 5. In all cases, call Fire Department and notify Utility Owner immediately.
- F. When placing concrete around or contiguous to non-metallic utility installations:
 - 1. Construct 2" cushion of foam, expansion joint or other resilient material or
 - 2. Provide sleeve or other opening resulting in 2" minimum-clear annular space between concrete and utility or
 - 3. Other City-accepted means to prevent embedment in or bonding to concrete.
- G. Where concrete is used for backfill or structures which would result in embedment, or partial embedment of metallic utility installations, or where Contractor damages coating, bedding, or cathodic protection system, notify City and arrange to secure advice of affected Utility regarding procedures to maintain or restore system integrity.

3.3 Removal and Reconstruction

- A. Remove interfering portions of utilities shown as "abandoned" or to be "abandoned in place."
 - 1. Before starting removal, ascertain from City or Utility whether abandonment is complete.
- B. Notify City's Representative in writing of construction schedule changes which may affect time available for protection, removal, or relocation of utilities.
- C. Replace damaged or removed utilities in kind, except as otherwise shown or authorized by City's Representative.
 - 1. Reconstruct utilities with new material of same size, type and quality as that removed.

3.4 Backfill and Compaction

- A. Backfill and compact under and around utilities so no voids are left.
- B. Before replacing utility, backfill trench and compact to elevation 1' above top of ends of utility.
 - 1. Excavate cross trench of proper width for utility.
- C. Sand-cement slurry may be used as backfill to ease compaction.
 - 1. Sand-cement slurry shall consist of 1 sack (94 pounds).

2. Portland cement per cubic yard of slurry.
3. Add sufficient moisture for workability without exceeding 6" slump.
4. Submit specific methods and procedures to City's Representative prior to construction.

3.5 Abandoned Utility Lines

- A. Remove and dispose of abandoned utilities within trench per Section 02 41 15.

3.6 Servicing Electrical Utilities

- A. Protect and interface with servicing Electrical Utility per Section 26 05 10.

3.7 Field Quality Control

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cement-Sand Slurry Backfill	Slump (6" Maximum)	ASTM C143	1 each batch	City	Contractor

- B. Replace and adjust valve boxes and covers as required in presence of City's Representative.

END OF SECTION

SECTION 31 23 00 EXCAVATION AND FILL

PART 1 - GENERAL

1.1 Work Included

- A. Structural, unclassified, and trenching excavation activities as required to complete Work under wet and dry conditions in whatever material or class of material is encountered, including:
 - 1. Contacting and notifying underground utilities, ≥48-hours before excavating in accordance with Section 31 05 50.
 - 2. Compliance with State and Federal safety regulations, including provisions of California Labor Code §6500, California Labor Code §6705, and California Code of Regulations Title 8, §1504.
 - a. Refer to Section 01 35 26 for additional description of these requirements.
 - 3. Designing, furnishing, placing, and removing sheeting, shoring and bracing needed to safely support sides of excavations.
 - 4. Compliance with applicable agencies' permit conditions for Work in public or railroad right-of-way, and for Work on private property.
 - 5. Loosening, excavating, removing, loading, and transporting excess soil from excavations.
 - 6. Stockpiling, exporting and importing material.
 - 7. Pumping, ditching, draining, and other required measures to remove or exclude water.
 - 8. Supporting and protecting structures above and below ground.
 - 9. Maintaining trees which are not permitted to be removed.
 - 10. Preparing and stabilizing subgrade for pipe, paving and structures.
 - 11. Backfilling around structures and backfilling of trenches and pits.
 - 12. Transporting, depositing, and compacting fill where required.
 - 13. Rough and fine grading, and preparation of right-of-way.
 - 14. Legal disposal of cleared, grubbed and excess excavated materials.
 - 15. Cleaning up debris, papers and loose rocks.
 - 16. Restoring fences and other disturbed property.
 - 17. Other incidental earthwork and supplementary operations needed to complete Work.
- B. Excavations for appurtenant structures including vaults and valve boxes shall be considered as trench excavation.
- C. Excavation shall include removal of water and materials which interfere with construction Work.
 - 1. Removal of water to levels below structure subgrade will be necessary only where required by Contract Documents.
- D. Excavation for pipe and conduit Work shall be by open trench unless otherwise shown.
 - 1. Should Contractor elect to tunnel or jack portions not so specified, they shall first obtain acceptance from City's Representative, and payment will be limited to prices bid for open trench Work.
- E. Refer to General Conditions §17 "Trenches" for additional Corona requirements for trench safety.
- F. Refer to the following sections for Work not covered herein.
 - 1. Section 01 35 26 for trench safety requirements.

2. Section 01 55 26 for trench plating requirements.
 3. Section 02 41 13 for site demolition and removal of surface improvements.
 4. Section 31 05 50 for requirements for protecting existing utilities.
 5. Section 31 23 13 for requirements for subgrade preparation.
 6. Section 33 05 26 for buried pipe identification tape.
- G. Conform to Standard Specifications for Public Works Construction (Greenbook) §200, 211, 300, 301, applicable permits, and requirements herein.
- H. Refer to the following City of Corona Standard Drawings:
1. Standard Drawing 406 for water pipe trenching and bedding.
- I. Obtain Cal OSHA annual Excavation and Dirt Moving Permit (required for excavations greater than 5' in depth)
- J. Except as modified herein, earthwork shall conform to Standard Specifications for Public Works Construction (Greenbook) §300.

1.2 **Related Work**

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 35 26: Governmental Safety Requirements
- D. Section 01 40 00: Quality Requirements
- E. Section 01 61 00: Common Product Requirements
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 01 73 00: Execution
- I. Section 01 73 33: Mechanical Identification
- J. Section 03 30 00: Cast-in-Place Concrete
- K. Section 31 05 50: Protecting Existing Utilities
- L. Section 31 23 13: Subgrade Preparation
- M. Section 33 05 26: Utility Identification

1.3 **Definitions**

- A. The following definitions apply:
1. **Lower Trench Zone**: Portion of trench above pipe zone and ≥ 60 " below finish grade in trenches ≥ 36 " wide.
 2. **Pavement Zone**: Portion of excavation containing aggregate base, asphalt or concrete paving.
 3. **Pipe Zone**: Portion of trench from 6" below pipe to plane 12" above top of pipe. (For trenches with parallel pipes, Material from 6" below lowest pipe to plane 12" above top of highest pipe.)
 4. **Relative Compaction**: Ratio of field dry or wet density to laboratory maximum dry or adjusted wet density, respectively expressed as percentage.
 - a. For testing purposes, percentages shall be determined by weight.
 5. **Street Zone**: Portion of trench below pavement subgrade to 30" below finished road surface.
 6. **Surface Zone**: Upper 12" of trench to finish surface in unimproved or landscaped areas.
 7. **Suitable Soil Material**: Imported or excavated material free from shale, sod, stones, concrete and clods ≥ 4 " diameter, roots, trash, lumber, organic material, ashes and other debris considered unsuitable by City.
 - a. Material shall have no unusual color or sulfide odor.
 8. **Trench Zone**: Portion of trench above pipe zone and above deep trench zone and below street zone or surface zone.

B. Refer to additional definitions under Section 2.2 Materials:

1.4 **Quality Assurance**

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Provide adequate equipment and methods to accomplish earthwork in accordance with applicable grading codes and ordinances, Contract Documents, and recommendations in accepted geotechnical report(s) and grading plan(s).
- C. City has hired a Geotechnical Engineer to oversee earthwork, perform laboratory and field tests, and verify compliance with recommendations from Geotechnical Report and Contract Documents.
 - 1. During grading and earthwork, Geotechnical Engineer will observe, map, and document subsurface exposures to verify geotechnical design assumptions.
 - 2. If observed conditions materially differ from interpreted assumptions during design, Geotechnical Engineer will inform City, recommend appropriate design changes to accommodate observed conditions, and notify review agency where required.
 - 3. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after being cleared for receiving fill, but before fill is placed, bottoms of "remedial removal" areas, key bottoms, and benches made on sloping ground to receive fill.
 - 4. Geotechnical Engineer will observe moisture-conditioning and processing of subgrade and fill materials and routinely test relative compaction of fill.
 - 5. Geotechnical Engineer will provide test results to City and Contractor.
 - 6. If, in opinion of Geotechnical Engineer, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of Work less than required in these specifications, Geotechnical Engineer will reject Work and may recommend to City that construction be stopped until conditions are rectified.

1.5 **References**

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASTM C12 Installing Vitrified Clay Pipe Lines
 - 2. ASTM D75 Sampling Aggregates
 - 3. ASTM C143 Slump of Hydraulic Cement Concrete
 - 4. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
 - 5. ASTM C1479 Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe
 - 6. ASTM D1556 Density and Unit Weight of Soil in Place by Sand Cone Method
 - 7. ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort
 - 8. ASTM D2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Application
 - 9. ASTM D2937 Density of Soil in Place by the Drive-Cylinder Method
 - 10. ASTM D4253 Maximum Index Density and Unit Weight of Soils Using Vibratory Table
 - 11. ASTM D4254 Maximum Index Density and Unit Weight of Soils and Calculation of Relative Density
 - 12. ASTM D4829 Expansion Index of Soils
 - 13. ASTM D6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - 14. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances
 - 15. AWWA C604 Installation of Steel Water Pipe – 4" and Larger
 - 16. AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
 - 17. AWWA M11 Steel Pipe – A Guide for Design and Installation
 - 18. AWWA M23 PVC Pipe – Design and Installation
 - 19. AWWA M41 Ductile Iron Pipe and Fittings
 - 20. AWWA M55 PE Pipe – Design and Installation
 - 21. California Test Method 202 Sieve Analysis of Fine and Coarse Aggregates

22. California Test Method 216 Relative Compaction of Untreated and Treated Soils and Aggregates
23. California Test Method 217 Sand Equivalent
24. California Test Method 231 Relative Compaction of Untreated and Treated Soils and Aggregates Using Nuclear Gage
25. California Test Method 301 Resistance "R" Value of Treated and Untreated Bases, Subbases, and Basement Soils by Stabilometer
26. SSPWC Standard Specifications for Public Works Construction (Greenbook) §300-2 "Unclassified Excavation"
27. SSPWC Standard Specifications for Public Works Construction (Greenbook) §300-3 "Structure Excavation and Backfill"
28. SSPWC Standard Specifications for Public Works Construction (Greenbook) §300-4 "Unclassified Fill"
29. SSPWC Standard Specifications for Public Works Construction (Greenbook) §300-5 "Borrow Excavation"
30. SSPWC Standard Specifications for Public Works Construction (Greenbook) §306-1 "Open-Trench Excavations"

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Work Plan	Submit Work plan to include: 1. Schedule 2. Sequence of grading 3. Estimated quantities of daily earthwork planned for site.	
Permits	Submit copies of permits obtained for excavation and grading required by state and local governing authorities	
	On City's request, submit written permission from property owner(s) permitting legal disposal of surplus material.	
Certificate of Compliance	Submit affidavit of compliance with California Construction Safety Order requirements prior to beginning excavation on any trench or excavation. Affidavit shall certify compliance with all shoring, bracing, sloping or other protective system provisions required by California Construction Safety Orders for worker protection from hazard of caving ground during excavation	
SAMPLES		
Materials Sample (Imported Backfill)	Submit 100-lbm dry weight sample of for imported backfill 10 Calendar Days before intended use. Clearly identify source, including street address and community of origin. (Do not use imported material at Work site if different from sample)	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Laboratory Report on Proposed Imported Backfill	Submit for acceptance 10 Calendar Days before intended use. Identify source, including street address and community of origin. (Do not use imported material at Work site if different from tested material)	
Certificate of Compliance	Submit certification from soils testing laboratory showing test results and certifying backfill and bedding materials conform to specified requirements.	

B. Refer to Section 01 33 00 for definition of requirements for Product Data.

1.7 **Delivery, Storage, and Handling**

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

1.9 **Unit Prices**

A. Refer to Section 01 22 00 for payment for excavation safety measures.

B. Refer to Section 01 22 00 for measurement and payment clauses for excavation and fill.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Buried Pipe Warning- Locating and Identification Tape	Refer to Section 33 05 26	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Refer to Section 31 05 16 for basic requirements for aggregate and rock products.
- C. The following definitions shall apply to soil and backfill:

ITEM	MATERIAL	SPECIFICATION
Granular Material (per Greenbook 217-1.1)	Sand, Gravel, or Crushed Aggregate	Sand equivalence ≥ 30 per California Test Method 217 or permeability coefficient $\geq 1.5"/hr$ $\leq 20\%$ of material shall pass through 200-mesh sieve.
Crushed Rock	Crushed Rock per SSPWC (Greenbook) § 200-1.2	Refer to Section 31 05 16
Pea Gravel	Gravel	100% passing $\frac{3}{4}"$ sieve 75-100% passing No 4 sieve 12-50% passing No 30 sieve 5-20% passing No 100 sieve 0-10% passing No 200 sieve
Imported Sand	Sand	Sand equivalence ≥ 30 per California Test Method 217 100% passing $\frac{3}{8}"$ sieve 75-100% passing No 4 sieve 12-50% passing No 30 sieve 5-20% passing No 100 sieve 0-15% passing No 200 sieve
Pervious Backfill (per Greenbook 217-4)	Gravel, Crushed Gravel, Crushed Rock, Natural Sands, and/or Manufactured Sands	Sand equivalence ≥ 60 per California Test Method 217 100% passing $\frac{3}{4}"$ sieve 80-100% passing $\frac{3}{8}"$ sieve 0-8% passing No 100 sieve 0-3% passing No 200 sieve
Suitable Structural Backfill Material (per Greenbook 217-2.1)	Imported or Excavated Material Meeting Specification	Sand equivalence ≥ 20 per California Test Method 217 35-100% passing No 4 sieve 20-100% passing No 30 sieve Material free from shale, stones, brick rubble, broken asphalt pavement, broken concrete and clods $>4"$ diameter within 12" of paving subgrade or pipe materials. Material free from shale, stones, brick rubble, broken asphalt pavement, broken concrete and clods $>4"$ diameter within 12" of structure. Material free from shale, stones, brick rubble, broken asphalt pavement, broken concrete and clods $>6"$ diameter at locations $>12"$ from subgrades or structures. Material shall be free from leaves, grass, sod, roots, stumps, sludge, trash, lumber, organic material, ashes and other debris considered unsuitable by City. Material shall have no unusual color or sulfide odor. Compact to specified densities.
Suitable Soil Material	Imported or Excavated Material Meeting Specification	Material defined in Part 1.3 "Definitions" above. Compact to specified densities.
Unclassified Fill	Imported or Excavated Material Meeting Specification	Material free from shale, stones, brick rubble, broken asphalt pavement, broken concrete and clods $>6"$ diameter. Material free from leaves, grass, sod, roots, stumps, sludge, trash, lumber, organic material, ashes and other debris considered unsuitable by City.

ITEM	MATERIAL	SPECIFICATION
		Material shall have no unusual color or sulfide odor. Compact to specified densities. Oversized rock material may, at City's discretion, be permitted to be disposed of in areas outside footprints of structures or utilities and $\geq 3'$ below finish grade elevations.
Cement-Sand Slurry	Cement (94-lb sacks per cubic yard of mix)	1 sack per cubic yard minimum, and not less than that required by applicable agency encroachment permits
	Maximum Slump	$\leq 6"$ per ASTM C143
Native Material	Material obtained from required site excavations When native material is unsuitable for use in backfill, it shall be disposed of off-site and suitable material capable of being compacted to required relative density shall be furnished by Contractor at their expense.	
Import Material	City-accepted material obtained from off-site borrow areas.	
Water for Compaction	Chloride Concentration	≤ 500 ppm
	Sulfate Concentration	≤ 500 ppm
	pH	7.0-9.0
	Purity	Free from acid, alkali, or organic materials injurious to pipe coatings
Buried Pipe Warning-Locating and Identification Tape	Refer to Section 33 05 26. Refer to section on appropriate utility pipe or conduit material for required message	

D. Materials for soil and backfill for pipelines and utilities shall be:

ITEM	MATERIAL	SPECIFICATION
OVEREXCAVATION BACKFILL		
Backfill of Tunnels beneath Concrete Flatwork	Sand	90% compaction per ASTM D1557 or California Test Method 216 Sand equivalence ≥ 30 per California Test Method 217 or permeability coefficient $\geq 1.5"/hr$
Pipe Base Material (Backfill material for Over-Excavation to be placed above trench bottom and below pipe zone)	Cement-Sand Slurry	Cement-sand slurry mix specified above
	Native or Imported Granular Material	90% compaction per ASTM D1557 or California Test Method 216 Sand equivalence ≥ 30 per California Test Method 217 or permeability coefficient $\geq 1.5"/hr$ Material shall be suitable soil material as defined above. Maximum lifts vary with equipment. Refer to 3.2 below.
BEDDING MATERIAL		
Pipe Zone Material for Pressure Pipe (Material from 6" below pipe to plane 12" above top of pipe)	Native or Imported Granular Material	90% compaction per ASTM D1557 or California Test Method 216 Sand equivalence ≥ 30 per California Test Method 217 or permeability coefficient $\geq 1.5"/hr$ No material $> 2"$ in any dimension shall be placed within 1' of pipes, valves, or structures. Material shall be suitable soil material as defined above. Maximum lifts vary with equipment. Refer to 3.2 below Place buried identification tape where specified
BACKFILL MATERIAL		
Lower Trench Zone Material (Material in Pipe Trench above Pipe Zone and $\geq 60"$ below finish grade in trenches 36" and wider)	Cement-Sand Slurry	Cement-sand slurry mix specified above
	Suitable Soil Material (where cement-sand slurry not required)	90% compaction per ASTM D1557 or California Test Method 216 Expansion Index of 0-50 per ASTM A4829 Maximum lifts vary with location and method. See below. May contain stones, asphalt pavement or concrete of up to 12" in largest dimension so long as fines surround such solids so no voids are present in placed backfill.

ITEM	MATERIAL	SPECIFICATION
		No material >2" in any dimension shall be placed within 1' of pipes, valves, or structures. Backfill within 24" of ductile-iron fittings or valves shall be clean, washed sand. Provide buried pipe warning and locator tape in pipe trench 18" above pipe.
Upper Trench Zone Material (Material in Pipe Trench above Pipe Zone and below Street Zone or Surface Zone)	Cement-Sand Slurry	Cement-sand slurry mix specified above
	Suitable Soil Material (where cement-sand slurry not required)	90% compaction per ASTM D1557 or California Test Method 216 Sand equivalence ≥ 20 per California Test Method 217 Expansion Index of 0-50 per ASTM A4829 Maximum lifts vary with location and method. See below. May contain stones, asphalt pavement or concrete ≤ 6 " in largest dimension so long as fines surround such solids so no voids are present in placed backfill. No material >2" in any dimension shall be placed within 1' of pipes, valves, or structures. Backfill within 24" of ductile-iron fittings or valves shall be clean, washed sand. Provide buried pipe warning and locator tape in pipe trench 18" above pipe.
Street Zone Material (Base material in pipe trench below pavement subgrade to 30" below finished road surface.	Crushed Aggregate Base Material	95% compaction per ASTM D1557 or California Test Method 216 No material >2.5" in any dimension shall be placed within street zone. Conform to SSPWC (Greenbook) §200-2.2, crushed aggregate base Contractor may substitute on-site materials conforming to SSPWC (Greenbook) §200-2.5, Processed Miscellaneous Base Expansion Index of 0-50 per ASTM A4829 Maximum lifts vary with equipment. Refer to 3.2 below Material shall be suitable soil material as defined above. Stones concrete and clods smaller than specified limit may not exceed 20% of backfill volume over pipe segment. Maximum lifts vary with equipment. Refer to 3.2 below
SURFACE AND PAVING MATERIAL		
Pavement Zone Material (Aggregate base and asphalt or concrete paving)	Refer to Paving Plans or Details	Refer to Section / 32 12 16 / 33 13 13
Surface Zone Material (upper 12" of trench to finish surface in unimproved or landscaped areas)	Topsoil per Section 32 90 00	80% compaction per ASTM D1557 or California Test Method 216 No material >2.5" in any dimension shall be placed within surface zone. Maximum lifts vary with equipment. Refer to 3.2 below

E. Materials for soil and backfill for site grading and unclassified fill shall be:

ITEM	MATERIAL	SPECIFICATION
Backfill for Over-Excavation Beneath General Excavation	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216
Loose Ground Remaining After Stripping	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216
Unclassified Fill Below Ground	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below
Unclassified Fill Embankments	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below

ITEM	MATERIAL	SPECIFICATION
		2:1 maximum embankment slope
Surface Zone Material (upper 12" below finish surface in unimproved or landscaped areas)	Topsoil per Section 32 90 00	80% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below

F. Materials for soil and backfill for paving shall be:

ITEM	MATERIAL	SPECIFICATION
Backfill for Over-Excavation Beneath Paving	Cement-Sand Slurry	Cement-sand slurry mix specified above
	Suitable Soil Material (where concrete slurry not required)	90% compaction per ASTM D1557 or California Test Method 216
Roadway/Paving Fills >3' Below Base	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below
Top 3' of Roadway/Paving Fills Below Base	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below
Top 6" where Roadway Paving is Placed Directly on Subgrade Material	Suitable Soil Material	95% compaction per ASTM D1557 or California Test Method 216
Top 6" where Alley, Curb, Gutter, Driveway, or Sidewalk Paving is Placed Directly on Subgrade Material	Suitable Soil Material	90% compaction per ASTM D1557 or California Test Method 216
Roadway/Paving Base	Crushed Aggregate Base Material	95% compaction per ASTM D1557 or California Test Method 216 Conform to SSPWC (Greenbook) §200-2.2, Crushed Aggregate Base Contractor may substitute on-site materials conforming to SSPWC (Greenbook) §200-2.2, Processed Miscellaneous Base Maximum lifts vary with equipment. Refer to 3.2 below Refer to Section 32 12 16 for asphalt-concrete paving or 32 13 13 for concrete paving

G. Materials for soil and backfill for structures shall be:

ITEM	MATERIAL	SPECIFICATION
Backfill for Over-Excavation Beneath Structures	Concrete	Refer to Section 03 30 00 Class A
Backfill of Tunnels Beneath Concrete Flatwork	Sand	90% compaction per ASTM D1557 or California Test Method 216
Structural Fills > 5' Below Foundation	Suitable Structural Backfill Material (per Greenbook 300-3.5)	90% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below
Top 5' of Structural Fill	Suitable Structural Backfill Material (per Greenbook 300-3.5)	95% compaction per ASTM D1557 or California Test Method 216 Maximum lifts vary with equipment. Refer to 3.2 below
Structural Bedding Beneath Footings, Slabs and Sand Blanket	Crushed Aggregate Base Material	95% compaction per ASTM D1557 or California Test Method 216 Conform to SSPWC (Greenbook) §200-2. Crushed Aggregate Base Contractor may substitute on-site materials conforming to SSPWC (Greenbook) §200-2.5, Processed Miscellaneous Base Unless otherwise shown, provide 8" layer of aggregate beneath 4" sand layer
Sand Blanket Beneath Slabs	Sand	90% compaction per ASTM D1557 or California Test

ITEM	MATERIAL	SPECIFICATION
		Method 216 Unless otherwise shown, provide 4" sand layer with 10-mil PVC vapor barrier with sealed laps in center of sand layer.

PART 3 - EXECUTION

3.1 Preparation

- A. Pipe and other underground improvements may or may not be shown on Plans.
 1. Preserve and protect such improvements whether shown or not.
 2. Refer to Section 31 05 50 for requirements for protecting existing utilities
 3. Where necessary to remove and replace or to relocate such improvements to prosecute Work, improvements shall be removed, maintained, and permanently replaced by Contractor at their expense, except as otherwise provided in Contract Documents.
 4. California Government Code §4216 states Contractors *"planning to conduct any excavation shall contact the appropriate regional notification center at least two working days but not more than 14 calendar days, prior to commencing excavation."*
- B. Control surface drainage and prevent surface water from entering excavations as follows:
 1. Control grading to prevent water running into excavations.
 2. Maintain feathered edges of asphalt around trench plates.
 3. Do not obstruct surface drainage away from receiving watershed.
 - a. Intercept and divert runoff around Work using temporary slopes, sand bags, dikes, swales, levees, curb walls, drainage ditches, gutters, sumps, drains or other means of channeling flow without interruption around excavations.
 4. Preserve existing drainage patterns except as otherwise shown.
 - a. Where construction methods cause temporary obstruction of drainage patterns, provide temporary facilities adequate for expected flows and a means of emergency removal of obstruction.
 5. Design surface drainage system to minimize erosion on or off site.
 6. Dispose of water in suitable manner without damage to adjacent property.
 - a. Do not drain water into Work built or under construction without prior consent of City's Representative.
 - b. Dispose of water according to permits and in such manner as not to be a menace to public health and public or private property.
- C. Refer to Section 31 23 19 for requirements for dewatering.
 1. Commence dewatering for structures and pipelines when groundwater is first encountered.
 2. Continue dewatering until water can be allowed to rise in accordance with provisions of Section 31 23 19.
- D. Remove and reconstruct asphalt paving improvements per Section 02 41 14 and 32 12 16.
- E. Remove and reconstruct concrete paving improvements per Section 02 41 14 and 32 13 13.
- F. Preparation for fill shall proceed as follows:
 1. Clear and grub areas to receive fill or embankment per Section 31 10 00.
 2. Scarify areas to receive fill to $\geq 6"$ to provide a bond between existing ground and fill material to be deposited thereon.
 3. Moisture condition scarified areas and compact to $\geq 85\%$.

4. When fills are to be placed over existing surface improvements to remain in place cut 4" drainage holes through structure or paving at 5' centers each way, or break or saw-cut pavement in grid pattern of 5' each way with minimum 1/4" gap between broken sections.
- G. Blasting shall be prohibited
- H. Excavate slopes to designated lines or slopes either by benching or as directed by City's Representative.
1. Provide benching when unclassified fill is to be placed on existing natural slope ≥ 1 vertical to 4 horizontal (25%).
 - a. When unclassified fill is constructed against existing slope, horizontally bench slope face to key unclassified fill into slope face.
 2. Bench into firm soils, free of loose or disturbed soils such that $\geq 2'$ vertical face height is exposed into firm soils unless otherwise shown on Plans.
 3. Scarify horizontal surface of each bench $\geq 6"$ before placing first lift of unclassified fill.
 4. Incorporate material cut for benched slope into fill.
- I. Minimize impacts of slides and slip-outs as follows:
1. Slide and slip-out materials shall include
 - a. Material outside planned excavation limits which is unstable and constitutes a potential slide, as determined by City's Representative
 - b. Material which has come into planned excavation limits
 - c. Material which has slipped out of new or old fills.
 2. Excavate slide and slip-out materials to designated lines or slopes either by benching or as directed by City's Representative.
 - a. Provide benching when unclassified fill is to be placed on existing natural slope ≥ 1 vertical to 4 horizontal (25%).
 - b. When unclassified fill is constructed against existing slope, horizontally bench slope face to key unclassified fill into slope face.
 - c. Bench into firm soils, free of loose or disturbed soils such that $\geq 3'$ vertical face height is exposed into firm soils unless otherwise shown on Plans.
 - d. Scarify horizontal surface of each bench $\geq 6"$ before placing first lift of unclassified fill.
 - e. Incorporate material cut for benched slope into fill.
 3. Slide and slip-out material may be reused in construction of unclassified fill or disposed of as directed by City's Representative.
- J. Finish excavation slopes to conform to lines and grades shown.
1. Remove debris and loose material.
 2. When completed, average plane of slopes shall conform to slopes shown.
 3. Refer to paragraph 3.3 below for allowable deviations from Plan elevations.
 4. No portion of slope shall encroach to interfere with planned use of facility.
 5. Excavation and grading shall be performed to provide finished surfaces in uniform planes with no abrupt breaks in surface.
 6. Round ends and tops of excavation slopes where shown on Plans.
- K. No material or stockpiles shall cause undue interference with public travel.
1. Provide clear access to fire hydrants, water valves, meters, and private drives, or other property or facilities that may have routine or emergency use.
- L. Prepare rock foundation material to receive structural foundation materials as follows:
1. When footing concrete or masonry is to rest upon rock, fully uncover and expose rock.
 2. Remove loose or fractured rock to depth sufficient to expose sound rock.

3. Roughly level off rock, or cut to approximate horizontal and vertical steps, and roughen rock to facilitate bond with foundation material.
 4. Grout seams in rock under pressure or treat as directed by City's Representative.
 5. Cost of grouting or treatment will be negotiated as Extra Work.
- M. Prepare excavated surfaces other than rock to receive structural foundation materials as follows:
1. Take care not to disturb bottom of excavation.
 2. Do not complete final removal of foundation material to grade until just before concrete or masonry is placed.
 3. Except where overexcavation is directed by City's Representative, excavation below grade shall be replaced at Contractor's expense with concrete of same class specified for foundation at time foundation is placed.
 4. Where City's Representative determines backfill will not be detrimental to structure, Contractor may backfill above grade with $\geq 90\%$ compacted material and then trim to grade shown.
 5. Where original ground surface is below footing elevations shown, backfill to 6" above grade with $\geq 90\%$ compacted material and then excavate to grade shown prior to placing concrete.
 6. Complete excavations for piers
- N. Do not deposit backfill against new concrete structures until concrete has developed specified 28-day compressive strength.

3.2 Installation

- A. Refer to Sections 01 73 00 for basic execution and installation requirements.
- B. Furnish and install excavation and fill at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Requirements of contract-referenced soils reports and investigations.
 2. Applicable OSHA and Cal OSHA regulations
 3. California Building Code Chapter 18 "Soils and Foundations."
 4. City of Corona Standard Drawings
 - a. Standard Drawing 406 for water pipe bedding.
 5. Manufacturer's installation and warranty requirements
 6. Standard Specifications for Public Works Construction (Greenbook) §300-2 "Unclassified Excavation"
 7. Standard Specifications for Public Works Construction (Greenbook) §300-3 "Structure Excavation and Backfill"
 8. Standard Specifications for Public Works Construction (Greenbook) §300-4 "Unclassified Fill"
 9. Standard Specifications for Public Works Construction (Greenbook) §300-5 "Borrow Excavation"
 10. Standard Specifications for Public Works Construction (Greenbook) §306-1 "Open Trench Excavations"
 11. Other applicable building code requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Earthwork within public rights-of-way controlled by a state, county or city, or earthwork within railroad rights-of-way shall be in accordance with requirements and provisions of permits issued by those agencies for construction within their respective rights-of-way.

1. Such permit requirements and provisions which are more restrictive than those specified herein, shall take precedence and supersede provisions of Contract Documents.
- F. Should excavated material not be suitable for fill material, import suitable fill material as specified.
- G. Wet soil should be anticipated near bodies of water, where ground is damp, or where geotechnical report shows evidence of groundwater.
1. Allow wet soil to dry to near-optimum moisture content before placing as backfill.
 2. Material having excessive moisture content may be dried by blading, discing, or harrowing to expedite drying.
 3. During compacting, maintain optimum practicable moisture content required for construction in each lift of backfill material.
 4. Maintain uniform moisture content throughout lift.
 5. If placement is discontinued and proper moisture content is not maintained, bring upper layer back to proper moisture content by sprinkling, cultivating, and rolling backfill material before placing new material.
 6. At time of compaction, water content of material shall be at optimum water content $\pm 2\%$.
 7. Do not work material containing excessive moisture to obtain compaction.
- H. Should contaminated soil be encountered, perform the following activities:
1. Promptly notify City's Representative contaminated or potentially contaminated soil has been encountered so City may identify party legally responsible for disposal of contaminated soil and properly direct Contractor how to proceed.
 2. Conduct Work in contaminated areas in accordance with applicable OSHA and Cal OSHA regulations.
 3. Segregate and cover contaminated soils prior to removal from site.
 4. Dispose of contaminated soils as directed by City and as required by law.
- I. Should excavation be carried below lines and grades shown, refill excavated space to proper elevation with material as specified in Part 2 above for correction of faulty grades after over-excavation.
1. Transfer construction stake grades into trench as needed to ensure trench bottom is accurately graded.
 2. Remove hard spots that prevent uniform thickness of pipe base.
 3. Remove boulders or other interfering objects at subgrade.
 4. Remove large gravel and cobbles encountered at trench bottom or pipe subgrade.
 5. Remove excessively wet, soft, spongy, unstable, or other unsuitable material encountered below proposed location of bedding material to depth directed by City's Representative.
 6. Replace over-excavated material with crushed rock, gravel or granular material of sufficient thickness to form unyielding bedding compacted to provide uniform support and firm foundation.
 7. Payment for removal of material and additional backfill required shall be in accordance with Contract Documents.
 - a. However, if necessity for such additional bedding material has been occasioned by act or failure to act on part of Contractor, Contractor shall bear expense of additional excavation and backfill to required depth.
 - b. Contractor's attention is called to their responsibilities in maintaining adequate dewatering procedures to ensure an otherwise stable foundation will not be rendered unfit due to water accumulation in trench.

8. Where rock is found, remove rock below grade, and backfill trench with clean imported sand to provide compacted foundation cushion with minimum allowable thickness of 6" under outside diameter of pipe barrel and clear space of 4" under pipe bells.
 - a. Payment for removal of rock and additional backfill shall be in accordance with Contract Documents.
9. Place refill material over full width of trench.
10. Prepare pipe subgrade at trench bottom for specific type of pipe material being installed in accordance with Specifications for said pipe.
11. Place bedding required by Contract Documents.
12. Before laying pipe, check grade with straightedge and correct irregularities.
- J. Unclassified fill shall be placed as follows:
 1. Construction of unclassified fill shall include preparing surface to receive unclassified fill, and depositing, conditioning, and compacting fill material.
 2. Unless special material is required, material for fill or embankments may consist of excavated material from unclassified and structural excavation or a mixture of excavated materials and suitable materials borrowed off-site.
 3. Off-site sources of fill shall be designated and are subject to evaluation and acceptance by City's Representative.
 4. City's Representative may determine locations at which each fill load shall be placed to obtain optimal material blending.
 5. City's Representative may, at their discretion, elect to accept incorporation of oversize rocks, boulders, hardpan, or cemented gravel in excess of specified maximum dimensions outside roadway, pipeline, structure, or foundation footprints and at depths $\geq 3'$ below finish grade.
 - a. Location and depth of oversized materials into unclassified fill shall be subject to acceptance by City's Representative.
 - b. Unclassified fill containing $\geq 25\%$ by volume of oversize rocks, boulders, hardpan, or cemented gravel placed in a plane $\geq 3'$ below finished grade may be constructed in layers of loose thickness before compaction up to maximum size of rock in material but $\leq 3'$ in thickness.
 - c. Fill interstices around rock in each layer with earth or other fine material and compact as specified
 6. Do not construct unclassified fill when material is frozen or snow blankets prevent proper compaction.
 7. Do not place material beyond sloping lines of embankment unless so ordered by City's Representative.
 8. Material allowed to be placed beyond embankment lines shown shall be compacted as required above unless otherwise authorized by City's Representative.
 9. Place unclassified fill material in horizontal layers of depths compatible with location, material being placed and type of equipment used, but not $> 8"$ unless otherwise specified or where Contractor demonstrates to City's satisfaction they can obtain specified relative compaction densities using equipment on site.
 10. Unless otherwise accepted, each horizontal layer shall cover length and width of area to be filled before next higher layer is placed.
 11. Evenly spread each layer as necessary.
 12. Top surface of each layer shall be approximately level, but with crown or crossfall of ≤ 1 vertical in 20 horizontal (5%) but ≥ 1 vertical in 50 horizontal (2%) to drain water during construction.
 13. Scarify each layer after compaction to provide bond with next layer.

14. As each layer is deposited, apply water to loose material in amount sufficient to ensure optimum moisture content, secure specified compaction, and provide firm, hard, and unyielding fill.
 15. Chemical additives may be used in water applied to fill material when accepted by City's Representative.
 16. If excess moisture is encountered in fill, allow fill to dry out, or manipulate each layer to aerate and dry out excess moisture.
 17. Compact material for embankments or fills by rolling with power rollers weighing ≥ 10 tons, with sheepsfoot rollers, vibratory rollers, pneumatic tire rollers, or other City-accepted mechanical means appropriate for soil type being compacted, and as required to accomplish Work.
 - a. Use of trucks, carryalls, scrapers, tractors, or other heavy hauling equipment shall not be considered as rolling in lieu of rollers, but traffic of such equipment shall be distributed over fill in such manner as to use compaction afforded thereby as an addition to compaction by rollers.
 18. Compact unclassified fill layers to specified relative compaction using hand-directed compaction equipment where it is impractical due to inaccessibility to use larger compacting equipment.
 19. Fill to lines and grades shown with maximum slope not exceeding that shown.
 20. Plan haul routes to avoid passing heavy off-highway equipment over pipelines with $< 4'$ cover.
 - a. Where crossings must be made, provide concrete encasement or accepted bridging.
 21. When soil types or a combination of soil types are encountered which tend to develop densely-packed surfaces as a result of spreading or compacting operations, sufficiently roughen each layer after compaction to ensure bond to succeeding layer.
- K. Finish grading shall proceed as follows:
1. Uniformly finish grade areas covered by Work, including excavated and filled sections and transition areas to elevations shown.
 2. Finished surface shall be smooth, compacted, and free from irregular surface changes.
 3. Round edges of spoil and borrow areas to blend into natural contours.
 4. Degree of finish ordinarily obtainable from blade grader will be satisfactory for open areas, but hand grading and raking will be required around structures and walkways.
 5. Finished surface outside slopes and embankments shall be $\leq 0.1'$ above or below established grade and sloped to prevent ponding.
- L. Structural excavation shall proceed as follows:
1. Excavation of material of whatever nature necessary for construction of structures and foundations shall be carried out to lines and grades shown, and as required to provide working clearance and safe construction slopes and to emplace shoring, sheeting, bracing, and other Work required.
 2. Except when concrete is authorized to be placed directly against excavated surfaces, establish clear space at sides of excavation to facilitate form construction and removal and provide for excavation protective support system.
 3. Notify City's Representative and request inspection of foundation subgrade upon completion of structure excavations.
 4. Do not place concrete or masonry foundation material until foundation subgrade preparation has been accepted by City's Representative.
 5. Where concrete is to be placed on original ground without subgrade preparation, do not use machinery using teeth nearer than 3" from finished subgrade.
 - a. Remove last 3" without disturbing subgrade.

M. Place structural backfill as follows:

1. Do not place backfill until structure footings, retaining walls, or other portions of structure or facility have been inspected by City's Representative and accepted for backfilling.
2. Do not place backfill until concrete has developed specified 28-day compressive strength.
3. Place backfill in horizontal layers, moistened and tamped, rolled or otherwise compacted.
4. Take care when backfilling to obtain adequate compaction beneath pipes and to avoid injury or displacement of such pipes.
5. Place backfill so no additional unbalanced loading occurs during placing.

N. Water settling or jetting will not be permitted.

O. Trench excavation and backfill for pipelines, pipeline structures, and conduits shall proceed as follows:

1. Alignment and grade for pipe shall be as shown.
 - a. When flow line is shown, it shall be invert or interior bottom of pipe.
 - b. When top of pipe is shown, it shall be exterior of pipe barrel.
 - c. In absence of such profile grade, pipe shall be laid on straight grade to permit complete drainage and to provide $\geq 36"$ of cover to finish ground or street subgrade unless otherwise shown.
2. Store excavated material only in Work area.
 - a. Weight of material stored at trench side shall not exceed surcharge loads used to prepare shoring and bracing calculations.
3. Where natural ground above pipeline trench has been overexcavated and/or pipeline is to be placed in new embankment, place and compact embankment material to elevation $\geq 12"$ above top of pipe prior to trench excavation.
4. Except where specified otherwise in Contract Documents or permits or where documented acceptance is obtained from City's Representative; length of open trench shall be $\leq 500'$ or distance necessary to accommodate amount of pipe installed in 1 day, whichever is greater.
 - a. Distance is collective length, including open excavation, pipe laying, and appurtenance construction and backfill which has not been temporarily resurfaced.
 - b. Complete backfilling and temporary paving so no more than 500' of trench is open in rear of pipe being laid.
 - c. Backfill or use trench plates to bridge excavations at sidewalk, driveway, alley, and other travelled crossings to provide safe access and egress at completion of each day's Work.
5. Failure of Contractor to comply with specified limitations may result in order to halt Work until such time as compliance is achieved.

P. Unless otherwise shown, minimum and maximum pipe trench width measured at top of pipe zone (12" above pipe crown) shall be as shown below, where D=nominal pipe diameter.

PRESSURE PIPE MATERIAL	APPLICABLE SPECIFICATION	NOMINAL PIPE SIZE (INCHES)	SIDE CLEARANCE (INCHES)	
			MINIMUM	MAXIMUM
Ductile Iron Pipe	AWWA C600 §4.3.2.3 and AWWA M41	All sizes	12"	as shown on plans
Steel Pipe	AWWA C604 §4.4.2.3 and AWWA M11	All sizes	6" or as shown on plans	as shown on plans

PVC Pressure Pipe	AWWA C605 AWWA M23	≤ 16"	8"	12"
		18"-30"	6"+D/8	18"
		> 30"	As shown on plans	

- Q. If maximum trench width is exceeded on either side of pipe at top of pipe zone, provide 1 of the following remedial measures at no additional cost to City.
1. Backfill trench with material specified for "Backfill for Over-Excavation" in Part 2 above to cradle pipe to spring line, or
 2. Modify bedding based on calculations accepted by City's Representative to accommodate wider trench width, or
 3. Substitute higher-strength pipe based on calculations accepted by City's Representative to accommodate wider trench width.
- R. Trench widths above top of pipe zone may exceed tabulated values but shall not undercut adjacent structures.
1. Edge of top of trench shall be set back $\geq 18"$ from footings or structures.
- S. Prepare trench bottom as follows:
1. Grade trench bottom to provide smooth, firm, and stable foundation at every point throughout length of pipe.
 2. Shape pipe subgrade to fit pipe bottom using drag template or other suitable method.
 - a. Excavate holes at joints to permit proper assembly and joint inspection.
 - b. At pipe joints, recess and shape trench bottom to relieve pipe bells, sockets, collars, couplings, or flanges of load.
- T. When placing concrete cradles, arches, or encasements within sheeted trenches, face sheeting against which concrete is placed with 1 or more thicknesses of building paper.
1. Withdraw sheeting without damaging or displacing concrete Work.
- U. Backfill over pipe as follows:
1. After pipe has been properly laid, and exterior joints grouted and inspected, begin backfilling operations using material as specified above.
 2. Place material in pipe zone as follows:
 - a. Hand-place material on pipe underside taking care to prevent lateral movement during subsequent backfilling.
 - b. For plastic pipe and fittings, place crushed rock bedding materials as shown by slicing, shovel-spading, or shover rodding to fill haunch areas below pipe.
 - c. Place material around and underneath pipe so pipe barrel is fully supported along full pipe length with no voids or uncompacted areas beneath pipe.
 - d. Unless sheeting or shoring is to be cut off and left in place, remove sheeting or shoring from pipe zone before compacting pipe zone material and placing backfill.
 - e. Immediately backfill voids left by removal of sheeting, piles and sheeting supports with clean sand vibrated into place to ensure dense and complete filling of voids.
 - f. Place and compact pipe zone material simultaneously on both sides of pipe for full trench width, moistened as required to achieve specified compaction.
 - g. Keep level of backfill same on each side.
 - h. Compact material within pipe zone using hand-directed mechanical tampers.
 - i. Contractor will be held responsible for displacements of pipes or other structures, damage to them or instability caused by improper depositing of backfill material or improper use or handling of tools or equipment.

- j. Place warning and locator tape at distance above top of pipe specified above.
 - k. Take care in backfilling to avoid damage to pipe coating, locating tape and conduits installed in pipe zone.
 - l. Complete pipe zone compaction before covering it with trench zone material.
3. Place material in trench zone as follows:
- a. Deposit trench zone material onto backfill previously placed in pipe zone.
 - b. Do not permit free fall of material until $\geq 2'$ of cover is provided over top of pipe.
 - c. Do not drop sharp, heavy pieces of material directly onto pipe or tamped material around pipe.
 - d. Compact trench backfill to specified compaction using hand-directed mechanical tampers.
 - e. Do not use jetting or flooding without written acceptance from City's Representative.
 - f. Do not use impact, free-fall, hammer, or "stomping" equipment except where pipe Manufacturer warrants in writing such methods will not damage their pipe.
 - g. Do not use axle-driven or tractor compaction equipment within 5' of pipelines, walls, or structures.
4. Place material in street zone in accordance with requirements of and to satisfaction of agency having jurisdiction.
- a. Backfill in traveled ways and public streets shall conform to right-of-way agreement, encroachment permit, excavation permit or applicable regulations of agency having jurisdiction over traveled way.
 - b. In absence of such provisions, compact soil by accepted hand-, pneumatic or mechanical-type tampers.
5. Backfill pipe located in public traveled right-of-way at end of each day's operations in accordance with applicable permit requirements.
6. Construct pavement section in accordance with Contract Documents.
7. Remove spoil piles from traffic lanes by end of Working Day.
8. Mechanical densification or compaction of backfill shall use means listed in table below or combination thereof.
- a. Method or methods used shall result in obtaining compaction of backfill in various specified zones and within maximum lifts specified.
 - b. Densification or compaction method or methods used shall not damage pipe, adjacent ground, existing improvements, or improvements installed as part of Work.
 - c. Some encroachment permits, work permits, or excavation permits limit methods of densification or compaction.
 - d. Place material for mechanically compacted backfill in lifts which, prior to compaction, shall not exceed depths specified for various methods or equipment types.

TYPE OF COMPACTION EQUIPMENT	MAXIMUM LIFT DEPTH
WORK IN TRENCHES	
Hand-directed mechanical tampers	$\leq 6"$ in pipe zone, $\leq 8"$ elsewhere.
Vibratory equipment with smooth contact surface	$\leq 8"$ in street zone $\leq 12"$ in pipe zone, $\leq 12"$ elsewhere
Rolling equipment, including, sheepsfoot (vibratory and nonvibratory), grid, segmented wheel, pneumatic, or vibratory-interrupted surface equipment	$\leq 8"$ in street zone $\leq 12"$ in pipe zone, $\leq 12"$ elsewhere
WORK OUTSIDE TRENCHES	
Hand-directed mechanical tampers	$\leq 8"$
Work $\leq 30"$ below surface to be paved	$\leq 8"$ all methods
Impact, free-fall, or "stomping" equipment	$\leq 36"$ (Do not use over concrete pipe, cement-mortar lined pipe, VCP, or PVC.
Vibratory equipment with smooth contact surface	$\leq 24"$

Rolling equipment, including, sheepsfoot (vibratory and nonvibratory), grid, segmented wheel, pneumatic, or vibratory-interrupted surface equipment	≤12"

V. Backfill over and around trench structures as follows:

1. Allow concrete to cure for the following durations before backfilling:

OPERATION	LOCATION	
	Against Sides of Structures	Over Top of Structures
Placing Loose Backfill	5 days	21 days
Compacting or Densifying Backfill	7 days	28 days or 100% of specified f_c

2. Where City's Representative determines it is not practical to obtain required compaction around structures by mechanical methods or jetting, provide trench backfill slurry or controlled low-strength material as directed.

3.3 **Field Quality Control**

- A. City's Representative will provide continuous inspection of fill and will field test fill and earth backfill as placed and compacted, and inspect excavations and subgrade before concrete is placed and provide periodic inspection of open excavations, embankments, and other cuts or vertical surfaces of earth.
- B. City's Representative will observe and test fills and based on laboratory results will determine whether fills have been placed in accordance with Contract Documents.
- C. City's Representative may require deepening of footings and order such deepening based on uncovered soil conditions.
- D. Where excavated material is not suitable for backfill, arrange for and furnish suitable imported backfill material capable of attaining specified relative density.
 - 1. Take reasonable measures, to protect excavated material from excessive moisture.
 - a. Measures shall include minimizing excavation during wet weather, directing runoff away from excavations, dewatering where specified, and covering excavated material with tarps or plastic during rain.
 - 2. If excavated material is found unsuitable due to high moisture content, process or dry material to reduce moisture content to optimum condition or remove wet material and replace with suitable material.
 - 3. If high moisture content is not due to Contractor's actions or inactions in protecting Work during construction, and if resulting quantity of unsuitable material exceeds that stipulated in Section 01 22 00, an adjustment in payment will be negotiated
 - 4. Arrange for removal and legal off-site disposal of unsuitable excavated material.

E. Additional field testing of earthwork shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
MATERIALS TESTING					
Trench Subgrade	Suitability of Subgrade	No unacceptable materials beneath pipe base	As directed	City	City
Backfill or Soil Prepared in Place	Sampling	ASTM D75	As directed	City	Contractor
	Sieve Analysis	ASTM C136 or California Test Method 202	1 sample for every 1000 tons of material from an individual material supplier	City	Contractor
	Sand Equivalence	California Test Method 217	1 sample for every 1000 tons of material from an individual material supplier	City	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
	R-Value	California Test Method 301	1 sample for every 1000 tons of material from an individual material supplier	City	Contractor
Concrete Slurry	Slump ($\leq 6"$)	ASTM C143	1 each batch	City	Contractor
FIELD DIMENSIONS					
Trenching and Excavation	Trench Width	Width specified in Part 2 above	As directed	City	Contractor
	Bedding Thickness	Depth specified in Part 2 above	As directed	City	Contractor
	Rock Size in Backfill	Size specified in Part 2 above	As directed	City	Contractor
COMPACTION TESTING					
Backfill or Soil Prepared in Place	Compaction (Laboratory Maximum Density/ Optimum Moisture Graph)	ASTM D1557 or California Test Method 216	1 sample for each soil type encountered	City	Contractor
	Field Density of Soil in Place	ASTM D1556 or ASTM D6938	As directed, at intervals $\leq$ each 2' layer of vertical rise, $\leq$ each 1000 cy compacted fill, and $\leq$ each 100' length of trench	City	Contractor
	Field Density of Soil in Place Compaction and Water Content (Nuclear Gauge)	California Test Method 231	As directed, at intervals $\leq$ each 2' layer of vertical rise, $\leq$ each 1000 cy compacted fill, and $\leq$ each 100' length of trench	City	Contractor
	Field Density of Soil in Place in Narrow Trenches	ASTM D2937	As directed, at intervals $\leq$ each 2' layer of vertical rise, and $\leq$ each 100' trench	City	City
	Field Density of Cohesionless Soils	ASTM D4253 and D4254	As directed, at intervals $\leq$ each 2' layer of vertical rise, $\leq$ each 1000 cy compacted fill, and $\leq$ each 100' length of trench	City	Contractor
ROUGH AND FINISH GRADE ELEVATIONS					
Rough Grade	Deviation from Plan Elevation	$\leq 0.10'$ vertical deviation from Plan elevation	All rough graded areas	Contractor	Contractor
Finish Grade	Deviation from Plan Elevation	$\leq \frac{1}{2}"$ vertical deviation from Plan elevation	All finish graded areas	Contractor	Contractor
Finish Grade on Slopes and Embankments	Deviation from Plan Elevation (Earth)	$\leq 6"$ vertical deviation from plan elevation on graded slopes for earth	All earthen slopes	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Paved Areas	11-Month Warranty Inspection	Demonstrate no visible pavement sags above pavement cut	1 inspection	City	Contractor

- F. City's Representative may modify ASTM D1557 at their option to calculate relative compaction based on adjusted laboratory maximum wet density calculated as follows:
- $D_a = 100D_m / (100 \pm W_a)$ where:
- D_a = Adjusted laboratory maximum wet density
- D_m = Maximum wet density per ASTM D1557
- $\pm W_a$ = % change in moisture content from field moisture to laboratory optimum moisture.
- Use - when field moisture content is > laboratory optimum moisture content.
- Use + when field moisture content is < laboratory optimum moisture content.
- G. Compaction shall be deemed to conform to Contract Documents when ≤ 1 test of 3 consecutive tests falls below specified relative compaction.
1. Failing test shall be ≤ 3 percentage points below specified compaction.
 2. Contractor shall pay costs of retesting of Work not conforming to Contract Documents.
 3. Allow sufficient time for testing and evaluation of results before material is needed.
 - a. City's Representative will be sole and final judge of suitability of materials.
 4. Do not use materials in question pending test results.
- H. Remove unsatisfactory material, recompact, adjust moisture or compaction methods, place new material, and perform other operations necessary to meet Contract requirements as directed by City's Representative whose decisions and directions will be considered final on these matters.
- I. City's Representative will not provide and is not being paid to provide directions or submittal review regarding Contractor's excavation safety procedures.
1. Questions or concerns of City's Representative will be referred to CAL/OSHA whose decisions or directions shall be considered final.

3.4 Protection

- A. Refer to Section 01 35 26 for requirements for excavation safety.

3.5 Adjusting and Cleaning

- A. Remove and dispose of surplus excavated material off-site and outside right-of-way or easements, unless otherwise provided for in Contract Documents.
- B. Disposal shall conform to ordinances and regulations of governmental agencies having jurisdiction and shall be done at no cost or liability to City.
- C. Do not deposit excavated material on private property unless written permission from property owner is secured by Contractor.
1. Before City will accept Work as being completed, Contractor shall file written release signed by property owners with whom they have entered into agreements for disposal of surplus excavated material absolving City from liability connected therewith.
- D. Do not deposit excess material in water courses or other locations where disposed material will interfere with natural drainage.
- E. After backfill is completed, dress site smooth and leave site in neat and presentable condition, free of cleared vegetation, rubbish and other construction wastes.

- F. Haul away and legally dispose of surplus rock or other excavated material which cannot be used for backfill.
- G. Hand rake areas next to structures where blade-type equipment cannot.

END OF SECTION

SECTION 31 23 13

SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 Work Included

- A. Preparation of natural, filled, or excavated roadbed material before placing subbase or base material, pavement, curbs, gutters, driveways, sidewalks, flatwork and other roadway structures.
- B. Work shall include:
 - 1. Compliance with State and Federal safety regulations.
 - 2. Compliance with applicable agencies' permit conditions for Work in public or railroad right-of-way, and for Work on private property.
 - 3. Maintaining trees which are not permitted to be removed.
 - 4. Rough and fine grading, and preparation of right-of-way.
 - 5. Weed abatement and soil sterilant application.
 - 6. Legal disposal of excess excavated materials.
 - 7. Cleaning up debris, papers and loose rocks.
 - 8. Restoring fences and other disturbed property.
 - 9. All other incidental earthwork and supplementary operations needed to complete Work.
- C. Refer to Section 31 23 00 for excavation and fill.
- D. Refer to Section 31 05 50 for requirements for protecting existing utilities.
- E. Refer to Section 33 01 35 for adjusting utility maintenance hole and vault frames and covers.
- F. Refer to the following City of Corona standard details:
 - 1. City of Corona Standard Detail 827 for soil preparation notes.
 - 2. City of Corona Standard Detail 828 for weed abatement notes.
- G. Conform to Standard Specifications for Public Works Construction (Greenbook) §403, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 31 05 50: Protecting Existing Utilities
- I. Section 31 23 00: Excavation and Fill

1.3 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Applicator of weed control materials shall be licensed by State of California as Pest Control Operator and Pest Control Advisor in addition to possessing applicable subcontractor licenses.

C. Materials and methods used for weed abatement shall conform to Federal, State, and local regulations.

1.4 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM C143 Slump of Hydraulic Cement Concrete
2. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
3. ASTM D1556 Density and Unit Weight of Soil in Place by Sand Cone Method
4. ASTM D1557 Laboratory Compaction Characteristics of Soil Using Modified Effort
5. ASTM D4253 Maximum Index Density and Unit Weight of Soils Using Vibratory Table
6. ASTM D4254 Maximum Index Density and Unit Weight of Soils and Calculation of Relative Density
7. ASTM D6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
8. California Test Method 216 Relative Compaction of Untreated and Treated Soils and Aggregates
9. California Test Method 217 Sand Equivalent
10. California Test Method 231 Relative Compaction of Untreated and Treated Soils and Aggregates Using Nuclear Gage
11. California Test Method 301 Resistance "R" Value of Treated and Untreated Bases, Subbases, and Basement Soils by Stabilometer
12. SSPWC Standard Specifications for Public Works Construction (Greenbook) §301-1 "Subgrade Preparation"

1.5 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Permits	Submit copies of permits obtained for excavation and grading required by state and local governing authorities	
	On City's request, submit written permission from property owner(s) permitting legal disposal of surplus material.	
Scale Broom Weed Eradication Letter	Submit for areas at risk of Scale Broom Weed presence.	
MANUFACTURER'S LITERATURE		
Product Data	Submit for herbicides and soil sterilants per Product Data requirements.	
	Submit MSDS sheets for herbicides and soil sterilants.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificates of Compliance	For herbicides, submit certificate of registration with California Department of Pesticide Regulation	

B. Refer to Section 01 33 00 for definition of requirements for Product Data.

1.6 **Delivery, Storage, and Handling**

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

1.7 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Current Growth Herbicide	Roundup® (Monsanto)	Columbus, OH (800) 246-7219
	DuPont Oust XP	Wilmington, DE (800) 441-7515
	Accepted equal	
Pre-Emergence Herbicide	Bayer Aventis Crop Science (formerly Rhône-Poulenc) "Ronstar G 50WP"	Leverkusen, DEU
	DuPont Oust XP	Wilmington, DE (800) 441-7515
	Elanco "Surflan"	Greenfield, IN (877) 352-6261
	Helena Chemical Co. Pro-Mate® Pendulum®	Collierville, TN (901) 761-0050
	Rainbow Technology "Weedkiller"	Pelham, AL (800) 637-6047
	Spike® 80DF Hervicide (Dow AgroSciences)	Indianapolis, IN (
	Accepted equal	

2.2 Materials

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Refer to Section 31 23 00 for basic requirements for soil and backfill.

C. Materials for subgrade preparation shall be:

ITEM	MATERIAL	SPECIFICATION
Subgrade	Suitable Soil Material	Refer to Section 31 23 00.
Current Growth Herbicide		Systemic non-selective herbicide
Pre-Emergent Herbicide		Selective herbicide to halt root growth

D. Herbicides or weedkillers shall be dry, free-flowing, dust-free water-soluble chemicals.

1. Herbicides shall inhibit growth of vegetation including dawny brome grass, puncture vine, plantain, and scale broom weed.
2. Herbicides shall be approved for use on Work by governmental agencies having jurisdiction, including US EPA and California Department of Pesticide Regulation.

PART 3 - EXECUTION

3.1 Preparation

A. Remove and reconstruct asphalt paving improvements per Greenbook Requirements.

3.2 Installation

A. Refer to Sections 01 73 00 and 01 73 33 for basic execution and installation requirements.

B. The following installation standards shall be followed:

1. Requirements of contract-referenced soils reports and investigations.
2. Applicable OSHA and Cal OSHA regulations
3. California Building Code Chapter 18 "Soils and Foundations."
4. Manufacturer's installation and warranty requirements
5. Standard Specifications for Public Works Construction (Greenbook) §301-1 "Subgrade Preparation"
6. Other applicable building code requirements

C. Refer variances between above documents and Contract Documents to City's Representative.

- D. Earthwork within public rights-of-way controlled by a state, county or city, or earthwork within railroad rights-of-way shall be in accordance with requirements and provisions of permits issued by those agencies for construction within their respective rights-of-way.
 - 1. Such permit requirements and provisions which are more restrictive than those specified herein, shall take precedence and supersede provisions of Contract Documents.
- E. Refer to Section 31 23 00 for requirements for grading and unclassified excavation, placement of unclassified fill, and compaction of subgrade.
- F. Excavate and shape subgrade to line, grade, and cross section shown.
 - 1. Subgrade shall be considered to extend over full width of excavated areas or areas receiving base course.
 - 2. Subgrade depth (street zone) shall be considered to extend to 30" below finished road surface.
- G. Scarifying and cultivating will be required in the following cases
 - 1. For dry soils impervious to water penetration.
 - 2. For soils containing excessive moisture which may result in unstable foundations.
 - 3. For soils which are nonuniform in character which may result in nonuniform relative compactions and subsequent differential settlements of finished surfaces.
 - 4. When pavement is to be placed directly over roadbed material.
- H. Scarify and cultivate as follows
 - 1. After completing rough grading, loosen roadbed to depth of $\geq 6"$.
 - 2. Work loosened material to finely divided condition.
 - 3. Remove rocks $>3"$ diameter.
 - 4. Bring moisture content to -1% of optimum or wetter by adding water, adding and blending dry suitable material, or by drying existing material.
 - 5. Compact material to specified relative compaction using City-accepted equipment.
 - 6. Compacted and trimmed material shall be firm, hard, and unyielding.
- I. When scarifying and cultivating are not required, prepare subgrade as follows:
 - 1. Bring moisture content of top 6" of subgrade material to optimum by adding water at surface.
 - 2. Compact material to specified relative compaction using City-accepted equipment.
 - 3. Compacted and trimmed material shall be firm, hard, and unyielding.
- J. Apply herbicides as follows:
 - 1. Treat vegetation to be exterminated and removed with current growth herbicide in accordance with Manufacturer's Instructions.
 - 2. Treat finished subgrade of specified areas with accepted pre-emergent herbicide.
 - a. Apply pre-emergent herbicide in liquid or dry form at uniform rate ≥ 8 ounces per square yard in accordance with Manufacturer's directions.
 - b. At option of City's Representative, area shall then be lightly sprinkled with water to prevent loss of herbicide or scuffing.
 - 3. Areas to receive soil sterilant include areas to receive asphalt concrete or Portland cement concrete structures and pavement, including embankments, walkways, slabs, drainage structures, parking, and road areas.
 - a. Other areas requiring soil sterilant are storage reservoir or pond surfaces to receive lining material of less than 3" in thickness and lining perimeter areas to distance of 5' from edge of lining material.
 - b. When treating paved areas, apply herbicides to full width of excavated or graded areas.

4. Apply herbicidal products according to Manufacturer's installation and warranty requirements.
5. Refer variances between Manufacturer's application instructions and Contract Documents to City's Representative.

K. Scale Broom Weed Eradication

1. Prior to construction of public improvements a letter will be required from qualified botanist, plant taxonomist, or field biologist specializing in native plants stating an investigation and/or eradication of *Lepidospartum Aquamatum* (Scale Broom Weed) has been completed.

3.3 **Field Quality Control**

A. Field testing of subgrade preparation shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Subgrade	Compaction	Refer to Section 31 23 00			
Subgrade Tolerances Beneath Pavement, Sidewalk, Curb, Gutter, Driveways, or Structures	Deviation from Plan Grade and Cross Section.	$\pm 1/4"$ maximum deviation from Plan Elevation	All locations	Contractor	Contractor
Subgrade Tolerances Beneath Subbase or Base Material or for Unpaved Areas	Deviation from Plan Grade and Cross Section.	$\pm 1/2"$ maximum deviation from Plan Elevation	All locations	Contractor	Contractor
Finish Grade	Deviation from Plan Grade and Cross Section	Refer to Section 31 23 00			

- B. Remove unsatisfactory material, recompact, adjust moisture or compaction methods, place new material, and perform other operations necessary to meet Contract requirements as directed by City's Representative whose decisions and directions will be considered final on these matters.

3.4 **Adjusting and Cleaning**

- A. Remove and dispose of surplus excavated material off-site and outside right-of-way or easements, unless otherwise provided for in Contract Documents.
- B. Disposal shall conform to ordinances and regulations of governmental agencies having jurisdiction and shall be done at no cost or liability to City.
- C. Dress site smooth and leave site in neat and presentable condition, free of cleared vegetation, rubbish and other construction wastes.
- D. Hand rake areas next to structures where blade-type equipment cannot reach.

END OF SECTION

SECTION 33 05 26

UTILITY IDENTIFICATION

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of buried utility identification systems, including markers and warning tape.
- B. Refer to Section 01 73 33 for identification procedures for above-ground piping, ducts, and conduit utilities.
- C. Refer to Section 26 05 10 for requirements for tagging and identifying electrical circuitry.
- D. Refer to City of Corona Standard Drawings 308 and 406 for requirements for warning identification tape installation.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 33: Mechanical Identification
- I. Section 09 90 00: Painting and Coating
- J. Section 26 05 10: Common Work Results for Electrical

1.3 System Description

- A. Furnish and install complete utility identification products including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building, fire, electrical, plumbing, and mechanical codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. California Fire Code (CFC)
 - 2. California Mechanical Code (CMC)
 - 3. California Plumbing Code (CPC)
 - 4. NFPA 70 National Electric Code (NEC)

1.6 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements.	
SAMPLES		
Material Samples	Submit samples of materials proposed for use.	

SUBMITTAL	DESCRIPTION	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, and Material Samples.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of utility identification products.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Detectable Warning Tape for Installation within 12" of Surface	Calpico, Inc "Type II"	South San Francisco, CA (650) 588-2241
	Blackburn Manufacturing Company	Paso Robles, CA (805) 226-9100
	Northtown "Hytech" Detectable Tape	Huntington Beach, CA (800) 972-7274
	Seton Name Plate Corporation	Branford, CT (855) 772-4204
	T Christy Enterprises	Anaheim, CA (800) 258-4583
	Terra Tape Division Griffolyn Reef Industries	Houston, TX (800) 231-2417
	Sentryline Detectable 620	
Nondetectable Warning Tape	Accepted equal	
	Calpico, Inc "Type I"	South San Francisco, CA (650) 588-2241
	Blackburn Manufacturing Company Type YT	Paso Robles, CA (805) 226-9100
	Northtown Company	Huntington Beach, CA (800) 972-7274
	Seton Name Plate Corporation	Branford, CT (855) 772-4204
	T Christy Enterprises	Anaheim, CA (800) 258-4583
	Terra Tape Division Griffolyn Reef Industries	Houston, TX (800) 231-2417
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.

- B. Utility identification products shall identify:

FLUID	WARNING TAPE MESSAGE (BURIED UTILITIES)	IDENTIFICATION TAPE MESSAGE (BURIED UTILITIES)	COLOR
Recycled Water	CAUTION: RECLAIMED WATERLINE BURIED BELOW – DO NOT DRINK	CAUTION: RECLAIMED WATER – DO NOT DRINK	Purple with black letters
Wastewater	CAUTION: SEWER BURIED BELOW	CAUTION: SEWER	Green with black letters
OTHER			
Electrical Conduit	CAUTION: ELECTRIC LINE BURIED BELOW	CAUTION: ELECTRIC	Red with black letters
Other Utilities			

C. Materials for utility identification products shall be:

ITEM	MATERIAL	SPECIFICATION
Identification Tape	Polyethylene	Tensile strength ≥ 60 lbf
Locator Tape	Polyethylene	Tensile strength ≥ 60 lbf
Warning Tape	Polyethylene	Tensile strength ≥ 60 lbf

D. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Identification Tape	Type	Nondetectable
	Width	6"
	Thickness	4 mils minimum
	Imprint	Refer to Pipe or Utility Specifications
	Location	Attach to pipe,
Warning and Locator Tape	Type	Detectable metallic-strip locator tape that can be registered by magnetic field locating device (for plastic pipe and conduit) Nondetectable for metallic pipe and conduit
	Width	6"
	Thickness	4 mils minimum
	Imprint	Refer to Pipe or Utility Specifications
	Location	12" above pipe or conduit

PART 3 - EXECUTION**3.1 Preparation**

A. Examine areas and conditions under which Work of this section will be performed.

3.2 Installation

A. Refer to Sections 01 73 00 and 01 73 33 for basic execution and installation requirements.

B. Furnish and install utility identification products above new utilities and exposed existing utilities.

C. The following installation standards shall be followed:

1. Applicable OSHA and Cal OSHA regulations
2. Other applicable fire, plumbing, mechanical and electrical code requirements
3. City of Corona Standard Drawing 308 and 406 for warning identification tape installation.
4. Manufacturer's installation and warranty requirements

D. Refer variances between above documents and Contract Documents to City's Representative.

E. Install utility identification products to tolerances recommended by Manufacturer.

3.3 Field Quality Control

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Utility Identification Products	Installation	Visual inspection of finished installation	1 inspection	City	City

END OF SECTION

SECTION 33 05 31

PIPING JOINT MATERIALS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of piping joint materials including bolts, nuts, washers, flange gaskets, and preparation for pipe welding.
- B. Bolts and nuts for flanges, grooved or shouldered couplings, sleeve type couplings and flange coupling adaptors and harnesses shall use materials specified herein.
- C. Joint materials for bell and spigot joints and adhesive or solvent-weld joints are covered in applicable sections for pipe material being joined.
- D. For purposes of chemical compatibility, use the following materials for elastomers and bolts unless otherwise recommended by Manufacturer:

SOLUTION OR CHEMICAL	STRENGTH	TEMP.	GASKET MATERIAL	BOLT MATERIAL
Recycled Water	n/a	33°F-100°F	FPM	SAE Type 316 Stainless Steel
Wastewater	n/a	33°F-100°F	FPM	SAE Type 316 Stainless Steel
Ammonium Sulfate (NH ₄) ₂ SO ₄		33°F-100°F	FPM	SAE Type 316 Stainless Steel
Sodium Hypochlorite NaOCl Solution	9-15%	33°F-100°F	FPM Viton	Titanium (Do not use C276 or SS due to nickel content reaction)

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 09 90 00: Painting and Coating
- I. Section 09 92 00: Galvanizing
- J. Section 33 05 33 Couplings, Tie Rods, and Unions

1.3 System Description

- A. Furnish and install bolts, nuts, washers and flange gaskets where required, including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable codes and standards.
- B. Coordinate drilling pattern and orientation of bolt holes between valves, appurtenances, and adjacent flanges

1.4 Quality Assurance

- A. Manufacturer of pipe and fittings shall employ manufacturing methods and material formulations in use for at least 5 years.
- B. City or City's Representative shall be entitled to inspect pipes and witness manufacturing process.
- C. Design flange geometry and fabricate flanged parts and fittings such that specified bolts can be field-inserted, field-assembled, field-disassembled, and removed in the field without using special tools or procedures other than standard commercial wrenches.
 - 1. Replace defective parts whose geometry precludes simple field assembly and disassembly.

2. Where scheduling precludes timely replacement of defective parts or fittings prior to commissioning, defective parts or fittings shall be replaced prior to release of bonds.

D. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Flanges	Bolt Circle Drilling	$\pm 1/16'$ diameter	All flanges	Contractor	Contractor
	Bolthole Spacing	$\pm 1/32''$ circumferentially	All flanges	Contractor	Contractor
	Eccentricity of Bolt Circle and Facing with Respect to Bore	$\pm 1/32''$ radially	All flanges	Contractor	Contractor

1.5 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASME/ANSI B1.1 Unified Screw Threads
2. ASME/ANSI B1.20.1 (ANSI B2.1) Pipe Threads – NPT National Pipe Thread Taper
3. ASME/ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings – Class 25, 125, 150 and 800
4. ASME/ANSI B16.4 Cast Iron Threaded Fittings
5. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
6. ASME/ANSI B16.21 Non Metallic Flat Gaskets for Pipe Flanges
7. ASME/ANSI B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings
8. ASME/ANSI B16.42 Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300
9. ASME/ANSI B16.47 Large Diameter Steel Flanges 26"-60"
10. ASME/ANSI B18.2.1 Square and Hex Bolts and Screws (Inch Series)
11. ASME/ANSI B18.2.2 Square and Hex Nuts (Inch Series)
12. ASME/ANSI B1.20.1 (ANSI B2.1) Pipe Threads – NPT National Pipe Thread Taper
13. ASME/ANSI B31.3 Process Piping
14. ASSE 1061 Performance Requirements for Push-Fit Fittings
15. ASTM A193 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
16. ASTM A194 Carbon and Alloy Steel Nuts for High Pressure and High Temperature Service
17. ASTM A242 High-Strength Low-Alloy Structural Steel
18. ASTM A307 Carbon Steel Bolts and Studs, 60,000-psi Tensile Strength
19. ASTM A563 Carbon and Alloy Steel Nuts
20. ASTM A588 High-Strength Low-Alloy Structural Steel, up to 50ksi
21. ASTM A606 Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
22. ASTM A709 Structural Steel for Bridges
23. ASTM A847 Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance
24. ASTM B98 Copper-Silicon Alloy Rod, Bar and Shapes
25. ASTM D2000 Classification System for Rubber Products in Automotive Applications
26. ASTM F467 Nonferrous Nuts for General Use
27. ASTM F468 Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
28. ASTM F593 Stainless Steel Bolts, Hex Cap Screws, and Studs
29. ASTM F594 Stainless Steel Nuts
30. ASTM F2854 Push-Fit Crosslinked Polyethylene (PEX) Mechanical Fittings for Crosslinked Polyethylene (PEX) Pipe
31. AWWA C111 Rubber Gasket Joints for Ductile Iron Pressure Pipe
32. AWWA C115/ANSI A21.15 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
33. AWWA C151/ANSI A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
34. AWWA C200 Steel Water Pipe 6" and larger
35. AWWA C207 Steel Pipe Flanges

36. AWWA C209 Cold-Applied Tape Coatings for Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
37. AWWA C217 Petrolatum and Petroleum Wax Tape Coatings for Exterior of Connections and Fittings for Steel Pipelines
38. AWWA C303 Concrete Pressure Pipe, Bar-Wrapped, Steel Cylinder Type
39. AWWA C900 Polyvinyl Chloride PVC Pressure Pipe and Fabricated Fittings 4"-60"
40. MIL A907E Antiseize Thread Compound, High-Temperature

1.6 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data.

1.7 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Store gaskets at temperature $\leq 70^{\circ}\text{F}$.
1. Do not expose to direct sunlight.
 2. Store gaskets in manner permitting free air circulation around elastomer.
- C. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of bolts, nuts, washers and flange gaskets.

1.8 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site and operational conditions.

PART 2 – PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
BOLTS AND NUTS		
Bolts and Nuts	A&G Engineering Company	Anaheim, CA (714) 630-7400
	Birmingham Fastener Supply (BF)	Birmingham, AL (800) 695-3511
	Copper State Bolt & Nut	Phoenix, AZ (800) 603-6887
	Industrial Threaded Products, Inc. (wholesaler)	Brea, CA (800) 976-2658
	Le Jeune Bolt Co. (L)	Burnsville, MN (952) 890-4482
	Nucor Fasteners (n)	Saint Joe, IN (260) 337-1600
	Ocean State Stainless, Inc. (wholesaler)	Huntington Beach, CA (714) 898-0404
	Pacific Coast Bolt (wholesaler)	Santa Fe Springs, CA (562) 944-9549
	Portland Bolt Co. (PB)	Portland, OR (800) 547-6758
	Robbins Mfg. Co., Inc.(R)	Fall River, MA (508) 675-2555
	ShurSeal Industries (wholesaler)	Edmonton, AB (780) 435-3771
	Silo Fastener, Inc. (S)	Kansas City, MO (816) 231-6750
	St Louis Screw & Bolt Co. (SL)	Saint Louis, MO (314) 389-7500
	Texas Bolt Company (TB)	Houston, TX (713) 869-7111
	Tripac Fasteners (wholesaler)	Corona, CA (951) 280-4488
	Unytite, Inc. (UNY)	Peru, IL (815) 224-2221
	Vegas Fastener Manufacturing (VFM)	Las Vegas, NV (702) 651-9222
	Vulcan Rivet & Bolt Corp (V)	Birmingham, AL (205) 841-2711
	Western Pacific Products (wholesaler)	Chino, CA (909) 591-2410
	Accepted Equal	
Studs	Nelson Stud Welding Div. (N)	Walnut, CA (909) 468-2105
	Stud Welding Associates (+)	Elyria, OH (440) 324-3042
	Accepted Equal	

Anti-Seize Compound for Stainless Steel Bolts and Nuts	Anti-Seize Technology "Pure White"	Franklin Park, IL (800) 991-1106
	Bostik Never Seez	Wauwatosa, WI (800) 726-7845
	Dixon Ticonderoga Company "AS470"	Lakehurst, NJ (732) 657-2255
	Husk-Itt Husky Lube O-Seal	Norco, CA (951) 340-4000
	Loctite	Dusseldorf, DEU (800) 624-7767
	Permatex	Hartford, CT (877) 376-2839
	Ramco Specialty Products Anti-seize	Huntington Beach, CA (800) 334-7071
	Ramco Specialty Products TRX-Synlube	Huntington Beach, CA (800) 334-7071
	T Christy Enterprises, Inc Anti-seize	Anaheim, CA (714) 507-3300
	Accepted Equal	
Rust Preventative Coating and Lubricant for Buried Bolts	No-Ox-Id "A Special" Sanchem / Northtown	Huntington Beach, CA (714) 972-7274
	Accepted equal	
Buried Bolt Bituminous Coatings for Existing Bolts	3M Company (EC 244)	St Paul, MN (888) 364-3577
	Carboline Bitumastic No 50	St Louis, MO (888) 227-2654
	Engard Coatings 858	Huntington Beach, CA (714) 891-4402
	Protecto-Wrap Company	Denver, CO (303) 777-3001
	Tnemec Co (46-465 HB Tnemecol)	Kansas City, KS (800) 863-6321
	Accepted Equal	
Fluoropolymer Coatings for Bolts or Nuts	Metal Coatings Corp FluoroKote #1	Houston, TX (888) 371-9849
	Tripac Fasteners 2000 Blue Coating System	Corona, CA (951) 280-4488
	Accepted Equal	
FLANGE GASKETS		
Flange Gaskets – Neoprene for Nonpotable Service with Pressures Exceeding 150 psi	Allstate Gasket	Deer Park, NY (631) 254-4050
	American Biltrite	Sherbrooke, PQ (888) 479-0190
	Garlock / Bluegard / Coltec / United Seal & Rubber Style 7797	Atlanta, GA (770) 729-8880
	Buffalo Matting and Rubber Co.	Buffalo, NY (866) 475-6494
	John Crane / Smiths (3160)	Cerritos, CA (562) 802-2555
	Johns Manville 104	Denver, CO (800) 654-3103
	ShurSeal Industries	Edmonton, AB (780) 435-3771
	Thermoseal / Klinger C4400	Sidney, OH (800) 990-7325
	Tripac Style 2000	Corona, CA (951) 280-4488
	US Pipe and Foundry "Flange-Tyte"	Birmingham, AL (866) 347-7473
	Western Pacific Products	Chino, CA (909) 591-2410
	Accepted equal	
	Accepted equal	
Flange Gaskets – FPM (Viton®) for Contaminated Soils and Chemical Feed Applications incompatible with EPDM or other elastomers	Allstate Gasket	Deer Park, NY (631) 254-4050
	American Biltrite	Sherbrooke, PQ (888) 479-0190
	ShurSeal Industries	Edmonton, AB (780) 435-3771
	Tripac	Corona, CA (951) 280-4488
	US Pipe and Foundry "Flange-Tyte"	Birmingham, AL (866) 347-7473
	West American Rubber Company (WARCO) Biltrite	Orange, CA (714) 532-3355
	Western Pacific Products	Chino, CA (909) 591-2410
	Accepted equal	
THREADED JOINT SEALANTS		
Teflon Threaded Pipe Joint Compound	Lake Chemical Company "La-Co Slic-Tite"	Elk Grove Village, IL (800) 621-4025
	Radiator Specialty Company RSC "Bakerseal"	Indian Trail, NC (704) 821-7643
	Accepted equal	
Extruded Butyl Rubber Pipe Joint Sealant	General Sealants Corporation GS-79	City of Industry, CA (626) 961-0211
	Accepted equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Provide new bolts, nuts, washers, and flanges when installing new valves onto existing flanges.

C. Unless otherwise specified, materials for bolts, nuts and washers for pipe and valve assembly below ground shall be.

ITEM	MATERIAL	SPECIFICATION
Bolts for Underground Ferrous Installations (Buried, or Submersible Locations, or in Underground Structures or Chemical Handling Areas)	SAE Type 316 Stainless Steel "CRES"	
	Threads	
Nuts for Underground Ferrous Installations (Buried or in Underground Structures)	PTFE-Coated SAE Type 316 Stainless Steel	
Mechanical Joint T-Head Bolts	Corrosion-Resistant "Cor-Ten" Type Weathering Steel	Conform to one of the following ASTM A242, ASTM A588, ASTM A606-4, ASTM A709-50W ASTM A847 $F_y \geq 45$ -ksi $F_u = 75$ ksi, $E = 29000$ ksi) T-head dimensions shall conform to AWWA C111
	Threads	Conform to ANSI/ASME B18.2.1 for Bolts Conform to ANSI B1.1 Class 2A fit Coarse Thread Series Threads may be either cut or cold-formed
Mechanical Joint T-Head Mating Nuts	Corrosion-Resistant "Cor-Ten" Type Weathering Steel	Conform to one of the following ASTM A242, ASTM A588, ASTM A606-4, ASTM A709-50W ASTM A847 Heavy hexagon series
	Threads	Conform to ANSI/ASME B18.2.2 for Nuts Conform to ANSI B1.1 Class 2B fit Coarse Thread Series Threads may be either cut or cold-formed
Coating System for New Stainless Steel Bolts and Washers on Flanges	Not required	
Coating for New Stainless Steel Nuts on Flanges and Mechanical Joints	Nickel-phosphate Undercoating plus Blue Teflon or Xylan Fluoropolymer Coating	PTFE, Fluorokote #1, Xylan 1424 or Equal Fluoropolymer Coating Dry film thickness of 1.0-1.2 mils
Coating for Existing Bolts and Nuts	Anti-Seize Lubricant	Conform to MIL A907E
Washers	Washer material shall be same as each bolt.	Provide washer for each nut.
Coating for Buried Nuts and Bolts	Accepted Manufacturer's coating listed above	1.0-1.2-mil MDFT

D. Unless otherwise specified, materials for bolts, nuts and washers for pipe and valve assembly above ground shall be.

ITEM	MATERIAL	SPECIFICATION
Bolts for Above-Ground Ferrous Installations	SAE Type 316 Stainless Steel	Conform to one of the following: ASTM A193 Grade B8M Class 1 SAE Type 316 ($F_y = 30$ ksi, $F_u = 75$ ksi, $E = 29000$ ksi) Bolt-Head Identification Mark – "B8M" ASTM A193 Grade B8M Class 2 SAE Type 316 ($F_y \geq 50$ ksi, $F_u \geq 90$ ksi, $E = 29000$ ksi)

ITEM	MATERIAL	SPECIFICATION
		Bolt-Head Identification Mark – “B8M” 1/4”-1/2” shall project through tightened nut. Heavy hexagon series
	Threads	Conform to ANSI/ASME B18.2.1 for Bolts Conform to ANSI B1.1 Class 2A fit Class 3A fit may be used for holes tapped for studs. UNC/UNRC Coarse Thread Series Threads may be either cut or cold-formed
Nuts for Above-Ground Ferrous Installations	PTFE-Coated SAE Type 316 Stainless Steel	Conform to ASTM A194, Grade 1, 2 or 2H Heavy hexagon series
	Threads	Conform to ANSI/ASME B18.2.2 for Nuts Conform to ANSI B1.1 Class 2B fit UNC/UNRC Coarse Thread Series Threads may be either cut or cold-formed
Coating for New Stainless Steel Bolts and Washers	Not required	
Coating for New Stainless Steel Nuts	Nickel-phosphate Undercoating plus Blue Teflon or Xylan Fluoropolymer Coating	PTFE, Fluorokote #1, Xylan 1424 or equal Fluoropolymer Coating Apply coating system to nut only. Dry film thickness of 1.0-1.2 mils
Coating for New Non-Stainless Steel Bolts, Nuts, and Washers	Nickel-phosphate Undercoating plus Blue Teflon or Xylan Fluoropolymer Coating	PTFE, Fluorokote #1, Xylan 1424 or Equal Fluoropolymer Coating Dry film thickness of 1.0-1.2 mils
Coating for Existing Bolts and Nuts	Antiseize Lubricant	
Washers	Washer material shall be same as each bolt.	Provide washer for each nut.

E. Unless otherwise specified, materials for flange gaskets shall be.

ITEM	MATERIAL	SPECIFICATION
Flange Gaskets on Metallic Flanges	Standards	Conform to ANSI B16.21 Gasket ID shall match flange bore ID
	Material	FPM (Viton) ASTM D2000 HK10A10B38EF31F15Z1 Temperature Standard Class III to 300°F Non-asbestos
	Thickness	≥1/8" (SBR) or other materials ≥1/16" (PTFE - Teflon)
	Working Pressure Rating	350 psi at 150°F
	Style	Full-face type with pre-punched boltholes where both flanges are flat-face. Ring flange gaskets extending to inner edge of bolts may be used where raised-face flange is present. Gasket surface finish shall have 16 serrations per inch 1/32" deep in concentric or spiral pattern.
	Tensile Strength	≥1500 psi (neoprene)
	Durometer Hardness	Shore "A" of 45-55

F. Unless otherwise specified, materials for bell-and-spigot ring gaskets shall be.

ITEM	MATERIAL	SPECIFICATION
Bell-and-Spigot Ring Gaskets	Standards	Conform to ANSI B16.21 Gasket ID shall match flange bore ID

ITEM	MATERIAL	SPECIFICATION
	Gaskets for DIP Pipe	Conform to AWWA C151
	Gaskets for Steel Pipe	Conform to AWWA C200
	Gaskets for PVC Pipe	Conform to AWWA C900
	Material	FPM (Viton) ASTM D2000 HK10A10B38EF31F15Z1 Temperature Standard Class III to 300°F Non-asbestos
	Working Pressure Rating	350 psi at 180°F
	Tensile Strength	≥15000 psi (neoprene)
	Elongation at Rupture	≥350%
	Durometer Hardness	Shore "A" of 20-65
	Compression Set	≤20% of original deflection
	Method B (constant deflection 22hrs @158°F (lock-joint only)	20
	Tensile Strength Change	≥85% of original strength
	Hardness Change	≤15%
	Water Absorption	≤10% volume change
	Ozone Resistance	No cracking in 2ppm-6ppm ozone at 25% elongation for 2 hours @100°F
	Specific Gravity	1.35-1.45

G. Unless otherwise specified, materials for threaded pipe joints shall be.

ITEM	MATERIAL	SPECIFICATION
Pipe Threads	Threading	Threaded per ANSI B1.20. Use taper pipe threads (NPT) except internal straight threads may be used in couplings (NPSC)
	Lubricant or Joint Compound	Teflon or Teflon Tape Apply to male threads only

PART 3 - EXECUTION

3.1 Preparation

- A. Clean and wire brush flange faces and threads of pipe, valves, bolts, studs, nuts, gaskets and pipeline equipment before assembling joints.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install bolts, nuts, washers and flange gaskets at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
1. Applicable OSHA and Cal OSHA regulations
 2. Applicable building, fire, plumbing, and mechanical code requirements
 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Do not force fit or spring pipe, conduit or equipment into place.
1. Corrective measures for cases of poor alignment shall be accepted in advance by City's Representative.

- F. Deflections at joints shall be $\leq 80\%$ of Manufacturers' published tolerance limits.
- G. Mitered piping joints are not permitted.
- H. Nonfabricated pipe bends shall conform to ASME/ANSI B31.3 and be free from wrinkles, creases or corrugations.
- I. Water pipe bends shall use approved AWWA fittings, except steel water pipe fittings in vaults or above grade may match API dimensions subject to City's approval.
- J. Cut pipe threads with sharp dies and made up with approved thread sealing compound.
 - 1. Threads to be seal welded shall be made up dry.
 - 2. Do not use Teflon sealers.
- K. Epoxy coated pipe, valves and fittings shall be fabricated and installed without cutting, notching or welding.
- L. Assemble threaded joints as follows:
 - 1. Clean threaded pipe joints by wire brushing or swabbing.
 - 2. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves.
 - 3. Joints shall be watertight.
- M. Assemble new flanges as follows:
 - 1. Clean flange surfaces to mate with gasket, removing loose dirt, scale and detritus by wire brushing.
 - 2. Repair pits, corrosion, dents or scratches which may make sealing impossible.
 - 3. Inspect gasket to verify gasket is of proper material and style, free of defects or damage.
 - 4. Inspect flange bolts and studs for proper material, size, threading and length.
 - 5. Inspect gasket seating surfaces, each nut, each washer, and facing on which nuts will rotate.
 - 6. Clean and lubricate bolt threads and nut contact surfaces using lubricant chemically compatible with materials involved.
 - 7. Where flanged pipe penetrates wall or slab, provide at least 8" from wall or slab to face of flange.
 - 8. Set pipe with flange bolt holes straddling pipe horizontal and vertical centerline.
 - 9. Install pipe without springing, forcing, or stressing pipe or adjacent connecting valves or equipment.
 - 10. Center gasket on flange.
 - 11. With gasket in place, align mating flange bolt holes.
 - a. Make sure mating flange faces are flush against gasket prior to bolt-up.
 - 12. Insert bolts, nuts and washers.
 - a. Hand-tighten by hand until snug.
 - 13. Before tightening bolts beyond hand-tight, operate adjacent valves through full range of motion to ensure clear unobstructed operation of discs and other internal parts.
 - 14. Do not tighten bolts with impact wrenches.
 - a. Bolts so tightened will be inspected for galling and shall be replaced if galling is discovered.
 - 15. Tighten bolts in sequence by 5-lbf increments following a 180° opposing sequence.
 - a. Begin with bolt nearest 12-o'clock position, proceed to opposing bolt nearest 6-o'clock position, then to 3-o'clock and 9-o'clock and continue tightening in similar alternating sequence until all bolts are tight.

16. Flange bolt torques shall be as recommended by valve, gasket, appurtenance, or pipe Manufacturer:
 17. Since gaskets relax after seating, retighten non-buried bolts 24 hours after installation and pressure testing to compensate for relaxation.
 18. If flanges leak under pressure testing, remove and dispose of nuts and bolts, reset or replace gasket, install new bolts and nuts, and retest joints.
 - a. Joints shall be watertight.
 19. Do not reuse bolts, nuts or gaskets from failed or disassembled flange joints.
- N. Connect new flanges to existing flanges as follows:
1. Clean flange surfaces to mate with gasket, removing loose dirt, scale and detritus by wire brushing.
 2. Repair pits, corrosion, dents or scratches which may make sealing impossible.
 3. Inspect gasket to verify gasket is of proper material and style, free of defects or damage.
 4. Inspect flange bolts and studs for proper material, size, threading and length.
 5. Inspect gasket seating surfaces, each nut, each washer, and facing on which nuts will rotate.
 6. Replace damaged items.
 - a. Replace existing bolts and nuts.
 7. Clean and lubricate bolt threads and nut contact surfaces by wire brushing and using lubricant chemically compatible with materials involved.
 8. Patch or repair scratches and damaged areas incurred while installing pipe.
 9. Call for inspection of existing flanges by City's Representative prior to attaching new pipe to existing pipe.
 10. Install pipe without springing, forcing, or stressing pipe or adjacent connecting valves or equipment.
 11. Where raised-face flange connects to flat-faced flange, provide ring-gasket filler between 2 flanges.
 - a. Ring-gasket filler shall be of same material as specified for gasket between flanges.
 12. Center gasket(s) on flange.
 13. With gasket in place, align mating flange bolt holes.
 - a. Make sure mating flange faces are flush against gasket prior to bolt-up.
 14. Insert bolts, nuts and washers.
 - a. Hand-tighten by hand until snug.
 15. Before tightening bolts beyond hand-tight, operate adjacent valves through full range of motion to ensure clear unobstructed operation of discs and other internal parts.
 16. Do not tighten bolts with impact wrenches.
 - a. Bolts so tightened will be inspected for galling and shall be replaced if any galling is discovered.
 17. Tighten bolts in sequence by 5-lbf increments following a 180° opposing sequence.
 - a. Begin with bolt nearest 12-o'clock position, proceed to opposing bolt nearest 6-o'clock position, then to 3-o'clock and 9-o'clock and continue tightening in similar alternating sequence until all bolts are tight.
 18. Flange bolt torques shall be as recommended by valve, gasket, appurtenance, or pipe Manufacturer:
 - a. Do not exceed torques shown in ASME B16.5.
 19. Since gaskets relax after seating, retighten non-buried bolts 24 hours after installation and pressure testing to compensate for relaxation.

20. If flanges leak under pressure testing, remove nuts and bolts, reset or replace gasket, install new bolts and nuts, and retest joints.

a. Joints shall be watertight.

21. Do not reuse bolts, nuts or gaskets from failed or disassembled flange joints.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Pipeline Joint Materials	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

B. If flanges leak under pressure testing, loosen or remove nuts and bolts, replace flange gasket, reinstall or retighten bolts and nuts and retest joints.

1. Joints shall be watertight.

END OF SECTION

SECTION 33 05 33

COUPLINGS, TIE RODS, AND UNIONS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of bolted sleeve-type couplings, tie rods, unions, and appurtenant joint and coating systems.
- B. Refer to Section 33 05 34 for grooved and shouldered (Victaulic) style couplings.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 09 90 00: Painting and Coating
- I. Section 09 96 56: Epoxy Linings and Coatings
- J. Section 33 05 31: Pipeline Joint Materials
- K. Section 33 05 34: Grooved and Shouldered (Victaulic-Style) Couplings
- L. Section 33 11 20: Polyethylene Encasement for Iron Pipe, Fittings, Couplings, and Valves
- M. Section 33 11 33: PVC and CPVC Schedule 40, 80, and 120 Plastic Pipe

1.3 System Description

- A. Furnish and install complete functional coupling, joint or joint-restraint system including appurtenant structural, and mechanical mountings, thrust restraints, or connections and coatings required for compliance with Manufacturer's installation requirements, and compliance with AWWA and other applicable standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Products coming into contact with potable water shall contain no more than 0.25% lead by average weight in compliance with Section 116875 of California Health and Safety Code.
- C. Before ordering materials to fit outside diameters of existing pipe of uncertain dimensions, including but not limited to cast iron pipe, pipe over 16" diameter, and pipe over 50 years old, the following procedures shall be followed:
 - 1. Excavate pipe to be joined at location coupling or restraint will be installed.
 - 2. Field measure pipe circumference at that location.
 - 3. Without removing pipe from service, measure outside diameters along x-axis and y-axis.
 - 4. Verify roundness of existing pipe is within Manufacturer's tolerances.
 - 5. If existing pipe roundness is outside coupling or restraint Manufacturer's tolerances, it may be necessary to cut pipe being joined and trace outside diameter template on sheet of butcher paper mounted to plywood board to allow custom fittings to be fabricated to match field pipe geometry.
- D. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Bolted Sleeve-Type Couplings and Flanged Coupling Adaptors	Proof-of-Design Test	Refer to AWWA C219 §5.2.2	1 prototype of each item	Contractor	Contractor
Bolted Split-Sleeve Couplings	Proof-of-Design Test	Refer to AWWA C227 §5.2.2	1 prototype of each item	Contractor	Contractor
Fusion-Bonded Epoxy Linings	Holidays and Lining Thickness	Refer to Section 09 96 56	1 each item	Contractor	Contractor

1.5 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
2. ASME/ANSI B16.39 Malleable Iron Threaded Pipe Unions
3. ASSE 1079 Dielectric Pipe Unions
4. ASTM A193 Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service
5. ASTM A283 Low and Intermediate Tensile Strength Carbon Steel Plates
6. ASTM A536 Ductile Iron Castings
7. ASTM C1173 Flexible Transition Couplings for Underground Piping Systems
8. ASTM D2464 Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings
9. AWWA C105 Polyethylene Encasement for Ductile-Iron Pipe Systems
10. AWWA C207 Steel Pipe Flanges for Waterworks Service – Sizes 4" through 144"
11. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
12. AWWA C219 Bolted Sleeve-Type Couplings for Plain End Pipe
13. AWWA C227 Bolted Split-Sleeve Couplings
14. AWWA C230 Stainless Steel Full-Encirclement Repair and Service Connection Clamps for 2" - 12" Pipe
15. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
16. AWWA M11 Steel Pipe, A Guide for Design and Installation
17. Fed Spec WW-F406
18. MSS SP123 Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube
19. NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances
20. NSF/ANSI 61 Drinking Water System Components – Health Effects
21. NSF/ANSI 372 Drinking Water System Components – Lead Content (Formerly NSF/ANSI 61 Annex G)

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
	Show lining and coating data and thicknesses on items 4" and larger	
Installation Instructions	Submit per Installation Instruction requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Product Data, and Installation Instructions,

1.7 **Delivery, Storage, and Handling**

- Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of couplings, and tie rods.
- Refer to AWWA C219 §6 for additional requirements for delivery, storage, and handling of bolted sleeve-type couplings.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Refer to City of Corona Approved List of Materials for Water Facilities for acceptable Manufacturers for sleeve-type couplings.
- B. Acceptable Manufacturers for steel bolted sleeve-type couplings include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Unrestrained Couplings – Steel Bolted Sleeve Type, for Identical Pipe Materials on each side	Dresser Piping Specialties (Style 38)	Bradford, PA (814) 362-9200
	JCM Industries, Inc (Style 201) or (Style 202)	Nash, TX (800) 527-8482
	Romac Industries (400) or (501)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 411)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Unrestrained Couplings – Steel Bolted Transition Sleeve Type, for Different Pipe Materials on each side	Dresser Piping Specialties (Style 162) or (Style 62)	Bradford, PA (814) 362-9200
	JCM Industries, Inc (Style 203)	Nash, TX (800) 527-8482
	Romac Industries (TC400)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 413)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Unrestrained Couplings – Insulating Sleeve Type, for Different Metallic Pipe Materials on each side (Also use on Buried Metallic Pipelines Penetrating Concrete Structures or Encased in Concrete)	Romac Industries (IC400 or IC501)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 416)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Unrestrained Couplings – Steel Bolted Reducing Sleeve Type, for Identical Pipe Materials of Different Diameters on Each Side	Dresser Piping Specialties (Style 62)	Bradford, PA (814) 362-9200
	JCM Industries, Inc (Style 204)	Nash, TX (800) 527-8482
	Romac Industries (RC400)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 415) 4"-48"	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Restrained Couplings – Steel Bolted Sleeve Type, for Identical Pipe Materials on each side	EBAA Iron (Mega-Coupling Series 3800)	Eastland, TX (800) 433-1716
	Romac Industries (400RG)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 471)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Restrained Couplings – Steel Bolted Sleeve Type, for Identical Pipe Materials of Different Diameters on Each Side	Smith Blair, Inc / Xylem (Style 476)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	

- C. Acceptable Manufacturers for cast or ductile iron bolted sleeve-type couplings include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Unrestrained Couplings – Cast Bolted Sleeve Type System, for Identical or Different Pipe Materials on Each Side 2"-12"	Romac Industries (501) or (XR501) 4"-12"	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem (Style 461) (Quantum) 4"12"	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Unrestrained Couplings –	Romac Industries (Macro) 2"-12"	Bothell, WA (800) 426-9341

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Cast Bolted Sleeve Extended Range Type for Identical or Different Pipe Materials on Each Side	Smith Blair, Inc / Xylem (Style 461) (Quantum) 4"12"	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	
Restrained Couplings – Cast Bolted Sleeve Extended Range Type for Identical or Different Pipe Materials on Each Side	Romac Industries (Alpha)	Bothell, WA (800) 426-9341
	Smith Blair, Inc / Xylem	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	

D. Acceptable Manufacturers for external harness-style systems include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
External Joint Restraint Systems – Restraint Lug and Eyebolt	Romac Industries Duc Lug & 90° Eye-Bolt	Bothell, WA (800) 426-9341
	Accepted Equal	
External Joint Restraint Systems – Restraint Plate and Tie Rod	Smith Blair, Inc / Xylem (Style 907)	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Accepted Equal	

E. Refer to sections for applicable pipe materials for requirements for follower-gland-type and harness-type mechanical joint restraints.

F. Acceptable Manufacturers for other coupling products, include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Cam Lock Fittings	Banjo Corporation	Crawfordsville, IN (765) 362-7367
	Central States Hose, Inc.	Denver, CO (303) 321-2661
	MMC International Co.	Inwood, NY (516) 239-7339
	Accepted Equal	
Restrained End Caps – Extended Range Type	Romac Industries (Alpha)	Bothell, WA (800) 426-9341
	Accepted Equal	
Polyethylene Encasement for Buried Couplings and Appurtenances	Refer to Section 33 11 20	
Tape for Polyethylene Encasement	Refer to Section 33 11 20	
PVC Compression Couplings, Repair Couplings, and Saddles	Refer to Section 33 11 33	
Unions (Dielectric Insulating)	Harrington Industrial Plastics, Inc.	Chino, CA (909) 597-8641
	Lochinvar	
	Pipe Seal and Insulator Company	
	Pipeline Coating and Engineering Company	
	Smith Blair, Inc / Xylem	Texarkana, AR (800) 643-9705 Orange, CA (714) 505-7079
	Spears Manufacturing Company	Sylmar, CA (818) 364-1611
	Zurn-Wilkins (DU) Series	Paso Robles, CA (805) 226-6297
	Accepted Equal	
Unions (Noninsulating Brass)	James Jones Company J-1528	Ontario, CA (800) 523-8618
	Mueller H-15403	Chattanooga, TN (423) 209-4800
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Materials for bolted-sleeve-type couplings shall conform to AWWA C219 and shall be:

ITEM	MATERIAL	SPECIFICATION
Sleeve	Steel (Use in vaults, meter boxes, structures, and above-ground)	Conform to ASTM A283 Grade C or carbon steel with minimum 30-ksi yield
	Stainless Steel	SAE Type 316
	Ductile Iron (Use for underground applications)	Conform to ASTM A536 65-45-12
Coupling and Harness Bolts	Stainless Steel	Refer to Section 33 05 31.
Gasket	EPDM	Conform to AWWA C111 Suitable for exposure to petroleum products, solvents, and temperatures up to 180°F
Sleeve Lining (couplings 3" and larger)	Fusion-Bonded Epoxy	Refer to Section 09 96 56. AWWA C550 12-mil minimum DFT Not required for stainless steel sleeves
Exterior Finish Coat	Fusion-Bonded Epoxy	Refer to Section 09 96 56. Not required for stainless steel sleeves
Polyethylene Encasement for Buried Couplings and Appurtenances	Polyethylene Sheet	Refer to Section 33 11 20

- C. Materials for coupling restraint systems for bolted-sleeve-type couplings or flanged coupling adaptors installed on ductile iron or PVC pipe shall be:

ITEM	MATERIAL	SPECIFICATION
Follower Gland	Ductile Iron	Conform to ASTM A536 65-45-12
Wedges	Ductile Iron	Single tooth, heat-treated for ductile iron applications
Actuating Bolts	Ductile Iron	Conform to ASTM A536 65-45-18
Breakaway Nuts	Carbon Steel	
	Cast Iron	
Tie Rods - Steel	Carbon Steel	Conform to NFPA 24 Conform to ASTM A193 Grade B7 threaded rods. Do not use all-thread
	Galvanized Coating	Conform to ASTM A123 - 3.4 mil thickness - 2.00 ounce/ft ²
Tie Rods – Stainless Steel	Stainless Steel	Conform to NFPA 24 SAE Type 304 / 316
Coating for New Bolts and Nuts	Nickel-phosphate Undercoating Blue Teflon or Xylan Fluoropolymer Coating	Refer to Section 33 05 31.
Coating for Existing Bolts and Nuts	Antiseize Lubricant	Refer to Section 33 05 31.
Lubrication for Above-Ground or Vault-Enclosed Steel Tie-Rod or Bolt Threads	Oil and Graphite, Blue Fluoropolymer Coating or Accepted Valve Manufacturer's Anti-seize Coating	Refer to Section 33 05 31.
Gland Exterior Finish Coat	Fusion-Bonded Epoxy	Refer to Section 09 96 56.
Coating on Buried Bolts and Nuts	Mastic	Refer to Section 33 11 19.
Polyethylene Encasement for Buried Couplings and Appurtenances	Polyethylene Sheet	Conform to AWWA C105 2 layers, 8 mils each

D. Materials for coupling restraint systems for bolted-sleeve-type couplings or flanged coupling adaptors installed on steel pipe shall be:

ITEM	MATERIAL	SPECIFICATION
Follower Gland	Ductile Iron	Conform to ASTM A536 65-45-12
Wedges	Ductile Iron	Single tooth, heat-treated for ductile iron applications
Harness Lug	Carbon Steel	
Tie Rods - Steel	Carbon Steel	Conform to ASTM A193 Grade B7 threaded rods. Do not use all-thread
	Galvanized Coating	Conform to ASTM A123 - 3.4 mil thickness - 2.00 ounce/ft ²
Tie Rods – Stainless Steel	Stainless Steel	SAE Type 304 / 316
Lubrication for Above-Ground Tie Rods and Bolt Threads	Oil and Graphite, Blue Fluoropolymer Coating or Accepted Valve Manufacturer's Anti-seize Coating	Refer to Section 33 05 31.
Coating on Buried Bolts and Nuts	Mastic	Refer to Section 33 11 19.
Polyethylene Encasement for Buried Couplings and Appurtenances	Polyethylene Sheet	Conform to AWWA C105 2 layers, 8 mils each

E. Materials for dismantling joints shall be:

ITEM	MATERIAL	SPECIFICATION
Dismantling Joints	Construction	Conform to AWWA C219 where applicable
	Spigot	Conform to ASTM A283 Steel Grade C or ASTM A536 Grade 65-45-12 Ductile Iron
	Flange Adaptor	Conform to ASTM A283 Steel Grade C or ASTM A536 Grade 65-45-12 Ductile Iron
	Gasket	EPDM Grade E or Buna-N
NSF Listing	Parts Exposed to Potable Water	Provide NSF 61 listed products and conform to NSF/ANSI 372 lead threshold for potable water applications.
Flanges Working Pressures 0-150 psi	Ductile Iron	Conform to ASME/ANSI B16.42 Class 150 Raised or plain faced
	Cast Iron	Conform to ASME/ANSI B16.1 Class 125 Raised or plain faced
	Carbon Steel	Conform to AWWA C207 Class D, or ANSI /ASME 16.5 Class 150 Conform to ASME/ANSI B16.47 Class 150 for valves 26" and larger Raised or plain faced
	Stainless Steel	Conform to AWWA C207 Class D, or ANSI /ASME 16.5 Class 150 Conform to ASME/ANSI B16.47 Class 150 for valves 26" and larger Raised or plain faced
Flanges Working Pressures 150-250 psi	Ductile Iron	Conform to ASME/ANSI B16.42 Class 150 Raised or plain faced
	Carbon Steel	Conform to AWWA C207 Class E, or ANSI /ASME 16.5 Class 150 Conform to ASME/ANSI B16.47 Class 150 for flanges 26" and larger Raised or plain faced
	Stainless Steel	Conform to AWWA C207 Class E, or ANSI /ASME 16.5 Class 150 Conform to ASME/ANSI B16.47 Class 150 for flanges 26" and larger Raised or plain faced
Flanges Sizes 6-60" Working Pressures 250-300 psi	Ductile Iron	Conform to ASME/ANSI B16.42 Class 300 Raised or plain faced
	Carbon Steel	Conform to AWWA C207 Class F, or ANSI /ASME 16.5 Class 300 Conform to ASME/ANSI B16.47 Class 250 for flanges 26" and larger Raised or plain faced
	Stainless Steel	Conform to AWWA C207 Class F, or ANSI /ASME 16.5 Class 300 Conform to ASME/ANSI B16.47 Class 250 for flanges 26" and larger Raised or plain faced
Flanges Working Pressures 300-	Carbon Steel	Conform to ASME/ANSI B16.5 Class 300 Conform to ASME/ANSI B16.47 Class 250 for flanges 26" and larger

ITEM	MATERIAL	SPECIFICATION
500 psi		Use ring gaskets
	Stainless Steel	Conform to ASME/ANSI B16.5 Class 300 Conform to ASME/ANSI B16.47 Class 250 for flanges 26" and larger Use ring gaskets
Flanges Working Pressures >500 psi	Carbon Steel	Provide drilling pattern and gasket appropriate for temperature and class of service. Use ring gaskets
	Stainless Steel	Provide drilling pattern and gasket appropriate for temperature and class of service. Use ring gaskets
Flange Alignment	Horizontal Pipelines	Boltholes shall straddle horizontal and vertical centerlines of pipe run to which valves are attached.
	Vertical Pipelines	Boltholes shall straddle plant North-South and plant East-West centerlines of pipe run to which valves are attached.
Tie Rods – Stainless Steel	Stainless Steel	SAE Type 304 / 316 Design to withstand imposed thrust at rated working pressure.
Lining	Epoxy	Refer to Section 09 96 56. Conform to AWWA C550 12 / 16-mil minimum DFT Do not coat sealing areas and bronze or stainless steel parts.
Exterior Finish Coat	Epoxy Urethane	Refer to Section 09 90 00.
Polyethylene Encasement for Buried Couplings and Appurtenances	Polyethylene Sheet	Conform to AWWA C105 2 layers, 8 mils each

- F. Materials for repair clamps shall only be used for applications with working pressures ≤ 150 psi and shall be:

ITEM	MATERIAL	SPECIFICATION
Repair Clamp	Stainless Steel	SAE Type 316
NSF Listing	Parts Exposed to Potable Water	Provide NSF 61 listed products and conform to NSF/ANSI 372 lead threshold for potable water applications.

- G. Materials for unions shall be:

ITEM	MATERIAL	SPECIFICATION
Insulating Unions (Use restricted to pipe $\leq 2\frac{1}{2}$ " with dissimilar metals on each side of union)	Standard	Conform to ASSE 1079 and ASTM D2464
	Location	Provide where dissimilar pipe materials mate
		Provide within 12" of regulating equipment, water heating, conditioning tanks and similar equipment requiring service by removal in manner facilitating ready removal.
	Material	PVC
	Class	Match Adjacent Pipe
Noninsulating Unions for Potable Water Service (Match adjacent pipe material)	Lead-Free Brass	Conform to ASTM B584, AWWA C800, NSF 61, and NSF 372 3-part with flared copper end connections where required
	Malleable Iron	Conform to ASME/ANSI B16.39
	Stainless Steel	SAE Type 316 Grade B7
Noninsulating Unions not for Potable Water Service (Match adjacent pipe material)	Bronze	Conform to ASTM B61 or B62 3-part with flared copper end connections where required
	Malleable Iron	Conform to ASME/ANSI B16.39
	Stainless Steel	SAE Type 316 Grade B7
NSF Listing	Parts Exposed to Potable Water	Provide NSF 61 listed products and conform to NSF/ANSI 372 lead threshold for potable water applications.

H. Materials for sewer transition couplings shall be:

ITEM	MATERIAL	SPECIFICATION
Transition Coupling - Sewer	Elastomeric with Stainless Steel tension bands	Conform to ASTM C1173

- I. Where pipeline pressures >150 psi, and where pipe tap for appurtenance into main >1" diameter, provide 2½" extra-heavy carbon steel coupling as outlet, and isolate fitting or appurtenance from main using 2" SAE Type 316 stainless steel bushing, 2" SAE Type 316 stainless steel nipple, and 2" type 316 stainless steel ball valve.

J. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Rated Working Pressure	150 / 200 / 250 / 300 psi	
Coating on Buried Bolts, Nuts and Tie-Rods	Refer to Section 09 90 00. ≥2 coats 12 / 16 mils MDFT per coat	
Dismantling Joints	Self-Contained Restraint Rating	Larger of 250 psi or rating of mating flanges
	Dimensions	No part of restraint system shall extend outside flange diameter Bore shall match nominal pipe diameter
	Tie Rod Diameter	Compatible with mating flange bolt diameter
	Longitudinal Adjustment	≥ 1" / 4" inward adjustment, ≥1" expansion
Harness for Bolted Sleeve Type Couplings and Flange Coupling Adaptors	Design Stress	Design harness and tie rods per AWWA M11 Tie rods shall withstand pressure without exceeding 50% of yield stress

K. Harnesses and tie-bolts or studs shall conform to AWWA M11 Table 13-6, 13-7, and 13-7A.

1. Tie rods shall withstand pressure without exceeding 50% of yield stress.
2. Minimum bolt requirements are:

NOMINAL PIPE SIZE	TEST PRESSURE					
	≤150 PSI		200 PSI		250 PSI	
	# OF BOLTS OR STUDS	SIZE	# OF BOLTS OR STUDS	SIZE	# OF BOLTS OR STUDS	SIZE
2"	2	⅝"	2	⅝"	2	⅝"
3"	2	⅝"	2	⅝"	2	⅝"
4"	2	⅝"	2	⅝"	2	⅝"
6"	2	⅝"	2	⅝"	2	⅝"
8"	2	⅝"	2	⅝"	2	⅝"
10"	2	⅝"	2	2"	2	¾"
12"	2	¾"	2	2"	2	⅞"
14"	2	¾"	2	2"	2	1"
16"	2	⅞"	2	2"	2	1⅛"
18"	2	1"	2	2"	2	1¼"
20"	2	1"	2	2"	2	1¼"
24"	4	⅞"	4	4"	4	1⅛"
30"	4	1⅛"	4	4"	4	1⅜"
36"	4	1¼"	4	4"	4	1⅜"

- L. Flanges shall conform to AWWA C207 requirements and shall mate with adjacent valves or fittings.
- M. Internal bore of couplings and joints shall be as close to that of pipe system as is commercially available.
- N. Coupling products referenced in this section shall be painted and coated, interior and exterior in accordance with Section 09 90 00 or 09 96 56 as applicable.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install products before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. On buried couplings and assemblies, lubricate threaded parts including bolts and compression collars before assembling couplings and joints.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install couplings, tie rods, flange connectors and unions at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building, fire, plumbing and mechanical code requirements
 - 3. Manufacturer's installation and warranty requirements
 - 4. AWWA M11 Steel Pipe, A Guide for Design and Installation
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Couplings, tie rods, flange connectors, and unions shall be furnished and installed by Contractor at location shown on Plans and Submittals.
- F. Bolting shall be completed as follows:
 - 1. Wire brush and clean flange before joining flange.
 - 2. Lubricate bolt threads with graphite and oil.
 - 3. Bolt heads and nuts shall rest squarely against metal.
 - a. Draw bolt heads and nuts tight against Work using suitable wrench $\geq 15"$ long or torque wrench set to provide similar torque.
 - 4. Tap bolt heads with hammer while nut is being tightened.
 - a. After being tightened, nuts shall be locked.
 - 5. Bolts shall extend entirely through nut projecting at least $\frac{1}{4}"$ but not more than $\frac{3}{8}"$ beyond outside nut face.
- G. Joint deflections for unrestrained bolted sleeve-type couplings shall not exceed:

PIPE NOMINAL DIAMETER	CENTER SLEEVE LENGTH					
	3.5"	4"	5"	6"	7"	10"
<2"	4.0°	4.0°	4.0°	4.0°	4.0°	4.0°
2"	4.0°	4.0°	4.0°	4.0°	4.0°	4.0°
3"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
4"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
6"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
8"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
10"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
12"	n/a	4.0°	4.0°	4.0°	4.0°	4.0°
14"	n/a	n/a	2.5°	3.0°	4.0°	4.0°
16"	n/a	n/a	2.5°	3.0°	4.0°	4.0°
18"	n/a	n/a	2.5°	3.0°	4.0°	4.0°
20"	n/a	n/a	n/a	3.0°	4.0°	4.0°
24"	n/a	n/a	n/a	3.0°	4.0°	4.0°
30"	n/a	n/a	n/a	2.0°	3.0°	3.0°

36"	n/a	n/a	n/a	2.0°	3.0°	3.0°
42"	n/a	n/a	n/a	n/a	2.0°	2.5°
48"	n/a	n/a	n/a	n/a	2.0°	2.5°
54"	n/a	n/a	n/a	n/a	1.5°	2.0°
60"	n/a	n/a	n/a	n/a	1.5°	2.0°
64"	n/a	n/a	n/a	n/a	1.5°	2.0°
66"	n/a	n/a	n/a	n/a	1.5°	2.0°
72"	n/a	n/a	n/a	n/a	1.5°	2.0°
84"	n/a	n/a	n/a	n/a	n/a	1.0°
96"	n/a	n/a	n/a	n/a	n/a	1.0°
108"	n/a	n/a	n/a	n/a	n/a	1.0°
120"	n/a	n/a	n/a	n/a	n/a	1.0°

1. Values shown above are based on that recommended by AWWA C219 Table 3.

H. Joint deflections for unrestrained split-sleeve couplings shall not exceed:

PIPE NOMINAL DIAMETER	BODY LENGTH						
	3"	4"	5"	6"	8"	10"	12"
2"	5.0°	5.0°	5.0°	n/a	n/a	n/a	n/a
3"	5.0°	5.0°	5.0°	n/a	n/a	n/a	n/a
4"	n/a	5.0°	5.0°	n/a	n/a	n/a	n/a
6"	n/a	4.0°	4.5°	4.5°	4.0°	3.0°	n/a
8"	n/a	4.0°	4.5°	4.5°	4.0°	3.0°	n/a
10"	n/a	4.0°	4.5°	4.5°	4.0°	3.0°	n/a
12"	n/a	4.0°	4.5°	4.5°	4.0°	3.0°	n/a
14"	n/a	4.0°	4.5°	4.5°	4.0°	3.0°	n/a
16"	n/a	n/a	n/a	3.5°	3.5°	2.75°	2.5°
18"	n/a	n/a	n/a	3.5°	3.5°	2.75°	2.5°
20"	n/a	n/a	n/a	3.5°	3.5°	2.75°	2.5°
24"	n/a	n/a	n/a	3.0°	3.0°	2.75°	2.5°
30"	n/a	n/a	n/a	3.0°	3.0°	2.75°	2.5°
36"	n/a	n/a	n/a	3.0°	3.0°	2.75°	2.5°
42"	n/a	n/a	n/a	2.0°	2.0°	1.75°	2.0°
48"	n/a	n/a	n/a	2.0°	2.0°	1.75°	2.0°
54"	n/a	n/a	n/a	n/a	1.5°	1.25°	1.5°
60"	n/a	n/a	n/a	n/a	1.5°	1.25°	1.5°
64"	n/a	n/a	n/a	n/a	1.5°	1.25°	1.5°
66"	n/a	n/a	n/a	n/a	1.5°	1.25°	1.5°
72"	n/a	n/a	n/a	n/a	1.5°	1.25°	1.5°
84"	n/a	n/a	n/a	n/a	n/a	n/a	1.0°
96"	n/a	n/a	n/a	n/a	n/a	n/a	1.0°
108"	n/a	n/a	n/a	n/a	n/a	n/a	1.0°
120"	n/a	n/a	n/a	n/a	n/a	n/a	1.0°

1. Values shown above are based on that recommended by AWWA C227 Table 3.

- I. Provide appropriate equipment connection couplings and fittings between field piping systems and equipment inlet and outlet connections.
- J. Unless otherwise shown, encase buried couplings and appurtenances with 2 layers of polyethylene wrap.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Couplings, Tie Rods, Flange Coupling Adaptors, and Unions	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 33 05 34

GROOVED AND SHOULDERED (VICTAULIC-STYLE) COUPLINGS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of grooved and shouldered couplings and appurtenant coating systems.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 09 90 00: Painting and Coating
- I. Section 09 96 56: Epoxy Linings and Coatings
- J. Section 33 05 31: Pipeline Joint Materials
- K. Section 33 05 33: Couplings, Tie Rods, Flange Connectors, and Unions

1.3 System Description

- A. Furnish and install complete functional thrust-restraining grooved and shouldered coupling system including appurtenant coatings required for compliance with Manufacturer's installation requirements, and compliance with AWWA and other applicable standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

- B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Fusion Bonded Epoxy Linings	Holidays and Lining Thickness	Refer to Section 09 96 56	1 each item	Contractor	Contractor

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM A47 Ferritic Malleable Iron Castings
2. ASTM A183 Carbon Steel Track Bolts and Nuts
3. ASTM A193 Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service
4. ASTM A283 Low and Intermediate Tensile Strength Carbon Steel Plates
5. ASTM A449 Hex Cap Bolts, Screws, and Studs
6. ASTM A536 Ductile Iron Castings
7. ASTM F593 Stainless Steel Bolts, Hex Cap Screws, and Studs
8. ASTM F594 Stainless Steel Nuts
9. ASTM D2000 Classification System for Rubber Products in Automotive Applications
10. AWWA C105 Polyethylene Encasement for Ductile-Iron Pipe Systems
11. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
12. AWWA C606 Grooved and Shouldered Joints
13. AWWA M11 Steel Pipe, A Guide for Design and Installation
14. NSF/ANSI 61 Drinking Water System Components – Health Effects

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
	Also submit Product Data for grooved connector gasket compatible with pipe's service condition.	
	Show lining and coating data and thicknesses on items 4" and larger	
Installation Instructions	Submit per Installation Instruction requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Product Data, and Installation Instructions,

1.7 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of grooved and shouldered couplings.
- C. Refer to AWWA C606 §6 for additional requirements for delivery, storage, and handling of grooved and shouldered couplings.

1.8 Project Site Conditions

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers for grooved couplings for steel pipe include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Couplings – Flexible Grooved Type for Steel Pipe 4"-24"	Gruv-Lok / Anvil International / Mueller	Exeter, NH (603) 418-2800
	Piedmont Pacific Corporation.	Vista, CA (510) 434-0990
	Shurjoint Piping Products	Las Vegas, NV (702) 644-4492
	Simplex-Grinnell / Tyco	Lansdale, PA (561) 912-6387
	Star Pipe Products, Inc.	Corona, CA (951) 898-0770
	Victaulic Company of America, Inc (Style 77)	Easton, PA (610) 559-3300
	Accepted Equal	
Couplings – Roll-Grooved Type for Steel Pipe 28"-42"	Gruv-Lok / Anvil International / Mueller	Exeter, NH (603) 418-2800
	Piedmont Pacific Corporation.	Vista, CA (510) 434-0990
	Shurjoint Piping Products	Las Vegas, NV (702) 644-4492
	Simplex-Grinnell / Tyco	Lansdale, PA (561) 912-6387
	Star Pipe Products, Inc.	Corona, CA (951) 898-0770
	Victaulic Company of America, Inc (Style 770)	Easton, PA (610) 559-3300
	Accepted Equal	

B. Acceptable Manufacturers for shouldered couplings for steel pipe include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Couplings –Shouldered Type for Steel Pipe 4"-60"	Gruv-Lok / Anvil International / Mueller	Exeter, NH (603) 418-2800
	Piedmont Pacific Corporation.	Vista, CA (510) 434-0990
	Shurjoint Piping Products	Las Vegas, NV (702) 644-4492
	Simplex-Grinnell / Tyco	Lansdale, PA (561) 912-6387
	Star Pipe Products, Inc.	Corona, CA (951) 898-0770
	Victaulic Company of America, Inc (Style 44 with Vic-Ring)	Easton, PA (610) 559-3300
	Accepted Equal	

C. Acceptable Manufacturers for couplings for ductile iron pipe include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Couplings – Grooved Type for Ductile Iron Pipe 3”-36”	Gruv-Lok / Anvil International / Mueller	Exeter, NH (603) 418-2800
	Piedmont Pacific Corporation.	Vista, CA (510) 434-0990
	Shurjoint Piping Products	Las Vegas, NV (702) 644-4492
	Simplex-Grinnell / Tyco	Lansdale, PA (561) 912-6387
	Star Pipe Products, Inc.	Corona, CA (951) 898-0770
	Victaulic Company of America, Inc (Style 31)	Easton, PA (610) 559-3300
	Accepted Equal	

2.2 **Materials**

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for grooved and shouldered couplings shall be:

ITEM	MATERIAL	SPECIFICATION
Coupling Housings (Match adjacent pipe material)	Ductile Iron	Conform to ASTM A536 grade 65-45-12
	Steel	
Lining (couplings 3” and larger)	Fusion-Bonded Epoxy	Refer to Section 09 96 56 AWWA C550 4-mil minimum DFT
	Liquid Epoxy	Refer to Section 09 96 56 AWWA C550 6-mil minimum DFT
Gaskets	Halogenated Butyl Rubber (Brown)	As recommended by Manufacturer for fluid conveyed AWWA C606 and ASTM D2000 Grade M FlushSeal (do not use with petroleum products)
	Nitrile Rubber (Red)	As recommended by Manufacturer for fluid conveyed AWWA C606 and ASTM D2000 Grade S FlushSeal (do not use for hot water service)
Bolts and Nuts (Use same material as flange bolts)	Carbon Steel	ASTM A183 or ASTM A449
	Stainless Steel	ASTM F593 and F594 SAE Type 316
Exterior Finish Coat	Epoxy Urethane	Refer to Section 09 90 00
Polyethylene Encasement for Buried Couplings and Appurtenances	Polyethylene Sheet	Conform to AWWA C105 2 layers, 8 mils each

C. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Rated Working Pressure	150 psi Do not use grooved and shouldered couplings for working pressures >100 psi.
Couplings – Grooved and Shouldered Type on Steel Pipe 4”-24” diameter	Minimum wall thickness and other dimensions of roll-grooved steel pipe shall be as shown in AWWA C606 Table 5 Shouldered ends shall conform to AWWA C606 Type C or D with dimensions per AWWA C606 Table 6.
Couplings – Grooved and Shouldered Type on Steel Pipe 30”-64” diameter	Pipe ends shall be shouldered per AWWA C606 Type C or D
Couplings – Grooved and Shouldered Type on DIP Pipe 4”-24” diameter	Minimum wall thickness of radius-grooved grooved DIP shall be Class 53. Pipe walls for flexible-joint couplings shall be radius-grooved to dimensions shown in AWWA C606 Table 2. Pipe walls for rigid-joint couplings shall be radius-grooved to dimensions shown in AWWA C606 Table 3. Cut grooving will not be accepted.

D. Internal bore of couplings and joints shall be as close to that of pipe system as is commercially available.

E. Coupling products referenced in this section shall be painted and coated, interior and exterior in accordance with Sections 09 90 00 and 09 96 56.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install products before submitting shop drawings or ordering.
 - 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. On buried couplings and assemblies, lubricate threaded parts including bolts and compression collars before assembling couplings and joints.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install couplings at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building, fire, plumbing and mechanical code requirements
 - 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Furnish and install couplings at locations shown on Plans and Submittals.
- F. Install grooved-end couplings as follows:
 - 1. Clean loose scale, rust, oil, grease, and dirt from pipe or fitting groove.
 - 2. Apply coupling Manufacturer's gasket lubricant to gasket exterior, lips, pipe ends, and housing interiors.
 - 3. Tighten couplings alternately and evenly until coupling halves are seated.
 - 4. Complete bolting as follows:
 - a. Lubricate bolt threads with graphite and oil.
 - b. Use torques recommended by coupling Manufacturer.
 - c. Boltheads and nuts shall rest squarely against metal.
 - d. Draw boltheads and nuts tight against Work using suitable wrench $\geq 15"$ long or torque wrench set to provide similar torque.
 - e. Tap bolt heads with hammer while nut is being tightened.
 - f. After being tightened, nuts shall be locked.
 - g. Bolts shall extend entirely through nut projecting $\frac{1}{4}"$ - $\frac{3}{8}"$ beyond outside nut face.
- G. Unless otherwise shown, encase buried couplings and appurtenances with 2 layers of polyethylene wrap.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Couplings	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 33 05 38

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of hangers, supports, and modular strut systems for pipe and conduit.
- B. Refer to the following sections for Work not covered herein.
 - 1. Section 05 05 19 for post-installed concrete anchors
 - 2. Section 05 05 23 for metal fastenings and welds
- C. Refer to City of Corona Standard Drawing 418 for requirements for adjustable pipe supports for the flash mixer.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 05 05 19: Post-Installed Concrete Anchors
- K. Section 05 05 23: Metal Fastenings and Welds
- L. Section 09 90 00: Painting and Coating

1.3 System Description

- A. Furnish and install complete functional pipe and conduit hanger and support systems where shown including appurtenant mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable mechanical and electrical codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications listed below and in various sections form part of specification to extent referenced. These are referred to within text by basic designation only.
 - 1. ASME/ANSI B31.1.0 Code for Pressure Piping
 - 2. ASTM A36 Carbon Structural Steel
 - 3. ASTM A123 (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 4. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 5. ASTM A193 Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service
 - 6. ASTM A194 Carbon and Alloy Steel Nuts for High-Pressure and High Temperature Service
 - 7. ASTM A240 Chromium and Chromium-Nickel Stainless Steel plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 8. ASTM A276 Stainless Steel Bars and Shapes
 - 9. ASTM A325 Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
 - 10. ASTM A575 Steel Bars, Carbon, Merchant Quality, M-Grades
 - 11. ASTM A576 Steel Bars, Carbon, Hot-Wrought, Special Quality

12. ASTM A635 Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength, Low-Alloy, and High-Strength Low-Alloy with Improved Formability
13. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
14. ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
15. ASTM A1046 Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by Hot Dip Process
16. ASTM A1059 Zinc-Alloy Thermo-Diffusion Coatings (TDC) on Steel Fasteners, Hardware, and Other Products
17. ASTM B6 Zinc
18. ASTM B209 Aluminum Alloy Duct Sheet
19. ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
20. ASTM B633 Electrodeposited Coatings of Zinc on Iron and Steel
21. ASTM D3917 Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
22. ASTM D4385 Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
23. ASTM E84 Surface Burning Characteristics of Building Materials
24. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
25. ASTM F594 Stainless Steel Nuts
26. AWS D1.1 Structural Welding Code – Steel
27. MFMA 4 Metal Framing Standards
28. MSS SP58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
29. MSS SP69 Pipe Hangers and Supports – Selection and Application
30. MSS SP89 Pipe Hangers and Supports – Fabrication and Installation Procedures
31. California Building Code (CBC)
32. California Electrical Code (CEC)
33. California Mechanical Code (CMC)
34. California Plumbing Code (CPC)
35. NFPA 24 Installation of Private Fire Service Mains and Their Appurtenances
36. NFPA 70 National Electric Code (NEC) Article 344.30

1.6 **Submittals**

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS AND PART SCHEDULES		
Shop Drawings	Submit for pipe hangers and supports per structural Shop Drawing requirements.	.
MANUFACTURER'S LITERATURE		
Product Data	Submit for pipe hangers and supports per Product Data requirements.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings and Product Data.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of hangers and supports.

1.8 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
FASTENERS AND CONNECTIONS		
Concrete Anchors – Epoxy Adhesive Anchor Systems	Refer to Section 05 05 19.	
Epoxy Grout for Anchor Bolts	Refer to Section 05 05 19.	
Metal-to-Metal Epoxy	Refer to Section 05 05 19.	
HANGERS AND SUPPORTS		
Plastic Pipe Hangers	Spears Manufacturing Co “Clic Top”	Sylmar, CA (818) 364-1611
	Accepted Equal	
Steel and Stainless Steel Pipe and Conduit Hangers	Anvil International (Grinnell)	Ontario, CA (603) 418-2800
	Bergen-Power Pipe Supports, Inc	Donora, PA (724) 379-5212
	Carpenter & Paterson Company “C&P”	Woburn, MA (781) 935-2950
	Elcen Metal Products Company	Franklin Park, IL (301) 984-6130
	Empire Industries, Inc	Manchester, CT (860) 647-1431
	Globe Pipe Hanger Products, Inc	Cleveland, OH (216) 362-6300
	Michigan Hanger Company, Inc	Niles, OH (330) 544-5403
	Modern Pipe Supports Corporation	Cleveland, OH (216) 361-1666
	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488
	PHD Manufacturing, Inc	Oceanside, CA (800) 321-2736
	Powerstrut / Atkore International	Harvey, IL (708) 339-1610
	Superstrut / American Electric, Thomas & Betts, Inc	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International	Harvey, IL (800) 882-5543
	Viking Corporation	Hastings, MI (800) 968-9501
	Wesanco Steel Products Corp	La Mirada, CA (714) 739-7562
	Accepted Equal	
Adjustable Clevis Hangers	Anvil International (Grinnell) Figure 260	Ontario, CA (603) 418-2800
	Bergen-Power Pipe Supports, Inc Figure 100	Donora, PA (724) 379-5212
	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line B3100 Series	Corona, CA (951) 280-4488
	Accepted Equal	
Adjustable Pipe Support	Bergen-Power Pipe Supports, Inc Figure 137	Donora, PA (724) 379-5212
	Cooper Industries/Eaton Nibco / Tolco Figure 312	Corona, CA (951) 280-4488
	Accepted Equal	
Ceiling Flanges	Unistrut Corporation Atkore International Type M30 or M31	Harvey, IL (800) 882-5543
	Accepted Equal	
Hanger Rod	Anvil International (Grinnell) Figure 140	Ontario, CA (603) 418-2800
	Bergen-Power Pipe Supports, Inc Figure 133	Donora, PA (724) 379-5212
	Cooper Industries/Eaton Nibco / Tolco Figure 103	Corona, CA (951) 280-4488
	Accepted Equal	
Hanger Rod – All- Thread	Anvil International (Grinnell) Figure 146	Ontario, CA (603) 418-2800
	Bergen-Power Pipe Supports, Inc Figure 94	Donora, PA (724) 379-5212
	Accepted Equal	
U-Bolt	Bergen-Power Pipe Supports, Inc Figure 283	Donora, PA (724) 379-5212
	Cooper Industries/Eaton Nibco / Tolco Figure 110	Corona, CA (951) 280-4488
	Accepted Equal	
Welded Eyebolt Rod	Bergen-Power Pipe Supports, Inc Figure 93	Donora, PA (724) 379-5212
	Cooper Industries/Eaton Nibco / Tolco Figure 101	Corona, CA (951) 280-4488
	Accepted Equal	
FRAMING STRUT SYSTEMS		
Galvanized Steel Bolted Framing	Allied Tube & Conduit	Harvey, IL (800) 882-5543
	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Strut Systems	ERICO International Corporation CADDY® Eristruct	Solon, OH (440) 248-0100
	Globe Pipe Hanger Products, Inc	Cleveland, OH (216) 362-6300
	G S Metals Corp	Pinckneyville, IL (618) 357-5353
	Powerstrut / Atkore International	Harvey, IL (708) 339-1610
	Superstrut / American Electric, Thomas & Betts, Inc	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International P-1000 series	Harvey, IL (800) 882-5543
	Wesanco Steel Products, Inc	La Mirada, CA (714) 739-7562
	Accepted Equal	
Continuous Concrete Inserts	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488
	Powerstrut / Atkore International	Harvey, IL (708) 339-1610
	Superstrut / American Electric, Thomas & Betts, Inc.	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International P-3200 series	Harvey, IL (800) 882-5543
	Wesanco Steel Products, Inc	La Mirada, CA (714) 739-7562
	Accepted Equal	
Individual Concrete Inserts	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488
	Powerstrut / Atkore International	Harvey, IL (708) 339-1610
	Superstrut / American Electric, Thomas & Betts, Inc	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International M26	Harvey, IL (800) 882-5543
	Wesanco Steel Products, Inc	La Mirada, CA (714) 739-7562
	Accepted Equal	
Conduit Clamps	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488
	Powerstrut / Atkore International	Harvey, IL (708) 339-1610
	Superstrut / American Electric, Thomas & Betts, Inc.	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International	Harvey, IL (800) 882-5543
	Wesanco Steel Products, Inc	La Mirada, CA (714) 739-7562
	Accepted Equal	
Corrosion-Resistant Alloy Steel Bolted Framing Strut Systems	Unistrut Corporation Atkore International Defender®	Harvey, IL (800) 882-5543
	Accepted Equal	
Stainless Steel Bolted Framing Strut Systems	Cooper Industries/Eaton Nibco / Tolco / Tripac / B-Line	Corona, CA (951) 280-4488
	Superstrut / American Electric, Thomas & Betts, Inc.	Memphis, TN (800) 816-7809
	Unistrut Corporation Atkore International Defender®	Harvey, IL (800) 882-5543
	Accepted Equal	
Fiberglass Channel Framing Strut Systems	Aikenstrut Division Atkore International	Harvey, IL (708) 339-1610
	Champion Fiberglass "Champion Strut"	Spring, TX (281) 655-8900
	Strut Tech Engineered Support Systems	Redmond, WA (425) 885-4403
	Unistrut Corporation Atkore International	Harvey, IL (800) 882-5543
	Accepted Equal	

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Pipe hangers and supports shall conform to MSS SP58 and be selected and applied per MSS SP69.
- C. Support system materials shall be as follows:

LOCATION	CONDUIT OR PIPE MATERIAL	SUPPORT SYSTEM	NOTES
Damp Locations	Stainless Steel Pipe	Stainless Steel	Field touch up cut ends and scratches before rust appears
	PVC Pipe or Conduit	PVC-Coated Steel	
Wet Locations	Galvanized Steel Pipe or Conduit (ERSC)	Stainless Steel	Field touch up cut ends and scratches before rust appears
	PVC-Coated Galvanized Steel Conduit (PVC_ERSC)	Stainless Steel / PVC-Coated Steel	Field touch up cut ends and scratches before rust appears
	Stainless Steel Pipe	Stainless Steel	

	PVC Pipe or Conduit	PVC-Coated Steel	Field touch up cut ends and scratches before rust appears
Corrosive Locations	PVC	Stainless Steel	Field touch up cut ends and scratches before rust appears

D. Materials for pipe and conduit hangers and supports shall be:

ITEM	MATERIAL	SPECIFICATION
Stainless Steel Continuous-Slot Channel Framing System	Stainless Steel Channel	Conform to ASTM A240 SAE Type 304 / 316
	Cold-Formed Fabrication	Conform to MFMA 4
	Stainless Steel Rods, Bars, and Fittings	Conform to ASTM A240 or A276 SAE Type 304 / 316
Pipe and Conduit Hangers (Above Ground)	Stainless Steel	SAE Type 304 / 316
Pipe and Conduit Hangers (Below Ground or Exposed to Water)	Stainless Steel	SAE Type 304 / 316
Ring Hangers (Use for Single Electrical Conduit Hangers)	Stainless Steel	SAE Type 304 / 316
	Dimensions	Hanger rods $\geq \frac{3}{8}$ " diameter for conduits ≤ 2 " trade size Hanger rods $\geq \frac{1}{2}$ " diameter for conduits 2½"-3" trade size Hanger rods $\geq \frac{5}{8}$ " diameter for conduits 3½"-4" trade size
Trapeze Hangers (Use for Multiple Pipes or Conduits Above Ground)	Stainless Steel	SAE Type 304 / 316
	Dimensions	12-gauge minimum Lipped channels $\geq 1\frac{1}{2}$ " x $1\frac{1}{2}$ " Hanger rods $\geq \frac{3}{8}$ " / $\frac{1}{2}$ " diameter
Concrete Inserts	Stainless Steel	SAE Type 304 / 316
	Design	Swivel-type for individual inserts
	Dimensions	12-gauge minimum Lipped channels $\geq 1\frac{1}{2}$ " x $1\frac{1}{2}$ "
Conduit Clamps	Stainless Steel	SAE Type 316
Pipe and Conduit Hangers (Below Ground or Exposed to Water)	Stainless Steel	SAE Type 316

E. Materials for fasteners and connections for pipe hangers and supports shall be:

ITEM	MATERIAL	SPECIFICATION
Bolts (Connection Bolts and Anchor Bolts) – Stainless Steel	Stainless Steel	Refer to Section 05 05 23
Bolts – Embedded Eyebolts	Stainless Steel	Refer to Section 05 05 23
Washers	Various materials	Refer to Section 05 05 23

F. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Pipe Hangers	Maximum horizontal spacing per California Plumbing Code Table 3-1 and 3-2 or Engineered Calculations except where stricter requirements are shown in Contract Documents. Conform to latest requirements of: ANSI Code for Pressure Piping B31.1 MSS Standard Practice SP-58, SP-69 and SP-89
Conduit Hangers	Maximum horizontal spacing per California Electrical Code or Engineered Calculations except where stricter requirements are shown in Contract Documents. Conform to latest requirements of California Electrical Code: For conduit on concrete or masonry, use PVC-coated 1-hole malleable iron clamps with pipe spacers (clamp backs) or PVC-coated preformed galvanized steel channels. Fasten hanger rods, conduit clamps and outlet and junction boxes to building structure using beam clamps. Support wall-mount junction boxes, pull-box enclosures, and panels with Type 316 stainless steel preformed channels.
Supports, Anchor Bolts, and Bolt Embedment Design	Suitable for design loads with safety factor ≥ 3 . Anchor with preset inserts, epoxy-adhesive anchors, self-drilling expansion-shield anchors or machine-bolt expansion anchors on concrete surfaces. Use preset inserts in prestressed concrete. Anchor with SAE Type 316 stainless steel anchors. Do not fasten supports to piping, ductwork, mechanical equipment or conduit. Do not drill or cut structural steel members.
Unacceptable Materials	Do not use perforated strap, iron bailing wire, or plumber's tape for supports.

G. Unless otherwise shown, pipe support hanger rod sizes on horizontal pipe shall be:

PIPE DIAMETER	$\leq \frac{1}{2}"$	$\frac{3}{4}"$	1"	1 $\frac{1}{4}"$	1 $\frac{1}{2}"$	2"	3"	4"	5"-8"	$\geq 10"$
Hanger Rod Diameter	$\frac{3}{8}$								$\frac{1}{2}"$	$\frac{5}{8}$

H. Unless otherwise shown, pipe support spacing on horizontal pipe shall be:

Unless otherwise shown, pipe support spacing on horizontal pipe shall be:

	PIPE DIAMETER									
PIPE MATERIAL	≤ ½"	¾"	1"	1¼"	1½"	2"	3"	4"	5"-8"	≥10"
Ductile Iron Pipe	≤6' spacing					≤8' spacing				
Schedule 40 and Schedule 80 PVC and ABS DWV Solvent Cemented Joints Under Pressure	≤3' spacing Provide for expansion every 30'			≤4' spacing Provide for expansion every 30'						
Metallic Conduit and Wireways	≤10' maximum spacing									

I. Unless otherwise shown, pipe support spacing on vertical pipe shall be:

	PIPE DIAMETER									
PIPE MATERIAL	$\leq \frac{1}{2}"$	$\frac{3}{4}"$	1"	1 $\frac{1}{4}"$	1 $\frac{1}{2}"$	2"	3"	4"	5"-8"	10"-12"
Steel and Brass Water or DWV Pipe Threaded or Welded Joints	Every other floor or grating level not to exceed 25'									
Metallic Conduit and Wireways	Each floor or grating level $\leq 10'$									

- J. For temperatures other than ambient or listed temperatures and for other piping materials or wall thicknesses, calculate or modify pipe support spacing in accordance with pipe Manufacturer's recommendations and requirements below
 - 1. Maximum deflection of pipe shall be $\leq(\text{span}/360)$
 - 2. Stress on steel pipe shall be $\leq 5,000$ psi
 - 3. Compute maximum span of steel pipe using formula $L = \sqrt{(7200tD)/(32t + D)}$
 - 4. Where: t=wall thickness (inches), D=diameter (inches), and L=maximum span (feet)
- K. Minimum spacing between conduit supports shall not exceed that shown in NEC §344.30
- L. Provide supports at:
 - 1. Changes of direction
 - 2. Both sides of flexible pipe connections
 - 3. Base of risers
 - 4. Floor penetrations
 - 5. Connections to pumps and equipment
 - 6. Valves and appurtenances
- M. Zinc coatings shall be applied by hot-dipped or electro-depositing process.
 - 1. Zinc shall comply with ASTM B6.
- N. Before leaving shop, steel not shown or specified to be galvanized or stainless shall receive 1 coat of pigmented primer recommended by Manufacturer of final paint system.
 - 1. Parts inaccessible after assembly shall receive second coat of same primer.
 - 2. Final painting shall be as specified in Section 09 90 00.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to fabricate and install pipe hangers and supports before submitting Shop Drawings or ordering.
 - 1. Inspect Work area before installing.
 - 2. If Work area conditions are unsatisfactory, do not install until completing satisfactory corrections.
 - 3. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Clean surfaces of metalwork to contact concrete, removing rust, dirt, grease and other foreign substances before concrete is placed.
- C. Secure embedded metalwork accurately in position in concrete forms to minimize displacement or vibration during concrete placement.
- D. Contractor, in conjunction with valve and equipment manufacturers, shall review structural design of valve anchorages shown on Plans.
 - 1. Provide revised design as necessary based on actual loads, design, and layout of equipment supplied.
 - 2. Design shall meet seismic requirements stated herein.
 - 3. Revised design shall be stamped by California-licensed professional engineer.

3.2 Installation

- A. Refer to Sections 01 73 00, 01 73 24, and 01 73 33 for execution and installation requirements.
- B. Installers shall be fully trained and Manufacturer authorized for installation.

- C. Furnish and install hangers and supports at true to line, level, and plumb at locations shown on Plans and Submittals.
- D. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building, fire, plumbing, mechanical and electrical code requirements.
 - 3. City of Corona Standard Drawing 418 for adjustable pipe supports.
 - 4. Manufacturer's installation and warranty requirements
 - 5. ASME/ANSI B31.1.0 Code for Pressure Piping
 - 6. MSS SP58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
 - 7. MSS SP69 Pipe Hangers and Supports – Selection and Application
 - 8. MSS SP89 Pipe Hangers and Supports – Fabrication and Installation Procedures
- E. Install hangers and supports as follows:
 - 1. Provide 2 nuts for each anchor bolt to level and hold down baseplate.
 - 2. Following installation of vertical support pipe, adjust nuts so plate is secure and water main is true to line and grade.
 - 3. Grade and alignment will be verified by City's surveyor, and leveling adjusted by Contractor until supported item is held true.
 - 4. After alignment has been verified, fill void beneath the baseplate with non-shrink grout,
- F. Refer variances between Manufacturer's installation instructions and Contract Documents to City's Representative.
- G. Refer to Section 05 05 19 for anchoring and bolting requirements.
- H. Refer to Section 05 05 23 for welding requirements.
- I. Install conduit supports as follows:
 - 1. Use trapeze hangers, strap hangers, wall brackets, u-bolts, clamps, pipe straps, or strut channel systems as appropriate.
 - a. Provide u-bolt or pipe strap at each floor or grating level of riser conduits.
 - b. Trapeze hangers shall be sway-braced.
 - c. Do not use perforated strap or plumbers tape for conduit supports.
 - 2. Clamp conduits to each trapeze hanger, at end of each run, and at each elbow.
 - 3. Support conduit at intervals and at locations required by NEC Article 344.30.
 - 4. Provide hangers and brackets to limit maximum uniform load on 1 support to ≤ 25 lbf.
 - a. Do not exceed maximum concentrated load recommended by Manufacturer on any support.
 - 5. Support materials shall be electrolytically compatible conduit being used.
 - 6. Support conduit from building structure.
 - a. Do not support conduit from process, gas, air, or water piping, or from other conduits.
 - b. Do not use suspended ceiling support systems to support raceways.
 - 7. For supports at structural steel members: Use SAE Type 316 stainless steel beam clamps.
 - a. Drilling or welding may be used only where shown on Plans.
 - 8. For hangers in metal roof decks:
 - a. Use fender washers.
 - b. Do not extend hardware above top of ribs.
 - c. Do not compromise vapor barrier, insulation, or roofing membrane.

9. Wherever conduit may be affected by dissimilar movements of supporting structures, provide flexible or expansion devices.
 10. Tighten connections to their recommended torques.
 11. Upon completion of fabrication, remove protective wraps and debris.
 12. Repair any damage due to installation.
- J. Attach pipe supports to chemical tanks using adhesive or magnetic methods.
1. No full or partial penetration of tank wall by mechanical fasteners will be permitted.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Pipe Hangers and Supports	Support Spacing	California Plumbing Code Table 3-1 and 3-2 and tables herein	All hangers and supports	City	City
	Grade and Alignment of Pipe within Pipe Supports	Survey - $\pm 1/16"$	All hangers and supports	City	City
	Snug Fit and Near- Equal Distribution of Load among Supports	Visual inspection	All hangers and supports	City	City
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 33 05 19

MANUAL VALVE OPERATORS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of manual valve operators.
- B. Refer to the following City of Corona Standard Drawings
 - 1. Standard Drawing 422 for requirements for valve box assemblies and stem extensions

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 05 05 19: Post-Installed Concrete Anchors
- J. Section 09 90 00: Painting and Coating
- K. Section 33 12 16: Plug Valves
- L. Section 33 12 17: Ball Valves
- M. Section 33 12 44: Air-Operated Actuators
- N. Section 33 12 46: Electric Motor Actuators
- O. Section 33 12 47: Hydraulic Cylinder Actuators

1.3 System Description

- A. Furnish and install complete operating manual valve operator including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building, plumbing, and electrical codes and standards.

1.4 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - 2. ASTM A148 Steel Castings, High Strength, for Structural Purposes
 - 3. ASTM A322 Steel Bars, Alloy, Standard Grades
 - 4. ASTM B427 Gear Bronze Alloy Castings
 - 5. ASTM D1785 Poly(Vinyl-Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
 - 6. ASTM D3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - 7. AWWA C504 Rubber-Seated Butterfly Valves 3"-72"
 - 8. AWWA C507 Ball Valves 6"-60"
 - 9. AWWA C515 Reduced Wall, Resilient Seated Gate Valves for Water Supply Service
 - 10. AWWA C517 Resilient-Seated Cast-Iron Eccentric Plug Valves
 - 11. AWWA C520 Knife Gate Valves, Sizes 2"-96"
 - 12. AWWA C540 Power Actuating Devices for Valves and Sluice Gates

1.5 Submittals

- A. Include submittals for manual valve operators in submittals for valves to which they are attached.

B. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit per equipment Shop Drawing requirements	.
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
	Include dimensions and orientations of valve operators to operate with valve stem extensions..	
	Show locations of internal stops for gear actuators.	
	Include factory torque sheets showing torque required through opening and closure.	
Installation Instructions	Submit per Installation Instruction requirements	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Test Record Transcripts	Submit for factory tests per test record transcript requirements	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

C. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, and Test Record Transcripts.

1.6 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of manual valve operators.
- C. Actuators and valves shall be assembled and factory-tested at valve factory and shipped and delivered to jobsite as a unit.

1.7 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

1.8 Unit Prices

- A. Payment for Work in this section shall be included as part of lump-sum or unit-price bid amount for which such Work is appurtenant.

PART 2 - PRODUCTS**2.1 Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Gear Actuators – Worm-Gear Type	AUMA USA GS Series	Tustin, CA (714) 247-1250
	EIM / Emerson Model WB Series	Houston, TX (281) 477-2801
	Limitorque Div Flowserve Model HBC or PT Series	Lynchburg VA (434) 528-8595
	Accepted Equal	
Valve Boxes and Covers – Circular Cover – Iron	Alhambra Foundry Company Ltd.	Alhambra, CA (626) 289-4294
	Bingham & Taylor Mark V	Culpepper, VA (540) 825-8334 Corona, CA 951 280 4588
	Long Beach Iron Works, Inc.	Long Beach, CA (562) 432-5451
	Neenah Foundry	Ontario, CA (626) 602-6796
	Rich Manufacturing Division Clow Valve Company Div McWane, Inc "Figure 930"	Corona, CA (951) 735-5555
	Reliable Iron Foundry, Inc.	Los Angeles, CA (323) 589-3322
	South Bay Foundry, Inc.	Santee, CA (619) 956-2780
	Star Pipe Products	Corona, CA (951) 898-0770
	Tyler Pipe Div McWane, Inc 6855 Series	Tyler, TX (903) 862-5511
	U S Foundry and Manufacturing Corp	Medley, FL (305) 885-0301
	Western Water Works Supply Company	Chino Hills, CA (909) 597-7000
	Accepted Equal	

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Valve Extension Stems – Solid Steel	Pipeline Products SX	San Marcos, CA (760) 744-8907
	Troy Valve Division Penn-Troy Manufacturing, Inc.	Troy, PA (570) 297-4442
	Trumbull Industries, Inc.	Youngstown, OH (800) 677-1799 Orange, CA (714) 505-7079
	Accepted Equal	
Valve Extension Stems – Stainless Steel	Troy Valve Division Penn-Troy Manufacturing, Inc.	Troy, PA (570) 297-4442
	Accepted Equal	

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
 1. Also refer to sections covering valves to which manual operators are attached.
- B. Provide valves complete with operating handwheels, handwheel locking devices, shafting, extension stems, gear actuators, operating nuts, position indicators, and wrenches required for operation.
- C.
- D. Actuators for valves in exposed service shall contain dial indicating position of valve disc or plug.
- E. Valves shall open by turning counterclockwise.
- F. Provide lever or wrench actuators for exposed valves $\leq 3"$.
- G. Provide traveling nut or worm-gear actuators on butterfly, ball, and plug valves $\geq 4"$ as specified below.
- H. Provide stop-limiting devices in actuators in open and closed positions.
- I. Where operating torque requirements for valve actuators are not stipulated by AWWA standards, valves shall open:
 1. with ≤ 80 -pound pull on handwheel when differential pressure across valve equals valve rated pressure class.
 2. with ≤ 150 -ft-pound torque input on operating nut when differential pressure across valve equals valve rated pressure class.
- J. Provide reduction gearing to meet maximum torque and pull design requirement.
 1. Gears shall be oil-lubricated.
 2. Provide shaft seal to prevent entry of dirt and water into actuator.
- K. Unless otherwise specified, materials for worm-and-gear actuators shall be.

ITEM	MATERIAL	SPECIFICATION
Gear Housing	Same material as valve body	Totally enclosed, watertight
Exposed Threaded Parts, Including Cap Screws, Case Bolts, Carriage Bolts, cover Screws, Machine Screws, Set Screws, and Bonnet Bolts	Stainless Steel	SAE Type 316
Worm	Hardened Alloy Steel	Conform to ASTM A148 Grade 105-85 or ASTM A322 Grade 41500 Grind and polish threads
Worm Gears	Gear Bronze	Conform to ASTM B427 Self-locking 1-piece machine-cut design to prevent creeping
Thrust Nut	Bronze	

ITEM	MATERIAL	SPECIFICATION
Exposed Threaded Parts, Including Cap Screws, Case Bolts, Carriage Bolts, cover Screws, Machine Screws, Set Screws, and Bonnet Bolts	Stainless Steel	SAE Type 316

- L. Unless otherwise specified, materials for valve boxes shall be H-25 traffic rated and shall be.

ITEM	MATERIAL	SPECIFICATION
Valve Boxes	Cast Iron	Conform to ASTM A126 Class B 2-piece sliding type
Valve Box Covers (Circular)	Cast Iron	Conform to ASTM A126 Class B 8" diameter tapered solid-skirt 20-lb minimum weight
	Coating	None / Polyester fusecoat
	Color	Purple for recycled water
	Inscription	"WATER"
Valve Stem Extension Pipes	Stainless Steel	SAE Type 316 Refer to dimensions below
Extension Pipe Stabilizing Plate	Steel	Two 6½" OD x 3/16" steel plates Weld to valve stem extension with ⅛" weld all-around on both sides. Weld on 1 plate near top of extension and 1 near bottom.

- M. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Minimum Rated Working Pressure	Class 150 (300 WOG psi at 150°F)
Design Differential Pressure	Assume differential pressure across plug or disc equals specified rated working pressure of valve.
Fluid Temperature	33°F-120°F
Surface Loading Criteria	H-25 (40k axle 20k wheel load)
Soil Cover	1'-20'

- N. The following product design criteria, options and accessories are required for worm gear operators:

ITEM	DESCRIPTION
Worm Gear Helix Angle	Design and cut to prevent valve creeping under flow conditions.
Worm Gear Shaft Supports	Support worm gear shaft at each end by ball or tapered roller bearings

2.3 Equipment

- A. Valves shall close drip tight at rated pressures.
- B. Valve operator shall hold valve in any intermediate position between fully open and fully closed without creeping or fluttering
- C. Valve operators shall be satisfactory for applications involving valve operation after long periods of inactivity.
- D. Unless otherwise shown, install valves in horizontal runs of pipe having centerline elevations ≤4' 6" above floor with operating stems vertical.
- E. Install buried operators with nut ≤48" below grade.
- F. Gear actuators shall conform to applicable requirements of AWWA C540.
- G. Where possible, actuators shall be self-locking to prevent disc or plug from creeping.

- H. Unless otherwise specified valves shall be furnished with actuators conforming to the following:

ITEM	DESCRIPTION	
Buried Valves and Valves within Manholes or Pipe Trenches	Valve Can and Cover	Provide as shown above except in manholes, vaults, tunnels, or pipe trenches
	Actuator	2" AWWA nut / Handwheel /
		Handwheels shall include arrow and wording to show rotation direction to OPEN or CLOSE valve.
	Extension Stem Connector to Actuator	Square socket to fit actuator nut
	Extension Stem	Required on valves where centerline of valve is >36" / 48" below grade. Extension stem shall bring nut to within 6" of surface. Use solid, round or square stock of diameter shown below. Center extension in valve well with extension pipe stabilizing plate.
	Valve size	Minimum extension stem diameter
	3" - 4"	7/8"
	6"	1"
	8"	1 1/8"
	10"-12"	1 1/4"
	14"	1 3/8"
	16"-18"	1 1/2"
	20"-36"	1 3/4"
	42"-54"	2"
	Stop-Limiting Devices	Provide for open and closed positions. Devices shall be adjustable without disassembling gear box
	Enclosure	Design for short-term immersion in water and for buried service Provide watertight shaft seals and watertight valve and actuator cover gaskets
	Lubrication	Oil-lubricated
	Position Indicator	Design to fit inside standard 5 1/4" valve box. Indicator shall show valve position and direction and number of turns required to fully open or close valve.
	Position Transmitter	Not required
Actuators on Manual Butterfly, Ball and Plug Valves 4"-20"	Enclosed traveling-nut type gear actuators / Enclosed worm-and-gear or traveling-nut type gear actuators. Size actuator per AWWA C504 for bi-directional pressures.	
Actuators on Ball and Plug Valves ≥ 6"	Enclosed worm-and-gear type gear actuators	

- I. Traveling nut gear actuators shall conform to the following:

ITEM	DESCRIPTION	
Traveling Nut Gear Actuators	Design	"Self-locking" conform to AWWA C540
	Allowable Input Torque	Withstand 450 ft-lbf against stop limiting devices with no damage

- J. Worm-gear actuators shall conform to the following:

ITEM	DESCRIPTION	
Worm Gear Actuators	Design	"Self-locking" 1-piece design Conform to AWWA C540
	Allowable Input Torque – Handwheel, Chainwheel, Lever, or Crank Actuators	200 lbf against stop limiting devices with no damage
	Allowable Input Torque – Operating Nuts	300 ft-lbf against stop limiting devices with no damage

- K. Worm-gear actuators for valves <24" shall rotate valve element (disc, plug, or ball) from fully closed to fully open position with number of turns of actuator nut or wheel between 1.5 and 3 x nominal valve diameter.

1. Actuators shall conform to the following requirements for turns to open or close:

WORM GEAR VALVE ACTUATOR SELECTION	
Nominal Valve Diameter	Specified Range of Turns
4"	6-12
6"	9-18
8"	12-24
10"	15-30
12"	18-36
14"	21-42
16"	24-48
18"	27-54
20"	30-60

- L. Worm-gear actuators for valves ≥ 24 " shall rotate valve element (disc, plug, or ball) from fully closed to fully open position with number of turns of actuator nut or wheel ≥ 1.5 x nominal valve diameter and ≤ 3 x nominal valve diameter.

M. Actuators shall conform to the following requirements for turns to open or close:

150-PSI WORM GEAR VALVE ACTUATOR SELECTION							
Nominal Valve Diameter	Specified Range of Turns	AUMA Make & Model	Turns to Open or Close	EIM Make Model	Turns to Open or Close	Limitorque Make & Model	Turns to Open or Close
24"	36-72	GS125.3	13*	WB52	64	PTA30/3.5	60
30"	45-90	GS160.3 / GS160.3 4:1	54.5*	WB52	64	PTA65/3.1	47
36"	54-108	GS160.3 / GS160.3 4:1	54.5*	WB54	70	PTA120/6.3	95
42"	63-126	GS200.3 / GZ200.3 8:1	108.5*	WB54	70	PTA120/6.3	95
48"	72-144	GS250.3 / GZ250.3 8:1	103*	WB65	148*	PTA250/6	96
54"	81-162	GS250.3 / GZ250.3 8:	103*	WB65	148	PTA250/18	288*
250-PSI WORM GEAR VALVE ACTUATOR SELECTION							
Nominal Valve Diameter	Specified Range of Turns	AUMA Make & Model	Turns to Open or Close	EIM Make Model	Turns to Open or Close	Limitorque Make & Model	Turns to Open or Close
24"	36-72	GS125.3	13*	WB52	64	PTA30/3.5	60
30"	45-90	GS160.3 / GS160.3 4:1	54.5*	WB52	64	PTA65/3.1	47
36"	54-108	GS160.3 / GS160.3 4:1	54.5*	WB54	70	PTA120/6.3	95
42"	63-126	GS200.3 / GZ200.3 8:1	108.5*	WB65	148*	PTA120/6.3	95
48"	72-144	GS250.3 / GZ250.3 8:1	103*	WB65	148*	PTA250/6	96
54"	81-162	GS250.3 / GZ250.3 8:	103*	WB74	270*	PTA250/18	288*

- Indicates number of turns does not meet requirement and spur-gear reduction is required to correct.
- Spur-gear submittal is required.

- N. Furnish special tools, wrenches and appliances needed to adjust, operate, maintain or repair valve operators supplied.

PART 3 - EXECUTION

3.1 Preparation

- A. Install valves and equipment so as to be easy to operate and service.
- Where geometry of manufactured valves and equipment and field conditions make it difficult or impossible for average workers to operate or service installed valve or piece of equipment, notify City's Representative of conflict before installing valve or item of equipment.

3.2 Installation

- A. Refer to Sections 01 73 00 and 01 73 24 for basic execution and installation requirements.
- B. Furnish and install valve operators on valves at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
- Applicable OSHA and Cal OSHA regulations.
 - Other applicable building, fire, plumbing, mechanical and electrical code requirements.
 - City of Corona Standard Drawings
 - Standard Drawing 422 for valve box assemblies and stem extensions
 - Manufacturer's installation and warranty requirements.
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install operators and extensions to tolerances recommended by Manufacturer.
- Unless otherwise shown, install manual valve operators true, plumb, and level using precision gauges and levels
- F. Support valve boxes and keep centered during backfill
- Center of valve box shall be within ½" of valve operating nuts.
 - Valve box shall be plumb to within 5°.
 - Do not use beveled pipe sections at top of valve box extension pipe.
 - Top cut shall be square and machine-made.
 - Where pavement has not been placed, extend valve box extension risers for key valves well above ground to facilitate location for emergency shutoffs.
 - Final valve box elevation shall be flush with pavement.

3.3 Field Quality Control

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Valve Boxes	Plumb	Center of valve box shall be within ½" of valve operating nuts and valve box shall be plumb to within 5°.	1 inspection	City	City
	Elevation	Valve box shall be flush with finished pavement	1 inspection	City	City
	11-month Warranty Inspection	Confirm Work conforms to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

3.4 Adjusting and Lubricating

- A. Plans do not show valve box cover elevations.
- Determine and set cover elevations in field so finished rim elevations are flush with finished pavement where directed by City's Representative.

END OF SECTION

SECTION 33 11 18

CEMENT-MORTAR LINING AND COATING OF STEEL PIPE

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of cement-mortar lined and coated fabricated steel pipe conforming to AWWA C205.
- B. Steel pipe sizes shown are nominal inside diameters.
 - 1. Nominal diameter shown shall be inside diameter after lining.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 33: Mechanical Identification
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 09 90 00: Painting and Coating

1.3 Definitions

- A. The following definitions apply:
 - 1. Type A Mortar Coating is defined as wire-fabric-reinforced mortar, mechanically or pneumatically applied to exterior surface of steel pipe and fittings.
 - 2. Mortar Lining is defined as centrifugally spun and pneumatically or mechanically applied mortar on interior of steel pipe and fittings.
 - 3. Pneumatically Applied Mortar is defined as proportioned combinations of Portland cement and aggregate pneumatically transported in dry state through pipe or hoses to nozzles where water is added just prior to discharge, and mixture is propelled to Work.
 - a. Also known as dry-mix process or gunite.

1.4 System Description

- A. Furnish and install complete pipe lining and coating system including appurtenant Work required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.5 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.
- B. Mortar application method and type of machinery and equipment shall have been used successfully for similar Work for ≥ 5 years.
 - 1. Machines used for centrifugal lining shall have been used successfully for similar work and shall have been shown to be capable of handling pipe of size and type specified.
- C. Employ supervisor who has ≥ 2 years' experience operating same type of equipment on similar work.
- D. Complete factory testing of steel pipe prior to lining and coating.

E. Factory testing of cement mortar linings and coatings shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cement-Mortar Lining and Coating	Surface Preparation	SSPC SP2 or SSPC SP3	Each pipe section	Contractor	Contractor
		If City opts for plant inspection, do not apply coating or lining before City's Representative accepts surface preparation. Coatings or lining applied without City's acceptance will be rejected and shall be removed and reapplied after City Inspection	Each pipe section	City	City
	Finish Tolerance	24" straightedge laid parallel to pipe axis along any part of surface shall at no point have space between lined surface and straightedge > 1/8". After troweling, 9 out of 10 places checked shall conform to specified tolerance.	Each pipe section	Contractor	Contractor
	Curing Temperature	Install temperature recorders of accepted type and maintain at curing chambers. Location of sensing bulbs and recorders shall be subject to acceptance from City's Representative. Submit 2 copies of charts of recorded curing chamber temperatures to City's Representative following completion of each curing cycle	Each curing cycle	Contractor	Contractor
Cement-Mortar Lining	28-day Strength	AWWA C205 §5.1 Sampling and Testing Cement Mortar for Linings	Refer to AWWA C205 §5.1	Contractor	Contractor
Cement-Mortar Coating	Absorption	AWWA C205 §5.1 Testing Cement Mortar for Coatings	Refer to AWWA C205 §5.2	Contractor	Contractor

F. City or City's Representative shall be entitled to inspect pipes and witness manufacturing process.

1.6 References

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASTM A82 Steel Wire, Plain, for Concrete Reinforcement
2. ASTM A185 Welded Wire Fabric, Plain, for Concrete Reinforcement
3. ASTM A497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
4. ASTM A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
5. ASTM C33 Concrete Aggregates
6. ASTM C40 Organic Impurities in Fine Aggregates for Concrete
7. ASTM C94 Ready-Mixed Concrete
8. ASTM C109 Compressive Strength of Hydraulic Cement Mortars
9. ASTM C150 Portland Cement
10. ASTM C171 Sheet Materials for Curing Concrete
11. ASTM C289 Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
12. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
13. ASTM C494 Chemical Admixtures for Concrete
14. ASTM C685 Concrete Made by Volumetric Batching and Continuous Mixing
15. ASTM C1240 Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
16. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4" and Larger – Shop Applied
17. AWWA C218 Liquid Coatings for Aboveground Steel Water Pipe and Fittings
18. AWWA C602 Cement-Mortar Lining of Water Pipelines 4" and Larger in Place
19. AWWA C604 Installation of Steel Water Pipe 4" and Larger

- 20. California Test Method 515D Relative Mortar Strength of Portland Cement Concrete Sand
- 21. Fed Spec SS-P-385 a.
- 22. NSF/ANSI 61 Drinking Water System Components – Health Effects
- 23. SSPC SP2 Hand Tool Cleaning
- 24. SSPC SP3 Power Tool Cleaning

1.7 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
MOBILIZATION SUBMITTALS		
Mortar Lining and Coating Lining Operations QA/QC Plan	On City's request, submit QA/QC procedures and methods to line, coat, cure, and protect pipe and fittings ≥ 15 working days prior to shop coating and lining of pipe and fittings. These procedures shall include: 1. Mortar coating equipment and procedures 2. Mortar lining equipment and procedures 3. Curing methods and equipment, including type of temperature recorders used and locations of instruments and recorders 4. Equipment for application of curing compound 5. Materials and methods proposed for repair to damaged coating or lining 6. Method and procedure used to ensure thickness and density of mortar lining and coating conforms to specified requirements 7. Description of curing methods used. 8. Bracing plan. 9. Procedures for transporting pipe from plant to job site	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements for protective coating	
	Submit source of fine aggregate from each source for acceptance prior to use.	
	Submit source and Product data on proposed mortar admixtures or additives.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit the following. 1. Mill test reports for reinforcing wire and welded wire fabric used for reinforcing or mortar linings and coatings. 2. Mill test reports for cement and mortar materials. 3. Lining and coating materials certification for each load of cement. 4. Lining and coating application certification for compliance with AWWA C205.	
Engineering Calculations (Mix Design)	Submit for each type of mortar. Include results of required tests and statement identifying mix ingredients and where each mix will be used in Work	
	Mix design shall include: 1. Type, brand, source, and amounts of cements, pozzolans, and admixtures 2. Sources and amounts of water and aggregates 3. Representative samples of sand 4. Specific gravity of materials 5. Certificate of compliance for cement and pozzolans. 6. Submit supporting test data upon request. 7. Test results for water 8. Material specifications, instructions for use, and MSDS sheets for solvent used to clean pipe interior before lining. 9. Material specifications, instructions for use, and MSDS sheets for curing compound.	
Test Record Transcripts	Submit mill reports and plant test reports per Test Record Transcript requirements.	
	Submit test reports for factory tests of mortar lining and coatings.	

SUBMITTAL	DESCRIPTION	
	Submit curing records.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Submit data used by Contractor in manufacture and quality control.
- C. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, Certificates of Compliance, and Test Record Transcripts.

1.8 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Pack, ship, handle, and store pipe in accordance with Manufacturer's instructions and AWWA C604 and AWWA M11 Chapter 12.
- C. Provide pipe bracing on specials, fittings, and straight pipe to prevent damage to pipe and fittings during handling, storage, hauling, and encasement in concrete.
 - 1. At plant, place internal pipe bracing at uncoated pipe ends immediately after completing mortar lining.
 - 2. Bracing shall restrict maximum and minimum diameter deviation to $>0.5\%$ from nominal diameter at any point.
 - 3. Where, additional interior braces are required before coating, add braces prior to mortar coating but after lining has received ≥ 72 -hour water cure or 12-hour steam cure.
 - 4. Braces may be temporarily removed when pipe is placed in coating machine
 - 5. To protect mortar coating and maintain diametric tolerances, replace pipe braces and place additional braces in pipe interior immediately after pipe is removed from coating machine.
 - 6. Where braces are placed on lined areas, provide sufficient bearing surface at ends of braces inside pipe so mortar lining is not damaged.
 - 7. Pipe bracing may be reused, provided damaged ends are redressed to provide square and uniform bearing and previously used fasteners are removed.
 - 8. Manufacturer's recommended vertical and horizontal bracing shall remain in place while pipe is loaded, transported, unloaded at job-site, and encased in concrete.
 - 9. Repair or replace pipe damaged during handling, hauling, storage, or encasement in concrete.
 - 10. Repair locations where bracing has attached to pipe and other coating and lining damage.
- D. If Contractor elects to water cure, in no event shall pipe be transported from coating yard before exterior mortar coating has aged 7 days.
- E. Transportation shall be by competent haulers and accomplished in manner preventing damage to pipe, lining, or coating.
 - 1. Use blocking and hold-downs during shipment to prevent movement or shifting.
 - 2. Bulkhead or cover both ends of pipe and fittings on trucks or rail cars to prevent excessive drying of interior lining.
 - 3. During transportation, pipe shall rest on saddles ≥ 36 " wide and shaped to outside diameter of coated pipe.
 - 4. Saddles shall contact pipe bottom along arc of $\geq 60^\circ$.
 - 5. Saddles shall be lined with $\geq \frac{5}{8}$ "-thick rubber belting.
 - 6. Belting shall overlap edges of saddles ≥ 3 ".
 - 7. Do not use nails or other fasteners that may damage coated pipe in installing rubber belting on saddles.
 - 8. Do not use chains or wire rope to secure pipe to transporting vehicle.

F. Throughout transportation, delivery, handling and installation:

1. Protect pipe linings and coatings from damage.
2. Keep pipe sections closed at ends.
3. If, in opinion of City's Representative, conditions require lined pipe be protected from sunrays due to extreme solar heat, cool pipe by covering it with wet burlap.
4. When handling pipe, lift pipe sections using belt slings spaced to prevent deformation of pipe section.
5. Should lining be damaged or found not to conform to Contract Documents, remove and replace damaged or unsatisfactory portions of lining.
6. Restore damaged portions of linings and coatings to condition equal to that specified in this section for original Work.
7. Schedule operations so pipe will be installed within 48 hours after discontinuing water curing or application to lining.
8. After pipe and fittings have been installed, keep mortar lining moist until pipeline is filled with water for testing.

1.9 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS**2.1 Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
CEMENT-MORTAR LINING AND COATING OF STEEL PIPE		
Fabricated Steel Pipe and Fittings	Use same Manufacturer as pipe fabricator or mill	

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.

- B. 3Materials for pipe lining and coating shall be:

MATERIAL/ COMPONENT	STANDARDS/ CHARACTERISTICS	SPECIFICATION/REQUIREMENT
MORTAR MATERIALS		
Cement	Type	Cement – Conform to ASTM C150 Type II/V low-alkali
	Source	Cement shall be procured from 1 mill,
Sand		Fine Aggregate – Refer to Section 03 30 00 Refer to gradation table below
	Properties	Relative mortar strength of fine aggregate shall exceed 90%
		Evaluate potential reactivity using methods in ASTM C33 Appendix
		Aggregate shall be innocuous when tested per ASTM C289
		Color of supernatant liquid shall not be darker than standard when tested per ASTM C40.
	Impurities	Sand shall be free from deleterious amounts of dust, clay lumps, shale, soft or flaky particles, mica, loam, oil, and alkali
Water	Quality	Quality of sand shall ensure 2" by 4" mortar cylinders, made with cement-sand mixture, develop compressive strengths at 7 and 28 days $\geq$ 90% of those developed by mortar prepared in same manner with same cement and graded Ottawa testing sand, in accordance with Caltrans Test Method 515D
	Impurities	Water shall be clean and free from detrimental quantities of organic matter, alkali, salts, and impurities that, in opinion of City's Representative, might reduce strength, durability, or other quality of mortar.
	Impurities	Water shall contain $\leq$ 650 ppm chlorides

		Water shall contain ≤ 1000 ppm sulfates as SO_4
		Water shall not contain amount of impurities causing change in setting time of Portland cement $>25\%$, nor reduction in compressive strength of mortar at 14 days of $>5\%$ when compared to results obtained with distilled water when tested in accordance with ASTM C109
		Water for curing shall not contain impurities in sufficient amount to cause discoloration of concrete or mortar or produce etching of surface
	Source	Change in water supply shall be tested by Contractor and accepted by City's Representative prior to use
Admixtures	High-Range Water-Reducing Admixtures	Conform to ASTM C494 Type E or F
	Water Reducing Admixtures	Conform to ASTM C494 Type A or D
	Non-Chloride Accelerators	Conform to ASTM C494 Type C or E
	Calcium Chloride or Added Chloride	Do not use.
	Air Entraining Agents	Do not use.
Mix Design	Exact proportions of each mix shall be determined by Contractor, subject to acceptance by City's Representative. City's Representative may order change in proportions if required to achieve satisfactory results. Mortar shall be well-mixed and of proper proportions and consistency Measurement of dry material shall be by volume, using accepted method. Mix design proportions may be converted to weights for use in weigh-batch plant.	
	Pneumatically-placed Flash Coating for Hand Trowelling	1 part cement : 2 parts sand
	Mortar for Spun-mortar Lining	1 part cement : $\leq 2\frac{1}{2}$ parts
	Mortar for Coating Machines, Pneumatically-Applied Lining and Pneumatically-Applied Coating	1 part cement : $\leq 3\frac{1}{2}$ parts sand
	Water-Cement Ratio	Control and minimize water-cement ratio. Make allowances for moisture collecting on pipe surfaces and for most effective application operation and adhesion of mortar to pipe
	CURING MATERIALS	
Curing Materials	Curing Compound	White-pigmented Conform to ASTM C309, Type 2, Class B, wax-resin or all-resin-base compound as modified below.
		Loss of water, when tested in accordance with ASTM C309, shall not exceed 0.45 kilogram per square meter in 72 hours.
		Curing compound shall conform to current local, state, and federal air-quality regulatory requirements.
		Curing compound may only be used with mortar coating. Do not use curing compound on mortar lining.
	Polyethylene Film for Pipe Ends	Conform to ASTM C171 Thickness ≥ 4 mils
	Whitewash	Conform to AWWA C203
LININGS AND COATINGS		
Lining and Coating Above-Ground Pipe or Pipe in Vaults	Cement-Mortar Lining	Conform to AWWA C205 and AWWA C602
		Hold back lining as necessary to allow full operation of butterfly or check valves at connections to steel pipe
		Line exposed portions of pipe interior with hand-applied epoxy per Section 09 96 56.
	Cement-Mortar Coating	Conform to AWWA C205 and AWWA C602
		Coating thickness: $\geq \frac{3}{4}$ " unless otherwise shown. Trim coating 6" to 12" above grade on spools penetrating to daylight or

		vault interiors
	Liquid Epoxy Lining	Line exposed portions of pipe interior not cement-mortar-lined with liquid epoxy per AWWA C210 and Section 09 96 56.
	Liquid Epoxy Coating	Conform to AWWA C210. Refer to Section 09 96 56.
	Fusion-Bonded Epoxy Lining and Coating	Conform to AWWA C213. Refer to Section 09 96 56.
	Extruded Polyolefin Coatings	Conform to AWWA C215 for Extruded Coatings Conform to AWWA C216 for Heat-Shrinkable Cross-Linked Coatings Refer to Section 33 11 19.
Lining and Coating Buried and Partially Buried Pipe	Cement-Mortar Lining	Conform to AWWA C205 and AWWA C602
		Hold back lining as necessary to allow full operation of butterfly or check valves at connections to steel pipe
		Line exposed portions of pipe interior with hand-applied epoxy per Section 09 96 56.
	Cement-Mortar Coating	Conform to AWWA C205 and AWWA C602
		Coating thickness: $\geq \frac{3}{4}$ " unless otherwise shown / ≥ 1 " (corrosive soil areas)
		Trim coating 6" to 12" above grade on spools penetrating to daylight or vault interiors.
STEEL REINFORCEMENT		
Spiral Wire Reinforcement for Cement-Mortar Coatings	Steel Wire	Conform to ASTM A82 14 gauge wire minimum
Circumferential Steel Bar Reinforcement	Steel Bar	Conform to ASTM A615 Grade 40
Circumferential Steel Wire Reinforcement	Steel Wire Fabric	Conform to ASTM A185 or ASTM A497 W-1.4/W1.4 (10-gauge) wire minimum Space at 2" on-center longitudinally and 4" on-center parallel to pipe axis
	Steel Spiral Wire	Conform to ASTM A82 12 gauge wire minimum spaced $\leq 1\frac{1}{4}$ " center-to-center

C. Materials for cement-mortar lined and coated steel pipe fittings shall be:

MATERIAL/COMPONENT	STANDARDS/CHARACTERISTICS	SPECIFICATION/REQUIREMENT
Fittings and Specials	Coatings	Same coating as adjacent pipe, as described above
	Linings	Same lining as adjacent pipe, as described above

D. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION
Cement-Mortar Lining	Centrifugally cast lining shall be product of 1 company in business of designing and manufacturing cement-mortar lined steel pipe. Do not use subcontractors or subcontracts to apply lining

E. Protect exposed portion of joint rings from corrosion by Manufacturer's standard coating.

F. Fine aggregate gradations shall conform to the following:

PERCENTAGE PASSING SIEVES BY WEIGHT			
SIEVE SIZE	PNEUMATICALLY-APPLIED MORTAR	SPUN MORTAR LINING	FLASH COAT FOR HAND-TROWELING
$\frac{3}{8}$ "	100%	100%	
#4	90-100%	90-100%	100%
#8	65-100%	75-90%	95-100%
#16	45-75%	55-75%	50-100%
#30	30-50%	30-50%	
#50	12-22%	10-25%	20-40%
#100	2-8%	0-10%	7-15%
#200	0-4%	0-5%	0-4%

ASTM C131 Test Grading	A	B	C

G. In addition, difference between percentages passing #30 and #50 sieves shall be $\leq 32\%$.

H. Deleterious substances in mortar aggregate sand shall not exceed:

SUBSTANCE	MAXIMUM % BY WEIGHT
Shale	$\leq 1\%$
Clay Lumps	$\leq 1\%$
Mica and other Deleterious Substances	$\leq 2\%$
Sum of Deleterious Substances	$\leq 3\%$

I. Cement-mortar lining and coating shall be as follows:

- For the following nominal inside diameters, standard AWWA C205 lining thickness and minimum cement-mortar coating thickness shall be:

Nominal Pipe Size (inches)	LINING		COATING	
	Thickness (inches)	Tolerance (inches)	Thickness (inches)	Tolerance (inches)
6"	$\frac{1}{4}"$	$-\frac{1}{16}"$, $+\frac{1}{8}"$	1"	$+\frac{1}{8}"$
8"	$\frac{1}{4}"$	$-\frac{1}{16}"$, $+\frac{1}{8}"$	1"	$+\frac{1}{8}"$
36"	$\frac{3}{8}"$	$-\frac{1}{16}"$, $+\frac{1}{8}"$	1"	$+\frac{1}{8}"$

- Larger diameters shall receive standard-thickness linings per AWWA C205 Table 1 and coatings per AWWA C205 Section 4.5.3.
- Factory surface preparation, reinforcement, lining, coating, and curing shall conform to AWWA C205.
- Allow linings and coatings to cure ≥ 7 days at $\geq 40^{\circ}\text{F}$ before shipping pipe to Work site.
- Apply curing or sealing compounds with care to prevent application of such compound to joint ends where compound will interfere with bond of joint mortar.
- Hold back lining and coating from socket and spigot ends per Manufacturer's standard practices.
 - Hold back coating from ends of butt-strap, mechanical coupling, and flanged joint pipe sufficient distance to permit field assembly of joints.
 - Terminate lining at pipe ends, except where otherwise specified or where necessary to accommodate free motion of butterfly or check valve discs.
- To protect surfaces from pitting or rusting, clean non-coated surfaces and apply brush coat of suitable NSF-61-ertified rust preventative material compatible with finish lining and coating materials to be field-applied
- Cement-mortar lining and coating of pipe joints in field shall conform to AWWA C205 §4.7 and AWWA C602 §4-8.

J. Fabricate special fittings of welded steel sheet or plate, lined and coated with cement-mortar of same type as adjoining pipe and applied as specified for lining and coating of specials in AWWA C205 and as modified herein.

K. Protect exposed portion of joint rings from corrosion by Manufacturer's standard coating.

PART 3 - EXECUTION

3.1 Installation

- Refer to Sections 01 73 00 and 01 73 33 for basic execution and installation requirements.
- Line and coat welded joints as follows:
 - Install extruded butyl rubber pipe joint sealant to welded joints.
 - Apply sealant per Manufacturer's instructions.

2. Coat interior surface of welded pipe with cement mortar.
 - a. Swab out excess mortar.

3.2 **Field Quality Control**

- A. Perform field tests before field-lining pipe, encasing pipe in concrete, burying, or covering pipe.
- B. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Cement Mortar Lining and Coating	Visual Inspection	Refer to Part 1.4 "Quality Assurance" of this specification.	All pipe at City's discretion	City	City
	Cement-Mortar Lining QA/QC Progress Inspections	AWWA C602 §5.3	1 inspection of first 500' installed of all steel pipe joints and spools from each pipe production run	Contractor	Contractor
	Cement-Mortar Lining QA/QC Final Inspection	AWWA C602 §5.3	1 inspection of all steel pipe joints and spools	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

3.3 **Field Repair Methods**

- A. Repair mortar coating and lining defects as follows:
 1. Remove and replace material lacking uniformity, exhibiting segregation, honeycombing, or lamination, or containing dry patches, slugs, voids, or sand pockets.
 2. After cutting or abrasive blasting, wet surfaces sufficiently in advance of shooting so while repair material is being applied, surfaces under repair remain moist but not so wet as to prevent adhesion and good bond.
 3. Remove mortar to pipe wall in areas where quality is defective, such as sand pockets, voids, oversanded areas, blisters, drummy areas, cracked areas, and thin spots.
 4. When removing defective mortar, cut back material to square shoulder.
 - a. Do not feather-edge joints.
 5. Do not hand-patch.
 6. If defective lining is removed and pneumatically reapplied, mortar lining shall be reinforced.
 7. Replace with pneumatically applied mortar to full required thickness.
 8. Do not begin scraping or cutting to remove high spots until mortar is stiff enough to withstand pull of cutting device.

3.4 **Protection**

- A. When pipe laying is not in progress, and during noon hour and overnight, close open end of pipe with tight-fitting cap or plug to prevent entrance of foreign matter into pipe.
- B. Do not use pipeline to drain water which has infiltrated into trench.
- C. Maintain inside of pipe free from foreign materials and in clean and sanitary condition until acceptance by City.

END OF SECTION

SECTION 33 11 20**POLYETHYLENE ENCASEMENT OF IRON PIPE, FITTINGS, COUPLINGS, AND VALVES****PART 1 - GENERAL****1.1 Work Included**

- A. Materials and installation of polyethylene encasement of iron pipe, fittings, couplings, and valves.
- B. Conform to Standard Specifications for Public Works Construction (Greenbook) §209-1, §306-8.2, applicable permits, and requirements herein.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 33: Mechanical Identification
- I. Section 03 30 00: Cast-in-Place Concrete
- J. Section 31 23 00: Excavation and Fill
- K. Section 33 05 26: Utility Identification

1.3 System Description

- A. Furnish and install polyethylene film wrap around iron pipe.
 - 1. Fittings, couplings, and valves in conformance with Manufacturer's installation requirements and in compliance with applicable construction safety codes and standards.

1.4 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ASTM A624 Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
 - 2. AWWA C105/ANSI A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems
 - 3. AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances
 - 4. AWWA M41 Ductile-Iron Pipe and Fittings
 - 5. NSF/ANSI 61 Drinking Water System Components – Health Effects
 - 6. SSPWC Standard Specifications for Public Works Construction (Greenbook) §209-1 "Ductile Iron Pipe (DIP)"
 - 7. SSPWC Standard Specifications for Public Works Construction (Greenbook) §306-8 "Prefabricated Pressure Pipe"

1.5 Submittals

- A. Furnish the following submittals:

SUBMITTAL	DESCRIPTION	
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Use AWWA C105 and C600 for pipe installation	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Deliver with polyethylene encasement affidavit from Manufacturer certifying compliance with requirements of AWWA C105 and Contract Documents	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 1-year warranty from date of final acceptance	

- B. Refer to Section 01 33 00 for definition of requirements for Product Data, Installation Instructions, and Certificates of Compliance.

1.6 Delivery, Storage, and Handling

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

1.7 Project Site Conditions

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - MATERIALS**2.1 Acceptable Manufacturers**

A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
V-BIO Enhanced Polyethylene Encasement	American Cast Iron Pipe Company (ACIPCO)	Birmingham, AL (800) 442-2347
	Ductile Iron Pipe Research Association (4"-64")	Birmingham, AL (205) 402-8700
	Trumbull Industries, Inc.	Youngstown, OH (800) 677-1799
	McWane Ductile / Pacific States Cast Iron Pipe Co.	Provo, UT (801) 373-6910
	U.S. Pipe and Foundry	Birmingham, AL (866) 347-7473
	Accepted equal	
Tape for Polyethylene Encasement	Berry Plastics CPG / Sealforlife "Polyken No 900"	Franklin, MA (877) 910-1725
	Canusa CPS / Shawcor Wrapid Tape	Toronto, ON (416) 743-7111
	JM Eagle, Inc., No V-10	Los Angeles, CA (310) 693-8200
	Plicoflex Inc No 340	Houston, TX
	Polyken / Seal for Life 934	Franklin, KY (508) 918-1714
	Protecto Wrap No 200	Denver, CO (303) 778-8537
	Scotchwrap (3M), No 50	St Paul, MN (888) 364-3577
	Tapecoat Co., 35 CT	Evanston, IL (847) 866-8500
	Accepted equal	

2.2 Materials

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for ductile-iron polyethylene PE film wrap for corrosion protection shall be:

MATERIAL/ COMPONENT	STANDARDS/ CHARACTERISTICS	SPECIFICATION/REQUIREMENT
Polyethylene PE Film Wrap for Corrosion Protection	Standards	Conform to AWWA C105/ANSI A21.50
	Material	Polyethylene plastic tube
	Thickness	≥8-mil, double layer on pipe ≥8-mil triple layer on fittings and appurtenances
Adhesive Tape to connect plastic film tubes and plastic film wrap at fittings and appurtenances	Dimensions	2"-wide adhesive tape ≥10-mil thick
	Backing	Polyethylene or other polyolefin
	Adhesive	Capable of bonding to polyethylene and pipeline coatings
Alternate to Plastic Film Wrap for Corrosion Protection	Finish Coat	15 mils MDFT Koppers Bituplastic No 33

C. Refer to Section 33 05 26 for requirements for identification, identification tape and warning tape for buried ductile iron pipe.

PART 3 - EXECUTION**3.1 Preparation**

A. Make field measurements needed to install DIP pressure pipe and fittings before submitting Shop Drawings or ordering.

1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 **Installation**

- A. Refer to Sections 01 73 00 and 01 73 33 for basic execution and installation requirements.
- B. Refer to Section 31 23 00 for open trench requirements.
- C. Provide polyethylene film wrap on ductile iron and cast iron pipe, fittings, restraints, couplings and expansion joints, as follows:
 - 1. Conform to requirements of AWWA C105.
 - 2. Wrap bell-spigot interfaces, flanges, restrained joint components, and irregular surfaces with wax tape or moldable sealant before placing polyethylene encasement.
 - 3. Wrap polyethylene film snugly around exterior ferrous surfaces and 8" beyond bells, overlapping at least 2" at each seam.
 - a. Provide watertight corrosion barrier.
 - b. Completely encase pipe, and prevent contact between pipe and surrounding soil.
 - c. Prevent soil or bedding material from becoming trapped between pipe and polyethylene wrap.
 - d. Minimize voids beneath polyethylene.
 - 4. Do not install polyethylene wrap on pipe sections or fittings to be concrete encased, installed within casing or installed through concrete slope anchors.
 - 5. Leave stainless steel nuts and bolts exposed.
 - 6. Secure PE wrap in place using 2" wide plastic tape.
 - a. At least 3 circumferential turns of polyolefin or polyethylene tape shall seal polyethylene wrap ends over pipe and above valve bonnets with no exposed edges.
 - b. Tape longitudinal seams and longitudinal overlaps, extending tape beyond and beneath circumferential seams.
 - c. Place circumferential or spiral wraps of tape at 2' intervals along pipe barrel to minimize space between polyethylene wrap and pipe.
 - d. Repair cuts, tears, punctures or damage to polyethylene wrap with adhesive tape or with short length of PE tube cut open, wrapped around pipe and secured in place.
 - 7. Overlap adjoining polyethylene tube coatings $\geq 12"$, and wrap ends prior to placing concrete anchors, collars, supports, or thrust blocks.
 - a. Hand-wrap polyethylene sheet, apply 2 wraps with no exposed edges to provide watertight corrosion barrier.
 - b. Secure in place with polyethylene or polyolefin adhesive tape.
 - 8. 15-mil coat of Koppers Bituplastic No 33 may be applied as alternate to polyethylene wrapping.
- D. Provide PE film wrap on ductile iron and cast iron valves as follows:
 - 1. Comply with AWWA C105.
 - 2. Wrap flanges, valves, and irregular surfaces with wax tape or moldable sealant before placing polyethylene encasement.
 - 3. Wrap polyethylene film snugly around valves.
 - a. Provide watertight corrosion barrier.
 - b. Completely encase valve, and prevent contact between pipe and surrounding soil.
 - c. Prevent soil or bedding material from becoming trapped between pipe and polyethylene wrap.
 - d. Press polyethylene wrap tightly into place, leaving no voids underneath and a smooth surface under coating for polyethylene sheet.
 - e. Minimize voids beneath polyethylene.
 - 4. Wrap valves with flat sheets of polyethylene.
 - a. Place sheet under valve and flanges or joints with connecting pipe and fold in half.

- b. Extend sheet to valve stem and secure sheet in place with polyethylene or polyolefin tape.
 - c. Apply 2nd layer and secure with tape.
 - d. Make 2 complete wraps, with no exposed edges.
 - e. Secure sheets with tape around valve stem below operating nut and around barrel of connecting pipe.
- 5. Place concrete anchor and thrust blocks after wrap is installed.
- E. Repair damaged polyethylene wrap by placing polyethylene sheet over damaged or torn area and securing in place with polyethylene or polyolefin adhesive tape.
- F. When connecting polyethylene-encased pipe or fittings to existing pipe, expose existing pipe, clean surface, and securely tape end of polyethylene to existing polyethylene as specified above.
 - 1. When existing pipe is polyethylene encased, wrap new polyethylene encasement over existing with overlap $\geq 24"$, and tape as specified above.
- G. Backfill by placing sand backfill within 1' of pipe, valves, and fittings per Section 31 23 00.
- H. In addition to polyethylene wrapping ductile iron pipe, wrap service lines of dissimilar metals and attendant corporation stop with polyethylene wrap or suitable dielectric tape for clear distance of $\geq 3'$ from main.

3.3 **Field Quality Control**

- A. Do not backfill joints until City's Representative has observed them.
 - 1. Leave open sufficient trench space in vicinity of each joint to permit visual observation around entire joint periphery.
- B. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Ductile Iron Pipe	Visual Inspection	AWWA C150	All pipe at City's discretion	City	City
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 33 12 26**AIR AND VACUUM VALVES FOR WATER SERVICE – ROLLING SEAL DESIGN****PART 1 - GENERAL****1.1 Work Included**

A. Materials, testing, and installation of air and vacuum valves for water service, including air release valves, air/vacuum valves, combination air and vacuum valves using rolling seal design as alternate to traditional design described in AWWA C512.

B. Valves specified in this section include:

ITEM	SIZE	DESCRIPTION
CAV1	1"	Combination Air and Vacuum Valve 1
CAV2	2"	Combination Air and Vacuum Valve 2

C. Valves shall be equivalent in function to valves described in AWWA C512.

D. Refer to the following sections for Work not covered herein.

E. Refer to the following City of Corona Standard Drawings:

1. City of Corona Standard Drawing 410 for 1" air valve assemblies.
2. City of Corona Standard Drawing 413R for 2" air valve assemblies for recycled water mains.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 01 73 33: Mechanical Identification
- J. Section 09 90 00: Painting and Coating
- K. Section 09 96 56: Epoxy Linings and Coatings
- L. Section 33 05 31: Pipeline Joint Materials

1.3 System Description

- A. Furnish and install complete operating air and vacuum valve including appurtenant structural and/or mechanical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.
- B. Air release valves shall automatically release small pockets of air that accumulate at high points in system.
- C. Combination air and vacuum valves shall automatically release small pockets of air that accumulate at high points in system and shall allow air to enter or exit pipe to alleviate excess air or vacuum conditions in pipe.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods or proper performance of Work of this section.

B. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Air and Vacuum Valves	Hydrostatic Test	AWWA C512 §5 "Verification"	1 each valve	Contractor	Contractor
	Seat Leakage Test	AWWA C512 §5 "Verification"	1 each valve	Contractor	Contractor
Interior Lining	Holidays and Lining Thickness	Refer to Section 09 96 56.	1 each ferrous valve	Contractor	Contractor

1.5 References**A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.**

1. ASME/ANSI B1.20.1 (ANSI B2.1) Pipe Threads – NPT National Pipe Thread Taper
2. ASME/ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings – Class 25, 125, 150 and 800
3. ASME/ANSI B16.4 Cast Iron Threaded Fittings
4. ASME/ANSI B16.42 Ductile Iron Flanged Fittings – Classes 150 and 300
5. ASTM A47 Ferritic Malleable Iron Castings
6. ASTM A126 Gray Iron Castings for Valves, Flanges and Pipe Fittings
7. ASTM A240 Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
8. ASTM A536 Ductile Iron Castings
9. AWWA C213 Fusion-Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines
10. AWWA C512 Air Release, Air/Vacuum and Combination Air Valves for Water Service
11. AWWA C514 Air Valve and Vent Inflow Preventer Assemblies for Potable Water Distribution System and Storage Facilities
12. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
13. NSF/ANSI 61 Drinking Water System Components – Health Effects

1.6 Submittals**A. Furnish the following submittals.**

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit for valves ≥6" per valve Shop Drawing requirements. Submit for lateral supports for valves weighing >30 lbs.	.
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
	Show lining and coating data and thicknesses.	
Installation Instructions	Submit per Installation Instruction requirements.	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit certified test results for leakage and hydrostatic tests	
	Submit certified report of testing of factory-applied linings	
CLOSEOUT SUBMITTALS		
O & M Instructions	Submit per Operation and Maintenance Instruction requirements	
Warranty	In lieu of affidavit of compliance with AWWA C512, furnish 3-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, O&M Instructions, and Certificates of Compliance.**1.7 Delivery, Storage, and Handling**

- Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of air and vacuum valves.

1.8 Project Site Conditions

- Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Refer to City of Corona Approved List of Materials for Water Facilities for acceptable Manufacturers for air and vacuum rolling-seal valves.

B. Acceptable Manufacturers for water applications include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Combination Air and Vacuum Valves	ARI USA, Inc D-060 Series	San Diego, CA (714) 505-9319 Orange, CA (714) 505-9319
	ARI USA, Inc D-040-C Series 1"-2" D-015 Series 3"-8"	San Diego, CA (714) 505-9319 Orange, CA (714) 505-9319
	City Standard – No Exceptions	
Combination Air and Vacuum Valves (for valves 1"-2" and working pressures <10 psi)	ARI Flow Control Accessories DT-040 LP Series 1" and 2" D-050 LP Series 2" D-060 LP Series 1" and 2" (for high flow)	San Diego, CA (714) 505-9319 Orange, CA (714) 505-7079
	City Standard – No exceptions	

C. Air release and air and vacuum valves shall be same model as combination air and vacuum valves of same size to allow valves to be interchangeable in field.

2.2 Materials

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for combination air and vacuum valves shall be:

ITEM	MATERIAL	SPECIFICATION
Body and Cover	Stainless Steel	Conform to ASTM A240 SAE Type 316
Float	Polycarbonate	
	Stainless Steel	Conform to ASTM A240 SAE Type 316
	EPDM for Recycled Water	
Body Bolts	Stainless Steel	SAE Type 316
Threaded Ends Sizes 3/8"-4" Working Pressures 0-400 psi	Stainless Steel	Female-threaded Conform to ASME/ANSI B1.20.1 (ANSI B2.1)
Flanges Sizes 1-8" Working Pressures 0-150 psi	Stainless Steel	Conform to AWWA C207 Class D, or ANSI /ASME 16.5 Class 150 Raised- or flat-faced
Flanges Sizes 1-8" Working Pressures 150-250 psi	Stainless Steel	Conform to AWWA C207 Class E, or ANSI /ASME 16.5 Class 150 Raised- or flat-faced
	Valves	Boltholes shall straddle horizontal and vertical centerlines of valve.
Flange Alignment	Various Stainless Steels	Refer to Section 33 05 31.
Flange Bolts, Nuts, and Washers		Refer to Section 33 05 31.
Flange Gaskets	Epoxy	Refer to Section 09 96 56. Conform to AWWA C213 and AWWA C550 8-mil minimum DFT Do not coat sealing areas and bronze or stainless steel parts.
Epoxy Lining (Iron Surfaces of Valves < 4")	Fusion-Bonded Epoxy	Refer to Section 09 96 56. Conform to AWWA C213 and AWWA C550 12-mil minimum DFT Do not coat sealing areas and bronze or stainless steel parts.

ITEM	MATERIAL	SPECIFICATION
Epoxy Finish Coat	Recycled Water Service	Purple

- C. The following product design criteria, options and accessories are required for combination air and vacuum valves:

ITEM	DESCRIPTION	
Design	Use Manufacturer's standard design	
	Design Pressure	150 psi
Valve Outlet	Screening	Provide mushroom cap covers and bug screens on valve outlets
Tap	Location	Field tap for valve in level pipe section no closer than 18" to bell, coupling, joint, or fitting. Only factory outlets will be permitted within 18" of joint or flange.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install air and vacuum valves before submitting shop drawings or ordering.
 1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Field tap for valve shall be made in level pipe section no closer than 18" to bell, coupling, joint, or fitting.
 1. Only factory outlets will be permitted within 18" of joint or flange.
 2. Do not field-tap or reuse existing taps in asbestos cement pipe.

3.2 Installation

- A. Refer to Sections 01 73 00, 01 73 24, and 01 73 33 for basic execution and installation requirements.
- B. Furnish and install air and vacuum valves at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 1. Applicable OSHA and Cal OSHA regulations
 2. Applicable fire, plumbing, and mechanical code requirements
 3. City of Corona Standard Plans:
 - a. City of Corona Standard Plan 410 for 1" air valve assemblies.
 - b. City of Corona Standard Plan 413R for 2" air valve assemblies for recycled water mains.
 4. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install air and vacuum valves to tolerances recommended by Manufacturer.
 1. Unless otherwise shown, install air and vacuum valves true and level using precision gauges and levels.
- F. Install threaded air-vacuum wastewater valves as follows:
 1. Clean threaded joints by wire brushing or swabbing.
 2. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves.

3. If joints leak under pressure testing, remove valve, reapply compound or tape, reinstall, and retest joints.
4. Joints shall be watertight.

3.3 **Field Quality Control**

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Air and Vacuum Valves	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	Pressure Test	Do not test valves at pressures > pressure rating of valve. If necessary, test and observe valves at 5 psi below rated pressure. Then close isolation valve beneath air and vacuum valves during hydrostatic testing	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 40 23 38**CHEMICAL FEED SOLUTION PIPING, VALVES AND APPURTENANCES****PART 1 - GENERAL****1.1 Work Included**

- A. Materials, testing, and installation of sodium hypochlorite and ammonium sulfate piping, valves and appurtenances.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 01 73 24: Seismic Restraint
- I. Section 01 73 33: Mechanical Identification
- J. Section 09 90 00: Painting and Coating
- K. Section 09 96 56: Epoxy Linings and Coatings
- L. Section 31 23 00: Excavation and Fill
- M. Section 33 05 31: Pipeline Joint Materials
- N. Section 33 05 38: Hangers and Supports
- O. Section 46 41 17: Inline Static Mixers and Injection Equipment

1.3 System Description

- A. Furnish and install complete operating sodium hypochlorite and ammonium sulfate piping, valves and appurtenances including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.
- B. Piping shall be Hastelloy C-276 with perfluoroalkoxy (PFA) tubing, and chemically compatible with the material being conveyed.
 - 1. Pipe not installed in conduits shall be secured to wall in accordance with California Plumbing Code and Contract Documents.
- C. Do not use the following for parts in direct contact with sodium hypochlorite or ammonium sulfate:
 - 1. Bronze, brass aluminum, iron, carbon steel, stainless steel
 - 2. Type 304 or Type 316 stainless steel
 - 3. Nylon, polycarbonate, polyurethane, or Delrin
 - 4. Gum rubber, neoprene, Buna N nitrile, SBR rubber or silanastic.
 - 5. Tungsten carbide seals

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
 - 1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings
 - 2. ASTM B619 Welded Nickel and Nickel-Cobalt Alloy Pipe

3. ASTM B622 Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube
4. ASTM D1785 Poly(Vinyl-Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
5. ASTM D2467 Socket-Type Poly(Vinyl-Chloride) (PVC) Plastic Pipe Fittings Schedule 80
6. ASTM D2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
7. ASTM D2737 Polyethylene (PE) Plastic Tubing
8. ASTM D6867 Perfluoroalkoxy (PFA)- Fluoropolymer Tubing
9. ASTM F437 Threaded Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
10. ASTM F438 Socket-Type Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe Fittings Schedule 40
11. ASTM F439 Socket-Type Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe Fittings Schedule 80
12. ASTM F441 Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe Schedules 40 and 80
13. ASTM F442 Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe (SDR-PR)
14. ASTM F493 Solvent Cements for Chlorinated Poly(Vinyl-Chloride) (CPVC) Plastic Pipe Fittings
15. ASTM F645 Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems
16. California Electrical Code (CEC)
17. California Fire Code (CFC)
18. California Mechanical Code (CMC)
19. California Plumbing Code (CPC)

1.6 Submittals

- A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit per piping Shop Drawing requirements.	.
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements. Clearly show Manufacturer's designation and model number and materials of construction and ratings of Work furnished.	
CLOSEOUT SUBMITTALS		
Warranty	Furnish 3-year warranty from date of final acceptance except where otherwise noted.	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings and Product Data.

1.7 Delivery, Storage, and Handling

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of sodium hypochlorite piping, valves and appurtenances.

1.8 Project Site Conditions

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Hastelloy C Pipe and Fittings	Corrosion Materials	Bolingbrook, IL (800) 706-7471
	High Performance Alloys	Tipton, IN (800) 472-5569
	Accepted equal	
PFA Teflon® Tubing	McMaster-Carr	Santa Fe Springs, CA (562) 692-5911
	Accepted equal	
PVC Plastic Pipe and Fittings 4"	Spears Manufacturing Company	Sylmar, CA (818) 364-1611
	City Standard – No Exceptions	
Compression-Type Fitting for PFA Tubing	Swagelok Company	San Diego, CA (800) 252-7087
	Accepted equal	
Hastelloy C Ball Valve	Dwyer Instruments	Michigan City, IN (219) 879-8000

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Wetted parts of sodium hypochlorite piping shall be constructed of materials compatible with sodium hypochlorite.
- C. Pipe and fittings outside spill containment area whether buried, exposed or embedded in concrete shall have double wall containments.
- D. Piping and appurtenances for sodium hypochlorite and ammonium sulfate services shall be chemically compatible with the following chemicals:

SOLUTION OR CHEMICAL	STRENGTH	TEMP.	FITTING & PIPE MATERIAL	GASKET, SEAL, AND ELASTOMER MATERIAL	BOLT MATERIAL
Sodium Hypochlorite NaOCl Solution	9-15%	33°F-100°F	Hastelloy C-276	FPM (Viton)	Stainless Steel
Ammonium Sulfate (NH ₄) ₂ SO ₄	38%	33°F-100°F	Hastelloy C-276	FPM (Viton)	SAE Type 316 Stainless Steel

- E. Materials for sodium hypochlorite and ammonium sulfate piping shall be:

ITEM	MATERIAL	SPECIFICATION	
Sodium Hypochlorite Piping	Hastelloy C Pipe	Pipe	All piping will be Hastelloy C-276 schedule 40. Conform to ASTM B619/ASTM B622.
		Joints	threaded joints except at valve connections Provide threaded or flanged adaptors as required for valve connections
		Backfill	Imported sand to 12" over top of pipe Native earth above pipe zone
	PFA Teflon® Tubing	Tube	Conform to ASTM D6867-19
		Joints	Compression union fittings
		Wall Thickness	0.063" wall thickness rated for 70 psi at 72°F
		Conduit	Install tubing in Schedule 40 PVC containment pipe with long radius sweeps
	Pipe Color and Labeling		Refer to Section 01 73 33.

- F. Materials for sodium hypochlorite and ammonium sulfate valves shall be:

ITEM	MATERIAL	SPECIFICATION
Valves	Body, end caps, ball and stem	Hastelloy C
	Trim	Hastelloy C
	Seat, Body Seals, and stem packing	TFM (modified PTFE)

G. Materials for ammonium sulfate piping shall be:

ITEM	MATERIAL	SPECIFICATION	
Ammonium Sulfate Piping	Hastelloy C Pipe	Pipe	All piping will be Hastelloy C-276 schedule 40. Conform to ASTM B619/ASTM B622.
		Joints	Threaded joints except at valve connections Provide threaded or flanged adaptors as required for valve connections
		Backfill	Imported sand to 12" over top of pipe Native earth above pipe zone
	PFA Teflon® Tubing	Tube	Conform to ASTM D6867-19
		Joints	Compression union fittings
		Wall Thickness	0.063" wall thickness rated for 70 psi at 72°F
		Conduit	Install tubing in Schedule 40 PVC containment pipe
	Pipe Color and Labeling		Refer to Section 01 73 33.

H. Materials for ammonium sulfate piping appurtenances shall be:

ITEM	MATERIAL	SPECIFICATION
Valves	Body	Hastelloy C-276
	Gaskets	FPM (Viton)
	Elastomeric Seats and Seals	FPM (Viton)

I. Materials for containment piping shall be:

ITEM	MATERIAL	SPECIFICATION
Containment Pipe:	Material	PVC
	Size	4"
	Wall Thickness	Schedule 40 (accepted for pressures up to 50 psi in below-ground applications) For higher pressures or above-ground pipe, use Schedule 80 Use Schedule 80 for threaded joints
	Test Pressure	Hydrostatic Test to 75 psi / Air Test to 5 psi

J. Materials for containment pipe bends shall be:

ITEM	MATERIAL	DESCRIPTION
Elbows	Material	Match containment pipe material and color.
	Size	4"
	Description	90° long radius and threaded

PART 3 - EXECUTION**3.1 Preparation**

- A. Make field measurements needed to install sodium hypochlorite and ammonium sulfate piping, valves and appurtenances before submitting Shop Drawings or ordering.
1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 Installation

- A. Refer to Sections 01 73 00, 01 73 24, and 01 73 33 for basic execution and installation requirements.
- B. Refer to Section 31 23 00 for open trench requirements.
- C. Furnish and install sodium hypochlorite and ammonium sulfate piping, valves and appurtenances at locations shown on Plans and Submittals.
- D. The following installation standards shall be followed:

1. Applicable OSHA and Cal OSHA regulations
 2. California Mechanical Code Chapter 14 "Process Piping"
 3. Other applicable building, fire, plumbing, and electrical code requirements
 4. Manufacturer's installation and warranty requirements
- E. Refer variances between above documents and Contract Documents to City's Representative.
- F. Install sodium hypochlorite and ammonium sulfate piping, valves and appurtenances as shown on Plans and Submittals.
- G. Install sodium hypochlorite and ammonium sulfate piping, valves and appurtenances to tolerances recommended by Manufacturer.
1. Unless otherwise shown, install piping, valves and appurtenances true, plumb, and level using precision gauges and levels.
- H. Do not solvent weld joints when ambient temperatures are < 40°F or > 90°F unless solvents specifically formulated for these conditions are used.
- I. Construct piping, conduits and tubing as shown except for adjustments to avoid interference with structural features.
1. Coordinate piping and conduits with electrical installation.
- J. Provide screw union-type takedown couplings as shown.
1. Provide unions within 3' of wall penetrations.
- K. Provide anchor brackets, guides, saddles or hangers as shown on Plans, required by plumbing codes and as needed to support piping.
1. Provide ≥ 1 support on each run at each change of direction.
 2. Pipe supports shall be either fiber-reinforced plastic or same material as piping or bolting material.
- L. Clean piping systems of foreign materials following completion of testing and prior to connection to operating equipment, or control and regulating instrumentation.
1. After cleaning, flush piping systems with clean water for ≥ 15 minutes.
 2. Contractor may, to facilitate cleaning of sections of buried or exposed piping between isolation valves, pressure test and clean system prior to connection to valving.
 - a. Use of this procedure shall not waive requirement for full pressure test of completed system.

3.3 **Field Quality Control**

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Piping System	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

END OF SECTION

SECTION 40 71 13

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of magnetic flow meters 3"-36".
- B. Furnish and install the following magnetic flow meters:

TAG	METER SIZE (IN)	TRANSMITTER LOCATION	MODEL NUMBER	NEMA RATING (BODY / TRANSMITTER)
FIT-001	36"	Local	Endress + Hauser 5W43B9H DN900	7/4X

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 40 00: Quality Requirements
- D. Section 01 61 00: Common Product Requirements
- E. Section 01 65 00: Product Delivery Requirements
- F. Section 01 66 00: Product Storage and Handling Requirements
- G. Section 01 73 00: Execution
- H. Section 09 90 00: Painting and Coating
- I. Section 09 96 56: Epoxy Linings and Coatings
- J. Section 26 05 10: Common Work Results for Electrical
- K. Section 33 05 16: Precast Concrete Utility Structures
- L. Section 33 05 31: Pipeline Joint Materials

1.3 System Description

- A. Electromagnetic-type factory-calibrated flow instruments using Faraday's law of induction to measure flow volume computed based on pipe's diameter (i.e., Flowrate proportional to induced voltage).
 - 1. Factory-calibrated transmitter.
- B. Flow meters shall measure and transmit flow data for process record keeping, variable monitoring, and control.
- C. Furnish and install complete operating flow meter including appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building, plumbing, and electrical codes and standards.
- D. Flow meter instrument output variables shall include:

ITEM	VARIABLE	DESCRIPTION
Output Signals (Analog)	Rate of flow	4-20mA signal

1.4 Quality Assurance

- A. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Flow Meter	Wet Calibration	Hydraulic Institute Standards	1 each meter	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Interior Lining	Holidays and Lining Thickness	Refer to Section 09 96 56.	1 each meter	Contractor	Contractor
Meter	Accuracy of Flow Measurement	AWWA M6	as directed	Contractor	Contractor

1.5 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
2. AWWA C207 Steel Pipe Flanges for Waterworks Service
3. AWWA C222 Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
4. AWWA C550 Protective Interior Coatings for Valves and Hydrants
5. AWWA C751 Magnetic Inductive Flowmeters
6. AWWA M6 Water Meters – Selection, Installation, Testing and Maintenance
7. NEMA/ANSI 250 Enclosures for Electrical Equipment
8. NFPA 70 National Electric Code

1.6 **Submittals**

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit per pipeline equipment Shop Drawing requirements	.
	Submit for transducers under electrically controlled equipment Shop Drawing requirements	
MANUFACTURER'S LITERATURE		
Product Data	Submit the following for items of standard manufacture:	
	Product name or identification in sufficient detail to facilitate reordering.	
	List of parts and construction materials referenced by ANSI, NEMA, ASTM, SAE or CDA specification and grade.	
	Dimensions, laying lengths, and weights.	
	Standard test reports for mass-produced equipment.	
	Lining and coating data and thicknesses.	
Installation Instructions	Submit per Installation Instruction requirements	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit certificate of factory testing and calibration for accuracy and capacity.	
Test Record Transcripts	Submit for factory tests per Test Record Transcript requirements.	
CLOSEOUT SUBMITTALS		
O & M Instructions	Submit per Operation and Maintenance Instruction requirements	
Warranty	Furnish 1-year warranty from date of final acceptance	

B. Refer to Section 01 33 00 for requirements for Shop Drawings, Product Data, Installation Instructions, O&M Instructions, Certificates of Compliance, and Test Record Transcripts.

1.7 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage and handling of magnetic flow meters.

1.8 **Project Site Conditions**

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. Refer to City of Corona List of Sole-Source Equipment for Water Facilities for acceptable Manufacturers for magnetic flow meters.
- B. Acceptable Manufacturers for in-plant magnetic flow meters include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
Magnetic Flow Meters	Endress + Hauser, Inc. Promag W300	Greenwood, IN (714) 674-9520
	City Standard - No Exceptions	
	Features	Option
	Basic Model	Promag W300
	Diameter	36"
	NEC Article 505 Classification	Non-Hazardous Areas
	Design	Fixed Flange zero x diameter inlet/outlet runs
	Power Supply	100-240VAC / 24VAC/DC
		4-20mA
	Housing	Compact Polycarbonate Housing
	Cable, Remote Version	
	Electrical Connection	Plug M12x1 + threaded NPT $\frac{1}{2}$ " adapter for Ethernet IP Connection
	Liner	Epoxy
		Class 150 Carbon Stainless Steel Flange ASME B16.5
	Electrodes	Flush-Mounted 1.4435/316L (Use for sewage and gritty water applications)
	Calibration Flow	0.2%
	Operation Language Display	English
	Application Package	Heartbeat Verification + Monitoring
	Additional Approval	NSF 61 Drinking Water Approval
	Firmware Version	01.00zz EtherNet/IP
	Marking	1xTAG-stainless steel label

- C. Flow indicators, totalizers, and transmitters, where shown shall be manufactured by same Manufacturer as flow sensing equipment and shall be fully compatible with equipment furnished.

2.2 Materials

- A. Refer to Section 01 61 00 for basic requirements for products and materials.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install magnetic flow meters before submitting shop drawings or ordering.
1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install flowmeters at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building, fire, plumbing and electrical code requirements
 - 3. AWWA C715 Cold-Water Meters – Electromagnetic and Ultrasonic Type for Revenue Applications
 - 4. AWWA C751 Magnetic Inductive Flowmeters
 - 5. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install magnetic meter with electrodes located at ends of a horizontal diameter (9 o'clock and 3 o'clock positions) to ensure continued electrode immersion when air bubbles are present in metered fluid.
- F. Provide sun shield over transmitters exposed to direct sunlight.
- G. Electrically isolate meter from adjacent piping and fittings to prevent stray-current interference.
- H. On meters $\geq 3"$, provide 1" outlet or service saddle and corporation stop on spool at least 2 pipe diameters downstream from meter.
 - 1. Coordinate location of tap with City's Representative.
- I. Construct grounding rod, and ground magnetic meter in conformance with Manufacturer's installation instructions.
- J. Finished installation shall be compatible with City's existing flow measurement and telemetry facilities.

3.3 Field Quality Control

- A. Field testing will include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Magnetic Meter	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Accuracy	City reserves right to either test meter in shop before placing meter in service or test in field using test tap to be furnished by Contractor.	As directed	City	Contractor
	Field Performance	Demonstrate Work conforms to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	Integration with City's Telemetry	Confirm successful operation with telemetry.	As directed	Contractor	Contractor
	11-month Warranty Inspection	Confirm accuracy of registration and compatibility with telemetry. Confirm Work conforms to Contract Documents and Manufacturer's printed literature	As directed	City	Contractor

3.4 Adjusting and Cleaning

- A. Provide services of Manufacturer's representative as needed for startup, inspection and necessary adjustments as needed to integrate new flowmeter into existing telemetry network.

END OF SECTION

SECTION 43 23 13**HORIZONTAL CENTRIFUGAL FRAME MOUNTED END-SUCTION PUMPS****PART 1 - GENERAL****1.1 Work Included**

- A. Materials, testing, and installation of horizontal centrifugal frame-mounted, end-suction water pumps.
- B. Pumps shall rotate counterclockwise when viewed from driver end.
- C. Pumps specified in this section include:

ITEM	HORSEPOWER	DESCRIPTION
P1	3 hp	Flash Mixer Pump 1

- D. Refer to the following sections for Work not covered herein.
 - 1. Section 05 50 00 for requirements for anchor bolts.
 - 2. Section 09 90 00 for requirements for painting requirements.
 - 3. Section 09 96 56 for requirements for epoxy lining and coating.
 - 4. Section 26 05 10 and subsequent sections for electrical requirements.
 - 5. Section 33 05 31 for requirements for flange bolting materials.
 - 6. Section 40 90 10 and subsequent sections for instrumentation and control requirements.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 10 02: Sequence of Operation
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 40 00: Quality Requirements
- E. Section 01 61 00: Common Product Requirements
- F. Section 01 63 00: Product Substitution Procedures
- G. Section 01 65 00: Product Delivery Requirements
- H. Section 01 66 00: Product Storage and Handling Requirements
- I. Section 01 73 00: Execution
- J. Section 01 73 24: Seismic Restraint
- K. Section 01 75 00: Starting and Adjusting
- L. Section 01 79 00: Demonstration and Training
- M. Section 05 05 19: Post-Installed Concrete Anchors
- N. Section 05 50 00: Metal Fabrications
- O. Section 09 90 00: Painting and Coating
- P. Section 09 96 56: Epoxy Linings and Coatings
- Q. Section 33 05 31: Pipeline Joint Materials
- R. Section 40 90 10: Common Work Results for Instrumentation and Control

1.3 Definitions

- A. The following definitions apply:
 - 1. Total Dynamic Head: Sum of velocity head plus vertical static head measured from minimum suction water level or minimum suction pressure hydraulic elevation to centerline of pump discharge.

1.4 System Description

- A. Furnish and install complete operating pumping system including pumps, motors and necessary appurtenances required by Contract Documents.
 - 1. Pumping units shall be supplied by 1 Manufacturer and shall be complete, including pumps, motors, baseplates, couplings, guards and accessories specified herein.

2. Furnish and install anchor bolts and appurtenant structural, mechanical and/or electrical mountings or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.
- B. Pumps, motors, drives, couplings and base plates shall be designed and built for 24-hour continuous service at points within specified range of operation, without overheating, damaging cavitation, or excessive vibration or noise.
- C. Refer to Section 01 10 02 for Sequence of Operation.

1.5 **Quality Assurance**

- A. Pumps furnished shall originate from ISO 9001-certified facility.
- B. Castings shall be free of blow holes, sand holes, and other detrimental effects, and shall be accurately machined.
- C. Rotating parts including impellers shall be statically and dynamically balanced.
- D. Pumps shall be engineered and manufactured under written Quality Assurance program, which has been in effect for ≥ 10 years.
 1. Quality assurance program shall include documentation of periodic internal and external audits to confirm compliance with such program.
- E. Entire pump, including volute or casing, base plate, coupling, shaft, impellers, and specified appurtenances shall be furnished by 1 pump Manufacturer.
- F. Factory testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Test Instrument Accuracy	Calibration	Calibrate Venturi meters per ANSI/Hi Standards Calibrate test instruments and gauges	within 30 days of scheduled tests.	Contractor	Contractor
Pump and Motor Assembly	Compliance with Purchase Order	Verify impeller, motor rating and electrical connections conform to Contract Documents	1 each pump assembly	Contractor	Contractor
	Holidays and Lining Thickness	Refer to Section 09 96 56.	1 each pump	Contractor	Contractor
	Dynamic Balance	NEMA Method MGI 12.06 (8W/N for pumps)	1 each pump assembly	Contractor	Contractor
	Factory Test and Factory-Certified Pump Curve	Witnessed running test conforming to AWWA E103 and ANSI/Hi 14.6 6-point curves shall include shutoff and 3 points as near as possible to specified performance points. Performance test to follow HI 14.6 Test Tolerance as standard by the acceptable pump manufacturer. Follow 2.1.G if an alternative pump manufacturer is proposed.	1 each pump assembly ≥ 50 hp 30-minute test to prepare 6-point curves for each pump assembly. On variable speed pumps, test each pump and prepare 6- point curves at four 100 rpm increments.	Contractor (Includes lodging and travel expenses for up to 3 personnel from City's and/or Design Engineer's offices.)	Contractor (Includes lodging and travel expenses for up to 3 personnel from City's and/or Design Engineer's offices.)
	Vibration	As needed to satisfy pump Manufacturer pumps will pass field tests described in Part 3 below.			
Pump	Hydrostatic Casing Test	Test heads per HI standards to 1.5 x design head or 1.25 x shutoff head, whichever is greater	1 ten-minute test each pump casing	Contractor	Contractor
3-Phase Motors	Prototype Test	NEMA MG1 §12.53a and IEEE 112 Test Method B	1 each type of motor furnished ≥ 5 hp	Contractor	Contractor
	Short Commercial Test Data	NEMA MG1 §12.51 and NEMA MG1 §23.46	1 each motor ≥ 5 hp	Contractor	Contractor

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
		including no load running current, current balance, full load current, locked rotor current, winding resistance, high potential test, bearing inspection, and vibration test			
	Insulation	168-hour test in humidity chamber at 40°C and 100% relative humidity	1 each motor ≥10hp	Contractor	Contractor
	Motor Noise	IEEE 85 with motor operating during test on rubber at no load with rated voltage and frequency	1 each motor ≥10hp	Contractor	Contractor
	Motor Vibration	Conform to NEMA MG1§20.52 maximum amplitudes. Test per NEMA MG1§12.06 and NEMA MG1 §20.53	1 each motor ≥10hp	Contractor	Contractor
	Dynamic Balance	Balance and measure per NEMA MG1 §12.06 or MG1 §20.52 with maximum amplitudes shown in NEMA MG1 §12.05	1 each motor ≥10hp	Contractor	Contractor

G. paid for by Contractor.

1. Witnessing engineer may be employee of Manufacturer and shall sign and seal copies of curves and test reports and certify tests were performed.
2. Refer to Section 01 40 00 for provisions allowing City to witness factory tests at their expense.

H. Perform testing after final connection of pump and motor and after completion of static and dynamic balancing.

1. If vibration levels fall outside of acceptable limits established by Hydraulic Institute or above, shut down pump and correct for vibration before further testing.

1.6 **References**

A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.

1. ANSI/AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings
2. ANSI/AFBMA 11 Load Rating and Fatigue Life for Roller Bearings
3. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings-Class 25, 125, 250 and 800
4. ANSI C50.41 Polyphase Induction Motors for Power Generating Stations
5. ANSI HI14.6 Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
6. ASTM A36 Carbon Structural Steel
7. ASTM A48 Gray Iron Castings
8. ASTM A276 Stainless and Heat Resisting Steel Bars and Shapes
9. ASTM B505 Copper Base Alloy Continuous Castings
10. ASTM B584 Copper Alloy Sand Castings for General Applications
11. AWWA C213 Fusion-Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines
12. AWWA C550 Protective Epoxy Interior Coatings for Valves and Hydrants
13. AWWA E103 Horizontal and Vertical Lineshaft Pumps
14. California Building Code (CBC)
15. California Code of Regulations Title 8 Industrial Relations, Subchapter 5, Electrical Safety Orders
16. California Electrical Code (CEC)
17. Hydraulic Institute Standard for Centrifugal, Rotary and Reciprocating Pumps.
18. IEEE 43 Testing Insulation Resistance of Rotating Machinery
19. IEEE 85 Airborne Sound Measurements on Rotating Electric Machinery
20. IEEE 112 Test Procedure for Polyphase Induction Motors and Generators
21. IEEE 115 Test Procedure for Synchronous Machines
22. IEEE 841 Chemical Industry Severe-Duty Squirrel Cage Induction Motors 600V and Below

23. ISO 9001 Quality Management Standard
24. NEMA/ANSI 250 Enclosures for Electrical Equipment
25. NEMA MG1 Motors and Generators.
26. NEMA MG2 Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators
27. NEMA MG10 Energy Management Guide for Selection and Use of Polyphase Motors
28. NEMA MG13 Frame Assignments for Alternating Current Integral Horsepower Induction Motors
29. NEMA Standards
30. NFPA 70 National Electric Code (NEC)
31. NSF/ANSI 60 Drinking Water Treatment Chemicals – Health Effects
32. NSF/ANSI 61 Drinking Water System Components – Health Effects
33. UL547 Thermal Protectors for Electric Motors

1.7 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Pump and Motor Assembly: Show certified dimensions, weights, and materials for volute, impellers, drive assemblies, shafts, bearings, seals, and shaft guards per equipment Shop Drawing requirements. Show outline dimensions and assembly, foundation and installation requirements. Show ASTM reference and grade for materials.	.
	Motor Wiring and Control: Show wiring and motor controls per electrically controlled equipment Shop Drawing requirements.	
	Anchor Bolts: Show placement, embedment, and edge distances as required by CBC Chapter 19. Show embedment distances and projections from concrete face.	
	Lining and Coating: Show lining and coating data and thicknesses.	
MANUFACTURER'S LITERATURE		
Product Data	Pretest Pump Curves: Show flowrate, TDH, efficiencies, horsepower, and NPSHR for full range of operating points. Mark specified operating points. Show shutoff head.	
	Other Data: Show moment of inertia of complete pump assembly, coupling data, seal data, bearing life calculations, pressure limitations, and specific speed.	
	Submit data or accessory items.	
Motor Data	Refer to motor data requirements of Section 26 05 10.	
Installation Instructions	Submit per Installation Instruction requirements	
QUALITY ASSURANCE AND CONTROL SUBMITTALS		
Certificate of Compliance	Submit pump system certification per Certificate of Compliance requirements of AWWA E103 and specifications.	
	Submit evidence of ISO 9001 factory certification	
	Submit coating system certification per Certificate of Compliance requirements	
	Submit Installation Certificate signed by equipment Manufacturer's factory-authorized representative stating equipment has been properly installed, shaft aligned and is ready for start-up and performance testing	
	Submit acknowledgement letter from pump Manufacturer that pump and motor being furnished are compatible for use with variable frequency drive.	
Engineering Calculations	Pump Seismic Restraint: Refer to Section 01 73 24 for requirements	
	Horsepower Requirements: Submit for full range of operation. Include shaft friction and thrust bearing losses.	
Testing Procedures	Submit written test procedures in advance of field pump tests.	
CLOSEOUT SUBMITTALS		
O & M Instructions	Submit per Operation and Maintenance Instruction requirements	
	Include parts list and list or recommended spare parts.	
	Include preventative maintenance schedules	
	Include troubleshooting data	
	Include certified performance data and curves from factory tests in O&M manual.	

SUBMITTAL	DESCRIPTION	
Warranty	Furnish 3-year warranty from date of final acceptance for pumps and motors. Warranty shall bear appropriate serial numbers.	

- B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, O&M Instructions, Certificates of Compliance, Engineering Calculations, and Test Record Transcripts.

1.8 **Delivery, Storage, and Handling**

- A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.
- B. Do not ship pumps until City has accepted test reports.
- C. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of horizontal centrifugal split-case pumps.
- D. Deliver anchor bolts and anchorage devices to be embedded into cast-in-place concrete in ample time to ensure Work is not delayed.
- E. Cover pump equipment as required to guard against entry of deleterious matter, and to protect Work from abrasion.

1.9 **Project Site Conditions**

- A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 **Acceptable Manufacturers**

- A. Acceptable Manufacturers include:

ITEM	MANUFACTURER	MANUFACTURER LOCATION
PUMPS		
	Peerless	2005 MLK St. Indianapolis, In (317)925-9661
	Flowserve Corporation	Hastings, NB (800) 728-7867 Tustin, CA (714) 505-9700
	Goulds / Xylem	Lubbock, TX (806) 763-7867 Irvine, CA (949) 680-4800
	Accepted equal	
ACCESSORIES		
Pump Shaft Couplings	Dodge Para-Flex / Baldor / ABB	Fort Smith, AR (479) 646-4711
	Accepted equal	
Mechanical Seals	A W Chesterton Co Seal 155	Groveland, MA (844) 484-7080
	Borg Warner Type U	
	Garlock Sealing Technologies	Palmyra, NY (315) 597-4811
	John Crane Inc Type 21	Cerritos, CA (562) 802-2555
	Accepted equal	
Motors	General Electric	Fairfield, CT (800) 626-2000
	US Electrical Motors / Nidec	St Louis, MO (888) 637-7333
	Accepted equal	
Lubricants (Motor)	Chevron-Texaco GST ISO VG32	San Ramon, CA (925) 842-1000
	Exxon-Mobil DTE Light ISO VG32	Irving, TX (800) 243-9966
	Accepted equal	
ANALYSIS AND TESTING		
Vibration Testing	Electrical Specialty Products	(909) 737-8827
	Allis USA	(949) 661-3324
	Accepted equal Class II vibration analyst certified by Vibration Institute of America	

- B. Pump Manufacturer shall have ≥5years' recent continuous product history in USA waterworks industry.

- C. Pumps furnished shall be capable of operating throughout their full submitted pump curve driven by motors of horsepower specified below or shown on Plans. The pump's non-overloading horsepower may not be greater than the rated horsepower of the motor(s) to be supplied.
- D. Pumps requiring larger motor than specified or shown are unacceptable in absence of written statement from City electrical infrastructure, drives and switchgear can support larger motor.
- E. Pump curve shall continuously rise from minimum head to shutoff with no intermediate dips.
- F. Specified pump and pump curve have been selected based on the reference pump noted in Paragraph 2.2 to provide City with optimum performance at multiple operating points, and not solely at best efficiency point.
- G. Contractor may substitute other pumps including pumps from accepted equal manufacturers, provided the following conditions are met:
 - 1. Provisions of HI14.6 limiting pump performance testing to 1 "guarantee point" shall not apply to pumps furnished on this project.
 - 2. Testing shall demonstrate performance at "Point B Best Efficiency Point (BEP) conforms to Acceptance Level 1E as defined in HI14.6.
 - a. Efficiencies at BEP shall meet or exceed specified efficiencies.
 - 3. Testing shall demonstrate performance at Points A and C to conforms Acceptance Level 1B as defined in HI14.6.
 - a. Efficiencies at Points A and C shall be within 3% of efficiencies specified for these points.
 - 4. Testing shall demonstrate shutoff head falls within $\pm 10\%$ of specified shutoff head unless City elects to waive this requirement.
 - 5. Pump Manufacturer, if not listed above, shall in City's opinion meet criteria for product substitution procedures specified in Section 01 63 00.
 - 6. At City's option, penalties described under Section 01 22 00 may be assessed for failing pumps in lieu of rejecting installed pumps.

2.2 **Materials**

- A. Refer to Section 01 61 00 for basic requirements for products and materials.
- B. Pumps and attached motors shall be constructed in accordance with AWWA E103.
- C. Pumps and attached motors shall be rated for continuous duty and shall operate smoothly throughout their specified pumping range without surging, cavitation or vibration.
- D. Castings shall be free from blow holes, sand holes and other flaws and shall be accurately machined and fitted to close dimensions.
- E. Materials for horizontal centrifugal split-case pumps shall be:

ITEM	MATERIAL	SPECIFICATION
Horizontal Centrifugal Pumps	Varies by part	Conform to AWWA E103 Table 1
PUMP ASSEMBLY		
Pump Casing	Cast Iron	Conform to ASTM A48 Class 30
Suction and Discharge Flanges Working Pressures 0-150 psi	Ductile Iron	Conform to ASME/ANSI B16.42 Class 150 Raised- or flat-faced
	Cast Iron	Conform to ASME/ANSI B16.1 Class 125 Raised- or flat-faced
Suction and Discharge Flanges Working Pressures 150-250 psi	Ductile Iron	Conform to ASME/ANSI B16.42 Class 150 Raised- or flat-faced
Flange Alignment	Pumps	Boltholes shall straddle horizontal and vertical centerlines of pump and discharge head

ITEM	MATERIAL	SPECIFICATION
Flange Bolts, Nuts, and Washers	Various Steels	Refer to Section 33 05 31.
Flange Gaskets		Refer to Section 33 05 31.
Volute Lining	Fusion-Bonded Epoxy	Refer to Section 09 96 56. Conform to AWWA C213 and C550 12-mil minimum DFT Do not coat bronze or stainless steel parts
Impellers	or Stainless Steel	Conform to ASTM A276
Impeller Bearings	Bronze	
Casing Wear Ring	or Stainless Steel	Conform to ASTM A276
Impeller Wear Ring	Nickel-Aluminum Bronze or Stainless Steel	Conform to ASTM B148 alloy 952, 953, 954, 955, 956, or 958 OR ASTM A276
Shaft	Stainless Steel	Conform to ASTM B582 SAE Type 416 Conform to ASTM A276 SAE Type 316 if TDS>1000 ppm
Shaft Sleeve	Stainless Steel	Conform to ASTM A743 SAE Type 316
SEALS AND LUBRICATION		
Mechanical Seals	Body	SAE Type 316 Stainless Steel
	O-ring	Viton / FKM Rubber
Lubricating Oil	Food Grade Oil	NSF/ANSI 60 listed for potable water applications
HARDWARE		
Fasteners, Bolts, Cap Screws, Anchor Bolts, Nuts, Washers and External Hardware	Stainless Steel	SAE Type 316
Pump Nameplates	Stainless Steel	SAE Type 316
		Permanently attach to discharge head frame with information impressed, engraved or embossed into plate
		Pump nameplates shall show Manufacturer's name, model and serial number, year of manufacture, rpm, horsepower, impeller diameter, rated flow capacity, head rating and NPSHR.
		See below for motor nameplate data
PROTECTIVE COATINGS		
Pump Exterior Finish Coat	Fusion-Bonded Epoxy or Epoxy Urethane	Refer to Section 09 90 00 or 09 96 56. 12 mil minimum thickness

F. Materials for motors shall be:

ITEM	MATERIAL	SPECIFICATION
HORIZONTAL MOTORS		
Motor Frames	Cast Iron	Conform to NEMA MG1
		Provide frame assignments per NEMA MG13
Motor Terminal Boxes	Cast Iron	Conform to ASTM A48
Screens over Openings	Stainless Steel	Required on WP1 motors 7.5-horsepower and larger
Stator Windings	Copper	
Fasteners, Bolts, Cap Screws, Anchor Bolts, Nuts, Washers and External Hardware	Stainless Steel	SAE Type 316
Flexible Connectors	Neoprene	Do not use flexible metal hose, either braided or unbraided.
Motor Nameplates	Stainless Steel	SAE Type 316
		Permanently attach to motor frame with information impressed, engraved, or embossed into plate.
		Show information required by NEMA MG1-10.39 <i>et seq</i> Show Manufacturer's name, model and serial number
		Show year of manufacture Show rpm, horsepower, input voltage, phase, and frequency, Show full load current and locked-rotor kVA code

ITEM	MATERIAL	SPECIFICATION
		Show motor type, frame, insulation class, centigrade degree rise and motor connection diagram. Show bearing numbers for both bearings Show efficiency and power factor at full load, and maximum recommended kVAR of power capacitors to result in 90% power factor.

G. The following product design criteria, options and accessories are required for pumps:

ITEM	DESCRIPTION				
Pump Design Criteria				Pump Efficiency η	HP drawn at operating point (hp)
		Q (gpm)	TDH (ft)		
	Shutoff	0	19.54	0%	1.10
	A	348	17.8	75%	2.08
	B (BEP)	450	15	77%	2.28
	C	556	12.1	71%	2.39
	Notes:		See Peerless Model 4X6-10 MTP 8196 – 1 stage – 9.26” Impeller Trim		
	Net Positive Suction Head Available NPSHA		32 ft		
	Specific Speed Ns		Ns = 1980		
	Pump Speed		Operating points shown are for 900 rpm		
Maximum Solid Size		3”			
PUMP ASSEMBLY					
Casing	Type	Upper and Lower half-castings containing volute and suction passages. Upper half casing shall be fully removable without disturbing suction or discharge piping.			
	Air Release Tap	Drill and tap highest point in upper casing for air release or pump priming tap.			
	Drain Tap	Drill and tap lowest point in lower casing for drain tap.			
	Drilling and Tapping	Provide tapped connection for air release valve			
Bearings	Bearing Life	ANSI/ABMA 9 L ₁₀ ≥ 50,000 hours			
	Lubrication	Grease Lubricated via Zerk fittings			
SEALS, LUBRICATION, AND FLUSHING					
Pump Seals	Type	Mechanical Seals			
Drip Ring	Required				
Mechanical Seals	Tungsten Carbide				
	Silicon Carbide	Carbon No 5 stationary face Direct-sintered Silicon Carbide rotating face			
	Carbon				
	Ceramic				
Lubricating Oil	Food Grade Oil	NSF/ANSI 60 listed for potable water applications			

H. The following electrical design criteria are required for equipment specified in this section:

ITEM	DESCRIPTION	
Electrical Work	NEC Article 505 Classification	Nonhazardous
Enclosures – Outdoor or Wet Locations	NEMA 250 Enclosure Rating	NEMA 4X – Watertight, Corrosion-Resistant, Stainless steel
Enclosures	Construction	Lockable With powdercoat epoxy finish on steel surfaces
	IEC 60529 Enclosure Rating for Underground Equipment	IP 65 water jet
Control Panel Mounting	Remote Mount	MCC

ITEM	DESCRIPTION	
Power Supply	Motor Circuit	460VAC – 3 ϕ – 60Hz
	Heating Circuit	120VAC – 1 ϕ – 60Hz

I. The following product design criteria, options and accessories are required for pump motors:

ITEM	DESCRIPTION	
HORIZONTAL MOTORS		
Motors	Motor Type	Squirrel cage induction conforming to NEMA MG1
	Operating Frequency	60 Hz
	Synchronous Speed	900 rpm (8 pole)
	Motor Nominal Horsepower	3 hp
	Efficiency	Premium Efficiency (RUS) Stamp guaranteed efficiency on nameplate
	Starting Code	Code K
	Locked-Rotor (Starting Inrush Current) Design Code	Code K
	Locked Rotor Current	Conform to NEMA standards Shall be ≤650% of motor full load current
	Duty	S1 Continuous Duty
	Drive Shaft	Solid Shaft Extend through both bearings with proper length to close couple directly to pump impeller
	Temperature Rise	NEMA Design B Rated for Operation at 40°C (104°F) Maximum temperature rise of windings measured by resistance method shall be ≤ 90°C under continuous operation at service factor horsepower, rated voltage, and frequency
	Safe Stall (Locked Rotor) Time	Locked rotor time = 57 s (cold); 32 s (hot)
	Service Factor	1.15
	Insulation	Class F (155°C) Motor insulation on VFD-driven motors shall meet inverter-duty rating requirements of NEMA MG1, Part 31. Dip and bake totally enclosed motors in epoxy resin. Completed insulation shall have resistance ≥1.5MΩ Vacuum-impregnate windings on open motors with 100% solid-epoxy resins when frames ≥ NEMA Frame 364. Completed insulation shall have resistance ≥10MΩ.
	External Ground Connection	/ ⅜" for motors ≤100-hp Bronze bolt and lock washer or bronze post connector Provide threaded motor frame hole to depth ≥1½ x hole diameter to ensure firm connection. If necessary, bond metal pad to motor frame to provide required threaded hole depth. Locate grounding means in connection box or on same side of motor as main lead terminal box.
	Overtemperature Protection Motor Windings (motors <200hp)	Provide automatic-reset normally closed bi-metallic thermal overload thermostats in each phase of motor windings per NEMA MG1
	Control Leads on Overtemperature Protection Devices	Provide color coded control leads and terminate in separate conduit box.
	Lifting Lug	Provide on motor, sized to permit lifting of motor.

ITEM	DESCRIPTION	
	Other Requirements	Insulate and brace windings for full voltage operation.
		Motor nameplate horsepower shall not be exceeded anywhere on pump curve.
	Space Heaters (Outdoor Applications)	120V - 1 ϕ cartridge or flexible wrap-around type condensation heaters / not required
	Junction Box	Motor shall have oversized power junction box and auxiliary junction box for overtemperature switch and space heater circuit.
Motor Bearings	Bearing Type	Use angular contact ball thrust bearings, spherical roller thrust bearings or plate thrust bearings as needed to meet required thrust loads and bearing life.
	Bearing Life (at highest rated motor speed and total load)	ANSI/ABMA 9 L ₁₀ of 50,000 hours
	Lubrication	Grease lubricated, Prelubricate at factory
	Bracing	Brace and lock bearings to prevent shaft movement and to withstand high thrust loads in all directions.
Motor Enclosure	Enclosure	Total Enclosed Fan Cooled (TEFC)
Motor Connection Boxes	Design	Bolted with adequate space for connections
	Gaskets	Provide gaskets between box and housing and between box and cover
	Markings	Permanently mark motor leads in agreement with connection diagram
Vibration Limit		≤ 0.002 " peak-to-peak unfiltered when measured per MG1 20.54
Vibration Control		Attach conduits and electrical connections to motor with slack flexible connectors located as near to mechanical equipment as possible. Where possible, install connector in pipe parallel to motor shaft.
Coatings	Epoxy	Refer to Section 09 90 00. Coat fabricated ferrous surfaces on inside and outside surfaces except machined surfaces, shafts, bearings, register fits, stainless steel surfaces, moving parts, and nameplates. Coat machined, polished, and non-ferrous surfaces with corrosion-prevention compound. Touch-up coated surfaces damaged during shipping. Do not field-paint motors unless motor warranty permits.

- J. Motor torque and slip characteristics shall be as recommended by pump Manufacturer and as specified.
- K. Motors shall start and accelerate driven equipment to design conditions without exceeding any specified design requirements.
- Where motor horsepower specified above or shown on Plans appears undersized for pump specified, refer conflict to City's Representative during submittal process for resolution.

PART 3 - EXECUTION

3.1 Preparation

- A. Make field measurements needed to install pumps before submitting shop drawings or ordering.
- Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.
- B. Verify structures, piping, and equipment are compatible.

- C. Prior to installation, provide 1 site visit and up to 4 hours of time on-site by pump Manufacturer's factory-authorized representative to provide the following services:
 - 1. Ensure equipment shipped to job-site has been handled according to Manufacturer's recommendations and is in good working order.
 - 2. Ensure equipment has been stored and protected according to Manufacturer's recommendations.
 - 3. Inspect and verify structures or surfaces on which equipment will be mounted have no defects which might adversely affect installation.
- D. Contractor shall promptly report to City, in writing, defects which may affect Work.
 - 1. Provide 1 copy of Manufacturer's field report to City.

3.2 Installation

- A. Refer to Section 01 73 00 for execution and installation requirements.
- B. Furnish and install pumps at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
 - 1. Applicable OSHA and Cal OSHA regulations
 - 2. Applicable building, fire, plumbing, and electrical code requirements
 - 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install pumps to tolerances recommended by Manufacturer.
 - 1. Unless otherwise shown, install pumps true and level using precision gauges and levels.
- F. Construct equipment sub-base plates and pump bases as follows:
 - 1. Welding shall conform to ASME Boiler and Pressure Vessel Code, §VIII
 - 2. Level baseplate in both directions.
 - 3. Align shafts between driver and driven unit.
 - 4. After completing leveling and base alignment and before grouting, tighten anchor bolts to proper torque value.
 - 5. Grout baseplate in place.
- G. Install pumps as follows:
 - 1. Support piping independent of pump.
 - 2. Plug taps and orifices not required for pump operation and controls.
 - 3. Check and align unit components.
 - 4. Make electrical connections in conformance with electrical plans and specifications.
 - 5. Connect unit heaters per Manufacturer's recommendations.
 - a. Make final wiring connections with short lengths of moisture proof flexible conduit.
 - b. Provide installation free from objectionable noise when heater is in operation.
 - 6. For each pump, neatly place copper pipe to convey leakage to nearest drainage inlet.
 - a. Provide compression fittings on copper pipe shall to allow disassembly.
 - 7. Furnish and apply initial supply of grease and oil, recommended by Manufacturer.

3.3 Field Quality Control

- A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Pumps and Motors	6-hour Field Performance Test to Demonstrate Conformance to Contract Documents and Manufacturer's Printed Literature	Conform to HI 14.6 and requirements below to extent possible in field. Tests shall be witnessed by pump Manufacturer's factory-authorized representative who shall certify installed pumping system complies with Contract Documents and Manufacturer's warranty requirements, that interlock and control features work properly, and that no drive equipment or shafting is overloaded at any point on published pump curve.	One 6-hour test each pump	Contractor	Contractor
	72-hour System Demonstration	Refer to Section 01 79 00. 6-hour field performance tests may be part of 72-hour system demonstration.	1 for pumping system	Contractor	Contractor
	Motor Current	Record current in each phase of each motor and include in O&M manual. Repair or replace motor or motor-driven equipment if current > motor nameplate FLC value.	Each phase of each motor	Contractor	Contractor
	Vibration	Running test with vibration analyzer per ANSI/HI 14.6 Do not exceed published HI standards or 0.20 in/sec RMS in absence of HI standards.	1 test each pump during 6-hour field performance test	Contractor	Contractor
	Installation, Noise, Odors, Heat and Leakage	Visual inspection of finished installation	1 inspection	City	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	City	Contractor

B. Field performance testing shall conform to the following:

1. Verify Work conforms to Contract Documents
2. Field test using job-supplied flow meters and pressure gauges
3. Bump motor to ensure motor is connected for proper rotation.
4. Conduct infrared survey/testing of vertical turbine pump/motor assemblies.
5. Verify controls, alarms and safety shutdowns are operational.
6. Verify proper pump sequencing occurs.
7. Verify valves, including check valves, open and close properly.
8. Make adjustments required to place equipment in proper operating condition and to optimize operation.

C. Vibration testing shall conform to the following:

1. Provide services of specialist in this field to conduct tests.
2. Factory test and certify each motor operating without pump.
3. Field test and certify each pump.
4. Statically and dynamically balance rotating parts on pumps and motors before testing.
5. Test each installed pump and motor at each operating speed for compliance with specified vibration and critical frequency limits.

6. To determine critical frequency, perform bump tests on each pump in each of 2 orthogonal planes 1 of which shall include discharge elbow.
 7. Determine natural frequency of pump support structure at each pump using bump test and analyzer with frequency finder.
 8. Perform vibration measurements at upper motor bearing of each pump at each operating speed.
 - a. Provide measurements in each of 2 orthogonal horizontal directions 1 of which shall be in plane of greatest vibration and in addition provide measurement in vertical (pump axial) direction.
 9. Conduct vibration level tests on each pump with pump operating at its rated capacity and motor/bearing temperatures stabilized.
 10. Vibration when measured in direction of maximum amplitude shall not exceed limits given in latest ANSI/HI nomograph for pump.
 11. Natural frequency of pump drive train shall not be within $\pm 25\%$ of drive train's calculated critical speed at any point in operating range.
 12. Adjust or replace units and/or modify dynamic balance, if required to meet specified vibration limits or to correct excessive vibration.
 13. Provide gussets, stiffeners, additional mass, or other measures to conform to vibration limitations.
 14. If installed pump vibrations exceed HI 2.4 thresholds, modify discharge head and other pumping components to correct deficiencies at no additional cost to City.
- D. Provide services of pump and motor Manufacturers' factory-authorized representatives on-site to witness and inspect startup of pump operation and perform the following services:
1. Provide technical assistance to Contractor during installation of pumping units.
 2. Check alignment and inspect installation prior to final grouting and start-up.
 3. Before startup, check equipment for proper lubrication, alignment, rotation, and freedom from excessive vibration.
 4. Notify Contractor and City of irregularities of installation which might render pump Manufacturer's warrantee null and void
 5. Present City with punch list detailing problems noted and suggested remedial actions.
 6. Prior to initial start-up, provide written statement equipment has been installed in accordance with Contract Documents and Manufacturer's installation and warranty instructions and is ready to be placed into operation.
 7. Assist in initial start-up, adjustments and field testing, including vibration testing.
 8. Test-operate system in City's presence and verify equipment conforms to specified requirements.
 9. If measured flows at above tabulated pump heads are $>5\%$ below flows obtained on factory test, adjust impellers or provide new impellers or otherwise repair or replace pumps or calibrate meters or pressure gages.
 10. Assist in correction of defective or faulty Work before and after acceptance by City.
 11. Re-visit job-site as often as necessary until all deficiencies are corrected and installation and operation is accepted by City.
 12. Prepare report on pump performance for submittal to City.
- E. Conduct field performance test in presence of City's Representative and City's personnel after ≥ 24 hours of field operation have occurred to burn in system.

- F. If field performance tests show excessive vibration or fail to demonstrate compliance with requirements of Contract Documents or certified curves furnished, City shall have right to either:
1. Decline acceptance of failing pumps and require Contractor to replace them, or
 2. Deduct agreed upon allowance for City's incremental cost of additional power from payment due Contractor.

3.4 Field Training of City's Personnel

- A. In addition to the above, provide services of pump Manufacturer's factory-authorized representative on-site for ≥ 8 man-hours (travel time excluded) to provide classroom instruction of City's personnel in proper recommended lubrication, operation and maintenance procedures as well as procedures for proper lockout out of each energy source.
- B. The following handouts shall be provided by Manufacturer's factory-authorized representative to attendees during classroom instruction:
1. Listing of actions (or inactions) by City which would render Manufacturer's warranty null and void.
 2. Written description of proper lubrication procedures.
 3. Written list of required scheduled maintenance including recommended service intervals to ensure warrantee remains valid and to ensure equipment remains functional.
 4. Written description of procedures for lockout of each energy source.

END OF SECTION

SECTION 46 41 17
INLINE STATIC MIXERS AND INJECTION EQUIPMENT

PART 1 - GENERAL

1.1 Work Included

- A. Materials, testing, and installation of inline static mixers and injection equipment.

1.2 Related Work

- A. Section 01 10 01: Summary of Work and Sequence of Construction
- B. Section 01 10 02: Sequence of Operation
- C. Section 01 33 00: Submittal Procedures
- D. Section 01 40 00: Quality Requirements
- E. Section 01 61 00: Common Product Requirements
- F. Section 01 65 00: Product Delivery Requirements
- G. Section 01 66 00: Product Storage and Handling Requirements
- H. Section 01 73 00: Execution
- I. Section 05 05 19: Post-Installed Concrete Anchors
- J. Section 09 90 00: Painting and Coating
- K. Section 09 96 56: Epoxy Linings and Coatings

1.3 System Description

- A. Furnish and install complete injection / static mixing equipment including appurtenant structural and/or, mechanical or connections required for compliance with Manufacturer's installation requirements and compliance with applicable building codes and standards.

1.4 Quality Assurance

- A. Use adequate numbers of skilled workmen trained and experienced in necessary trades and crafts and completely familiar with specified requirements and methods for proper performance of Work of this section.

1.5 References

- A. Reference publications below form part of this specification to extent referenced and are referred to within text by basic designation only.
- 1. ASME/ANSI B16.5 Steel Pipe Flanges and Flanged Fittings (Including ratings for Class 150, 300, 400, 600, 900, 1500, and 2500)
 - 2. AWWA C207 Steel Pipe Flanges
 - 3. AWWA C653 Disinfection of Water Treatment Plants
 - 4. California Building Code (CBC)
 - 5. California Electrical Code (CEC)
 - 6. California Fire Code (CFC)
 - 7. California Mechanical Code (CMC)
 - 8. California Plumbing Code (CPC)
 - 9. NEMA/ANSI 250 Enclosures for Electrical Equipment
 - 10. NFPA 70 National Electric Code (NEC)
 - 11. NSF/ANSI 61 Drinking Water System Components – Health Effects

1.6 Submittals

A. Furnish the following submittals.

SUBMITTAL	DESCRIPTION	
DRAWINGS		
Shop Drawings	Submit per pipeline equipment Shop Drawing requirements.	.
MANUFACTURER'S LITERATURE		
Product Data	Submit per Product Data requirements.	
Installation Instructions	Submit per Installation Instruction requirements.	
CLOSEOUT SUBMITTALS		
O & M Instructions	Submit per Operation and Maintenance Instruction requirements.	
Warranty	Furnish 1-year warranty from date of final acceptance.	

B. Refer to Section 01 33 00 for definition of requirements for Shop Drawings, Product Data, Installation Instructions, and O&M instructions.

1.7 Delivery, Storage, and Handling

A. Refer to Sections 01 65 00 and 01 66 00 for delivery, storage, and handling requirements.

B. Strictly follow Manufacturer's instructions and warranty requirements for delivery, storage, and handling of static mixers and injection equipment.

1.8 Project Site Conditions

A. Refer to Section 01 10 01 for full list of project site conditions.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

A. Refer to City of Corona List of Sole-Source Equipment for Water Facilities for acceptable Manufacturers for injection quills.

B. Refer to City of Corona List of Sole-Source Equipment for Water Facilities for acceptable Manufacturers for static mixers.

C. Acceptable Manufacturers include:

ITEM	MANUFACTURER		MANUFACTURER LOCATION
	SAF-T-FLO Water Services, Inc.		Anaheim, CA (800) 957-2383 Irwindale, CA (626) 856-5656
Sodium Hypochlorite Injection Quill	Features	Option	Manufacturer's Code
	Basic Model	Retractable 250 psi rated ½" and ¾" Main Connection X ½" and ¾" Solution Tube	EB168
	Valve/Compression Material	Stainless Steel	S
	Solution Tube Material	Hastelloy® C276	H
		12" and 4"	12/4
	Tip Configuration	Saf-T-Seal Tip – Viton	CV
	Check Valve Option (Same material as solution tube)	Check Valve – Viton O-Rings	V
	Flexible Hose Assembly	FTA	
	Accepted equal		
Static Mixer	Komax Systems, Inc.		Huntington Beach, CA (714) 933-7400
	No exception		

2.2 Materials

A. Refer to Section 01 61 00 for basic requirements for products and materials.

B. Materials for injection quills shall be:

ITEM	MATERIAL	SPECIFICATION
Ball Valve	PVC	SCH 80
	Hastelloy® C276	
	Stainless Steel	SAE Type 316
Ball Valve Sodium Hypochlorite	Hastelloy® C276	1" and ½"
Solution Tube	PFA	
	PVDF (Kynar)	
	PVC	
	Stainless Steel	SAE Type 316
	Hastelloy® C276	
	Length	6" / 12" / 18"
Solution Tube Sodium Hypochlorite	PFA	
	Length	6" / 12" / 18"
Tip Configuration (<1" inlet)	Saf-T Seal FPM (Viton)	
Check Valve	PVC	
Inlet Connection	PVC	½" NPT
Safety Chains	Stainless Steel	SAE Type 316 – two required
Assembly		Rated for pressures 0-250psi

C. The following product design criteria, options and accessories are required:

ITEM	DESCRIPTION	
Chemical Criteria	Fluid Injected	15% Sodium Hypochlorite Solution
	Receiving Fluid	Recycled Water
Hydraulic Criteria	Injection Flow Rate	300 gal/hr
	Receiving Fluid Flow Rate	10,000 gpm
	Density	62.4 pcf
	Viscosity	
	Pressure	3-15 psi
	Temperature	60-80°F
Number of Injection Fittings on Static Injection Mixer	2	

PART 3 - EXECUTION**3.1 Preparation**

- A. Refurbish and install static mixer as stated on the Plans. Provide pressure wash of exterior coatings and advise City of any interior deflects. Recoat exterior per Section 09 90 00,
1. Make minor changes in dimensions and alignments as needed to avoid utilities or structural conflicts.

3.2 Installation

- A. Refer to Section 01 73 00 for basic execution and installation requirements.
- B. Furnish and install injection equipment at locations shown on Plans and Submittals.
- C. The following installation standards shall be followed:
1. Applicable OSHA and Cal OSHA regulations
 2. Applicable building and plumbing code requirements
 3. Manufacturer's installation and warranty requirements
- D. Refer variances between above documents and Contract Documents to City's Representative.
- E. Install injection equipment to tolerances recommended by Manufacturer.

1. Unless otherwise shown, install equipment true, plumb, and level using precision gauges and levels.

3.3 Field Quality Control

A. Field testing shall include:

ITEM	TEST FOR	TEST STANDARD (ASTM OR OTHER TEST STANDARD)	FREQUENCY	FIRST TEST PAID FOR BY	RETESTS PAID FOR BY
Static Mixers and Injection Equipment	Installation & Leakage	Visual inspection of finished installation	1 inspection	City	City
	Field Performance	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 test	Contractor	Contractor
	11-month Warranty Inspection	Demonstrate compliance to Contract Documents and Manufacturer's printed literature	1 inspection	City	Contractor

END OF SECTION