GREAT BASIN ENGINEERING INC

TERAKEE FARM Cluster Subd
APPROX 700 NORTH 3600 WEST
WEBER COUNTY, UTAH 84401
SECONDARY WATER MODEL
Project No. 16N704
11-19-2021

General Site Information:

The proposed cluster subdivision is located approximately at 700 North 3600 West along the Weber River just over 2 miles west of the Interstate 15 Freeway in Weber County, Utah. Construction will consist of 206 Parcels of Residential Lots, two Park Parcels, and two Parcels for agricultural use. New roadways are also planned for access. Other improvements will include sidewalks, curb and gutter, underground utilities (including a secondary water system, herein after referred to as the "System"), and similar related improvements when completed. Secondary water will be piped through the System via water pumps (one fixed and one VFD), 4-, 6-, 8-, 10-, and 12-inch diameter main lines, 2-inch residential laterals, and 1-inch individual lot connections, where individual meters may be required.

Secondary water will be supplied by diverting from an adjoining Oxbow along the Weber River into a wet well, where pumps will supply flow and pressure to the System. Water rights are available or will be purchased for this use. This water will be supplemented by any storm water which falls on the site. The System will deliver water through new secondary water piping to each residential lot of this subdivision, as well as common areas and park strips for use with landscaping in these locations during night hours. The two agricultural parcels will also be provided irrigation water but will be restricted to watering times during the day, so as not to conflict with residential and park use.

Design Requirements:

This development lies within Zone 4 of the Irrigated Crop Consumptive Use Zones and Normal Annual Effective Precipitation - Utah map, which is found at the end of Section R309-510-7 of the Utah Rules. Referring to this Zone in Table 510-7 in Utah Rule R309, the Peak Instantaneous Demand (PID) is found to be 7.92 gpm/irrigated acre (irr-ac). The State also requires developers within this Zone to provide irrigation water rights of 1.87 acre-feet/irr-ac per year (ac-ft/irr-ac-yr), and to design for a Peak Day Demand of 3.96 gpm. A total of 132.76 irr-ac for this site yields a water right requirement of 248.26 ac-ft/yr. Since a single water share is allowed up to 2.8 ac-ft per year, this requires ensuring that 88.7 shares are available for use. Since shares are sold in half-share increments, this rounds the requirement to 89 shares.

It is the experience of this office that many watering guidelines are not always followed or closely regulated for residential use in secondary water systems. Therefore, a safety factor of 2 is chosen to act as a buffer for the PID, resulting in a design rate of 15.84 gpm/irr-ac for the residential and park areas. This rate is applied to the Residential Lots, ROWs, and Parks. Water for the park strips in the ROWs is assigned to the residential lots in a pro-rated fashion (by lot area) since low owners are required to maintain the park strip along their frontage.

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It is understood that during non-agricultural use (night-time), not every lot, common area, or park strip will be watering simultaneously, and that at any given time, a single lot or area may be utilizing more or less than 15.84 gpm/irr-ac, as this PID is an average throughout the development. The irrigated acreage within the non-agricultural areas totals 66.96. This yields a design PID of about 1060 gpm for the non-agricultural areas during nightly use. Watering nights/times for the non-agricultural areas will be split or assigned to decrease the irrigated acreage being watered at any given time during the watering season.

For the agricultural areas, a safety factor is less important. Agricultural usage will occur during the day through a total of 4 connection points. The usage rates are easier to enforce under these conditions. The requirement for the 65.80 acres of agricultural area are thus 65.80*7.92 = 521 gpm. It is possible that only one of the two pumps may be needed during these times.

The requirements provided by the State of Utah and Hooper Irrigation company are supplemented, by reasonable requirements from nearby Marriott-Slaterville Public Works Standards. For service saddle connections, the Hooper Irrigation Company Standards require “All service saddles for connections to C900 PVC pipe sizes 4-inch to 10-inch diameter shall be Mueller Model H-13490 Series or Ford S-90”. The Marriott-Slaterville standards require that pressures be designed between 60 psi and 100 psi for individual connections.

Copies of the State of Utah, Hooper Irrigation Company and Marriott-Slaterville Standards are attached to this report.

Model Software and Input:

The software used for this analysis is EPANET 2.2, which is a free service that is available on the epa.gov website. Naming conventions for junctions (nodes) and pipes (links) are as follows:

- Lateral connections to the main lines serving residential lots and park areas are labeled as Nodes 1 through 66. The connection which contributes to the lowest numbered lot is labeled Node 1; the connection contributing to the next higher previously-unserved lot is labeled Node 2, and so on through Node 66, whether they contribute to a Park or not. For example, since Node 1 serves only Lots 1 and 2, this leaves Lot 3 as the next higher previously-unserved lot. Therefore, Node 2 must be the node that serves Lot #3. In fact, Node 2 serves Lots 3, 4, 112, and 113.
- Individual connections to the 2” laterals near the ROW lines are labeled by the corresponding main line connection number, followed by a lower-case letter (a, b, c,…) in order of increasing lot number. For example, the connection to the 2” lateral serving Lots 3 and 4 is labeled as Node 2a and the connection to the 2” lateral serving Lots 112 and 113 is labeled as Node 2b.
- The 2” laterals that lead to the individual connection nodes are labeled with a capital letter, corresponding to the labeled individual connection node designation. For example, the lateral connected to Node 2a is called Link 2A and the lateral connected to Node 10d is called 10D.

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- The nodes representing the connection to the main lines which serve the agricultural areas are labeled as Node 67 and 68, with the same pattern as for residential for naming the lateral and connection near the adjacent ROW boundary.
- The remaining nodes are along the main lines, are not at the ends of connection laterals, and do not have associated demands. These are labeled as Nodes 69 through 78, roughly in order of nearby Lot numbers where possible for ease of navigating the model. For example, the lowest numbered remaining node nearest to Lots 1 through 20 is labeled Node 69, and the lowest numbered remaining node nearest to Lots 21 through 45 is labeled Node 70, and so on.
- The remaining irrigation lines are all mainlines and are designated as P1 through P82, also roughly in order of nearby lot numbers where possible. For example, the main line connecting Node 22 to node 74 is labeled as P26.

To model the System, head vs. flow curves were needed to incorporate the water pumps. The Design PID for residential/parks, as mentioned, is about 1060 gpm. Since this is higher than the Design PID for Agricultural areas, it is used in the pump selection process. It is reasonable to consider using two 530 gpm pumps (one constant flow and one with a VFD) to provide up to 1060 gpm for the System. A reputable manufacturer, Grundfos, was contacted to provide guidance on selecting a possible pump combination to meet these criteria. The manufacturer's website was consulted to locate suitable choices. For the pumps, the GRUNDFOS 475S300-4-AB, 3*460 V, 60 Hz pump was selected. A corresponding head (ft) vs. flow (gpm) curve and the O&M manuals are attached to this report.

The water pumps were modeled as "pumps" in EPANET. They are labeled as "P-1" and "P-2" on the attached exhibits. For analyses, either the agricultural demands, or the non-agricultural demands are used, as explained in the next section.

Modeled Scenarios:

Two scenarios are analyzed using the EPANET model, conservatively assuming the full PID for the site under each scenario. The VFD pump will provide more or less head, as needed, during times when there is an increase or decrease in flow from what the constant head pump is able to provide. For Scenario 1, the night-time usage is modeled with both pumps on, where the non-agricultural areas receive watering. For Scenario 2, the day-time usage is modeled with only one pump on, where only the two agricultural areas are taking demand.

Data showing specifics for the pipe and node properties can be found in the attached exhibits (Appendix A) and calculations/results (Appendix D) as well. Only junctions with positive demands and pipes with positive velocities are shown in these calculations to eliminate unnecessary and unimportant data from the Appendices.

The results are sorted by base demand for nodes, and length for pipes to make it easier to analyze/critique the data.

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Results:

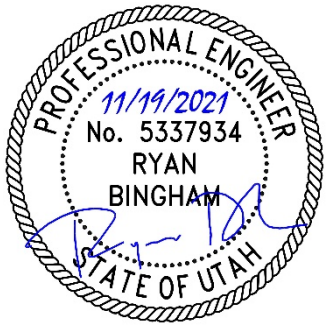
In Scenario 1, when providing non-agricultural areas the PID, pressures between 60 and 66 psi are obtained for all connection points, as required.

In Scenario 2, when providing agricultural areas the PID, the pressures at 67a, 67b, 68a, and 68b are 66, 66, 60, and 60 psi, respectively. This also meets the requirement to provide between 60 and 100 psi at connection points.

Velocities in each pipe were less than 10 fps under both scenarios. Moreover, most of the velocities are under 3 fps, which is reasonable for secondary water systems.

Great Basin Engineering, Inc.

Prepared by Ryan Bingham, P.E.



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Appendix A – Maps

Appendix B – Design Parameters and Details

Appendix C – Pump Curves

Appendix D – Model Calculations/Results

Appendix E – Pump O&M Manuals

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APPENDIX A

Maps

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Not to Scale

Farm 1

Park 1

24' ROW

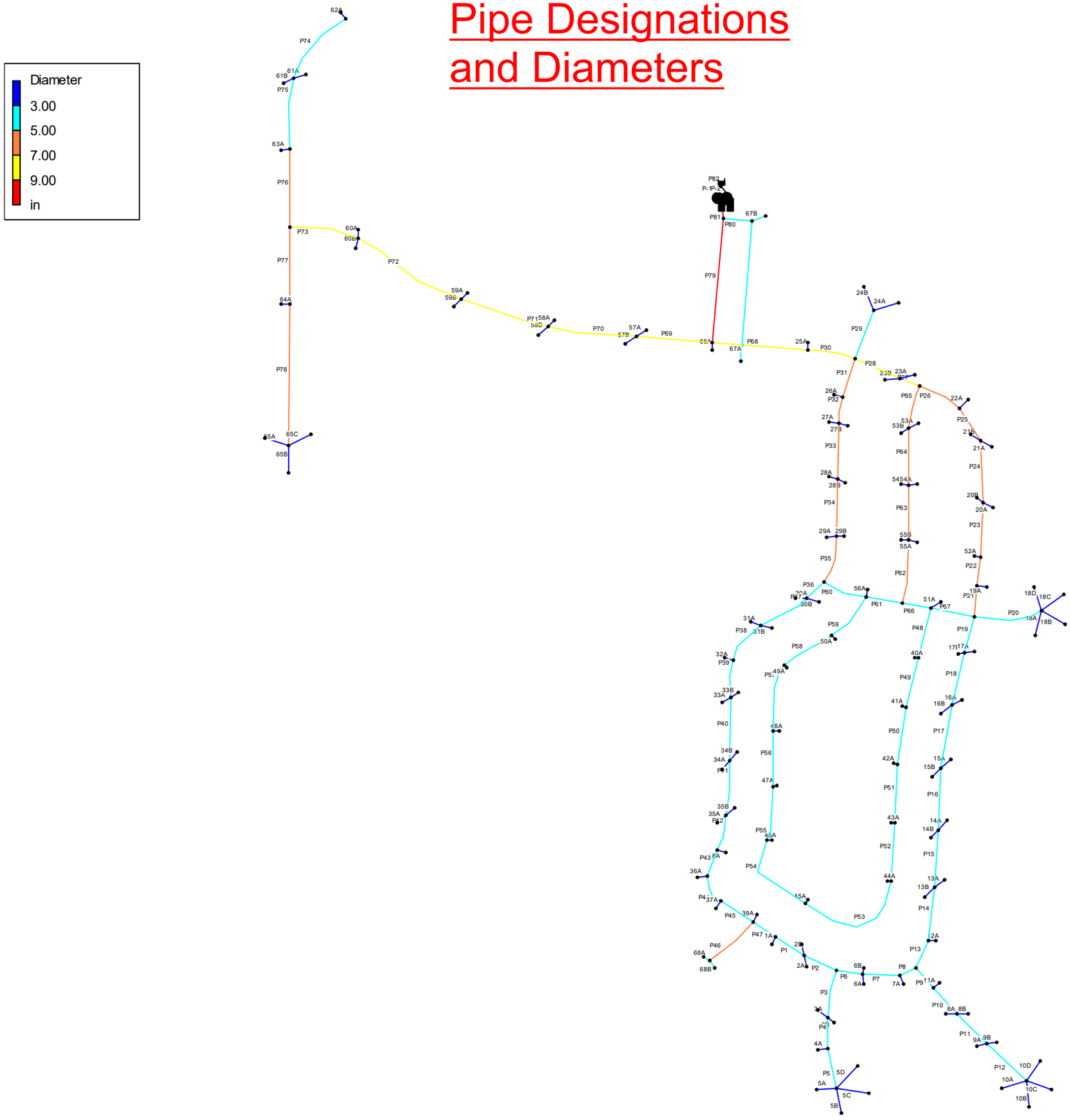
Park 2

Park

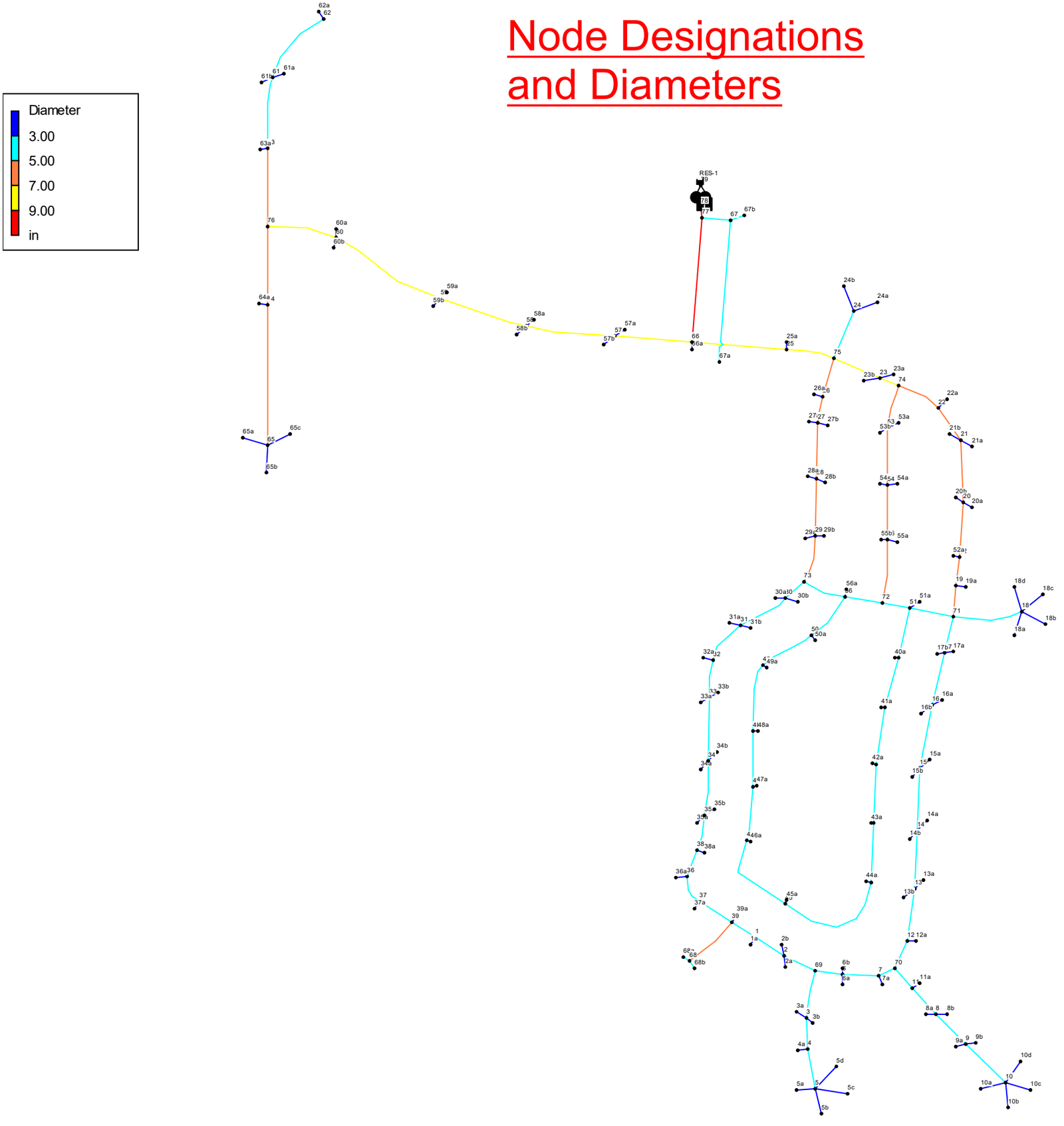
Farm 2

Pumphouse

Pipe Designations and Diameters



Node Designations and Diameters



APPENDIX B

Design Parameters and Details

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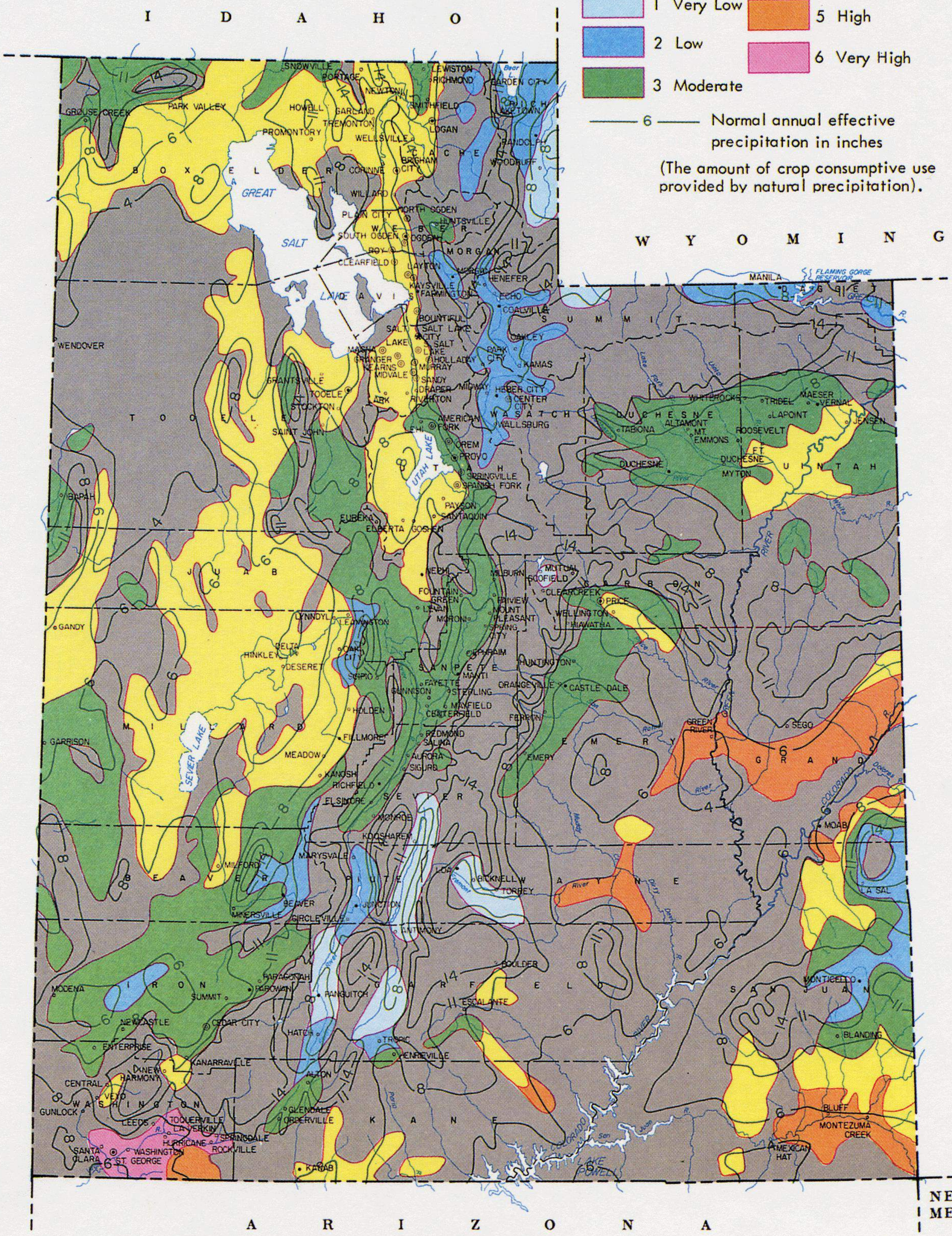

IRRIGATED CROP CONSUMPTIVE USE ZONES AND NORMAL ANNUAL EFFECTIVE PRECIPITATION

UTAH

NOVEMBER 1978

10 0 10 20 30 40 50 60 MILES

SCALE 1:3,000,000

M7-0L-23893

Source:
Base map prepared by SCS, WTSC Carto Staff from USGS 1:1,000,000 National Atlas.
Thematic detail compiled by state staff.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE USDA-SCS-FORT WORTH, TEXAS 1983

Note 4. Or Peak Day Demand = 20 x [Water Area (ft^2)/30] + Deck Area (ft^2)

(3) Irrigation Use.

If a water system provides water for irrigation, Table 510-3 shall be used to determine the peak day demand and average yearly demand for irrigation water use. The following procedure shall be used:

(a) Determine the location of the water system on the map entitled *Irrigated Crop Consumptive Use Zones and Normal Annual Effective Precipitation, Utah* as prepared by the Soil Conservation Service (available from the Division). Find the numbered zone, one through six, in which the water system is located (if located in an area described "non-arable" find nearest numbered zone).

Guidance: The irrigation zone map is provided below. This map is available on the Division of Drinking Water's website.

(b) Determine the net number of acres which may be irrigated.

Guidance: To determine the net number of acres to be irrigated, start with the gross acreage, then subtract any area of roadway, driveway, sidewalk, or patio pavement along with housing foundation footprints that can be reasonably expected for lots within a new subdivision or which is representative of existing lots. Before any other land area which may be considered "non-irrigated" (e.g., steep slopes, wooded acres, etc.) is subtracted from the gross area, the Director should be consulted and agree that the land in question will not be irrigated. For instance, in the case of a heavily wooded mountain home subdivision, it may be claimed that large lawns will not be put in by the lot owners. The division should review and concur with this judgment.

(c) Refer to Table 510-3, which assumes direct application of water to vegetation, to determine peak day demand and average yearly demand for irrigation use.

(d) Consider water losses due to factors such as evaporation, irrigation delivery method, overwatering, pipe leaks, etc. Apply a safety factor to the irrigation demand in the design accordingly.

Table 510-3 Source Demand for Irrigation		
Map Zone	Peak Day Demand (gpm/irrigated acre)	Average Yearly Demand (AF/ irrigated acre) (Note 1)

1	2.26	1.17
2	2.80	1.23
3	3.39	1.66
4	3.96	1.87
5	4.52	2.69
6	4.90	3.26

NOTE FOR TABLE 510-3:

Note 1. The average yearly demand for irrigation water use (in acre-feet per irrigated acre) is based on 213 days of irrigation, e.g., April 1 to October 31.

Guidance: If the irrigation season differs from the assumed 213 days, the average yearly demand numbers may need to adjusted.

(4) Variations in Source Yield.

(a) Water systems shall consider that flow from sources may vary seasonally and yearly. Where flow varies, the number of service connections supported by a source shall be based on the minimum seasonal flow rate compared to the corresponding seasonal demand.

(b) Where source capacity is limited by the capacity of treatment facilities, the maximum number of service connections shall be determined using the treatment plant design capacity instead of the source capacity.

Guidance: Some water sources, such as deep wells, yield consistent quantities of water while others, such as springs, yield inconsistent quantities that vary seasonally and annually. Sources that yield inconsistent quantities of water should be studied and understood prior to the commitment of those sources for future uses, such as providing will-serve letters or approving proposed developments.

60 to 239	$Q= 80+ 20N^{0.5}$
240 or greater	Q= 1.6N

NOTES FOR TABLE 510-6:

Q is total peak instantaneous demand (gpm). N is the maximum number of connections. However, if the only water use is via service buildings, the peak instantaneous demand shall be calculated for the number of plumbing fixture units as presented in the state-adopted plumbing code.

(d) For small non-community water systems, the peak instantaneous demand for indoor water use shall be calculated on a per-building basis for the number of plumbing fixture units as presented in the state-adopted plumbing code.

(3) Peak Instantaneous Demand for Irrigation Use.

Peak instantaneous demand for irrigation use is given in Table 510-7. The procedure for determining the map zone and irrigated acreage for using Table 510-7 is outlined in R309-510-7(3).

Table 510-7 Peak Instantaneous Demand for Irrigation Use	
Map Zone	Peak Instantaneous Demand (gpm/irrigated acre)
1	4.52
2	5.60
3	6.78
4	7.92
5	9.04
6	9.80

(4) Fire Flow.

(a) Distribution systems shall be designed to deliver needed fire flow if fire flow is required by the local fire code official or if fire hydrants intended for fire flow are provided. The distribution system shall be sized to provide minimum pressures as required by R309-105-9 to all points in the distribution system when needed fire flows are imposed during peak day demand in the distribution system.

(b) The water system shall consult with the local fire code official regarding needed fire flow in the area under consideration. The fire flow information shall be provided to the Division during the plan review process.

MARRIOTT-SLATERVILLE CITY CORPORATION
PUBLIC WORKS STANDARDS

SUBMITTED & RECOMMENDED

9/4/2012

JONES & ASSOCIATES — DATE
CONSULTING CITY ENGINEER

APPROVAL

9/4/12

KEITH H. BUTLER — DATE
MAYOR

9.4.12

WILLIAM M. MORRIS — DATE
CITY ADMINISTRATOR

REGISTERED PROFESSIONAL ENGINEER
No. 276381
CHRIS L BRENHOLT
9/4/2012
STATE OF UTAH

DECEMBER 2002
REVISED: SEPTEMBER 2012

PREPARED BY:
JA JONES & ASSOCIATES
CONSULTING ENGINEERS
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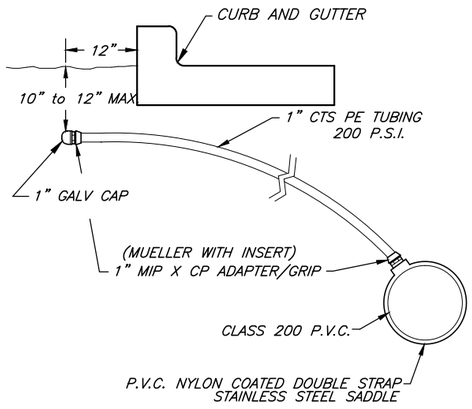
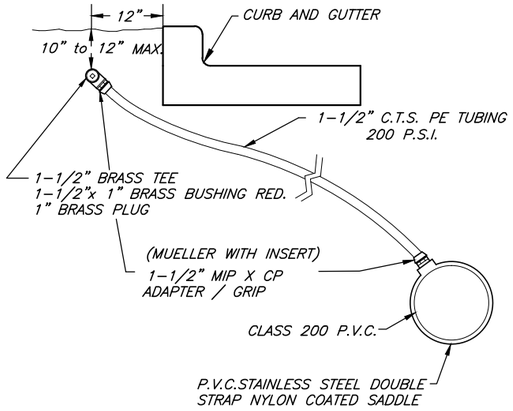
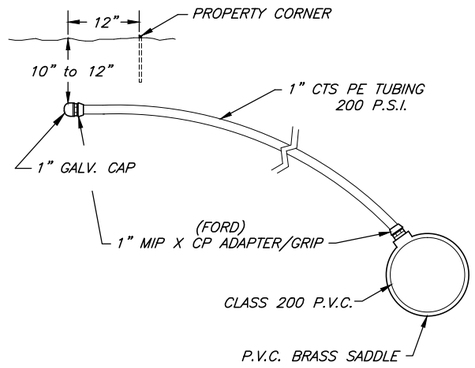
Index of Drawings



TYPICAL SINGLE SERVICE LATERAL



TYPICAL DOUBLE SERVICE LATERAL



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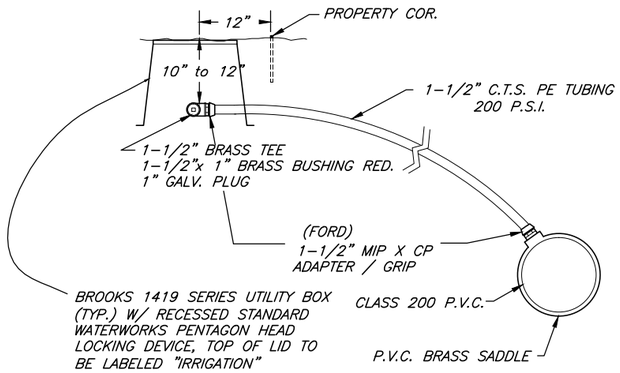
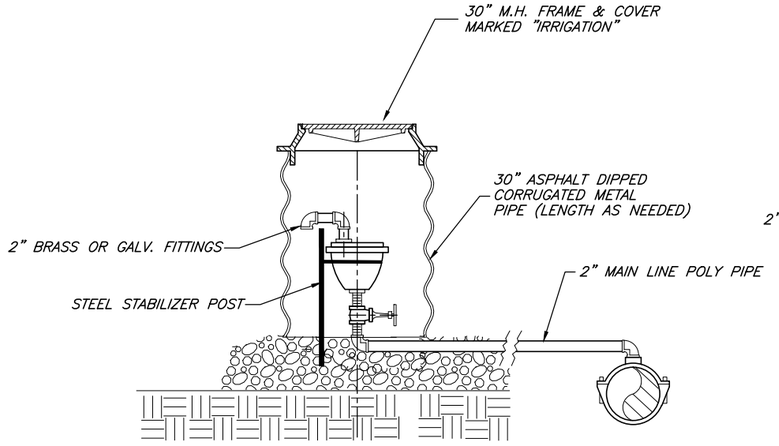
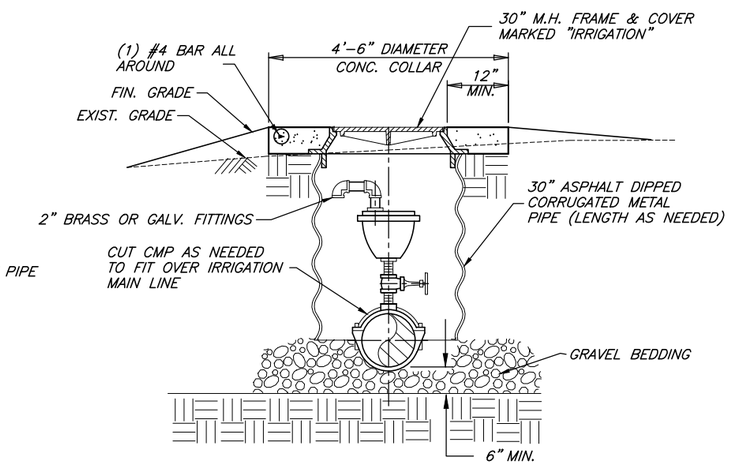


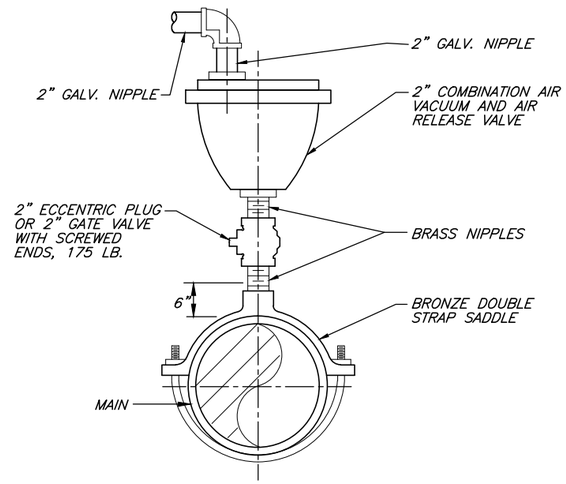
TYPICAL DOUBLE SERVICE LATERAL



AIR VACUUM & AIR RELEASE VALVE PARK STRIP OR SHOULDER INSTALLATION



AIR VACUUM & AIR RELEASE VALVE STREET INSTALLATION



AIR-VACUUM AND AIR-RELEASE VALVE

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CHRIS L. BRENNHOLT
STATE OF UTAH

PROJECT ENGINEER

9/04/12
DATE

REV.	DATE	APPR.	
1	12/04	G.L.S.	INCLUDED IN PUBLIC WORKS STANDARDS

SCALE: N.T.S.

DESIGNED BEB
DRAWN BEB
CHECKED CLB

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MARRIOTT-SLATERVILLE CITY CORPORATION
PUBLIC WORKS STANDARDS

SECONDARY WATER LATERAL & AIR VAC DETAILS

SHEET: 12 OF 20 SHEETS
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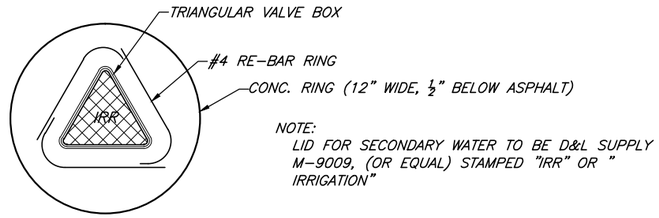
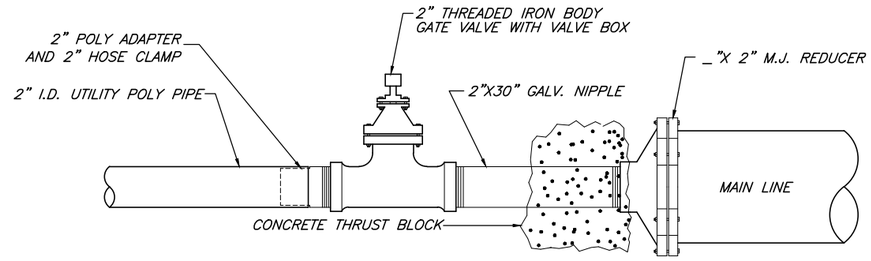
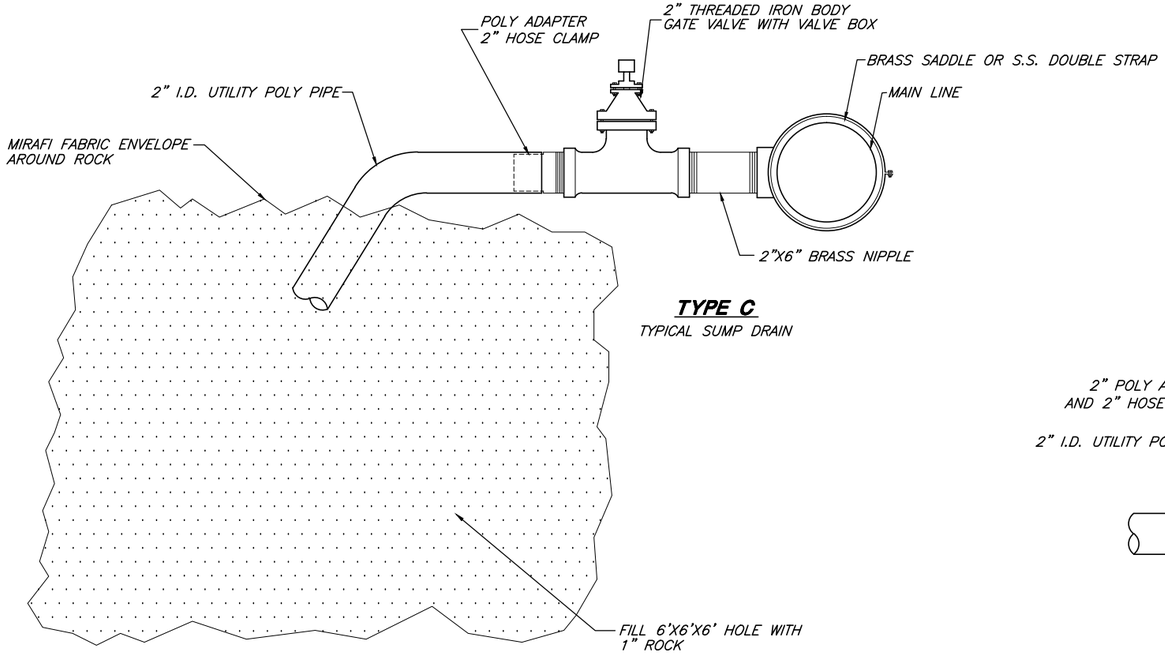




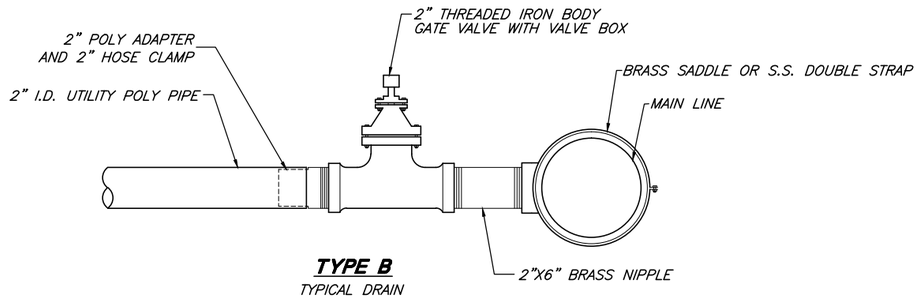
TYPE A

TYPICAL M.J. REDUCER AND BLOW-OFF DRAIN



TYPE C

TYPICAL SUMP DRAIN



TYPE B

TYPICAL DRAIN

DRAIN VALVE DETAILS

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PROJECT ENGINEER

9/04/12
DATE

REV.	DATE	APPR.	
1	12/04	G.L.S.	INCLUDED IN PUBLIC WORKS STANDARDS

SCALE: N.T.S.

DESIGNED BEB
DRAWN BEB
CHECKED CLB

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PUBLIC WORKS STANDARDS

SECONDARY WATER VALVE & DRAIN DETAILS

SHEET: 13 OF 20 SHEETS
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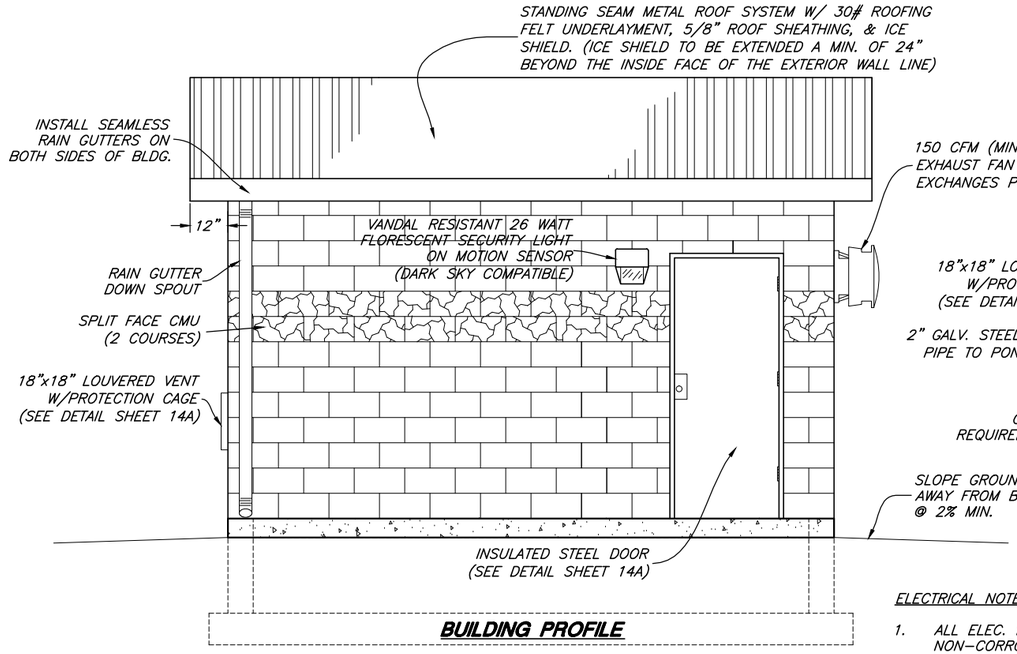
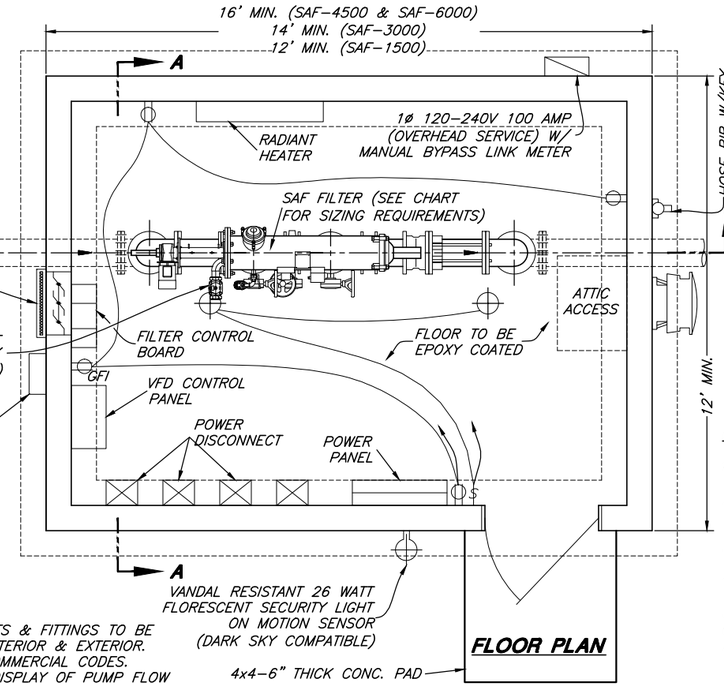


BUILDING PROFILE



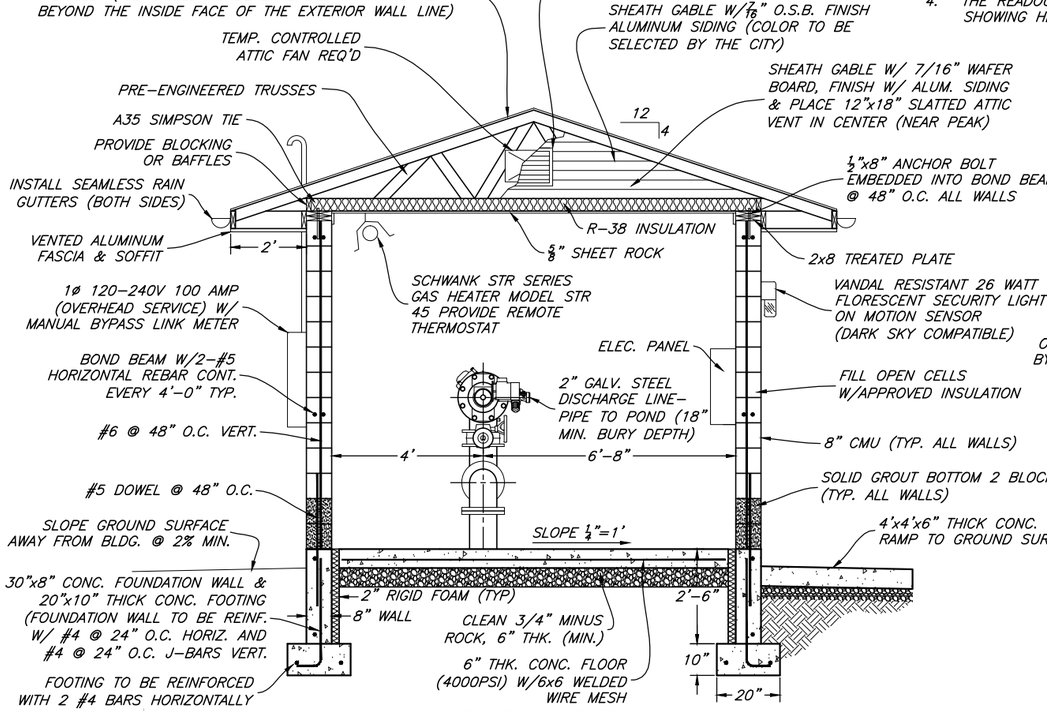
FLOOR PLAN

AMIAD MODEL "SAF" FILTER				
MODEL	MIN. LINE SIZE	MAX. FLOW	DIM "A"	DIM "B" MIN.
2" SAF-1500	3"	100 GPM	13.8"	2.66'
3" SAF-1500	4"	200 GPM	13.8"	2.66'
4" SAF-1500	6"	350 GPM	13.8"	2.66'
4" SAF-3000	6"	400 GPM	24.4"	3.94'
6" SAF-3000	8"	660 GPM	24.4"	3.94'
6" SAF-4500	10"	880 GPM	24.4"	4.92'
8" SAF-4500	10"	1100 GPM	24.4"	4.92'
8" SAF-6000	12"	1400 GPM	24.4"	4.26'
10" SAF-6000	12"	1760 GPM	24.4"	4.26'

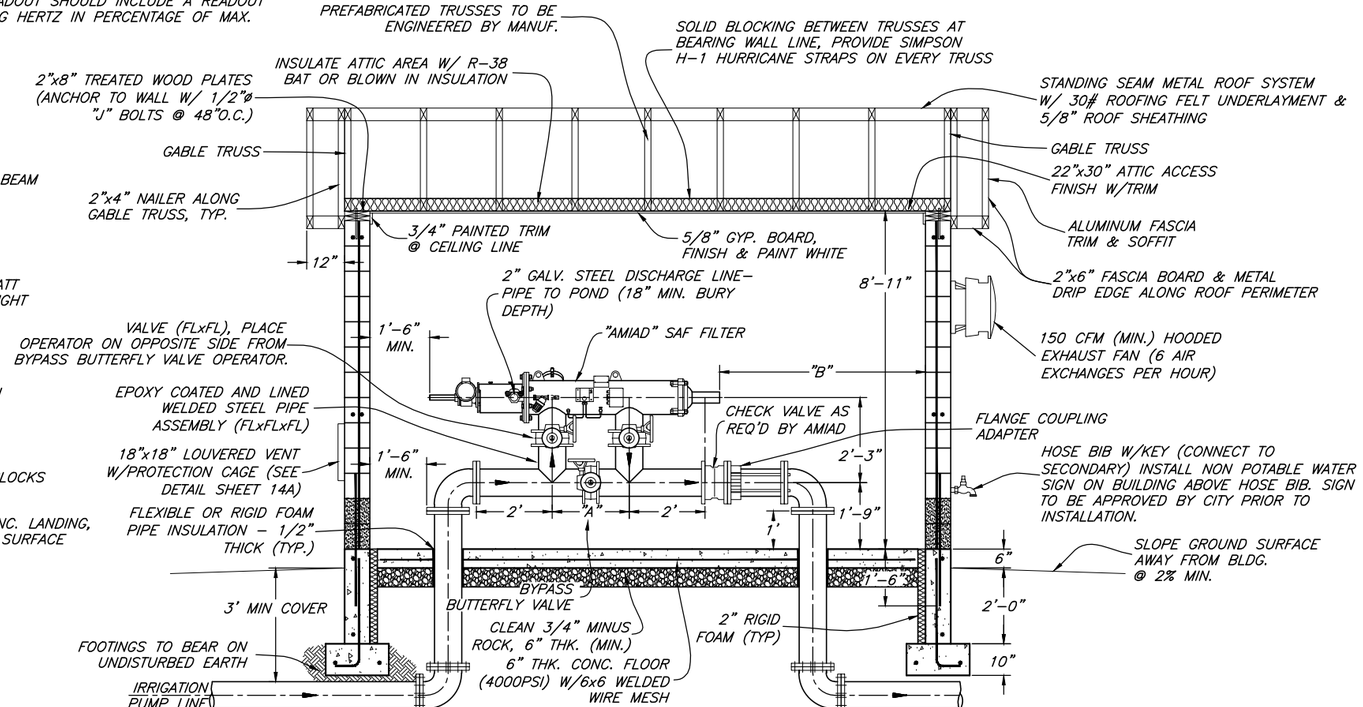
AMIAD FILTER NOTES:
1. SCREEN TO BE 200 MICRON
2. CONTROL TO BE STAINLESS STEEL
3. FILTER LID TO BE EPOXY COATED STEEL
4. CLEANING MECHANISM TO BE STAINLESS STEEL
5. EXHAUST VALVE TO BE EPOXY COATED CAST IRON.

ELECTRICAL NOTES:
1. ALL ELEC. FIXTURES, CONDUITS & FITTINGS TO BE NON-CORROSIVE MATERIAL-INTERIOR & EXTERIOR.
2. ALL ELEC. TO BE TO NEC COMMERCIAL CODES.
3. CONTROLS TO HAVE DIGITAL DISPLAY OF PUMP FLOW RATE.
4. THE READOUT SHOULD INCLUDE A READOUT SHOWING HERTZ IN PERCENTAGE OF MAX.

GENERAL NOTES
1. ALL PIPE SHALL BE DUCTILE IRON CLASS 50 UNLESS OTHERWISE NOTED.
2. ALL STRUCTURAL CONSTRUCTION SHALL COMPLY W/CURRENT UBC & LOCAL BUILDING CODES & SHALL BE CONSISTENT WITH COMMAND CONSTRUCTION PRACTICES OF THE TRADES.
3. EARTH TONE CMU BLOCK COLOR TO BE SELECTED BY THE CITY.
4. METAL ROOF, FASCIA TRIM & SOFFIT, & METAL DRIP EDGE COLOR TO BE SELECTED BY THE CITY.
5. IRRIGATION LINE IS TO HAVE 3' MINIMUM COVER.
6. ALL FLANGES TO BE ANSI CLASS 150/125
7. ALL PIPING, VALVES, FITTINGS, METERS, AND OTHER MISC. PARTS OF THE PIPING SYSTEM SHALL BE PAINTED W/1 COAT OF PRIMER AND 2 COATS OF ACRYLIC ENAMEL PAINT (PURPLE COLOR TO BE APPROVED BY THE CITY.



BUILDING SECTION A-A



BUILDING SECTION B-B

REGISTERED PROFESSIONAL ENGINEER
No. 276381
CHRIS L BREINHOLT
STATE OF UTAH

PROJECT ENGINEER

9/04/12
DATE

REV.	DATE	APPR.	
1	12/04	GLS	INCLUDED IN PUBLIC WORKS STANDARDS
2	8/09	CLB	ADDED EXHAUST FAN AND LOUVERED VENT

SCALE: N.T.S.

DESIGNED BEB
DRAWN BEB
CHECKED CLB

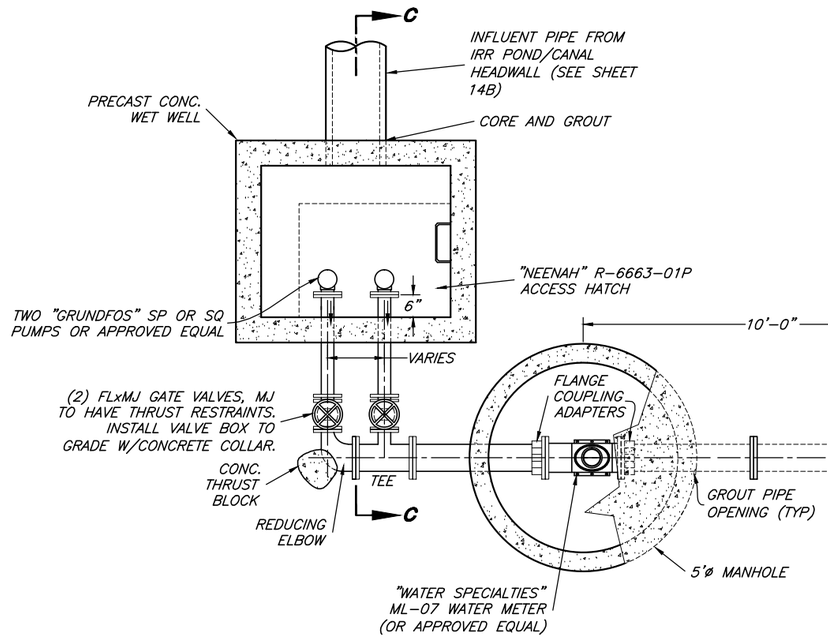
JONES & ASSOCIATES
CONSULTING ENGINEERS
1716 East 5600 South
Ogden, Utah 84403 (801) 476-9767

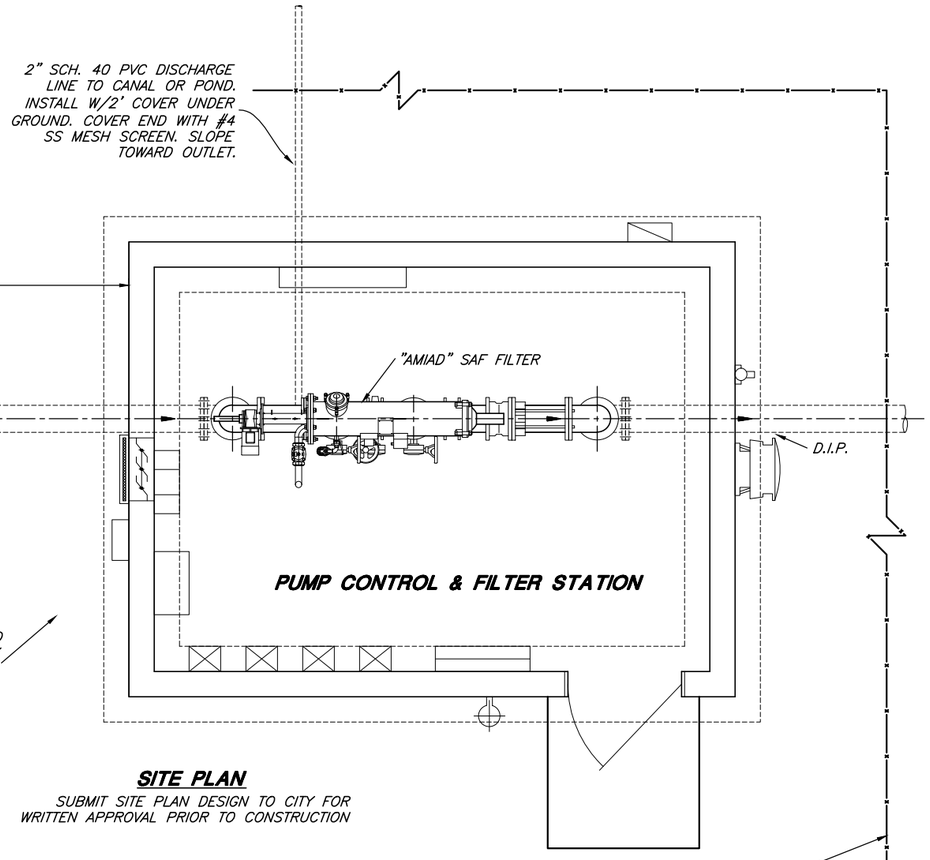
MARRIOTT-SLATERVILLE CITY CORPORATION
PUBLIC WORKS STANDARDS

SECONDARY WATER PUMP CONTROL & FILTER STATION

SHEET: 14 OF 20 SHEETS
0

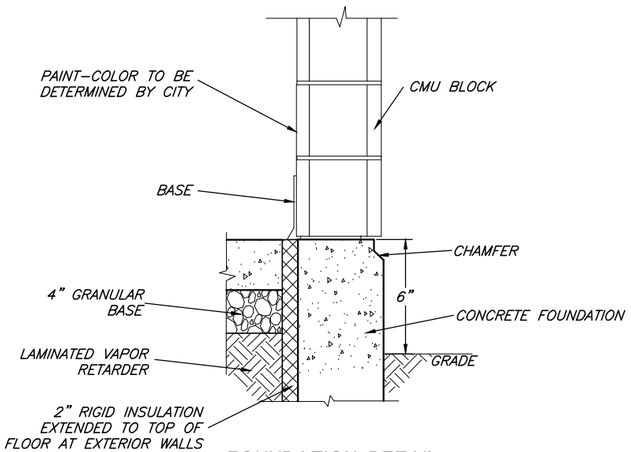
NOTES:
1. ALL MANHOLE OR VAULT PIPE JUNCTIONS ARE TO HAVE RUBBER BOOT OR OTHER APPROVED WATERTIGHT SEAL.
2. COORDINATE INSTALLATION OF POWER TRANSFORMER & POWER LINE W/UP&L SIZE & CONST. TRANSFORMER PAD PER UP&L SPECS. TRANSFORMER TO BE SIZED FOR PUMPS & FILTER REQUIREMENTS.
3. ALL D.I.P. IN CONTACT W/EARTH IS TO BE POLYETHYLENE ENCASED.



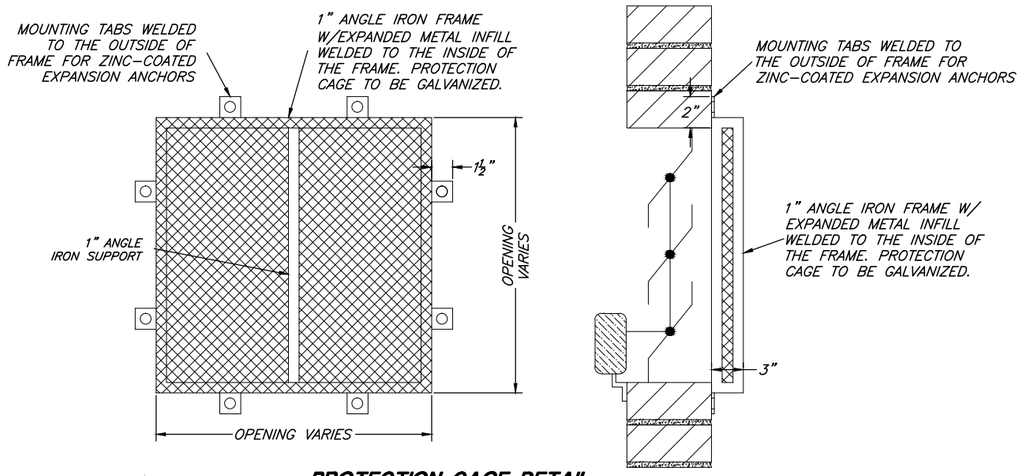


SITE PLAN

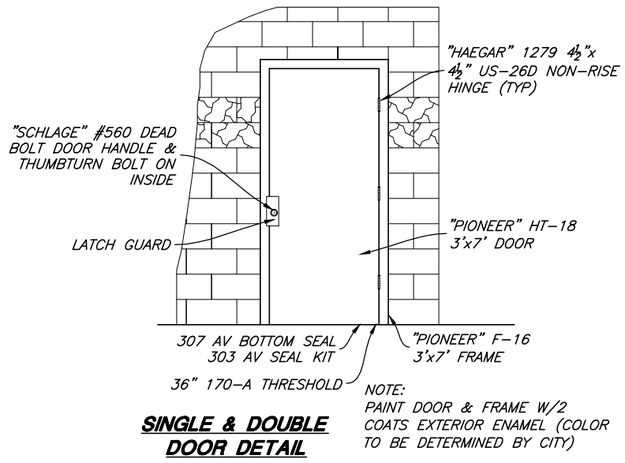
SUBMIT SITE PLAN DESIGN TO CITY FOR WRITTEN APPROVAL PRIOR TO CONSTRUCTION



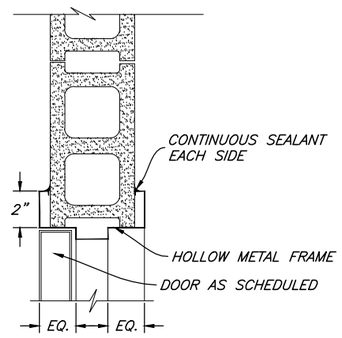
FOUNDATION DETAIL



PROTECTION CAGE DETAIL



SINGLE & DOUBLE DOOR DETAIL



FRAME DETAIL

REGISTERED PROFESSIONAL ENGINEER — No. 276381 — CHRIS L. BRENKHOLT — STATE OF UTAH

PROJECT ENGINEER

9/04/12
DATE

REV.	DATE	APPR.	
1	12/04	GLS	INCLUDED IN PUBLIC WORKS STANDARDS
2	8/09	CLB	ADDED EXHAUST FAN AND LOUVERED VENT

SCALE: N.T.S.

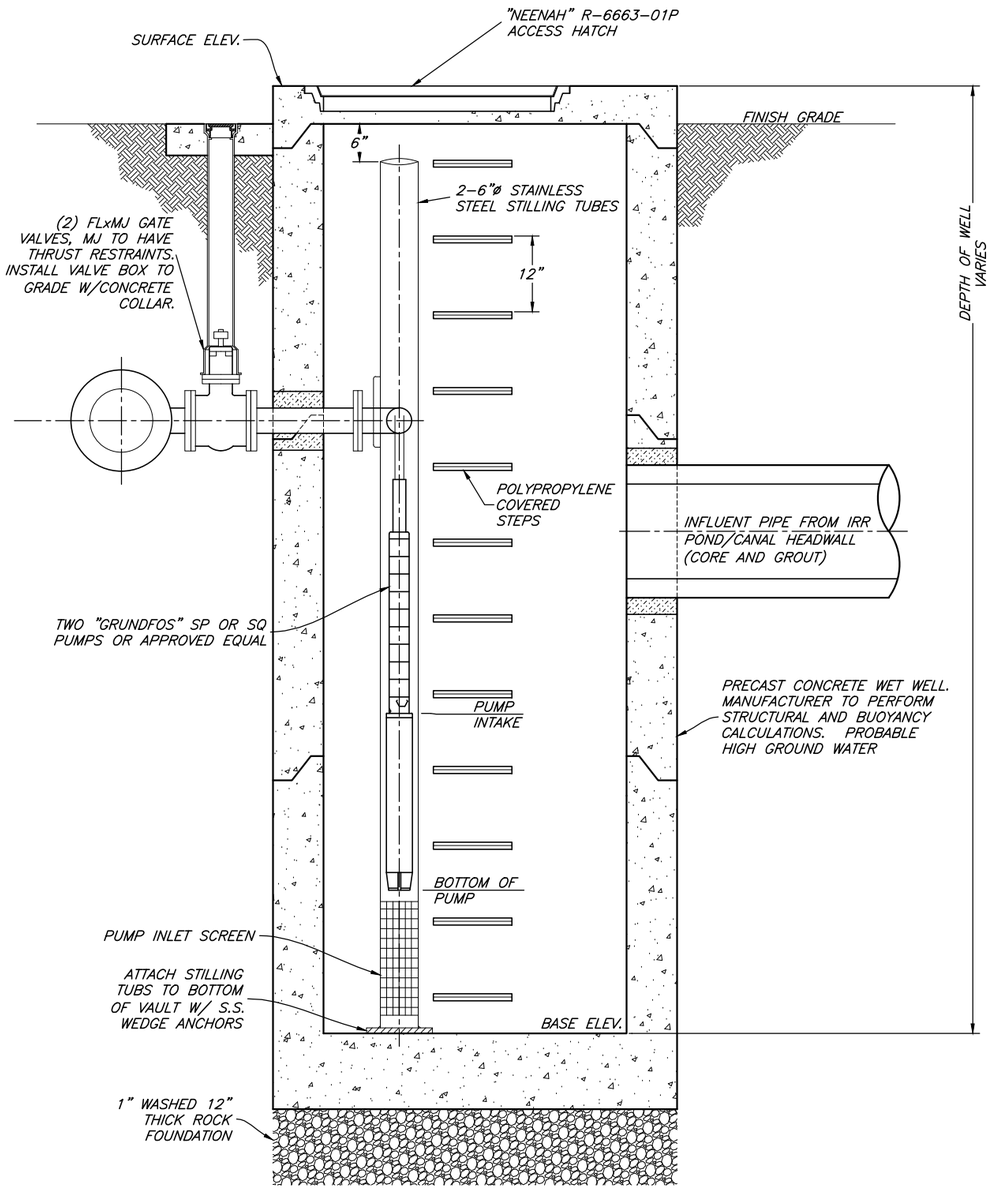
DESIGNED BEB
DRAWN BEB
CHECKED CLB

JA JONES & ASSOCIATES
CONSULTING ENGINEERS
1716 East 5600 South
Ogden, Utah 84403 (801) 476-9767

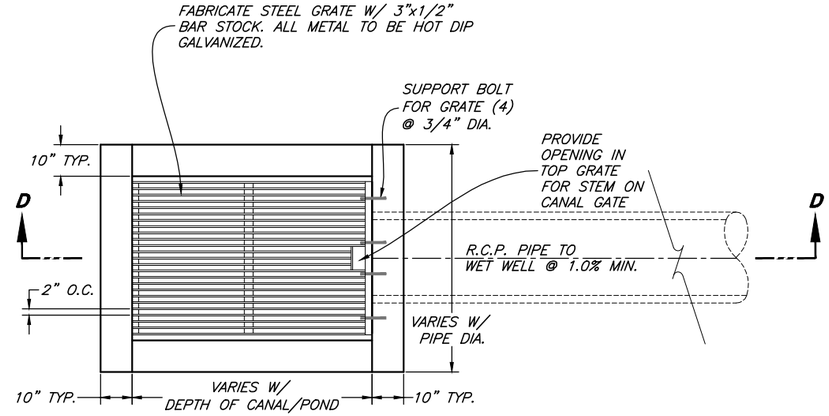
MARRIOTT-SLATERVILLE CITY CORPORATION
PUBLIC WORKS STANDARDS

SECONDARY WATER PUMP CONTROL & FILTER STATION

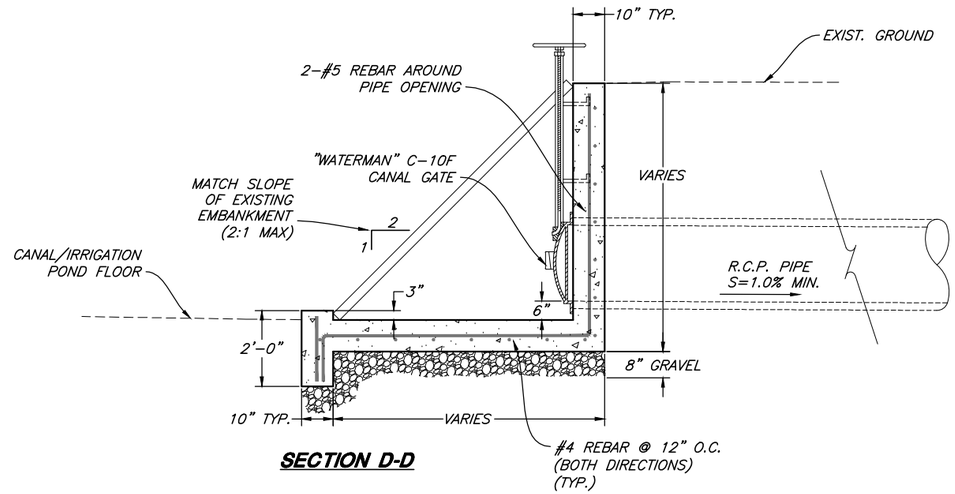
SHEET: 14A
OF 20 SHEETS
0



WET WELL SECTION C-C



PLAN VIEW



SECTION D-D

INLET HEADWALL

IRRIGATION POND OR CANAL

REGISTERED PROFESSIONAL ENGINEER
No. 276381
CHRIS L. BRENNHOLT
STATE OF UTAH

PROJECT ENGINEER

9/04/12
DATE

REV.	DATE	APPR.	
1	12/04	GLS	INCLUDED IN PUBLIC WORKS STANDARDS
2	8/09	CLB	ADDED EXHAUST FAN AND LOUVERED VENT

SCALE: N.T.S.

DESIGNED BEB
DRAWN BEB
CHECKED CLB

JA JONES & ASSOCIATES
CONSULTING ENGINEERS
1716 East 5600 South
Ogden, Utah 84403 (801) 476-9767

MARRIOTT-SLATERVILLE CITY CORPORATION
PUBLIC WORKS STANDARDS

SECONDARY WATER PUMP CONTROL & FILTER STATION

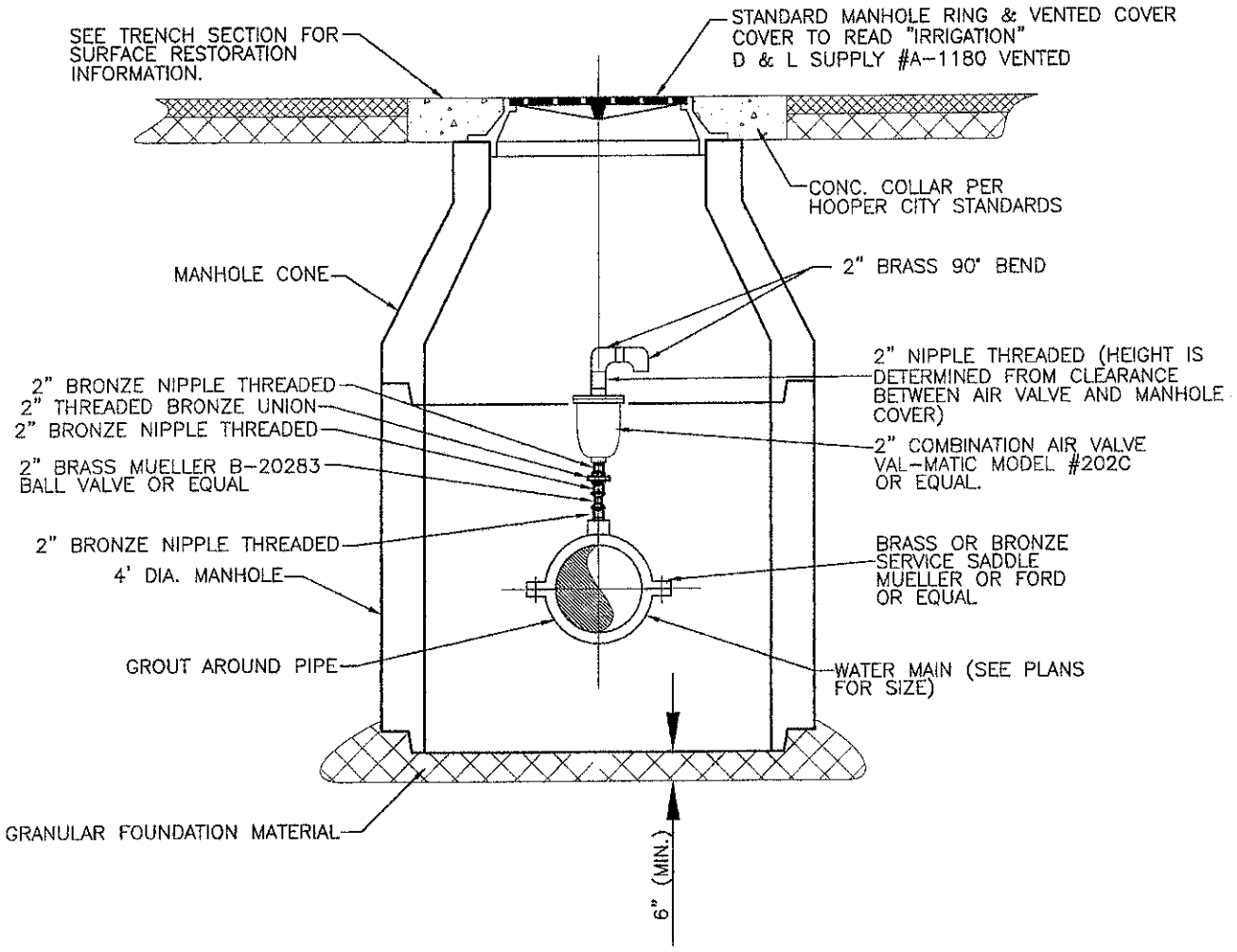
SHEET: 14B
OF 20 SHEETS
0

HOOPER IRRIGATION COMPANY

PRESSURE IRRIGATION STANDARDS AND SPECIFICATIONS

JULY 2003

J-U-B
Engineers • Surveyors • Planners



COMBINATION AIR-VAC DETAIL

N.T.S.

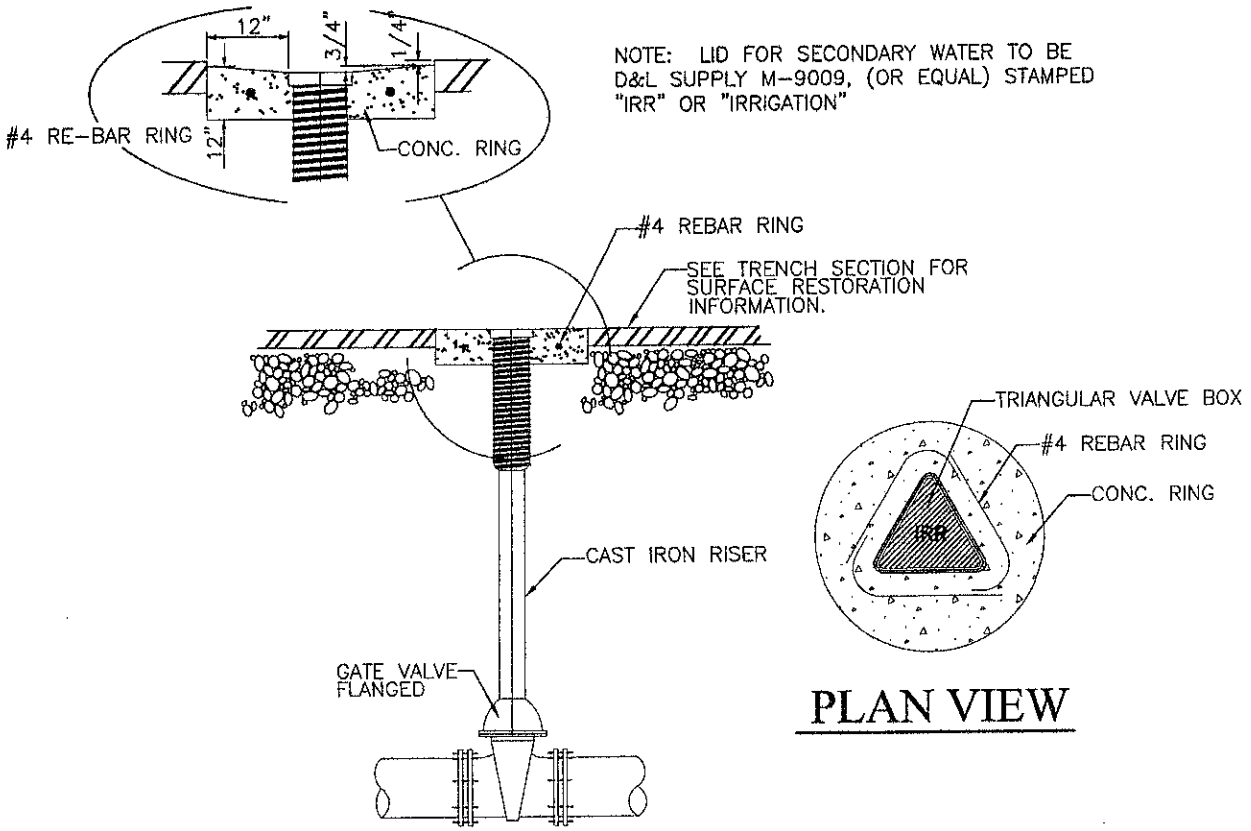
NO.	REVISION DESCRIPTION	BY	APR.	DATE
1				
2				
3				

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

COMBINATION AIR-VAC DETAIL

SHEET	PI-1
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



VALVE BOX CONCRETE COLLAR DETAIL

N.T.S.

REVISION

NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				
4				

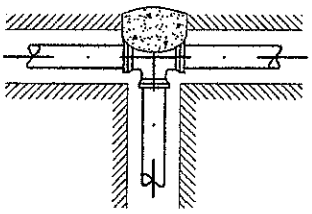
J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

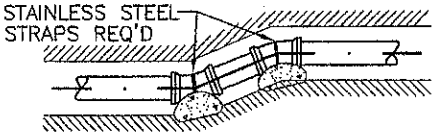
VALVE BOX CONCRETE COLLAR

SHEET PI-2

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–

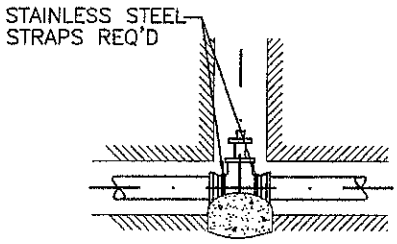


TEE

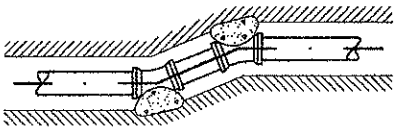


VERTICAL APPLICATION

45°, 22 1/2°, OR
11 1/4° BEND

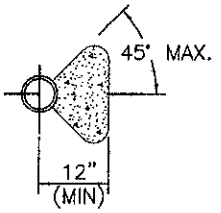


VALVE ANCHORS REQ'D
FOR VALVES 12" OR LARGER

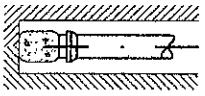


HORIZONTAL APPLICATION

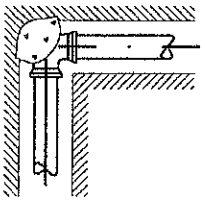
45°, 22 1/2°, OR
11 1/4° BEND



TYPICAL SECTION
THRU THRUST BLOCK



DEAD END



90° BEND

DIMENSION TABLE

THRUST BLOCK BEARING AREA IN SQ. FT. (SEE CONDITIONS BELOW)			
	CONDITION		
PIPE SIZE	90° BEND	OTHER BENDS	VALVES, TEES, DEAD ENDS
4	1.8	1.0	1.3
6	4.0	2.2	2.8
8	7.1	3.8	5.0
10	11.1	6.0	7.9
12	16.0	8.7	11.3
14	21.8	11.8	15.4
16	28.4	15.4	20.1
18	36.0	19.5	25.4
20	44.4	24.0	31.4
24	64.0	34.6	45.2
27	81.0	43.8	57.3
30	100.0	54.1	70.7
42	195.9	106.0	138.5
48	255.9	138.5	181.0

CONDITIONS:

LINE PRESSURE – 120 PSI
SOIL BEARING CAPACITY – 1500 PSF

NOTE: ALL FITTINGS SHALL BE WRAPPED WITH 12 MIL POLYETHYLENE PRIOR TO POURING THE CONCRETE THRUST BLOCK.

THRUST BLOCKING

N.T.S.

REVISION

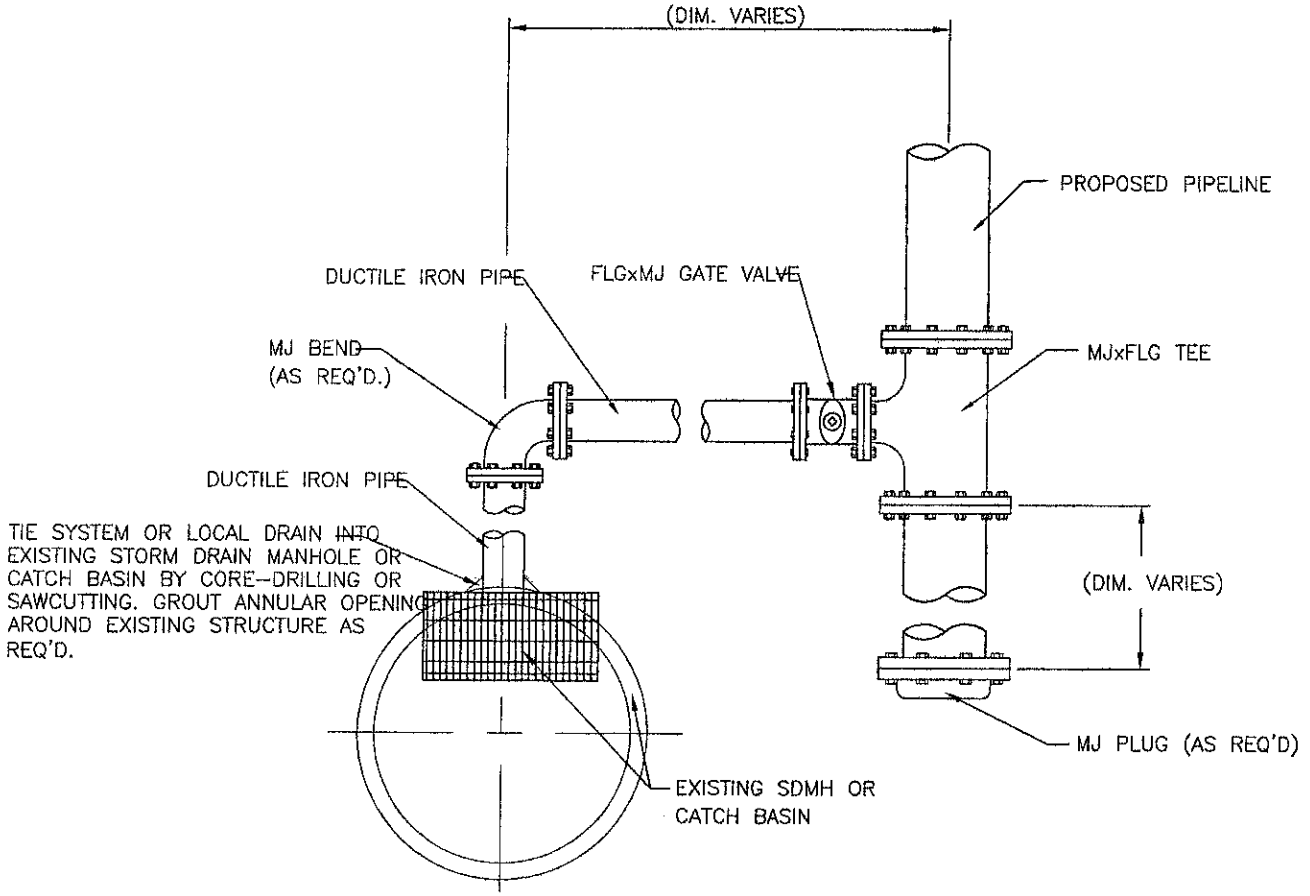
NO.	DESCRIPTION	BY	APR.	DATE

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

THRUST BLOCKING DETAILS

SHEET	PI-3
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NOTE:
DRAIN SIZE TO BE APPROVED
BY COMPANY ENGINEER.

LOCAL / SYSTEM DRAIN DETAIL

N.T.S.

REVISION

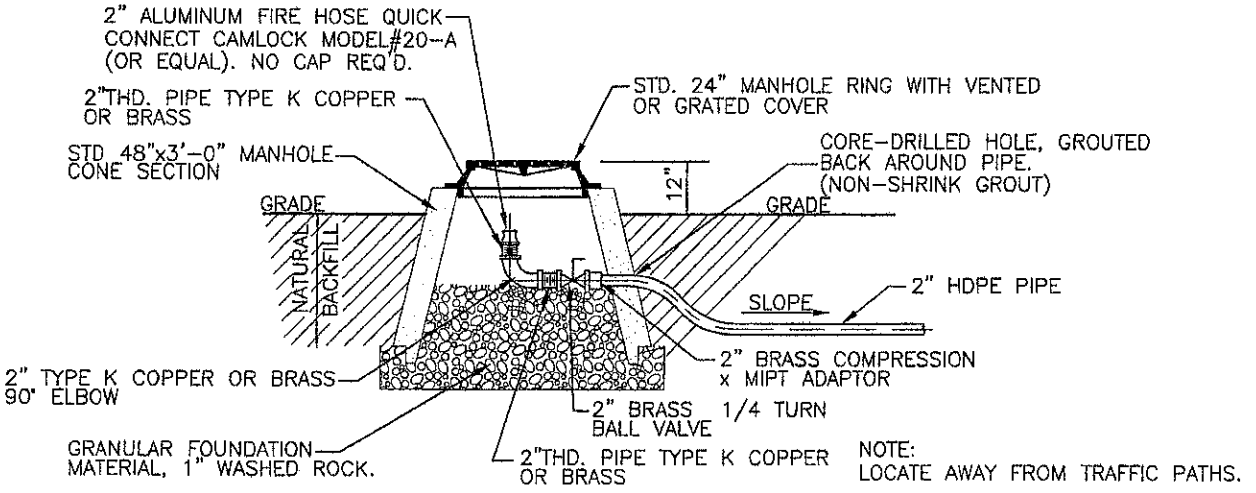
NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				

J-U-B Engineers • Surveyors • Planners

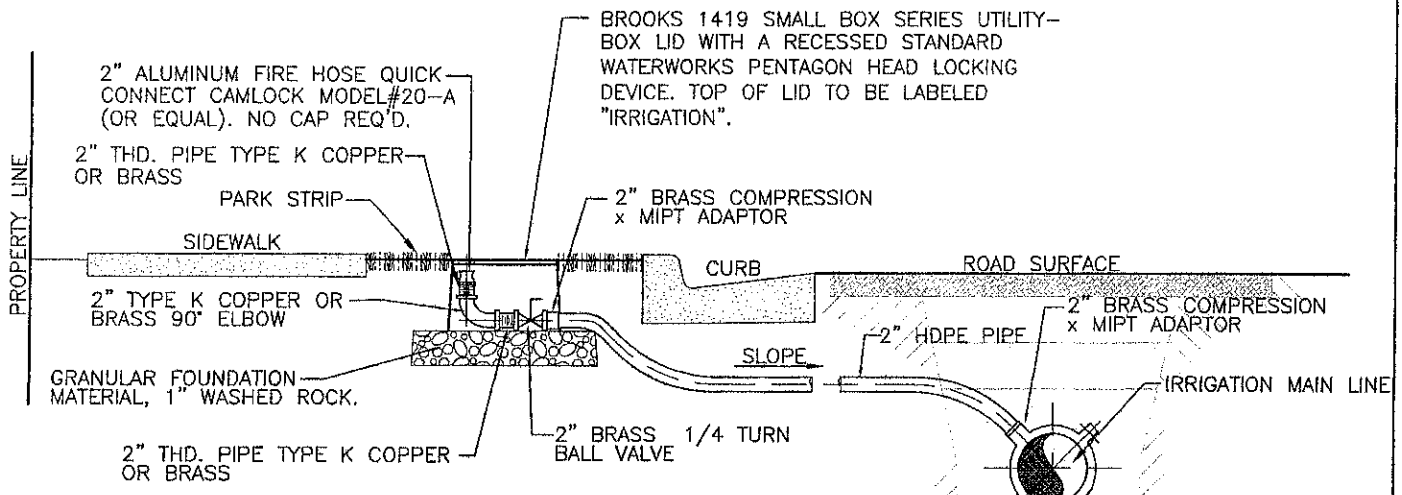
Hooper Irrigation Company
Pressure Irrigation Standards

LOCAL/SYSTEM DRAIN DETAIL

SHEET	PI-4
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NO CURB & GUTTER



SIDEWALK, CURB & GUTTER

CONNECTION TO C900 PVC MAIN (4" THRU 10")
- 2" SERVICE SADDLE, MUELLER BOLTED 2 PC. BRONZE SERIES #H-13490 OR FORD BOLTED #S-90

2" CONNECTION TO DUCTILE IRON MAIN (12" & LARGER)
- 2" SERVICE SADDLE REQ'D., DOUBLE STRAP BRONZE MUELLER SERIES #BR2B OR BRASS FORD #202B

NOTE:
STAINLESS STEEL PIPE STIFFENERS ARE REQUIRED TO BE USED ON ALL CONNECTIONS ON POLY PIPE.

AIR INLET & REMOVAL FACILITY

N.T.S.

REVISION

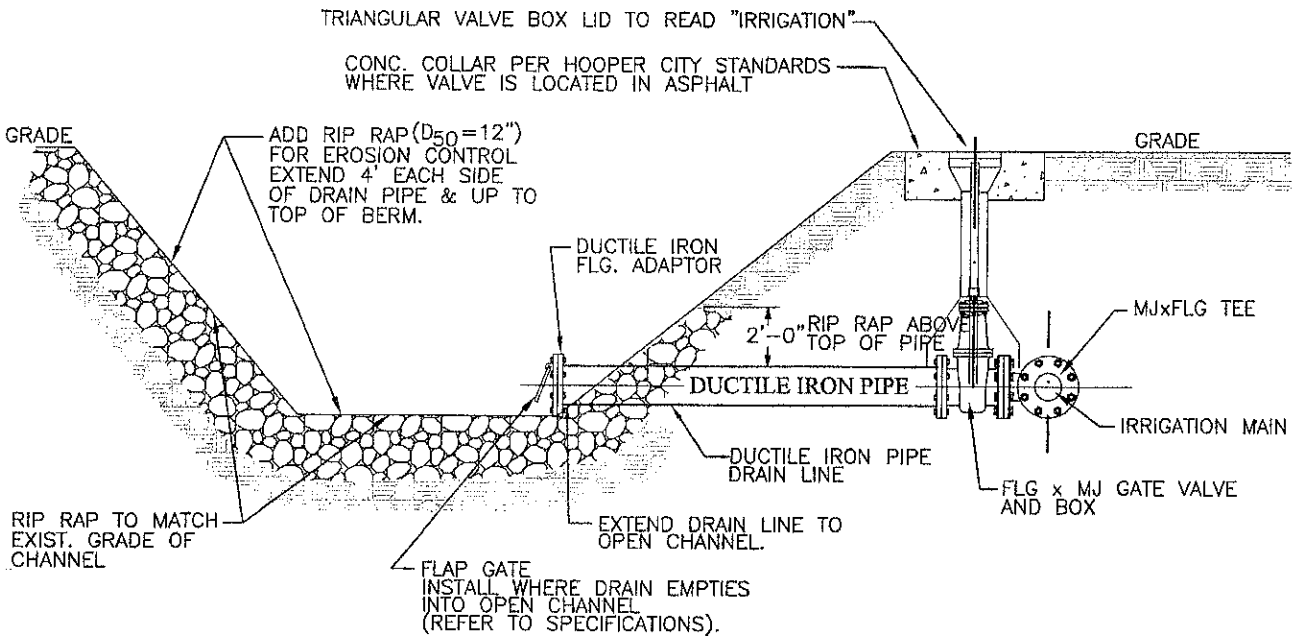
NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

AIR INLET & REMOVAL FACILITY

SHEET	PI-5
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	—



NOTE:
DRAIN SIZE TO BE APPROVED BY COMPANY ENGINEER.

OPEN CHANNEL DRAIN

N.T.S.

REVISION

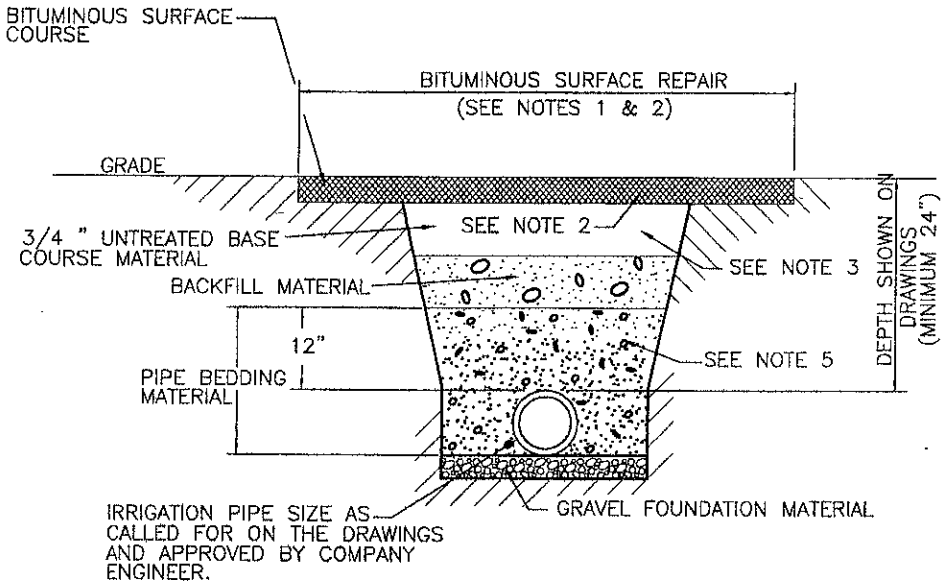
NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				
4				

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

OPEN CHANNEL DRAIN

SHEET	PI-6
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	-



NOTES:

1. SAW CUT BITUMINOUS ASPHALT SURFACE 0.5' WIDER THAN TRENCH ON EACH SIDE FOR FINAL TRENCH REPAIR WHERE BITUMINOUS SURFACE EXISTS.
2. BITUMINOUS SURFACE IS TO BE 6" OR TO MATCH EXISTING THICKNESS, WHICHEVER IS GREATER FOR STATE ROADS & 4" FOR ALL OTHER ROADS.
3. 3/4 " UNTREATED BASE COURSE MATERIAL IS TO BE 12" OR TO MATCH EXISTING THICKNESS, WHICHEVER IS GREATER.
4. SLOPE TRENCH SIDES TO MEET OSHA SAFETY REQUIREMENTS, (LATEST REV.)
5. SEE SPECIFICATIONS FOR GRADATION & COMPACTION REQUIREMENTS.
6. REFER TO U.D.O.T. STANDARDS FOR TRENCH SECTION DETAIL.

BITUMINOUS SURFACE TRENCH SECTION

N.T.S.

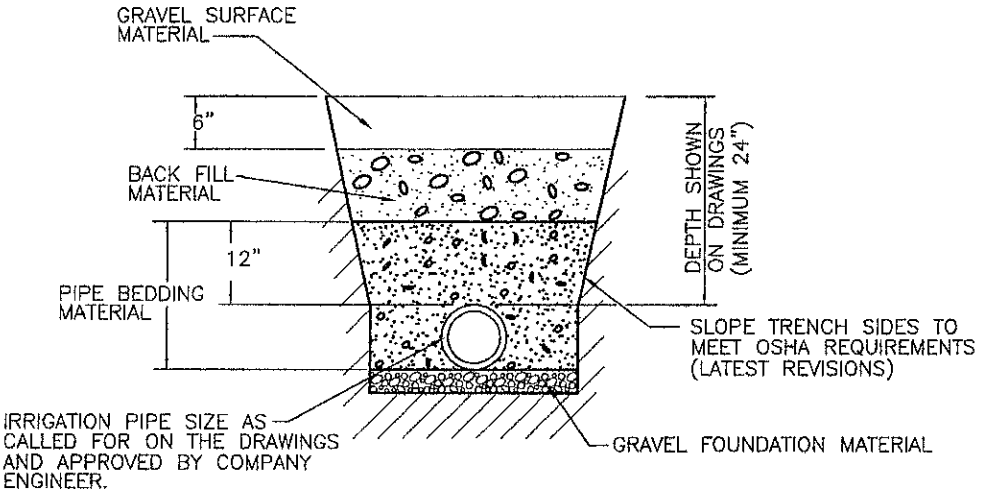
NO.	DESCRIPTION	BY	APR.	DATE
	REVISION			

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

BITUMINOUS SURFACE
TRENCH SECTION

SHEET	PI-7
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NOTES:

SEE SPECIFICATIONS FOR GRADATION & COMPACTION REQUIREMENTS.

GRAVEL SURFACE TRENCH SECTION

N.T.S.

REVISION

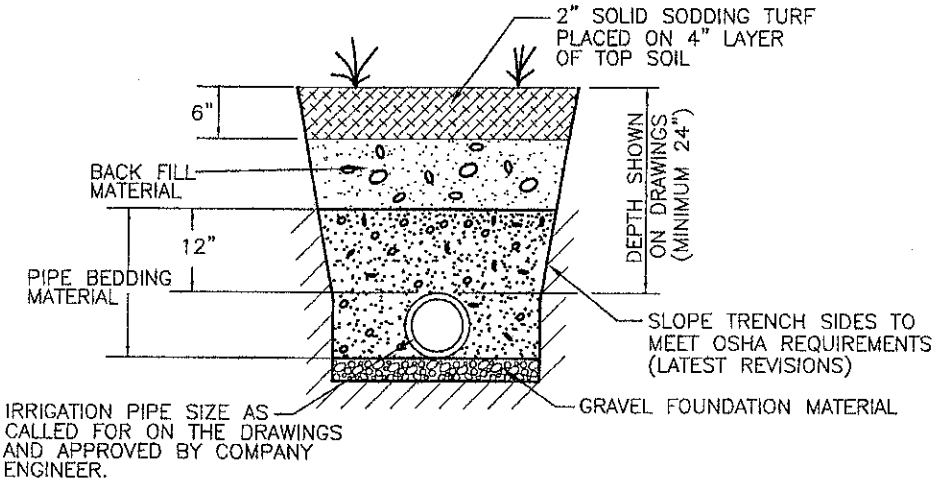
NO.	DESCRIPTION	BY	APR.	DATE

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

GRAVEL SURFACE
TRENCH SECTION

SHEET	PI-8
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NOTES:

SEE SPECIFICATIONS FOR GRADATION & COMPACTION REQUIREMENTS.

TURF SURFACE
TRENCH SECTION

N.T.S.

REVISION

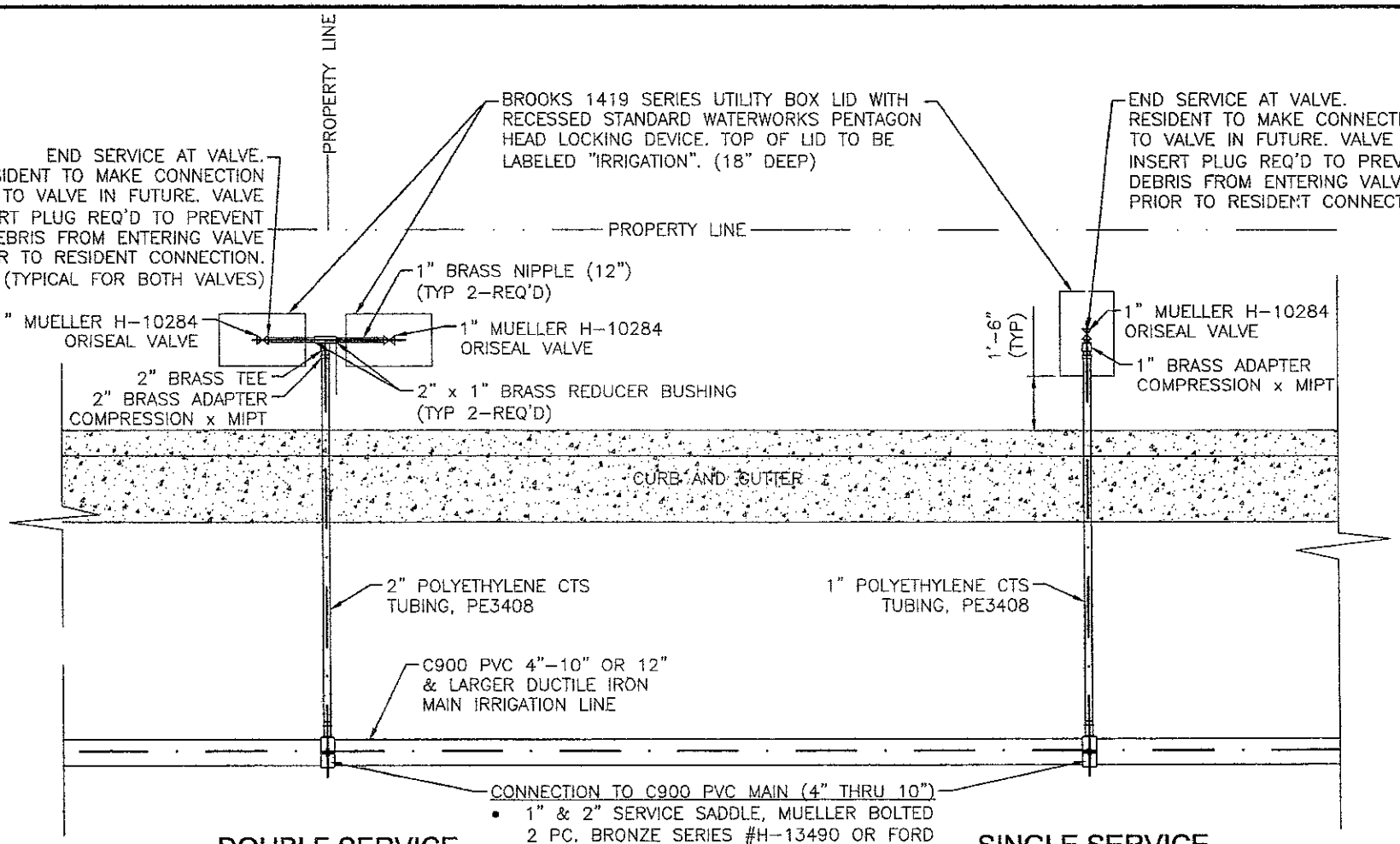
NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				
4				

J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

TURF SURFACE
TRENCH SECTION

SHEET	PI-9
CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NOTE:
STAINLESS STEEL PIPE STIFFENERS ARE REQUIRED TO BE USED ON ALL CONNECTIONS ON POLY PIPE.

TYPICAL SERVICE CONNECTIONS

N.T.S.

REUSE OF DRAWINGS
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NO.	DESCRIPTION	BY	APR.	DATE
A	REV. DRAWING TO ADD CURB & GUTTER & CALLOUTS	DBS	TLA	12-15-04
B	REV. DRAWING TO ADD TWO BOXES ON DOUBLE SERVICE	JDW	GLS	5-15-14

REVISION

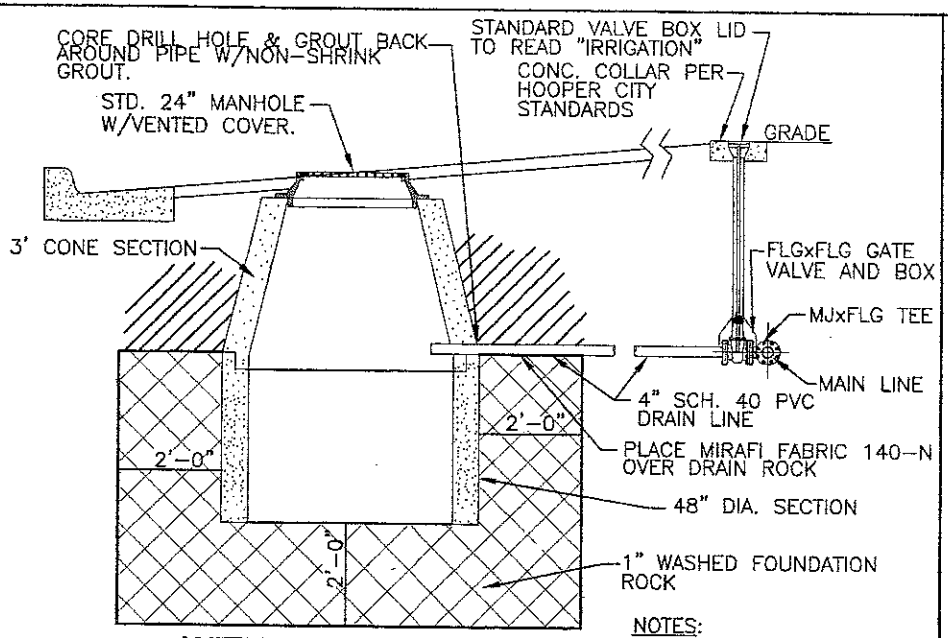
J-U-B Engineers • Surveyors • Planners

Hooper Irrigation Company
Pressure Irrigation Standards

TYPICAL SERVICE CONNECTION DETAIL

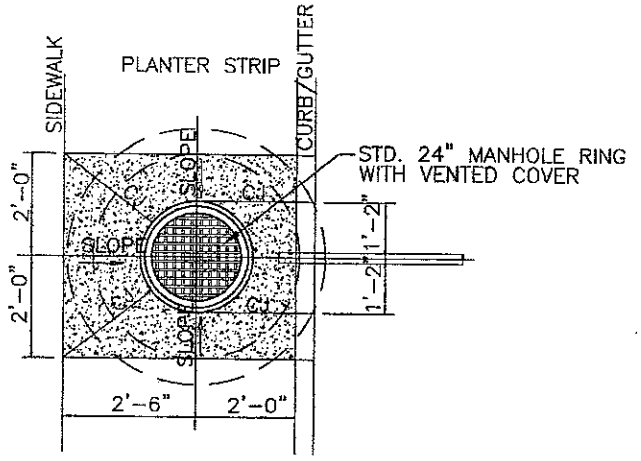
SHEET PI-10

CAD DWG: detail01.dwg
PLOT SCALE: N/A
DATE: DECEMBER 2004
DRAWN BY: D.STEELE
DESIGN BY: D.STEELE
CHECKED BY: TLA
SCALE: -

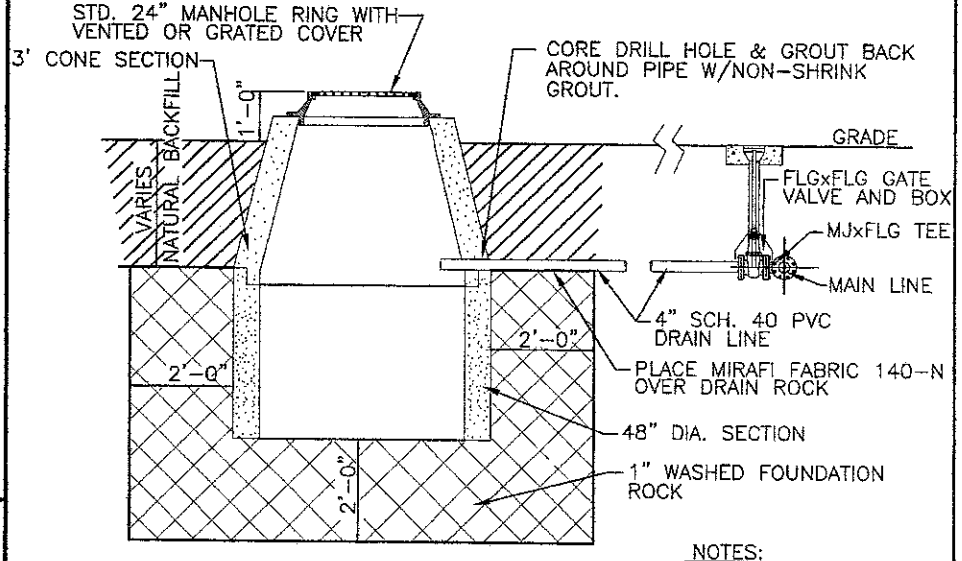


NOTES:
- REFER TO DRAWINGS FOR PIPE SIZES.

WITH CURB/GUTTER (IN STREET) N.T.S.

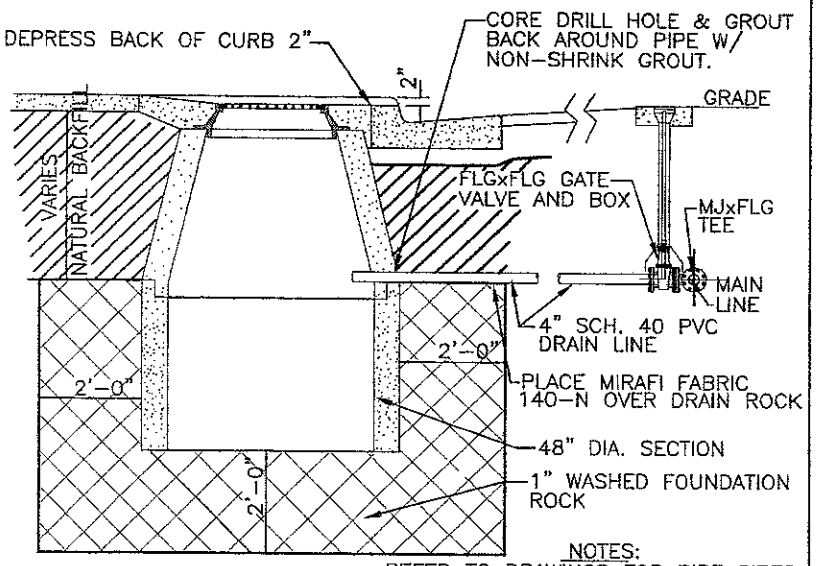


PLAN VIEW N.T.S.



NOTES:
- REFER TO DRAWINGS FOR PIPE SIZES.

WITHOUT CURB/GUTTER N.T.S.



NOTES:
- REFER TO DRAWINGS FOR PIPE SIZES.

WITH CURB/GUTTER (BEHIND CURB) N.T.S.

NO. | DESCRIPTION | BY | APR. | DATE

REVISION

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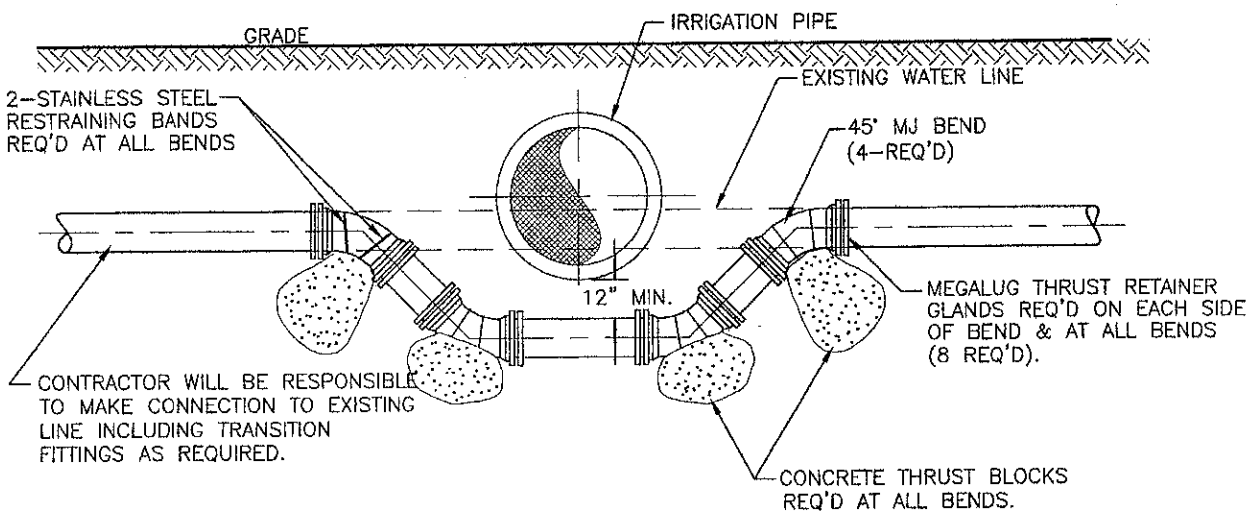
Hooper Irrigation Company
Pressure Irrigation Standards
TYPICAL LOCAL DRAIN W/SUMP DETAILS

SHEET PI-11

CAD DWG: detail01.dwg
PLOT SCALE: N/A
DATE: MAY 2003
DRAWN BY: D.STEELE
DESIGN BY: DETAILS
CHECKED BY: TLA
SCALE: -



NOTES:

BEFORE RELOCATING AN EXISTING WATERLINE THE CONTRACTOR SHALL NOTIFY ALL AFFECTED BUSINESSES AND RESIDENTS 24 HOURS BEFORE CONSTRUCTION. THE CONTRACTOR MUST DEMONSTRATE TO THE CITY THAT ALL OF THE MATERIALS ARE ON HAND THAT MAY BE NEEDED BEFORE RELOCATING ANY WATERLINES. RELOCATION OF WATERLINES WILL NOT BE STARTED AFTER 10:00 A.M. THE CITY SHALL OPERATE ALL MAINLINE WATER VALVES AND THE CONTRACTOR MUST CONTACT THE CITY IF SERVICE IS REQUIRED.

WATER LINE RELOCATION DETAIL

N.T.S.

REVISION

NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				
4				

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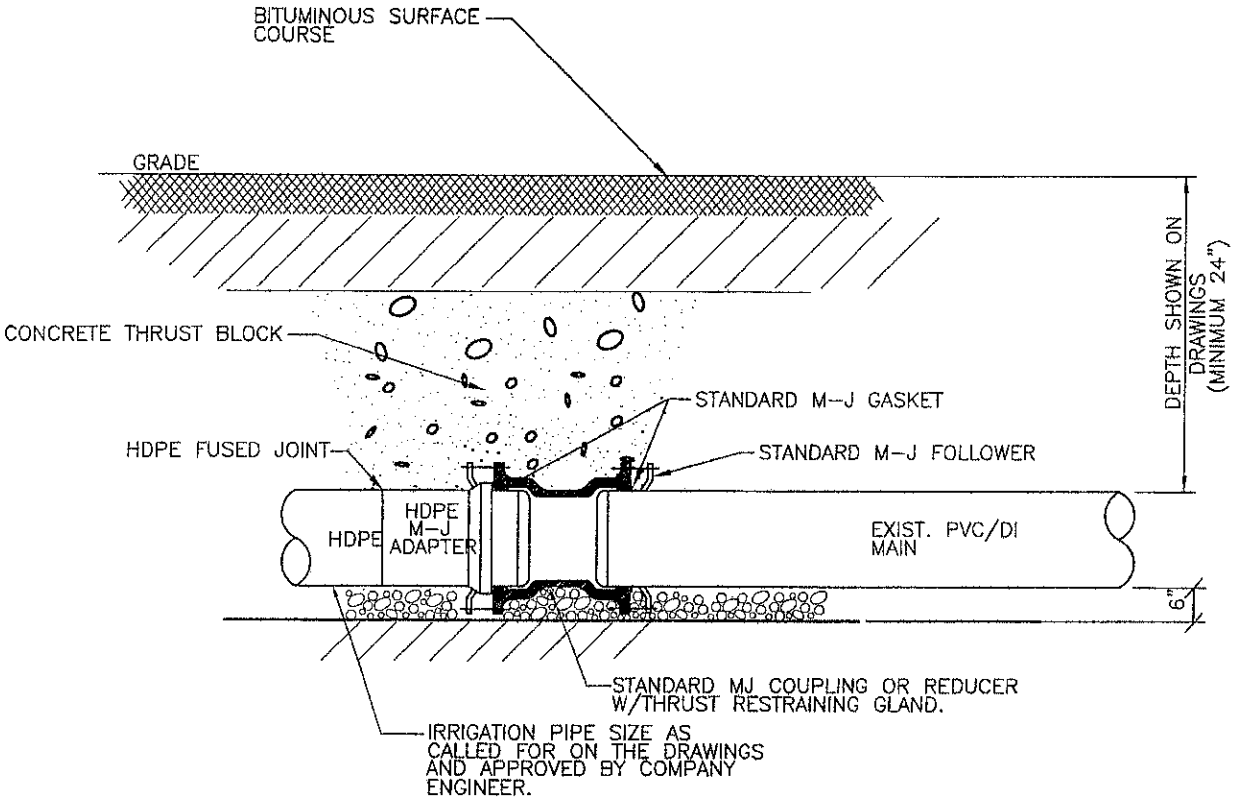
Hooper Irrigation Company
Pressure Irrigation Standards

WATERLINE
RELOCATION DETAIL

SHEET PI-12

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



NOTE:

1. REFER TO SHEET # PI-7, 8 & 9 TRENCH DETAILS FOR BEDDING MATERIAL ETC...

2. ALL FITTINGS SHALL BE WRAPPED WITH 12 MIL POLYETHYLENE PRIOR TO POURING THE CONCRETE THRUST BLOCK.

HDPE CONNECTION DETAIL

N.T.S.

REVISION

NO.	DESCRIPTION	BY	APP.	DATE

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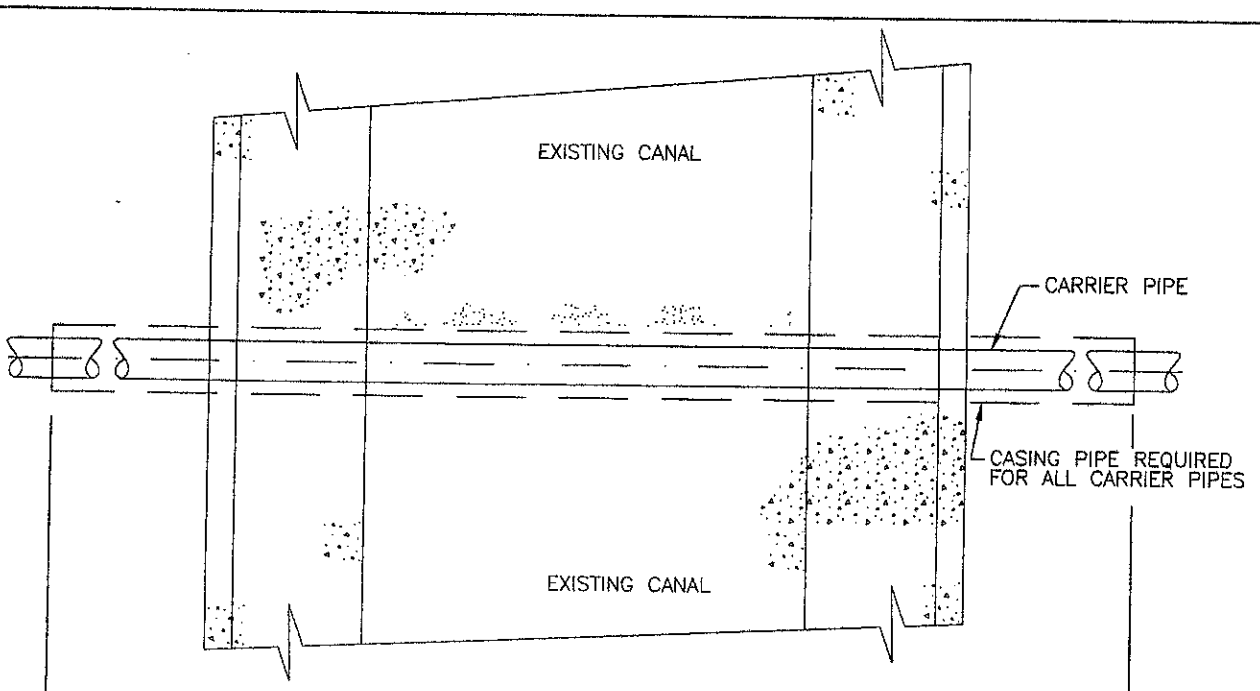
Hooper Irrigation Company
Pressure Irrigation Standards

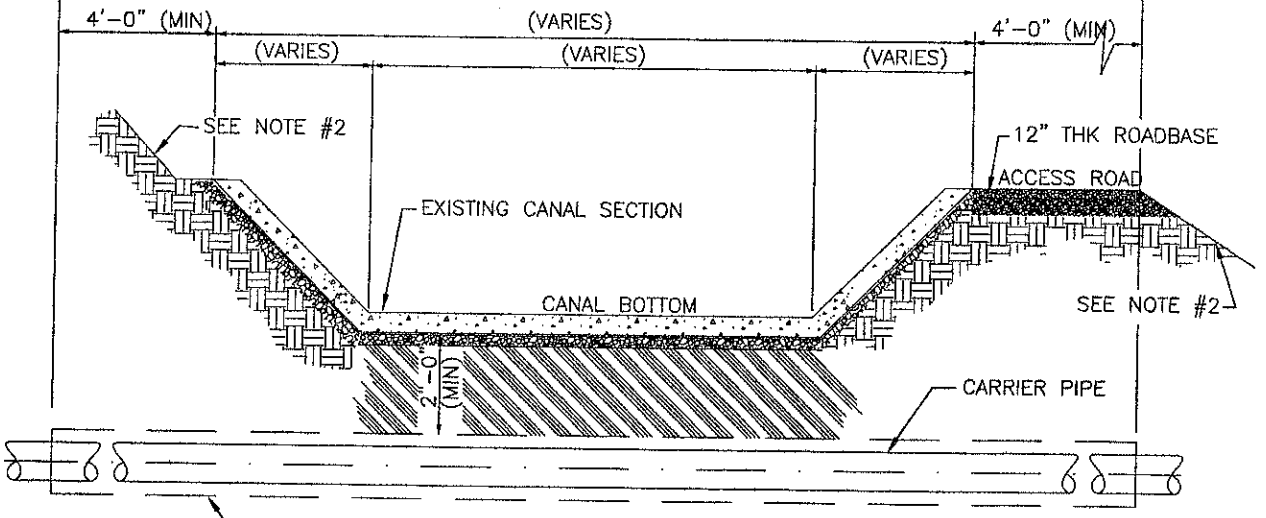
HDPE
CONNECTION DETAIL

SHEET PI-13

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	MAY 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



PLAN VIEW



CASING PIPE: SIZE IS TO BE DETERMINED BASED ON CARRIER PIPE.
MAT'L. TYPE:
STEEL WELDED
PIPE CASING (SEE DETAIL PI-17)

OPEN CONCRETE-LINED CHANNEL
ELEVATION VIEW

NOTES:

1) BEFORE CROSSING THE CANAL WITH A UTILITY THE CONTRACTOR SHALL OBTAIN WRITTEN AUTHORIZATION FROM HOOPER IRRIGATION COMPANY. THE CONTRACTOR MUST DEMONSTRATE TO HOOPER IRRIGATION COMPANY THAT ALL OF THE MATERIALS ARE ON HAND THAT MAY BE NEEDED BEFORE STARTING CONSTRUCTION ON IRRIGATION COMPANY PROPERTY OR EASEMENTS.

2) CONTRACTOR SHALL BE RESPONSIBLE FOR TOTAL RESTORATION OF THE CONSTRUCTION AREA, INCLUDING REVEGETATION & RESTORATION OF ACCESS ROADWAY

TYPICAL CANAL CROSSING

N.T.S.

REVISION

NO.	DESCRIPTION	BY	APR.	DATE

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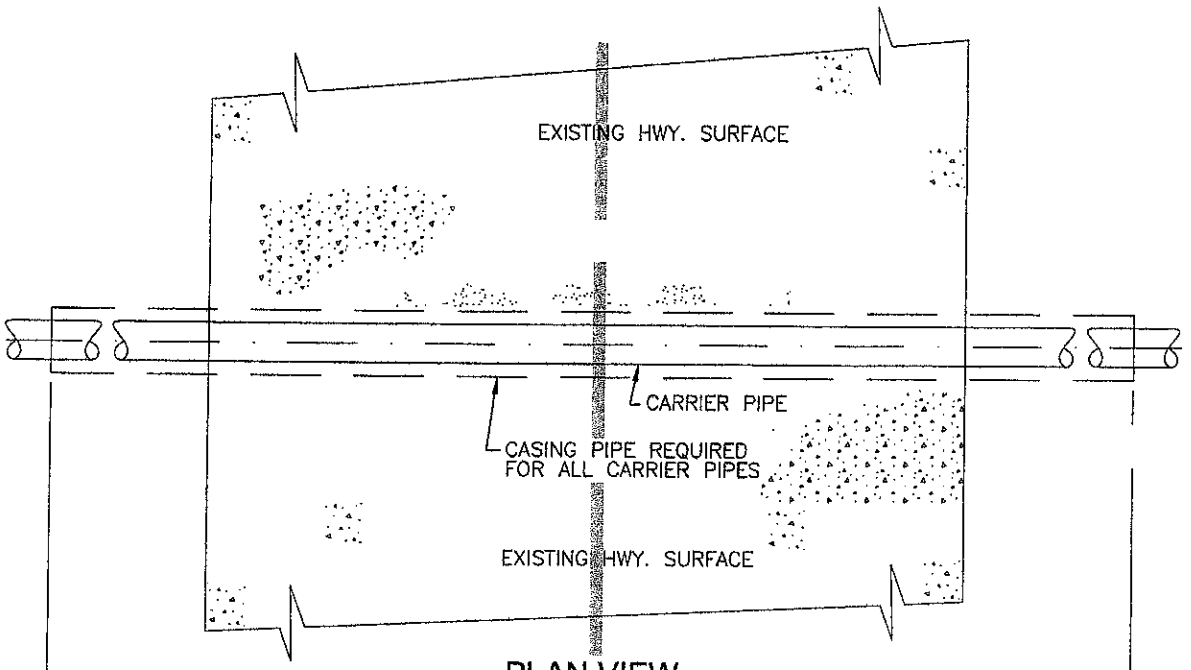
Hooper Irrigation Company
Pressure Irrigation Standards

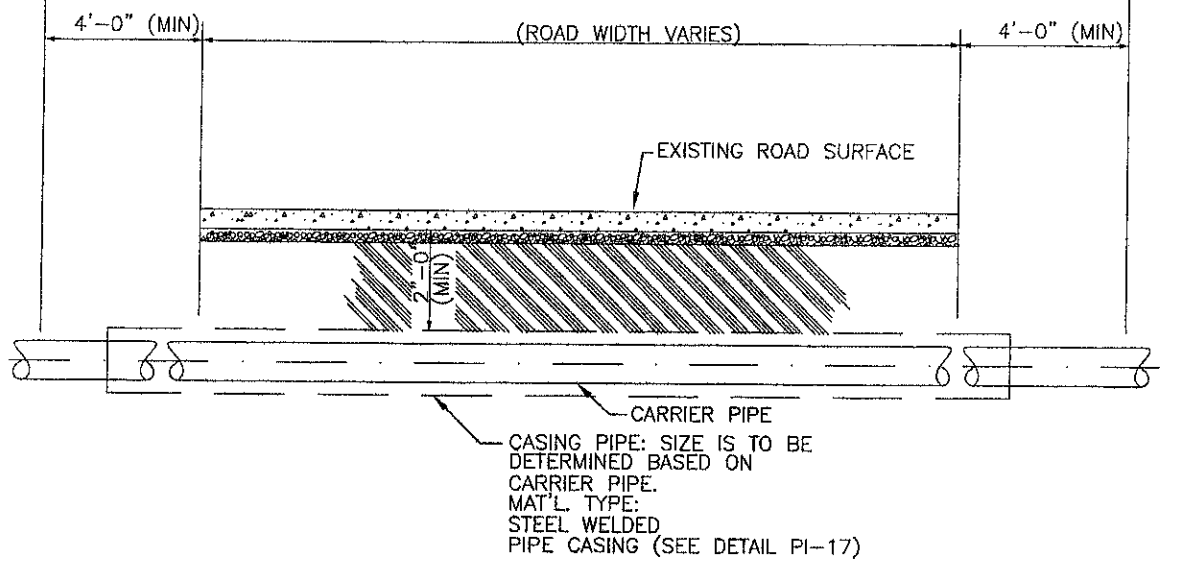
TYPICAL CANAL
CROSSING DETAIL

SHEET PI-14

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	JUNE 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	–



PLAN VIEW
N.T.S.



ELEVATION VIEW

NOTES:

1) WORK TO BE PERFORMED WITHIN UDOT RIGHT-OF-WAYS SHALL BE DONE IN ACCORDANCE WITH DIVISION 19 OF SPECIFICATIONS.
2) CONTRACTOR SHALL BE RESPONSIBLE FOR TOTAL RESTORATION OF THE CONSTRUCTION AREA, INCLUDING REVEGETATION & RESTORATION OF ACCESS ROADWAY

TYPICAL UDOT HWY. CROSSING

N.T.S.

REVISION

NO.	DESCRIPTION	BY	APR.	DATE
1				
2				
3				
4				

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Hooper Irrigation Company
Pressure Irrigation Standards

TYPICAL UDOT HWY.
CROSSING DETAIL

SHEET PI-15

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	JUNE 2003
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	-

NO.	DESCRIPTION	BY	APR.	DATE
1	REVISION			

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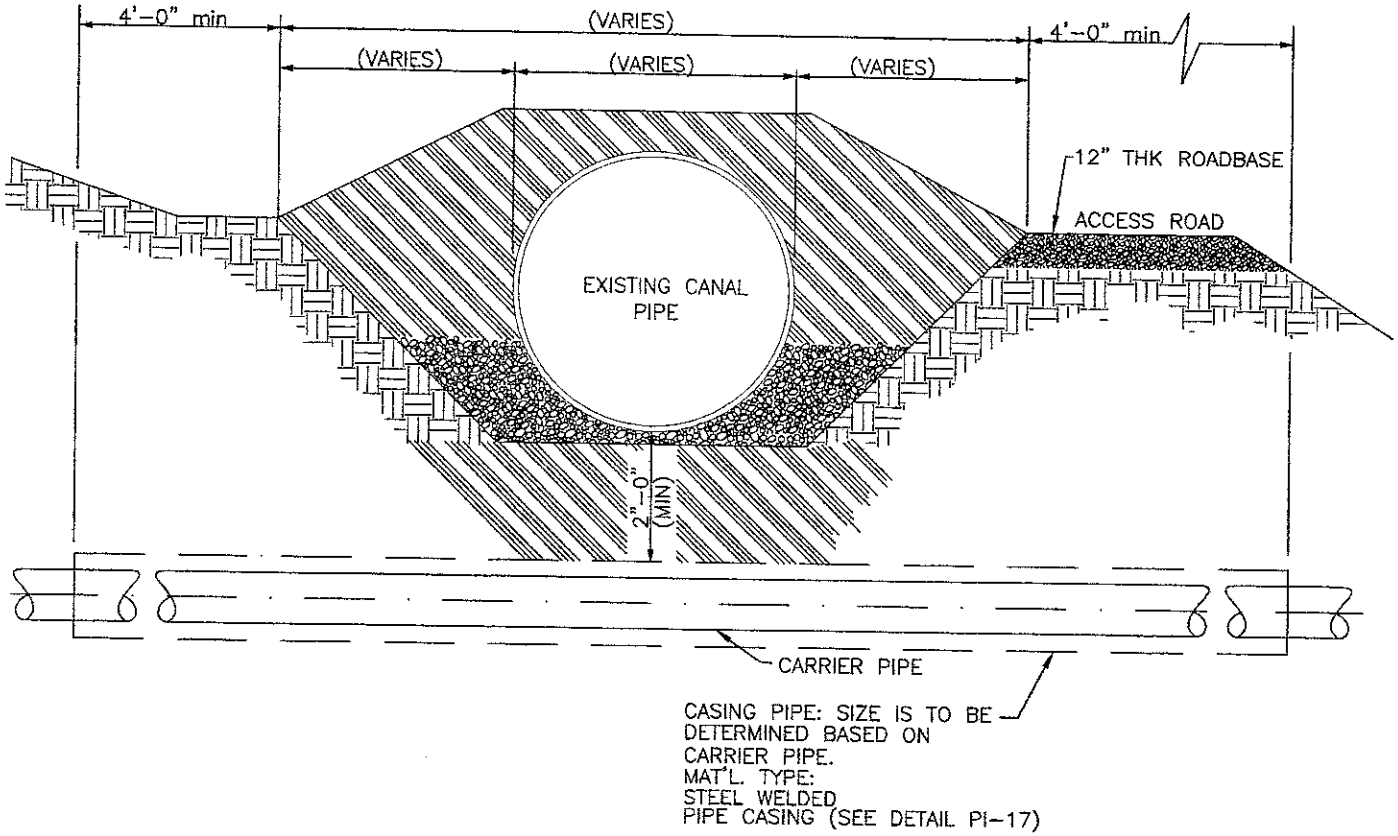
Hooper Irrigation Company
Pressure Irrigation Standards

TYPICAL PIPED CANAL CROSSING DETAIL

SHEET PI-16

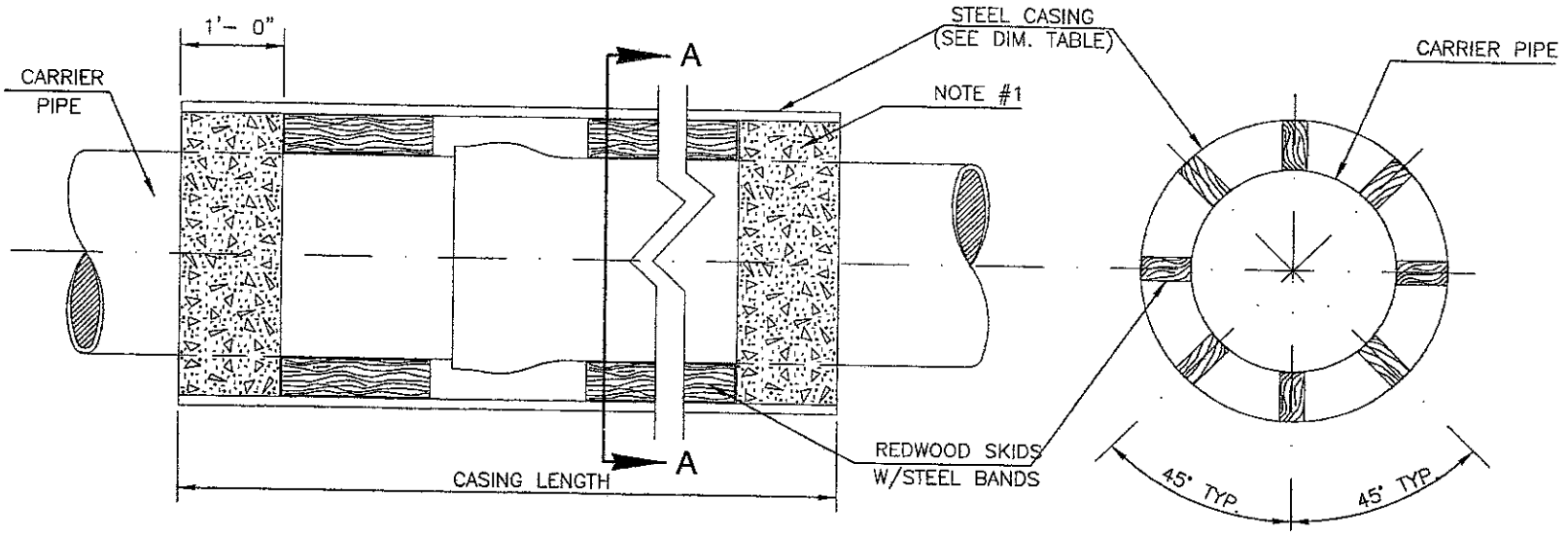
CAD DWG: detail01.dwg
PLOT SCALE: N/A
DATE: JUNE 2003
DRAWN BY: D.STEELE
DESIGN BY: DETAILS
CHECKED BY: TLA
SCALE: -



ELEVATION VIEW

TYPICAL PIPED CANAL CROSSING

N.T.S.



SECTION A-A

N.T.S.

NOTES:

1. ANNULAR SPACE AT ENDS OF STEEL CASING SHALL BE CONCRETE GROUTED.
2. STEEL PIPE TO HAVE A MINIMUM YIELD STRENGTH OF 42,000 PSI.

DIMENSION TABLE

CARRIER PIPE	CASING STEEL PIPE		
DIAMETER (INCHES)	DIAMETER (INCHES)	MIN. WALL THK. W/PROTECTIVE COATING	MIN. WALL THK. W/OUT PROTECTIVE COATING
4" & UNDER	12" & UNDER	0.188"	0.188"
6" & 8"	14" & 16"	0.219"	0.312"
10"	18"	0.250"	0.312"
12"	20"	0.281"	0.375"
14"	22"	0.312"	0.375"
16"	24"	0.344"	0.438"
18"	26"	0.375"	0.438"
20" & 21"	28" & 30"	0.406"	0.500"
24"	32"	0.438"	0.500"
27"	34" & 36"	0.469"	0.562"
30"	38",40",42"	0.500"	0.562"

PIPE CASING DETAIL

N.T.S.

REUSE OF DRAWINGS

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NO.	DESCRIPTION	BY	APP.	DATE
	REVISION			

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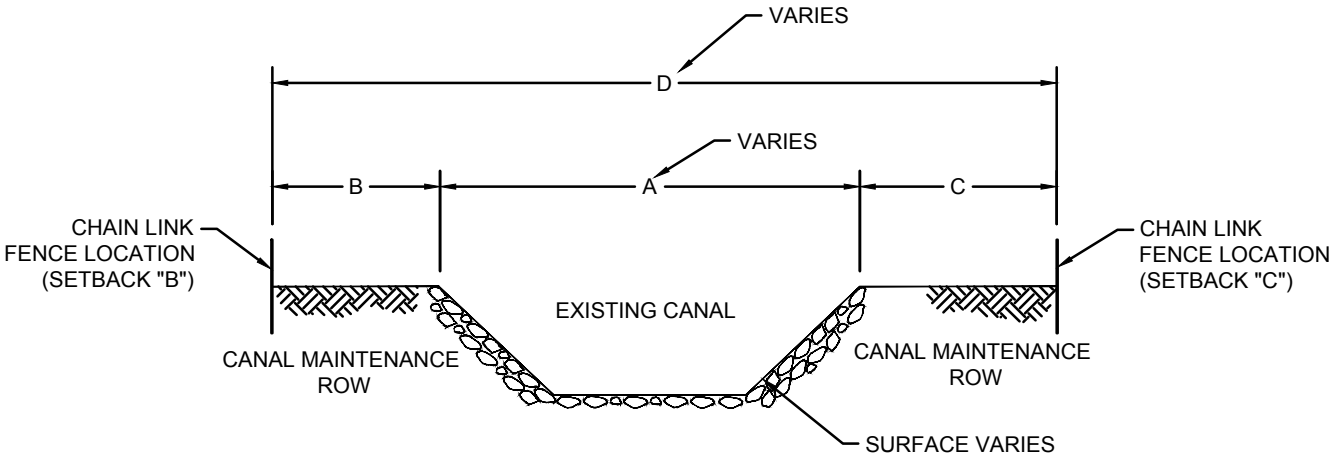
Hooper Irrigation Company
Pressure Irrigation Standards
TYPICAL PIPE CASING DETAIL

SHEET PI-17

CAD DWG: detail01.dwg
PLOT SCALE: N/A
DATE: JUNE 2003
DRAWN BY: D.STEELE
DESIGN BY: DETAILS
CHECKED BY: TLA
SCALE: -

HOOPER IRRIGATION COMPANY (H.I.C.)
CANAL R.O.W. DETAIL



CANAL	A	B	C	D
DIMENSIONS	VARIES	12'	22'	VARIES

NOTE:

1. RIGHT OF WAY (R.O.W.) ESTABLISHED BY HISTORIC PRESCRIPTIVE USE.
2. ANY IMPROVEMENTS TO PROPERTIES LOCATED WITHIN H.I.C. R.O.W. SHALL CONFORM TO CURRENT STANDARD .
3. FENCES SHALL BE BUILT AT THE SETBACKS FOR "C" AND "B".

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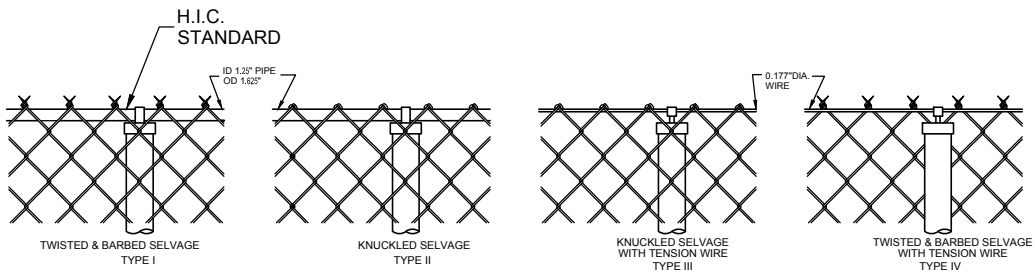
NOTES

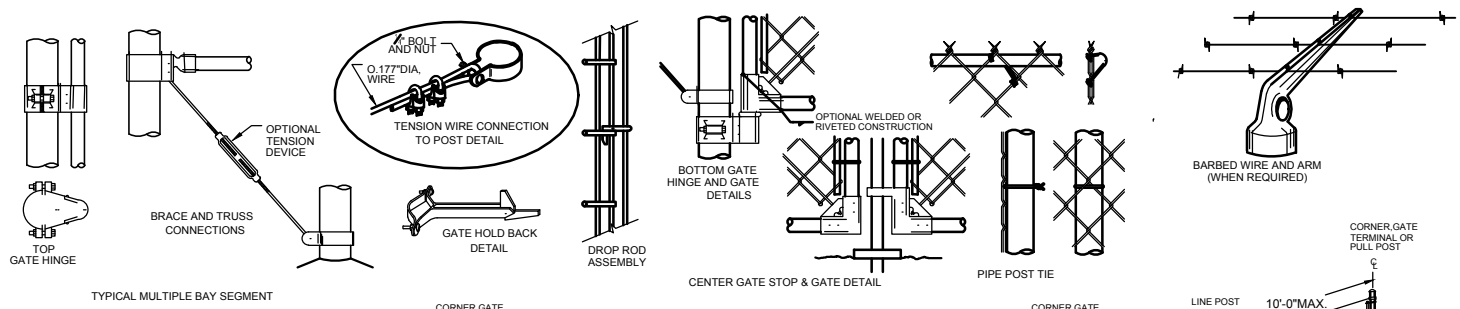
SUMMARY

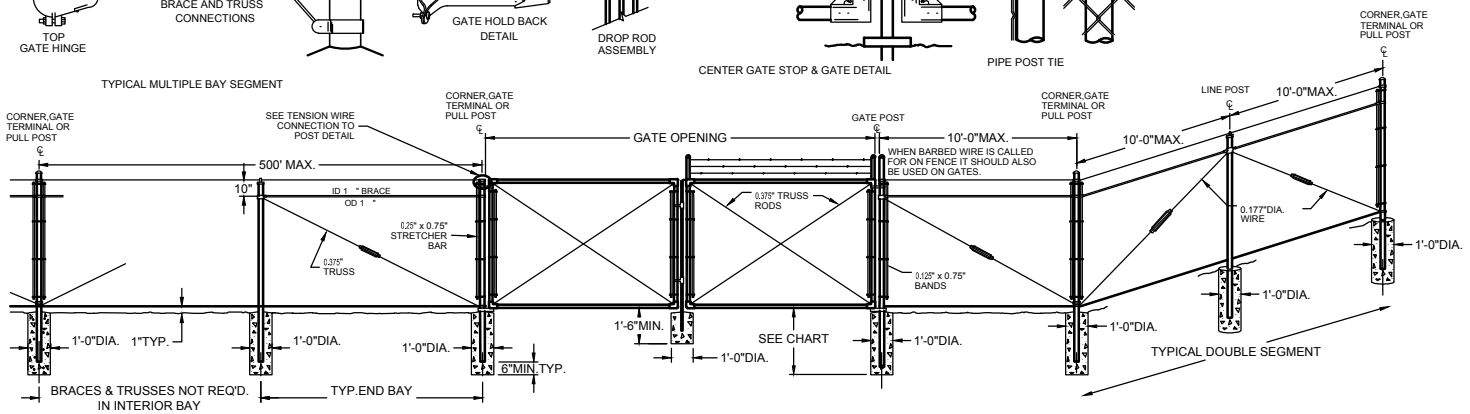
HOOPER IRRIGATION COMPANY (H.I.C.)
FENCE DETAIL



NOTES:

1. POSTS: SCHEDULE 40 PIPE.
   TRIPLE COATED HIGH TENSILE STEEL PIPE OR ROLL-FORMED C-SECTION OF THE SIZE SHOWN IN THE CHART AND AS DEFINED IN THE STANDARD SPECIFICATION. WEIGHT IN lb/ft WITH TOLERANCE OF 5 PERCENT. OTHER TYPES OF POSTS WITH EQUAL OR GREATER SECTION MODULUS MAY BE USED IF APPROVED, IN ADVANCE, BY THE ENGINEER.
2. FABRIC HEIGHTS LESS THAN 5';
   TRUSS RODS AND BRACES NOT REQUIRED.





H.I.C. STANDARD

HEIGHT OF FABRIC	DEPTH OF POSTS	LENGTH OF END CORNER OR PULL POSTS	LENGTH OF LINE POSTS	SIZE OF POSTS									
				END, CORNER & PULL POSTS				LINE POST MIN.SIZE					
				NOM. SIZE	OUTSIDE DIA.	PIPE WEIGHT ASTM A 120	PIPE WEIGHT TRIPLE COAT	NOM. SIZE	OUTSIDE DIA.	PIPE WEIGHT ASTM A 120	PIPE WEIGHT TRIPLE COAT	OUTSIDE DIMENSIONS C-SECTION	WT/FT
7'	3'	10'	9'-8"	2"	2.875"	5.79	4.64	2"	2.375"	3.65	3.11	1.875 x 1.625	2.28
6'	3'	9'	8'-8"	2"	2.375"	3.65	3.11	1"	1.900"	2.72	2.23	1.875 x 1.625	1.85
5'	3'	8'	7'-8"	2"	2.375"	3.65	3.11	1"	1.900"	2.72	2.23	1.875 x 1.625	1.85
4'	2'	6'	5'-8"	2"	2.375"	3.65	3.11	1"	1.900"	2.72	2.23	1.875 x 1.625	1.85
3'	2'	5'	4'-8"	2"	2.375"	3.65	3.11	1"	1.900"	2.72	2.23	1.875 x 1.625	1.85

H.I.C. STANDARD

HEIGHT	GATE OPENING	GATE POST	GATE FRAME
UNDER 6'	SINGLE TO 6' OR DOUBLE TO 12'	2"	1"
	SINGLE OVER 6' TO 8' OR DOUBLE OVER 12' TO 16'	2"	
	SINGLE OVER 8' TO 12' OR DOUBLE 16' TO 24'	3"	
6' AND OVER *	SINGLE TO 6' OR DOUBLE TO 12'	2"	1"
	SINGLE OVER 6' TO 13' OR DOUBLE OVER 12' TO 24'	3"	
	SINGLE OVER 13' TO 18' OR DOUBLE OVER 24' TO 36'	6"	
	SINGLE OVER 18' OR DOUBLE OVER 36'	8"	

* GATES OVER 6' IN HEIGHT AND WIDER THAN 12' WILL REQUIRE 3 INDUSTRIAL PRESSED STEEL HINGES.

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OFFICE: 801.476.0202 FAX: 801.476.0066

NOTES

SUMMARY

DIVISION 15

SERVICE CONNECTION

15.01 GENERAL:

This section covers the installation of service connection and components to homeowner's property line.

15.02 SERVICE SADDLE SPECIFICATIONS:

For service connections to C900 PVC main, all service saddles shall be of a "Full encirclement design," and shall be O.D. controlled, which design will eliminate the possibility of pipe crushing due to the over torquing of the nuts upon installation. All service saddles for connections to C900 PVC pipe sizes 4 inch to 10 inch diameter shall be Mueller Model H-13490 Series or Ford S-90.

15.03 CORPORATION STOP:

For service connections to Ductile Iron main on pipe sizes that are 12 inch diameter and larger, corporation stops shall be used to connect to the main. Corporation stops shall be manufactured and tested to ANSI/AWWA C800. The body is to be cast from 85-5-5-5 ASTM B62 brass alloy and be of a straight through design. All corporation stops shall be Mueller 1500 series (or approved equal), with CTS 110 compression outlet. Stainless steel pipe stiffeners are required to be used to eliminate cold flow of plastic pipe and compression fittings.

15.04 POLYETHYLENE TUBING:

Pipe for the transmission of irrigation water from main to utility box and from the utility box at property line shall be Polyethylene CTS tube. Polyethylene CTS tube shall be manufactured in accordance with the standard specification for Polyethylene (PEP plastic tubing as issued by the American Standard for Testing and Materials under ASTM D 2737 and AWWA C-901.

Material designation code:	Polyethylene PE 3408
Plastic Extrusion Compound:	Type III, class C, grade 34, as defined

in ASTM D 1248

The standard pipe dimension ratio is CTS (SDR) 9, which has a 200 psi pressure rating. All tubing for service lines shall be cut and installed in a neat and workmanlike manner by a method recommended by the manufacturer. No joints will be allowed between the main and the service valve. Tubing shall be WESTFLEX PE 3408 Gold Label or equivalent.

15.05 COMPRESSION CONNECTION:

MUELLER 110 COMPRESSION COUPLINGS AND FITTINGS OR FORD C84-44Q (1-INCH) OR FORD C84-77Q (2-INCH) COMPRESSION COUPLINGS ARE TO BE USED ON ALL P.E. PLASTIC PIPE INSTALLATIONS.

(a) The interior surface of the coupling nut, including threads, shall have a baked on, fluorocarbon coating to reduce assembly friction and prevent the gasket from turning and twisting during tightening. The nut shall bottom on a cast or machined shoulder on the body when properly assembled. This design will provide a visual check to assure connection is properly assembled.

(b) The sealing gasket shall be of molded synthetic rubber (ASTM D-2000) with molded in place bronze spring (ASTM A-134 Alloy #6) to eliminate the possible cold flow of the gasket between the pipe and fitting. A gripper band of hardened stainless steel (ANSI Type 401) shall be fitted into the gasket. When the gasket is compressed it will cause the gripper ring to distort the pipe giving the fitting a high resistance to pull out. The gripper band shall overlap itself to prevent cold flow of the gasket into the cavity under the band.

(c) When compression fittings are used with P.E. Pipe, Stainless Steel pipe stiffeners are required to be used to eliminate cold flow of plastic pipe.

(d) All fittings are to be for CTS Polyethylene pipe.

(e) The Minimum pull out load for the fitting when used with PE plastic pipe shall be as follows for each given size:

SIZE	MINIMUM PULL OUT (FT.LBS.)
1"	400
1½"	500
2"	500

15.06 SERVICE FITTINGS:

All service fittings such as brass tees, and brass ells shall be Mueller 110 Compression Connections or Ford Q Fittings.

15.07 MARK II ORI-SEAL VALVE:

These valves shall be closed bottom design and sealed against external leakage at the top by means of a non-adjustable resilient pressure actuated seal, and shall be provided with a secondary resilient seal disposed above the pressure seal for added protection of the bearing surfaces against ground water infiltration. Shutoff shall be affected by a resilient pressure actuated seal so disposed in the key (or plug) as to completely enclose the inlet body port (flow way), in the closed position. All Curb valves shall be quarter turn valves and the fully open and closed positions shall be controlled by check lugs which are integral parts of the key and body. The maximum pressure rating shall be 175 PSI water at a maximum temperature of 180 degrees Fahrenheit.

All fittings are to be CTS Size, used on CTS (Copper Tube Size) Polyethylene pipe. No IPS polyethylene pipe or fittings are to be used.

Curb stops valves shall be MUELLER H-15172, 110 COMPRESSION by FIP, STOP AND WASTE CONFIGURATION. (no substitution is allowed)

A protective insert plug shall be placed on the open side of the valve (the side where the resident will connect into in the future) in order to prevent dirt and debris from entering the valve.

15.08 SERVICE BOX:

Service box shall be an 11 3/4-inch by 17-inch standard green fiberglass irrigation box with cover. Service Box shall be installed over the Ori-Seal valve. A sign shall be attached or embossed to or on the cover indicating as follows: "IRRIGATION" Box shall be Brooks 1419 series utility box with lid recessed and shall be provided with Waterworks Pentagon Head locking device or equivalent.

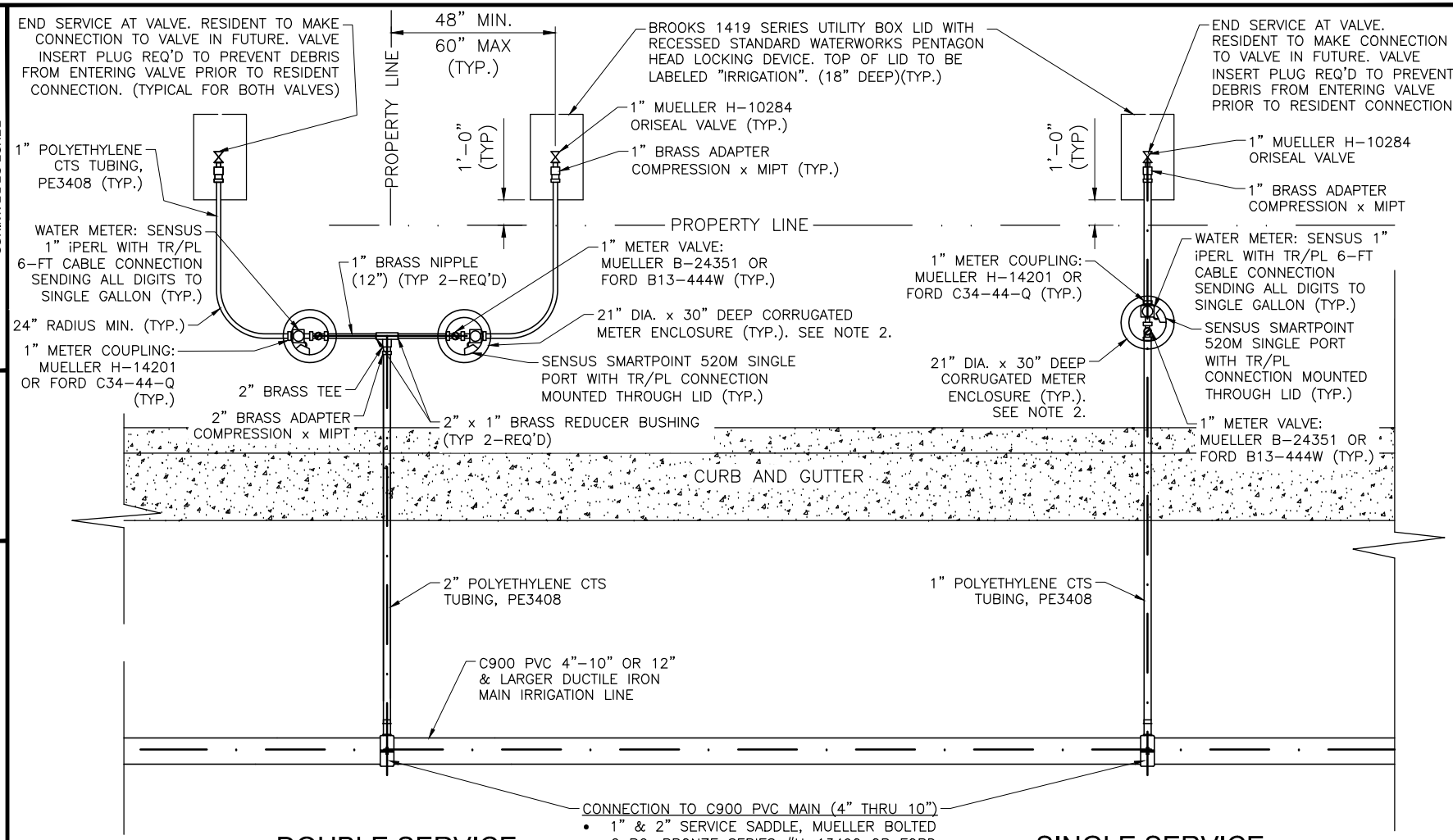
The location of the service box should be coordinated with each property owner. A double service near a shared property corner is encouraged in order to reduce construction and maintenance costs. Determination of service location shall be provided by Hooper Irrigation Company (Owner) and coordinated with the resident and the Contractor. The location shall be near the property line and away from traffic impact areas. The location shall be marked on the ground with a flag, stake, paint, or other methods chosen by the Owner. The Contractor must coordinate with the Owner and the resident when a service box location may provide conflicts with existing infrastructure or difficulties in construction. Note: Service box must be a minimum of 5’-0” away, either side of culinary water meter. Field notes of the actual installed location of the service box must be shown on the as-built drawings by the Contractor. Contractor shall be required to write in permanent ink Marker on the lid of the service box footage from service box to main. This will serve as another means of locating the main in the roadway and for dewatering pay quantities.

15.09 SERVICE BORE:

All services on the opposite side of the street from the main will be bored under the asphalt. No open trenching for services will be permitted unless approved by engineer. All approved open trenching for service installation will require a minimum of 1’-0” (one Foot) trench width in order to achieve the necessary compaction and asphalt replacement. Boring will also be required in areas where construction will cross existing sidewalk, and/or curb and gutter. Sidewalk and/or curb and gutter that is damaged or removed on this project shall be replaced in same or better condition (than before the damage or removal) at no additional cost to the Owner.

15.10 FLOW METERS:

As of March 12, 2018, flow meters shall be installed on all new secondary services per the Hooper Irrigation Company "Typical Service Connections" detail in the standard drawings. Meters shall be of type Sensus iPerl for all services 1" in size and smaller. For services larger than 1", the Hooper Irrigation Company engineer should be consulted for information about meter type and model. Meters shall be located behind the curb and gutter in the park strip area per the standard detail.



NOTE:
1. STAINLESS STEEL PIPE STIFFENERS ARE REQUIRED TO BE USED ON ALL CONNECTIONS ON POLY PIPE.
2. INSURE VALVE CONTROL NUT CAN BE SERVICED BY WRENCH WHEN POSITIONING UNDER ENCLOSURE LID

TYPICAL SERVICE CONNECTIONS

N.T.S.

NO.	DESCRIPTION	BY	APR.	DATE
1	REV. DRAWING TO ADD CURB & GUTTER & GALLOUTS	DBS	TLA	12-15-0
2	REV. DRAWING TO ADD TWO BOXES ON DOUBLE SERVICE	JDM	GLS	5-15-14
3	REV. DRAWING TO ADD FLOW METERS ON ALL SERVICES	JRH	GLS	3-15-18

REVISION

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Pressure Irrigation Standards

TYPICAL SERVICE CONNECTION DETAIL

SHEET PI-10

CAD DWG:	detail01.dwg
PLOT SCALE:	N/A
DATE:	DECEMBER 2004
DRAWN BY:	D.STEELE
DESIGN BY:	D.STEELE
CHECKED BY:	TLA
SCALE:	-

demand. The storage amount given herein correlates with Pine View Water System requirements. This is done so that if a transfer ever takes place, the system will comply.

1. **Fencing**: Reservoirs should be fenced around the perimeter with room between the fence and the perimeter for maintenance vehicles (min 20'). Fencing shall be 6 feet tall chain link in accordance with these Public Works Standards and conform to City Zoning requirements.
2. **Lining**: Reservoirs shall be clay lined to inhibit percolation or infiltration. The corners should rounded to avoid stress concentrations in the event of future concrete lining.
3. **Side Slope**: Due to the fact that most of these basins will be in residential areas, the maximum side slope of the basis shall be two (2) feet horizontal to one (1) feet vertical.
4. **Depth**: Irrigation basins shall not exceed 12 feet deep and, in the presence of ground water, consideration for draining the basin must be given.
5. **Grates, Pipes and Screens**: All grates and screens shall be hot dip galvanized to avoid corrosion. Pipes shall be in accordance with the pipe specification given herein.
6. **Freeboard**: The top of the embankment in all areas shall be one (1) foot above the highest water elevation.
7. **Ground Covers:** The surface area around the basin shall be covered with weed barrier fabric and gravel. Gravel shall 2" minus and be 4" thick over the top of the weed barrier.
8. **Embankment (Fill) Construction:** If a raised embankment is constructed for the reservoir (constructed with granular materials), it shall be provided with a minimum of 6" of clay cover on the inside of the berm to prevent water passage through the soil as well as the clay lining.
9. **Excavation (Cut) Construction:** If the basin is constructed primarily by excavation, then it may be necessary to provide an impermeable liner and land drain system when constructed in the proximity of basements or other below grade structures as determined by a geotechnical evaluation.

G. PRESSURIZATION

Gravity systems are always desirable, however pumps may need to be used. Pumps, which shall directly pressurize the system, shall be Variable Frequency Drive (VFD) pumps with redundancy designed for meeting the peak instantaneous flows.

The hydraulics of the system should be set for a peak instantaneous flow equal to the following formula:

$$Q = U*180*N^{0.55}$$

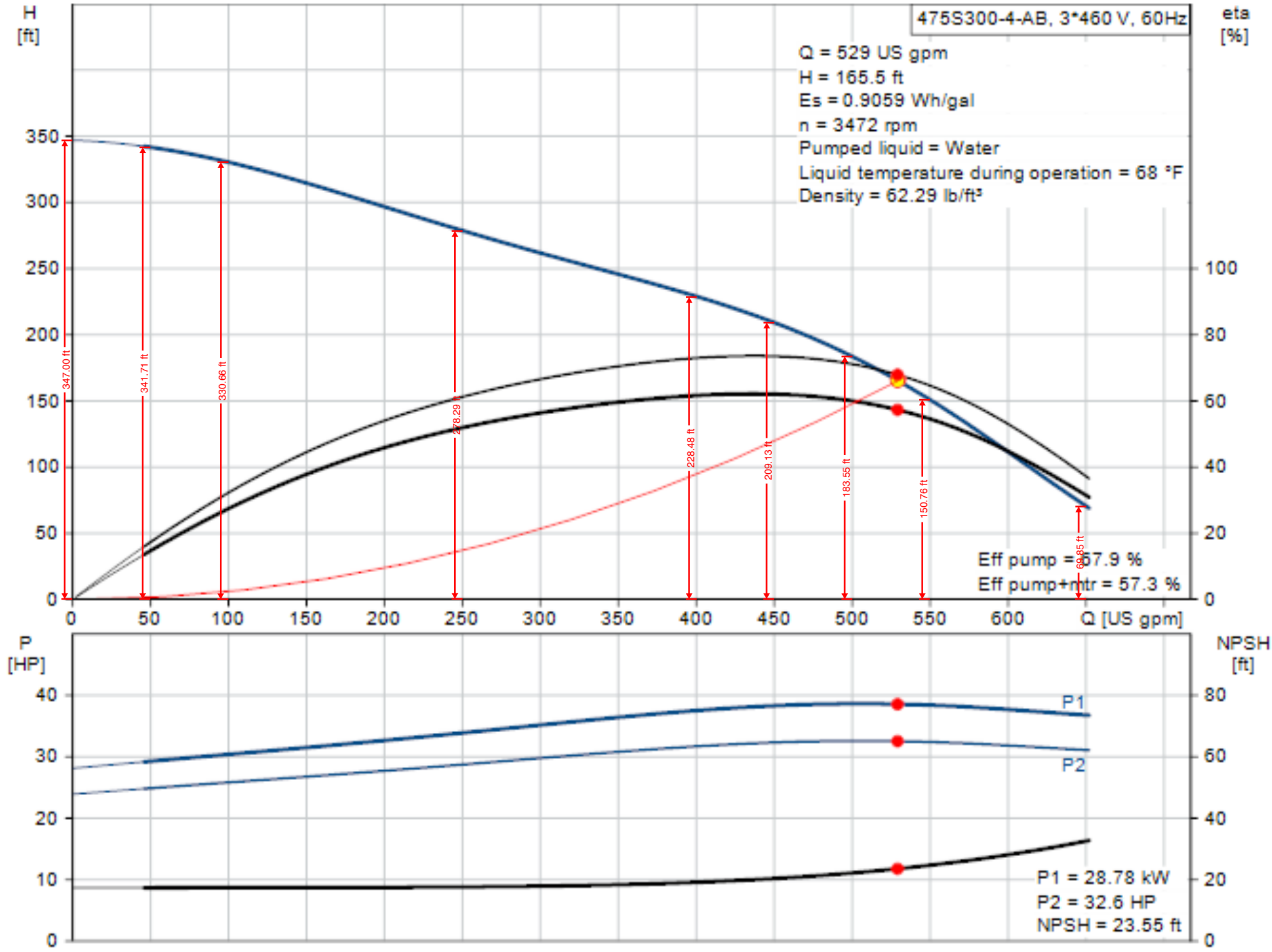
Where: Q is the instantaneous flow rate in g.p.m.
U is the usage factor (no less than 60% or 0.6)
N is the total number of Irrigable acres

In no case shall the Peak Instantaneous Flow Rate per irrigable acre be less than 8gpm. Pressures should be designed between 60 psi (139' TDH) and 100 psi (230' TDH). Pump

APPENDIX C

Head / Headloss Curves

TEL (801) 394-4515 • FAX (801) 392-7544 • 5746 South 1475 East • Ogden, Utah 84403 • www.greatbasinengineering.com


475S300-4-AB, 3*460 V, 60Hz
Q = 529 US gpm
H = 165.5 ft
Es = 0.9059 Wh/gal
n = 3472 rpm
Pumped liquid = Water
Liquid temperature during operation = 68 °F
Density = 62.29 lb/ft³
H [ft]
eta [%]
Q [US gpm]
347.00 ft
341.71 ft
330.66 ft
278.29 ft
228.48 ft
209.13 ft
183.55 ft
150.76 ft
69.85 ft
Eff pump = 57.9 %
Eff pump+mtr = 57.3 %
P [HP]
NPSH [ft]
P1
P2
P1 = 28.78 kW
P2 = 32.6 HP
NPSH = 23.55 ft

GREAT BASIN ENGINEERING INC

APPENDIX D

Model Calculations/Results

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Project : TERAKEE FARM Cluster Subd Date: 11/19/2021

(This report assumes that the necessary water rights either are or will be provided to meet the needs of this system)
In this report, **"Source"** refers to water taken from the oxbow retention pond.

Secondary Water Source and Storage/Use Sizing for TERAKEE FARM Cluster Subd

Total Irrigable Acreage =	**132.76**	irr-ac
*Zone =	**4**	

* Zone Determined from Irrigated Crop Consumptive Use Zones and Normal Annual Effective Precipitation, Utah (See Utah Rule R309-510-7(3)

Source Requirements:

Volume: (See Table 510-3 in Utah Rule R309-510-7(3))

Unit Water Right Requirement =	1.87	ac-ft/irr-ac per year
Total Water Right Requirement =	**248.26**	ac-ft/yr
1 Share =	**2.80**	ac-ft/yr
Required number of Shares =	**88.7**	
Number of Watering Days =	213	days (Assumes April - October)
Volume available for use =	8.16	ac-ft/wk

Flow Rate: (See Table 510-3 in Utah Rule R309-510-7(3))

This is N/A, since the source is directly from the Weber River, rather than diverting to a pond.

Storage/Use Requirements:

Volume: (See Table 510-5 in Utah Rule R309-510-8(2c))

This is N/A, since the source is directly from the Weber River, rather than storing in a pond.

Flow Rate: (See Table 510-7 in Utah Rule R309-510-9(3))

Required Unit Peak Inst. Demand =	7.92	gpm/irr-acre
Safety Factor =	2.0	(For non-agricultural areas)
Design Unit Peak Inst. Demand =	15.84	gpm/irr-acre
Total Agricultural Irrigated Acreage =	65.80	irr-ac
Total Non-Agricultural Irrigated Acreage =	66.96	irr-ac
Design (Ag.) Peak Inst. Demand =	521	gpm
Design (Non-Ag.) Peak Inst. Demand =	**1060.6**	gpm (use this for pump sizing)

Agricultural areas shall be watered during the day when watering of non-agricultural areas is prohibited and vis versa for night-time non-agricultural waterings.

Agricultural Use

	Area (ac)	
Total Agricultural =	**65.80**	irr-ac
Required Unit Peak Inst. Demand =	7.92	gpm/irr-ac
Required Peak Inst. Demand =	521	gpm (S.F. not required for Ag.)
Pro-rated allowed PID for Farm 1	**116.5**	gpm
Pro-rated allowed PID for Farm 2	**404.7**	gpm

Subd	Irrigable Area: Residential Lots*	Common Area**	Rights-of-Way***	Agricultural****	Units	Totals	Units
T.F.C.S.	2608052	178141	130425	2866355	SF	5782973	SF
T.F.C.S.	59.87	4.09	2.99	65.80	AC	132.76	AC

*Assumes 2500 sf non-irrig per lot for Lots

**Assumes 5% non-irrig areas for gravel paths, small structures, etc.

***Use 80.0% non-irrig areas for 50' ROWs since 10' is landscape. Entire 24' ROWs are hardscape.
****Note that Agricultural areas shall have watering times that do not conflict with non-agricultural areas in order to ensure flow rate and pressures are not adversely impacted by Agricultural areas.

Residential Area =	3123052	sf
Farm Area (Ag) =	2866355	sf
Park Area =	187517	sf
24' Road Area =	57004	sf
50' Road Area =	652124	sf
Total Terakee Area =	6886053	sf
Total Terakee Area =	158.08	ac

Design Unit Peak Instantaneous Demand (P.I.D.) = 15.84 gpm/irr-ac
Total Residential P.I.D. (includes ROWs) = 995.81 gpm

Residential Lots

Lot # or Parcel	Size (sf)	Initial Irrigable area (sf)	Adjusted* Irrigable area (sf)	Des. Peak Instant. (gpm)
1	9395	6895	7287	2.65
2	8380	5880	6230	2.27
3	8188	5688	6030	2.19
4	5371	2871	3096	1.13
5	5596	3096	3330	1.21
6	6252	3752	4013	1.46
7	6358	3858	4124	1.50
8	6934	4434	4724	1.72
9	6094	3594	3848	1.40
10	7455	4955	5266	1.91
11	7796	5296	5621	2.04
12	9148	6648	7030	2.56
13	7927	5427	5759	2.09
14	7600	5100	5418	1.97
15	7248	4748	5050	1.84
16	5251	2751	2970	1.08
17	4837	2337	2539	0.92
18	5080	2580	2792	1.02
19	5773	3273	3514	1.28
20	7528	5028	5342	1.94
21	8029	5529	5864	2.13
22	6820	4320	4605	1.67
23	5795	3295	3537	1.29
24	6828	4328	4613	1.68
25	5736	3236	3475	1.26
26	5958	3458	3707	1.35
27	7800	5300	5625	2.05
28	7347	4847	5153	1.87
29	8696	6196	6559	2.39
30	7252	4752	5055	1.84
31	7355	4855	5162	1.88
32	7809	5309	5635	2.05
33	8649	6149	6510	2.37
34	7451	4951	5262	1.91
35	6138	3638	3894	1.42
36	5578	3078	3311	1.20
37	5605	3105	3340	1.21
38	5227	2727	2945	1.07
39	6307	3807	4070	1.48
40	5945	3445	3693	1.34
41	15923	13423	14088	5.12
42	17951	15451	16200	5.89
43	15633	13133	13786	5.01
44	14295	11795	12392	4.51
45	13904	11404	11984	4.36
46	14129	11629	12219	4.44
47	13902	11402	11982	4.36
48	14607	12107	12717	4.62
49	12563	10063	10588	3.85
50	12541	10041	10565	3.84
51	6701	4201	4481	1.63
52	8008	5508	5842	2.12
53	7785	5285	5610	2.04
54	7177	4677	4976	1.81
55	6466	3966	4236	1.54
56	7685	5185	5506	2.00
57	6702	4202	4482	1.63
58	6333	3833	4098	1.49
59	8376	5876	6226	2.26
60	7028	4528	4821	1.75
61	5454	2954	3182	1.16
62	17557	15057	15790	5.74
63	16310	13810	14491	5.27
64	16596	14096	14789	5.38
65	21174	18674	19558	7.11
66	16194	13694	14371	5.23
67	18144	15644	16402	5.96
68	16675	14175	14872	5.41
69	15577	13077	13727	4.99
70	13561	11061	11628	4.23
71	17623	15123	15859	5.77
72	18826	16326	17112	6.22
73	21056	18556	19435	7.07
74	16454	13954	14641	5.32
75	12318	9818	10333	3.76
76	12488	9988	10510	3.82
77	11500	9000	9481	3.45
78	11472	8972	9452	3.44
79	12751	10251	10783	3.92
80	11795	9295	9788	3.56
81	10774	8274	8724	3.17
82	10077	7577	7998	2.91
83	10272	7772	8201	2.98
84	11555	9055	9537	3.47
85	10340	7840	8271	3.01
86	13571	11071	11638	4.23
87	9401	6901	7293	2.65
88	11141	8641	9107	3.31
89	13894	11394	11974	4.35
90	12645	10145	10674	3.88
91	11146	8646	9112	3.31
92	9642	7142	7544	2.74
93	11190	8690	9157	3.33
94	11212	8712	9180	3.34
95	11861	9361	9857	3.58
96	11017	8517	8977	3.26
97	10731	8231	8679	3.16
98	6194	3694	3953	1.44
99	8427	5927	6279	2.28
100	8906	6406	6778	2.46
101	9607	7107	7508	2.73
102	10385	7885	8319	3.03
103	9216	6716	7101	2.58
104	8977	6477	6852	2.49
105	8879	6379	6750	2.45
106	8961	6461	6835	2.49
107	7659	5159	5478	1.99
108	8797	6297	6665	2.42
109	11347	8847	9321	3.39
110	7918	5418	5749	2.09
111	8164	5664	6005	2.18
112	8275	5775	6120	2.23
113	8842	6342	6712	2.44
114	9395	6895	7288	2.65
115	7463	4963	5275	1.92
116	8845	6345	6715	2.44
117	9378	6878	7270	2.64
118	9240	6740	7125	2.59
119	9823	7323	7733	2.81
120	10601	8101	8544	3.11
121	10129	7629	8052	2.93
122	9736	7236	7642	2.78
123	9564	7064	7463	2.71
124	9731	7231	7637	2.78
125	7043	4543	4837	1.76
126	7455	4955	5266	1.91
127	8444	5944	6297	2.29
128	8254	5754	6099	2.22
129	8434	5934	6286	2.29
130	8077	5577	5915	2.15
131	8457	5957	6311	2.29
132	7832	5332	5659	2.06
133	9084	6584	6963	2.53
134	7020	4520	4814	1.75
135	11317	8817	9289	3.38
136	7166	4666	4965	1.81
137	8975	6475	6850	2.49
138	7661	5161	5481	1.99
139	7629	5129	5448	1.98
140	7605	5105	5422	1.97
141	7711	5211	5533	2.01
142	6020	3520	3771	1.37
143	8562	6062	6419	2.33
144	7710	5210	5532	2.01
145	6094	3594	3849	1.40
146	7423	4923	5233	1.90
147	7604	5104	5421	1.97
148	7657	5157	5477	1.99
149	7360	4860	5167	1.88
150	7861	5361	5689	2.07
151	6443	3943	4212	1.53
152	6180	3680	3938	1.43
153	8005	5505	5839	2.12
154	7886	5386	5715	2.08
155	8688	6188	6551	2.38
156	9118	6618	6999	2.54
157	9597	7097	7498	2.73
158	5356	2856	3080	1.12
159	6610	4110	4386	1.60
160	8628	6128	6488	2.36
161	7959	5459	5791	2.11
162	6803	4303	4587	1.67
163	7878	5378	5707	2.08
164	5965	3465	3715	1.35
165	5986	3486	3736	1.36
166	6359	3859	4125	1.50
167	7357	4857	5165	1.88
168	7300	4800	5104	1.86
169	6875	4375	4662	1.70
170	7650	5150	5469	1.99
171	6863	4363	4650	1.69
172	7826	5326	5653	2.06
173	7767	5267	5591	2.03
174	6173	3673	3930	1.43
175	28169	25669	26845	9.76
176	25264	22764	23819	8.66
177	22625	20125	21069	7.66
178	22077	19577	20499	7.45
179	23782	21282	22276	8.10
180	31164	28664	29965	10.90
181	34539	32039	33481	12.17
182	74847	72347	75473	27.44
183	69230	66730	69621	25.32
184	46673	44173	46122	16.77
185	21819	19319	20230	7.36
186	73441	70941	74008	26.91
187	69906	67406	70325	25.57
188	59566	57066	59553	21.66
189	63564	61064	63719	23.17
190	63629	61129	63786	23.19
191	65029	62529	65245	23.73
192	55525	53025	55343	20.12
193	49609	47109	49181	17.88
194	42108	39608	41367	15.04
195	41980	39480	41233	14.99
196	60058	57558	60066	21.84
197	71267	68767	71743	26.09
198	57399	54899	57296	20.83
199	44707	42207	44074	16.03
200	49423	46923	48987	17.81
201	45269	42769	44660	16.24
202	41131	38631	40349	14.67
203	38870	36370	37994	13.82
204	39243	36743	38381	13.96
205	39985	37485	39155	14.24
206	40728	38228	39929	14.52
Park 1	162667	154534	154534	56.19
Park 2	24850	23607	23607	8.58
Farm 1	640653	640653	640653	116.48
Farm 2	2225703	2225703	2225703	404.67

*These include a pro-rated value of the irrigable area in the ROWs. The Common Areas and Farmland are assigned unique diversion points, and thus do not require pro-ration.

Totals

	Size (sf)	Irrigable area (sf)	Des. Peak Instant. (gpm)
*ROWs	709128	130425	0.00
Res Lots	3123052	2608052	996
Common Area	187517	178141	65
Agricultural	2866355	2866355	521

*ROW flows are accounted for by pro-rating and adding to the Initial Lot Irrigable areas to become Adjusted Irrigable areas.

Connection with Demand	Demand (gpm)	Serves these Lots		Additional Service
1a	4.92	1	2	
2a	3.32	3	4	
2b	4.67	112	113	
3a	2.67	5	6	
3b	1.94	17	18	
4a	3.22	7	8	
5a	3.31	9	10	
5b	4.60	11	12	
5c	4.06	13	14	
5d	2.92	15	16	
6a	3.22	19	20	
6b	11.23	114		All Park 2
7a	3.81	21	22	
8a	2.96	23	24	
8b	2.29	37	38	
9a	2.61	25	26	
9b	2.62	35	36	
10a	3.92	27	28	
10b	4.22	29	30	
10c	3.93	31	32	
10d	4.28	33	34	
11a	2.82	39	40	
12a	5.12	41		
13a	10.90	42	43	
13b	4.36	115	116	
14a	8.86	44	45	
14b	5.23	117	118	
15a	8.80	46	47	
15b	5.92	119	120	
16a	8.47	48	49	
16b	5.71	121	122	
17a	5.47	50	51	
17b	5.49	123	124	
18a	4.16	52	53	
18b	3.35	54	55	
18c	3.63	56	57	
18d	3.75	58	59	
19a	2.91	60	61	
20a	11.01	62	63	
20b	3.87	148	149	
21a	12.49	64	65	
21b	3.60	150	151	
22a	11.19	66	67	
23a	10.40	68	69	
23b	3.38	166	167	
24a	10.00	70	71	
24b	13.29	72	73	
25a	5.32	74		
26a	3.76	75		
27a	7.27	76	77	
27b	3.55	168	169	
28a	7.36	78	79	
28b	3.68	170	171	
29a	6.73	80	81	
29b	4.09	172	173	
30a	5.89	82	83	
30b	3.72	98	99	
31a	6.48	84	85	
31b	5.19	100	101	
32a	6.88	86	87	
33a	7.67	88	89	
33b	5.61	102	103	
34a	7.19	90	91	
34b	4.95	104	105	
35a	6.07	92	93	
35b	4.48	106	107	
36a	6.92	94	95	
37a	6.42	96	97	
38a	5.81	108	109	
39a	4.27	110	111	
40a	29.86	125		1/2 Park 1
41a	4.20	126	127	
42a	4.50	128	129	
43a	4.45	130	131	
44a	30.15	132		1/2 Park 1
45a	4.28	133	134	
46a	5.18	135	136	
47a	4.48	137	138	
48a	3.95	139	140	
49a	3.38	141	142	
50a	4.35	143	144	
51a	2.52	145	158	
52a	3.87	146	147	
53a	3.56	152	153	
53b	2.71	164	165	
54a	4.46	154	155	
54b	3.74	162	163	
55a	5.27	156	157	
55b	4.47	160	161	
56a	3.02	159	174	
57a	18.42	175	176	
57b	28.20	204	205	
58a	15.12	177	178	
58b	28.49	202	203	
59a	19.00	179	180	
59b	34.05	200	201	
60a	39.62	181	182	
60b	36.86	198	199	
61a	42.09	183	184	
61b	47.23	187	188	
62a	34.27	185	186	
63a	23.17	189		
64a	46.92	190	191	
65a	38.01	192	193	
65b	30.04	194	195	
65c	47.93	196	197	
66a	14.52	206		
67a	58.24			1/2 Farm 1
67b	202.34			1/2 Farm 2
68a	58.24			1/2 Farm 1
68b	202.34			1/2 Farm 2
	1581.71			

Non-Agricultural Only

Network Table - Nodes

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 3b	32	1.94	172.48	60.87
Junc 8b	34	2.29	172.46	60.00
Junc 51a	33	2.52	178.33	62.97
Junc 9a	34	2.61	172.41	59.97
Junc 9b	34	2.62	172.41	59.97
Junc 3a	32	2.67	172.48	60.87
Junc 53b	33	2.71	179.43	63.45
Junc 11a	34	2.82	172.52	60.02
Junc 19a	33	2.91	178.40	63.00
Junc 5d	32	2.92	172.41	60.84
Junc 8a	34	2.96	172.46	59.99
Junc 56a	33	3.02	178.62	63.10
Junc 4a	32	3.22	172.45	60.86
Junc 6a	32	3.22	172.54	60.89
Junc 5a	32	3.31	172.41	60.84
Junc 2a	32	3.32	172.58	60.91
Junc 18b	34	3.35	178.22	62.49
Junc 23b	33	3.38	179.75	63.59
Junc 49a	33	3.38	178.24	62.93
Junc 27b	33	3.55	179.54	63.50
Junc 53a	33	3.56	179.42	63.44
Junc 21b	34	3.60	179.06	62.85
Junc 18c	34	3.63	178.21	62.49
Junc 28b	33	3.68	179.18	63.34
Junc 30b	34	3.72	177.90	62.35

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 54b	34	3.74	179.16	62.90
Junc 18d	34	3.75	178.21	62.49
Junc 26a	33	3.76	179.74	63.58
Junc 7a	32	3.81	172.56	60.90
Junc 20b	34	3.87	178.74	62.71
Junc 52a	33	3.87	178.51	63.05
Junc 10a	34	3.92	172.34	59.94
Junc 10c	34	3.93	172.34	59.94
Junc 48a	33	3.95	178.05	62.85
Junc 5c	32	4.06	172.38	60.83
Junc 29b	33	4.09	178.86	63.20
Junc 18a	34	4.16	178.21	62.48
Junc 41a	33	4.20	177.86	62.77
Junc 10b	34	4.22	172.33	59.94
Junc 39a	32	4.27	172.73	60.98
Junc 45a	33	4.28	177.76	62.73
Junc 10d	34	4.28	172.33	59.94
Junc 50a	33	4.35	178.41	63.01
Junc 13b	33	4.36	173.06	60.69
Junc 43a	33	4.45	177.72	62.71
Junc 54a	34	4.46	179.15	62.89
Junc 55b	33	4.47	178.93	63.23
Junc 47a	33	4.48	177.94	62.80
Junc 35b	33	4.48	173.45	60.86
Junc 42a	33	4.50	177.78	62.73
Junc 5b	32	4.6	172.38	60.83

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 2b	32	4.67	172.57	60.91
Junc 1a	32	4.92	172.65	60.94
Junc 34b	33	4.95	174.00	61.10
Junc 12a	33	5.12	172.73	60.54
Junc 46a	33	5.18	177.85	62.76
Junc 31b	33	5.19	176.53	62.19
Junc 14b	33	5.23	173.65	60.94
Junc 55a	33	5.27	178.92	63.23
Junc 25a	33	5.32	180.73	64.01
Junc 17a	33	5.47	177.16	62.46
Junc 17b	33	5.49	177.16	62.47
Junc 33b	33	5.61	174.89	61.48
Junc 16b	33	5.71	175.78	61.87
Junc 38a	32	5.81	173.17	61.17
Junc 30a	34	5.89	177.88	62.35
Junc 15b	33	5.92	174.53	61.32
Junc 35a	33	6.07	173.43	60.85
Junc 37a	32	6.42	172.85	61.03
Junc 31a	33	6.48	176.51	62.18
Junc 29a	33	6.73	178.83	63.19
Junc 32a	33	6.88	175.56	61.77
Junc 36a	32	6.92	172.98	61.09
Junc 34a	33	7.19	173.98	61.09
Junc 27a	33	7.27	179.51	63.48
Junc 28a	33	7.36	179.16	63.33
Junc 33a	33	7.67	174.86	61.47

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 16a	33	8.47	175.76	61.86
Junc 15a	33	8.80	174.48	61.30
Junc 14a	33	8.86	173.59	60.92
Junc 24a	34	10	179.77	63.16
Junc 23a	33	10.40	179.64	63.54
Junc 13a	33	10.90	172.97	60.65
Junc 20a	34	11.01	178.64	62.67
Junc 22a	33	11.19	179.20	63.35
Junc 6b	32	11.23	172.48	60.87
Junc 21a	34	12.49	178.91	62.79
Junc 24b	34	13.29	179.61	63.09
Junc 66a	33	14.52	181.99	64.56
Junc 58a	33	15.12	179.67	63.55
Junc 57a	33	18.42	180.67	63.99
Junc 59a	33	19.00	178.61	63.09
Junc 63a	33	23.17	176.66	62.25
Junc 57b	33	28.20	180.16	63.77
Junc 58b	33	28.49	179.06	63.29
Junc 40a	33	29.86	177.73	62.71
Junc 65b	34	30.04	174.60	60.92
Junc 44a	33	30.15	177.42	62.58
Junc 59b	33	34.05	178.04	62.85
Junc 62a	34	34.27	173.89	60.61
Junc 60b	33	36.86	176.86	62.33
Junc 65a	34	38.01	173.87	60.61
Junc 60a	33	39.62	176.86	62.34

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 61a	33	42.09	173.36	60.82
Junc 64a	33	46.92	175.58	61.78
Junc 61b	33	47.23	173.10	60.70
Junc 65c	34	47.93	172.53	60.03

Non-Agricultural Only

Network Table - Links

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 43A	9.87	2	4.45	0.45
Pipe 40A	11.54	2	29.86	3.05
Pipe 47A	11.77	2	4.48	0.46
Pipe 49A	12.27	2	3.38	0.35
Pipe 42A	12.33	2	4.50	0.46
Pipe 41A	12.45	4	4.20	0.11
Pipe 45A	12.49	2	4.28	0.44
Pipe 46A	12.75	2	5.18	0.53
Pipe 44A	13.01	2	30.15	3.08
Pipe 48A	16.20	2	3.95	0.40
Pipe 50A	17.16	2	4.35	0.44
Pipe 52A	19.91	2	3.87	0.40
Pipe 6B	20.54	2	11.23	1.15
Pipe 55B	21.54	2	4.47	0.46
Pipe 54B	22.61	2	3.74	0.38
Pipe 56A	23.33	2	3.02	0.31
Pipe 17B	23.54	2	5.49	0.56
Pipe 25A	24.23	2	5.32	0.54
Pipe 29B	24.26	2	4.09	0.42
Pipe 12A	24.48	2	5.12	0.52
Pipe 1A	25.44	2	4.92	0.50
Pipe 63A	25.50	2	23.17	2.37
Pipe 3B	25.92	2	1.94	0.20
Pipe 39A	25.94	2	4.27	0.44
Pipe 66A	26.26	2	14.52	1.48

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 11A	26.77	2	2.82	0.29
Pipe 38A	27.02	2	5.81	0.59
Pipe 58A	27.04	2	15.12	1.54
Pipe 62A	27.24	2	34.27	3.50
Pipe 26A	27.44	2	3.76	0.38
Pipe 28A	27.44	2	7.36	0.75
Pipe 60A	27.73	2	39.62	4.05
Pipe 64A	27.73	2	46.92	4.79
Pipe 59A	27.75	2	19.00	1.94
Pipe 20B	27.81	2	3.87	0.40
Pipe 28B	28.51	2	3.68	0.38
Pipe 53B	28.86	2	2.71	0.28
Pipe 27B	28.94	2	3.55	0.36
Pipe 17A	29.05	2	5.47	0.56
Pipe 7A	29.18	2	3.81	0.39
Pipe 33B	29.50	2	5.61	0.57
Pipe 37A	29.50	2	6.42	0.66
Pipe 54A	29.62	2	4.46	0.46
Pipe 55A	30.09	2	5.27	0.54
Pipe 9A	30.10	2	2.61	0.27
Pipe 27A	30.43	2	7.27	0.74
Pipe 6A	30.69	2	3.22	0.33
Pipe 4A	30.73	2	3.22	0.33
Pipe 59B	31.06	2	34.05	3.48
Pipe 32A	31.08	2	6.88	0.70
Pipe 33A	31.08	2	7.67	0.78

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 9B	31.26	2	2.62	0.27
Pipe 29A	31.45	2	6.73	0.69
Pipe 19A	31.77	2	2.91	0.30
Pipe 60B	31.92	2	36.86	3.76
Pipe 36A	32.40	2	6.92	0.71
Pipe 20A	32.60	2	11.01	1.12
Pipe 8A	32.79	2	2.96	0.30
Pipe 30A	33.55	2	5.89	0.60
Pipe 16A	34.32	2	8.47	0.86
Pipe 34A	34.32	2	7.19	0.73
Pipe 31B	34.43	2	5.19	0.53
Pipe 35B	34.63	2	4.48	0.46
Pipe 31A	34.72	2	6.48	0.66
Pipe 2A	34.79	2	3.32	0.34
Pipe 2B	34.97	2	4.67	0.48
Pipe 14B	35.09	2	5.23	0.53
Pipe 8B	35.35	2	2.29	0.23
Pipe 3A	35.53	2	2.67	0.27
Pipe 57A	35.56	2	18.42	1.88
Pipe 15B	35.89	2	5.92	0.60
Pipe 35A	35.91	2	6.07	0.62
Pipe 22A	35.91	2	11.19	1.14
Pipe P81	36.07	12	1060.55	3.01
Pipe 61B	36.41	2	47.23	4.82
Pipe 53A	36.68	2	3.56	0.36
Pipe 51A	36.81	2	2.52	0.26

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 61A	38.34	2	42.09	4.30
Pipe 34B	38.44	2	4.95	0.51
Pipe 13A	38.48	2	10.90	1.11
Pipe 21A	38.80	2	12.49	1.28
Pipe 21B	39.40	2	3.60	0.37
Pipe 30B	39.48	2	3.72	0.38
Pipe 58B	40.94	2	28.49	2.91
Pipe 15A	41.24	2	8.80	0.90
Pipe 14A	42.92	2	8.86	0.90
Pipe 16B	43.43	2	5.71	0.58
Pipe 57B	43.88	2	28.20	2.88
Pipe 13B	44.06	2	4.36	0.45
Pipe 23A	45.35	2	10.40	1.06
Pipe 23B	47.67	2	3.38	0.35
Pipe P8	54.49	4	-18.84	0.48
Pipe 5A	59.74	2	3.31	0.34
Pipe P27	63.90	8	-303.48	1.94
Pipe P36	75.68	4	122.60	3.13
Pipe 18A	76.85	2	4.16	0.42
Pipe 65A	77.85	2	38.01	3.88
Pipe 65C	77.96	2	47.93	4.89
Pipe 10D	78.97	2	4.28	0.44
Pipe 18D	79.35	2	3.75	0.38
Pipe 5B	79.55	2	4.60	0.47
Pipe 24A	80.30	2	10.00	1.02
Pipe 10A	80.34	2	3.92	0.40

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 10B	80.92	2	4.22	0.43
Pipe P9	81.20	4	29.65	0.76
Pipe 10C	81.90	2	3.93	0.40
Pipe 24B	82.31	2	13.29	1.36
Pipe 18B	83.21	2	3.35	0.34
Pipe 18C	84.91	2	3.63	0.37
Pipe P6	84.95	4	-0.58	0.01
Pipe P32	85.27	6	166.98	1.89
Pipe 65B	85.42	2	30.04	3.07
Pipe P47	85.61	4	35.05	0.89
Pipe P43	86.19	4	52.66	1.34
Pipe P66	86.99	4	80.62	2.06
Pipe P22	91.36	6	-120.28	1.36
Pipe P44	93.01	4	45.74	1.17
Pipe P21	94.36	6	-117.37	1.33
Pipe 5D	94.91	2	2.92	0.30
Pipe P13	95.39	4	-48.49	1.24
Pipe P4	99.04	4	18.11	0.46
Pipe 5C	101.65	2	4.06	0.41
Pipe P1	104.91	4	30.13	0.77
Pipe P10	107.80	4	26.83	0.68
Pipe P2	108.94	4	22.14	0.57
Pipe P42	112.73	4	58.47	1.49
Pipe P7	113.29	4	-15.03	0.38
Pipe P19	115.41	4	-122.82	3.14
Pipe P61	115.98	4	-32.34	0.83

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe P39	116.93	4	94.44	2.41
Pipe P45	119.73	4	39.32	1.00
Pipe P25	120.69	6	-155.12	1.76
Pipe P5	124.34	4	14.89	0.38
Pipe P31	124.49	6	170.74	1.94
Pipe P11	131.95	4	21.58	0.55
Pipe P65	135.34	6	-137.17	1.56
Pipe P67	137.70	4	-20.35	0.52
Pipe P60	138.87	4	11.71	0.30
Pipe P38	141.82	4	101.32	2.59
Pipe P26	144.88	6	166.31	1.89
Pipe P3	148.09	4	22.72	0.58
Pipe P35	148.44	6	134.30	1.52
Pipe P30	151.00	8	-511.29	3.26
Pipe P28	152.94	8	-317.26	2.02
Pipe P48	157.35	4	57.75	1.47
Pipe P29	159.04	4	23.29	0.59
Pipe P49	160.04	4	27.89	0.71
Pipe P59	163.33	4	-41.03	1.05
Pipe P14	164.17	4	-53.61	1.37
Pipe P37	165.89	4	112.99	2.88
Pipe P23	167.35	6	-124.15	1.41
Pipe P18	168.44	4	-111.86	2.86
Pipe P55	169.11	4	-24.87	0.63
Pipe P41	169.24	4	69.02	1.76
Pipe P12	169.80	4	16.35	0.42

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe P63	172.46	6	-122.70	1.39
Pipe P33	172.53	6	156.16	1.77
Pipe P56	173.14	4	-29.35	0.75
Pipe P58	174.14	4	-36.68	0.94
Pipe P50	177.52	4	23.69	0.60
Pipe P64	177.62	6	-130.90	1.49
Pipe P34	178.00	6	145.12	1.65
Pipe P15	179.76	4	-68.87	1.76
Pipe P52	182.56	4	14.74	0.38
Pipe P51	183.00	4	19.19	0.49
Pipe P16	191.64	4	-82.96	2.12
Pipe P24	194.04	6	-139.03	1.58
Pipe P62	196.48	6	-112.96	1.28
Pipe P40	198.56	4	81.16	2.07
Pipe P82	200	15	1060.55	1.93
Pipe P17	200.38	4	-97.68	2.49
Pipe P57	211.71	4	-33.30	0.85
Pipe P73	214.88	8	-309.66	1.98
Pipe P20	216.76	4	14.89	0.38
Pipe P75	221.38	4	123.59	3.16
Pipe P69	237.23	8	529.42	3.38
Pipe P76	241.24	6	146.76	1.67
Pipe P77	242.39	6	162.90	1.85
Pipe P74	250.62	4	34.27	0.87
Pipe P70	277.09	8	482.80	3.08
Pipe P54	278.36	4	-19.69	0.50

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe P71	280.69	8	439.19	2.80
Pipe P68	294.59	8	-516.61	3.30
Pipe P53	369.62	4	-15.41	0.39
Pipe P72	377.97	8	386.14	2.46
Pipe P79	385.06	10	1060.55	4.33
Pipe P78	436.32	6	115.98	1.32

Agricultural Only

Network Table - Nodes

Node ID	Elevation ft	Base Demand GPM	Head ft	Pressure psi
Junc 67a	34	58.24	186.06	65.89
Junc 68a	33	58.24	172.60	60.49
Junc 67b	34	202.34	186.07	65.89
Junc 68b	33	202.34	172.00	60.23

Agricultural Only

Network Table - Links

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe 68A	23.08	4	58.24	1.49
Pipe 68B	27.24	4	202.34	5.17
Pipe P81	36.07	12	521.16	1.48
Pipe 67B	43.66	4	202.34	5.17
Pipe P8	54.49	4	-121.04	3.09
Pipe P27	63.90	8	-157.15	1.00
Pipe P36	75.68	4	139.54	3.56
Pipe P6	84.95	4	-121.04	3.09
Pipe P32	85.27	6	103.43	1.17
Pipe P47	85.61	4	-121.04	3.09
Pipe P43	86.19	4	139.54	3.56
Pipe P66	86.99	4	37.34	0.95
Pipe P80	89.96	4	260.58	6.65
Pipe P22	91.36	6	-85.73	0.97
Pipe P44	93.01	4	139.54	3.56
Pipe P21	94.36	6	-85.73	0.97
Pipe P13	95.39	4	-121.04	3.09
Pipe P1	104.91	4	-121.04	3.09
Pipe P2	108.94	4	-121.04	3.09
Pipe P42	112.73	4	139.54	3.56
Pipe P7	113.29	4	-121.04	3.09
Pipe P19	115.41	4	-121.04	3.09
Pipe P61	115.98	4	-34.07	0.87
Pipe P39	116.93	4	139.54	3.56
Pipe P45	119.73	4	139.54	3.56

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe P25	120.69	6	-85.73	0.97
Pipe P31	124.49	6	103.43	1.17
Pipe P65	135.34	6	-71.42	0.81
Pipe P67	137.70	4	-35.31	0.90
Pipe P60	138.87	4	-36.11	0.92
Pipe P38	141.82	4	139.54	3.56
Pipe P26	144.88	6	85.73	0.97
Pipe P35	148.44	6	103.43	1.17
Pipe P30	151.00	8	-260.58	1.66
Pipe P28	152.94	8	-157.15	1.00
Pipe P48	157.35	4	2.03	0.05
Pipe P49	160.04	4	2.03	0.05
Pipe P59	163.33	4	2.03	0.05
Pipe P14	164.17	4	-121.04	3.09
Pipe P37	165.89	4	139.54	3.56
Pipe P23	167.35	6	-85.73	0.97
Pipe P18	168.44	4	-121.04	3.09
Pipe P55	169.11	4	2.03	0.05
Pipe P41	169.24	4	139.54	3.56
Pipe P63	172.46	6	-71.42	0.81
Pipe P33	172.53	6	103.43	1.17
Pipe P56	173.14	4	2.03	0.05
Pipe P58	174.14	4	2.03	0.05
Pipe P50	177.52	4	2.03	0.05
Pipe P64	177.62	6	-71.42	0.81
Pipe P34	178.00	6	103.43	1.17

Link ID	Length ft	Diameter in	Flow GPM	Velocity fps
Pipe P46	179.71	6	-260.58	2.96
Pipe P15	179.76	4	-121.04	3.09
Pipe P52	182.56	4	2.03	0.05
Pipe P51	183.00	4	2.03	0.05
Pipe P16	191.64	4	-121.04	3.09
Pipe P24	194.04	6	-85.73	0.97
Pipe P62	196.48	6	-71.42	0.81
Pipe P40	198.56	4	139.54	3.56
Pipe P82	200	15	521.16	0.95
Pipe P17	200.38	4	-121.04	3.09
Pipe P57	211.71	4	2.03	0.05
Pipe P54	278.36	4	2.03	0.05
Pipe P68	294.59	8	-260.58	1.66
Pipe P53	369.62	4	2.03	0.05
Pipe P79	385.06	10	260.58	1.06
Pipe 67A	446.00	4	58.24	1.49

APPENDIX E

Pump O&M Manual

TEL (801) 394-4515 • FAX (801) 392-7544 • 5746 South 1475 East • Ogden, Utah 84403 • www.greatbasinengineering.com

SP

Stainless steel submersible pumps 4", 6", 8", and 10"

Installation and operating instructions

be
think
innovate

GRUNDFOS

Original installation and operating instructions

CONTENTS

WARNING

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

Keep this booklet with the pump for future reference and information regarding its operation.

WARNING

The installation of this product requires experience with and knowledge of the product.

Persons with reduced physical, sensory or mental capabilities must not use this product, unless they are under supervision or have been instructed in the use of the product by a person responsible for their safety. Children must not use or play with this product.

1. Limited warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, FOB Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

2. Symbols used in this document

WARNING

If these safety instructions are not observed, it may result in personal injury.

WARNING

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

CAUTION

Caution

If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

Note

Notes or instructions that make the job easier and ensure safe operation.

3. Product description

3.1 Introduction

Your Grundfos SP submersible pump is of the highest quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

3.2 Applications

Grundfos SP submersible pumps are suitable for the following applications:

- groundwater supply to waterworks
- irrigation in horticulture and agriculture
- groundwater lowering (dewatering)
- pressure boosting
- industrial applications
- domestic water supply.

3.3 Features and benefits

- State-of-the-art hydraulics provide high efficiency and low operating costs
- 100 % stainless steel components inside and outside for long service life
- sand resistant
- resistant to aggressive water
- monitoring, protection, and communication via protection unit MP 204, and GO remote control.

3.4 Type key

Example **475 S 500 - 5 - A B**

- 475: Rated flow rate in gpm
- S: Type range
  Stainless steel parts of material
  S = AISI 304
  N = AISI 316
  R = AISI 904L
- 500: Hp of motor
- 5: Number of impellers
- A: First reduced-diameter impeller (A, B or C)
- B: Second reduced-diameter impeller (A, B or C)

4. Delivery, handling and storage

4.1 Delivery

CAUTION

Caution

Keep the pump in the shipping carton until it is placed in the vertical position during installation.

Handle the pump with care.

Examine the components carefully to make sure no damage has occurred to the pump end, motor, cable or control box during shipment.

4.2 Handling

Keep the pump in the shipping carton until it is ready to be installed. The shipping carton is specially designed to protect it from damage. During unpacking and prior to installation, make sure that the pump is not dropped or mishandled.

Do not expose the pump to unnecessary impact and shocks.

The motor is equipped with a power cable.

CAUTION

Caution

Never use the power cable to support the weight of the pump.

You will find a loose nameplate with an adhesive backing with the pump. If the nameplate is blank, complete it in pen and attach it to the control box.

Note

Fix the extra nameplate supplied with the pump at the installation site.

4.3 Storage

4.3.1 Storage temperature

Pump: -4 - +140 °F (-20 - +60 °C).

Motor: -4 - +158 °F (-20 - +70 °C).

Store the motors in a closed, dry and well ventilated room.

CAUTION

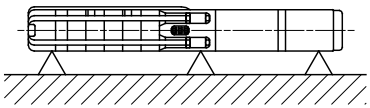
Caution

If MMS motors are stored, the shaft must be turned by hand at least once a month. If a motor has been stored for more than one year before installation, the rotating parts of the motor must be dismantled and checked before use.

Do not expose the pump to direct sunlight.

If the pump has been unpacked, store it horizontally, adequately supported, or vertically to prevent misalignment. Make sure that the pump cannot roll or fall over.

During storage, the pump can be supported as shown in fig. 1.



TM00 1349 2495

Fig. 1 Pump position during storage

4.3.2 Frost protection

If the pump has to be stored after use, it must be stored on a frost-free location, or the motor liquid must be frost-proof.

5. Operating conditions

Flow rate, Q:		Up to 1400 gpm (318 m^3/h)
Head, H:		Up to 2657 ft (810 m)
Liquid temperature:		32-140 °F (0-60 °C)
Maximum submersible depth:	MS 402	492 ft (150 m) (213 psi)
	MS 4000	1969 ft (600 m) (852 psi)
	MS 6000	1969 ft (600 m) (852 psi)
	All MMS	1969 ft (600 m) (852 psi)

6. Installation

Install products in accordance with the local code of the authority having jurisdiction. Installation must be carried out by a qualified person.

WARNING

Risk of electric shock. Do not remove cord and strain relief. Do not connect conduit to pump.

6.1 Pre-installation checklist

Make the following checks before beginning installation:

- condition of the well
- condition of the water
- installation depth
- power supply
- cable type.

These checks are all critical for the proper installation of this submersible pump.

6.1.1 Condition of the well

If the pump is to be installed in a new well, make sure that the well is fully developed and bailed or blown free of cuttings, drillings and sand. The stainless steel construction of the Grundfos submersible pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil-lubricated line-shaft turbine pump in an existing well, the well must be blown or bailed clear of oil.

Determine the maximum depth of the well, and the draw-down level at the pump's maximum capacity. Use this data for pump selection and to determine installation depth.

Check the inside diameter of the well casing to ensure that it is larger than the size of the pump and motor.

6.2 Positional requirements

WARNING

Leave the inlet screen in place if the pump installation is accessible to human touch.

Depending on the motor type, the pump can be installed either vertically or horizontally. A complete list of motor types suitable for horizontal installation is shown in section *6.2.1 Motors suitable for horizontal installation*.

If the pump is installed horizontally, make sure that the outlet port never falls below the horizontal plane. See fig. 2.

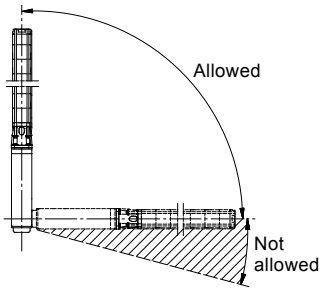


Fig. 2 Positional requirements

If the pump is installed horizontally, e.g. in a tank, we recommend that you fit it in a flow sleeve.

6.2.1 Motors suitable for horizontal installation

Motor	Output power 60 Hz	Output power 50 Hz
	[Hp (kW)]	[Hp (kW)]
MS	0.5 - 40 (0.37 - 30)	All
MMS6	50-60 (37 - 44.7)	5-50 (3.7 - 37)
MMS 8000	30-150 (22-112)	30-150 (22-112)
MMS 10000	100-250 (75-190)	100-250 (75-190)

CAUTION

Caution

During operation, the suction interconnector of the pump must always be completely submerged in the liquid. Make sure that the NPSH values are fulfilled.

WARNING

If the pump is used for pumping hot liquids of 104-140 °F (40-60 °C), make sure that persons cannot come into contact with the pump and the installation, e.g. by installing a guard.

6.2.2 Pumped liquids

CAUTION

Caution

This pump has been tested for use with water only. Water temperature should not exceed rated motor temperature. SP pumps can withstand water temperatures up to 140°F (60°C). Water temperature that exceeds motor rated temperature directly shortens the motor life. The suitability of this pump for use with liquids other than water is the responsibility of the end user.

Submersible pumps are designed for pumping the following liquids:

- clear and cold water that is free of air and gasses
- clean, thin, non-explosive liquids without solid particles or fibers.

Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gasses.

See the flow velocity table in section *10.1 Motor cooling requirements*.

Flow rate, Q:	0.44 - 1475 gpm (0.1 - 335 m^3/h)
Head, H:	Maximum 2657 ft (810 m)

When the pump and motor are used for pumping water above the rated temperatures of the motor, pay special attention to minimum water flow past the motor for cooling. Water temperature that exceeds motor rated temperature directly shortens the motor life.

The Grundfos stainless steel submersible pump is highly resistant to the normal corrosive environment found in some water wells. If water well tests show that the water has an excessive or unusual corrosive quality, or exceeds the motor temperature rating, contact your Grundfos representative for information concerning specially designed pumps for these applications.

6.3 Preparation

WARNING

Before starting work on the pump, make sure that the power supply has been switched off and that it cannot be accidentally switched on.

6.3.1 Checking of liquid in motor

The MS submersible motors are factory-filled with SML-3 liquid, which is frost-proof down to -4 °F (-20 °C).

Note

Check the level of the liquid in the motor, and refill the motor, if required. Use clean water.

CAUTION

Caution

If frost protection is required, use special Grundfos liquid to refill the motor. Otherwise clean water may be used for refilling. However, never use distilled water.

Carry out refilling of liquid as described below.

6.3.2 Grundfos submersible motors MS 4000 and MS 402

The filling hole for motor liquid is placed in the following positions:

MS 4000: In the top of the motor.

MS 402: In the bottom of the motor.

1. Position the submersible pump as shown in fig. 3.
   Make sure that the filling screw is at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe as shown in fig. 3 until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the pump.

Torques:

MS 4000: 2.2 ft-lbs (3.0 Nm).

MS 402: 1.5 ft-lbs (2.0 Nm).

The submersible pump is now ready for installation.

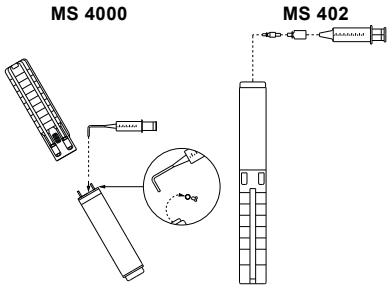


Fig. 3 Pump position during filling, MS 4000 and MS 402

6.3.3 Grundfos submersible motors, MS 6000C

- If the motor is delivered from stock, the liquid level must be checked before the motor is fitted to the pump. See fig. 4.
- On pumps delivered directly from Grundfos, the liquid level has already been checked.
- In the case of service, the liquid level must be checked. See fig. 4.

Filling procedure:

The filling hole for motor liquid is placed in the top of the motor.

1. Position the submersible pump as shown in fig. 4.
   Make sure that the filling screw is at the highest point of the motor.
2. Remove the screw from the filling hole.
3. Inject liquid into the motor with the filling syringe (see fig. 4) until the liquid runs back out of the filling hole.
4. Replace the screw in the filling hole and tighten securely before changing the position of the motor.

Torque: 2.2 ft-lbs (3.0 Nm).

The submersible pump is now ready for installation.

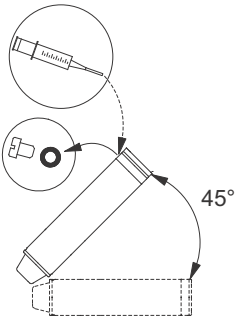


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Fig. 4 Motor position during filling, MS 6000C

6.3.4 Grundfos submersible motors, MMS6, MMS 8000, and MMS 10000

Filling procedure:

1. Place the motor at a 45 ° angle with the top of the motor upwards. See fig. 5.
2. Unscrew the plug A and place a funnel in the hole.
3. Pour tap water into the motor until the motor liquid inside the motor starts running out at A.

CAUTION

Caution

Do not use motor liquid as it contains oil.

4. Remove the funnel and refit the plug A.

CAUTION

Caution

Before fitting the motor to a pump after a long period of storage, lubricate the shaft seal by adding a few drops of water and turning the shaft.

The submersible pump is now ready for installation.

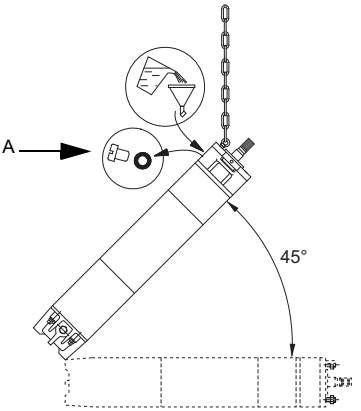

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Fig. 5 Motor position during filling, MMS

6.3.5 Installation depth

Make sure that the installation depth of the pump is always at least 3 ft (1 m) below the maximum draw-down level of the well. For flow rates exceeding 100 gpm (22.7 m^3/h), refer to performance curves for recommended minimum submergence.

Never install the pump so that the bottom of the motor is lower than the top of the well screen or within five feet of the well bottom.

If the pump is to be installed in a lake, pond, tank or large diameter well, make sure that the water velocity passing over the motor is sufficient to ensure proper motor cooling. The minimum recommended water flow rates ensuring proper cooling are listed in section *10.1 Motor cooling requirements*.

6.3.6 Power supply

Check the motor voltage, phase number and frequency indicated on the motor nameplate against the actual power supply.

6.3.7 Power cable type

The power cable used between the pump and control box or control panel must be approved for submersible pump applications. Conductors may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation must be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association (CSA) certified cable may also be used. See section *10.4 Submersible drop cable selection charts (60 Hz)* for recommended cable lengths.

6.4 Removing and fitting the cable guard

If the cable guard is attached with screws, remove the screws to loosen the cable guard. To fit the cable guard on the pump, tighten the screws to fit the cable guard securely to the pump.

CAUTION

Caution When the cable guard has been fitted, make sure that the pump chambers are aligned.

6.5 Splicing the motor cable

Note A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

If the splice is carefully made, it will work as well as any other portion of the cable, and will be completely watertight. Grundfos recommends that you use a heat shrink splice kit. Make the splice in accordance with the kit manufacturer's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the submersible drop cable carefully for damage.
2. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. See fig. 6. On single-phase motors, be sure to match the colors.
3. Strip back and trim off 1/2 inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation.
4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-Kon" type connector on each lead, making sure that lead colors are matched. Using "Sta-Kon" crimping pliers, indent the lugs. See fig. 7. Be sure to squeeze hard on the pliers, particularly in the case of a large cable.
5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working towards the ends. See fig. 8.
6. Continue to apply the heat to the tubing taking care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete. See fig. 9.

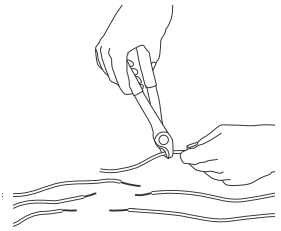

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Fig. 6 Cutting and stripping the motor leads

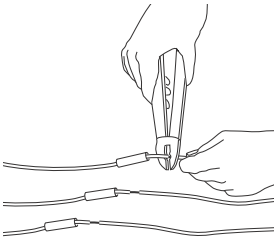

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Fig. 7 Crimping the connectors

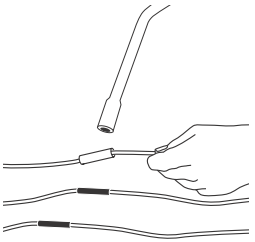

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Fig. 8 Applying heat to the connector

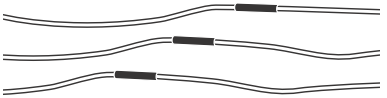

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Fig. 9 Completed splices

6.6 Riser pipe

Note Make sure that the riser pipe or hose are properly sized and selected on the basis of estimated flow rates and friction-loss factors.

6.6.1 If an adapter is required

We recommend that you first install the riser pipe to the pipe adapter. Then install the riser pipe with the adapter to the pump outlet port.

Use a back-up wrench when attaching the riser pipe to the pump. Make sure that the pump is gripped only by the flats on the top of the outlet chamber. The body of the pump, cable guard or motor must not be gripped under any circumstance.

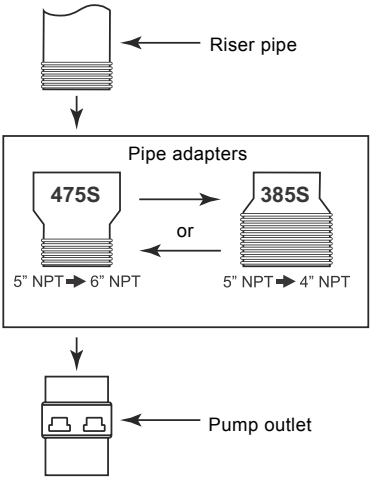

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Fig. 10 Pipe adapters

6.6.2 If a steel riser pipe is used

We recommend that you always use steel riser pipes with the large submersible pumps. Use an approved pipe thread compound on all joints. Make sure the joints are adequately tightened in order to prevent the joints from coming loose when the motor starts and stops.

When tightened, make sure that the first section of the riser pipe does not come in contact with the check valve retainer.

After the first section of the riser pipe has been attached to the pump, clamp the lifting wire to the pump, if there is a provision on the pump for a lifting wire. If not, clamp the lifting wire to the first section of the riser pipe.

When raising the pump and riser pipe section to upright position, be careful not to place bending stress on the pump by picking it up by the pump end only.

Make sure that the power cables are not cut or damaged in any way when the pump is being lowered in the well.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage. Nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with clips or tape just above and below the splice.

6.6.3 If a plastic or flexible riser pipe is used

We recommend that you use plastic type riser pipes only with the smaller domestic submersible pumps.

CAUTION

Caution When a plastic riser pipe is used, we recommend that you attach a safety cable to the pump to lower and raise it.

Note Important: Plastic and flexible pipes tend to stretch under load. Take this stretching into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch also affects the calculation of the pump installation depth. As a general rule, you can estimate that plastic pipe stretches to approximately 2 % of its length. For example, if you installed 200 feet (61 m) of plastic riser pipe, the pump may actually be down 204 feet (62 m). If the installation depth is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

Contact the pipe manufacturer or representative to ensure that the pipe type and physical characteristics are suitable for this use.

Use the correct joint compound recommended by the pipe manufacturer. In addition to making sure that joints are securely fastened, we recommend that you use a torque arrester when using a plastic pipe.

Do not connect the first plastic or flexible riser pipe section directly to the pump. Always attach a metallic nipple or adapter into the valve casing at the top of the pump. When tightened, make sure that the threaded end of the nipple or adapter does not come in contact with the check valve retainer.

Fasten the submersible drop cable to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Grundfos nylon cable clips or waterproof tape may be used. Protect the cable splice by securing it with Grundfos cable clips or tape just above each joint.

Check valves

Always install a check valve at the top of the well. In addition, for installations deeper than 200 feet (61 m), install check valves at no more than 200 ft (61 m) intervals.

Protect the well from contamination

To protect against surface water entering the well and contaminating the water source, make sure that the well is finished off above grade and that a locally approved well seal or pitless adapter unit is utilized.

6.7 Electrical and variable-frequency drive information

WARNING

USA: All electrical work must be performed by a qualified electrician and installed in accordance with the National Electrical Code, local codes and regulations.

WARNING

Canada: All electrical work must be performed by a qualified electrician and installed in accordance with the Canadian Electrical Code, local codes and regulations.

WARNING

Provide acceptable grounding in order to reduce the risk of electric shock during operation of this pump. If the means of connection to the box connected to the power supply is other than a grounded metal conduit, ground the pump by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the terminal box.

Make sure that the voltage, phase number and frequency of the power supply match those of the motor. Motor voltage, phase number, frequency and full-load current information can be found on the nameplate attached to the motor.

Motor electrical data can be found in section *10.6.1 Grundfos submersible motors, 60 Hz*.

WARNING

If voltage variations are larger than ± 10 %, do not operate the pump.

Direct-on-line starting is used due to the extremely short run-up time of the motor (maximum 0.1 second), and the low moment of inertia of the pump and motor. Direct-on-line starting current (locked rotor current) is between 4 and 6.5 times the full-load current.

If direct-on-line starting is not acceptable and reduced starting current is required, use an autotransformer or resistant starters for 5 to 30 hp motors, depending on the cable length. For motors over 30 hp, use autotransformer starters.

6.7.1 Engine-driven generators

If the submersible pump is going to be operated by an engine driven generator, we suggest that you contact the manufacturer of the generator to ensure the proper generator is selected and used. See section *10.2 Guide for engine-driven generators in submersible pump applications* for generator sizing guide.

If power is going to be supplied through transformers, section *10.3 Transformer capacity required for three-phase submersible motors* outlines the minimum KVA rating and capacity required for satisfactory pump operation.

6.7.2 Control box or panel wiring

Single-phase motors

Connect single-phase motors as indicated in the motor control box.

A typical single-phase wiring diagram using a Grundfos control box is shown in fig. 11.

CAUTION

Caution Motor burnout protection via CUE, CU331SP, or MP 204.

Use approved dry-run protection such as with MP 204.

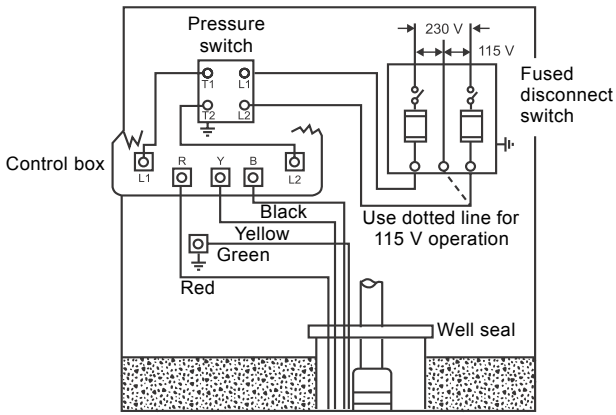

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Fig. 11 Single-phase wiring diagram for Grundfos control boxes

Three-phase motors

Use three-phase motors with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current imbalance and overload current.

Use a properly sized starter with ambient-compensated, class 10, extra quick-trip overload relays or an MP204 to give the best possible motor winding protection.

Each of the three motor legs must be protected with overloads. The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. A three-phase motor wiring diagram is shown in fig. 12.

CAUTION

Caution

Ensure that the pump is totally submerged before you check the direction of rotation. Severe damage may be caused to the pump and motor if they are run dry.

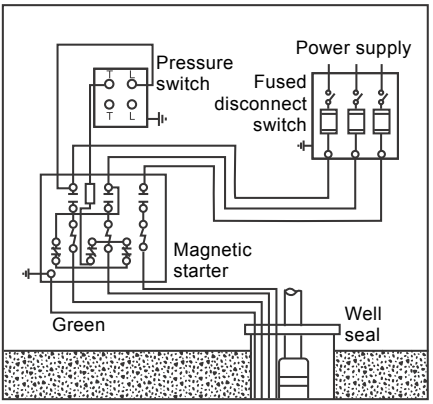

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Fig. 12 Three-phase wiring diagram for Grundfos motors and other motor manufacturers

6.7.3 Variable-frequency drive operation

Grundfos motors

Three-phase Grundfos motors can be connected to a variable frequency drive (VFD).

Note

If a Grundfos MS motor with temperature transmitter is connected to a variable frequency drive, a fuse incorporated in the transmitter will melt, and the transmitter will be inactive. The transmitter cannot be reactivated. This means that from that point on, the motor will operate like a motor without a temperature transmitter.

If a new temperature transmitter is required, a Pt100/1000 sensor for fitting to the submersible motor can be ordered from Grundfos.

During variable-frequency drive operation, we recommend that you do not run the motor at a frequency higher than the nominal frequency (50 or 60 Hz) and not lower than 30 Hz. In connection with pump operation, it is important never to reduce the frequency (and consequently the speed) to such a low level that the necessary flow of cooling liquid past the motor is no longer ensured.

To avoid damage to the pump, make sure that the motor stops when the pump flow falls below 0.1 x rated flow.

Depending on the type of variable frequency drive, it may expose the motor to detrimental voltage peaks.

The variable frequency drive must have some kind of output sine-wave filter to limit voltage peaks (Upeak) and to reduce dU/dt (or dV/dt) which causes stress on the insulation of the submersible motor. For sine-wave filter location placement within the system, see fig. 13.

CAUTION

Caution

We recommend that you protect your motor from voltage peaks (Upeak) and excess dU/dt (or dV/dt) by using a sine-wave filter if one or more of the following conditions are present:

- The motor nameplate voltage is above 379 V.
- The variable frequency drive (VFD) uses pulse width modulation (PWM) and/or IGBT-BJT switches.
- The VFD voltage rise time is less than 2 msec (NEMA MG 1-2011).
- The power cable length from the VFD to the submersible motor terminals is 0 to 1500 ft (0 to 457 m).
- The power quality is not stable.
- Keep the motor peak voltage (U_{peak}) and dU/dt within the limits listed in the table below.

For recommended best practice, use a resistor-inductor-capacitor (RLC) type sine-wave filter. An equivalent type LC sine-wave filter is acceptable.

Consult the VFD manufacturer for specific sine-wave filter recommendation.

Maximum peak voltage and dU/dt for Grundfos submersible motors		
Motor series	**Maximum U_{peak} voltage**	**Maximum dU/dt**
MS 402	650 V phase-phase	2000 V/micro s.
MS 4000	850 V phase-phase	2000 V/micro s.
MS6 / MS 6000C	850 V phase-phase	2000 V/micro s.
MMS6 / MMS 6000	850 V phase-ground	500 V/micro s.
MMS 8000	850 V phase-ground	500 V/micro s.
MMS 10000	850 V phase-ground	500 V/micro s.

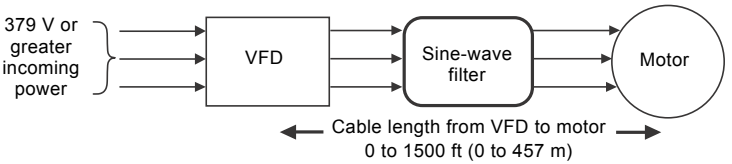


Fig. 13 Location of the sine-wave filter in the system

For further details, contact your VFD supplier or Grundfos.

6.7.4 High-voltage surge arresters

Use a high-voltage surge arrester to protect the motor against lightning and switching surges.

Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area.

Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

Install the correct voltage-rated surge arrester on the supply side of the control box. See fig. 14 and fig. 15. The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations.

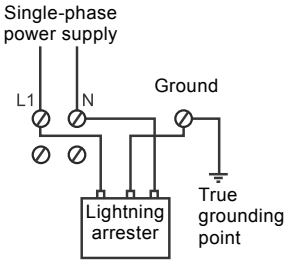


Fig. 14 Single-phase installation

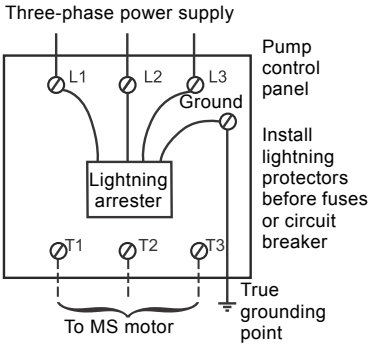


Fig. 15 Three-phase installation

The warranty on all three-phase submersible motors becomes void in these cases:

- The motor is operated with single-phase power through a phase converter.
- Three-leg ambient compensated, extra quick-trip overload protectors are not used.
- Three-phase current imbalance is not checked and recorded. See section *7. Startup*.
- High-voltage surge arresters are not installed.

Note

6.7.5 Control box or panel grounding

WARNING

The control box or control panel must be permanently grounded in accordance with the National Electrical Code and local codes or regulations.

The ground wire must be a bare copper conductor at least the same size as the submersible drop cable wire size.

Run the ground wire as short a distance as possible and fasten it securely to a true grounding point.

True grounding points are considered to be one of the following:

- a grounding rod driven into the water strata
- a steel well casing submerged into the water lower than the pump installation depth
- steel outlet pipes without insulating couplings.

If plastic outlet pipe and well casing are used or if a grounding wire is required by local codes, connect a properly sized, bare copper wire to a stud on the motor and run to the control panel.

WARNING

Do not ground to a gas supply line. Connect the grounding wire to the ground point first and then to the terminal in the control box or control panel.

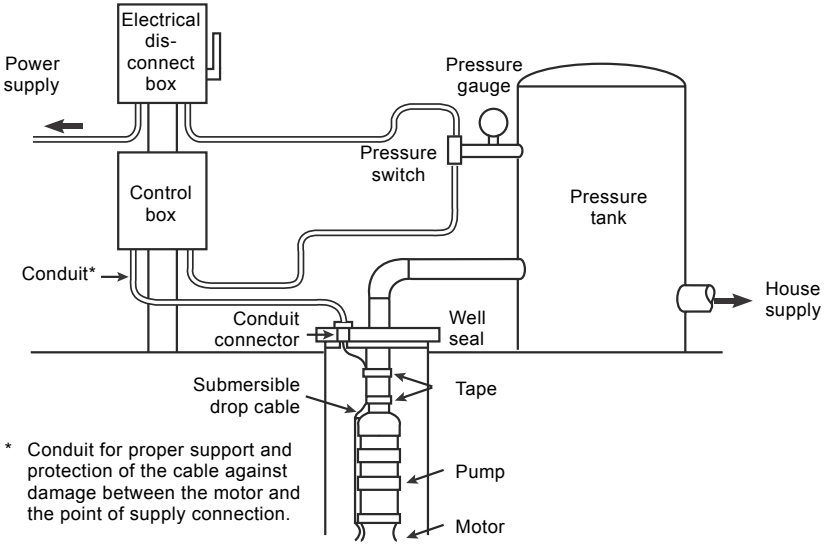


Fig. 16 Wiring and installation diagram

6.7.6 Wiring checks and installation

Before making the final surface wiring connection of the submersible drop cable to the control box or control panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 200 megaohms. See the table in section *6.7.7 Insulation resistance and ohm value chart*.

If the insulation resistance of the cable and splice is measured at higher than 200 megaohms, run the submersible drop cable through the well seal by means of a conduit connector to prevent foreign matter from entering the well casing.

Always protect the submersible drop cable with conduit from the pump to the control box or control panel. See fig. 16.

Finish the wiring and verify that all electrical connections are made in accordance with the wiring diagram.

Check to ensure that the control box or control panel and high-voltage surge arrester have been grounded.

Route conductors properly such as in conduit where called for by Local Code to protect the conductors.

6.7.7 Insulation resistance and ohm value chart

Insulation resistance in a submersible pumping system is a measure of the ability of the motors and/or cables to withstand normal voltage and transient voltage without breakdown and failure. An "adequate" level of insulation resistance is not a constant value, but depends on the installation voltage and conditions, and whether the measured resistance is lowered by a specific weak point or by widely distributed conductance such as in cable insulation material itself. For this reason, values for acceptable resistance cannot be specific.

Insulation resistance measurements

Measure insulation resistance at the time of initial motor installation and periodically thereafter. In deep set submersible installations, take measurements throughout the installation process to detect potential cable insulation or connection damage before the unit is completely installed. The insulation resistance table in this section describes the condition of the insulation system for a submersible motor system of 600 V or less, based on megohmmeter readings.

Note Measure the insulation resistance in accordance with local codes and regulations.

The table below shows suggested values of insulation resistance and the test voltage in relation to the rated voltage of the motor.

Rated voltage	**≤ 500 [V]**	**> 500 [V]**
Condition of motor and cable	[MΩ]	[MΩ]
New motor without submersible drop cable	≥ 200	≥ 200
Used motor which can be re-installed in well	≥ 10	≥ 10
New motor in well	≥ 20	≥ 20
Motor in good condition in well	≥ 0.5	≥ 1
Damaged insulation	< 0.5	< 1

If the rated motor voltage is less than or equal to 500 V, the insulation resistance must be measured at a test voltage of 500 VDC.

If the rated motor voltage is greater than 500 V, the insulation resistance must be measured at a test voltage of 1000 VDC.

7. Startup

After the pump has been set into the well and the wiring connections have been made, go through the following procedures:

1. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
2. Adjust the gate valve one-third of the way open.
3. On three-phase units, check direction of rotation and current imbalance according to the instructions below. For single-phase units proceed directly to *7.1.3 Developing the well*.
4. Do not operate the pump with the outlet valve closed. This can result in motor and pump damage due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

7.1 Startup with three-phase motors

7.1.1 Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50 % chance that the motor will run in the proper direction. To make sure the motor is running in the proper direction, carefully follow these procedures:

1. Start the pump and check the water quantity and pressure developed.
2. Stop the pump and interchange any two leads.
3. Start the pump and again check the water quantity and pressure.
4. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

7.1.2 Check for current imbalance

Current imbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current imbalance be checked in all three-phase systems.

Note Make sure that the current imbalance between the phases do not exceed 5 % under normal operating conditions.

Determine if the supply power service is a two-transformer or three-transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See section *10.3 Transformer capacity required for three-phase submersible motors*.

The percentage of current imbalance can be calculated by means of the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% current imbalance} = \frac{\text{Greatest amp difference from the average}}{\text{Average current}} \times 100$$

To determine the percentage of current imbalance:

1. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.
2. Shift or roll the motor leads from left to right so the submersible drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.
3. Again shift submersible drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.
4. Add the values for each hookup.
5. Divide the total by 3 to obtain the average.
6. Compare each single leg reading from the average to obtain the greatest amp difference from the average.
7. Divide this difference by the average to obtain the percentage of imbalance.

Use the wiring hookup which provides the lowest percentage of imbalance. See section *10.6.3 Correcting for three-phase current imbalance* for a specific example of correcting for three-phase current imbalance.

7.1.3 Developing the well

After proper rotation and current imbalance have been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.

Slowly open the valve in small increments as the water clears until the desired flow rate is reached. Do not operate the pump beyond its maximum flow rating.

Note Do not stop the pump until the water runs clear.

If the water is clean and clear when the pump is first started, open the valve slowly until the desired flow rate is reached. As the valve is being opened, check the drawdown to ensure that the pump is always submerged.

Note Make sure that the dynamic water level is always more than 3 feet (0.9 m) above the suction interconnector of the pump.

Disconnect the temporary piping arrangements and complete the final piping connections.

CAUTION

Caution Do not operate the pump with the outlet valve closed. This can result in motor and pump damage due to overheating. Install a properly sized relief valve at the well head to prevent the pump from running against a closed valve.

Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

8. Operation

Check the pump and system periodically for water quantity, pressure, drawdown, periods of cycling and operation of controls.

If the pump fails to operate, or there is a loss of performance, refer to section *9. Troubleshooting*.

8.1 Minimum flow rate

To ensure the necessary cooling of the motor, do not set the pump flow rate so low that the cooling requirements specified in section *6.2.2 Pumped liquids* cannot be met.

8.1.1 Frequency of starts and stops

Motor type		Number of starts
MS 402		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 4000		• Minimum 1 per year is recommended. • Maximum 100 per hour. • Maximum 300 per day.
MS 6000C		• Minimum 1 per year is recommended. • Maximum 30 per hour. • Maximum 300 per day.
MMS6	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 40 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 10 per hour. • Maximum 70 per day.
MMS 8000	PVC windings	• Minimum 1 per year is recommended. • Maximum 3 per hour. • Maximum 30 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 8 per hour. • Maximum 60 per day.
MMS 10000	PVC windings	• Minimum 1 per year is recommended. • Maximum 2 per hour. • Maximum 20 per day.
	PE/PA windings	• Minimum 1 per year is recommended. • Maximum 6 per hour. • Maximum 50 per day.

8.2 Soft starter

The starting voltage is minimum 55 % of the value stamped on the nameplate.

If a high locked-rotor torque is required or if the power supply is not optimal, the starting voltage must be higher.

Run-up time (until voltage stamped on nameplate is reached): Maximum 3 seconds.
Run-out time: Maximum 3 seconds.

If the above-mentioned run-up and run-out ramps are followed, unnecessary heating of the motor is avoided.

If the soft starter is fitted with bypass contacts, the soft starter will only be in operation during run-up and run-out.

Do not use the soft starter in connection with operation via a generator.

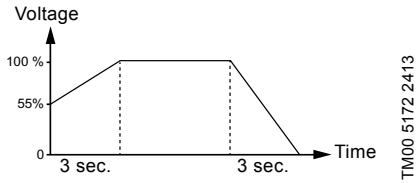


Fig. 17 Operation with a soft starter

8.3 Maintenance and service

All pumps are easy to service.

Service kits and service tools are available from Grundfos.

The pumps can be serviced at a Grundfos service center.

WARNING

If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

If Grundfos is requested to service the pump, Grundfos must be contacted with details about the pumped liquid, etc. before the pump is returned for service. Otherwise Grundfos can refuse to accept the pump for service.

Possible costs of returning the pump are paid by the customer.

9. Troubleshooting

The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed:

- a combination of voltmeter and ammeter
- an ohmmeter.

These are relatively inexpensive and can be obtained from most water systems suppliers.

WARNING

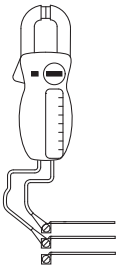
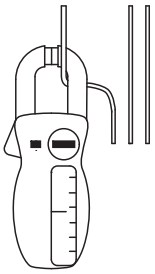
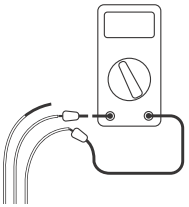
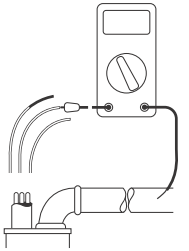
When working with electrical circuits, use caution to avoid electric shock.

We recommend that you use rubber gloves and boots and that you take care to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well.

WARNING

Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electric shock.

9.1 Preliminary tests

Test	How to measure	What it means
Supply voltage  TM00 1371 5092	By means of a voltmeter set to the proper scale, measure the voltage at the control box or starter. • On single-phase units, measure between line and neutral. • On three-phase units, measure between the legs (phases).	When the motor is under load, the voltage must be within ± 10 % of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor power supply and the pump must not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor must be changed to the correct supply voltage.
Current  TM00 1372 5082	• By means of an ammeter set to the proper scale, measure the current on each power lead at the control box or starter. See section *10.6 Electrical data* for motor amp draw information. • Current must be measured when the pump is operating at a constant outlet pressure with the motor fully loaded.	If the amp draw exceeds the listed service factor amps (SFA), or if the current imbalance is greater than 5 % between each leg on three-phase units, check for the following: • Burnt contacts on motor-protective circuit breaker. • Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances. • Supply voltage too high or low. • Motor windings are shortened. • Pump is damaged, causing a motor overload.
Winding resistance  TM05 0028 0511	• Turn off power and disconnect the submersible drop cable leads in the control box or starter. • By means of an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and Rx10 for values over 10 ohms. • Zero-adjust the ohmmeter and measure the resistance between leads. Record the values. • Motor resistance values can be found in section *10.6 Electrical data*. Cable resistance values are in section *6.7.7 Insulation resistance and ohm value chart*.	If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motors may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the submersible drop cable leads are mixed. To verify lead colors, see resistance values in section *10.6 Electrical data*.
Insulation resistance  TM05 0029 0511	• Turn off power and disconnect the submersible drop cable leads in the control box or starter. • By means of an ohmmeter or megohmmeter, set the scale selector to Rx 100K and zero adjust the meter. • Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).	For ohm values, refer to section *9.2 Checking pump performance*. Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance.

9.2 Checking pump performance

The troubleshooting chart on page 26 may require that you test the pump's performance against its curve. To do so, perform these steps:

1. Install pressure gauge.
2. Start pump.
3. Gradually close the outlet valve.
4. Read pressure at shut-off.
5. After taking reading, open valve to its previous position.
6. To calculate pump performance, first convert psi reading to feet.
   For water: psi x 2.31 = ____ feet.
7. Add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running.
8. Refer to the specific pump curve for the shut-off head (pressure) for that pump model. If the measured head is close to the curve, pump is probably OK.

9.3 Troubleshooting chart

Problem	Possible cause and/or how to check	Possible remedy
1. The pump does not run.	a) There is no power at the pump control panel. How to check: Check for voltage at the control panel.	If there is no voltage at the control panel, check the feeder panel for tripped circuits.
	b) The fuses are blown or the circuit breakers are tripped. How to check: Remove the fuses and check for continuity with the ohmmeter.	Replace blown fuses or reset the circuit breaker. If new fuses blow or the circuit breaker trips, the electrical installation and motor must be checked.
	c) The motor starter overloads are burnt or have tripped out (three-phase only). How to check: Check for voltage on the line or load side of the motor starter.	Replace burnt heaters or reset. Inspect the starter for other damage. If the heater trips again, check the supply voltage and the starter holding coil.
	d) The starter does not energize (three-phase only). How to check: Energize the control circuit and check for voltage at the holding coil.	If there is no voltage, check the control circuit. If there is voltage, check the holding coil for short circuits. Replace bad coil.
	e) The controls are defective. How to check: Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
	f) The motor and/or cable are defective. How to check: Turn off the power. Disconnect the motor leads from the control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure the lead-to-ground values with an ohmmeter (Rx100K). Record the measured values.	If an open motor winding or ground is found, pull the pump from the well and recheck values at the surface. Repair or replace the motor or cable.
	g) The capacitor is defective (single-phase only). How to check: Turn off the power, then the capacitor. Check with an ohmmeter (Rx100K). When the meter is connected, look for the needle to jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.

Problem	Possible cause and/or how to check	Possible remedy
2. The pump runs but does not deliver water.	a) The groundwater level in the well is too low or the well is collapsed. How to check: Check the well drawdown. The water level must be at least three feet above the suction interconnector during operation.	If the water level is not at least three feet above the suction interconnector during operation, then lower the pump if possible, or throttle back the outlet valve and install a water level control.
	b) The integral pump check valve is blocked. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is not operating close to the pump curve, pull the pump from the well and inspect the outlet section. Remove the blockage, repair the valve and valve seat, if necessary. Check for other damage. Rinse out the pump and re-install.
	c) The inlet strainer is clogged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is not operating close to the pump curve, pull the pump from the well and inspect. Clean the inlet strainer, inspect the integral check valve for blockage, rinse out the pump and re-install.
	d) The pump is damaged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump is damaged, repair as necessary. Rinse out the pump and re-install.
3. The pump runs, but at reduced capacity.	a) The direction of rotation is wrong (three-phase only). How to check: Check for proper electrical connection in the control panel.	Correct the wiring and change the leads as required.
	b) The drawdown is larger than anticipated. Check the drawdown during pump operation.	Lower the pump, if possible. If not, throttle back the outlet valve and install a water level control.
	c) The outlet piping or valve are leaking. How to check: Examine the system for leaks.	Repair leaks.
	d) The pump inlet strainer or check valve are clogged. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump performance is not close to the pump curve, pull the pump from the well and inspect. Clean the strainer, inspect the integral check valve for blockage, rinse out the pump and re-install.
	e) The pump is worn. How to check: Check the pump performance against the pump curve. See section *9.2 Checking pump performance*.	If the pump performance is not close to the pump curve, pull the pump from the well and inspect.

Problem	Possible cause and/or how to check	Possible remedy
4. The pump cycles too much.	a) The pressure switch is not properly adjusted or is defective. How to check: Check the pressure setting on switch and operation. Check the voltage across closed contacts.	Re-adjust the switch or replace it if it is defective.
	b) The level control is not properly set or is defective. How to check: Check the setting and operation.	Re-adjust the setting; refer to the manufacturer data. Replace the level control if it is defective.
	c) The pressure in the diaphragm tank is insufficient or the tank or piping is leaking. How to check: Pump air into the tank or diaphragm chamber. Check the diaphragm for leaks. Check the tank and piping for leaks with soap and water solution. Check the air to water volume.	Repair or replace any damaged components.
	d) The snifter valve or bleed orifice are plugged. How to check: Examine the valve and orifice for dirt or corrosion.	Clean and/or replace any defective snifter valve or bleed orifice.
	e) The tank is too small. How to check: Check the tank size. We recommend that the tank volume is approximately 10 gallons for each gpm or pump capacity.	If the tank is too small, replace it with a proper size tank.

Problem	Possible cause and/or how to check	Possible remedy
5. Fuses blow or circuit breakers trip.	a) The voltage is too high or low. How to check: Check the voltage at the pump control panel. If not within ± 10 %, check the cable size and length of run to pump control panel.	If the cable size is correct, contact the power company. If not, correct and/or replace as necessary.
	b) The three-phase current imbalance is too high or low. How to check: Check the current draw on each lead. The imbalance must be within ± 5 %.	If current imbalance is not within ± 5 %, contact the power supply company.
	c) The control box wiring and components are incorrect or defective (single-phase only). How to check: Check that the control box parts match the parts list. Check to see that the wiring matches the wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	d) The capacitor is defective (single-phase only). How to check: Turn off the power, then the capacitor. Check by means of an ohmmeter (Rx100K). When the ohmmeter is connected, look for the needle to jump forward and slowly drift back.	If there is no ohmmeter needle movement, replace the capacitor.
	e) The starting relay is defective (certain types of single-phase only). How to check: Check the resistance of the relay coil by means of an ohmmeter (Rx1000K). Check the contacts for wear.	Replace any defective starting relay.

10. Technical data

10.1 Motor cooling requirements

10.1.1 Maximum water temperature - minimum velocity/flow past the motor

Maximum water temperature - minimum velocity/flow past the motor

Motor type	Minimum well casing or sleeve diameter	Minimum velocity	Minimum flow	Maximum temperature of pumped liquid	
				Vertical installation	Horizontal installation
	[in. (mm)]	[ft/s (m/s)]	[gpm (m^3/h)]	[°F (°C)]	[°F (°C)]
MS 402 / MS 4000	4 (102)	0.00 (0.00)	0.0 (0.0)	86 (30)	Flow sleeve recommended*
MS 402 / MS 4000	4 (102)	0.25 (0.08)	1.2 (0.27)	104 (40)	104 (40)
MS 6000C (T40)	6 (152)	0.50 (0.15)	9 (2)	104 (40)	104 (40)
MS 6000C (T60)	6 (152)	3.30 (1.00)	30 (6.8)	140 (60)	140 (60)
MMS 6 (T30)	6 (152)	0.15 (0.05)	13 (3)	86 (30)	86 (30)
MMS 6 (T50)	6 (152)	0.15 (0.05)	13 (3)	122 (50)	122 (50)
MMS 8000 (T30)	8 (203)	0.50 (0.15)	25 (5.7)	86 (30)	86 (30)
MMS 6 (T50)	8 (203)	0.50 (0.15)	25 (5.7)	122 (50)	122 (50)
MS 10000 (175, 200 hp)	10 (254)	0.50 (0.15)	55 (12.5)	86 (30)	86 (30)
MS 10000 (250 hp)	10 (254)	0.50 (0.15)	41 (9.3)	68 (20)	68 (20)

ft/s = feet per second

* A flow inducer or flow sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

Note: For MMS6, 50 hp and MMS 8000, 150 hp, the maximum liquid temperature is 9 °F (5 °C) lower than the values stated in the table. For MMS 10000, 250 hp, the temperature is 18 °F (10 °C) lower.

10.2 Guide for engine-driven generators in submersible pump applications

1- or 3-phase motor [Hp]	Generator [kW]	
	Externally regulated	Internally regulated
0.33	1.5	1.2
0.5	2.0	1.5
0.75	3.0	2.0
1	4.0	2.5
1.5	5.0	3.0
2	7.5	4.0
3	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

Note:

- The table is based on typical +176 °F (+80 °C) rise continuous duty generators with 35 % maximum voltage dip during startup of single-phase and three-phase motors.
- Contact the manufacturer of the generator to make sure the unit has adequate capacity to run the submersible motor.
- If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

10.3 Transformer capacity required for three-phase submersible motors

3-phase motor [Hp]	Minimum total KVA required*	Minimum KVA rating for each transformer	
		Two transformers Open Delta or Wye	Three transformers Delta or Wye
1.5	3	2	1
2	4	2	1.5
3	5	3	2
5	7.5	5	3
7.5	10	7.5	5
10	15	10	5
15	20	15	7.5
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

10.4 Submersible drop cable selection charts (60 Hz)

The following tables list the recommended copper conductor sizes and various cable lengths for submersible motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for +167 °F (+75 °C) wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To ensure adequate starting torque, the maximum cable lengths are calculated to maintain 95 % of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power consumption.

CAUTION

Caution

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

10.4.1 115 V and 230 V, 1-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	**12**	**10**	**8**	**6**	**4**	**3**	**2**	**1**	**0**	**00**	**000**	**0000**
115 V 1-ph 60 Hz	0.33	130 (40)	210 (64)	340 (104)	540 (165)	840 (256)	1300 (396)	1610 (491)	1960 (597)	2390 (728)	2910 (887)	3540 (1079)	4210 (1283)	5060 (1542)
	0.5	100 (30)	160 (49)	250 (76)	390 (119)	620 (189)	960 (293)	1190 (363)	1460 (445)	1780 (543)	2160 (658)	2630 (802)	3140 (957)	3770 (1149)
230 V 1-ph 60 Hz	0.33	550 (168)	880 (268)	1390 (424)	2190 (668)	3400 (1036)	5250 (1600)	6520 (1987)	7960 (2426)	9690 (2954)	11770 (3587)	14320 (4365)	17050 (5197)	20460 (6236)
	0.5	400 (122)	650 (198)	1020 (311)	1610 (491)	2510 (765)	3880 (1183)	4810 (1466)	5880 (1792)	7170 (2185)	8720 (2658)	10620 (3237)	12660 (3859)	15210 (4636)
	0.75	300 (91)	480 (146)	760 (232)	1200 (366)	1870 (570)	2890 (881)	3580 (1091)	4370 (1332)	5330 (1625)	6470 (1972)	7870 (2399)	9380 (2859)	11250 (3429)
	1	250 (76)	400 (122)	630 (192)	990 (302)	1540 (469)	2380 (725)	2960 (902)	3610 (1100)	4410 (1344)	5360 (1634)	6520 (1987)	7780 (2371)	9350 (2850)
	1.5	190 (58)	310 (94)	480 (146)	770 (235)	1200 (366)	1870 (570)	2320 (707)	2850 (869)	3500 (1067)	4280 (1305)	5240 (1597)	6300 (1920)	7620 (2323)
	2	150 (46)	250 (76)	390 (119)	620 (189)	970 (296)	1530 (466)	1910 (582)	2360 (719)	2930 (893)	3620 (1103)	4480 (1366)	5470 (1667)	6700 (2042)
	3	120 (37)	190 (58)	300 (91)	470 (143)	750 (229)	1190 (363)	1490 (454)	1850 (564)	2320 (707)	2890 (881)	3610 (1100)	4470 (1362)	5550 (1692)
	5	-	110* (34*)	180 (55)	280 (85)	450 (137)	710 (216)	890 (271)	1110 (338)	1390 (424)	1740 (530)	2170 (661)	2680 (817)	3330 (1015)
	7.5	-	-	120* (37*)	200 (61)	310 (94)	490 (149)	610 (186)	750 (229)	930 (283)	1140 (347)	1410 (430)	1720 (524)	2100 (640)
	10	-	-	-	160* (49*)	250 (76)	390 (119)	490 (149)	600 (183)	750 (229)	930 (283)	1160 (354)	1430 (436)	1760 (536)
	15	-	-	-	-	170* (52*)	270 (82)	340 (104)	430 (131)	530 (162)	660 (201)	820 (250)	1020 (311)	1260 (384)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum allowable length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of the service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.2 200-208 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
200-208 V 3-ph 60 Hz	.5	710 (216)	1140 (347)	1800 (549)	2840 (866)	4420 (1347)	-	-	-	-	-	-	-	-
	.75	510 (155)	810 (245)	1280 (390)	2030 (619)	3160 (963)	-	-	-	-	-	-	-	-
	1	430 (131)	690 (210)	1080 (329)	1710 (521)	2670 (814)	4140 (1262)	5140 (1567)	-	-	-	-	-	-
	1.5	310 (94)	500 (152)	790 (241)	1260 (384)	1960 (597)	3050 (930)	3780 (1152)	-	-	-	-	-	-
	2	240 (73)	390 (119)	610 (186)	970 (296)	1520 (463)	2360 (719)	2940 (896)	3610 (1100)	4430 (1350)	5420 (1652)	-	-	-
	3	180 (55)	290 (88)	470 (143)	740 (226)	1160 (354)	1810 (552)	2250 (686)	2760 (841)	3390 (1033)	4130 (1259)	-	-	-
	5	110* (34*)	170 (52)	280 (85)	440 (134)	690 (210)	1080 (329)	1350 (411)	1660 (506)	2040 (622)	2490 (759)	3050 (930)	3670 (1119)	4440 (1353)
	7.5	-	-	200 (61)	310 (94)	490 (149)	770 (235)	960 (293)	1180 (360)	1450 (442)	1770 (539)	2170 (661)	2600 (792)	3150 (960)
	10	-	-	-	230* (70*)	370 (113)	570 (174)	720 (219)	880 (268)	1090 (332)	1330 (405)	1640 (500)	1970 (600)	2390 (728)
	15	-	-	-	160* (49*)	250* (76*)	390 (119)	490 (149)	600 (183)	740 (226)	910 (277)	1110 (338)	1340 (408)	1630 (497)
	20	-	-	-	-	190* (58*)	300* (91*)	380 (116)	460 (140)	570 (174)	700 (213)	860 (262)	1050 (320)	1270 (387)
	25	-	-	-	-	-	240* (73*)	300* (91*)	370* (113*)	460 (140)	570 (174)	700 (213)	840 (256)	1030 (314)
	30	-	-	-	-	-	-	250* (76*)	310* (94*)	380* (116*)	470 (143)	580 (177)	700 (213)	850 (259)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum allowable length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.3 230 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
230 V 3-ph 60 Hz	.5	930 (283)	1490 (454)	2350 (716)	3700 (1128)	5760 (1756)	8910 (2716)	-	-	-	-	-	-	-
	.75	670 (204)	1080 (329)	1700 (518)	2580 (786)	4190 (1277)	6490 (1978)	8060 (2457)	9860 (3005)	-	-	-	-	-
	1	560 (171)	910 (277)	1430 (436)	2260 (689)	3520 (1073)	5460 (1664)	6780 (2067)	8290 (2527)	-	-	-	-	-
	1.5	420 (128)	670 (204)	1060 (323)	1670 (509)	2610 (796)	4050 (1234)	5030 (1533)	6160 (1878)	7530 (2295)	9170 (2795)	-	-	-
	2	320 (98)	510 (155)	810 (247)	1280 (390)	2010 (613)	3130 (954)	3890 (1186)	4770 (1454)	5860 (1786)	7170 (2185)	8780 (2676)	-	-
	3	240 (73)	390 (119)	620 (189)	990 (302)	1540 (469)	2400 (732)	2980 (908)	3660 (1116)	4480 (1366)	5470 (1667)	6690 (2039)	8020 (2444)	9680 (2950)
	5	140* (43*)	230 (70)	370 (113)	590 (180)	920 (280)	1430 (436)	1790 (546)	2190 (668)	2690 (820)	3290 (1003)	4030 (1228)	4850 (1478)	5870 (1789)
	7.5	-	160* (49*)	260 (79)	420 (128)	650 (198)	1020 (311)	1270 (387)	1560 (475)	1920 (585)	2340 (713)	2870 (875)	3440 (1049)	4160 (1268)
	10	-	-	190* (58*)	310 (94)	490 (149)	760 (232)	950 (290)	1170 (357)	1440 (439)	1760 (536)	2160 (658)	2610 (796)	3160 (963)
	15	-	-	-	210* (64*)	330 (101)	520 (158)	650 (198)	800 (244)	980 (299)	1200 (366)	1470 (448)	1780 (543)	2150 (655)
	20	-	-	-	-	250* (76*)	400 (122)	500 (152)	610 (186)	760 (232)	930 (283)	1140 (347)	1380 (421)	1680 (512)
	25	-	-	-	-	-	320* (98*)	400 (122)	500 (152)	610 (186)	750 (229)	920 (280)	1120 (341)	1360 (415)
	30	-	-	-	-	-	260* (79*)	330* (101*)	410* (125*)	510 (155)	620 (189)	760 (232)	930 (283)	1130 (344)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V / 100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.4 460 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]												
		14	12	10	8	6	4	3	2	1	0	00	000	0000
460 V 3-ph 60 Hz	.5	3770 (1149)	6020 (1835)	9460 (2883)	-	-	-	-	-	-	-	-	-	-
	.75	2730 (832)	4350 (1326)	6850 (2088)	-	-	-	-	-	-	-	-	-	-
	1	2300 (701)	3670 (1119)	5770 (1759)	9070 (2765)	-	-	-	-	-	-	-	-	-
	1.5	1700 (518)	2710 (826)	4270 (1301)	6730 (2051)	-	-	-	-	-	-	-	-	-
	2	1300 (396)	2070 (631)	3270 (997)	5150 (1570)	8050 (2454)	-	-	-	-	-	-	-	-
	3	1000 (305)	1600 (488)	2520 (768)	3970 (1210)	6200 (1890)	-	-	-	-	-	-	-	-
	5	590 (180)	950 (290)	1500 (457)	2360 (719)	3700 (1128)	5750 (1753)	-	-	-	-	-	-	-
	7.5	420 (128)	680 (207)	1070 (326)	1690 (515)	2640 (805)	4100 (1250)	5100 (1554)	6260 (1908)	7680 (2341)	-	-	-	-
	10	310 (94)	500 (152)	790 (241)	1250 (381)	1960 (597)	3050 (930)	3800 (1158)	4680 (1426)	5750 (1753)	7050 (2149)	-	-	-
	15	-	340* (104*)	540 (165)	850 (259)	1340 (408)	2090 (637)	2600 (792)	3200 (975)	3930 (1198)	4810 (1466)	5900 (1798)	7110 (2167)	-
	20	-	-	410 (125)	650 (198)	1030 (314)	1610 (491)	2000 (610)	2470 (753)	3040 (927)	3730 (1137)	4580 (1396)	5530 (1686)	-
	25	-	-	330* (101*)	530 (162)	830 (253)	1300 (396)	1620 (494)	1990 (607)	2450 (747)	3010 (917)	3700 (1128)	4470 (1362)	5430 (1655)
	30	-	-	270* (82*)	430 (131)	680 (207)	1070 (326)	1330 (405)	1640 (500)	2030 (619)	2490 (759)	3060 (933)	3700 (1128)	4500 (1372)
	40	-	-	-	320* (98*)	500* (152*)	790 (241)	980 (299)	1210 (369)	1490 (454)	1830 (558)	2250 (686)	2710 (826)	3290 (1003)
	50	-	-	-	-	410* (125*)	640 (195)	800 (244)	980 (299)	1210 (369)	1480 (451)	1810 (552)	2190 (668)	2650 (808)
	60	-	-	-	-	-	540* (165*)	670* (204*)	830 (253)	1020 (311)	1250 (381)	1540 (469)	1850 (564)	2240 (683)
	75	-	-	-	-	-	440* (134*)	550* (168*)	680* (207*)	840 (256)	1030 (314)	1260 (384)	1520 (463)	1850 (564)
	100	-	-	-	-	-	-	-	500* (152*)	620 (189*)	760* (232*)	940 (287)	1130 (344)	1380 (421)
	125	-	-	-	-	-	-	-	-	-	600* (183*)	740* (226*)	890* (271*)	1000 (305)
	150	-	-	-	-	-	-	-	-	-	-	630* (192*)	760* (232*)	920* (280*)
	175	-	-	-	-	-	-	-	-	-	-	-	670* (204*)	810* (247*)
	200	-	-	-	-	-	-	-	-	-	-	-	590* (180*)	710* (216*)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V/100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.4.5 575 V, 3-phase, 60 Hz

Maximum submersible power cable length (maximum cable length in feet, starter to motor)

Motor rating	[Hp]	AWG copper wire size [ft (m)]													
		14	12	10	8	6	4	3	2	1	0	00	000	0000
575 V 3-ph 60 Hz	5	5900 (1798)	9410 (2868)	-	-	-	-	-	-	-	-	-	-	-
	.75	4270 (1301)	6810 (2076)	-	-	-	-	-	-	-	-	-	-	-
	1	3630 (1106)	5800 (1768)	9120 (2780)	-	-	-	-	-	-	-	-	-	-
	1.5	2620 (799)	4180 (1274)	6580 (2006)	-	-	-	-	-	-	-	-	-	-
	2	2030 (619)	3250 (991)	5110 (1558)	8060 (2457)	-	-	-	-	-	-	-	-	-
	3	1580 (482)	2530 (771)	3980 (1213)	6270 (1911)	-	-	-	-	-	-	-	-	-
	5	920 (280)	1480 (451)	2330 (710)	3680 (1122)	5750 (1753)	-	-	-	-	-	-	-	-
	7.5	660 (201)	1060 (323)	1680 (512)	2650 (808)	4150 (1265)	-	-	-	-	-	-	-	-
	10	490 (149)	780 (238)	1240 (378)	1950 (594)	3060 (933)	4770 (1454)	5940 (1811)	-	-	-	-	-	-
	15	330* (101*)	530 (162)	850 (259)	1340 (408)	2090 (637)	3260 (994)	4060 (1237)	-	-	-	-	-	-
	20	-	410* (125*)	650 (198)	1030 (314)	1610 (491)	2520 (768)	3140 (957)	3860 (1177)	4760 (1451)	5830 (1777)	-	-	-
	25	-	-	520 (158)	830 (253)	1300 (396)	2030 (619)	2530 (771)	3110 (948)	3840 (1170)	4710 (1436)	-	-	-
	30	-	-	430* (131*)	680 (207)	1070 (326)	1670 (509)	2080 (634)	2560 (780)	3160 (963)	3880 (1183)	4770 (1454)	5780 (1762)	7030 (2143)
	40	-	-	-	500* (152*)	790 (241)	1240 (378)	1540 (469)	1900 (579)	2330 (710)	2860 (872)	3510 (1070)	4230 (1289)	5140 (1567)
	50	-	-	-	410* (125*)	640* (195*)	1000 (305)	1250 (381)	1540 (469)	1890 (576)	2310 (704)	2840 (866)	3420 (1042)	4140 (1262)
	60	-	-	-	-	540* (165*)	850 (259)	1060 (323)	1300 (396)	1600 (488)	1960 (597)	2400 (732)	2890 (881)	3500 (1067)
	75	-	-	-	-	-	690* (210*)	860 (262)	1060 (323)	1310 (399)	1600 (488)	1970 (600)	2380 (725)	2890 (881)
	100	-	-	-	-	-	-	640* (195*)	790* (241*)	970 (296)	1190 (363)	1460 (445)	1770 (539)	2150 (655)
	125	-	-	-	-	-	-	-	630* (192*)	770* (235*)	950 (290)	1160 (354)	1400 (427)	1690 (515)
	150	-	-	-	-	-	-	-		660* (202*)	800* (244*)	990* (302*)	1190 (363)	1440 (439)
	175	-	-	-	-	-	-	-	-	-	700* (214*)	870* (265*)	1050* (320*)	1270 (387)
	200	-	-	-	-	-	-	-	-	-	-	760* (232*)	920* (280*)	1110* (338*)

Note:

* Indicates single conductor only (not jacketed).

No asterisk indicates both jacketed cable and single-conductor cables.

- The table is based on copper wire. If aluminum wire is used, multiply lengths by 0.5.
  The maximum permissible length of aluminum is considerably shorter than copper wire of same size.
- Make sure that the portion of the total cable which is between the service entrance and a motor starter/controller does not exceed 25 % of the total maximum length to ensure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
- The table is based on maintaining motor terminal voltage at 95 % of service entrance voltage, running at maximum nameplate amperes. In general, a voltage drop must be maintained at 3 V/100 ft or less.
- 1 foot = 0.305 meter (1 meter = 3.28 feet).

10.5 Approvals

<table>
<tr><td>SP 4"</td><td colspan="3"></td></tr>
<tr><td>SP 4" pump end (5S - 77S)</td><td colspan="3">WATER QUALITY
Drinking Water System Component
NSF/ANSI 61
MH26400
NSF/ANSI 372</td></tr>
<tr><td>MS 6000C motor</td><td>Submersible Motor
NSF/ANSI 372
MH26400</td><td rowspan="3"></td><td></td></tr>
<tr><td>MS 4000 motor</td><td></td><td rowspan="2">IAPMO
File 6591
0.25 % lead</td></tr>
<tr><td>MS 402 motor</td><td></td></tr>
</table>

The Grundfos SP pumps are certified when driven by a certified motor provided with suitable overheating protection.

10.6 Electrical data

10.6.1 Grundfos submersible motors, 60 Hz

Grundfos submersible motors, 60 Hz										
Hp	Ph	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
4-inch, single-phase, 2-wire motors (control box not required)										
0.5	1	115	1.60	35	15	55.0	12.0	62	76	900
0.5	1	230	1.60	15	7	34.5	6.0	62	76	900
0.75	1	230	1.50	20	9	40.5	8.4	62	75	900
1	1	230	1.40	25	12	48.4	9.8	63	82	900
1.5	1	230	1.30	35	15	62.0	13.1	64	85	900
4-inch, single-phase, 3-wire motors										
0.5	1	115	1.60	35	15	42.5	12.0	61	76	900
0.5	1	230	1.60	15	7	21.5	6.0	62	76	900
0.75	1	230	1.50	20	9	31.4	8.4	62	75	900
1	1	230	1.40	25	12	37.0	9.8	63	82	900
1.5	1	230	1.30	35	15	45.9	11.6	69	89	900
2	1	230	1.25	35	20	57.0	13.2	72	86	1500
3	1	230	1.15	45	30	77.0	17.0	74	93	1500
5	1	230	1.15	70	45	110.0	27.5	77	92	1500
4-inch, three-phase, 3-wire motors										
1.5	3	230	1.30	15	8	40.3	7.3	75	72	900
1.5	3	460	1.30	10	4	20.1	3.7	75	72	900
1.5	3	575	1.30	10	4	16.1	2.9	75	72	900
2	3	230	1.25	20	10	48	8.7	76	75	900
2	3	460	1.25	10	5	24	4.4	76	75	900
2	3	575	1.25	10	4	19.2	3.5	76	75	900
3	3	230	1.15	30	15	56	12.2	77	75	1500
3	3	460	1.15	15	7	28	6.1	77	75	1500
3	3	575	1.15	15	6	22	4.8	77	75	1500
5	3	230	1.15	40	25	108	19.8	80	82	1500
5	3	460	1.15	20	12	54	9.9	80	82	1500
5	3	575	1.15	15	9	54	7.9	80	82	1500
7.5	3	230	1.15	60	30	130	25.0	81	82	1500
7.5	3	460	1.15	35	15	67	13.2	81	82	1500
7.5	3	575	1.15	30	15	67	10.6	81	82	1500
10	3	460	1.15	50	30	90	18	81	80	1500

CAUTION

Caution

Single-phase motors (thermally protected): Use with approved motor control that matches motor input in full load amperes.

CAUTION

Caution

Three-phase motors: Use with approved motor control that matches motor input in full load amperes with overload element(s) selected or adjusted in accordance with control instructions.

Grundfos submersible motors, 60 Hz										
Hp	Ph	Volt [V]	SF	Circuit breaker or fuses		Amperage		Full load		Max. thrust [lbs]
				Std.	Delay	Start [A]	Max. [A]	Eff. [%]	Power factor	
6-inch, three-phase motors										
7.5	3	208-230	1.15	65	40	114-130	23.4 - 27.5	81	85-84	6070
7.5	3	460	1.15	30	17	68	13.2	81	85	6070
7.5	3	575	1.15	30	17	51	10.2	81	85	6070
10	3	208-230	1.15	90	50	126-142	30.0 - 37.5	82	86-84	6070
10	3	460	1.15	40	25	75	17.4	82	85	6070
10	3	575	1.15	40	25	56.5	13.4	82	85	6070
15	3	208-230	1.15	130	75	198-224	44.5 - 53.5	83	86-84	6070
15	3	460	1.15	60	35	112	25	83	84	6070
15	3	575	1.15	60	35	84	19.4	83	84	6070
20	3	208-230	1.15	175	100	310-350	57.5 - 71.5	84	86-84	6070
20	3	460	1.15	80	45	186	33.5	84	84	6070
20	3	575	1.15	80	45	144	26	84	84	6070
25	3	208-230	1.15	200	125	395-445	71-87	84	87-84	6070
25	3	460	1.15	100	60	236	41	84	84	6070
25	3	575	1.15	100	60	180	32	84	84	6070
30	3	208-230	1.15	250	150	445-500	81-104	84	87-84	6070
30	3	460	1.15	125	70	265	48	85	85	6070
30	3	575	1.15	125	70	194	37	85	85	6070
40	3	460	1.15	170	90	330	65	85	84	6070
40	3	575	1.15	170	90	250	49.5	85	84	6070
50	3	460	1.15	225	125	405	73.0	83	83	6182
8-inch, three-phase motors										
40	3	460	1.15	175	100	380	55.7	83	85	13000
50	3	460	1.15	225	125	550	67.8	84	85	13000
60	3	460	1.15	250	150	640	80.4	86	85	13000
75	3	460	1.15	300	175	580	97.4	86	86	13000
100	3	460	1.15	400	225	570	130.4	87	86	13000
125	3	460	1.15	500	300	600	160.0	87	87	13000
150	3	460	1.15	600	350	580	191.3	86	87	13000
10-inch, three-phase motors										
175	3	460	1.15	700	400	570	230.4	88	85	13000
200	3	460	1.15	800	500	620	265.2	87	82	13000
250	3	460	1.15	1100	600	610	352.2	87	79	13000

10.6.2 Other motor manufacturers

Refer to the other motor manufacturers' application maintenance manual.

10.6.3 Correcting for three-phase current imbalance

Example: Check for current imbalance for a 230 volt, three-phase, 60 Hz submersible motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each submersible drop cable lead for hookups 1, 2 and 3.

Observe that hookup 3 must be used since it shows the least amount of current imbalance. Therefore, the motor will operate at maximum efficiency and reliability.

By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_3. This indicates the imbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the imbalance would be caused by the motor or a poor connection.

If the current imbalance is greater than 5 %, contact your power supply company for help.

For a detailed explanation of three-phase balance procedures, see section *7.1 Startup with three-phase motors*.

	Step 1 (hookup 1)	Step 2 (hookup 2)	Step 3 (hookup 3)
(T_1)	DL_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)	DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)	DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4	Total = 75 amps	Total = 75 amps	Total = 75 amps
Step 5	Average current =	$\frac{\text{total current}}{\text{3 readings}}$ =	$\frac{75}{3}$ = 25 amps
Step 6	Greatest amp difference from the average:	(hookup 1) = 25 - 23 = 2 (hookup 2) = 26 - 25 = 1 (hookup 3) = 25.5 - 25 = 0.5	
Step 7	% imbalance	(hookup 1) = 2/25 x 100 = 8 (hookup 2) = 1/25 x 100 = 4 (hookup 3) = 0.5/25 x 100 = 2	

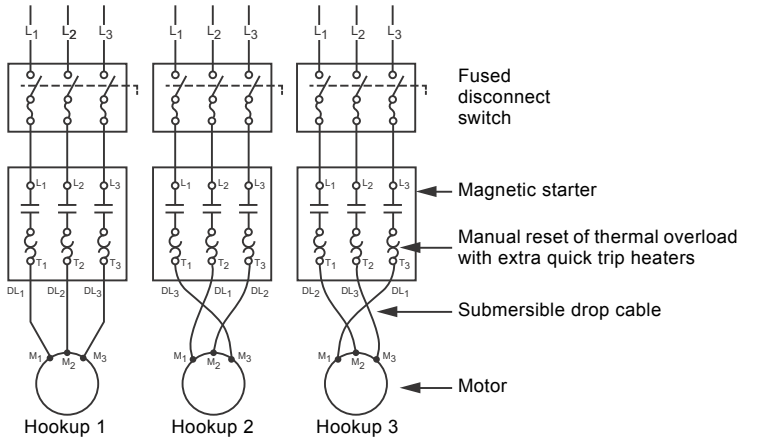


Fig. 18 Correcting for three-phase current imbalance

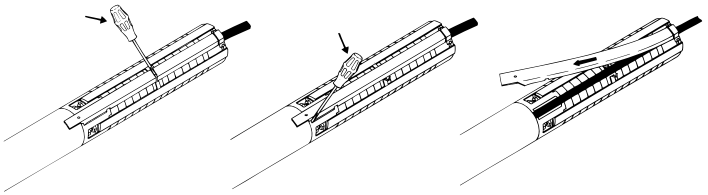
11. Disposal

This product or parts of it must be disposed of in an environmentally sound way:

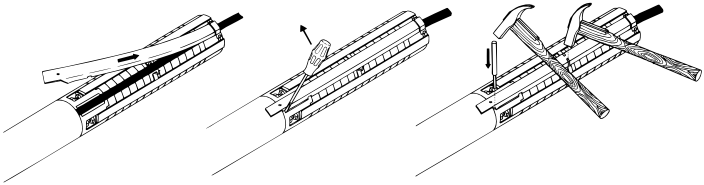
1. Use the public or private waste collection service.
2. If this is not possible, contact the nearest Grundfos company or service workshop.

Removal and fitting of cable guard

Removing cable guard



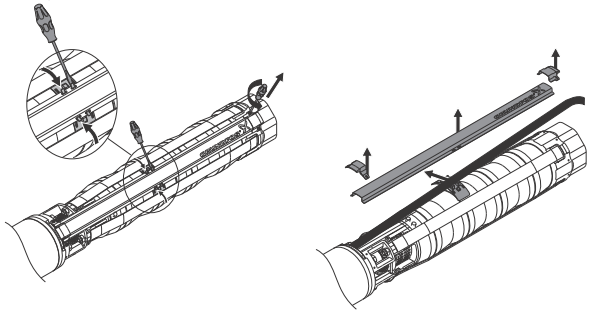
Fitting cable guard



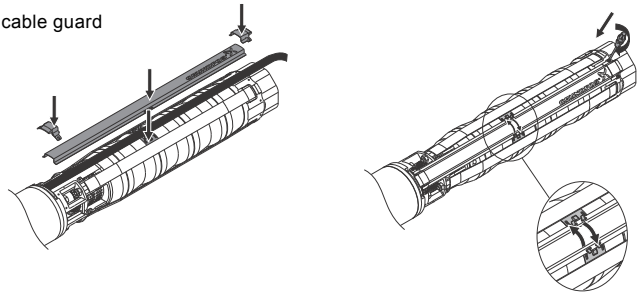
TM00 1323 0603

Fig. 1 Removal and fitting of cable guard for SP 5S, 7S, 10S, 16S, and 25S (smooth shaft)

Removing cable guard

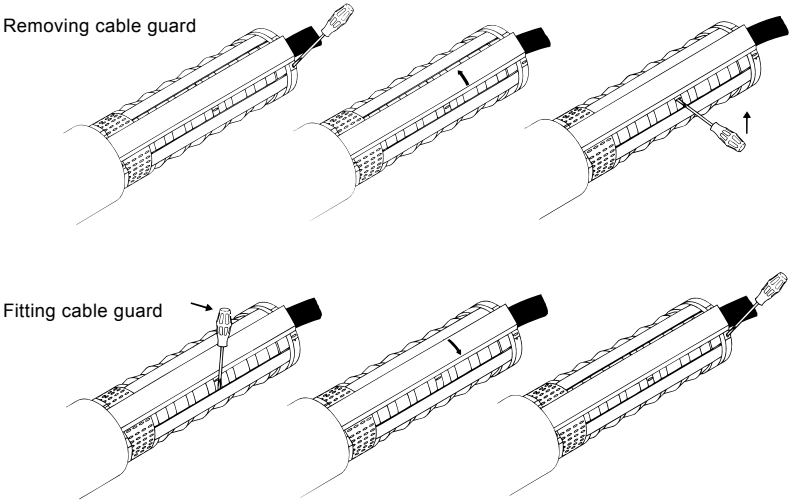


Fitting cable guard



TM06 0693 0814

Fig. 2 Removal and fitting of cable guard for SP 35S, 45S, 62S, 77S, 150S, 230S, and 300S

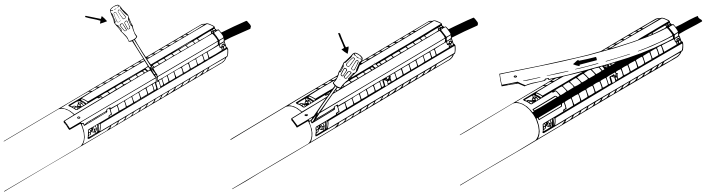


TM00 1326 0603

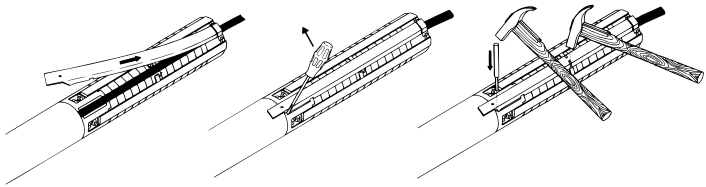
Fig. 3 Removal and fitting of cable guard for SP 385S, 475S, 625S, 800S, and 1100S

Dépose et fixation du protège-câble

Dépose du protège-câble



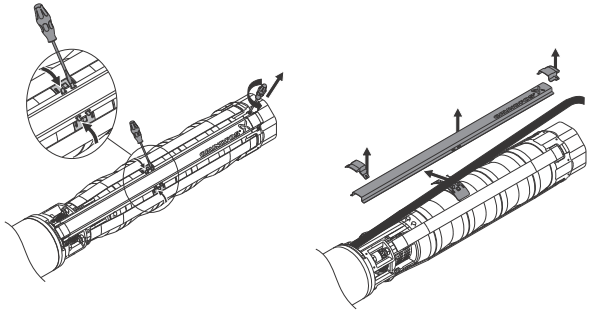
Fixation du protège-câble



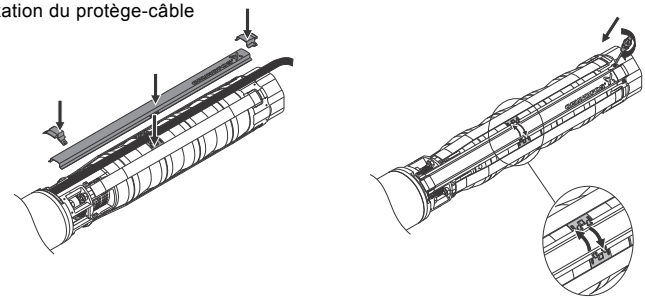
TM00 1323 0603

Fig. 1 Dépose et fixation du protège-câble pour SP 5S, 7S, 10S, 16S, et 25S (arbre lisse)

Dépose du protège-câble

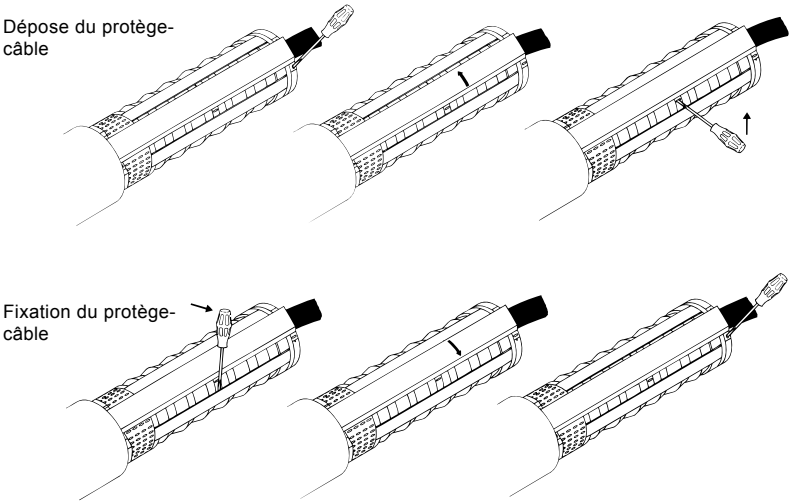


Fixation du protège-câble



TM06 0693 0814

Fig. 2 Dépose et fixation du protège-câble pour SP 35S, 45S, 62S, 77S, 150S, 230S, et 300S

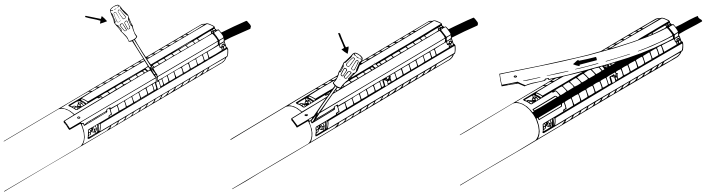


TM00 1326 0603

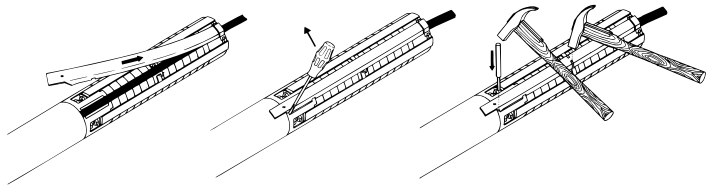
Fig. 3 Dépose et fixation du protège-câble pour SP 385S, 475S, 625S, 800S, et 1100S

Desmontaje e instalación de la cubierta del cable

Desmontaje de la cubierta del cable



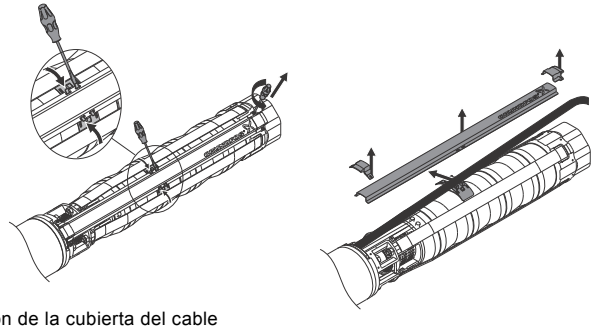
Instalación de la cubierta del cable



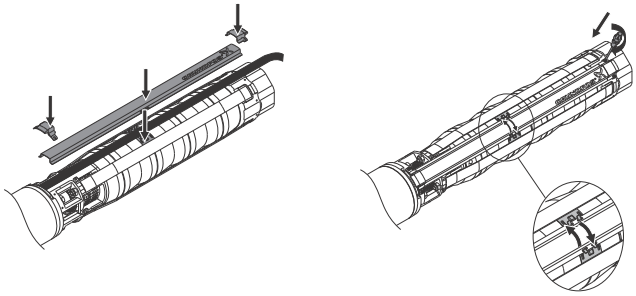
TM00 1323 0603

Fig. 1 Desmontaje e instalación de la cubierta del cable para bombas SP 5S, 7S, 10S, 16S y 25S (eje flexible)

Desmontaje de la cubierta del cable



Instalación de la cubierta del cable



TM06 0693 0814

Fig. 2 Desmontaje e instalación de la cubierta del cable para bombas SP 35S, 45S, 62S, 77S, 150S, 230S, y 300S

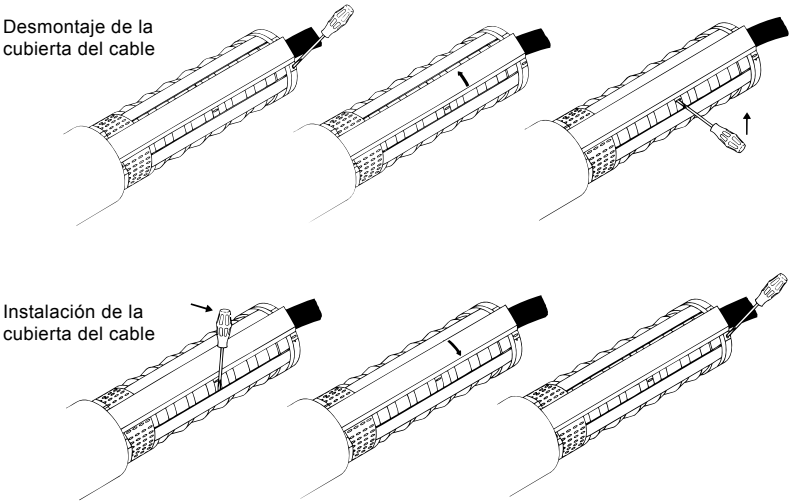


Fig. 3 Desmontaje e instalación de la cubierta del cable para bombas SP 385S, 475S, 625S, 800S y 1100S

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