Navajo Gallup Water Supply Project
Reach 24.1 JAN

Final Design Submittal

September 2016

Souder, Miller & Associates
Engineering ♦ Environmental ♦ Surveying
www.soudermiller.com

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Summary and Steady State Hydraulic Profiles - Generated with Excel Spreadsheet

Reach 24.1 JAN Summary of Steady State Hydraulic Profiles Generated with Excel Spreadsheets

Operational Conditions:

Counselor Tank Base Elevation:	7,302 feet aMSL
Counselor Tank Height:	30 feet
Counselor Tank Normal Elevation (80% Full):	7,326 feet aMSL
Counselor Tank Overflow Elevation:	7,332 feet aMSL

Proposed JAN Border Tank Base Elevation:	7,050 feet aMSL
Proposed JAN Border Tank Height:	30 feet
Proposed JAN Border Tank Normal Elevation (80% Full):	7,074 feet aMSL
Proposed JAN Border Tank Overflow Elevation:	7,080 feet aMSL
Proposed JAN Border Tank Altitude Valve Elevation:	7,045 feet aMSL

Reach 24.1 Design Flow Rate[1]	2,375 gpm
Reach 24.1 JAN Design Flow Rate[1]	966 gpm
Reach 25 Design Flow Rate[1]	1,409 gpm

[1] Design flow rates correspond to authorized flow rates based on 2040 demand with 1.3 peaking factor.

Six scenarios were considered in this analysis, and are summarized in the table below. The parameters of these scenarios, and the results of each, are given in the following pages.

Summary of Considered Scenarios

Scenario	Flow Condition	Design C-factor of Pipe	Reach 25 Pump	Tank Level	
				Counselor	JAN Border
1a	Minimum	130	On	Empty	Full
1b	Normal	140	On	80%	80%
1c	Maximum	150	On	Full	Empty
2a	Minimum	130	Off	Empty	Full
2b	Normal	140	Off	80%	80%
2c	Maximum	150	Off	Full	Empty

Notes:

- Reach 24.1 and Reach 25 are constructed of 14" DR 18 PVC.
- Reach 24.1 JAN will be constructed of 10" DR 18 PVC.
- The proposed JAN Border tank and altitude valve at the JAN Border tank are not part of the Reach 24.1 JAN design package. However, they are critical to the Reach 24.1 JAN pipeline design, so preliminary design parameters for each are included in the Hydraulic Profiles.
- Hydraulic profile stationing begins at the Counselor Tank located at Sta. 00+00 of Reach 24.1, and increases along Reach 24.1 to Sta. 143+30 where Reach 24.1 ends and Reach 25 begins at the Reach 24.1 JAN stubout tee. Reach 24.1 JAN begins at the branch of the stubout tee at Sta. -00+39 of Reach 24.1 JAN, and continues to Sta. 159+63, where it terminates at the Jicarilla Apache Nation (JAN) reservation boundary. From there, a short pipeline that is to be constructed by the Jicarilla Apache Nation will deliver water to the proposed JAN border tank. The proposed JAN border tank, which is not a part of Reach 24.1 JAN, is located in the hydraulic models at Sta. 163+00, approximately 30,670 LF from the Counselor tank.
- Each scenario includes head losses from the following appurtenances:
  - Friction losses throughout the PVC pipeline.
  - Minor losses through fittings and valves along the pipeline.
  - The surge tank site piping located at Sta. 00+53 of Reach 24.1 JAN.
  - An electromagnetic flow meter, a rate of flow control valve (RFV) set to 966 gpm, and an orifice plate on the RFV, located in a vault at Sta. 159+08, just before the end of Reach 24.1 JAN.
  - The proposed altitude valve with anti-cavitation trim, located at the proposed JAN border tank at Sta. 163+00.
- Actual Reach 24.1 JAN pipe selection was based on maximum, static pressures.
  - Static pressures are shown on the hydraulic profiles of each scenario.

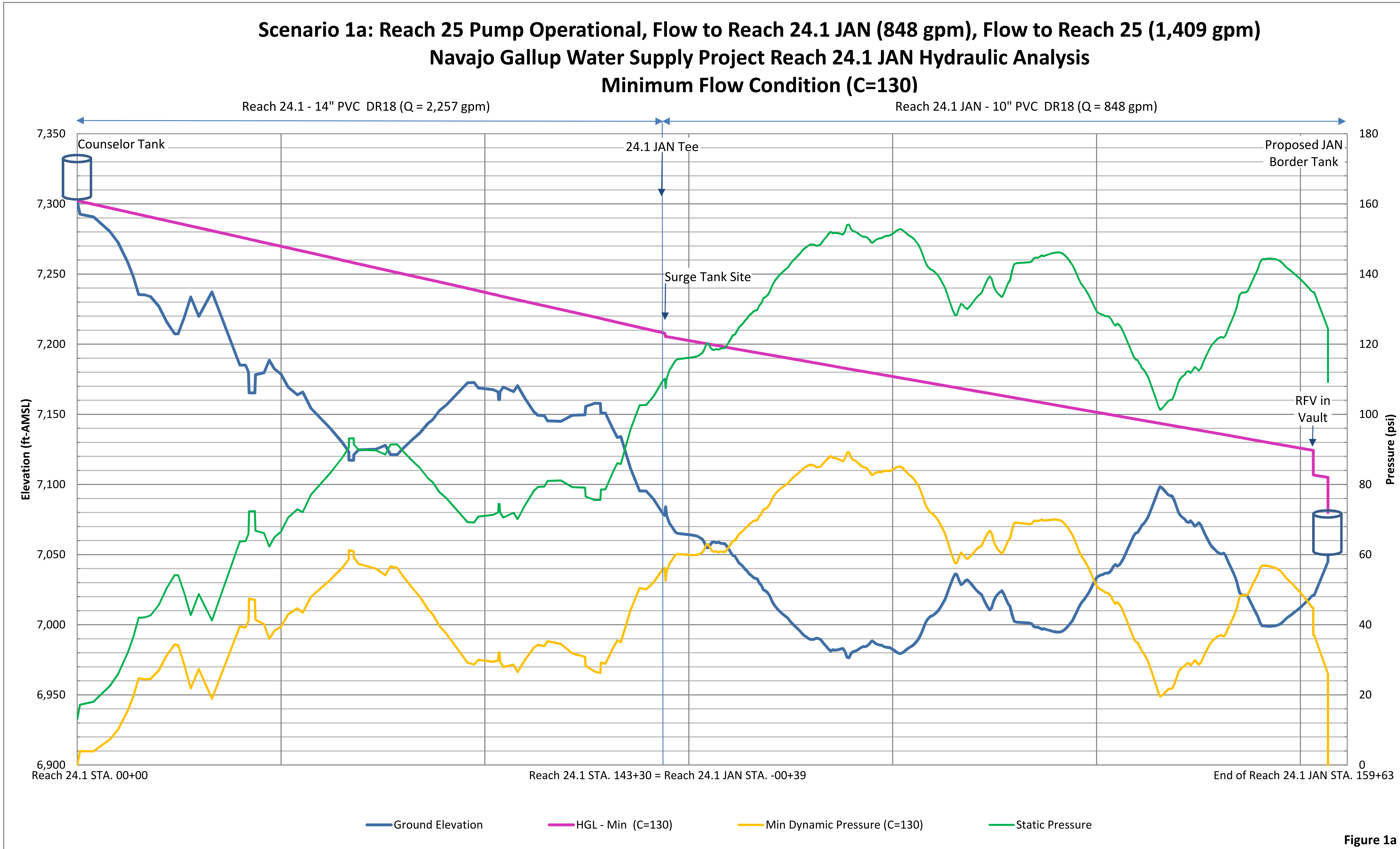
The summary table on the next page shows the parameters for each scenario considered, as well as key values generated from the hydraulic profile calculations.

Reach 24.1 JAN Summary of Hydraulic Scenario Analysis in Excel

Scenario	Flow Condition	Design C-factor of Pipe	Reach 25 Pump	Tank Level[1]		Flow (GPM)			Rate of Flow Control Valve Headloss[2]						Pressure at Rate of Flow Control Valve (psi)		Altitude Valve[2] with Anti-Cav Trim Headloss		Pressure at Altitude Valve (psi)	
				Counselor	JAN	Reach 24.1	Reach 25	Reach 24.1 JAN	Open Valve ft	Open Valve psi	Orifice Plate ft	Orifice Plate psi	Valve Closure ft	Valve Closure psi	Inlet	Outlet (pre-orifice)	ft	psi	Inlet	Outlet
1a	Minimum	130	On	Empty	Full	2,257	1,409	**848**	7.6	3.3	8.9	3.9	0.0	0.0	44.2	40.9	24.9	10.8	25.9	15.2
1b	Normal	140	On	80%	80%	2,375	1,409	**966**	8.8	3.8	11.6	5.0	12.6	5.5	52.1	42.8	32.3	14.0	26.6	12.6
1c	Maximum	150	On	Full	Empty	2,375	1,409	**966**	8.8	3.8	11.6	5.0	64.4	27.9	64.0	32.3	32.3	14.0	16.2	2.2
2a	Minimum	130	Off	Empty	Full	966	0	**966**	8.8	3.8	11.6	5.0	40.0	17.3	66.6	45.5	32.3	14.0	29.2	15.2
2b	Normal	140	Off	80%	80%	966	0	**966**	8.8	3.8	11.6	5.0	85.8	37.1	83.7	42.8	32.3	14.0	26.6	12.6
2c	Maximum	150	Off	Full	Empty	966	0	**966**	8.8	3.8	11.6	5.0	128.8	55.8	91.9	32.3	32.3	14.0	16.2	2.2

Conclusions:

- The Reaches 24.1 / 25 / 24.1 JAN system meets the authorized 24.1 JAN flow of 966 gpm in all but one of the six scenarios.
  - Scenario 1A (Min), based on an empty upstream tank and full downstream tank, with the Reach 25 pump on, and C-factor of 130, is projected to deliver 848 gpm. However, this is deemed acceptable because Scenario 1A is not a normal operating condition; it is the minimum flow boundary condition, based on conveying water from an empty upstream (Counselor) tank to a full downstream (JAN) tank. In reality, while such a condition is possible and was therefore analyzed, it would not be considered normal. The Counselor tank would typically be maintained approximately 80% full by the upstream reaches. Moreover, if the JAN tank were already full, the altitude valve would begin to close gradually, throttling back the flow rate to zero, so conveying the full 966 gpm to the JAN tank would not be an issue.
  - In the five remaining scenarios, the RFV valve must modulate (i.e. partially close) to limit flow to 966 gpm. All normal operating scenarios are capable of providing the 966 gpm authorized flow rate.
  - The authorized flow rate of 1,409 gpm to Reach 25 is met under all scenarios in which there is flow to Reach 25 (Scenarios 1a, 1b, and 1c).
- A failure analysis was performed on the RF control valve, by modeling system hydraulics if this valve were to fail completely open (i.e. fail to modulate to control flow).
  - Under the highest flow conditions, Scenario 2C (Max), uncontrolled flow delivered to JAN would reach 1,296 gpm. The RFV limits flow to 966 gpm in Scenario 2C by partially closing the valve to add an additional 50 psi of headloss to the system. If the RFV were to fail and flow rate increased to 1,296 gpm, positive pressures would still be maintained throughout the system. The same is true for all four scenarios in which the RFV limits flow.
- In conclusion, the hydraulic scenarios considered show Reach 24.1 JAN to have sufficient capacity to meet JAN's authorized flow rate without impeding the ability of Reach 25 to deliver its authorized flow rate to NTUA.



Scenario 1a: Reach 25 Pump Operational, Flow to Reach 24.1 JAN (848 gpm), Flow to Reach 25 (1,409 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Minimum Flow Condition (C=130)
Reach 24.1 - 14" PVC DR18 (Q = 2,257 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 848 gpm)
Counselor Tank
24.1 JAN Tee
Proposed JAN Border Tank
Surge Tank Site
RFV in Vault
Elevation (ft-AMSL)
Pressure (psi)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA. 159+63
Ground Elevation
HGL - Min (C=130)
Min Dynamic Pressure (C=130)
Static Pressure

Figure 1a

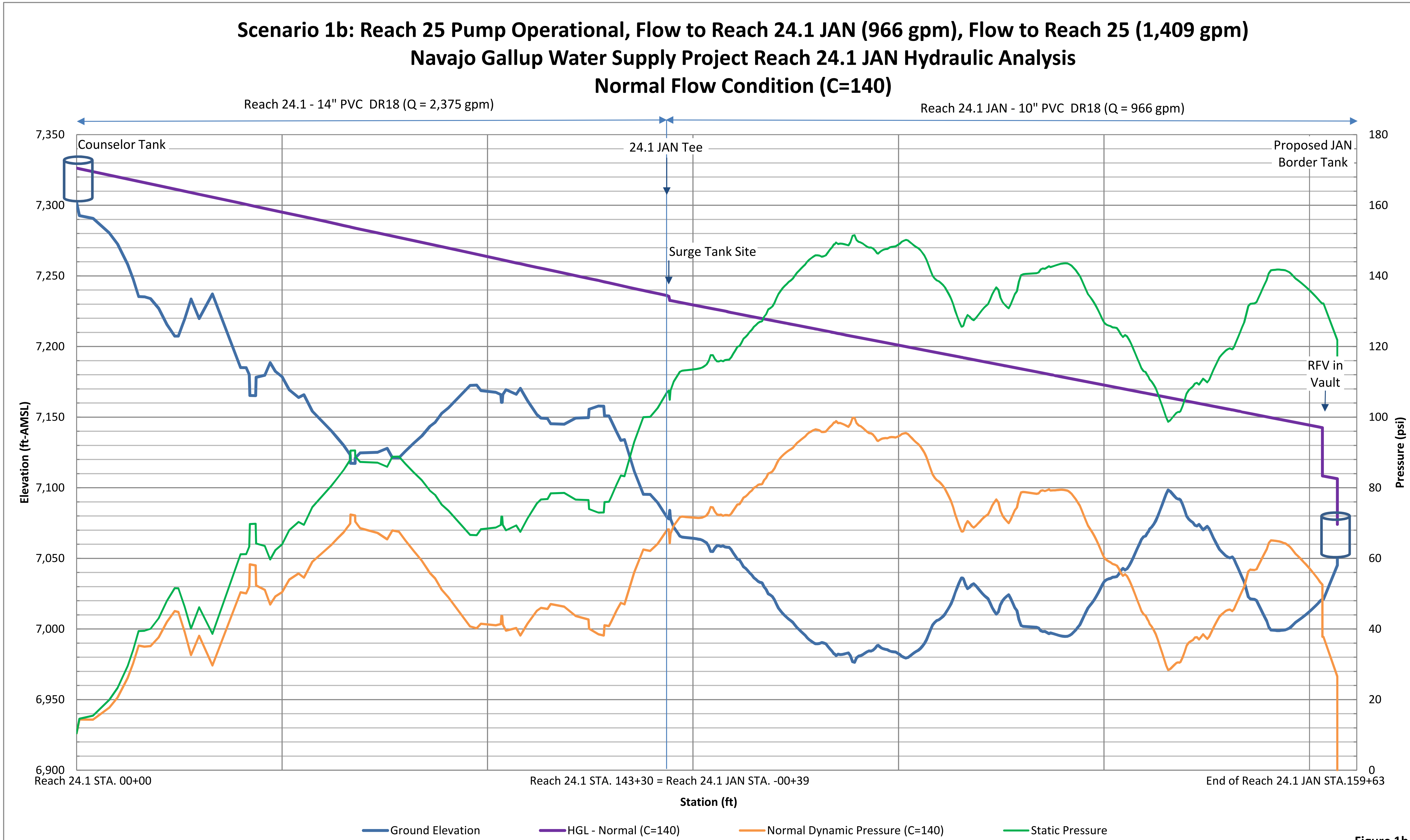
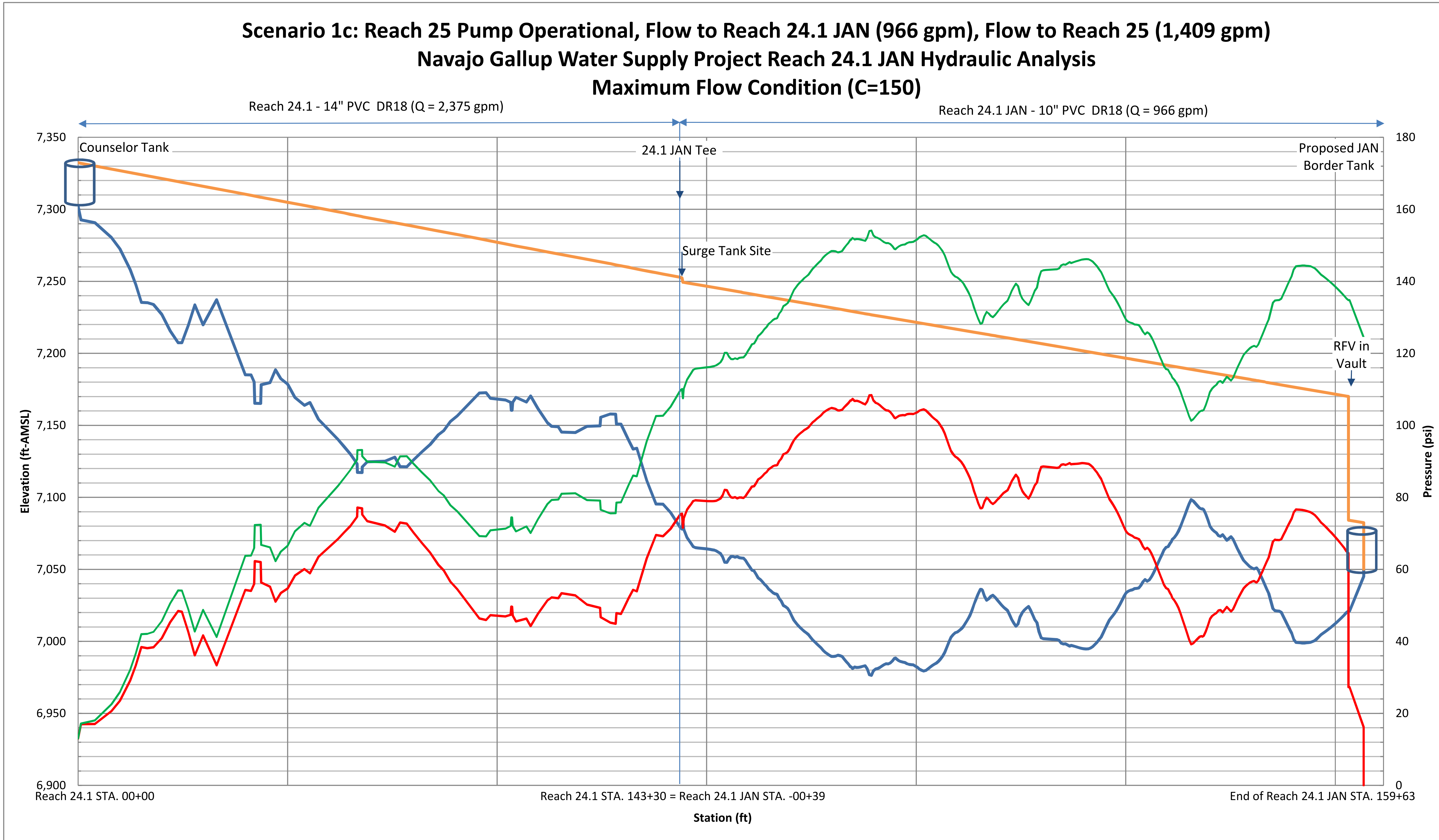
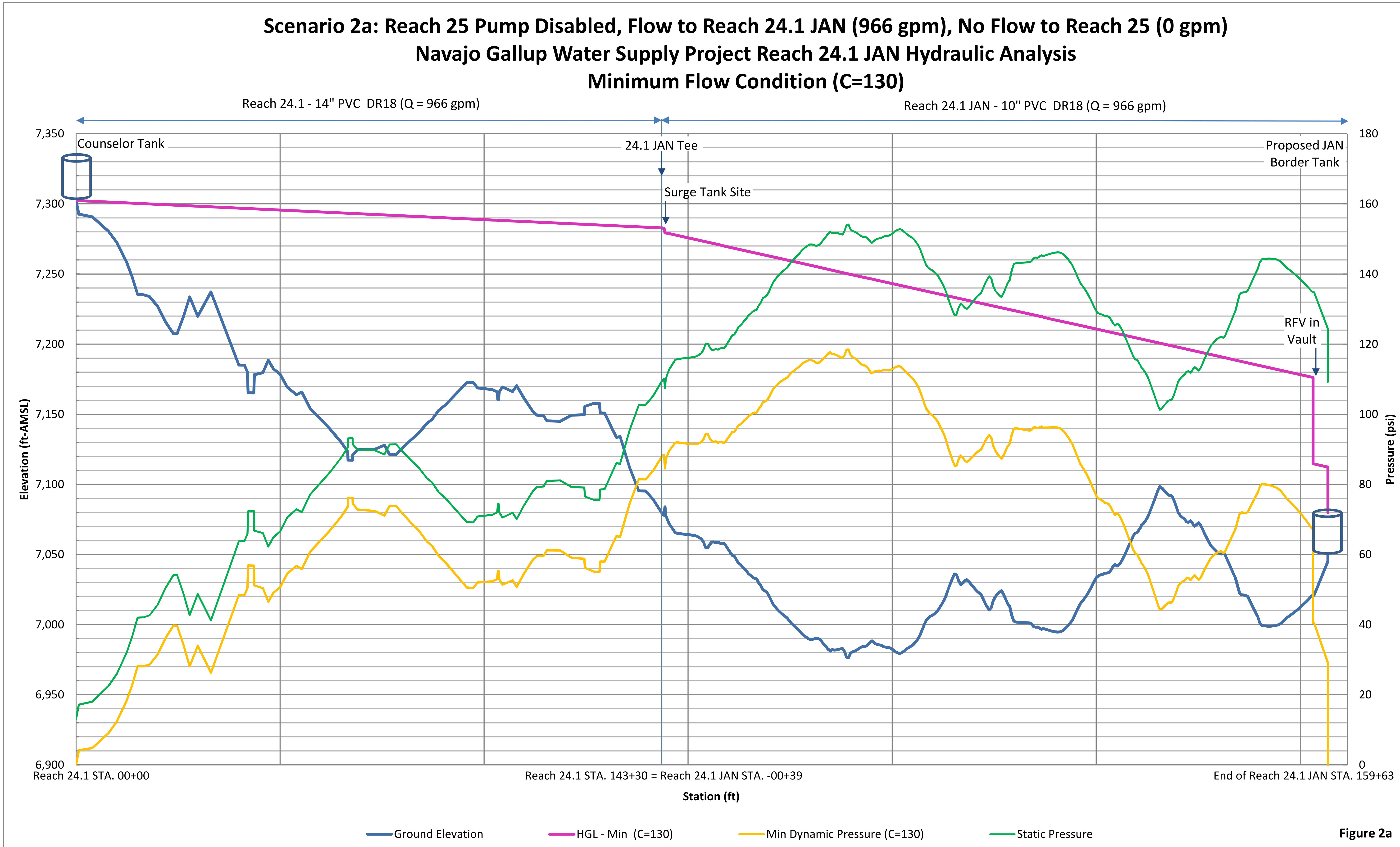

Scenario 1b: Reach 25 Pump Operational, Flow to Reach 24.1 JAN (966 gpm), Flow to Reach 25 (1,409 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Normal Flow Condition (C=140)
Reach 24.1 - 14" PVC DR18 (Q = 2,375 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 966 gpm)
Counselor Tank
24.1 JAN Tee
Proposed JAN Border Tank
Surge Tank Site
RFV in Vault
Elevation (ft-AMSL)
Pressure (psi)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA.159+63
Station (ft)
Ground Elevation
HGL - Normal (C=140)
Normal Dynamic Pressure (C=140)
Static Pressure

Figure 1b



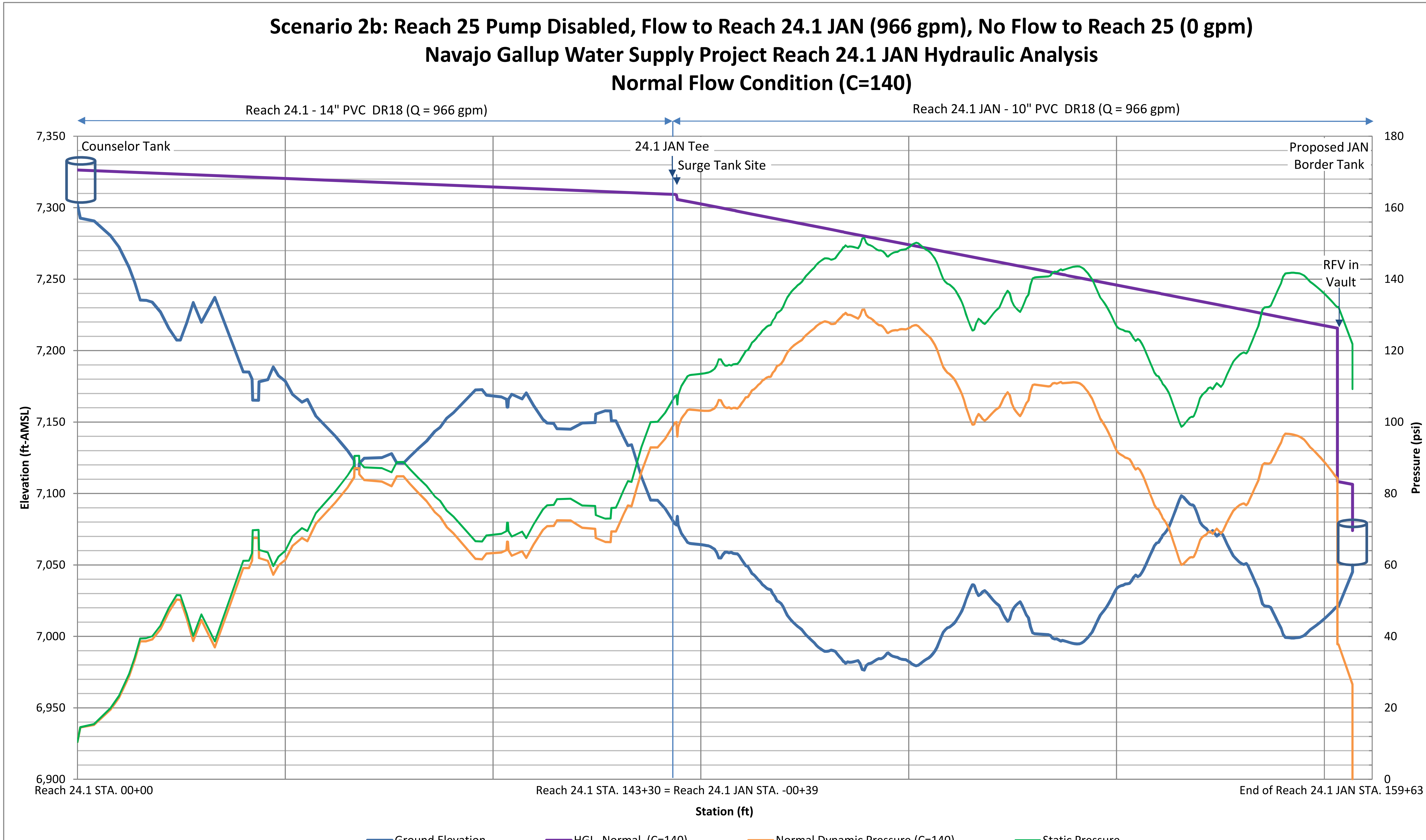
Scenario 1c: Reach 25 Pump Operational, Flow to Reach 24.1 JAN (966 gpm), Flow to Reach 25 (1,409 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Maximum Flow Condition (C=150)
Reach 24.1 - 14" PVC DR18 (Q = 2,375 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 966 gpm)
Counselor Tank
24.1 JAN Tee
Surge Tank Site
Proposed JAN Border Tank
RFV in Vault
Elevation (ft-AMSL)
Pressure (psi)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA. 159+63
Station (ft)
Ground Elevation
HGL - Max (C=150)
Max Dynamic Pressure (C=150)
Static Pressure

Figure 1c



Scenario 2a: Reach 25 Pump Disabled, Flow to Reach 24.1 JAN (966 gpm), No Flow to Reach 25 (0 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Minimum Flow Condition (C=130)
Reach 24.1 - 14" PVC DR18 (Q = 966 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 966 gpm)
Counselor Tank
24.1 JAN Tee
Surge Tank Site
Proposed JAN Border Tank
RFV in Vault
Elevation (ft-AMSL)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
Pressure (psi)
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA. 159+63
Station (ft)
Ground Elevation
HGL - Min (C=130)
Min Dynamic Pressure (C=130)
Static Pressure

Figure 2a



Scenario 2b: Reach 25 Pump Disabled, Flow to Reach 24.1 JAN (966 gpm), No Flow to Reach 25 (0 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Normal Flow Condition (C=140)
Reach 24.1 - 14" PVC DR18 (Q = 966 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 966 gpm)
Counselor Tank
24.1 JAN Tee
Surge Tank Site
Proposed JAN Border Tank
RFV in Vault
Elevation (ft-AMSL)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
Pressure (psi)
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA. 159+63
Station (ft)
Ground Elevation
HGL -Normal (C=140)
Normal Dynamic Pressure (C=140)
Static Pressure

Figure 2b

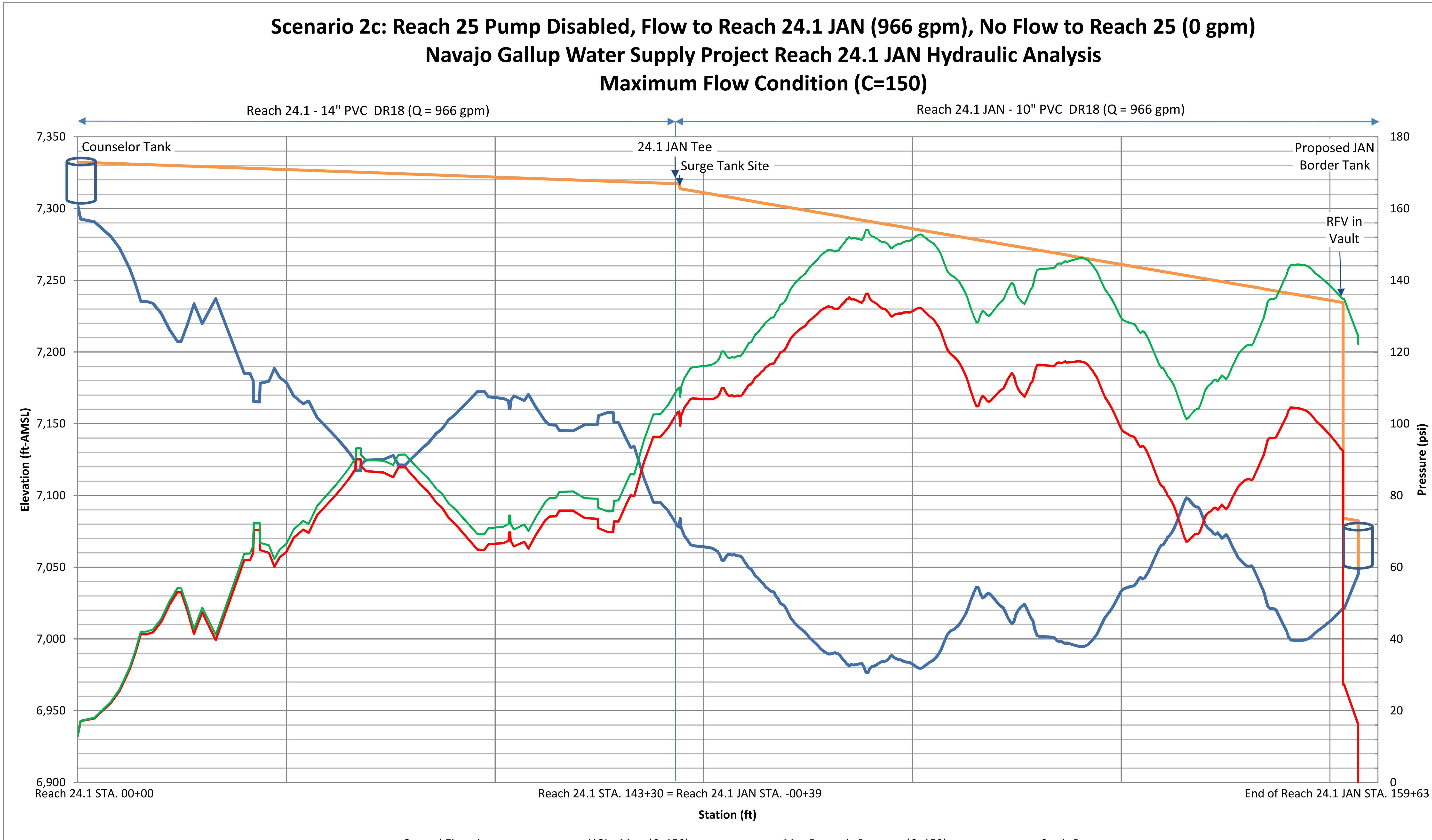

Scenario 2c: Reach 25 Pump Disabled, Flow to Reach 24.1 JAN (966 gpm), No Flow to Reach 25 (0 gpm)
Navajo Gallup Water Supply Project Reach 24.1 JAN Hydraulic Analysis
Maximum Flow Condition (C=150)
Reach 24.1 - 14" PVC DR18 (Q = 966 gpm)
Reach 24.1 JAN - 10" PVC DR18 (Q = 966 gpm)
Counselor Tank
24.1 JAN Tee
Surge Tank Site
Proposed JAN Border Tank
RFV in Vault
Elevation (ft-AMSL)
Pressure (psi)
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
180
160
140
120
100
80
60
40
20
0
Reach 24.1 STA. 00+00
Reach 24.1 STA. 143+30 = Reach 24.1 JAN STA. -00+39
End of Reach 24.1 JAN STA. 159+63
Station (ft)
Ground Elevation
HGL - Max (C=150)
Max Dynamic Pressure (C=150)
Static Pressure

Figure 2c

Summary and Steady State Hydraulic Profiles - Generated with Bentley WaterCAD

Reach 24.1 JAN Summary of Steady State Hydraulic Profiles Generated with Bentley WaterCAD

Operational Conditions:

Counselor Tank Base Elevation:	7,302 feet aMSL
Counselor Tank Height:	30 feet
Counselor Tank Normal Elevation (80% Full):	7,326 feet aMSL
Counselor Tank Overflow Elevation:	7,332 feet aMSL

Proposed JAN Border Tank Base Elevation:	7,050 feet aMSL
Proposed JAN Border Tank Height:	30 feet
Proposed JAN Border Tank Normal Elevation (80% Full):	7,074 feet aMSL
Proposed JAN Border Tank Overflow Elevation:	7,080 feet aMSL
Proposed JAN Border Tank Altitude Valve Elevation:	7,045 feet aMSL

Reach 24.1 Design Flow Rate[1]	2,375 gpm
Reach 24.1 JAN Design Flow Rate[1]	966 gpm
Reach 25 Design Flow Rate[1]	1,409 gpm

[1] Design flow rates correspond to authorized flow rates based on 2040 demand with 1.3 peaking factor.

Six scenarios were considered in this analysis, and are summarized in the table below. The parameters of these scenarios, and the results of each, are given in the following pages.

Summary of Considered Scenarios

Scenario	Flow Condition	Design C-factor of Pipe	Reach 25 Pump	Tank Level	
				Counselor	JAN Border
1a	Minimum	130	On	Empty	Full
1b	Normal	140	On	80%	80%
1c	Maximum	150	On	Full	Empty
2a	Minimum	130	Off	Empty	Full
2b	Normal	140	Off	80%	80%
2c	Maximum	150	Off	Full	Empty

Notes:

- Reach 24.1 and Reach 25 are constructed of 14" DR 18 PVC.
- Reach 24.1 JAN will be constructed of 10" DR 18 PVC.
- The proposed JAN Border tank and altitude valve at the JAN Border tank are not part of the Reach 24.1 JAN design package. However, they are critical to the Reach 24.1 JAN pipeline design, so preliminary design parameters for each are included in the Hydraulic Profiles.
- Hydraulic profile stationing begins at the Counselor Tank located at Sta. 00+00 of Reach 24.1, and increases along Reach 24.1 to Sta. 143+30 where Reach 24.1 ends and Reach 25 begins at the Reach 24.1 JAN stubout tee. Reach 24.1 JAN begins at the branch of the stubout tee at Sta. -00+39 of Reach 24.1 JAN, and continues to Sta. 159+63, where it terminates at the Jicarilla Apache Nation (JAN) reservation boundary. From there, a short pipeline that is to be constructed by the Jicarilla Apache Nation will deliver water to the proposed JAN border tank. The proposed JAN border tank, which is not a part of Reach 24.1 JAN, is located in the hydraulic models at Sta. 163+00, approximately 30,670 LF from the Counselor tank.
- Each scenario includes head losses from the following appurtenances:
  - Friction losses throughout the PVC pipeline.
  - Minor losses through fittings and valves along the pipeline.
  - The surge tank site piping located at Sta. 00+53 of Reach 24.1 JAN.
  - An electromagnetic flow meter, a rate of flow control valve (RFV) set to 966 gpm, and an orifice plate on the RFV, located in a vault at Sta. 159+08, just before the end of Reach 24.1 JAN.
  - The proposed altitude valve with anti-cavitation trim, located at the proposed JAN border tank at Sta. 163+00.
- Actual Reach 24.1 JAN pipe selection was based on maximum, static pressures.
  - Static pressures are shown on the hydraulic profiles of each scenario.

Variations between Excel and WaterCAD models:

The WaterCAD model provided a means to validate the Excel model. Raw data used in both models was the same, including elevations and stations per the survey data obtained by SMA to create the construction drawings. The major friction losses through the pipe are modeled identically in WaterCAD and Excel using the Hazen-Williams equation. The WaterCAD hydraulic analysis that follows, and the Excel hydraulic analysis in the preceding section, produced very similar results.

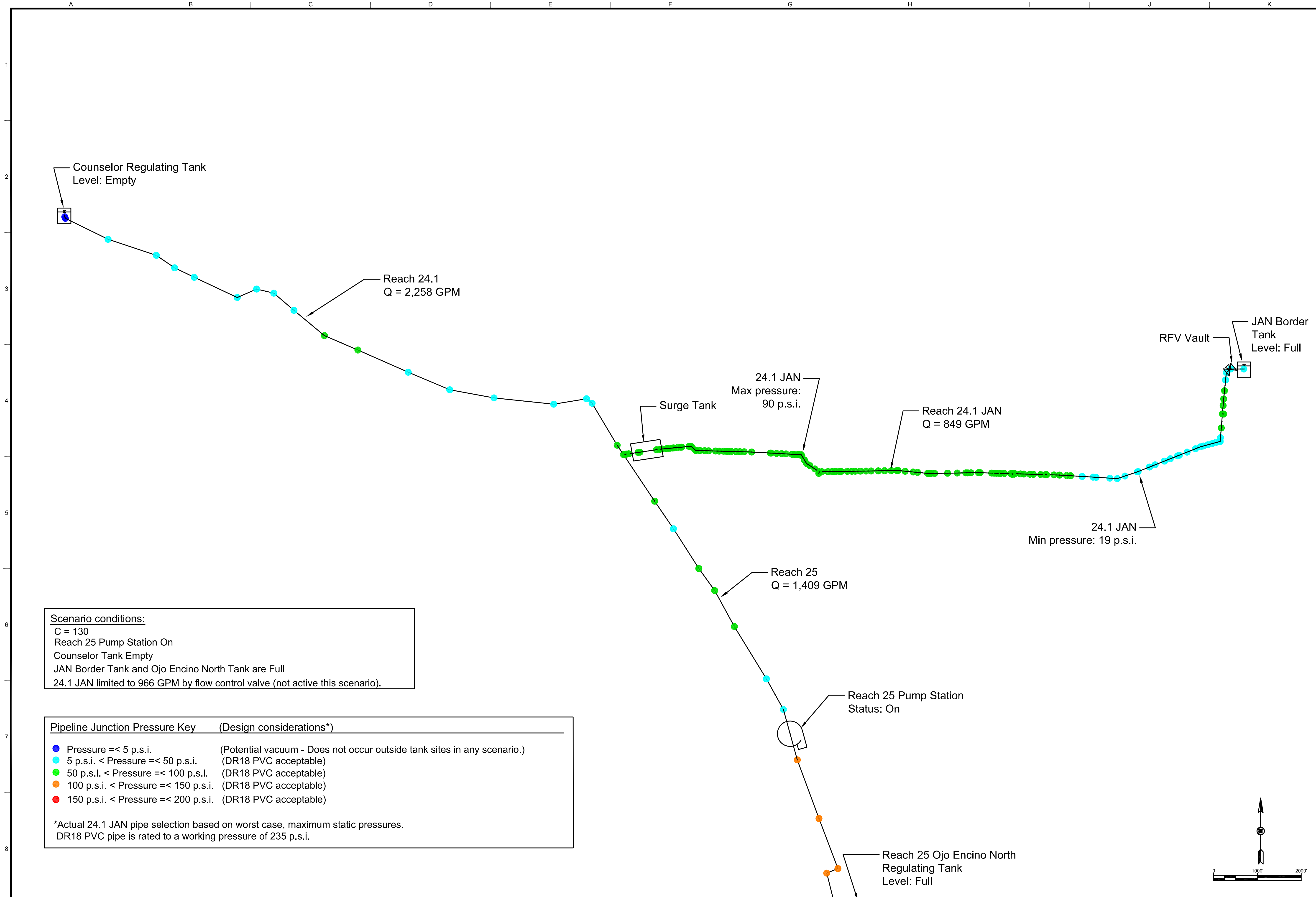
The summary table on the next page shows the parameters for each scenario considered, as well as key values generated from the hydraulic profile calculations.

Reach 24.1 JAN Summary of Hydraulic Scenario Analysis in Bentley WaterCAD

Scenario	Flow Condition	Design C-factor of Pipe	Reach 25 Pump	Tank Level		Flow (GPM)			Rate of Flow Control Valve Headloss						Pressure at Rate of Flow Control Valve (psi)		Altitude Valve with Anti-Cav Trim Headloss		Pressure at Altitude Valve (psi)	
				Counselor	JAN	Reach 24.1	Reach 25	Reach 24.1 JAN	Open Valve ft	Open Valve psi	Orifice Plate ft	Orifice Plate psi	Valve Closure ft	Valve Closure psi	Inlet	Outlet (pre-orifice)	ft	psi	Inlet	Outlet
1a	Minimum	130	On	Empty	Full	2,258	1,409	**849**	7.6	3.3	8.9	3.8	0.0	0.0	44.1	40.9	24.9	10.8	25.7	14.9
1b	Normal	140	On	80%	80%	2,375	1,409	**966**	8.8	3.8	11.6	5.0	11.6	5.0	51.7	42.9	32.3	14.0	26.5	12.6
1c	Maximum	150	On	Full	Empty	2,375	1,409	**966**	8.8	3.8	11.6	5.0	63.3	27.4	63.6	32.4	32.3	14.0	16.2	2.2
2a	Minimum	130	Off	Empty	Full	966	0	**966**	8.8	3.8	11.6	5.0	40.1	17.3	66.7	45.5	32.3	14.0	29.1	15.1
2b	Normal	140	Off	80%	80%	966	0	**966**	8.8	3.8	11.6	5.0	85.1	36.9	83.5	42.9	32.3	14.0	26.5	12.6
2c	Maximum	150	Off	Full	Empty	966	0	**966**	8.8	3.8	11.6	5.0	128.0	55.4	91.6	32.4	32.3	14.0	16.2	2.2

Conclusions:

- The Reaches 24.1 / 25 / 24.1 JAN system meets the authorized 24.1 JAN flow of 966 gpm in all but one of the six scenarios.
    - Scenario 1A (Min), based on an empty upstream tank and full downstream tank with the Reach 25 pump on, and C-factor of 130, is projected to deliver 849 gpm. However, this is deemed acceptable because Scenario 1A is not a normal operating condition; it is the minimum flow boundary condition, based on conveying water from an empty upstream (Counselor) tank to a full downstream (JAN) tank. In reality, while such a condition is possible and was therefore analyzed, it would not be considered normal. The Counselor tank would typically be maintained approximately 80% full by the upstream reaches. Moreover, if the JAN tank were already full, the altitude valve would begin to close gradually, throttling back the flow rate to zero, so conveying the full 966 gpm to the JAN tank would not be an issue.
    - In the five remaining scenarios, the RFV valve must modulate (i.e. partially close) to limit flow to 966 gpm. All normal operating scenarios are capable of providing the 966 gpm authorized flow rate.
    - The authorized flow rate of 1,409 gpm to Reach 25 is met under all scenarios in which there is flow to Reach 25 (Scenarios 1a, 1b, and 1c).
- A failure analysis was performed on the RF control valve, by modeling system hydraulics if this valve were to fail completely open (i.e. fail to modulate to control flow).
    - Under the highest flow conditions, Scenario 2C (Max), uncontrolled flow delivered to JAN would reach 1,279 gpm. The RFV limits flow to 966 gpm in Scenario 2C by partially closing the valve to add an additional 50 psi of headloss to the system. If the RFV were to fail and flow rate increased to 1,279 gpm, positive pressures would still be maintained throughout the system. The same is true for all four scenarios in which the RFV limits flow.
- In conclusion, the hydraulic scenarios considered show Reach 24.1 JAN to have sufficient capacity to meet JAN's authorized flow rate without impeding the ability of Reach 25 to deliver its authorized flow rate to NTUA.



Rev # | Date | Description | By | Chk'd

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Scenario 1A
Reach 25 Pump On, Min Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

Designed	Drawn	Checked
RMB	RMB	TTT

Date: 3/18/2016
Scale: Horiz: N/A Vert: N/A
Project No: 6921307
Sheet: Map-1A

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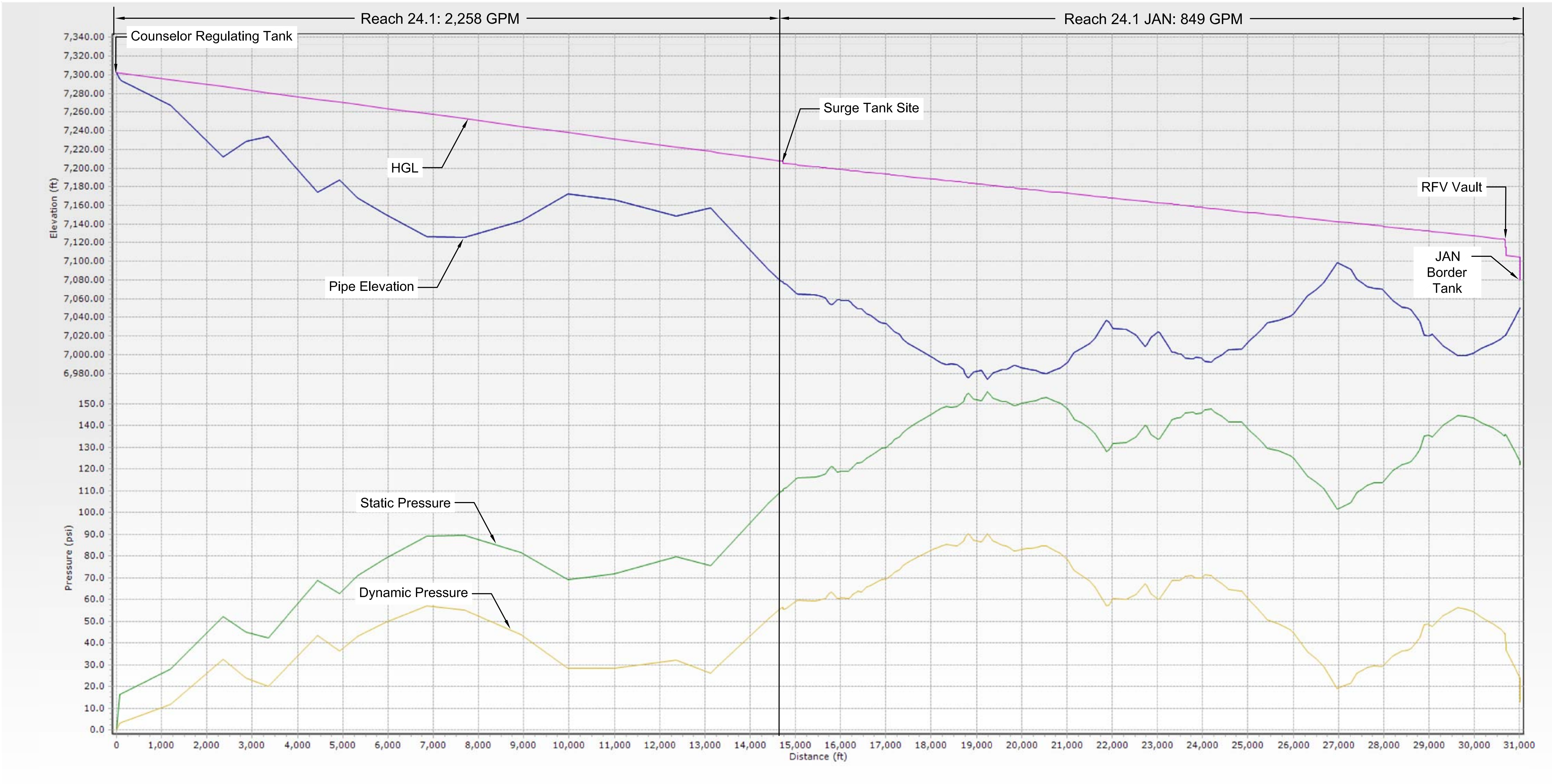
Scenario 1A

Reach 25 Pump On

Minimum Flow Condition



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Scenario 1A
Reach 25 Pump On, Min Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

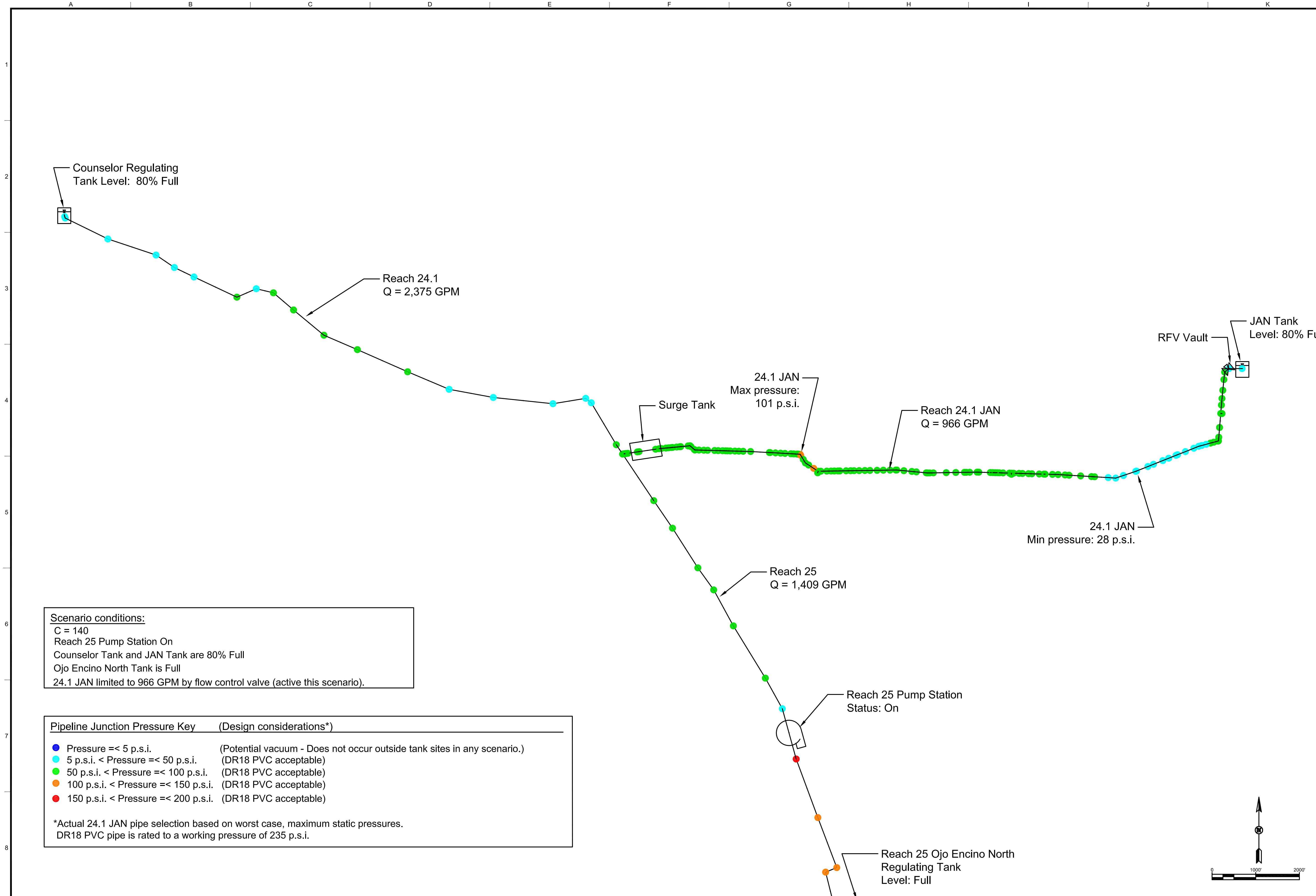
Designed	Drawn	Checked
RMB	RMB	TTT

Date: 3/18/2016

Scale: Horiz: N/A Vert: N/A

Project No: 6921307

Sheet: Profile-1A



Scenario conditions:
C = 140
Reach 25 Pump Station On
Counselor Tank and JAN Tank are 80% Full
Ojo Encino North Tank is Full
24.1 JAN limited to 966 GPM by flow control valve (active this scenario).

Pipeline Junction Pressure Key	(Design considerations*)
Pressure =< 5 p.s.i.	(Potential vacuum - Does not occur outside tank sites in any scenario.)
5 p.s.i. < Pressure =< 50 p.s.i.	(DR18 PVC acceptable)
50 p.s.i. < Pressure =< 100 p.s.i.	(DR18 PVC acceptable)
100 p.s.i. < Pressure =< 150 p.s.i.	(DR18 PVC acceptable)
150 p.s.i. < Pressure =< 200 p.s.i.	(DR18 PVC acceptable)

*Actual 24.1 JAN pipe selection based on worst case, maximum static pressures.
DR18 PVC pipe is rated to a working pressure of 235 p.s.i.

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Scenario 1B
Reach 25 Pump On, Normal Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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RMB	RMB	TTT

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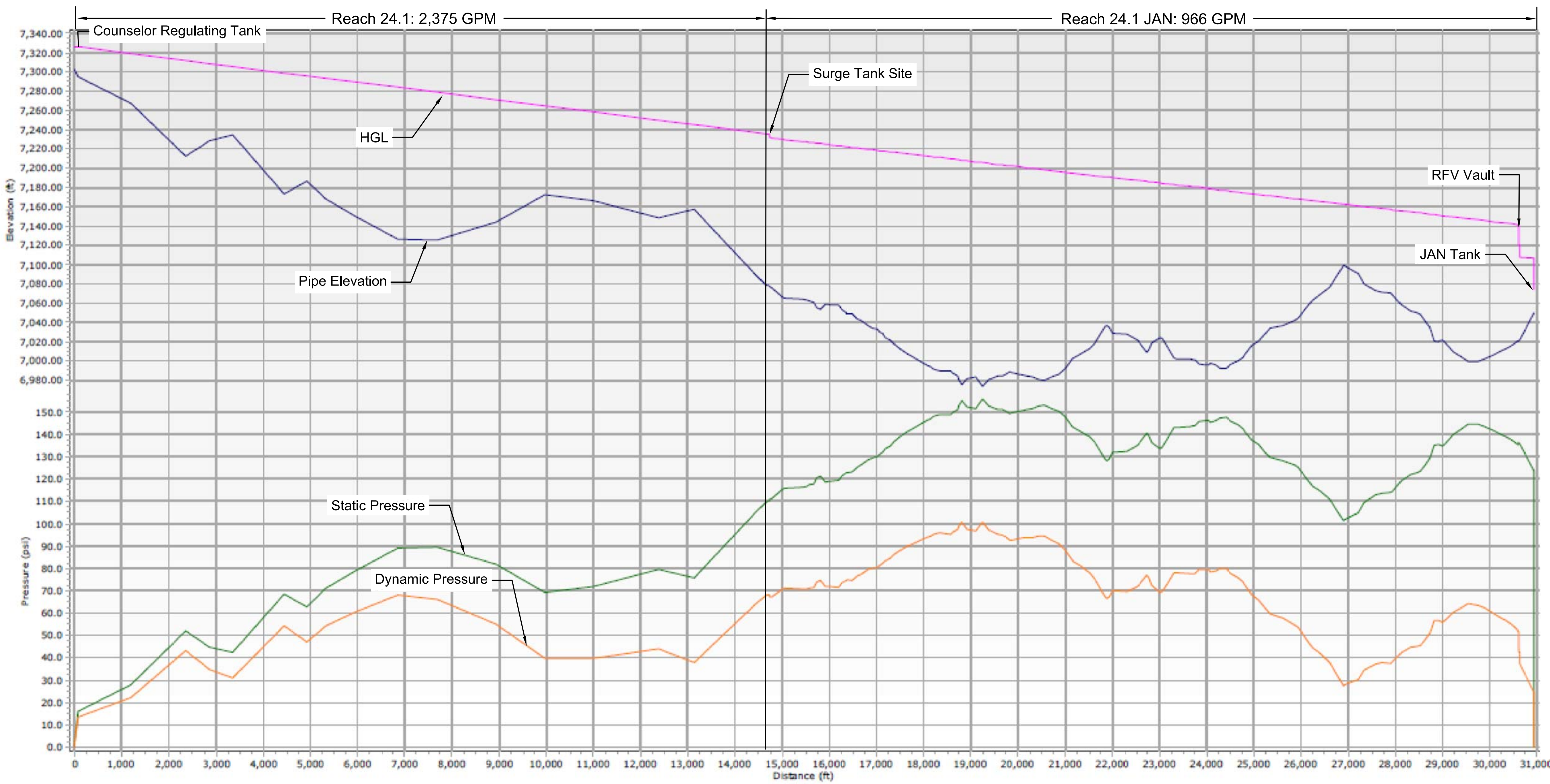
Project No: 6921307
Sheet: Map-1B

Scenario 1B

Reach 25 Pump On

Normal Flow Condition



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Scenario 1B
Reach 25 Pump On, Normal Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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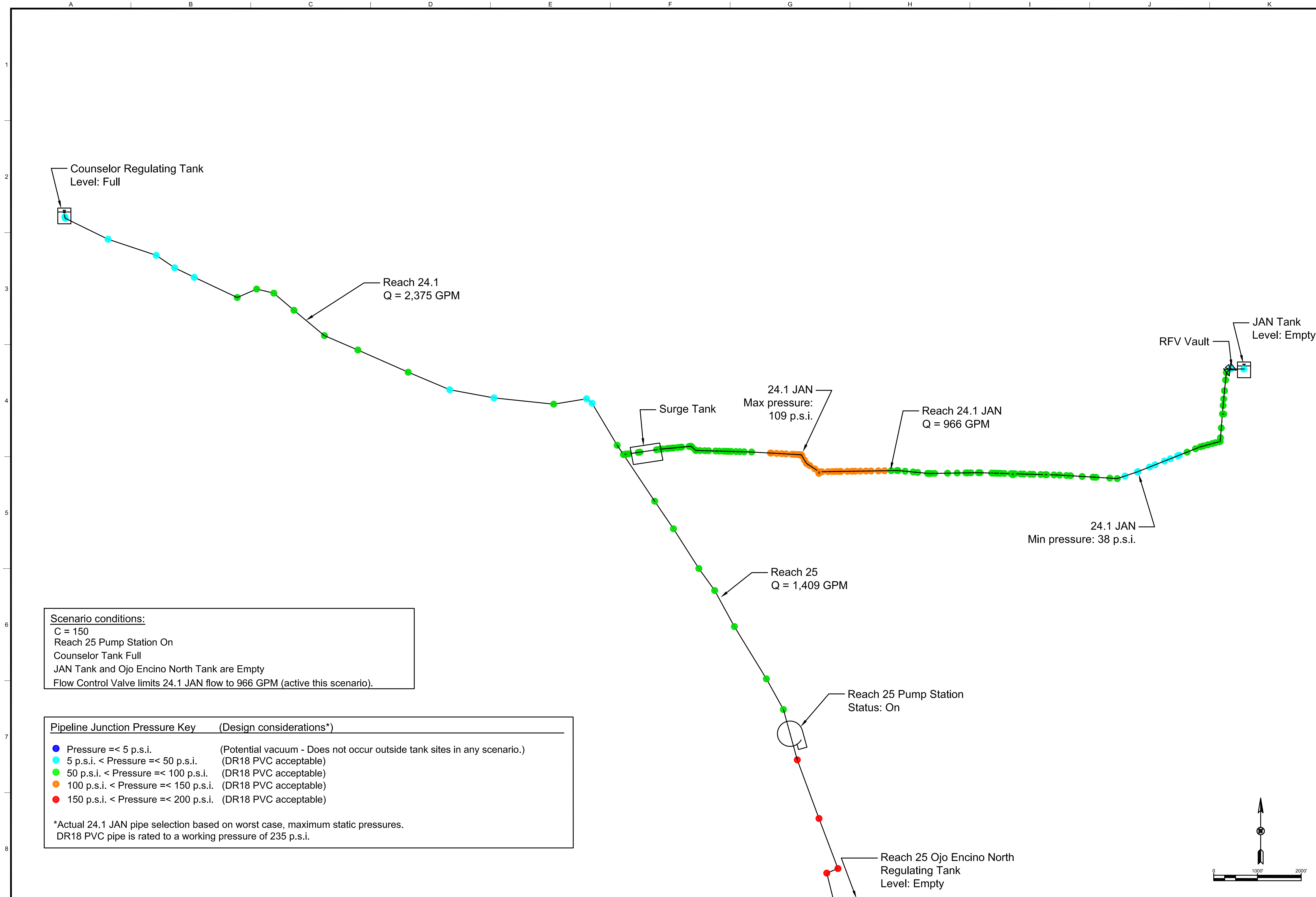

Scenario conditions:
C = 150
Reach 25 Pump Station On
Counselor Tank Full
JAN Tank and Ojo Encino North Tank are Empty
Flow Control Valve limits 24.1 JAN flow to 966 GPM (active this scenario).

Pipeline Junction Pressure Key (Design considerations*)

- Pressure =< 5 p.s.i. (Potential vacuum - Does not occur outside tank sites in any scenario.)
- 5 p.s.i. < Pressure =< 50 p.s.i. (DR18 PVC acceptable)
- 50 p.s.i. < Pressure =< 100 p.s.i. (DR18 PVC acceptable)
- 100 p.s.i. < Pressure =< 150 p.s.i. (DR18 PVC acceptable)
- 150 p.s.i. < Pressure =< 200 p.s.i. (DR18 PVC acceptable)

*Actual 24.1 JAN pipe selection based on worst case, maximum static pressures.
DR18 PVC pipe is rated to a working pressure of 235 p.s.i.

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Scenario 1C
Reach 25 Pump On, Max Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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Project No: 6921307
Sheet: Map-1C

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Scenario 1C

Reach 25 Pump On

Maximum Flow Condition

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Scenario 1C
Reach 25 Pump On, Max Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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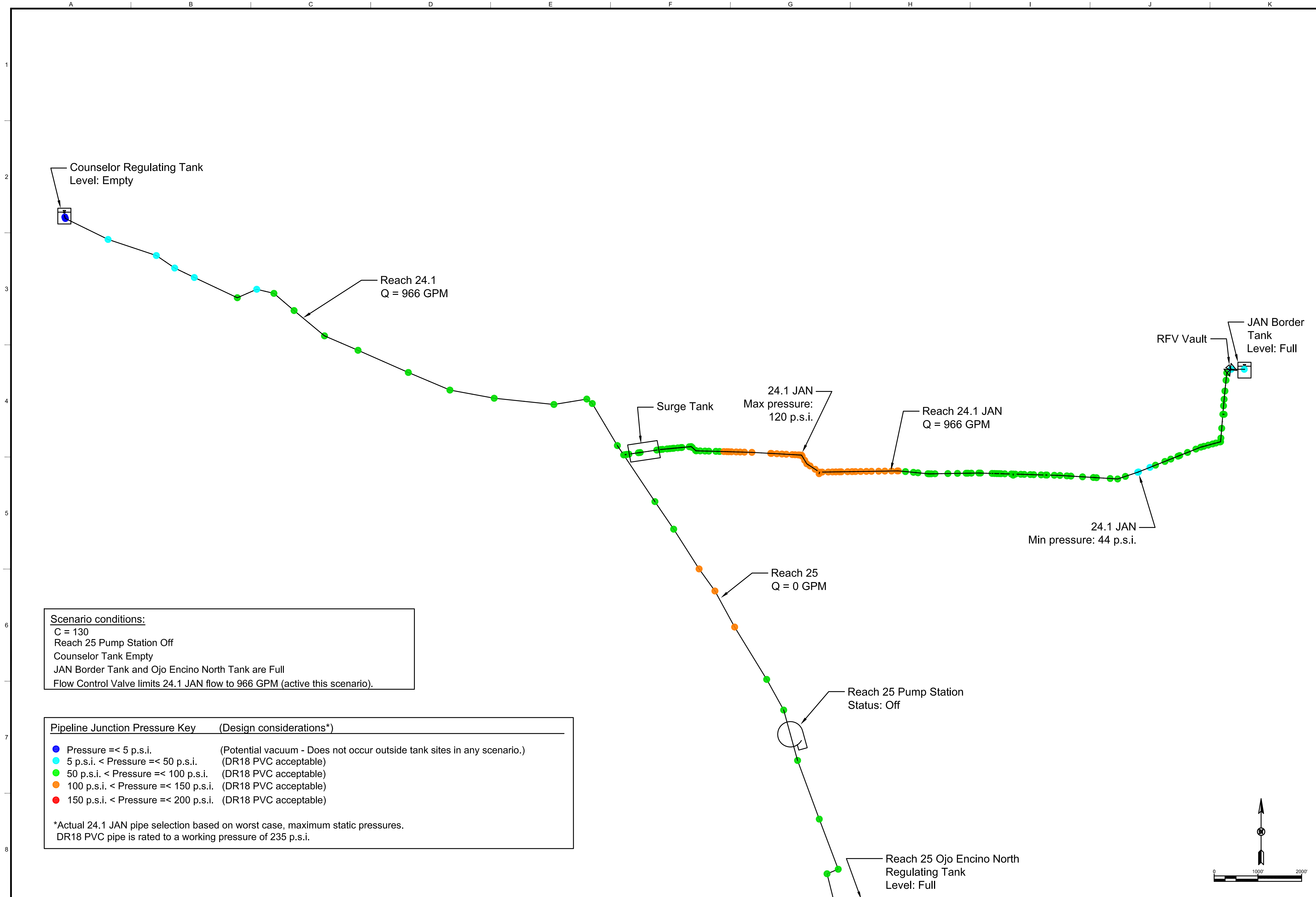

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Scenario 2A
Reach 25 Pump Off, Min Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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Sheet: Map-2A

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Scenario 2A

Reach 25 Pump Off

Minimum Flow Condition

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Scenario 2A
Reach 25 Pump Off, Min Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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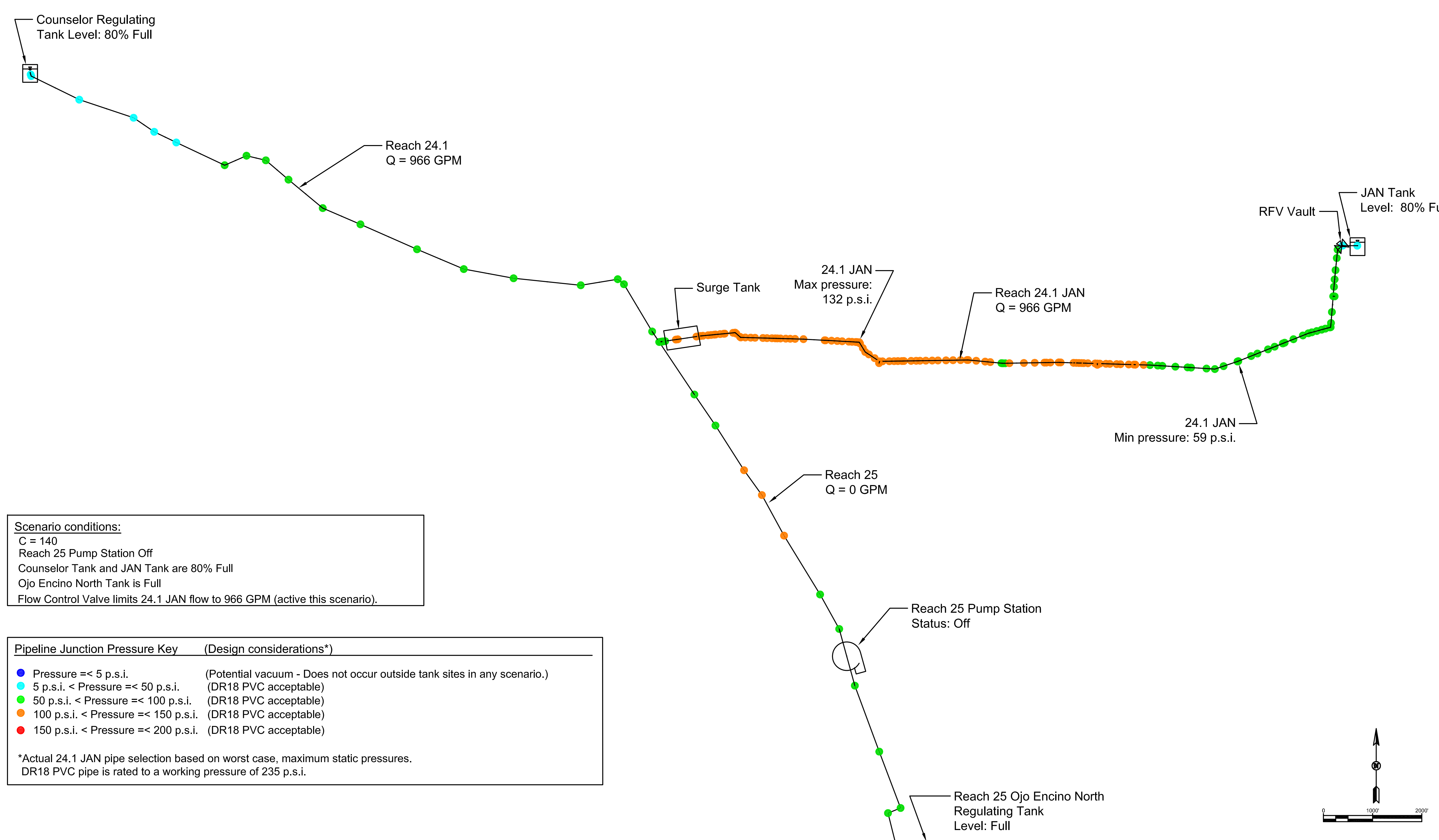

Scenario conditions:

C = 140

Reach 25 Pump Station Off

Counselor Tank and JAN Tank are 80% Full

Ojo Encino North Tank is Full

Flow Control Valve limits 24.1 JAN flow to 966 GPM (active this scenario).

Pipeline Junction Pressure Key	(Design considerations*)
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50 p.s.i. < Pressure =< 100 p.s.i.	(DR18 PVC acceptable)
100 p.s.i. < Pressure =< 150 p.s.i.	(DR18 PVC acceptable)
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Scenario 2B
Reach 25 Pump Off, Normal Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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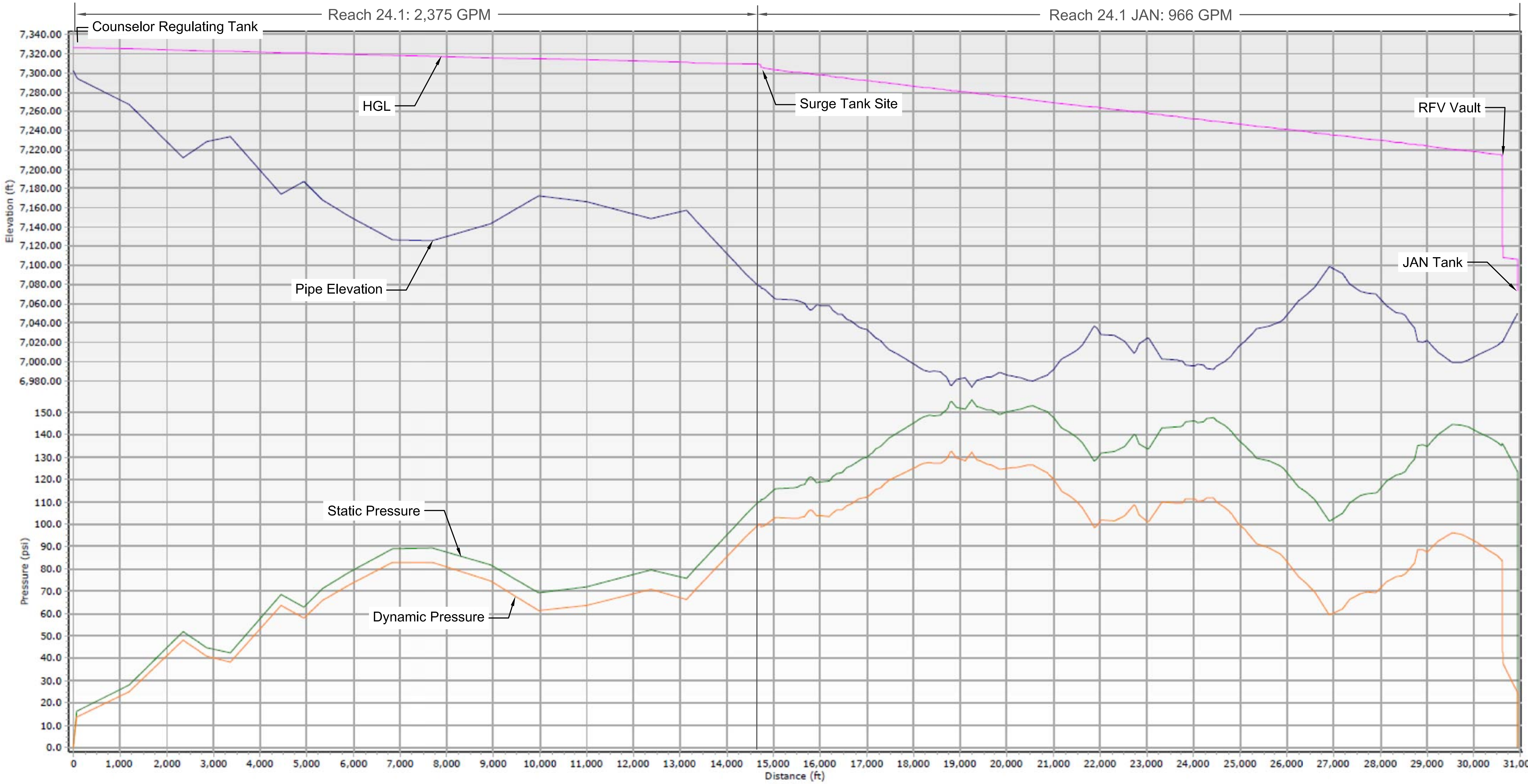
Sheet: Map-2B

Scenario 2B

Reach 25 Pump Off

Normal Flow Condition



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Scenario 2B
Reach 25 Pump Off, Normal Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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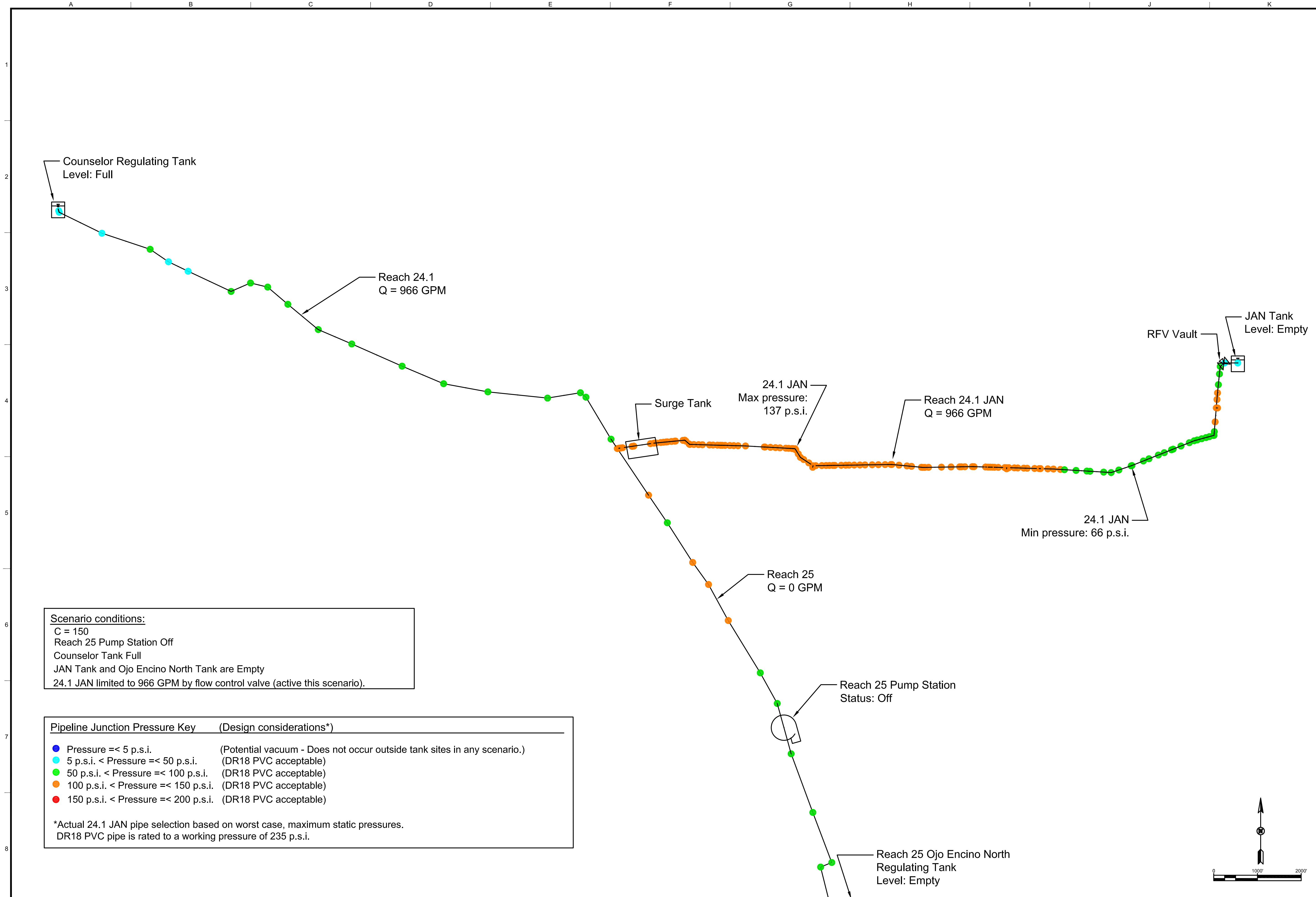

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Scenario 2C
Pump Off, Max Flow Condition
NGWSP Reach 24.1 JAN Hydraulic Analysis

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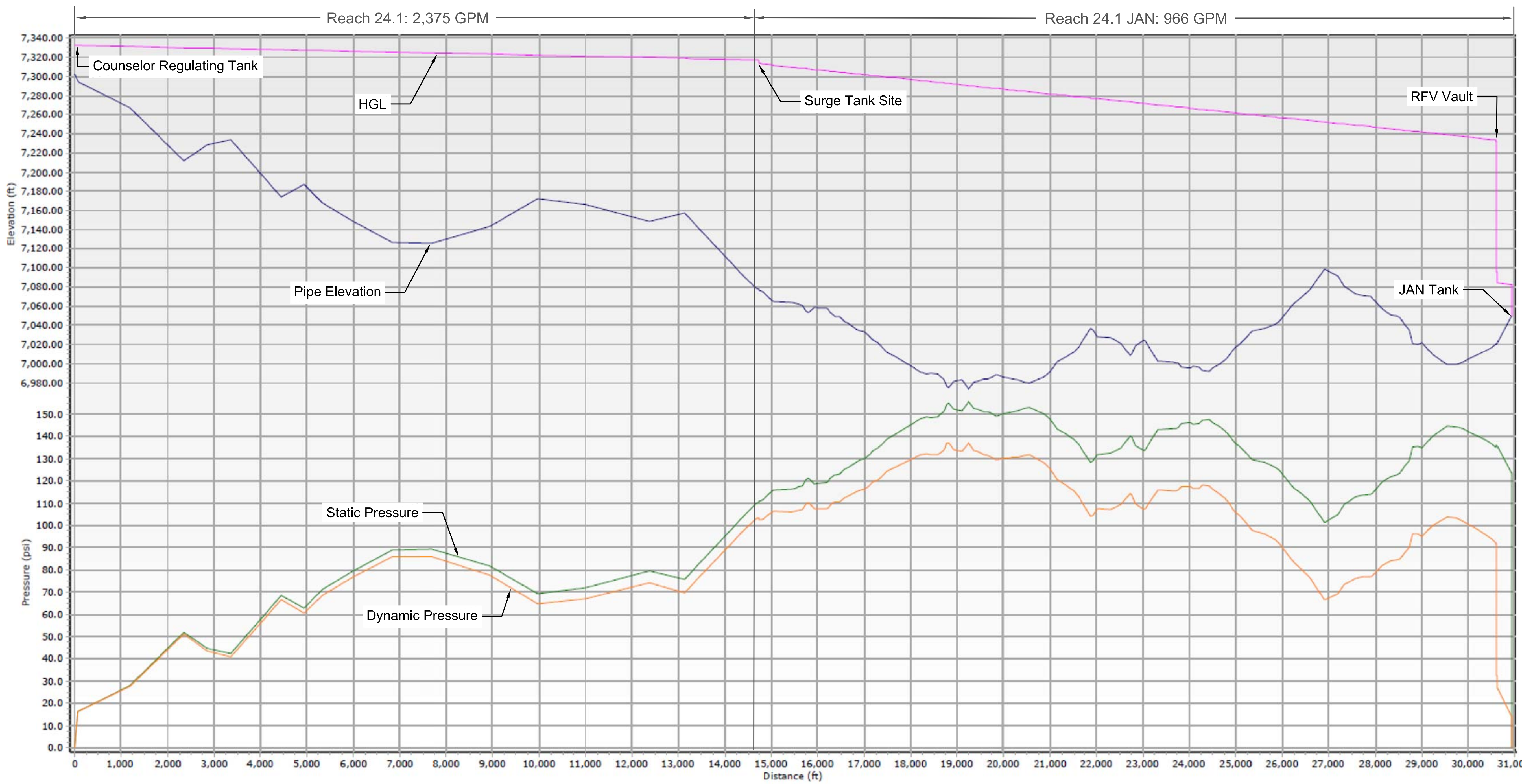
Scenario 2C

Reach 25 Pump Off

Maximum Flow Condition



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Scenario 2C
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NGWSP Reach 24.1 JAN Hydraulic Analysis

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Project No: 6921307

Sheet: Profile-2C

Design Criteria Based on Transients Analysis

Project-Specific Design Criteria for NGWSP Reach 24.1 JAN
Based on Transients Analysis, (URS, April 14, 2016 and May 4, 2016)

1. Air valves:
    a. All air valves shall be 2” VBV with 1/8” ARV orifice size (except at stations 122+63 and 122+88, see item e. below).
    b. Install air valves on downstream side of all sectionalizing valves, to relieve downsurge in case of accidental closure while line is flowing.
        i. Also install at all high points, every ~½ mile, on downhill side of sectionalizing valves, etc. based on normal design principles.
    c. Take measures to prevent operator accidentally interchanging 2” VBVs with 2” combos (used in previous reaches) when replacing/ servicing valves:
        i. Use 2” flanges for VBVs.
        ii. We used 2” NPT ends for combos in previous reaches.
        iii. Hang warning tags on VBVs reminding operator not to replace with 2” combos.

            Note: The 2” VBV/ARVs used in 24.1 JAN are identical to the ones we will use in Reaches 26.1, 26.2 & 26.3. This is to make it easier for NTUA to maintain inventory.
    d. Install VBV as close to surge tank as possible to protect bladder in event of a line break.
    e. Air valves at stations 122+63 and 122+88 shall be 4” VBV with 1/8” ARV orifice size. There shall be two redundant valves at this location in case one valve fails.
2. In-line sectionalizing valves:
    a. Warning placards and locking lids to reduce risk of accidental closure when pipeline is flowing.
    b. VBVs downstream of every sectionalizing valve (as noted above).
3. Flush valves:
    a. Do not locate flush too close to surge tank (somewhat subjective; locate it as far away as possible).
    b. Limit flow rates through all flush valves using orifice plates to 20% below maximum safe flow rates given in the transients report.
        i. Use single large-bore orifice plates for flushes. Large-bore orifices are less likely to trap the rocks or construction debris we are trying to flush out.
        ii. See Tab 6 of the Reach 24.1 JAN Final Design Book for orifice plate calculations for flush valves.

4. Surge tank:
    a. Located at Station 00+53 of Reach 24.1 JAN.
    b. Minimum required volume: 4862-gallon capacity.
        i. Design volume: 5283-gallon capacity
    c. Surge tank rated to 250 psi working pressure, 375 psi test pressure.
    d. 14-inch lateral piping between main line and tank. Use 14-inch tank inlet. The resistance from the main line and surge tank needs to be approximately 0.02 ft/cfs^2 or less (actual resistance will be 0.021 $ft./cfs^2$, which was verified to be acceptable).
    e. 35 psi pre-charge pressure, or as recommended by surge tank manufacturer after their own transient analysis.
    f. Specify contractor to isolate tank from main line until main line is flushed to keep debris out of tank. This will be accomplished by installing a blind flange on the riser pipe, which will be removed after the transmission line is flushed.
    g. Surge tank differential pressure transmitter will be connected to SCADA to relay information to Reach 25 pump station and Ft. Defiance to disable Reach 25 pump station when surge tank pre-charge level is out of acceptable range.
    h. The Reach 24.1 JAN magnetic flow meter will be connected to SCADA to relay information to Reach 25 pump station and Ft. Defiance to lock the Reach 25 pump to prevent from changing states for 5 minutes if the Reach 24.1 JAN flowrate changes by more than 100 gpm in 1 minute. (NOTE: This last mitigation measure is not strictly necessary if we use the 5283-gallon surge tank, but provides an additional level of protection).
5. Ojo Tank:
    a. The Ojo tank requires a minimum water level of 9 feet to prevent low pressures below 5 psi due to steady state pressures for a number of scenarios considered in this report.
    b. The Ojo tank level corresponding to the “pump on” set-point to turn on the Reach 25 pumps will be significantly greater than 9 ft.
6. Counselor Tank:
    a. The Counselor tank requires a minimum water level of 6 feet to prevent low pressures below 5 psi due to steady state pressures for a number of scenarios considered in this report. The Reach 25 Pump Station SOO is already programmed to disable the pump when the tank level drops below 7 ft. The Phase 2 pump station “pump on” set point is significantly higher than this.

7. Reach 25 Pump Station SOO (as relevant to Reach 24.1JAN only):
    a. There is to be a 5-minute delay between changing the flowrate of Reach 24.1 JAN and changing the pump or bypass state.
        i. "Changing flow rate" for 24.1 JAN shall be determined as a change in flow rate (as measured by the mag meter in the surge tank bldg.) of more than 100 gpm within a 60 second period.
    b. Reach 25 pump shall be disabled if the Reach 24.1 JAN surge tank level is less than 10%, or greater than 85% full.
    c. The Reach 25 pump shall be disabled if the Counselor tank level drops below 7 ft.
    d. The Reach 25 pump is to turn on when the Ojo Encino tank reaches a minimum "pump on" water level, which shall be significantly higher than 9 ft.
8. Rate of Flow (RF) Control Valve
    a. Located at JAN reservation border, which is downstream of last hill.
    b. Will be set to maximum design flowrate of 966 gpm.
    c. 180 second open/close time.
9. JAN Tank Altitude Valve (part of follow-on Cutter-JAN Inter-tie project, to be completed by JAN):
    a. Locate as close to JAN tank as possible: approximated at Station 163+00.
    b. 180 second open/close time.
    c. VBV immediately downstream of altitude valve.
    d. Will include anti-cavitation trim with 14 psi pressure drop at design flow rate of 966 gpm, to maintain HGL safely above hill near end of 24.1 JAN line.

Surge Tank Branch Line
Resistance Calculations

Surge Tank Resistance Calculations

C-Factor Unitless	Flow (gpm)	Flow (CFS)	Avg. Velocity (ft/s)	Quantity	G (ft/s^2)	Surge Tank Inlet Size (in)
130	966	2.15	2.17		32.2	14.00

Item	Fitting Size	ID (in)	Quantity		Head Loss (ft)	Equivalent Length (ft)
Tee 14x14x14	14	13.5	1	1	0.0500	37.0
90 Elbow	14	13.5	1	1	0.0243	18.0
Pipe (LF)	14	13.5	16	1	0.0216	16.0
			Total Head Loss (ft)		**0.0959**	

Resistance (ft/cfs^2)
0.021

Valve Spacing
Summary Table

24.1 JAN Valve Type & Spacing

Isolation Valves

Station (LF)	Elevation (ft-AMSL)	Size (in)	Pipe DR	Static Pressure (psi)	Valve Type	By-pass?	Orifice plate # holes	Spacing from last valve (LF)	Spacing < 1 mile?	If no, how many feet over 1 mile spacing? (LF)
-00+32 [1]	7080	14	18	110	BFV	Yes	9	-	-	-
00+63 [2]	7088	8	Stnd Wall Steel	106	BFV	No	N/A	95	Yes	-
14+78	7058	10	18	119	Gate	No	N/A	1415	Yes	-
17+75	7048	10	18	123	Gate	No	N/A	297	Yes	-
37+72	6989	10	18	149	Gate	No	N/A	1997	Yes	-
47+00	6981	10	18	152	Gate	No	N/A	928	Yes	-
73+95	7032	10	18	130	Gate	No	N/A	2695	Yes	-
98+18	6998	10	18	145	Gate	No	N/A	2423	Yes	-
100+80	7004	10	18	142	Gate	No	N/A	262	Yes	-
140+26	7037	10	18	128	Gate	No	N/A	3946	Yes	-
158+89	7018	10	18	136	Gate	No	N/A	1863	Yes	-
159+28	7020	10	18	136	Gate	No	N/A	39	Yes	-

[1] Installed during construction of Reach 24.1

[2] Valve located above ground inside surge tank building

24.1 JAN Valve Type & Spacing

Flush Valves

Station (LF)	Elevation (ft-AMSL)	Pipe DR	Static Pressure (psi)	Valve Type	Discharge Type	Orifice Diameter (in)	Spacing from last valve (LF)
46+84	6981	18	152	2" Ball	Above Grade Discharge	1.60	-
86+77	7001	18	143	2" Ball	Above Grade Discharge	1.45	3993
149+50	6999	18	145	2" Ball	Above Grade Discharge	1.49	6273

24.1 JAN Valve Type & Spacing

Air Valves

Station (LF)	Elevation (ft-AMSL)	Valve size	Static Pressure (psi)	Spacing from last valve (LF)	Spacing < 1/2 mile?	If no, how many feet over 1/2 mile spacing? (LF)
-00+15	7079	2" VBV/ 1" ARV	110	-	-	-
00+66 [1]	7089	2" VBV/ 1" ARV	106	81	Yes	-
14+96	7058	2" VBV/ 1" ARV	119	1430	Yes	-
17+92	7049	2" VBV/ 1" ARV	123	296	Yes	-
37+89	6989	2" VBV/ 1" ARV	149	1997	Yes	-
51+00	6988	2" VBV/ 1" ARV	149	1311	Yes	-
71+44	7035	2" VBV/ 1" ARV	129	2044	Yes	-
74+13	7032	2" VBV/ 1" ARV	130	269	Yes	-
82+58	7024	2" VBV/ 1" ARV	134	846	Yes	-
93+28	7004	2" VBV/ 1" ARV	143	1070	Yes	-
100+97	7005	2" VBV/ 1" ARV	142	769	Yes	-
122+63	7097	4" VBV/ 1" ARV	102	2166	Yes	-
122+88	7096	4" VBV/ 1" ARV	102	25	Yes	-
140+43	7036	2" VBV/ 1" ARV	129	1755	Yes	-
159+45	7020	2" VBV/ 1" ARV	135	1902	Yes	-

[1] Valve located above-ground inside surge tank building

Orifice Plate Calculations for Flush Valves

Gravity	g	32.2	ft/s^2
C factor	C_{main}	150	-
C factor	C_{drain}	140	-
Orifice Plate thickness (3/8")		0.03	ft
HGL Scenario 2c			

Orifice Plate Calculations for Flush Valves

Flush Valve Number	Station (LF)	Type of Flush Valve Discharge	Flush Line Length (LF)	Flowrate (gpm)	Flowrate (cfs)	Drain Pipe ID (D_1) (in)	Dynamic Pressure @ Tee @ FV Design Flow (psi)	Dynamic Pressure @ Tee @ FV Design Flow (ft)	Elev Drop in Drain (ft)	Total Available Head (ft)	h_L Through Drain (ft)	Friction h_L Across Orifice (ft)	Orifice h_L Req'd - TOTAL (ft)	Orifice Diameter, D_2 (in)	C_d	Orifice Area, A_0 (ft^2)	Velocity Through Orifice (fps)	Orifice Area, A_0 (ft^2)	Orifice Diameter, D_2 (in)
1	46+84	2" Above-Ground	18	490	1.09	1.94	147	339.6	0	339.6	75.9	0.3	263.3	**1.60**	0.6000	0.0140	78.19	0.0140	**1.60**
2	86+77	2" Above-Ground	18	400	0.89	1.94	137	316.5	0	316.5	52.1	0.4	264.0	**1.45**	0.6000	0.0115	77.72	0.0114	**1.45**
3	149+50	2" Above-Ground	18	416	0.93	1.94	134	309.5	0	309.5	56.1	0.4	253.1	**1.49**	0.6000	0.0121	76.55	0.0121	**1.49**

Note: All flow rates used were at least 20% lower than recommended by the URS report: NGWSP Reach 24.1 JAN Transient Analysis and Transient Control Recommendations dated April 14, 2016.

Air Valve Sizing Calculations

Air Valve Sizing Calculations

Sizing Small Orifice for Releasing Air During Regular Operation

		Scenarios[1]	
	Units	**Max Flow:** C=140 Counselor Tank Full JAN Tank Empty No Reach 25 Flow	**Min Pressure:** C=130 Counselor Tank Empty JAN Tank Full Reach 25 Flow: 1409 gpm
Flow at critical ARV station[2]	GPM	966	848
	CFM	129.1	113.4
% Water flow as air to vent[3]	N/A	2%	2%
Required air flow, Q_a	**SCFM**	**2.58**	**2.27**
Orifice diameter, d	in	**3/32**	**3/32**
Inlet pressure[4], P_1	psi	74.3	31.3
Gauge WP at critical ARVs (Sta. 122+63 & 122+88)	psig	63.0	20.0
Atmospheric pressure[4], P_{atm}	psi	11.30	11.30
Differential pressure, ΔP	psi	34.9	14.7
Inlet temperature, T	Rankine	520	520
Coefficient of discharge, C_d	N/A	0.65	0.65
Expansion factor of air, Y	N/A	0.71	0.71
Specific gravity of air, S_g	N/A	1.0	1.0
Unitless constant	N/A	678	678
Orifice release capacity[5], Q_o	**SCFM**	**6.14**	**2.59**
Is $Q_o >= Q_a$?[6]		**Yes**	**Yes**

Notes:

[1] The two most critical scenarios for sizing ARV orifices on Reach 24.1 JAN are shown above. As flow increases, Q_a, the air in the pipe needing to be released, also increases. As working pressure at a given air valve decreases, the orifice release capacity, Q_o, also decreases. The Max Flow and Min Pressure scenarios above, are therefore the critical cases to consider.

[2] The critical ARV stations on Reach 24.1 JAN are the duplicate ARVs at Sta. 122+63 & 122+88. Due to their high elevation, the ARVs at Sta.122+63 & 122+88 have the lowest working pressure of all the ARVs on Reach 24.1 JAN. They are therefore the critical locations for conservatively sizing an orifice large enough to release air during operation. An air release orifice sized for Sta. 122+63 & 122+88 will be more than sufficient for air release elsewhere in the pipeline.

[3] Standard assumption per page 12 of AWWA M51. A copy of all pertinent AWWA M51 pages are attached to these calculations for reference.

[4] Inlet pressure, P_1, is equal to the gauge working pressure at the critical station determined from the steady state hydraulic calculations, plus the atmospheric pressure, P_{atm}. The P_{atm} used is adjusted for an elevation of 7096 feet, at the critical ARV location, assuming an average temperature of 59˚F (15˚C). ARVs at lower elevations would have a higher P_{atm}, increasing the orifice release capacity, Q_o.

[5] See Equation 4-1 of AWWA M51 for calculation of discharge of air through small orifice and common values used.

[6] Since Q_o is greater than Q_a for all scenarios, a **3/32" diameter orifice is sufficient** for releasing air during regular operation. **However, based on transients analysis, a maximum 1/8" diameter orifice is recommended for pipe filling.** This 1/8" orifice used to exhaust air during pipe filling also serves as air release. The larger 1/8" orifice diameter that will be used adds an additional factor of safety to the design beyond these calculations.

Sizing Large Orifice for Controlled Pipeline Filling and Draining

	Units	Filling	Draining
Differential pressure[1], ΔP	psi	2	-1
Atmospheric pressure[2], P_{atm}	psi	11.30	11.30
Volume conversion	ft^3/Gal	0.134	0.134
Water velocity[3], v	ft/s	**1.25**	**2.56**
Pipe inside diameter, D	in	9.79	9.79
Pipe cross-sectional area	in^2	75.3	75.3
Pipe cross-sectional area	ft^2	0.52	0.52
Fill/drain rate in pipe[4], q	CFM	39.2	80.2
Fill/drain rate in pipe[4], q	gpm	292.6	600.0
Required air flow rate[5], Q_{air}	SCFM	46.1	73.3
Required orifice diameter[6]	in	**1.0**	**1.0**
Design orifice diameter[6]	**in**	**1/8**	**2.0**

Notes:

[1] Typical differential pressure value for filling was found in the Sizing for Pipeline Filling section of AWWA M51. Although transients analysis was used to design the pipeline to maintain 5 psi positive pressure throughout, when draining, a minimal vacuum would occur at the vacuum breakers to allow air flow.

[2] The Patm used is adjusted for an elevation of 7096 feet, at the critical ARV location (Sta. 122+63 & 122+88), assuming an average temperature of 59˚F (15˚C).

[3] Filling flowrate shall be maintained such that the maximum velocity in the pipeline is 1.25 ft/s per industry standards. Orifice plates for flush valves were sized to allow 20% lower than the recommended maximum flowrate per transient analysis for each flush valve, yielding a maximum reduced flowrate in any one of the flush valve of 600 gpm (flush valve at sta. 46+84). This flushing flowrate of 600 gpm would cause a 2.56 ft/s velocity in Reach 24.1 JAN.

[4] Pipeline draining flowrates and velocities will be controlled through the use of orifice plates on the flush valves.

[5] The required air flowrate, Q_{air}, is calculated using AWWA M51, Equation 4-3, which adjusts from the pressure inside the pipe to atmospheric conditions. A copy of the pertinent AWWA M51 pages have been attached for reference.

[6] **Recommended orifice size, considering transients analysis:**

For FILLING: per Table 4-2 OF AWWA M51, an orifice diameter of 1.0 inches will allow up to 111 SCFM of air to discharge at a differential pressure of 2 psi. However, **transients analysis recommended a maximum orifice size of 1/8" for pipe filling, to provide additional protection to the pipeline in the event of a column separation, by retaining air in between the water columns.** This deliberately undersized air release orifice means that air will bleed slowly out of pipeline. During initial filling after construction, the contractor's fill rate is usually limited by available water from the existing NTUA system, so the air will probably exhaust at approximately the same rate as the pipe fills. During re-filling after future line repairs, there may be temporary air pockets "trapped" at high points in the line where ARVs are located, which should bleed off after a few hours or days, depending on size. These air pockets will not damage the pipeline, although they may cause a temporary reduction in maximum flow rate until the air bleeds off. This temporary air retention was considered to be worth the trade-off for an added level of surge protection.

For DRAINING: per Table 4-3 of AWWA M51, **an orifice diameter of 1.0 inch will allow 76 SCFM of air to enter the pipeline at a differential pressure of -1 psi**, which is more than the required air flow of 73.3 SCFM. However, **transients analysis recommended a 2.0 inch vacuum breaker orifice for pipe draining**. A 2.0 inch vacuum breaker orifice will also provide consistency with the vacuum breaker orifice size of NGWSP Reaches 26.1 and 26.2. For pipe draining, an oversized orifice size translates to a more conservative design.

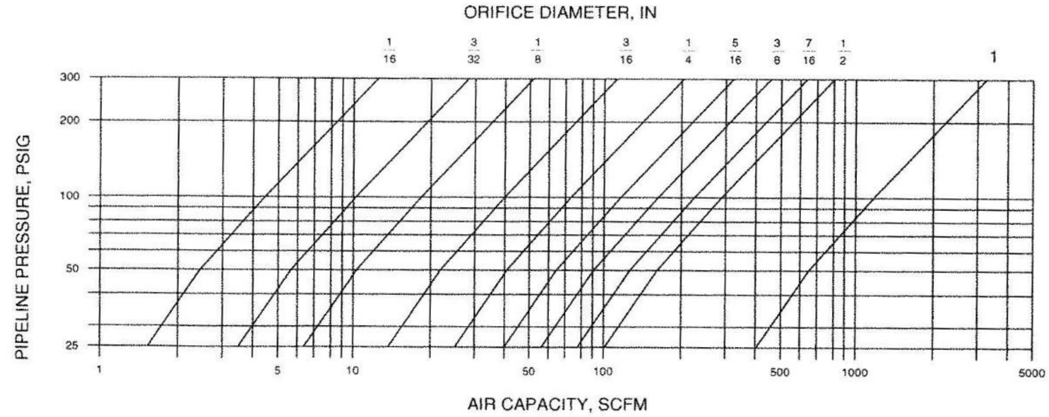


Figure 4-1 Discharge of air through small orifice, cfm

Example

A pipeline with a flow rate of 10,500 gpm requires an air-release valve at a location with a valve elevation of 600 feet and a hydraulic grade line elevation of 831 feet.

1. 10,500 gpm /7.48 = 1,404 cfm
2. 1,404 × 0.02 = 28 scfm
3. (831 – 600) × 0.433 = 100 psi
4. Select $^3/_{16}$ in. orifice from Table 4-1 that provides 40.9 scfm at 100 psi.

The capacity information shown in Table 4-1 and Figure 4-1 is based on the compressible adiabatic flow equation and sonic flow (Technical Paper No. 410, 1982).

$$Q = 678 Y d^2 C_d \sqrt{\Delta P P_1 / (T S_g)} \quad \text{(Eq 4-1)}$$

Where:

Q	=	flow rate, scfm
Y	=	expansion factor, 0.71 for air flow (Technical Paper No. 410, 1982)
d^2	=	orifice diameter, in^2.
C_d	=	coefficient of discharge, 0.7
ΔP	=	differential pressure, 0.47 P_1 (for sonic flow)
P_1	=	inlet pressure, psia (pipeline pressure + 14.7 psi) (assumes sea level atmospheric pressure of 14.7 psia; pressure will vary with altitude)
T	=	inlet temperature, 520 degrees Rankine
S_g	=	specific gravity, 1.0 (for air)

For subsonic conditions where pipeline pressures are generally less than 13 psig (90 kPa [gauge]):

$$Q = 14.77\, d^2 \left[\Delta P(P + 14.7)\right]^{1/2} \quad \text{(Eq 4-2)}$$

Where:

P = pipeline pressure, psig

SIZING FOR PIPELINE FILLING

For the initial filling of a pipeline, air should be vented at the same volumetric rate as the pipeline is being filled. In many cases, one pump is turned on until the line is full. The recommended procedure, however, is to fill the pipeline at a gradual rate to prevent surges in the line. A suggested filling rate is about 1 ft/sec (0.3 m/sec). For more information, see the discussion of water hammer in chapter 5.

The volumetric rate of air from initial filling is vented to atmosphere at a typical differential pressure of 2 psi (13.8 kPa). Valves equipped with antislam or slow-closing devices may be sized with a differential pressure of 5 psi (34.5 kPa). The following method may be used to approximate the orifice size required for pipeline filling. Generic tables, graphs, and formulas are provided to suit the preference of the user.

The applicable flow equation is based on compressible adiabatic flow through a short nozzle or tube where there is no heat transfer to the air. Also, it is assumed that the valve is at sea level and a temperature of 60°F (15.5°C). At high altitudes or extreme temperatures, equations of a more general nature should be used. For the purpose of generating the tables and graphs in Table 4-2 and Figure 4-2, a discharge coefficient of 0.7 is used. A discharge coefficient of 0.7 is an approximation and falls between a smooth flow nozzle and a square-edged orifice. Therefore, capacity charts of valve suppliers should be consulted before selecting the final valve size.

Orifice sizing method for pipeline filling

(Assumes air valve is at sea level and 60°F [15.5°C]).

Step 1. Calculate the venting flow rate in scfm using:

$$Q = q\,(.134\ \text{ft}^3/\text{gal})\ \frac{(\Delta P + 14.7\ \text{psi})}{(14.7\ \text{psi})} \qquad \text{(Eq 4-3)}$$

Where:

Q = flow rate, scfm
q = fill rate, gpm
ΔP = differential pressure, 2 psi

Step 2. Refer to Table 4-2 or Figure 4-2 and select the orifice diameter that provides the required flow at the selected venting pressure.

Example

A 66-in. pipeline will fill at a flow rate of 10,500 gpm (1 ft/sec), and the air valve will vent the air at a pressure of 2 psi.

1. Q = (10,500) (.134) (2.0 + 14.7 / 14.7) = 1,598 scfm
2. Referring to Table 4-2 and Figure 4-2, at 2 psi, select a 4 in. orifice that will vent 1,780 scfm.

Table 4-2 Air discharge table of large orifices (C_d = 0.7, T = 60°F, sea level)

Differential Pressure (*psi*)	Orifice Diameter, *In.* 1	2	3	4	6	8	10	12	14	16	18	20
1.0	79	317	712	1,270	2,850	5,070	7,910	11,400	15,500	20,200	25,600	31,700
1.5	97	387	870	1,550	3,480	6,190	9,670	14,000	18,900	24,700	31,300	38,600
2.0	111	445	1,000	1,780	4,010	7,120	11,100	16,000	21,800	28,500	36,100	44,500
2.5	124	497	1,120	1,990	4,470	7,950	12,400	17,900	24,300	31,800	40,200	49,600
3.0	136	543	1,220	2,170	4,890	8,690	13,600	19,500	26,600	34,700	44,000	54,300
3.5	146	585	1,320	2,340	5,270	9,370	14,600	21,100	28,700	37,500	47,400	58,500
4.0	156	625	1,410	2,500	5,620	10,000	15,600	22,500	30,600	40,000	50,600	62,500
4.5	165	662	1,490	2,650	5,960	10,600	16,500	23,800	32,400	42,300	53,600	66,200
5.0	174	697	1,570	2,790	6,270	11,100	17,400	25,100	34,100	44,600	56,400	69,700

NOTE: Metric conversions—in. × 25.4 = mm, cfm × 0.4719 = L/sec, psi × 6.89476 = kPa.

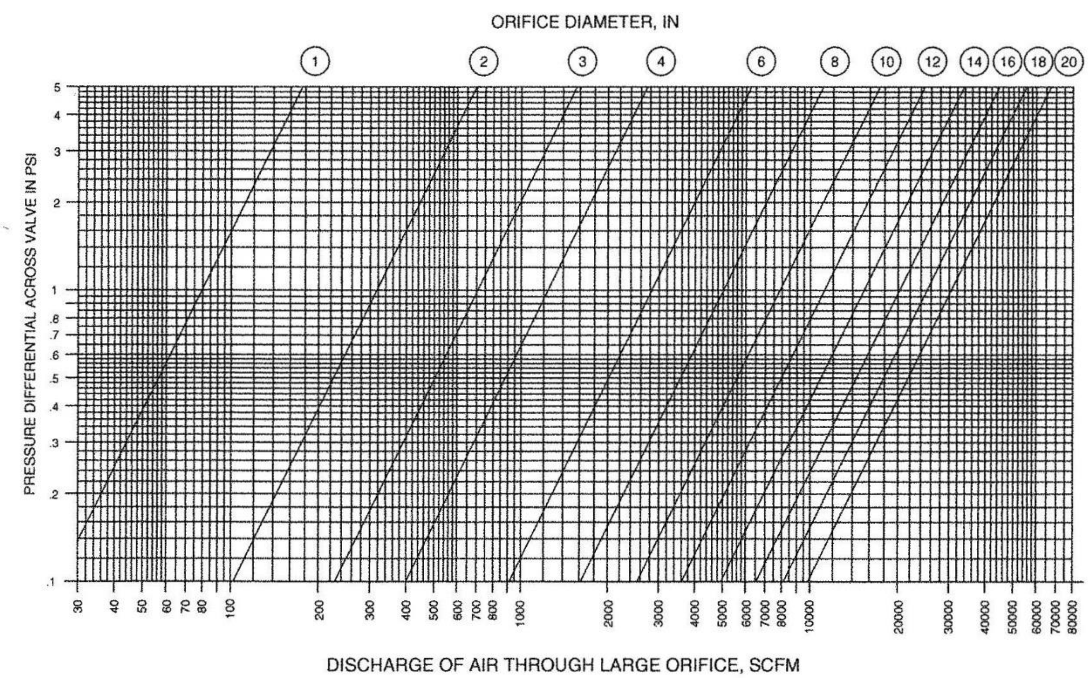


Figure 4-2 Air discharge graph of large orifices (C_d = 0.7).

SIZING FOR PIPELINE DRAINING

When it is necessary to drain a pipeline for repairs, the pipeline should be drained at a controlled rate of about 1–2 ft/sec (0.3–0.6 m/sec) to minimize pressure transients. An air valve at the high point adjacent to the draining location must be sized to admit air at the same volumetric rate as the pipeline being drained.

SIZING FOR GRAVITY FLOW

A power failure or line break may result in a sudden change in the flow velocity because of column separation and gravity flow. The gravity flow may result in excessive vacuum conditions occurring at the adjacent high points. Most small and medium-size pipes commonly used in the water industry can withstand a complete vacuum; however, because of low stiffness, large-diameter pipelines may collapse from negative internal pressures. Therefore, sizing air valves for gravity flow conditions is important to maintaining the integrity of the pipeline. Air valves at high points should be sized to allow the inflow of air to minimize negative pressures in the pipeline and prevent possible damage to pump seals, equipment, or the pipeline itself.

When sizing an air valve orifice for gravity flow, the pipe slope will determine the volume of air required to prevent excessive vacuum. An appropriate air valve should be provided at the nearest high point with the orifice sized to allow the required inflow of air to replace the water in the pipeline. Figure 4-3 illustrates the required inflow of air required for various pipe sizes and slopes.

The orifice sizing of an air valve for inflow is typically based on the lower of 5 psi (34 kPa) or the allowable negative pressure below atmospheric pressure for the pipeline with a suitable safety factor. Sonic flow will occur when the outlet-to-inlet pressure ratio (ASME, 1971) falls below 0.53. Knowing that the inlet pressure is atmospheric pressure (14.7 psia [101 kPa]), then any negative pipeline pressure below 7.8 psia (54 kPa (absolute)) or –7 psig (48 kPa) (vacuum) will produce sonic flow. Because the flow will be sonic and restricted, flow volume will not increase beyond –7 psi (48 kPa) differential.

If gravity flow occurs in a pipeline with a change in slope where the pipeline lower section has a steeper slope than the upper section, then an air/vacuum valve should be considered at the location where the pipeline changes slope. The gravity flow will be greater in the pipeline section with the steeper slope. The air/vacuum valve orifice should be sized so that the inflow of air at this point equals the difference in the two flow rates at the allowable negative pressure.

The applicable flow equation is based on compressible adiabatic flow through a short nozzle or tube where there is no heat transfer to the air and subsonic flow. For the purpose of estimating circular orifice sizes, a discharge coefficient, C_d, of 0.7 was used to generate Table 4-3 and Figure 4-4. A discharge coefficient of 0.7 is an approximation and falls between a smooth flow nozzle and a square-edged circular orifice. Capacity charts of valve suppliers should be consulted before selecting the final valve size.

Table 4-3 Air inflow table of large orifices (C_d = 0.7)

Differential Pressure (*psig*)	Orifice Diameter, *In.*											
	1	2	3	4	6	8	10	12	14	16	18	20
1.0	76	306	688	1,220	2,750	4,890	7,650	11,000	15,000	19,600	24,800	30,600
1.5	92	366	824	1,470	3,300	5,860	9,160	13,200	17,900	23,500	29,700	36,700
2.0	103	414	931	1,660	3,720	6,620	10,300	14,900	20,300	26,500	33,500	41,400
2.5	113	452	1,020	1,810	4,070	7,230	11,300	16,300	22,100	28,900	36,600	45,200
3.0	121	484	1,090	1,930	4,350	7,740	12,100	17,400	23,700	31,000	39,200	48,300
3.5	127	510	1,150	2,040	4,590	8,160	12,700	18,400	25,000	32,600	41,300	51,000
4.0	133	532	1,200	2,130	4,780	8,510	13,300	19,100	26,100	34,000	43,000	53,200
4.5	137	550	1,240	2,200	4,950	8,800	13,700	19,800	26,900	35,200	44,500	55,000
5.0	141	565	1,270	2,260	5,080	9,030	14,100	20,300	27,700	36,100	45,700	56,500

NOTE: Metric conversions—in. × 25.4 = mm, cfm × 0.4719 = L/sec, psi × 6.89476 = kPa.

Hydrostatic Testing Pressure Calculations and Components Pressure Ratings

REACH 24.1 JAN PRESSURE TEST CALCULATIONS

Counselor Tank overflow elevation	7332	ft
NTUA elevation differential rule:	57	ft
NTUA pressure differential rule:	25	psi

Description	Testing Range			Low Point		High Point/ARV		Static Pressure Difference Low to High	Max Test Pressure (at Low Point)	Min. Test Pressure (at High Point)
	Beginning Station	Ending Station	Length of Test Range	Station	Elevation	Station	Elevation			
-	LF	LF	ft	LF	ft-amsl	LF	ft-amsl	psi	psi	psi
BFV --> GV	-0+32	14+78	1510	10+77	7053	00+66 [1]	7088	15	**235**	**220**
GV --> GV	14+78	17+75	297	17+20	7049	14+96	7058	4	**235**	**231**
GV --> GV	17+75	37+72	1997	37+72	6989	17+92	7048	25	**235**	**210**
GV --> GV	37+72	47+00	928	40+06	6970	37+89	6989	8	**235**	**227**
GV --> GV	47+00	73+95	2695	58+00	6979	71+44	7035	24	**235**	**211**
GV --> GV	73+95	100+80	2685	88+93	6997	74+13	7032	15	**235**	**220**
GV --> GV	100+80	140+26	3946	100+80	7004	122+63	7097	40	**250**	**210**
GV --> GV	140+26	159+28 [2]	1902	149+50	6999	140+43	7036	16	**235**	**219**

[1] ARV at Sta. 00+66 is located inside the surge tank building.

[2] End of line (end cap) is at Sta. 159+63.

REACH 24.1 JAN PRESSURE TEST PARAMETERS

Test Section[1]			Testing ARV Location			Allowable Leakage Calculations[2]		
Beginning Station	Ending Station	Length of Test Section	Station	Elevation	Test Pressure	Approximate Number of Joints Tested (N)	Nominal Diameter of Pipe (D)	Allowable Leakage 2 Hour Test (2Q)
LF	LF	ft	LF	ft-amsl	psi	-	in	Gal.
-0+32	14+78	1510	00+66 [3]	7088	**220**	76	10	**3.13**
14+78	17+75	297	14+96	7058	**231**	15	10	**0.62**
17+75	37+72	1997	17+92	7048	**210**	100	10	**4.14**
37+72	47+00	928	37+89	6989	**227**	46	10	**1.92**
47+00	73+95	2695	71+44	7035	**211**	135	10	**5.58**
73+95	100+80	2685	74+13	7032	**220**	134	10	**5.56**
100+80	140+26	3946	122+63	7097	**210**	197	10	**8.17**
140+26	159+28 [4]	1902	140+43	7036	**219**	95	10	**3.94**

Notes:

[1] All pipe used on Reach 24.1 JAN is 10" DR18 PVC, with a pressures rating of 235 psi.

[2] Where the Allowable Leakage $(Q) = \frac{ND(P^{1/2})}{7400}$.

[3] ARV at Sta. 00+66 is located inside the surge tank building.

[4] End cap at the end of Reach 24.1 JAN is at Sta. 159+63.

ANTICIPATED PRESSURE RATINGS OF COMPONENTS ON REACH 24.1 JAN

Surge Tank (C-13 & C-14)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Charlatte	Charlatte America Surge Tank, Model HCA 5283G 250PD/375PT-H	250	375	N/A
Proco	14" Proco Fitting Style 231HP-EJ171/BB (High Pressure expansion Joint)	200	300	Exhibit 1
Tyler Union	MJ DI Fittings (14" tee, 14" 90˚ell)	350	700	Exhibit 2
Tyler Union	FL DI Fittings (14"x8" reducer, 10"x8" reducer, 90˚ell, tee, flange)	250	500	Exhibit 2
Elster	8" FL x FL Mag meter, Elster EVOQ4	230	-	Exhibit 3
Valmatic	8" FL x FL Butterfly valve with hand wheel actuator and limit switch AWWA C504, 250B	250	250	Exhibit 4
Rosemount	Pressure transducer	300	-	Exhibit 17
Apollo	2" Flanged ball valve, SS	275	-	Exhibit 14
Apollo	1/4" and 1/2" SS ball valves	1500	-	Exhibit 11
Kunkle	1/2" Pressure relief valve	300	-	Exhibit 18
Ametek	Ametek 88C vertical mount pressure transmitter 0-200 psi range	200	600	Exhibit 20
Wika	Pressure gauge 0-200 psi range ***Note: ball valve must be closed during pressure testing; TP is then equal to that of the ball valve.***	200	200	Exhibit 21
Valmatic	2" Valmatic 1852AVB.3XFSVH Vacuum Relief Valve w/ Screened Hood, ANSI Class 250 Flange	400	600	Exhibit 8
Valmatic	1" Valmatic Model # 38HPDISVH Air Release Valve	500	750	Exhibit 9
ASCO	Solenoid valve	300	-	Exhibit 19
N/A	8" x 2" Tapped threaded flange, ANSI class 150 SS 304	275	425	Exhibit 5
N/A	SS 304 fittings: various sizes (tees, nipples, reducing bushings, etc)	750-1695	-	Exhibit 5

10" Pipline Gate Valve (DT-5)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Mueller	10" MJ x MJ Mueller Gate Valve A-2361	350	700	Exhibit 16

8" Rate of Flow Control Valve and Meter Vault (DT-6)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Tyler Union	MJ DI Fittings (10" x 8" reducer)	350	700	Exhibit 2
Singer	8" Singer Flow control valve, Model 106-RF-X142-G	250	-	Exhibit 6
Romac	8" Dismantling joint, 304 SS bolts Romac Model DJ400 (Class E flanges)	275	413	Exhibit 7
Elster	8" FL x FL Mag meter, Elster EVOQ4	230	-	Exhibit 3

2" Vacuum Relief Valve with 1" Air Release Valve Assembly (DT-7)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Valmatic	2" Valmatic 1852AVB.3XFSVH Vacuum Relief Valve w/ Screened Hood, ANSI Class 250 Flange	400	600	Exhibit 8
Valmatic	1" Valmatic Model # 38HPDISVH Air Release Valve	500	750	Exhibit 9
Romac	14" x 2" or 10" x 2" Romac 202NS Tapping Saddle, DI. SS 304 dual straps	350	-	Exhibit 10
Apollo	Ball valves (2", 1", 1/4") SS, NPT	1500-2000	-	Exhibit 11
N/A	SS 304 fittings: various sizes (tees, nipples, reducing bushings, etc)	750-1695	-	Exhibit 5
N/A	2" flange (threaded) ANSI class 300, SS 304 flat face	720	1100	Exhibit 5
Tyler Union	MJ DI Fittings (reducing tee, 4" x 2" tapped threaded MJ plug)	350	700	Exhibit 2

4" Vacuum Relief Valve with 1" Air Release Valve Assembly (DT-8)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Valmatic	4" Valmatic 1804AVB.3XFSVH vacuum relief valve w/ screened hood, ANSI class 125 flange	200	300	Exhibit 13
Valmatic	1" Valmatic Model # 38HPDISVH Air Release Valve	500	750	Exhibit 9
Tyler Union	MJ DI Fittings (reducing tee, 6"x4" tapped threaded MJ plug)	350	700	Exhibit 2
Apollo	4" Flanged ball valve, SS 125/150# Flange	275	-	Exhibit 14
N/A	4" flange (threaded) ANSI class 150, SS 304 flat face	275	425	Exhibit 5
Apollo	Ball valves (2", 1", 1/4") SS, NPT	1500-2000	-	Exhibit 11
N/A	SS 304 fittings: various sizes (tees, nipples, and reducing bushings, etc)	650-1695	-	Exhibit 5

2" Flush Valve With Above-Ground Discharge Assembly (DT-9)

Manufacturer	Valve Name & Description	Working psi	Test psi	Documentation:
Apollo	2" Apollo Series 76-AR ball valve	1500	-	Exhibit 15
Tyler Union	MJ DI Fittings (12" x 2" or 10" x 2" tapped tee)	350	700	Exhibit 2
N/A	2" steel fittings (cap and elbow)	1000-3000	-	Exhibit 12
N/A	2" companion flange (threaded) SS 304, ANSI class 150 flat face	275	425	Exhibit 5

Emily Sotelo

From: Dave Buchwald <dbuchwald@pipestoneeq.com>
Sent: Monday, September 19, 2016 9:29 AM
To: Emily Sotelo
Cc: 'Kira Witwer'; Tory Tadano; Andrew Robertson
Subject: Proco 231HP Pressure Rating & Test Pressures

Hello again Emily,

We've got confirmation back from the factory now that HP joints are usually 200 psi design and 300 psi test pressure. We can order these joints up to 250 psi design and 375 psi test pressure if needed. Only tradeoff is allowable movement (expansion, compression, torsion etc.) which is not an issue with our surge vessel applications. Specs should also require fully rated control rod set which we always do anyway.

I think that's all I owe you related to this item. When you've got the specs fully developed, feel free to send them over to me and Kira and we'll take a look.

Have a great day!
Dave

From: Dave Buchwald [mailto:dbuchwald@pipestoneeq.com]
Sent: Wednesday, September 14, 2016 4:46 PM
To: 'Emily Sotelo' <emily.sotelo@soudermiller.com>
Cc: 'Kira Witwer' <kwitwer@pipestoneeq.com>; 'Tory Tadano' <tory.tadano@soudermiller.com>; 'Andrew Robertson' <andrew.robertson@soudermiller.com>
Subject: RE: Proco pressure rating

Hi Emily,

We're back from the RMSAWWA conference now and able to focus on a few things. I've spoken with Proco and should have an answer back tomorrow on the test pressure. It's usually 1.5x the max operating but may be lower for the higher pressure rated joints.

I think we can beef up the specs a little based on the information we receive tomorrow and the attached submittal document from a previous reach. The official internal part number is 231HP-EJ171/BB which means a domestic specially built 231 joint. We always specify the pressure rating because anything over the standard 231 joint rating carries the same part number.

Other details that we can add to the specs are Butyl Rubber Tube & Cover (that's the BB part). Anything else on the attached that you want to add would be fine.

If you look at the bottom right corner of the drawing, you'll see the test pressure for the 16x6 and 6x6 was 1.5x.

Thanks,
Dave

From: Emily Sotelo [mailto:emily.sotelo@soudermiller.com]
Sent: Wednesday, September 14, 2016 11:05 AM
To: David Buchwald <dbuchwald@pipestoneeq.com>

Exhibit 2

23U - ANSI/AWWA C153/A21.53
Mechanical Joint Compact
Ductile Iron Fittings
Revised 6/2016

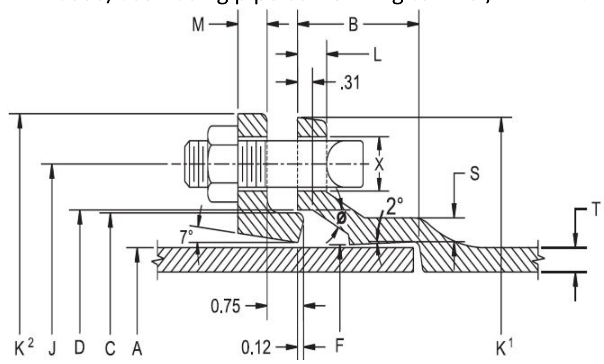
TYLER UNION®
Quality Waterworks Products

☐ **DOMESTIC** ☐ **NON-DOMESTIC**

SUBMITTAL: C153 MECHANICAL JOINT PRODUCT

(Current revisions for the noted Standards apply)

SIZES: 2” through 64” (2” not included in ANSI/AWWA C153 standard)
STANDARDS: ANSI/AWWA C153/A21.53, NFPA13/24, 3”-16” UL and 3”-10” FM listed & approved (File - Tyler Union)
MATERIAL: Cast of ASTM A536 qualified ductile iron. Date code is cast on and required for traceability.
PRESSURE RATING: *Flanged fittings rated at 250 psi. Mechanical joints 2” – 24” rated at 350 psi and 30” – 48” at 250 psi.
*Note: With rubber annular ring flange gasket, 2” – 24” Flanged fittings can be rated at 350 psi.
Note: Wyes over 12” are not pressure rated. Contact Tyler Union for rating in your application.
DEFLECTION: Max joint deflection 2”– 12”, 5° and 14”– 48”, 3°. Reduces by 50% at nominal pipe & fitting diameters
NSF-61 & NSF372: Meets all requirements including Annex G, Tyler Union’s Underwriters Laboratory listing MH16439.
ASPHALT COATING: Per ANSI/AWWA C104/A21.4 and ANSI/AWWA C153/A21.53.
CEMENT LINING: Per ANSI/AWWA C104/A21.4, with double cement lining.
EPOXY COATING: Fusion bonded epoxy per ANSI/AWWA C116/A21.16. Additional coatings available upon request.
BARE FITTINGS: Available upon request.
FASTENERS: High strength low alloy weathering steel per ANSI/AWWA C111/A21.11 and ASTM A242
INSTALLATION: Install per AWWA C600/C651 using pipe conforming to ANSI/AWWA C151/A21.51 or AWWA C900/905.



NOMINAL JOINT DIMENSIONS IN INCHES — **BOLTS**

Size Inches	A Dia. DI Pipe	B Hub Depth	C Dia. GLAND	D Dia.	F Dia.	J Dia. GLAND	K¹ Dia.	K² Dia. GLAND	L	M GLAND	S	T	X	Size	Qty.
2	2.51	2.50	3.50	3.60	2.61	4.75	6.19	6.89	0.58	0.62	0.36	0.30	3/4	5/8x3.0	2
3	3.96	2.50	4.84	4.94	4.06	6.19	7.62	7.69	0.58	0.62	0.39	0.33	3/4	5/8x3.0	4
4	4.80	2.50	5.92	6.02	4.90	7.50	9.06	9.12	0.60	0.75	0.39	0.34	7/8	3/4x3.5	4
6	6.90	2.50	8.02	8.12	7.00	9.50	11.06	11.12	0.63	0.88	0.43	0.36	7/8	3/4x3.5	6
8	9.05	2.50	10.17	10.27	9.15	11.75	13.31	13.37	0.66	1.00	0.45	0.38	7/8	3/4x4.0	6
10	11.10	2.50	12.22	12.34	11.20	14.00	15.62	15.62	0.70	1.00	0.47	0.40	7/8	3/4x4.0	8
12	13.20	2.50	14.32	14.44	13.30	16.25	17.88	17.88	0.73	1.00	0.49	0.42	7/8	3/4x4.0	8
14	15.30	3.50	16.40	16.54	15.44	18.75	20.31	20.25	0.79	1.25	0.55	0.47	7/8	3/4x4.5	10
16	17.40	3.50	18.50	18.64	17.54	21.00	22.56	22.50	0.85	1.31	0.58	0.50	7/8	3/4x4.5	12
18	19.50	3.50	20.60	20.74	19.64	23.25	24.83	24.75	1.00	1.38	0.68	0.54	7/8	3/4x4.5	12
20	21.60	3.50	22.70	22.84	21.74	25.50	27.08	27.00	1.02	1.44	0.69	0.57	7/8	3/4x4.5	14
24	25.80	3.50	26.90	27.04	25.94	30.00	31.58	31.50	1.02	1.56	0.75	0.61	7/8	3/4x5.0	16
30	32.00	4.50	33.29	33.46	32.17	36.88	39.12	39.12	1.31	2.00	0.82	0.66	1-1/8	1x6.0	20
36	38.30	4.50	39.59	39.76	38.47	43.75	46.00	46.00	1.45	2.00	1.00	0.74	1-1/8	1x6.0	24
42	44.50	4.50	45.79	45.96	44.67	50.62	53.12	53.12	1.45	2.00	1.25	0.82	1-3/8	1-1/4x6.5	28
48	50.80	4.50	52.09	52.26	50.97	57.50	60.00	60.00	1.45	2.00	1.35	0.90	1-3/8	1-1/4x6.5	32
54	Available on Request														
60	Available on Request														
64	Available on Request														

Anniston: 1501 W 17th St. ● Anniston, AL 36201 ● (800) 226-7601
Corona: 1001 El Camino Ave. ● Corona, CA 92879 ● (866) 527-8471
Tyler: 11910 CR 492 ● Tyler, Texas 75706 ● (800) 527-8478
Dallas: 1201 Ave. S. Suite100 ● Grande Prairie, TX 75050
Elmer: 701 Kenyon Ave. Elmer, New Jersey 03318
New Lenox: 2200 West Haven● New Lenox, IL 60451
Portland: 15670 N. Lombard St. ● Portland, OR 97203
Oxford: 1800 Greenbrier Dear Road ●Anniston, AL 36207

Exhibit 2

Micah Johnson

From: Mark Vess <Mark.Vess@tylerunion.com>
Sent: Tuesday, May 03, 2016 9:18 AM
To: Micah Johnson
Subject: RE: test pressure verification

Micah,

You are correct, Tyler Union conducts proof of design testing as per AWWA which is 2 times the fittings working pressure.

Regards,
Mark Vess
Technical Sales Support Specialist | Tyler Union Waterworks (a Division of McWane) |mark.vess@tylerunion.com | 256-240-4263

From: Micah Johnson [mailto:micah.johnson@soudermiller.com]
Sent: Tuesday, May 03, 2016 10:14 AM
To: Mark Vess
Subject: RE: test pressure verification

Mark,

Thanks for clarifying the testing pressure over the phone. Please confirm that the test pressure for Tyler Union fittings is two times (2x) the working pressure as you have summarized in your email below.

Thanks,

SMA

Micah Johnson, EI
Civil Staff Designer

Souder, Miller & Associates
Engineering ♦ Environmental ♦ Surveying
3451 Candelaria Blvd. NE Suite D
Albuquerque, NM 87107
www.soudermiller.com
(505) 299-0942 (office)
(720) 357-4879 (mobile)
(505) 293-3430 (fax)

From: Mark Vess [mailto:Mark.Vess@tylerunion.com]
Sent: Tuesday, May 03, 2016 6:24 AM
To: Micah Johnson <micah.johnson@soudermiller.com>
Subject: RE: test pressure verification

Exhibit 3

elster
Vital Connections

evoQ$_4$ Electromagnetic Meter

Size 2" to 12"

The evoQ$_4$ is a single meter that meets the needs of traditional turbine, compound, single jet and magnetic meters.

Performance	Inches	2	3	4	6	8	10	12
	mm	50	80	100	150	200	250	300
> 95% Accuracy	GPM	0.25	0.6	1.7	4	8	32	32
	m3/hr	0.06	0.14	0.4	0.9	1.8	7.3	7.3
98.5% - 101.5% Accuracy	GPM	1-220	2-550	4-880	8-1400	16-3500	50-5500	65-5500
	m3/hr	0.23-50	0.5-125	0.9-200	1.8-318	3.6-795	11.4-1249	14.8-1249
Maximum flow	GPM	220	550	880	1400	3500	5500	5500
	m3/hr	50	125	200	318	795	1249	1249
Max. operating pressure	psi	230	230	230	230	230	150	150
	Bar	16	16	16	16	16	10	10

Materials

Body	Stainless steel grade 304
Flow tube	Stainless steel grade 316
Liner	Polyethylene epoxy
Electrodes	Stainless steel grade 316
Flanges	Epoxy coated cast iron
Register	Stainless steel with glass lens
Register housing/lid	UV-resistant plastic
Environmental class	IP68 hermetically sealed unit waterproof to 30 ft depth

Features	Benefits
10 year continuous life	No need for costly and time-consuming replacement
No moving parts	Maintenance free
0.5 second sampling rate	Highest accuracy
Wide measuring range	Suitable for all commercial applications
Simple installation	No additional training required
Pulse or encoder connectivity	Pre-equipped or retrofitted for your AMR and telemetry needs
AWWA lay lengths	Simple changeout
IP68 sealed	Provides long trouble-free life
NSF61 Annex G listed	Zero lead contaminants

Operation

The evoQ$_4$ is a battery powered electromagnetic water meter that is suitable for a wide range of metering applications. Using Faraday's law of electromagnetic induction, two magnets provide a magnetic field within the pipe; two electrodes measure the induced voltage that is proportional to the flow of conductive water through the field in the pipe. Every 0.5 seconds the measurement is taken and the totalized volume is calculated and updated on the LCD display. The meter is designed for 10 years of continuous operation with no battery changes necessary.

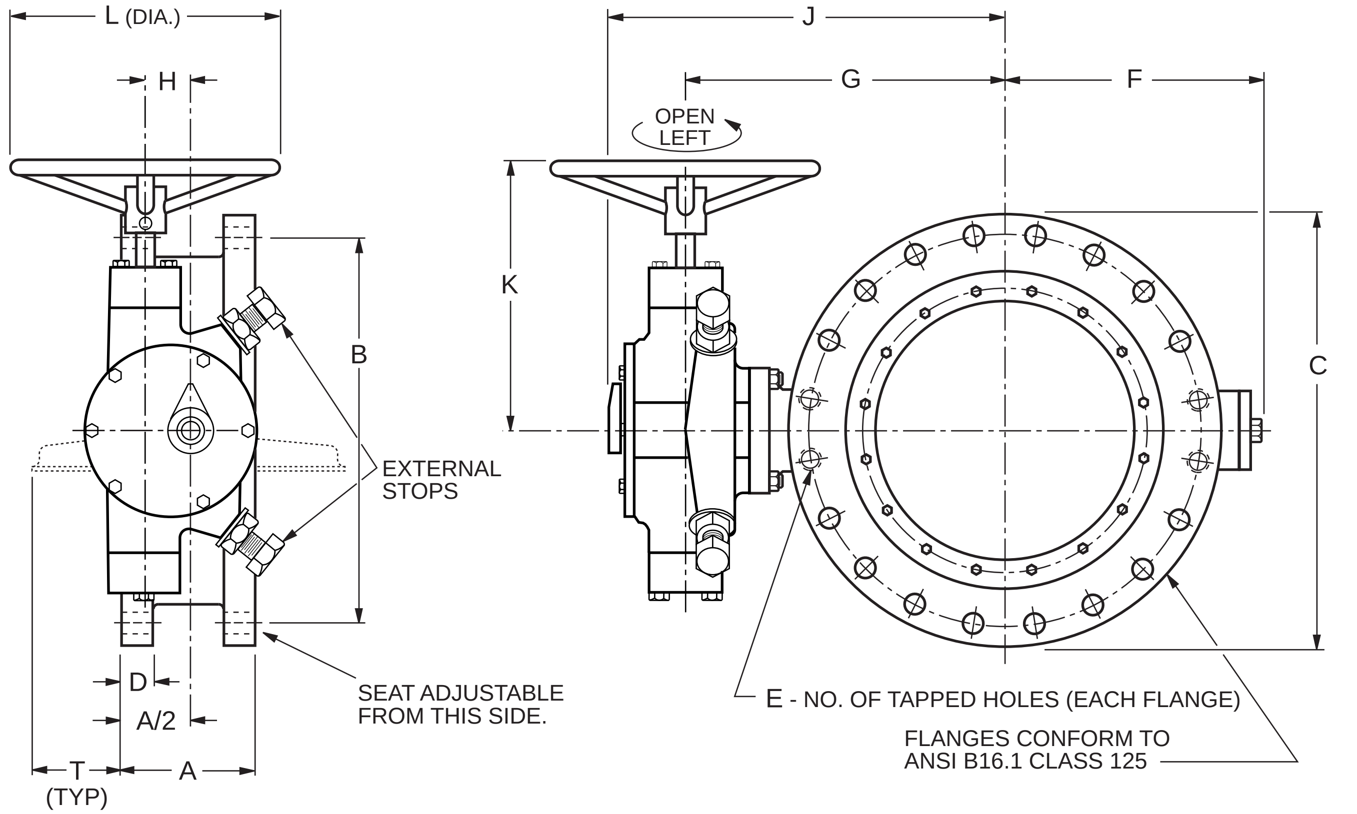
Application

The meter is for use only with potable cold water up to 120°F. The meter will typically register at +/-0.75% accuracy at normal and high flows and better than 95% accuracy at extended low flows. The evoQ$_4$ product line is suited for metering utility customer services for potable water. With the addition of outputs described below, the meter can fulfill a number of distribution management roles as well.

Pulse or encoder output

The meter can be fitted with a pulse output device that can be attached to a radio transceiver module or a data logger. The pulse output can be programmed in the factory to meet the needs of the utility. For utilities preferring encoded output technologies, an encoder module is available for interface with AMR or AMI systems.

Exhibit 4



SEE DRAWING NO. VM-2004-M FOR STANDARD 250B MATERIALS OF CONSTRUCTION.

COLD WORKING PRESSURE 250 PSI (250B)

CLASS 125 LB. DUCTILE IRON FLANGE DIMENSIONS, INCHES

VALVE SIZE	AWWA C504 CLASS	A	B	C	D	E Qty.	E Tap	E Deep	F	G	H	J	K	L	T	TURNS TO OPEN	NO. OF BOLTS	BOLT SIZE	ACTU-ATOR SIZE	SHPG. WT. LBS.
3	250B	5.00	6.00	7.50	0.94	4	5/8-11	1.06	6.00	7.44	1.50	10.13	9.38	8.00	—	15	4	5/8	LS-1A	71
4	250B	5.00	7.50	9.00	0.94	0	—	—	6.00	7.44	1.50	10.13	9.38	8.00	—	15	8	5/8	LS-1A	71
6	250B	5.00	9.50	11.00	1.00	4	3/4-10	1.00	7.00	8.13	1.50	10.81	9.38	8.00	0.69	15	8	3/4	LS-1.2A	90
8	250B	6.00	11.75	13.50	1.12	0	—	—	8.00	9.13	1.50	11.75	9.38	8.00	1.18	15	8	3/4	LS-1.2A	125
10	250B	8.00	14.25	16.00	1.18	0	—	—	10.00	11.50	2.00	14.31	10.38	12.00	1.13	20	12	7/8	LS-2A	200
12	250B	8.00	17.00	19.00	1.25	0	—	—	11.06	12.56	2.00	15.38	10.38	12.00	2.13	20	12	7/8	LS-2A	250
14	250B	8.00	18.75	21.00	1.38	0	—	—	13.50	15.62	3.50	19.19	19.13	20.00	3.13	35	12	1	LS-3A	400
16	250B	8.00	21.25	23.50	1.44	0	—	—	14.62	16.69	3.50	20.19	19.13	20.00	4.13	35	16	1	LS-3A	480
18	250B	8.00	22.75	25.00	1.56	4	11/8-7	1.56	15.50	17.94	5.00	21.50	20.88	24.00	5.13	50	16	1 1/8	LS-4A	640
20	250B	8.00	25.00	27.50	1.69	4	11/8-7	1.69	17.50	19.94	5.00	23.50	20.88	24.00	6.06	50	20	1 1/8	LS-4A	775
24	250B	8.00	29.50	32.00	1.88	4	11/4-7	1.88	20.50	22.94	5.00	26.50	20.88	24.00	8.06	50	20	1 1/4	LS-4A	1,085

250B / 125 LB. DUCTILE IRON FLANGED BUTTERFLY VALVE WITH HANDWHEEL ACTUATOR

DATE 3-12-11

VAL-MATIC® VALVE AND MANUFACTURING CORP.

DRWG. NO. VM-2403/LS

Manual No.
BFV-OM1-3

Val-Matic®
3"-24" Butterfly Valve

Operation, Maintenance and Installation Manual

VAL-MATIC®

VALVE AND MANUFACTURING CORP.

905 Riverside Dr. ● Elmhurst, IL 60126
Phone (630) 941-7600 ● Fax (630) 941-8042
www.valmatic.com

TROUBLESHOOTING

Several problems and solutions are presented below to assist you in troubleshooting the valve assembly in an efficient manner.

Leakage at Valve Shaft: Replace packing.

Leakage at Flanges: Tighten flange bolts, replace gasket.

Valve Leaks when Closed: Flush debris from seat by cycling valve. Adjust actuator closed stop. Inspect seat for damage and adjust seat bolts 1/4 turn at a time.

If the valve continues to leak after adjustment, check for the following items and make the corrections.

1. Verify that there is no damage to the rubber seat. Replace if torn or damaged.
2. Check that the metal set in the body is clean and free of scale and scratches.
3. Check that the actuator is fully closed and the seal is centered in the body seat. Adjustment to the actuator stop nuts or bolts may be necessary.
4. Check the roundness of the adjoining pipe and pipe flange. Pipe loads may cause distortion to the adjoining pipe and valve.
5. Verify that the test pressure is less than the cold working pressure (CWP) shown on the valve nameplate.

- Hard to Open: Flush line of debris. Check grease in actuator. Check interior of valve for deposits or debris. On buried valves, check alignment of operating stem and nut.
- Leaking Oil: Tighten actuator cover bolts. If leak persists, remove actuator cover, inspect grease, and replace actuator gasket.
- Noisy Operation: Flow noise is normal. Loud flow noise similar to hammering may be cavitation from dropping high pressures across valve; review application of valve. For gear actuator noise, inspect grease; add new grease if there are uncoated moving parts or grease has broken down into oil.

DISASSEMBLY

Disassembly may be required to repair the valve. Work on the valve should be performed by a skilled mechanic with proper tools and a power hoist for large valves. The valve must be removed from the pipeline for disassembly. The actuator can be removed with the valve in the line (the line must be drained) or after the valve is removed from the line. Refer to Figure 2 for valve construction and parts.

WARNING: Open valve and drain line before removing actuator or the valve may suddenly open causing injury or fluid loss. Place valve in closed or slightly open position to remove from the line or damage to the disc edge may occur.

1. Open valve slightly and drain the pipeline. Close valve until disc edge just touches the seat. Valve and actuator can be removed as a unit from the pipeline.
2. Remove the small cover on the actuator to expose the shaft key. Remove the actuator mounting bolts and lift actuator from valve taking care not to lose key (14). Access to the traveling nut actuator will be under the actuator cover.
3. Remove bottom cap screws (16) and thrust bearing cap (15). Remove the seat bolts (8) and seat retaining ring (7).
4. Matchmark the taper pins with the disc holes. Remove the taper pin nuts (11) and taper pins (9). Press or hammer out the shaft (4) with a dead blow hammer. The bearings (5) will likely be pushed out with the shaft.
5. Clean and inspect parts. Replace worn parts as necessary and lubricate parts with FDA grease.

Exhibit 5

Table 1A List of Material Specifications

SS-304

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications [Note (1)] Forgings	Castings	Plates
1.1	C–Si	2-1.1	A 105	A 216 Gr. WCB	A 515 Gr. 70
	C–Mn–Si		A 350 Gr. LF2		A 516 Gr. 70
					A 537 Cl. 1
	C–Mn–Si–V		A 350 Gr. LF6 Cl. 1		
	$3\frac{1}{2}$ Ni		A 350 Gr. LF3		
1.2	C–Mn–Si	2-1.2		A 216 Gr. WCC	
				A 352 Gr. LCC	
	C–Mn–Si–V		A 350 Gr. LF6 Cl. 2		
	$2\frac{1}{2}$Ni			A 352 Gr. LC2	A 203 Gr. B
	$3\frac{1}{2}$Ni			A 352 Gr. LC3	A 203 Gr. E
1.3	C–Si	2-1.3		A 352 Gr. LCB	A 515 Gr. 65
	C–Mn–Si				A 516 Gr. 65
	$2\frac{1}{2}$Ni				A 203 Gr. A
	$3\frac{1}{2}$Ni				A 203 Gr. D
	C–$\frac{1}{2}$Mo			A 217 Gr. WC1	
				A 352 Gr. LC1	
1.4	C–Si	2-1.4			A 515 Gr. 60
	C–Mn–Si		A 350 Gr. LF1 Cl. 1		A 516 Gr. 60
1.5	C–$\frac{1}{2}$Mo	2-1.5	A 182 Gr. F1		A 204 Gr. A
					A 204 Gr. B
1.7	$\frac{1}{2}$Cr–$\frac{1}{2}$Mo	2-1.7	A 182 Gr. F2		
	Ni–$\frac{1}{2}$Cr–$\frac{1}{2}$Mo			A 217 Gr. WC4	
	$\frac{3}{4}$Ni–$\frac{3}{4}$Cr–1Mo			A 217 Gr. WC5	
1.9	$1\frac{1}{4}$Cr–$\frac{1}{2}$Mo	2-1.9		A 217 Gr. WC6	
	$1\frac{1}{4}$Cr–$\frac{1}{2}$Mo–Si		A 182 Gr. F11 CL.2		A 387 Gr. 11 Cl. 2
1.10	$2\frac{1}{4}$Cr–1Mo	2-1.10	A 182 Gr. F22 Cl. 3	A 217 Gr. WC9	A 387 Gr. 22 Cl. 2
1.11	C–$\frac{1}{2}$Mo	2-1.11			A 204 Gr. C
1.13	5Cr–$\frac{1}{2}$Mo	2-1.13	A 182 Gr. F5a	A 217 Gr. C5	
1.14	9Cr–1M0	2-1.14	A 182 Gr. F9	A 217 Gr. C12	
1.15	9Cr–1M0–V	2-1.15	A 182 Gr. F91	A 217 Gr. C12A	A 387 Gr. 91 Cl. 2
1.17	1Cr–$\frac{1}{2}$Mo	2-1.17	A 182 Gr. F12 Cl. 2		
	5Cr–$\frac{1}{2}$Mo		A 182 Gr. F5		
2.1	18Cr–8Ni	2-2.1	A 182 Gr. F304	A 351 Gr. CF3	A 240 Gr. 304
			A 182 Gr. F304H	A 351 Gr. CF8	A 240 Gr. 304H
2.2	16Cr–12Ni–2Mo	2-2.2	A 182 Gr. F316	A 351 Gr. CF3M	A 240 Gr. 316
			A 182 Gr. F316H	A 351 Gr. CF8M	A 240 Gr. 316H
	18Cr–13Ni–3Mo		A 182 Gr. F317		A 240 Gr. 317
	19Cr–10Ni–3Mo			A 351 Gr. CG8M	
2.3	18Cr–8Ni	2-2.3	A 182 Gr. F304L		A 240 Gr. 304L
	16Cr–12Ni–2Mo		A 182 Gr. F316L		A 240 Gr. 316L

Exhibit 5

Table F2-2.1 Pressure–Temperature Ratings for Group 2.1 Materials

Nominal Designation	Forgings	Castings	Plates
18Cr–8Ni	A 182 Gr. F304 (1)	A 351 Gr. CF3 (2)	A 240 Gr. 304 (1)
	A 182 Gr. F304H	A 351 Gr. CF8 (1)	A 240 Gr. 304H

Working Pressures by Classes, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	230	600	800	1200	1800	3000	5000
300	205	540	715	1075	1615	2690	4480
400	190	495	660	995	1490	2485	4140
500	170	465	620	930	1395	2330	3880
600	140	440	590	885	1325	2210	3680
650	125	430	575	865	1295	2160	3600
700	110	420	565	845	1265	2110	3520
750	95	415	550	825	1240	2065	3440
800	80	405	540	810	1215	2030	3380
850	65	395	530	790	1190	1980	3300
900	50	390	520	780	1165	1945	3240
950	35	380	510	765	1145	1910	3180
1000	20	355	470	710	1065	1770	2950
1050	...	325	435	650	975	1630	2715
1100	...	255	345	515	770	1285	2145
1150	...	205	275	410	615	1030	1715
1200	...	165	220	330	495	825	1370
1250	...	135	180	265	400	670	1115
1300	...	115	150	225	340	565	945
1350	...	95	125	185	280	465	770
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 800°F.

1.9 Denotation

1.9.1 Pressure Rating Designation. Class, followed by a dimensionless number, is the designation for pressure–temperature ratings as follows:

Class 150 300 400 600 900 1500 2500

1.9.2 Size. NPS, followed by a dimensionless number, is the designation for nominal flange or flange fitting size. NPS is related to the reference *nominal diameter*, DN, used in international standards. The relationship is, typically, as follows:

NPS	DN
½	15
¾	20
1	25
1¼	32
1½	40
2	50
2½	65
3	80
4	100

GENERAL NOTE: For NPS ≥ 4, the related DN is DN = 25 (NPS).

2 PRESSURE-TEMPERATURE RATINGS

2.1 General

Pressure-temperature ratings are maximum allowable working gage pressures in bar units at the temperatures in degrees Celsius shown in Tables 2-1.1 through 2-3.17 for the applicable material and class designation. Tables F2-1.1 through F2-3.17 of Annex F list pressure-temperature ratings using psi units for pressure at the temperature in degrees Fahrenheit. For intermediate temperatures, linear interpolation is permitted. Interpolation between class designations is not permitted.

2.2 Flanged Joints

A flanged joint is composed of separate and independent, although inter-related components: the flanges, the gasket, and the bolting, which are assembled by another influence, the assembler. Proper controls must be exercised in the selection and application for all these elements to attain a joint that has acceptable leak tightness. Special techniques, such as controlled bolt tightening are described in ASME PCC-1.

2.3 Ratings of Flanged Joints

2.3.1 Basis. Pressure-temperature ratings apply to flanged joints that conform to the limitations on bolting in para. 5.3 and on gaskets in para. 5.4, which are made up in accordance with good practice for alignment and assembly (see para. 2.2). Use of these ratings for flanged joints not conforming to these limitations is the responsibility of the user.

2.3.2 Mixed Flanged Joints. If the two flanges in a flanged joint do not have the same pressure–temperature rating, the rating of the joint at any temperature is the lower of the two flange ratings at that temperature.

2.4 Rating Temperature

The temperature shown for a corresponding pressure rating is the temperature of the pressure-containing shell of the component. In general, this temperature is the same as that of the contained fluid. Use of a pressure rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the requirements of applicable codes and regulations. For any temperature below –29°C (–20°F), the rating shall be no greater than the rating shown for –29°C (–20°F). See also paras. 2.5.3 and 5.1.2.

2.5 Temperature Considerations

2.5.1 General. Use of flanged joints at either high or low temperatures shall take into consideration the risk of joint leakage due to forces and moments developed in the connected piping or equipment. Provisions in paras. 2.5.2 and 2.5.3 are included as advisory with the aim of lessening these risks.

2.5.2 High Temperature. Application at temperatures in the creep range will result in decreasing bolt loads as relaxation of flanges, bolts, and gaskets takes place. Flanged joints subjected to thermal gradients may likewise be subject to decreasing bolt loads. Decreased bolt loads diminish the capacity of the flanged joint to sustain loads effectively without leakage. At temperatures above 200°C (400°F) for Class 150 and above 400°C (750°F) for other class designations, flanged joints may develop leakage problems unless care is taken to avoid imposing severe external loads, severe thermal gradients, or both.

2.5.3 Low Temperature. Some of the materials listed in Tables 1A and 1B, notably some carbon steels, may undergo a decrease in ductility when used at low temperatures to such an extent as to be unable to safely resist shock loading, sudden changes of stress, or high stress concentration. Some codes or regulations may require impact testing for applications even where temperatures are higher than –29°C (–20°F). When such requirements apply, it is the responsibility of the user to ensure these requirements are communicated to the manufacturer prior to the time of purchase.

2.6 System Hydrostatic Testing

Flanged joints and flanged fittings may be subjected to system hydrostatic tests at a pressure of 1.5 times the 38°C (100°F) rating rounded off to the next higher 1 bar (25 psi) increment. Testing at any higher pressure is the responsibility of the user, taking into account the requirements of the applicable code or regulation.

Exhibit 5

The Phoenix Forge Group
PHOENIX * CAPITOL * CAMCO * CAPPRODUCTS

ISO 9001

MAXIMUM ALLOWABLE WORKING PRESSURE (PSI) AT DESIGN TEMPERATURE (F)
ASTM A312 Grade 304/304L Stainless Steel Welded Pipe Nipples
FOR REFERENCE ONLY

Nominal Pipe Size	Wall Thickness	Weight Class	Schedule No.	Temperature								
				-425 to 100	200	300	400	500	600	700	800	850
1/8	0.068	STD	40	2095	2095	2095	1985	1860	1760	1695	1630	1605
	0.095	XS	80	3890	3890	3890	3680	3445	3260	3145	3025	2980
1/4	0.088	STD	40	1695	1695	1695	1605	1500	1420	1370	1320	1300
	0.119	XS	80	3210	3210	3210	3035	2845	2690	2595	2500	2460
3/8	0.091	STD	40	1455	1455	1455	1375	1290	1220	1175	1135	1115
	0.126	XS	80	2825	2825	2825	2675	2505	2370	2285	2200	2165
1/2	0.109	STD	40	1265	1265	1265	1195	1120	1060	1020	985	970
	0.147	XS	80	2440	2440	2440	2310	2165	2045	1975	1900	1870
3/4	0.113	STD	40	1100	1100	1100	1040	975	920	890	855	840
	0.154	XS	80	2100	2100	2100	1985	1860	1760	1700	1635	1610
1	0.133	STD	40	980	980	980	925	865	820	790	760	750
	0.179	XS	80	1865	1865	1865	1765	1655	1565	1510	1455	1430
1-1/4	0.140	STD	40	875	875	875	825	775	735	705	680	670
	0.191	XS	80	1645	1645	1645	1560	1460	1380	1330	1280	1265
1-1/2	0.145	STD	40	825	825	825	780	730	690	665	645	635
	0.200	XS	80	1550	1550	1550	1470	1375	1300	1255	1205	1190
2	0.154	STD	40	750	750	750	710	665	630	605	585	575
	0.218	XS	80	1420	1420	1420	1345	1260	1190	1150	1105	1090
2-1/2	0.203	STD	40	735	735	735	700	655	620	595	575	565
	0.276	XS	80	1370	1370	1370	1295	1215	1150	1105	1065	1050
3	0.216	STD	40	695	695	695	655	615	580	560	540	530
	0.300	XS	80	1290	1290	1290	1220	1140	1080	1040	1005	990
3-1/2	0.226	STD	40	665	665	665	630	590	560	540	520	510
	0.318	XS	80	1235	1235	1235	1170	1095	1035	1000	960	945
4	0.237	STD	40	650	650	650	615	575	545	525	505	500
	0.337	XS	80	1200	1200	1200	1135	1060	1005	970	935	920

NOTES:

1). The allowable working pressures were calculated based on formulas and allowable stress as specified in the ASME B31.3 Process Piping Code.
2). Considerations were taken into account for the wall thickness material removed by threading.
3). No allowances were made for corrosion, erosion, mechanical loads, and/or bending moments.
4). Allowable working pressures listed are non-shock working pressures.
5). For temperatures and working pressures above those listed consult the end users piping engineer.
6). This information is to be used as a reference guide only. Specifying the correct pipe schedule and pressure class of fitting depends on many different factors. Therefore, it is the ultimate responsibility of the end user's piping engineer to specify the correct pipe schedule and pressure class of fitting that will safely work in his intended application.

KK 11/08

Exhibit 5

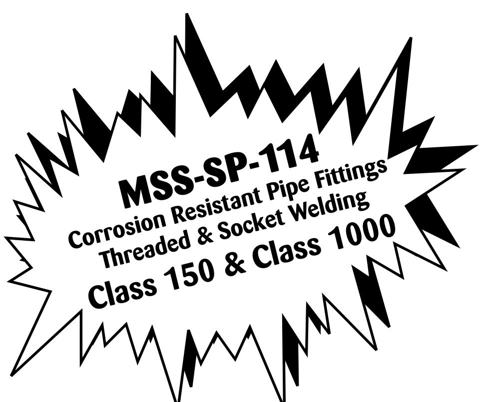
GENERAL INFORMATION

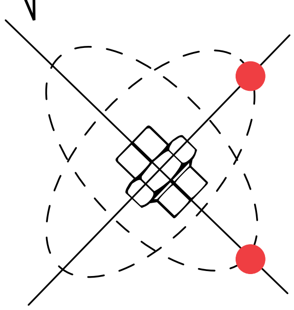
ASP 150 LB. STAINLESS STEEL PIPE FITTINGS

Dimensions and materials conform to MSS-SP-114, Class 150 or Class 1000, Threaded or Socket-Welding. Pipe Threads conform to ASME B1.20.1. Cast 150 LB Pipe Fittings are manufactured from material conforming to ASTM-A-351 (CF8/304, CF8M/316, or CN7M/A-20). ASP Cast 150 LB Fittings are suitable for use at pressure temperature ratings for MSS-SP-114 Class 150 Fittings (300 psi CWP / 150 psi SWP). ASP Forged/Barstock 150 LB Fittings are manufactured from forged or wrought barstock materials conforming to the chemistry of ASTM-A-182 (F304 or F316) or ASTM-B-473 (A-20) in a proper state of heat treatment to provide desired mechanical properties and corrosion resistance. ASP Forged/Barstock 150 LB Fittings are suitable for use at pressure temperature ratings for MSS-SP-114 Class 1000 Fittings (1000 psi CWP). All ASP 150 LB Stainless Steel Pipe Fittings are identified with the ASP Trademark, Nominal Pipe Size, and Material Grade.

ASP 2000 LB, 3000 LB & 6000 LB STAINLESS STEEL THREADED AND SOCKET-WELDING FITTINGS

Dimensions and materials conform to ASME B16.11, MSS-SP-79 (Inserts), MSS-SP-83 (Unions), and other standards where applicable. Threads conform to ASME B1.20.1. Socket-welding Fittings may be bored for use with Schedule 40, 80, 160, and XXS Pipe as required. Material conforms to ASTM-A-182, F304, F304L, F316, or F316L; Alloy-20 material conforms to ASTM-B-462 (forged) or ASTM-B-473 (barstock). Material conformance to QQ-S-763 and other alloys may be available upon request for quotation. All ASP 2000 LB, 3000 LB, and 6000 LB Fittings are permanently identified with the ASP Trademark, Nominal Pipe Size, Pressure Rating, Material Designation and Alloy, and Heat Code Identification.





All ASP Pipe Fittings are manufactured under our Quality System Program which has been developed to meet the requirements of ISO-9001. Upon request for quotation, our Quality System Program has provisions for implementation to meet the requirements of ASME NCA-3800, NQA-1, 10CFR50 Appendix B, MIL-I-45208, MIL-STD-45662, and other quality program requirements. Additional information on Canadian Commercial Registration Numbers for both commercial and nuclear applications is available on request.

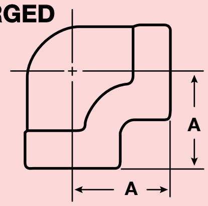
DIMENSIONS SHOWN IN THIS CATALOG ARE NOMINAL AND SUBJECT TO APPLICABLE STANDARD AND MANUFACTURER'S TOLERANCES. MATERIALS AND DIMENSIONS OTHER THAN THOSE REQUIRED BY APPLICABLE STANDARDS REFERENCED ARE SUBJECT TO CHANGE WITHOUT NOTICE AT THE MANUFACTURER'S OPTION.

Exhibit 5

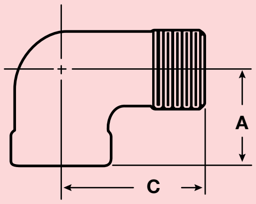
MSS-SP-114
Corrosion Resistant Pipe Fittings
Threaded & Socket Welding
Class 150 & Class 1000

THREADED FITTINGS

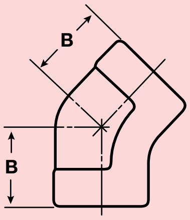
FORGED



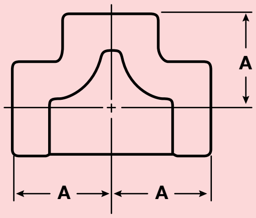
90° ELBOW



STREET ELBOW

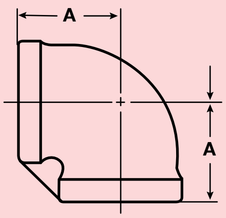


45° ELBOW

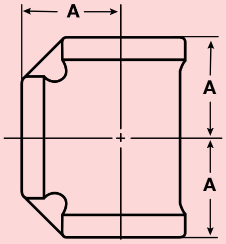


TEE

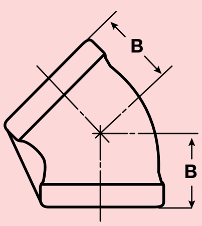
CAST



90° ELBOW



TEE



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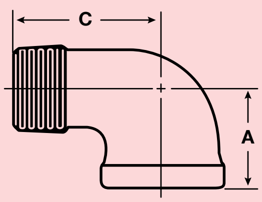
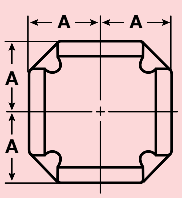


STREET ELBOW



CROSS

NOTES:

1. Dimensions conform to MSS-SP-114.
2. Pipe Threads conform to ASME B1.20.1.
3. Forged 150 LB Fittings are suitable for use at 1000 psi CWP.
4. Reducing 90 Degree Elbows and Tees are available on request.
5. Socket-welding ends available on request.

FORGED 1000 p.s.i. CWP Service — **CAST** 150 p.s.i. Steam Service

SIZE	1/8	1/4			3/8	1/2		
A	13/16	13/16			15/16	1 1/8		
B	11/16	11/16			13/16	7/8		
C	1-11/16	1 7/32			1 7/16	1 5/8		
DIA.	49/64	49/64			1 1/64	1 13/64		

CAST
150 p.s.i. Steam Service

SIZE	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
A	1 5/16	1 1/2	1 3/4	1 15/16	2 1/4	2 11/16	3 1/16	3 13/16
B	1	1 1/8	1 5/16	1 7/16	1 11/16	1 15/16	2 3/16	2 5/8
C	1 7/8	2 1/8	2 1/2	2 3/4	3 1/4	3 7/8	4 1/2	5 11/16
DIA.	1 15/32	1 13/16	2 3/16	2 15/32	3	3 19/32	4 9/32	5 13/32

INDEX

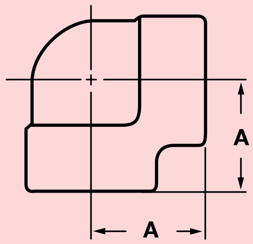
ELBOWS AND TEES

THREADED FITTINGS

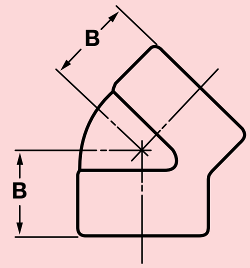
FORGED
High Pressure Service

SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
	2000 p.s.i. COLD NON-SHOCK SERVICE								
A	13/16	13/16	31/32	1 1/8	1 5/16	1 1/2	1 3/4	2	2 3/8
B	11/16	11/16	3/4	7/8	1	1 1/8	1 15/16	1 3/8	1 11/16
DIA.	7/8	7/8	1 1/16	1 5/16	1 1/2	1 13/16	2 3/16	2 7/16	2 31/32
	3000 p.s.i. COLD NON-SHOCK SERVICE								
A	13/16	31/32	1 1/8	1 5/16	1 1/2	1 3/4	2	2 3/8	2 1/2
B	11/16	3/4	7/8	1	1 1/8	1 5/16	1 3/8	1 11/16	1 23/32
DIA.	7/8	1 1/16	1 5/16	1 1/2	1 13/16	2 3/16	2 7/16	2 31/32	3 5/16
	6000 p.s.i. COLD NON-SHOCK SERVICE								
A	31/32	1 1/8	1 5/16	1 1/2	1 3/4	2	2 3/8	2 1/2	—
B	3/4	7/8	1	1 1/8	1 5/16	1 3/8	1 11/16	1 23/32	—
DIA.	1 1/16	1 5/16	1 1/2	1 13/16	2 3/16	2 7/16	2 1/32	3 5/16	—

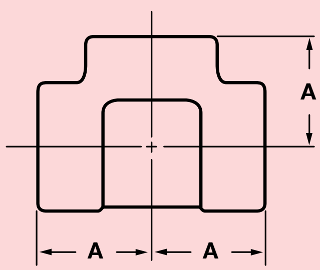
SIZE	2 1/2	3							
	2000 p.s.i. COLD NON-SHOCK SERVICE								
A	3	3 3/8							
B	—	—							
DIA.	3 5/8	4 5/16							
	3000 p.s.i. COLD NON-SHOCK SERVICE								
A	3 3/8	3 3/4							
B	—	—							
DIA.	4 5/16	4 3/4							



90° ELBOW



45° ELBOW



TEE

Specialty and Custom Fittings Available Subject to Quotation

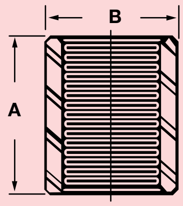
NOTES:

1. Dimensions of 90s, Tees, 45s, and Crosses conform to ASME B16.11.
2. Cross Dimensions correspond to Center-to-end and Diameter dimensions of Tees.
3. Pipe Threads conform to ASME B1.20.1.
4. Reducing 90 Degree Elbows, Tees, and Crosses are available upon request.
5. Dimensions of 3000 LB Street Elbows are available upon request.

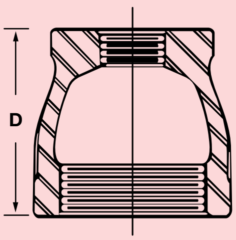
Exhibit 5

COUPLINGS-REDUCERS-CAPS

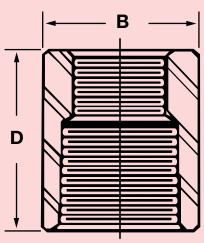
THREADED FITTINGS



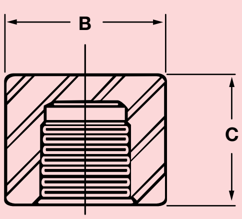
COUPLING



REDUCING COUPLING



REDUCING COUPLING



CAP

SIZE	⅛	¼	⅜	½	¾	1	1¼	1½	2
	1000 p.si. COLD NON-SHOCK SERVICE (BAR OR FORGED)								
A	1	1	1⅛	1⅜	1½	1⅝	2	2⅛	2½
B	⅝	¾	⅞	1 1/16	1 5/16	1⅝	1⅞	2¼	2¾
C	¾	⅞	15/16	15/16	1¼	1½	1⅝	1¾	1⅞
D	1	1	1⅛	1⅜	1½	1⅝	2	2 5/32	2 21/32
	3000 p.s.i. COLD NON-SHOCK SERVICE (BAR OR FORGED)								
A&D	1¼	1⅜	1½	1⅞	2	2⅜	2⅝	3⅛	3⅜
B	⅝	¾	⅞	1⅛	1⅜	1¾	2¼	2½	3
C	¾	1	1	1¼	1 7/16	1⅝	1¾	1⅞	2
	6000 p.s.i. COLD NON-SHOCK SERVICE (BAR OR FORGED)								
A&D	1¼	1⅜	1½	1⅞	2	2⅜	2⅝	3⅛	3⅜
B	⅞	1	1¼	1½	1¾	2¼	2½	3	3⅝
C	13/16	1 1/16	1¼	1 7/16	1 9/16	1⅞	1 15/16	1 5/16	2 1/16

SIZE	2½	3	4						
	150 p.si. STEAM SERVICE (CAST)								
A	3	3¼	3¾						
B	3 5/16	4	5 1/16						
C	2	2¼	2½						
D	3¼	3 11/16	4⅜						
	3000 p.s.i. COLD NON-SHOCK SERVICE (BAR OR FORGED)								
A&D	3⅝	4¼	4¾						
B	3⅝	4¼	5½						
C	2⅝	2 11/16	1 15/16						

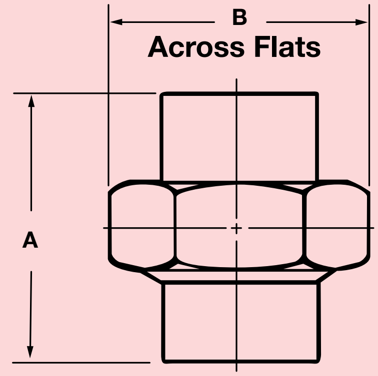
NOTES:

1. Dimensions of 150 LB items conform to MSS-SP-114. Socket Welding Fittings available upon request.
2. Dimensions of 3000 LB and 6000 LB items conform to ASME B16.11.
3. Pipe Threads conform to ASME B1.20.1
4. 150 LB Half-Couplings are approximately half the length of 150 LB Full Couplings.
5. 2½" thru 4" 150 LB Cast Reducing Couplings are Bell Reducers.
6. 150 LB Forged/Barstock Couplings and Reducers up to 2" and Caps up to 1" are suitable for use at 1000 psi CWP.

Exhibit 5

UNIONS

THREADED FITTINGS



FORGED OR BAR STOCK

SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
	1000 p.s.i. COLD NON-SHOCK SERVICE								
A	1 1/2	1 1/2	1 1/2	1 13/16	2	2	2 5/8	3	3 1/8
B	1 1/8	1 1/8	1 5/16	1 1/2	1 3/4	2 3/16	2 5/8	3	3 5/8
	3000 p.s.i. COLD NON-SHOCK SERVICE								
A	—	1 1/2	1 7/8	2	2	2 1/2	2 7/8	3	3 3/8
B	—	1 5/16	1 1/2	1 3/4	2 3/16	2 1/2	3 1/16	3 13/32	4 5/32
	CAST 150 p.s.i. STEAM SERVICE								
SIZE	2 1/2	3	4						
A	3 5/8	4 1/4	4 1/2						
B	4 1/2	5 3/8	6 3/4						

NOTES:

1. Pipe Threads conform to ANSI B1.20.1.
2. 150 LB Unions of any ally are supplied with Type 304 Union Nuts. Type 316 Nuts are available on request.
3. Dimensions of 3000 LB Unions conform to MSS-SP-83.
4. General dimensions of 3000 LB Socket-welding Unions are the same as shown for 3000 LB Threaded Unions of the same size. Dimensions of Socket-Welding End Connections and Fitting Bores conform to MSS-SP-83 and ASME B16.11. requirements for 3000 LB Socket-Welding Fittings.
5. 6000 LB Threaded and Socket-welding Unions are available on request.

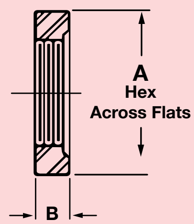
NIPPLES, LOCKNUTS AND WELDING SPUDS

THREADED FITTINGS

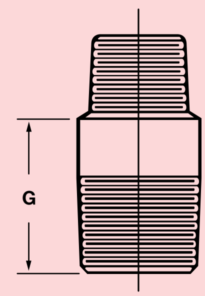
BAR STOCK OR FORGED (except as noted)
150 p.s.i. Service

SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
A	3/4	7/8	1	1 3/16	1 1/2	1 3/4	2 1/8	2 3/8	2 7/8
B	3/6	1/4	9/32	5/16	11/32	3/8	7/16	15/32	17/32
C	1 3/8	1 1/2	1 5/8	1 3/4	2	2 1/4	2 11/16	3	3 1/2
D	27/32	31/32	31/32	1 5/32	1 11/32	1 23/32	1 15/16	2 5/16	2 11/16
E	3/32	1/8	1/8	5/32	5/32	3/16	3/16	3/16	3/16
F	15/32	1/2	1/2	19/32	21/32	25/32	3/4	3/4	13/16
G	—	1 1/8	1 1/8	1 1/4	1 1/2	1 5/8	1 3/4	1 3/4	2 1/8

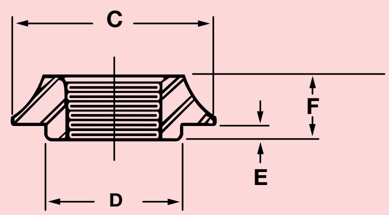
SIZE	2 1/2	3	4						
A	3 1/2	4 9/32	5 3/8						
B	19/32	11/16	13/16						
C	4 1/16	4 5/8	5 13/16						
D	3 3/16	3 11/16	4 3/4						
E	3/16	3/16	3/16						
F	1	1	1 1/8						
G	2 1/4	2 1/4	2 3/8						



LOCKNUT



REDUCING (SWAGED) NIPPLE



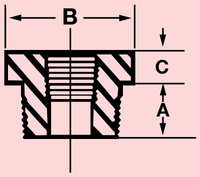
WELDING SPUD

NOTES:

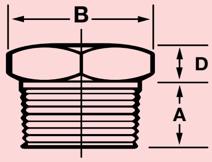
1. Pipe Threads conform to ASME B1.20.1.
2. General dimensions and threading of locknuts are based on ASME B16.14.
3. Locknuts 1-1/2" and larger - CAST.
4. Welding Spuds 2-1/2" and larger - CAST.

PLUGS AND BUSHINGS

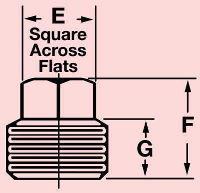
THREADED FITTINGS



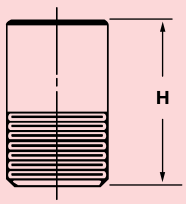
HEX BUSHING



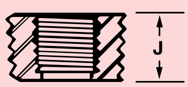
HEX HEAD PLUG



SQUARE HEAD PLUG



ROUND HEAD PLUG



FLUSH BUSHING

BAR STOCK OR FORGED (except as Noted)

SIZE	1/8	1/4	3/8	1/2	3/4	1
A	3/8	1/2	33/64	43/64	11/16	27/32
B	7/16	5/8	3/4	7/8	1 1/8	1 5/16
C	—	1/8	5/32	3/16	7/32	1/4
D	1/4	1/4	5/16	5/16	3/8	3/8
E	9/32	3/8	7/16	9/16	5/8	13/16
F	5/8	11/16	13/16	15/16	1 1/16	1 1/4
G	3/8	7/16	1/2	9/16	5/8	3/4
H	1 3/8	1 5/8	1 5/8	1 3/4	1 3/4	2
J	—	7/16	1/2	9/16	5/8	3/4

SIZE	1 1/4	1 1/2	2	2 1/2	3	4
A	7/8	7/8	15/16	1 1/16	1 1/8	1 1/4
B	1 3/4	2	2 1/2	3 1/8	3 5/8	5
C	9/32	5/16	11/32	1/2	1/2	5/8
D	9/16	5/8	45/64	1/2	1/2	5/8
E	15/16	1 1/8	1 5/16	1 1/2	1 11/16	2 1/2
F	1 1/2	1 1/2	1 5/8	2	2 1/8	2 1/2
G	13/16	13/16	7/8	1 1/16	1 1/8	1 1/4
H	2	2	2 1/2	2 3/4	2 3/4	3
J	13/16	13/16	7/8	1 1/16	1 1/8	1 1/4

NOTES:
1. Pipe threads conform to ASME B1.20.1.
2. Hex Plugs and Bushings 1/8" through 2", Square Head Plugs 1-1/4" through 2", Flush Bushings and Round Head Plugs conform to ASME B16.11; material conforms to ASTM-A-182.
3. General dimensions of 150 LB Plugs and Bushings are based on ASME B16.14.
4. 150 LB Hex Plugs and Bushings 2-1/2" and 3" Forged; 4" - Cast.
5. 150 LB Square Head Plugs 1" and smaller - Bar or Forged; over 2" - Cast.
6. Non-cast 150 LB items suitable for use at 1000 psi CWP.
7. ASME B16.11 items are not identified by pressure class and may be used for ratings up through ASME Pressure Class 6000.
8. Socket-welding Plugs available on request.

Specialty and Custom Fittings Available Subject to Quotation

Models 106-RF / 206-RF
Rate of Flow Control Valve

106-RF Globe

KEY FEATURES

- Accurately limits flow to a pre-set maximum
- Easily adjustable flow limit
- Paddle-style orifice plate included
- Optional orifice plate housing

Product Overview

The 106-RF and 206-RF rate of flow control valves are based on the 106-PG or 206-PG main valves. The valve is ideal for limiting the flow to a pre-determined maximum (via maintaining a continuous pressure differential across an orifice).

When the pressure differential is less than the set-point, the valve opens, allowing flow to meet pre-determined demand. At the desired maximum set-point, the pilot reacts to small changes in sensing pressure and controls the main valve position by modulating the pressure above the diaphragm.

When the pressure drop across the orifice exceeds the set-point, the valve closes slightly, limiting the flow to the pre-set maximum. The orifice is usually sized to generate a pressure differential of 3 to 5 psi / 0.2 to 0.35 bar at the desired flow. Adjusting the pilot setting permits the maximum flow to be changed in the field above or below the original point.

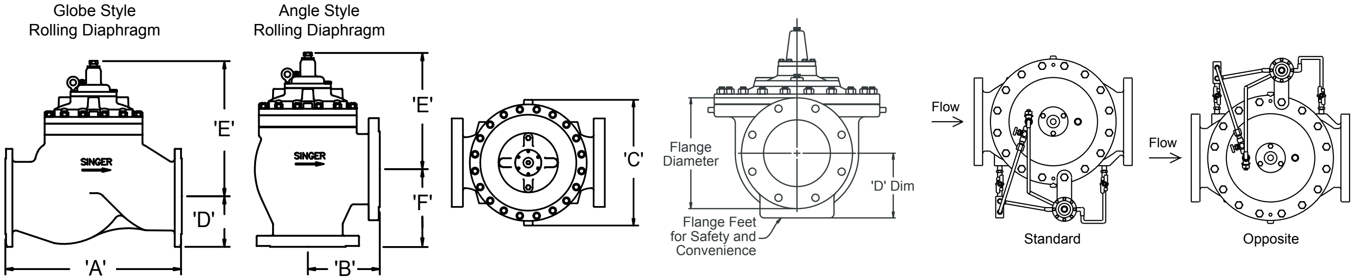
Exhibit 6

Model 106-PG / S106-PG Full Port, Single Chamber, Hydraulically Operated Valve

ANSI Valve Data (US Units) - Not to be used on valves with approvals.

Size	**DWG**	**Standard**	**Rolling Diaphragm System**								
Inches	**REF**	**ANSI**	**6 in**	**8 in**	**10 in**	**12 in**	**14 in**	**16 in**	**20 in**	**24 in**	**36 in**
Globe Dimensions			**All figures shown in inches unless otherwise stated.**								
Lay Length	A	FNPT	-	-	-	-	-	-	-	-	-
Centerline to Bottom	D	FNPT	-	-	-	-	-	-	-	-	-
Lay Length	A	150F	20.00	25.38	29.75	34.00	31.00	41.38	52.00	61.50	76.00
Centerline to Bottom	D	150F	5.60	7.63	8.56	9.50	10.50	11.75	14.43	17.13	23.50
Lay Length	A	300F	21.00	26.38	31.12	35.50	32.50	43.50	53.62	63.25	78.00
Centerline to Bottom	D	300F	6.34	7.88	9.31	10.25	11.50	12.75	15.75	19.65	25.50
Angle Dimensions											
Center Inlet to Discharge	B	FNPT	-	-	-	-	-	-	-	-	-
Center Discharge to Inlet	F	FNPT	-	-	-	-	-	-	-	-	-
Center Inlet to Discharge	B	150F	-	-	11.50	13.75	-	18.00	-	-	-
Center Discharge to Inlet	F	150F	-	-	12.50	12.50	-	15.69	-	-	-
Center Inlet to Discharge	B	300F	-	-	12.19	14.50	-	18.81	-	-	-
Center Discharge to Inlet	F	300F	-	-	13.19	13.25	-	16.50	-	-	-
Common Dimensions (Globe & Angle)											
Width	C		12.75	16.09	22.13	26	26	32	35	49.68	64.5
Height (To Stem Cap) Globe	E		15.43	20.19	23.31	26.75	26.8	31.4	35.5	45.75	61
Height (To Stem Cap) Angle	E		-	-	20	23.75	-	28.5	-	-	-
Body Port Tapping		FNPT	3/8	1/2	3/4	3/4	3/4	3/4	3/4	3/4	1
Stem Cap Plug		MNPT	3/8	3/8	3/4	3/4	3/4	3/4	3/4	3/4	1
Cover Port Tapping		FNPT	1/2	1/2	3/4	3/4	3/4	3/4	3/4	3/4	1
Valve Stroke			1-11/16	2-7/8	3-1/4	3-3/4	3-3/4	4-3/4	5-9/16	6	9
Displaced Bonnet Volume (Gallons)			0.50	1.00	1.50	2.30	2.30	6.75	9.00	14.75	43.00
Approximate Shipping Weight (Lbs)			350	650	900	1300	1400	2300	3450	5000	13500
Flow Capacities (USGPM) Globe & Angle											
C_v - Globe			460	800	1300	2100	2575	3300	5100	7600	16340
C_v - Angle			-	-	1400	2450	-	4000	-	-	-
Continuous (Globe)			1800	3100	4900	7000	8500	11000	17500	25000	55470
Intermittent (Globe)			2250	3875	6100	8800	11500	14250	21700	31200	69338
Momentary (Globe)			4000	7000	11000	16000	19000	25000	39000	56200	124700
Maximum Pressure Ratings (Ductile Only)											
PSI[1]		FNPT	-	-	-	-	-	-	-	-	-
PSI		150F	250	250	250	250	250	250	250	250	250
PSI[1]		300F	400	400	400	400	400	400	400	400	400
Maximum Temperature											
Fahrenheit			180º	180º	180º	180º	180º	180º	180º	180º	180º

[1]Valves rated and stamped 400 psi as standard. Valves rated and stamped 600 psi on request.



See pilot system information, page 259.
For additional Engineering notes, see page 292.

ROMAC INDUSTRIES, INC.

STYLE DJ400 DISMANTLING JOINT WITH CLASS "E" FLANGE 3"- 12" w/ TIE RODS

SUBMITTAL INFORMATION

MATERIALS	
Flanged Spool	AWWA C207 Class E Steel Ring Flange, compatible with ANSI Class 125 and 150 bolt circles. Pipe is STD weight class per ASTM A53.
End Ring and Body	The end ring and body are made from ASTM A536 65-45-12 Ductile Iron.
Gaskets	Compounded for water and sewer service meeting the requirements of ASTM D 2000. Other compounds available on request.
Bolts and Nuts	ASTM A588 HSLA bolt material. Stainless Steel, Types 304 or 316 is optional.
Tie Rods	High tensile steel per ASTM A193 grade B7. Stainless steel, type 304 or 316 is optional.
Coatings	Fusion bonded epoxy, NSF 61 certified. All surfaces are coated, including flange faces.
PRESSURE	When properly installed on a pipe that is within the coupling manufacturer's tolerances, Romac style DJ400 can work at pressures up to the maximum rating of the flange. AWWA Class E flanges are rated for 275 psi. Higher working pressures can be accommodated. Consult your representative.
ASSEMBLY TOLERANCE	Two inch adjustment see catalog. For a different length, contact Romac Engineering.
SIZE	3" – 12", See drawing B2114-A. Larger sizes available on request.
AWWA C219	The DJ400 meet the specifications set forth in the AWWA C219 Standard.

Romac Document Number 20-8-0028 6/15

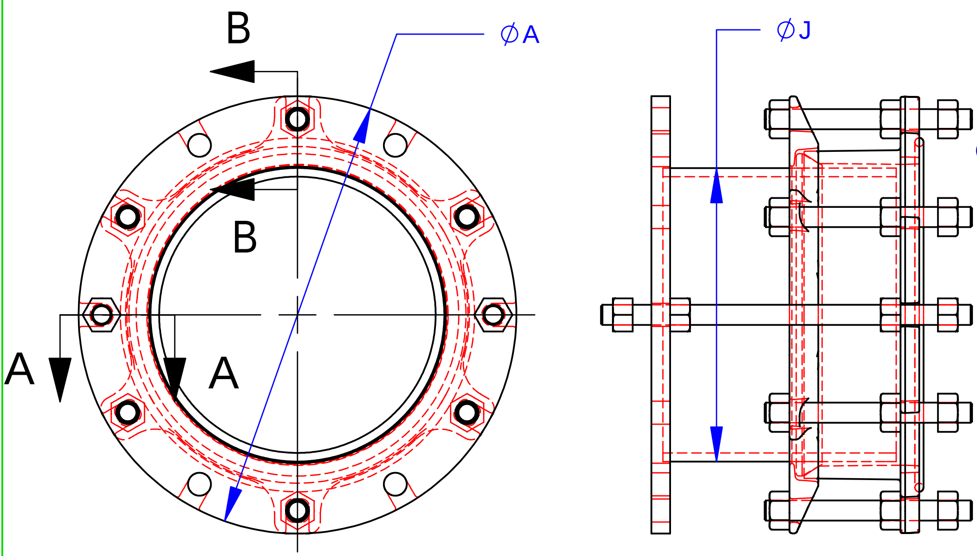
Exhibit 7

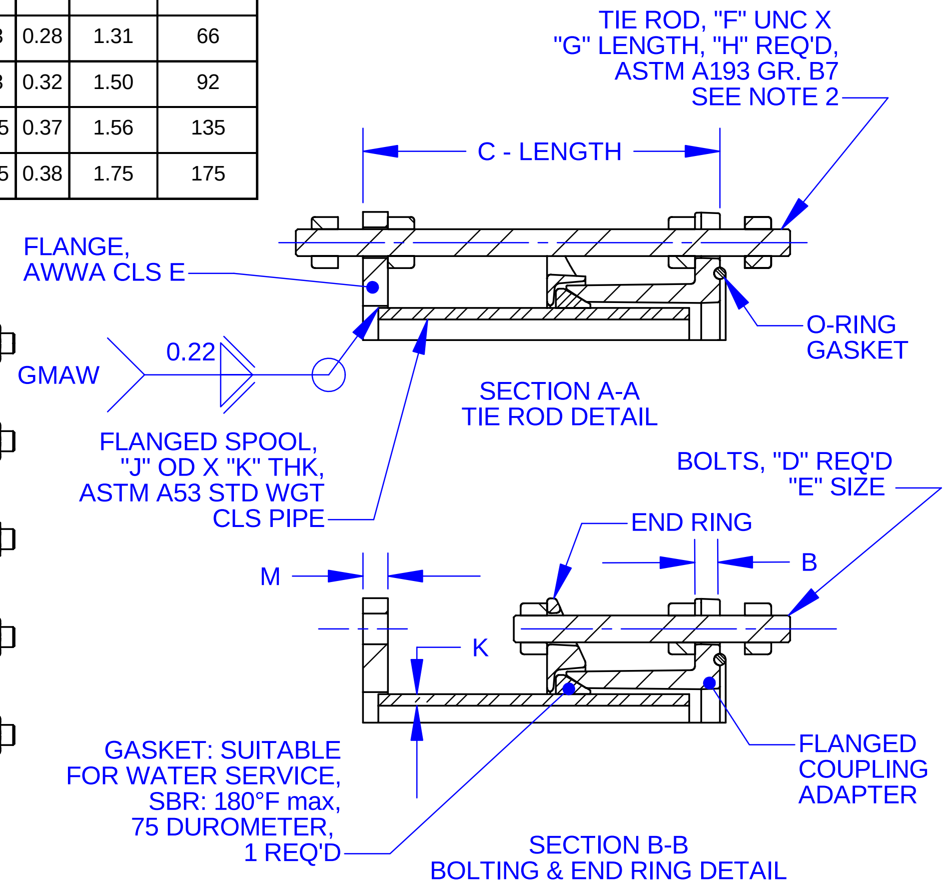
B2114-A

NOM SIZE	FLANGE OD A	FCA FLANGE THK B	C - LENGTH NOM.	C - LENGTH MIN.	C - LENGTH MAX.	BOLTS QTY D	BOLTS SIZE E	TIE RODS SIZE F	TIE RODS LENGTH G	TIE RODS STEEL QTY H	SS QTY H	SPOOL OD J	SPOOL THK K	SPOOL FLANGE THK M	APPROX. WEIGHT LBS
3	7.50	0.60	9.00	8.00	10.00	4	5/8 - 11	5/8 - 11	14.50	2	2	3.50	0.22	0.94	35
4	9.00	0.60	9.00	8.00	10.00	4	5/8 - 11	5/8 - 11	14.50	2	2	4.50	0.24	1.13	44
6	11.00	0.63	9.38	8.38	10.38	4	3/4 - 10	3/4 - 10	16.00	2	2	6.63	0.28	1.31	66
8	13.50	0.63	9.38	8.38	10.38	4	3/4 - 10	3/4 - 10	16.00	2	2	8.63	0.32	1.50	92
10	16.00	1.24	11.50	10.50	12.50	6	5/8 - 11X 7/8 - 9	7/8 - 9	18.75	2	4	10.75	0.37	1.56	135
12	19.00	1.25	11.50	10.50	12.50	6	7/8 - 9	7/8 - 9	18.75	2	4	12.75	0.38	1.75	175

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
1	ADDED O-RING, REMOVED EXTRA FLANGES	4-Feb-03	NST III
2	ADDED SS TIE ROD COLUMN	15-Mar-05	NST III
3	ADDED NOTE 6 AND WELD SYMBOL	26-Jun-06	NST III





NOTES:

1. COATING: CUSTOMER SPECIFIED. ROMAC NSF 61 SHOPCOAT PAINT OR NSF 61 CERTIFIED FUSION BONDED EPOXY.
2. FASTENERS: CUSTOMER SPECIFIED. HSLA PER ASTM A588 OR STAINLESS STEEL TYPE 304 (ASTM A193 B8) OR 316 (ASTM A193 B8M).
3. PRESSURE RATED UP TO FLANGES PROVIDED; 3" -12" AWWA CLS E 275 PSIG WORKING, 413 PSIG TEST.
4. WHEN INSTALLING, POSITION THE FLANGED COUPLING END IN THE REQUIRED LOCATION & THEN FOLLOW BOLTING INSTRUCTIONS.
5. NOT INTENDED TO PROVIDE LATERAL MOVEMENT IN PIPELINE.
6. ALL WELDING PERFORMED IN ACCORDANCE WITH AWS D1.1

SIGNATURES		DATE
DRWN	DEL EATON	2 DEC 02
CHECKED	GEORGE DENISON	2 DEC 02
ISSUED		
ENGRG	NIELS THOGERSEN	20 DEC 02

MATERIAL: ASTM A536 - DUCTILE IRON A53 - PIPE

ROMAC IND. INC., SEATTLE, WA

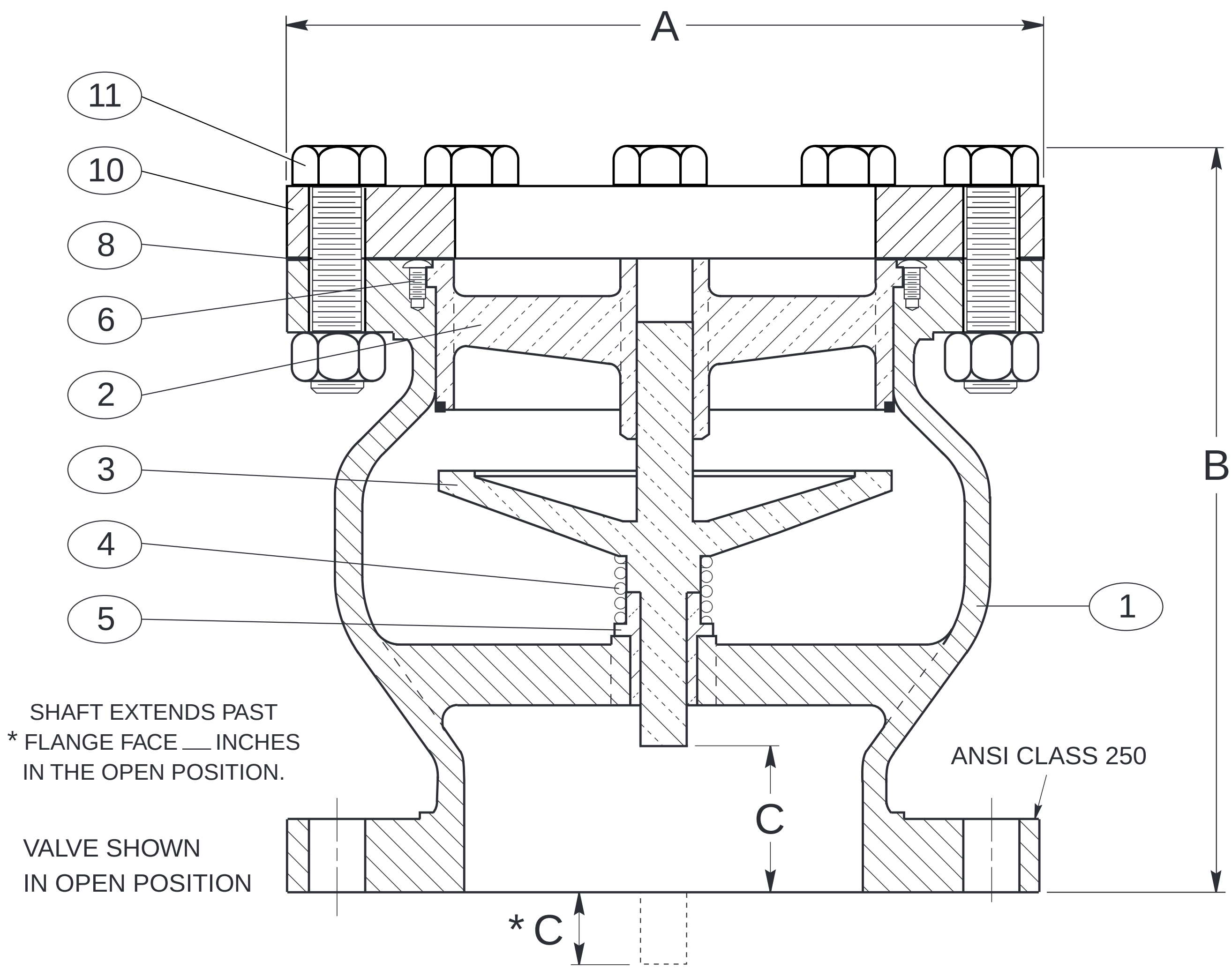
TITLE: DISMANTLING JOINT DJ400 - W/ TIE RODS 3" - 12", CLS E FLANGE

SIZE	DWG. NO.	REV. NO.
A	B2114-A	3

SCALE: NTS

SHEET 1 OF 1

Exhibit 8



SEE DRAWING NO. VM-1800VB-M & VM-1812VB-M
FOR STANDARD MATERIALS OF CONSTRUCTION.

VALVE SIZE	MODEL NUMBER	CWP (PSI)	A	B	C
2	1852 VB	400	7.50	7.06	1.00
2.5	1875 VB	400	7.50	7.06	1.00
3	1853 VB	400	8.25	7.69	1.38
4	1854 VB	400	10.00	9.06	1.75
5	1855 VB	400	11.00	10.44	2.00
6	1856 VB	400	12.50	11.75	2.50
8	1858 VB	400	15.00	14.75	3.25
10	1860 VB	400	17.50	18.19	4.25
12	1862 VB	400	20.50	17.13	* 0.75
14	1864 VB	300	23.00	18.75	* 1.43
16	1866 VB	300	25.50	20.82	* 2.25
18	1868 VB	300	28.00	22.06	* 2.25
20	1870 VB	300	30.50	24.06	* 2.93
24	1874 VB	300	36.00	27.88	* 3.63
30	1880 VB	300	43.00	33.50	* 5.00

PART NO.	NAME
1	BODY
2	SEAT W/ BUNA-N
3	DISC
4	SPRING
5	BUSHING
6	SEAT RETAINING SCREWS
8	GASKET
10	RING PLATE
11	BOLT AND NUT ASSEMBLY

Revised 11-16-11

250 LB. CLASS VACUUM BREAKER	DATE 4-3-73
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-1850VB

GLOBE-STYLE VACUUM BREAKER VALVE
Val-Matic® Specification

1 Scope
1.1 This specification covers the design, manufacture, and testing of 2 in. (50 mm) through 42 in. (1050 mm) Vacuum Breakers suitable for pressures up to 400 psig (2760 kPa) water service.
1.2 The Vacuum Breaker shall be of the globe style high flow type with rapid linear opening to automatically admit large quantities of air to enter a system on negative pressure. An optional Air Release Valve can be directly piped to relieve air under positive pressures.

2 Standards, Approvals and Verifications
2.1 The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.
2.2 Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

3 Connections
3.1 The valves shall be provided in sizes 2 in (50 mm) through 42 in. (1050 mm) and have flanges in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges. Iron flanges shall be flat faced. Sizes 10 in (250 mm) and smaller shall be capable of mating directly to a wafer butterfly valve without disc interference.

4 Design
4.1 The valve design shall incorporate a center guided, spring loaded disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe size.
4.2 All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.25 psi (1.7 kPa) and to fully open at a pressure differential of 2 psi (14 kPa).
4.3 The valve disc and seat shall have a seating surface finish of 32 micro-inch or better to ensure positive seating at all pressures. A Buna-N seal shall be provided on the seat to provide zero leakage at both high and low pressures without overloading or damaging the seal. The seal design shall provide both a metal to metal and a metal to Buna-N seal.

5 Materials
5.1 The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Optional body material include ASTM A536 Grade 65-45-12 ductile iron.
5.2 The seat and plug shall be ASTM B584 Alloy C83600 cast bronze or ASTM B148 Alloy C95200 aluminum bronze. Optional trim material include ASTM A351 Grade CF8M stainless steel.
5.3 The compression spring shall be ASTM A313 Type 316 stainless steel with ground ends.

6 Options
6.1 An optional screened hood on the outlet shall be provided when specified.
6.2 An Air Release Valves shall be furnished and integrally piped with bronze full-ported ball valve when specified.
6.2.1 The Air Release Valve shall be automatic float operated and designed to release accumulated air from a piping system while the system is in operation and under pressure.
6.2.2 The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection. The cover shall be bolted to the valve body and sealed with a flat gasket. Resilient seats shall be replaceable and provide drop tight shut off to the full valve pressure rating.
6.2.3 The floats shall be unconditionally guaranteed against failure including pressure surges. Mechanical linkage shall provide sufficient mechanical advantage so that the valve will open under full operating pressure and consist of two levers and an adjustable threaded resilient orifice button.
6.2.4 The valve body and cover shall be constructed of cast iron. The orifice, float and linkage mechanism shall be constructed of Type 316 stainless steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be Buna-N or Viton.
6.2.5 Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550 when specified.

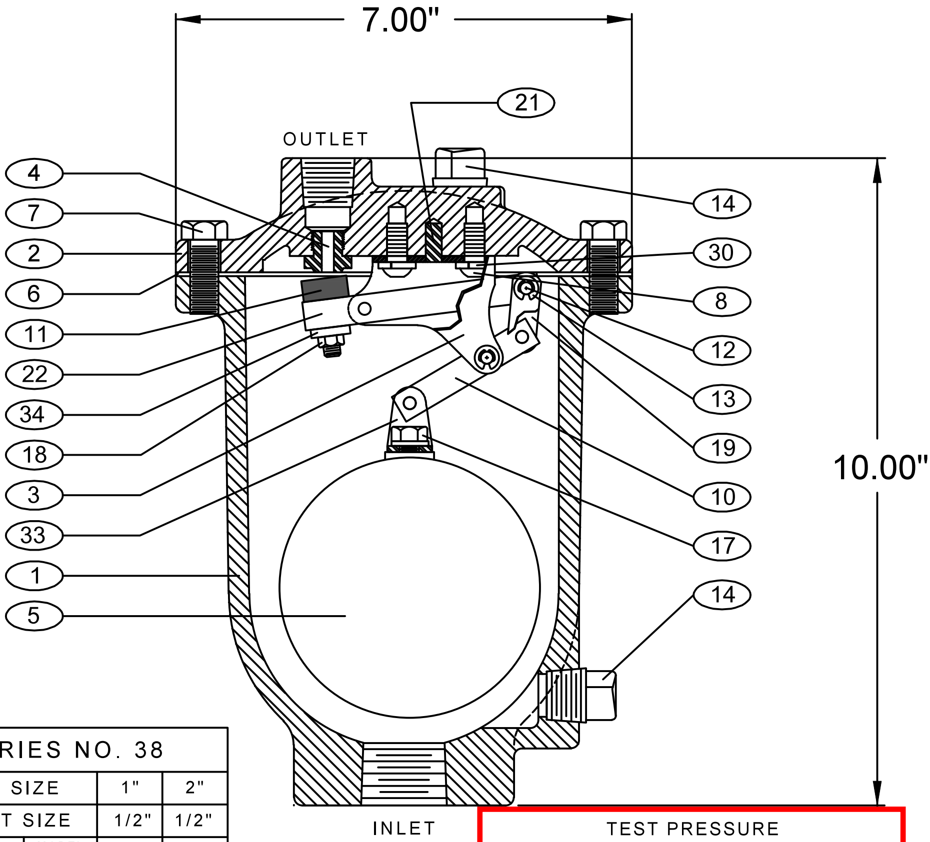
7 Cross Contamination and Security Protection
7.1 All Air (Release, Vacuum, etc.) Valves installed in vaults or flood prone locations shall include an inflow prerventer to prevent the introduction of contaminated water through the air valve outlet. The Inflow Preventer shall allow the admittance and exhaustion of air while preventing contaminated water from entering during normal operation conditions. The Inflow Preventer shall be flow tested by an independent third party to certify performance.

8 Manufacture
8.1 The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
8.2 The exterior of the valve shall be coated with a universal alkyd primer.
8.3 Vacuum Breakers shall be Series #1800VB as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL, USA or approved equal.

Revised 7-5-11

VACUUM BREAKER VALVE SPECIFICATION	DATE 6-6-06
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-1800VB-S

Exhibit 9



TEST PRESSURE
1.5 TIMES COLD WORKING PRESSURE

SERIES NO. 38				
INLET SIZE			1"	2"
OUTLET SIZE			1/2"	1/2"
WORKING PRESSURE	150 PSI CWP	MODEL NO.	38	38.2
		ORIFICE SIZE	3/16"	3/16"
	300 PSI CWP	MODEL NO.	38.5	38.6
		ORIFICE SIZE	5/32"	5/32"
	500 PSI CWP	MODEL NO.	38HP	38HP.2
		ORIFICE SIZE	1/8"	1/8"

SEE DRAWING NO. VM-38-M FOR STANDARD MATERIALS OF CONSTRUCTION
SEE DRAWING NO. VM-38DISV-M FOR SUPER VALVE MATERIALS OF CONSTRUCTION

WATER QUALITY
NSF / ANSI 61
2LA8

1. BODY
2. COVER
3. LEVER FRAME
4. SEAT
5. FLOAT
6. GASKET
7. COVER BOLT
8. RETAINING SCREW
10. FLOAT ARM
11. ORIFICE BUTTON
12. PIVOT PIN
13. RETAINING RING
14. PIPE PLUG
17. FLOAT RETAINER
18. LOCK NUT
19. LINK
21. LOCATING PIN
22. ORIFICE BUTTON ARM
30. WASHER
33. CLEVIS
34. LOCK WASHER

Revised 8-19-14 (Rev 1)

AIR RELEASE VALVE	DATE 6-16-10
VAL-MATIC VALVE AND MANUFACTURING CORP.	DRWG. NO. VMC-38

ROMAC INDUSTRIES, INC.

STYLE 101NS & 202NS SERVICE SADDLE

SUBMITTAL INFORMATION

MATERIALS

Casting	The saddle body is cast from ductile (nodular) iron, meeting or exceeding ASTM A 536, Grade 65-45-12.
Gasket	Gasket is made from Nitrile Butadiene Rubber (NBR) compounded for water and sewer service and a tolerance of petroleum products in accordance with ASTM D 2000 MBC 610 and NSF 61 Certified. Other compounds available for special applications.
Straps	Type 304 (18-8) heavy gauge Stainless Steel per ASTM A 240. Straps are two inches wide to spread out clamping forces on the pipe. GMAW and GTAW welds. Passivated for corrosion resistance.
Bolts, Nuts	For sizes 1-1/2" through 3", 1/2" UNC roll thread Type 304 (18-8) Stainless Steel bolts with heavy hex nuts. 4" and above use 5/8" UNC roll thread Type 304 (18-8) Stainless Steel bolts with heavy hex nuts. Rod for bolts are per ASTM A 240 and nuts are per ASTM A 194. All welds fully passivated for enhanced corrosion resistance. Nuts coated to prevent galling.
Washers	Flat, type 304 (18-8) heavy gauge Stainless Steel.
Coating	Casting is coated with fusion bonded black nylon, 10-12 mils thick, with a dielectric strength of 1,000 v/mil and NSF 61 Certified.
PRESSURE RATING	Ductile iron, cast iron and steel pipe: rating of pipe up to 350 psi maximum, on pipe sizes up through 24 inch, larger than 24 inch up to 30 inch pressure rating is 150 psi. PVC, asbestos cement and other pipe: up to the maximum rating of the pipe. For other applications please consult your representative.
AWWA STANDARDS	These service saddles meet the requirements of ANSI/AWWA C800, Underground Service Line Valves and Fittings.
SIZES AND RANGES	See Catalog.

Exhibit 11

76-100 SERIES

Stainless Steel Ball Valve with Mounting Pad 1/4" - 1"

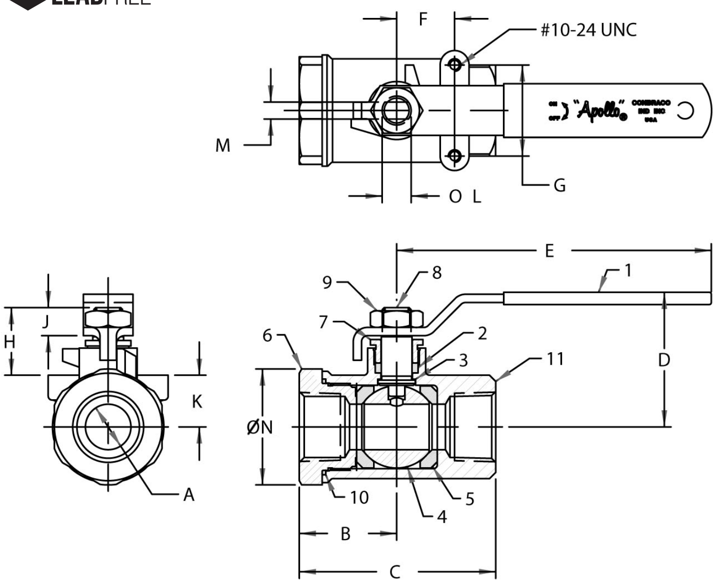
Female NPT Thread, 2000 CWP (psig). Cold Non-Shock. (See referenced P/T chart)
150 psig Saturated Steam.
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

FEATURES

- Investment cast components
- Reinforced seats
- Mounting pad for easy actuator mounting
- Blow-out-proof stem design
- Adjustable packing gland
- Stainless Steel lever and nut
- Fire safe to API 607 (requires -24 suffix)
- Meets NACE MR0175 (2000) & MR0103 (2012)
- CSA CGA 3.16-M88 (Requires "GS" suffix)
- NSF/ANSI 61 Section 8, Annex G
- NSF-372, Drinking Water System Components - Lead Content

CERTIFIED LEADFREE



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	304 SS w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	A276-316 Stainless Steel
5	Seat (2)	RPTFE
6	Retainer	A351-CF8M SS or A276-316 SS
7	Gland nut	A276-316 Stainless Steel
8	Stem	A276-316 Stainless Steel
9	Lever nut	18-8 Stainless Steel
10	Body seal	PTFE
11	Body	A351-CF8M Stainless Steel

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-P -01-	BSPP (Parallel) Thread Connection	1/4" to 3"
-T -01-	BSPT (Tapered) Thread Connection	1/4" to 3"
-02-	Stem Grounded	1/4" to 3"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90º Reversed Stem	1/4" to 3"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 2"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-19-	Lock Plate	1/4" to 2"
-21-	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite packing, PTFE body seal, RPTFE bearing (Fire Safe API 607, 6th edition, ISO 10497:2010)	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 3"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-44-	Seal Welded	1/4" to 2"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Latch Lock Oval Handle	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-64-	250# Steam Trim (MPTFE Seats & Packing)	1/4" to 3"
-GS	CSA CGA 3.16	All

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	N	WT.
76-101-01A	1/4"	0.37	1.02	2.05	1.71	3.85	0.50	1.12	0.88	0.34	0.53	0.375	0.234	1.16	0.58
76-102-01A	3/8"	0.37	1.02	2.05	1.71	3.85	0.50	1.12	0.88	0.34	0.53	0.375	0.234	1.16	0.55
76-103-01A	1/2"	0.50	1.12	2.23	1.79	3.85	0.50	1.12	0.90	0.34	0.59	0.375	0.234	1.38	0.63
76-104-01A	3/4"	0.68	1.47	2.96	2.03	4.75	0.87	1.37	1.02	0.42	0.78	0.437	0.256	1.75	1.30
76-105-01A	1"	0.87	1.67	3.34	2.16	4.75	0.87	1.37	1.02	0.42	0.91	0.437	0.256	1.94	1.60

** LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-14, GRAPH NO. 14

76-100 SERIES

Stainless Steel Ball Valve with Mounting Pad 1.25" - 2"

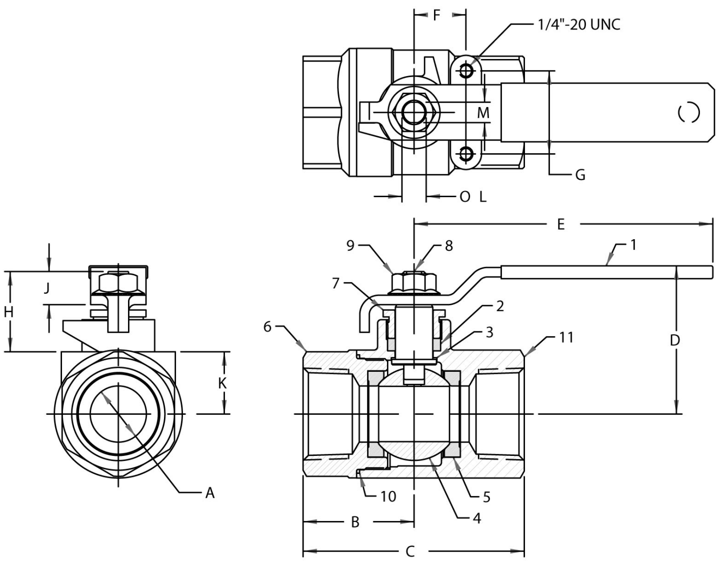
Female NPT Thread, 1500 CWP (psig). Cold Non-Shock. (See referenced P/T chart)
150 psig Saturated Steam.
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

FEATURES

- Investment cast components
- Reinforced seats
- Mounting pad for easy actuator mounting
- Blow-out-proof stem design
- Adjustable packing gland
- Stainless Steel lever and nut
- Fire safe to API 607 (requires -24 suffix)
- Meets NACE MR0175 (2000) & MR0103 (2012)
- CSA CGA 3.16-M88 (Requires "GS" suffix)
- NSF/ANSI 61 Section 8, Annex G
- NSF-372, Drinking Water System Components - Lead Content

CERTIFIED LEADFREE



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	304 SS w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	A276-316 Stainless Steel
5	Seat (2)	RPTFE
6	Retainer	A351-CF8M Stainless Steel
7	Gland nut	A276-316 Stainless Steel
8	Stem	A276-316 Stainless Steel
9	Lever nut	18-8 Stainless Steel
10	Body seal	PTFE
11	Body	A351-CF8M Stainless Steel

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-P -01-	BSPP (Parallel) Thread Connection	1/4" to 3"
-T -01-	BSPT (Tapered) Thread Connection	1/4" to 3"
-02-	Stem Grounded	1/4" to 3"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90º Reversed Stem	1/4" to 3"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 2"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-19-	Lock Plate	1/4" to 2"
-21-	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite packing, PTFE body seal, RPTFE bearing (Fire Safe API 607, 6th edition, ISO 10497:2010)	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 3"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-44-	Seal Welded	1/4" to 2"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Latch Lock Oval Handle	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-64-	250# Steam Trim (MPTFE Seats & Packing)	1/4" to 3"
-GS	CSA CGA 3.16	All

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	J	K	L	M	WT.
76-106-01	1.25"	1.00	2.00	4.00	2.68	5.40	0.94	1.50	1.50	0.60	1.12	0.625	0.377	3.10
76-107-01	1.5"	1.25	2.17	4.34	3.25	7.75	0.94	1.50	1.50	0.60	1.28	0.625	0.377	4.20
76-108-01	2"	1.50	2.69	5.43	3.24	7.75	0.94	1.50	1.46	0.60	1.50	0.625	0.377	6.10

** LEAD FREE: The wetted surfaces of this product shall contain no more than 0.25% lead by weighted average. Complies with Federal Public Law 111-380. ANSI 3rd party approved and listed.*

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-13, GRAPH NO. 12

Exhibit 12

FORGED FITTINGS, SOCKET-WELDING AND THREADED

1 SCOPE

1.1 General

This Standard covers ratings, dimensions, tolerances, marking and material requirements for forged fittings, both socket-welding and threaded, as illustrated in Tables 4 through 7 and A4 through A7, inclusive.

1.1.1 Fitting Types/Configuration. Types of fittings covered by this Standard are shown in Tables 1A and 1B, by class and size range. Fittings shown in Tables 4 through 7 and A4 through A7 may also be made with combinations of socket-welding and threaded ends.

1.1.2 Partial Compliance Fittings. Fittings with special dimensions, threads or counterbores, and fittings made from nonstandard materials may be made by agreement between the manufacturer and the purchaser (see para. 5.2). When such fittings meet all other stipulations of this Standard, they shall be considered in partial compliance therewith, provided they are appropriately marked (see para. 4).

1.1.3 Quality Systems. Nonmandatory requirements relating to the product manufacturer's Quality System Program are described in Annex C.

1.2 References

1.2.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Annex D, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the individual references. Instead, the specific edition reference is identified in Annex D. A fitting made in conformance and conforming to this Standard, in all other respects, will be considered to be in conformance to the Standard, even though the edition reference may be changed in a subsequent addendum to or revision of the Standard.

1.2.2 Codes and Regulations. A fitting used under the jurisdiction of the ASME Boiler and Pressure Vessel Code, the ASME Code for Pressure Piping, or a governmental regulation is subject to any limitation of that code or regulation. This includes any maximum temperature limitation, or rule governing the use of a material at low temperature, or provisions for operation at a pressure exceeding the ratings in this Standard.

1.3 Service Conditions

Criteria for selection of fitting types and materials suitable for particular fluid service are not within the scope of this Standard.

1.4 Welding

Installation welding requirements are not within the scope of this Standard. Installation welding shall be done in accordance with the applicable piping Code or regulation covering the piping system into which the fittings are installed.

1.5 Standard Units

The values stated in either metric units or inch units are to be regarded separately as standard. Within the text, the inch units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

Tables 4 through 7 show fittings dimensional requirements in millimeters. Tables A4 through A7 show the dimensional requirements for inch dimensioned fittings.

2 PRESSURE RATINGS

2.1 General

These fittings shall be designated as Class 2000, 3000, and 6000 for threaded end fittings and Class 3000, 6000, and 9000 for socket-weld end fittings.

2.1.1 Basis of Rating. The schedule of pipe corresponding to each Class of fitting for rating purposes is shown in Table 2. Design temperature and other service conditions shall be limited as provided by the applicable piping code or regulation for the material of construction of the fitting. Within these limits the maximum allowable pressure of a fitting shall be that computed for straight seamless pipe of equivalent material (as shown by comparison of composition and mechanical properties in the respective material specifications). The wall thickness used in such computation shall be that tabu-

TABLE 1A TYPES OF FITTINGS BY CLASS DESIGNATION AND DN (NOMINAL SIZE) RANGE

	Socket-Weld			Threaded		
	Class Designation			Class Designation		
Description	3000	6000	9000	2000	3000	6000
45 deg., 90 deg. Elbows	DN6-DN100	DN6-DN50	DN15-DN50	DN6-DN100	DN6-DN100	DN6-DN100
Tees, Crosses	DN6-DN100	DN6-DN50	DN15-DN50	DN6-DN100	DN6-DN100	DN6-DN100
Coupling, Half-Coupling	DN6-DN100	DN6-DN50	DN15-DN50	. . .	DN6-DN100	DN6-DN100
Cap	DN6-DN100	DN6-DN100	DN15-DN50	. . .	DN6-DN100	DN6-DN100
Square, Hex, Round Plug	. . .	. . .	. . .	DN6-DN100 [See Note (1)]		
Hex and Flush Bushing	. . .	. . .	. . .	DN6-DN100 [See Note (1)]		

NOTE:
(1) Plugs and bushings are not identified by Class Designation. They may be used for ratings up through Class 6000 designation.

TABLE 1B TYPES OF FITTINGS BY CLASS DESIGNATION AND NPS SIZE RANGE

	Socket-Weld			Threaded		
	Class Designation			Class Designation		
Description	3000	6000	9000	2000	3000	6000
45 deg., 90 deg. Elbows	⅛-4	⅛-2	½-2	⅛-4	⅛-4	⅛-4
Tees, Crosses	⅛-4	⅛-2	½-2	⅛-4	⅛-4	⅛-4
Coupling, Half-Coupling	⅛-4	⅛-2	½-2	. . .	⅛-4	⅛-4
Cap	⅛-4	⅛-4	½-2	. . .	⅛-4	⅛-4
Square, Hex, Round Plug	. . .	. . .	. . .	⅛-4 [See Note (1)]		
Hex and Flush Bushing	. . .	. . .	. . .	⅛-4 [See Note (1)]		

NOTE:
(1) Plugs and bushings are not identified by Class Designation. They may be used for ratings up through Class 6000 designation.

lated in ANSI/ASME B36.10M for the size and applicable schedule of pipe reduced by applicable manufacturing tolerances and other allowances (e.g., threaded allowances).

Any corrosion allowance and any variation in allowable stress due to temperature or other design shall be applied to the pipe and fitting alike.

2.1.2 Nonstandard Pipe Wall Thickness. Since ANSI/ASME B36.10M does not include Schedule 160 nor Double Extra Strong thickness for DN6, 8, and 10 (NPS ⅛, ¼, and ⅜), the values in Table 3 may be used as the nominal wall thicknesses of the pipe for rating purposes.

2.1.3 Combination End Fittings. The Class for fittings made with combinations of socket-welding and threaded ends shall be based on the end configuration that has the lowest rating from Table 2.

2.2 Pressure Test Capability

Pressure testing is not required by this Standard but the fittings shall be capable of withstanding a hydrostatic test pressure required by the applicable piping code for seamless pipe of material equivalent to the fitting forging and of the schedule or wall thickness correlated with the fitting Class and end connection of Table 2.

3 SIZE AND TYPE

3.1 General

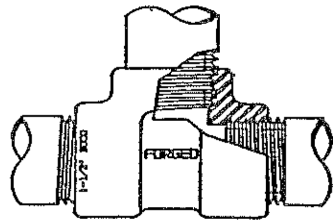
The following table shows nominal pipe size (NPS) used for inch dimensioned fittings versus nominal diameter (DN), used for millimeter dimensioned fittings.

FITTINGS

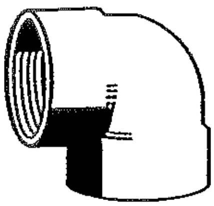
SCREWED FITTINGS

Exhibit 12

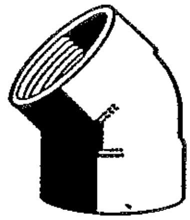
These fittings are made in sizes 1/8" through 4" and in pressure ratings of 150 lb. (1000 lbs. WOG). 2000, 3000 and 6000 lbs. The 150 lb. fitting is made in both cast and forged material. The others are of forged material.



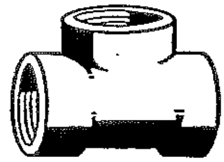
Screwed Fittings Available:



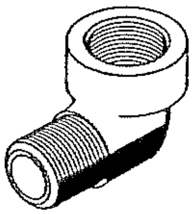
90° ELL



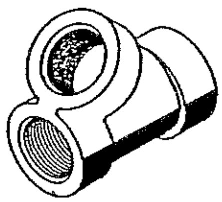
45° ELL



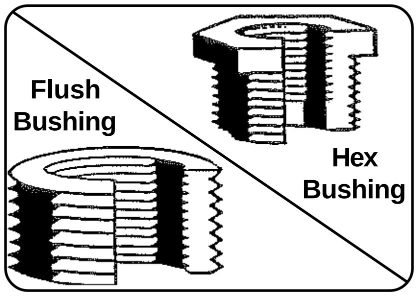
Tee



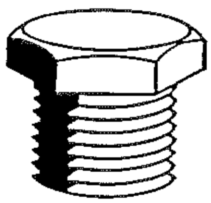
Street Elbow



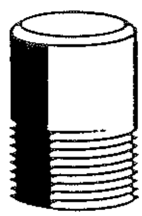
Lateral



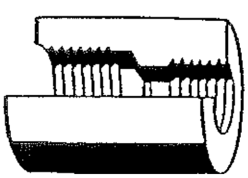
Square Head Plug



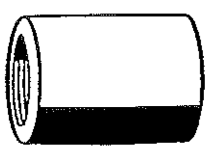
Hex Head Plug



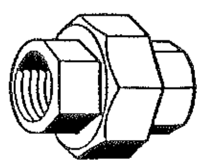
Round Head Plug



Reducing Coupling



Coupling



Union

Exhibit 12

The Phoenix Forge Group

PHOENIX * CAPITOL * CAMCO * CAPPRODUCTS

ISO 9001

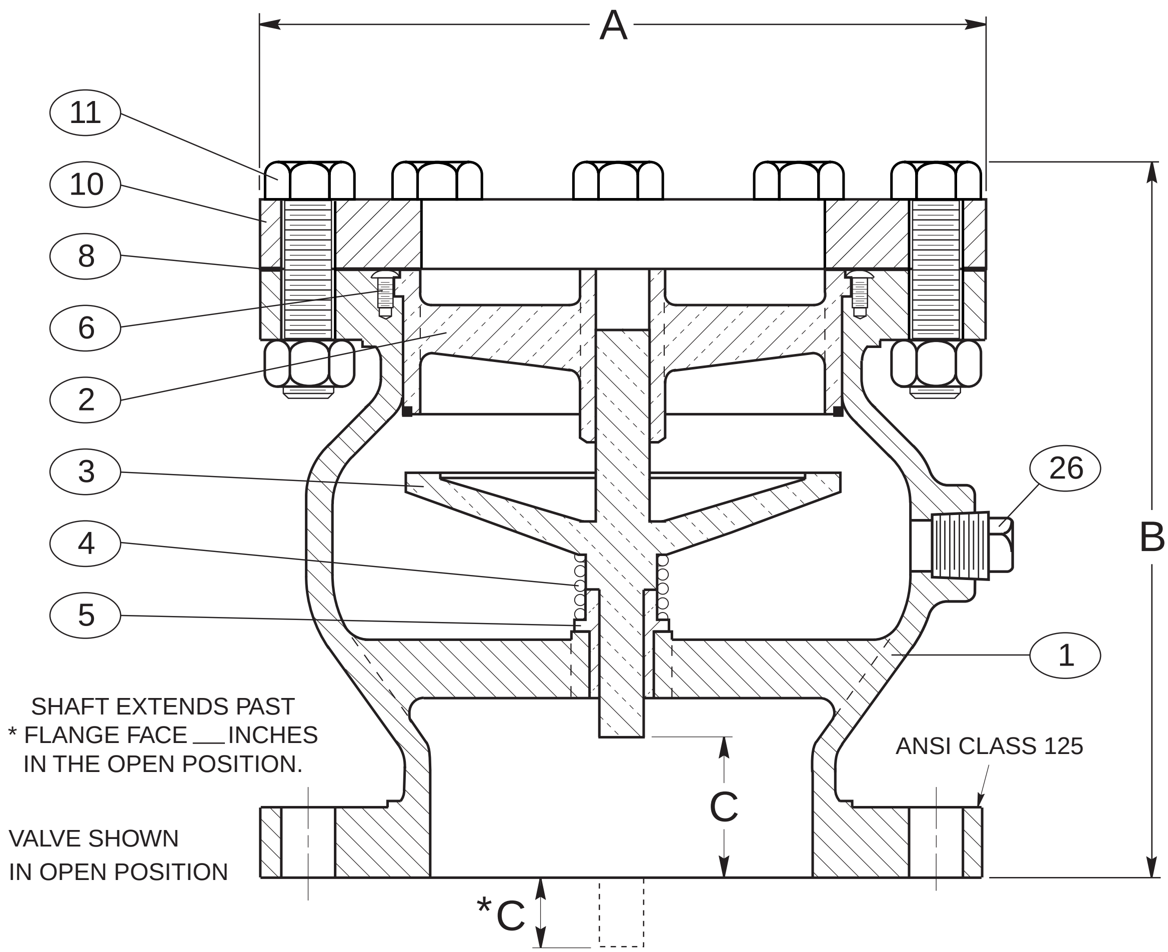
MAXIMUM ALLOWABLE WORKING PRESSURE (PSI) AT DESIGN TEMPERATURE (F)
ASTM A106 Grade B Carbon Steel Seamless Threaded Pipe Nipples
ASTM A234 WPB Swage Nipples and Bull Plugs
FOR REFERENCE ONLY

Nominal Pipe Size	Wall Thickness	Weight Class	Schedule No.	Temperature -20 to 100	200	300	400	500	600	650
1/8	0.068	STD	40	3140	3140	3140	3140	2965	2715	2670
	0.095	XS	80	5820	5820	5820	5820	5500	5035	4945
1/4	0.088	STD	40	2535	2535	2535	2535	2400	2195	2155
	0.119	XS	80	4805	4805	4805	4805	4540	4155	4085
3/8	0.091	STD	40	2180	2180	2180	2180	2060	1885	1850
	0.126	XS	80	4235	4235	4235	4235	4000	3660	3600
1/2	0.109	STD	40	1890	1890	1890	1890	1790	1635	1610
	0.147	XS	80	3655	3655	3655	3655	3455	3160	3105
	0.188	…	160	5625	5625	5625	5625	5315	4865	4780
	0.294	XXS	…	10710	10710	10710	10710	10120	9265	9100
3/4	0.113	STD	40	1645	1645	1645	1645	1555	1420	1395
	0.154	XS	80	3145	3145	3145	3145	2970	2720	2670
	0.218	…	160	5620	5620	5620	5620	5310	4860	4775
	0.308	XXS	…	9175	9175	9175	9175	8675	7940	7800
1	0.133	STD	40	1465	1465	1465	1465	1385	1265	1245
	0.179	XS	80	2795	2795	2795	2795	2640	2420	2375
	0.250	…	160	4990	4990	4990	4990	4715	4315	4240
	0.358	XXS	…	8385	8385	8385	8385	7925	7250	7125
1-1/4	0.140	STD	40	1310	1310	1310	1310	1235	1130	1110
	0.191	XS	80	2465	2465	2465	2465	2330	2135	2095
	0.250	…	160	3870	3870	3870	3870	3660	3350	3290
	0.382	XXS	…	7180	7180	7180	7180	6785	6210	6105
1-1/2	0.145	STD	40	1235	1235	1235	1235	1170	1070	1050
	0.200	XS	80	2320	2320	2320	2320	2195	2010	1975
	0.281	…	160	4010	4010	4010	4010	3790	3465	3405
	0.400	XXS	…	6620	6620	6620	6620	6255	5725	5625
2	0.154	STD	40	1120	1120	1120	1120	1060	970	955
	0.218	XS	80	2125	2125	2125	2125	2010	1840	1810
	0.344	…	160	4225	4225	4225	4225	3995	3655	3595
	0.436	XXS	…	5870	5870	5870	5870	5545	5075	4990
2-1/2	0.203	STD	40	1105	1105	1105	1105	1045	955	940
	0.276	XS	80	2050	2050	2050	2050	1935	1775	1740
	0.375	…	160	3390	3390	3390	3390	3205	2930	2880
	0.552	XXS	…	5930	5930	5930	5930	5605	5130	5040
3	0.216	STD	40	1040	1040	1040	1040	980	900	885
	0.300	XS	80	1930	1930	1930	1930	1825	1670	1640
	0.438	…	160	3460	3460	3460	3460	3270	2995	2940
	0.600	XXS	…	5380	5380	5380	5380	5085	4655	4575
3-1/2	0.226	STD	40	995	995	995	995	940	860	845
	0.318	XS	80	1850	1850	1850	1850	1745	1600	1570
4	0.237	STD	40	975	975	975	975	920	840	825
	0.337	XS	80	1795	1795	1795	1795	1695	1550	1525
	0.531	…	160	3465	3465	3465	3465	3275	3000	2945
	0.674	XXS	…	4770	4770	4770	4770	4505	4125	4055
5	0.258	STD	40	920	920	920	920	870	795	785
	0.375	XS	80	1695	1695	1695	1695	1605	1465	1440
	0.625	…	160	3435	3435	3435	3435	3245	2970	2920
	0.750	XXS	…	4345	4345	4345	4345	4100	3760	3695
6	0.280	STD	40	890	890	890	890	840	770	755
	0.432	XS	80	1735	1735	1735	1735	1640	1500	1475
	0.719	…	160	3415	3415	3415	3415	3225	2950	2900
	0.864	XXS	…	4300	4300	4300	4300	4065	3720	3655
8	0.322	STD	40	855	855	855	855	810	740	730
	0.500	XS	80	1615	1615	1615	1615	1525	1400	1375
	0.906	…	160	3435	3435	3435	3435	3245	2970	2920
	0.875	XXS	…	3290	3290	3290	3290	3110	2845	2795

NOTES:

1). The allowable working pressures were calculated based on formulas and allowable stress as specified in the ASME B31.3 Process Piping Code.
2). Considerations were taken into account for the wall thickness material removed by threading.
3). No allowances were made for corrosion, erosion, mechanical loads, and/or bending moments.
4). Allowable working pressures listed are non-shock working pressures.
5). For temperatures and working pressures above those listed consult the end users piping engineer.
6). This information is to be used as a reference guide only. Specifying the correct pipe schedule and pressure class of fitting depends on many different factors. Therefore, it is the ultimate responsibility of the end user's piping engineer to specify the correct pipe schedule and pressure class of fitting that will safely work in his intended application.

Exhibit 13



SEE DRAWING NO. VM-1800VB-M & VM-1812VB-M FOR STANDARD MATERIALS OF CONSTRUCTION.

PART NO.	NAME
1	BODY
2	SEAT W/ BUNA-N
3	DISC
4	SPRING
5	BUSHING
6	SEAT RETAINING SCREWS
8	GASKET
10	RING PLATE
11	BOLT AND NUT ASSEMBLY
26	PLUG

VALVE SIZE	MODEL NUMBER	CWP (PSI)	A	B	C
2	1802 VB	200	7.00	6.68	1.00
2.5	1825 VB	200	7.00	6.68	1.00
3	1803 VB	200	7.50	7.25	1.38
4	1804 VB	200	9.00	8.69	1.75
5	1805 VB	200	10.00	10.00	2.00
6	1806 VB	200	11.00	11.31	2.50
8	1808 VB	200	13.50	14.19	3.25
10	1810 VB	200	16.00	17.38	4.25
12	1812 VB	200	19.00	15.63	* 0.63
14	1814 VB	150	21.00	17.81	* 1.31
16	1816 VB	150	23.50	19.69	* 2.12
18	1818 VB	150	25.00	21.13	* 2.12
20	1820 VB	150	27.50	23.13	* 2.75
24	1824 VB	150	32.00	26.75	* 3.50
30	1830 VB	150	38.75	32.25	* 4.88
36	1836 VB	150	46.00	48.38	* 8.00
42	1842 VB	150	53.00	53.63	* 9.25

Revised 11-14-11

125 LB. CLASS VACUUM BREAKER	DATE 4-22-83
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-1800VB

GLOBE-STYLE VACUUM BREAKER VALVE
Val-Matic® Specification

1 Scope
1.1 This specification covers the design, manufacture, and testing of 2 in. (50 mm) through 42 in. (1050 mm) Vacuum Breakers suitable for pressures up to 400 psig (2760 kPa) water service.
1.2 The Vacuum Breaker shall be of the globe style high flow type with rapid linear opening to automatically admit large quantities of air to enter a system on negative pressure. An optional Air Release Valve can be directly piped to relieve air under positive pressures.

2 Standards, Approvals and Verifications
2.1 The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.
2.2 Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

3 Connections
3.1 The valves shall be provided in sizes 2 in (50 mm) through 42 in. (1050 mm) and have flanges in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges. Iron flanges shall be flat faced. Sizes 10 in (250 mm) and smaller shall be capable of mating directly to a wafer butterfly valve without disc interference.

4 Design
4.1 The valve design shall incorporate a center guided, spring loaded disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe size.
4.2 All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.25 psi (1.7 kPa) and to fully open at a pressure differential of 2 psi (14 kPa).
4.3 The valve disc and seat shall have a seating surface finish of 32 micro-inch or better to ensure positive seating at all pressures. A Buna-N seal shall be provided on the seat to provide zero leakage at both high and low pressures without overloading or damaging the seal. The seal design shall provide both a metal to metal and a metal to Buna-N seal.

5 Materials
5.1 The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Optional body material include ASTM A536 Grade 65-45-12 ductile iron.
5.2 The seat and plug shall be ASTM B584 Alloy C83600 cast bronze or ASTM B148 Alloy C95200 aluminum bronze. Optional trim material include ASTM A351 Grade CF8M stainless steel.
5.3 The compression spring shall be ASTM A313 Type 316 stainless steel with ground ends.

6 Options
6.1 An optional screened hood on the outlet shall be provided when specified.
6.2 An Air Release Valves shall be furnished and integrally piped with bronze full-ported ball valve when specified.
6.2.1 The Air Release Valve shall be automatic float operated and designed to release accumulated air from a piping system while the system is in operation and under pressure.
6.2.2 The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection. The cover shall be bolted to the valve body and sealed with a flat gasket. Resilient seats shall be replaceable and provide drop tight shut off to the full valve pressure rating.
6.2.3 The floats shall be unconditionally guaranteed against failure including pressure surges. Mechanical linkage shall provide sufficient mechanical advantage so that the valve will open under full operating pressure and consist of two levers and an adjustable threaded resilient orifice button.
6.2.4 The valve body and cover shall be constructed of cast iron. The orifice, float and linkage mechanism shall be constructed of Type 316 stainless steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be Buna-N or Viton.
6.2.5 Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550 when specified.

7 Cross Contamination and Security Protection
7.1 All Air (Release, Vacuum, etc.) Valves installed in vaults or flood prone locations shall include an inflow prerventer to prevent the introduction of contaminated water through the air valve outlet. The Inflow Preventer shall allow the admittance and exhaustion of air while preventing contaminated water from entering during normal operation conditions. The Inflow Preventer shall be flow tested by an independent third party to certify performance.

8 Manufacture
8.1 The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
8.2 The exterior of the valve shall be coated with a universal alkyd primer.
8.3 Vacuum Breakers shall be Series #1800VB as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL, USA or approved equal.

Revised 7-5-11

VACUUM BREAKER VALVE SPECIFICATION	DATE 6-6-06
VAL-MATIC® VALVE AND MANUFACTURING CORP.	DRWG. NO. VM-1800VB-S

87A-100 SERIES

Stainless Steel ASME Class 150 Flanged Std. Port Ball Valve - 1.5" through 2"

For **STANDARDS COMPLIANCE** and **STANDARD FEATURES** refer to page D-3.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

STANDARD MATERIAL LIST

	PART	MATERIAL
1	Body	ASTM A351 CF8M
2	Retainer	ASTM A276 Type 316
3	Ball	ASTM A276 Type 316
4	Stem	ASTM A276 Type 316
5	Packing Gland	ASTM A276 Type 316
6	Stem Seals	PTFE
7	Seats	RPTFE
8	Gland Screws	ASTM A193 B8 Class 1
9	Gland Plate	302 or 304 SS
10	Stem Nut	316 SS
11	Lever	302 or 304 SS with Vinyl Grip
12	Stem Bearing	RPTFE
13	Stop	ASTM A276 Type 316
14	Stop Screw	18-8 SS
15	Lock Plate	302 or 304 SS
16	Body Seal	RPTFE
17	Lockwasher	302 or 304 SS
18	Grounding Spring	SS

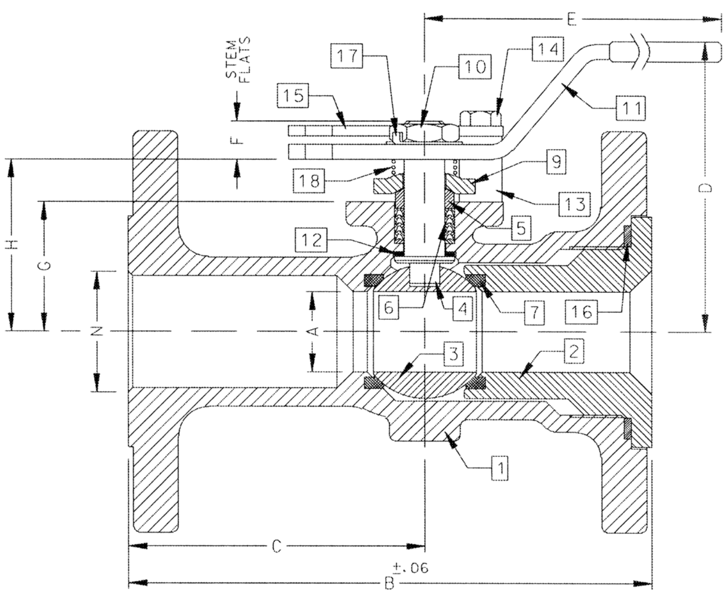
VARIATIONS AVAILABLE:

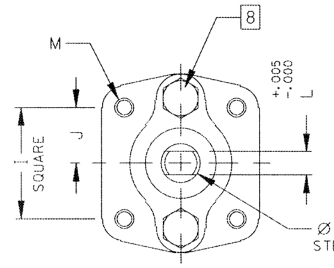
87H - Hastelloy
87M - Monel (1.5" to 2" only)
87N - Nickel
87S - 304L SS

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION
-01	Standard Configuration
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)
-14-	Side Vented Ball (Uni-Directional)
-15-	Wheel Handle, Steel
-21-	UHMWPE Seats
-24-	Graphite packing, spiral wound graphite body seal, RPTFE bearing (API 607, 6th edition, ISO 10497:2010)
-35-	PTFE Seats and Seals
-38-	PEEK Seats and Graphite Packing
-49-	No Lubrication. Assembled Dry.
-57-	Oxygen Cleaned
-65-	MPTFE Seats and Graphite Packing (Fire Safe)
-69-	Drilled and Tapped Purge Port with Plug
-70-	4" Extended Bonnet
-73-	316 SS Spiral Wound Gaskets w/PTFE Filler
-76-	Live Loaded (Lever)
-77-	Live Loaded (Gear, Actuator)
-80-	Multi-Seal (Super TFE) 87A/88A Series
-82-	Flat Face Flanges
-90-	Double Packed 4" Extended Bonnet
-9P-	Double Packed 4" Extended Bonnet with Monitoring Port
-EP-	Garlock EVSP Stem Packing w/Spiral Wound Graphite Gasket (Fire Safe by Design)
-KF-	PCTFE Stem Bearing
-MP-	Positive Material Identification
-TC-	With Test Certificate
-TD-	Tested to API Spec 6D
-UL-	UL & CSA Listed (w/Markings)





ACTUATOR MOUNTING

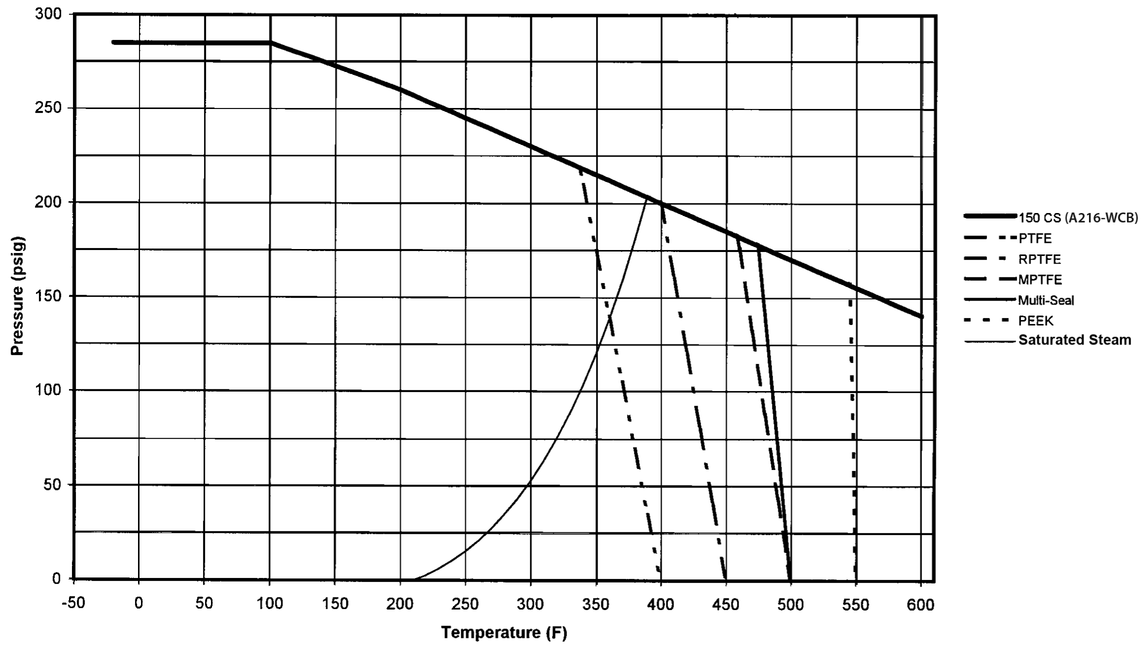
FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-9, GRAPH NO. 2

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	WT.
87A-107-01	1.5"	1.25	6.50	3.50	4.85	6.53	0.47	1.85	2.38	1.392	0.696	0.500	0.287	1/4-20	1.50	9
87A-108-01	2"	1.50	7.00	3.69	4.62	6.65	0.72	2.41	3.09	1.949	0.974	0.625	0.412	5/16-18	2.00	18

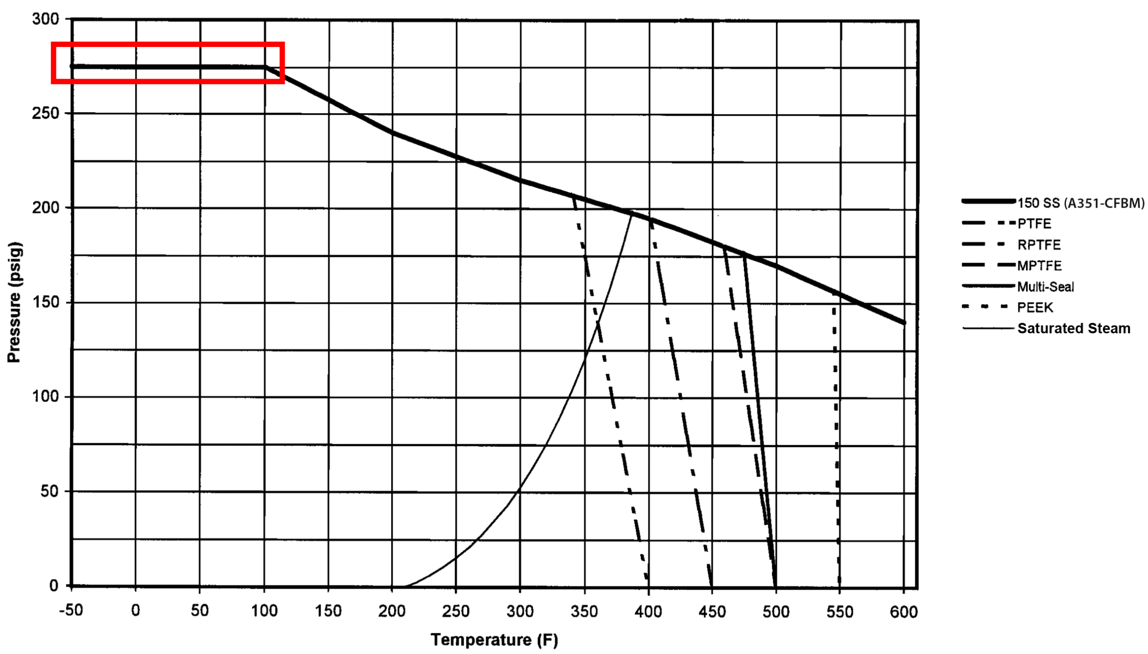
Exhibit 14

PRESSURE TEMPERATURE RATINGS

Class 150 (CS) ASTM A216-WCB (GRAPH 1)



Class 150 (SS) ASTM A351-CF8M (GRAPH 2)



87A-100 SERIES

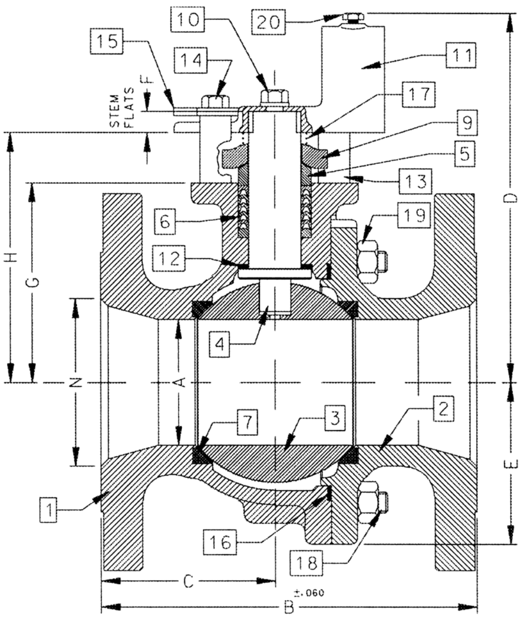
Stainless Steel ASME Class 150 Flanged Std. Port Ball Valve - 4" through 8"

For **STANDARDS COMPLIANCE** and **STANDARD FEATURES** refer to page D-3.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

STANDARD MATERIAL LIST

	PART	MATERIAL
1	Body	ASTM A351 CF8M
2	Retainer	ASTM A351 CF8M
3	Ball	ASTM A276 Type 316 or A351 CF8M
4	Stem	ASTM A276 Type 316
5	Packing Gland	ASTM A276 Type 316
6	Stem Seals	PTFE
7	Seats	RPTFE
8	Gland Screws	ASTM A193 B8 Class 1
9	Gland Plate	316 SS
10	Adapter Screw	18-8 SS
11	Handle Adapter	316 SS
12	Stem Bearing	RPTFE
13	Stop	ASTM A276 Type 316
14	Stop Screw	316 SS
15	Lock Plate	302 or 304 SS
16	Body Seal	RPTFE
17	Grounding Spring	SS
18	Body Joint Stud	ASTM A193 Grade B8M
19	Body Joint Nut	ASTM A194 Grade 8
20	Lockwasher	302 or 304 SS
21	Pipe Handle	Galvanized Steel (not Shown)



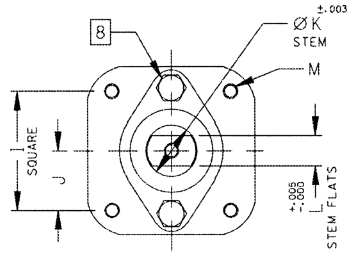
VARIATIONS AVAILABLE:

87H - Hastelloy
87N - Nickel
87S - 304L SS

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION
-01	Standard Configuration
-14-	Side Vented Ball (Uni-Directional)
-21-	UHMWPE Seats
-24-	Graphite packing, spiral wound graphite body seal, RPTFE bearing (API 607, 6th edition, ISO 10497:2010)
-35-	PTFE Seats and Seals
-49-	No Lubrication. Assembled Dry.
-57-	Oxygen Cleaned
-65-	MPTFE Seats and Graphite Packing (Fire Safe)
-67-	Cleaned For Industrial Gases
-69-	Drilled and Tapped Purge Ports with Plugs
-70-	Extended Bonnet
-73-	316 SS Spiral Wound Gaskets w/PTFE Filler
-76-	Live Loaded (Lever)
-77-	Live Loaded (Gear, Actuator)
-80-	Multi-Seal (Super TFE) 87A/88A Series
-82-	Flat Face Flanges
-90-	Double Packed 4" Extended Bonnet
-9P-	Double Packed 4" Extended Bonnet with Monitoring Port
-EP-	Garlock EVSP Stem Packing w/Spiral Wound Graphite Gasket (Fire Safe by Design)
-KF-	PCTFE Stem Bearing
-MG-	Gear Operator with Standard Handwheel
-MH-	Gear Operator with Standard Handwheel & Locking Device
-MJ-	Gear Operator with Oversize Handwheel
-MK-	Gear Operator with Oversize Handwheel & Locking Device
-MP-	Positive Material Identification
-TC-	With Test Certificate
-TD-	Tested to API Spec 6D
-UL-	UL & CSA Listed (w/Markings)



ACTUATOR MOUNTING

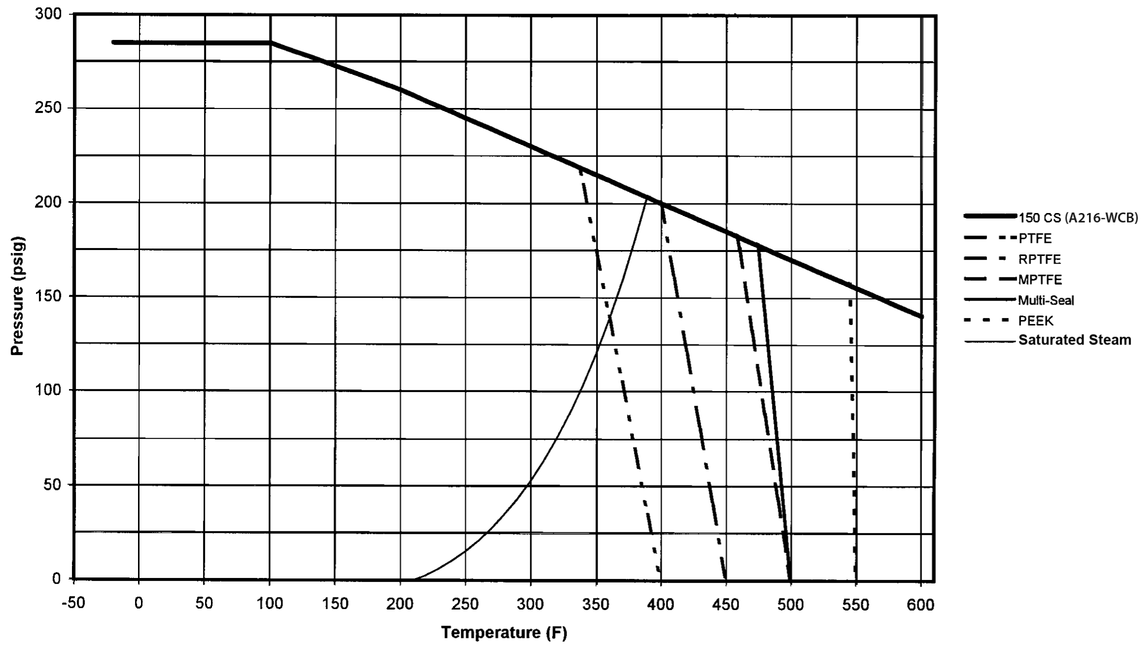
FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-9, GRAPH NO. 2

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	WT.
87A-10A-01	4"	3.00	9.00	4.18	8.80	3.88	0.50	4.75	5.95	2.840	1.420	1.250	0.725	3/8-16	4.00	73
87A-10C-01	6"	4.00	10.50	4.69	9.99	5.13	0.50	5.94	7.13	2.840	1.420	1.250	0.725	3/8-16	6.00	117
87A-10E-01	8"	6.00	18.00	9.00	13.73	7.00	1.00	7.75	9.48	4.596	2.298	2.000	1.375	3/4-10	8.00	310

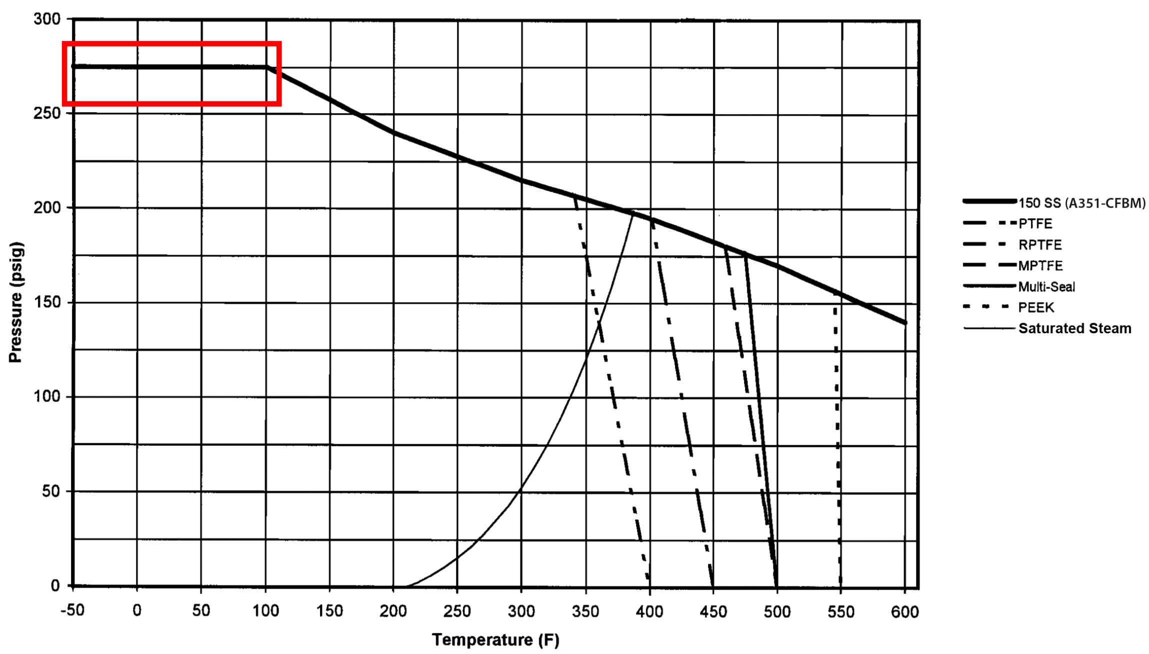
Exhibit 14

PRESSURE TEMPERATURE RATINGS

Class 150 (CS) ASTM A216-WCB (GRAPH 1)



Class 150 (SS) ASTM A351-CF8M (GRAPH 2)



76-AR SERIES

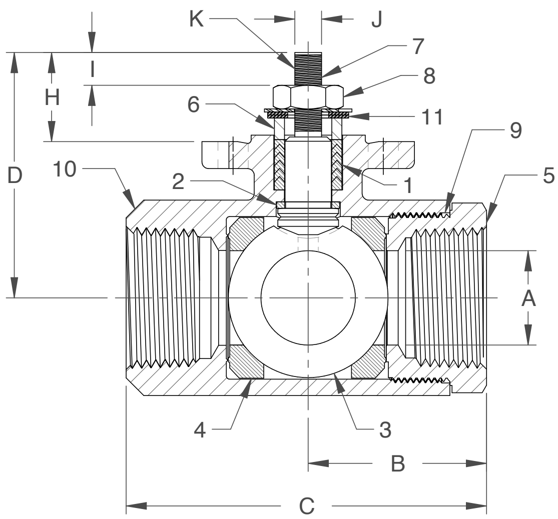
Stainless Steel Std. Port Ball Valve with Actuator Ready ISO Mounting Pad

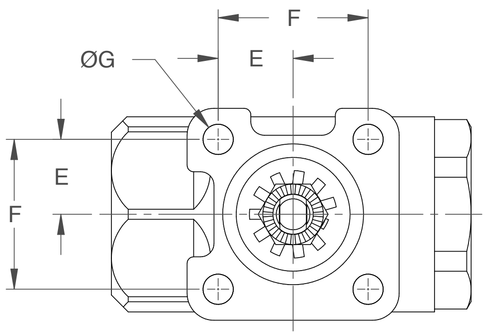
Female NPT Thread, 1/4"-1" 2000 CWP (psig) 1.25"-2" 1500 CWP (psig), 2.5"-3" 1000 CWP (psig). Cold Non-Shock.
250 psig Saturated Steam. (See referenced P/T chart)
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY ON ALL DOMESTIC MADE PRODUCT

FEATURES

- Multi-piece packing set
- ISO 5211 mounting pad
- Blow-out-proof stem design
- Fire safe "by design" (requires -24 suffix)
- Adjustable packing gland
- Live loaded packing





OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

(SUFFIX)	OPTION	SIZES
-01	Standard Configuration	All
-14-	Vented Ball	1/4" to 3"
-24-	Graphite packing (fire safe "by design")	1/4" to 3"
-27-	Latch Lock Handle	1/4" to 2"
-35-	PTFE Seats	1/4" to 3"
-49-	No Lubrication. Assembled Dry.	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 3"

STANDARD MATERIAL LIST

	PART	MATERIAL
1	Stem packing	MPTFE
2	Stem bearing	PEEK/PTFE
3	Ball	316 SS
4	Seat (2)	MPTFE
5	Retainer	A276-316 (1/4" to 1") A351-CF8M (1.25" to 3")
6	Gland	A276-316
7	Stem	A276-316
8	Jam nut	SS
9	Body seal	PTFE (1.25" to 3")
10	Body	A351-CF8M
11	Bellville Washers(s)	Stainless Steel

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-14, GRAPH NO. 14 (1/4" TO 1") REFER TO PAGE M-13, GRAPH NO. 12 (1.25" TO 2") REFER TO PAGE M-12, GRAPH NO. 8 (2.5" TO 3")

PRODUCT NUMBER	SIZE	A	B	C	D	E	F	G	H	I	J (FLATS)	K (THRDS) UNF	WT.
76-AR1-64	1/4"	0.37	1.02	2.04	1.40	0.59	1.17	0.28	0.61	0.18	.247/.249	3/8-24	0.52
76-AR2-64	3/8"	0.37	1.02	2.04	1.40	0.59	1.17	0.28	0.61	0.18	.247/.249	3/8-24	0.48
76-AR3-64	1/2"	0.50	1.12	2.23	1.54	0.59	1.17	0.28	0.61	0.16	.247/.249	3/8-24	0.58
76-AR4-64	3/4"	0.68	1.47	2.96	2.16	0.70	1.39	0.28	0.84	0.37	.247/.249	3/8-24	1.26
76-AR5-64	1"	0.87	1.66	3.34	2.28	0.70	1.39	0.28	0.82	0.37	.247/.249	3/8-24	1.62
76-AR6-64	1.25"	1.00	2.00	4.00	2.92	0.98	1.95	0.34	1.16	0.37	.370/.372	5/8-18	3.22
76-AR7-64	1.5"	1.25	2.18	4.34	3.16	0.98	1.95	0.34	1.16	0.37	.370/.372	5/8-18	4.06
76-AR8-64	2"	1.50	2.75	5.43	3.32	0.98	1.95	0.34	1.16	0.37	.370/.372	5/8-18	6.18
76-AR9-64	2.5"	2.00	3.12	6.25	3.85	0.98	1.95	0.34	1.16	0.37	.370/.372	5/8-18	12.96
76-AR0-64	3"	2.50	3.37	6.75	4.18	0.98	1.95	0.34	1.16	0.37	.370/.372	5/8-18	17.06

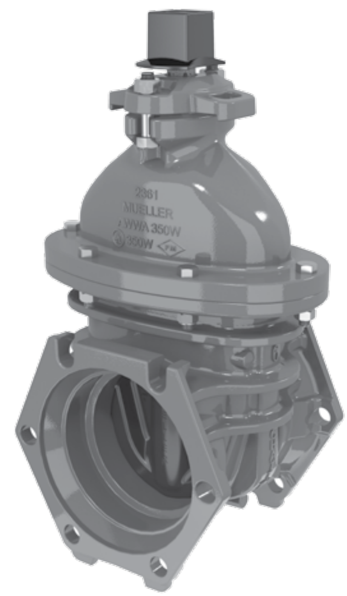
Exhibit 16

Mueller Co.

4"- 12" A-2361 RESILIENT WEDGE GATE VALVES - M.J. x M.J.

Rev. 7-15 Shaded area indicates changes

- Catalog number–
  A-2361-20 Mechanical joint ends (with accessories unassembled)
  A-2361-23 Mechanical joint ends (less accessories)
  A-2361-25 Mechanical joint ends (with transition gaskets accessories unassembled)
- Sizes – 4", 6", 8", 10", 12"
- Meets or exceeds all applicable requirements of ANSI/AWWA C515 Standard, UL Listed, FM Approved, and certified to ANSI/NSF 61 & 372.
- Standard mechanical joint ends comply with ANSI/AWWA C111
- Iron body with nominal 10 mils MUELLER® Pro-Gard® Fusion Epoxy Coated interior and exterior surfaces
- Epoxy coating meets or exceeds all applicable requirements of ANSI/AWWA C550 Standard.
- Iron wedge, symmetrical & fully encapsulated with molded rubber; no exposed iron
- Non-rising stem (NRS)
- Triple O-ring seal stuffing box (2 upper & 1 lower O-rings) with fourth o-ring serving as dirt seal
- 2" square wrench nut (optional handwheel available)–-open left or open right
- 350 psig (2400 kPa/24 barg) maximum working pressure, 700 psig (4800 kPa/48 barg) static test pressure
- UL Listed, FM Approved: 350 psig (2400 kPa/24 barg)
- Mueller valves are designed for potable water application



A-2361-20

Options

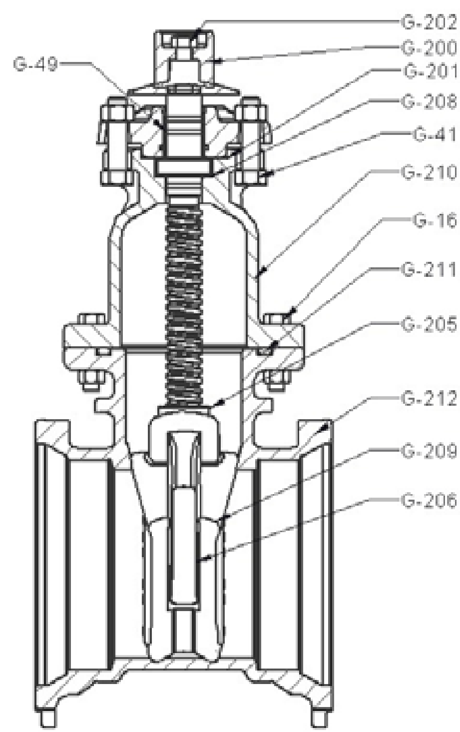
See page 10.46 for more information on Resilient Wedge Gate Valve options

- Position indicators
- ASTM B98-C66100/H02 stem
- Stainless steel fasteners: Type 316
- Handwheel
- Stainless steel stem: Type 304, Type 316
- EPDM Disc and o-rings

Resilient wedge gate valve parts

Catalog Part No.	Description	Material	Material Standard
G-16	Bonnet Bolts & Nuts	304 Stainless Steel	ASTM F593 (bolt) ASTM F594 (nut)
G-41	Stuffing Box Bolts & Nuts	304 Stainless Steel	ASTM F593 (bolt) ASTM F594 (nut)
G-49	Stem O-rings (3)	Nitrile	ASTM D2000
G-200	Wrench Nut Cap Screw	304 Stainless Steel	ASTM F593
G-201	Stuffing Box O-ring	Nitrile	ASTM D2000
G-202	Wrench Nut	Ductile Iron	ASTM A536 ▼
G-203	Stem	Bronze	ASTM B138
G-204	Hand Wheel (not shown)	Cast Iron	ASTM A126 CL.B
G-205	Stem Nut	Bronze	ASTM B584
G-206	Guide Cap Bearings	Acetal	-
G-207	Stuffing Box with dirt seal	Ductile Iron Nitrile	ASTM A536 ▼ ASTM D200
G-208	Anti-friction Washers (2)	Acetal	-
G-209	Wedge, Rubber Encapsulation	Ductile Iron* SBR	ASTM A536 ▼ ASTM D2000
G-210**	Bonnet	Ductile Iron	ASTM A536 ▼
G-211**	Bonnet gasket	Nitrile	ASTM D2000
G-212**	Body	Ductile Iron	ASTM A536 ▼

**Fully encapsulated in molded rubber with no iron exposed*
▼ Material strength ASTM A536 65-45-12 minimum



SEE PAGE 10.53 FOR ORDERING INSTRUCTIONS

Exhibit 17

Rosemount 3051L Level Transmitter

Rosemount 3051L level transmitters combine the features and benefits of a 3051 pressure transmitter with the durability and reliability of a direct mount seal all in a single model number.

Level transmitters can also be ordered with an additional 1199 remote seal to form a Tuned-System Assembly that offers improved performance and reduced costs compared to traditional symmetrical (balanced) assemblies.

Product features and capabilities include:

- Variety of process connections
- Quantified performance for the entire transmitter / seal assembly (QZ option)
- 4-20 mA HART, FOUNDATION fieldbus, Profibus-PA, and 1-5 Vdc HART low power protocols

Additional Information
Specifications: page 101
Certifications: page 122
Dimensional Drawings: page 130

Table 10. Rosemount 3051L Level Transmitter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.
The Expanded offering is subject to additional delivery lead time.

Model	**Transmitter Type**			
3051L	Level Transmitter			
Pressure Range				
Standard				**Standard**
2	−250 to 250 inH_2O (−0,6 to 0,6 bar)			★
3	−1000 to 1000 inH_2O (−2,5 to 2,5 bar)			★
4	−300 to 300 psi (−20,7 to 20,7 bar)			★
Transmitter Output				
Standard				**Standard**
A	4–20 mA with Digital Signal Based on *HART* Protocol			★
F	FOUNDATION fieldbus Protocol			★
W[1]	Profibus – PA Protocol			★
Expanded				
M[2]	Low-Power 1–5 Vdc with Digital Signal Based on *HART* Protocol (See Option Code C2 for 0.8–3.2 Vdc Output)			
Process Connection Size, Material, Extension Length (High Side)				
Standard				**Standard**
Code	**Process Connection Size**	**Material**	**Extension Length**	★
G0[3]	2-in./DN 50 / 50A	316L SST	None, Flush Mount	★
H0[3]	2-in./DN 50 / 50A	Alloy C-276, seam welded	None, Flush Mount	★
J0	2-in./DN 50 / 50A	Tantalum, seam welded	None, Flush Mount	★
A0[3]	3-in./DN 80 / 80A	316L SST	None, Flush Mount	★
A2[3]	3-in./DN 80 / 80A	316L SST	2-in./50 mm	★
A4[3]	3-in./DN 80 / 80A	316L SST	4-in./100 mm	★
A6[3]	3-in./DN 80 / 80A	316L SST	6-in./150 mm	★

Install on 1/2 npt connection on outlet of tank

Exhibit 18

Models 912, 913, 918 and 919 ASME Section VIII, Air/Steam/Gas/Liquid, "UV" National Board Certified.
Also available for Vacuum Service.
PED Certified for Non-Hazardous Gas.

Model 912

Model Descriptions

Model 912: Full nozzle design. Stainless Steel (SS) warn ring and disc with brass/bronze base. Bronze/brass body and bonnet.

Model 913: Full nozzle design. Bronze/brass body and bonnet. 316 SS trim (base, disc and disc holder).

Model 918: Same as model 912 except resilient seat/seal. Superior "leak-free" performance. FM approved with 316 SS base for fire pump installations in "BDD" and "BDE" sizes[2].

Model 919: Same as model 913 except resilient seat/seal. Superior "leak-free" performance. Bronze body and bonnet. 316 SS trim (base, disc and disc holder).

Features

- Available with soft seat.
- Threaded cap is standard (back pressure tight).
- Hex on valve nozzle provides for easy installation.
- Warn ring offers easy adjustability.
- Pivoting disc design corrects misalignment and offers exceptional performance.
- Guide to nozzle ratio reduces friction.
- Full nozzle design for optimum flow performance.
- Threaded side outlet for piped off discharge to eliminate fugitive emissions.

Pressure and Temperature Limits

Models 912, 918: – Steam
3 to 250 psig [0.2 to 17.2 barg][1]
-320° to 406°F [-195° to 208°C]

Models 913, 919: – Steam
3 to 300 psig [0.2 to 20.7 barg][1]
-320° to 425°F [-195° to 219°C]

Models 912, 918: – Air/Gas/Liquid
3 to 300 psig [0.2 to 20.7 barg]
-320° to 406°F [-195° to 208°C]

Models 913, 919: – Air/Gas/Liquid
3 to 1400 psig [0.2 to 96.5 barg]
-320° to 425°F [-195° to 219°C]

Vacuum – 6" to 29" HG
[200 to 1000 mbarg] – 300°F [149°C]

Maximum back pressure 50 psig [3 barg] - threaded cap and packed lever[3]

Applications

- Air/gas compressors - intercoolers - aftercoolers.
- Liquid filled pressure vessels/systems - ASME Section VIII (UV).
- Pressure vessels - containing gas, air, liquid or steam. Including tanks and receivers.
- Vacuum systems including pumps, tanks and equipment.
- Optional materials for low temperature - cryogenic applications.
- Oil/gas separators.
- Overpressure relief and protection of pumps, tanks, lines and hydraulic systems.
- By-pass relief or pressure regulation.

Options

- Threaded cap. (variation 01)
- Threaded cap with gag. (variation 02)
- Plain lever. (variation 03)
- Plain lever with gag. (variation 04)
- Plain lever with vibration dampener. (variation 05)
- Packed lever. (variation 06)
- Packed lever with gag. (variation 07)

Code:

Notes:

1. ASME standard valves for air or steam service must have lift lever. For steam boilers and generators.
2. Requires Variation 08 for specific set pressure or variations listed below for adjustable relief pressure settings:
   Variation 10: 60 - 125 psig [4.1 - 8.6 barg],
   Variation 11: 125 - 175 psig [8.7 - 12 barg], or
   Variation 12: 176 - 250 psig [12.1 - 17.2 barg]
3. Back pressure increases set pressure on a one to one basis, and reduces capacity. Back pressure in excess of 10% of set pressure is not recommended.

Exhibit 18

KUNKLE SAFETY AND RELIEF PRODUCTS
MODEL 900

Specifications - Models 912, 913, 918, and 919

Models 912, 913, 918, 919 ASME Section VIII, Steam/Air/Gas/ Liquid, "UV" National Board Certified. Also available for Vacuum Service

Service Recommendations for Resilient Seat/Seal Materials

Seat/Seal Materials[1]	Service Recommendation
BUNA-N (-30° to 275°F) [-40° to 135°C]	Air, Anhydrous Ammonia, Butane, Carbon Dioxide, Diesel Oil, Ethyl Chloride, Ethyl Ether, Freons #11 and 12, Fuel Oil, Gasoline, Helium, Hydrogen Sulphide, Kerosene, Lube Oil, Natural Gas, Nitrogen, Oxygen (Gas), Propane, Propylene, Sulphur Dioxide, Vinyl Chloride
Viton® A (-15° to 406°F) [-26° to 208°C]	Acetone, Air, Amyl Alcohol, Aniline, Benzine, Butane, Carbon Disulphide, Carbon Tetrachloride Dowtherm "A" and "E," Ethyl Chloride, Ethylene, Ethylene Glycol, Ethyl Alcohol, Gasoline, Hexane, Hydrogen Sulphide, Isobutyl Alcohol, JP - 4 Fuel, JP - 5 Fuel, Kerosene, Lube Oil, Natural Gas, Naphtha, Nitrogen, Propane, Propylene, Propyl Alcohol, Sulphur Dioxide, Toluene, Trichloroethylene, Turpentine, Water, Xylene
Silicone (-100° to 406°F) [-73° to 208°C]	Air, Helium, Nitrogen, Oxygen (Gas)
Ethylene Propylene (-70° to 400°F) [-57° to 205°C]	Steam, Hot Water
Neoprene (-45° to 300°F) [-43° to 149°C]	Air, Anhydrous Ammonia, Butane, Butyl Alcohol, Castor Oil Denatured Alcohol, Ethanol, Ethyl Alcohol, Freons (12, 13, 14 and 22), Glycols, Natural Gas and Silicate Esters

Note:

1. These recommendations are a guide only. For the final selection of the proper material, your experience with available elastomers of various lading fluids should be considered.

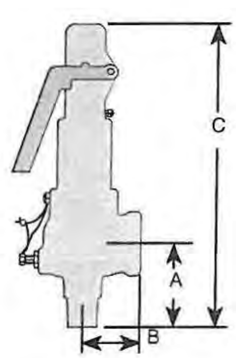
Specifications

Model[2] Number	Orifice	Connections ANSI Standard Inlet		Connections ANSI Standard Outlet		Maximum Set Pressure psig [barg] 912-918[4]		Maximum Set Pressure psig [barg] 913-919[5]		Dimensions, in [mm] A		B		C Plain Lever		C Threaded Cap		C Packed Lever		Approx. Weight lb [kg]
9*BDC	D	1/2"	[12.7]	3/4"	[19.0]	300	[20.7]	1400	[96.5]	2 3/8	[60]	1 5/8	[41]	8 3/8	[213]	7 1/4	[184]	9	[229]	3 [1.4]
9*BDC[7]	D	1/2"	[12.7]	1"	[25.4]	300	[20.7]	1400	[96.5]	2 3/8	[60]	1 5/8	[41]	8 3/8	[213]	7 1/4	[184]	9	[229]	3 [1.4]
9*BDD[3]	D	3/4"	[19.0]	3/4"	[19.0]	—	—	1400	[96.5]	2 3/8	[60]	1 5/8	[41]	8 3/8	[213]	7 1/4	[184]	9	[229]	3 [1.4]
9*BDD[3,8]	D	3/4"	[19.0]	1"	[25.4]	—	—	1400	[96.5]	2 3/8	[60]	1 5/8	[41]	8 3/8	[213]	7 1/4	[184]	9	[229]	3 [1.4]
9*BDE[3]	D	1"	[25.4]	1"	[25.4]	—	—	1400	[96.5]	2 5/8	[67]	1 5/8	[41]	8 5/8	[219]	7 1/2	[191]	9 1/8	[232]	3 [1.4]
9*BED	E	3/4"	[19.0]	1 1/4"	[31.8]	300	[20.7]	1000	[68.9][9]	2 5/8	[67]	2	[51]	8 3/4	[222]	7 5/8	[194]	9 3/8	[238]	4 [1.8]
9*BEF[3]	E	1 1/4"	[31.8]	1 1/4"	[31.8]	—	—	1000	[68.9][9]	3	[76]	2	[51]	9 1/8	[232]	8	[203]	9 3/4	[248]	4 [1.8]
9*BFE	F	1"	[25.4]	1 1/2"	[38.1]	300	[20.7]	700	[48.3][10]	2 7/8	[73]	2 3/8	[60]	9 7/8	[251]	8 3/4	[222]	10 1/2	[267]	6 [2.7]
9*BFG[3]	F	1 1/2"	[38.1]	1 1/2"	[38.1]	—	—	700	[48.3][10]	3	[76]	2 3/8	[60]	10	[254]	8 7/8	[225]	10 5/8	[270]	6 [2.7]
9*BGF	G	1 1/4"	[31.8]	2"	[50.8]	300	[20.7]	600	[41.4]	3 1/4	[83]	2 5/8	[67]	11 1/4	[286]	10 1/8	[257]	11 3/4	[298]	8 [3.6]
9*BGH[3]	G	2"	[50.8]	2"	[50.8]	—	—	600	[41.4]	3 1/4	[83]	2 5/8	[67]	11 1/4	[286]	10 1/8	[257]	11 3/4	[298]	8 [3.6]
9*BHG	H	1 1/2"	[38.1]	2 1/2"	[63.5]	300	[20.7]	500	[34.5]	3 1/2	[89]	2 3/4	[70]	13	[330]	11 1/8	[283]	12 1/2	[318]	11 [5.0]
9*BJH	J[6]	2"	[50.8]	3"	[76.2]	300	[20.7]	500	[34.5][11]	4	[102]	3 1/4	[83]	14 1/2	[368]	12 1/2	[318]	15 1/8	[384]	15 [6.8]

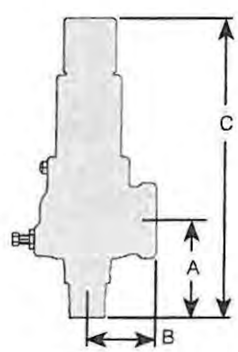
Dimensions are for reference only.

Notes:

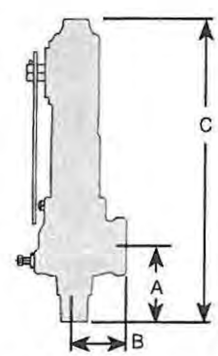
1. Maximum temperature controlled by resilient seat/seal material.
2. Replace asterisk with desired Model Number. Data applicable to all models.
3. Available with SS trim (models 913 and 919) only.
4. Maximum pressure on steam is 250 psig.
5. Maximum pressure on steam is 300 psig.
6. For C dimensions: pressures above 200 psig [14 barg] add 1.25" [31.8 mm] to the overall height.
7. Special variation required (12 - Threaded Cap, 13 - Threaded Cap with gag, 14 - Plain Lever, 17 - Packed Lever).
8. Special variation required (13 - Threaded Cap, 14 - Plain Lever, 17 - Packed Lever).
9. 900 psig for liquid service or high temp alloy spring.
10. 600 psig for liquid service or high temp alloy spring.
11. 367 [25.3] for plain lever with gag.



Plain Lever



Threaded Cap



Packed Lever

ASCO® RedHat

Direct Acting, Normally Closed

General Service Solenoid Valves

Brass or Stainless Steel Bodies

1/8" to 3/8" NPT

2/2 SERIES 8262 8263

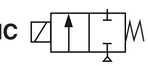
2-WAY

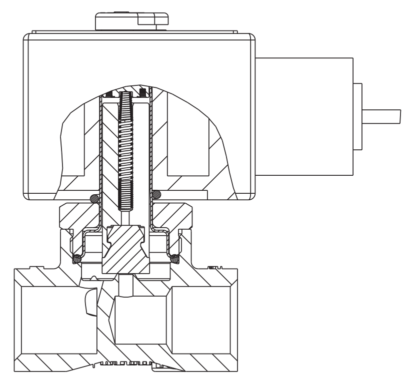
Features

- Welded core tube provides higher pressure ratings
- Reliable, proven design with high flows
- Small poppet valves for tight shutoff
- Wide range of elastomers for specialty service applications
- Mountable in any position
- Tapped mounting holes in body standard

Construction

Valve Parts in Contact with Fluids		
Body	Brass	Cast 304 Stainless Steel
Seals and Discs	NBR or Cast UR	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	Silver

NC 



Electrical

Watt Rating and Power Consumption				Spare Coil Part No.			
	AC			General Purpose		Explosionproof	
DC Watts	Watts	VA Holding	VA Inrush	AC	DC	AC	DC
10.6	6.1*	16	30	238210	238510	238214	238514
18.6	9.1*	20	45	238210	238510	238214	238514
11.6	10.1	25	50	238610	238910	238614	238914
22.6	17.1	40	70	238610	238910	238614	238914

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering. Other voltages available when required.

*On 50 hertz service, the rating for the 6.1/F solenoid is 8.1 watts, and the rating for the 9.1/F solenoid is 11.1 watts.

Solenoid Enclosures

Standard: Watertight, Types 1, 2, 3, 3S, 4, and 4X.

Optional: Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9. (To order, add prefix "EF" to catalog number)

See Optional Features Section for other available options.

Options

Mounting bracket (suffix MB)
Quarter-turn manual operator with screw slot (suffix MS)
Panel mount (prefix GP for conduit; *consult ASCO for other electrical connections*)
Vacuum service (suffix VVM, VVH; *see Vacuum Section for more details.*)
Oxygen service (suffix N)
Silicone Free (suffix SF)

Elastomers: Viton (suffix V), Ethylene Propylene (suffix E), Neoprene (suffix J), Teflon (suffix T), Low Temp NBR (suffix A)

Note: For suffix A, Fluid temp. range -40˚F to 167˚F only for valves with 10.1, 17.1, 11.6, and 22.6 watt coils.

Refer to Engineering Section for fluid and temperature compatibility.

Nominal Ambient Temp. Ranges

The nominal limitation of 32°F (0°C) is advisable for any valve that might contain moisture (water vapor).

AC: -13˚F to 131˚F (-25˚C to 55˚C)

DC: -13˚F to 104˚F (-25˚C to 40˚C)
-13˚F to 131˚F (-25˚C to 55˚C)

Note: Max ambient for explosionproof (EF) is 125˚F (52˚C) for AC, 131˚F (55˚C) for DC.

Optional: For AC, the max. ambient temperature is 140˚F (60˚C) with Class H coil (with or without prefix EF)

Refer to Engineering Section for details.

Approvals

CSA certified. UL listed, as indicated. Safety Shutoff Valves FM approved. Meets applicable CE directives.

Refer to Engineering Section for details.

2/2 SERIES 8262 8263

ASCO®

Specifications (English units)

Pipe Size (ins.)	Orifice size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi) Max. AC@131°F Air-Inert Gas	Max. AC@131°F Water	Max. AC@131°F Lt. Oil @ 300ssu	Max. DC@104°F Air-Inert Gas	Max. DC@104°F Water	Max. DC@104°F Lt. Oil @ 300ssu	Max. DC@131°F Air-Inert Gas	Max. DC@131°F Water	Max. DC@131°F Lt. Oil 300ssu	Max. Fluid Temp. °F AC	Max. Fluid Temp. °F DC	Catalog Number Brass	Catalog Number Stainless Steel	Const. Ref.	UL Listing	Watt Rating/Class of Coil Insulation AC	Watt Rating/Class of Coil Insulation DC
NORMALLY CLOSED (Closed when de-energized), NBR Disc																			
1/8	3/64	0.06	2200	2200	1700	-	-	-	-	-	-	140	-	-	8262H175 ①	1	●	10.1/F	-
1/8	3/64	0.06	-	-	-	2000	2000	1725	1900	1900	1700	-	140	-	8262H176 ①	1	●	-	22.6/H
1/8	3/64	0.06	-	-	-	1500	1500	1500	1500	1500	1500	-	140	8262H089 ①	-	1	●	-	22.6/H
1/8	3/64	0.06	2025	1710	825	965	745	720	920	700	675	140	140	-	8262H079 ①	2	●	9.1/F	18.6/H
1/8	3/64	0.06	1500	1350	825	750	620	565	700	565	530	140	140	8262H096 ①	-	2	●	6.1/F	10.6/H
1/8	3/64	0.06	1500	1350	825	-	-	-	-	-	-	140	-	-	8262H173 ①	2	●	6.1/F	-
1/8	3/64	0.06	1500	1500	1500	1170	1145	945	1000	965	855	140	140	8262H099 ①	-	1	●	10.1/F	11.6/H
1/8	3/64	0.06	750	750	725	750	640	550	750	600	500	180	180	8262H001	8262H012	2	❍	6.1/F	10.6/H
1/8	3/32	0.21	720	410	410	610	410	410	600	410	400	180	180	8262H277	8262H178	1	❍	17.1/F	22.6/H
1/8	3/32	0.21	-	-	-	290	290	270	240	240	255	180	180	-	8262H177	1	❍	-	11.6/H
1/8	3/32	0.21	500	350	325	295	210	205	285	200	195	180	180	8262H011	-	2	❍	9.1/F	18.6/H
1/8	3/32	0.21	370	330	190	235	160	160	215	150	145	180	180	8262H014	8262H015	2	❍	6.1/F	10.6/H
1/8	1/8	0.35	500	380	355	275	275	235	250	250	225	180	180	8262H105	8262H174	1	❍	17.1/F	22.6/H
1/8	1/8	0.35	340	300	215	-	-	-	-	-	-	-	180	-	8262H179	1	❍	10.1/F	-
1/8	1/8	0.35	275	260	195	165	130	130	155	120	120	180	180	8262H016	-	2	❍	9.1/F	18.6/H
1/8	1/8	0.35	185	180	120	130	110	95	120	100	90	180	180	8262H002	8262H006	2	❍	6.1/F	10.6/H
1/4	3/64	0.06	2200	2200	1700	1170	1145	945	1000	965	855	140	140	-	8262H214 ①	3	●	10.1/F	11.6/H
1/4	3/64	0.06	1500	1500	1500	1170	1145	945	1000	965	855	140	140	8262H200 ①	-	3	●	10.1/F	11.6/H
1/4	3/64	0.06	1500	1500	1500	1500	1500	1500	1500	1500	1500	140	140	8262H107 ①	-	3	●	17.1/F	22.6/H
1/4	3/64	0.06	-	-	-	2000	2000	1725	1900	1900	1700	-	140	-	8262H181 ①	3	●	-	22.6/H
1/4	3/64	0.06	1500	1350	825	750	620	530	700	565	495	140	140	8262H106 ①	8262H180 ①	4	●	6.1/F	10.6/H
1/4	3/64	0.06	750	750	725	750	640	550	750	600	500	180	180	8262H019	8262H080	4	❍	6.1/F	10.6/H
1/4	3/32	0.21	720	410	410	610	410	410	600	410	400	180	180	8262H109	8262H183	3	❍	17.1/F	22.6/H
1/4	3/32	0.21	590	410	410	290	290	270	240	240	225	180	180	8262H108	8262H182	3	❍	10.1/F	11.6/H
1/4	3/32	0.21	500	350	270	295	210	205	285	200	195	180	180	8262H021	-	4	❍	9.1/F	18.6/H
1/4	3/32	0.21	370	330	160	235	160	160	215	150	145	180	180	8262H020	8262H086	4	❍	6.1/F	10.6/H
1/4	1/8	0.35	500	380	355	275	275	235	250	250	225	180	180	8262H110	8262H185	3	❍	17.1/F	22.6/H
1/4	1/8	0.35	340	300	215	130	125	115	110	105	100	180	180	8262H232	-	3	❍	10.1/F	11.6/H
1/4	1/8	0.35	340	300	215	-	-	-	-	-	-	180	-	-	8262H184	3	❍	10.1/F	-
1/4	1/8	0.35	275	260	150	165	130	120	155	120	115	180	180	8262H023	-	4	❍	9.1/F	18.6/H
1/4	1/8	0.35	185	180	90	130	110	90	120	100	85	180	180	8262H022	8262H007	4	❍	6.1/F	10.6/H
1/4	5/32	0.52	300	210	210	135	135	135	115	115	115	180	180	8262H112	8262H187	3	❍	17.1/F	22.6/H
1/4	5/32	0.52	210	200	145	65	63	63	55	54	54	180	180	8262H202	-	3	❍	10.1/F	11.6/H
1/4	5/32	0.52	210	200	145	-	-	-	-	-	-	180	180	-	8262H220	3	❍	10.1/F	-
1/4	5/32	0.52	150	140	100	95	75	75	85	72	70	180	180	8262H113	-	4	❍	9.1/F	18.6/H
1/4	5/32	0.52	100	100	55	72	60	55	67	53	52	180	180	8262H111	8262H186	4	❍	6.1/F	10.6/H
1/4	7/32	0.73	125	125	125	70	70	70	65	65	65	180	180	8262H114	8262H188	3	❍	17.1/F	22.6/H
1/4	7/32	0.73	100	100	100	35	35	35	30	30	30	180	180	8262H208	-	3	❍	10.1/F	11.6/H
1/4	7/32	0.73	100	100	100	-	-	-	-	-	-	180	-	-	8262H226	3	❍	10.1/F	-
1/4	7/32	0.73	55	54	40	38	33	31	35	30	28	180	180	8262H013	8262H036	4	❍	6.1/F	10.6/H
1/4	9/32	0.88	90	90	90	53	50	47	48	46	44	180	180	8262H212	8262H230	3	❍	17.1/F	22.6/H
1/4	9/32	0.88	65	75	60	25	25	22	22	22	20	180	180	8262H210	-	3	❍	10.1/F	11.6/H
1/4	9/32	0.88	65	75	60	-	-	-	-	-	-	180	-	-	8262H189	3	❍	10.1/F	-
1/4	9/32	0.88	36	36	33	27	23	21	24	22	20	180	180	8262H090	8262H038	4	❍	6.1/F	10.6/H
3/8	1/8	0.35	500	380	355	275	275	160	250	250	150	180	180	8263H115	8263H191	5	❍	17.1/F	22.6/H
3/8	1/8	0.35	340	300	215	130	125	85	110	105	75	180	180	8263H232	-	5	❍	10.1/F	11.6/H
3/8	1/8	0.35	340	300	215	-	-	-	-	-	-	180	-	-	8263H190	5	❍	10.1/F	-
3/8	1/8	0.35	275	260	140	165	130	110	155	120	105	180	180	8263H003	-	6	❍	9.1/F	18.6/H
3/8	1/8	0.35	185	180	90	130	110	80	120	100	75	180	180	8263H002	8263H330	6	❍	6.1/F	10.6/H
3/8	5/32	0.52	300	210	195	135	135	100	115	115	90	180	180	8263H118	8263H193	5	❍	17.1/F	22.6/H
3/8	5/32	0.52	210	185	100	65	63	50	55	54	44	180	180	8263H200	-	5	❍	10.1/F	11.6/H
3/8	5/32	0.52	210	185	100	-	-	-	-	-	-	180	-	-	8263H331	5	❍	10.1/F	-
3/8	5/32	0.52	150	140	80	95	75	75	85	72	70	180	180	8263H117	-	6	❍	9.1/F	18.6/H
3/8	5/32	0.52	100	100	50	72	60	55	67	53	52	180	180	8263H116	8263H192	6	❍	6.1/F	10.6/H
3/8	7/32	0.73	125	100	100	70	70	70	65	65	65	180	180	8263H206	8263H332	5	❍	17.1/F	22.6/H
3/8	7/32	0.73	100	86	70	35	35	35	30	30	30	180	180	8263H124	-	5	❍	10.1/F	11.6/H
3/8	7/32	0.73	100	86	70	-	-	-	-	-	-	180	-	-	8263H195	5	❍	10.1/F	-
3/8	7/32	0.73	55	54	29	38	33	31	35	30	28	180	180	8263H119	8263H194	6	❍	6.1/F	10.6/H
3/8	9/32	0.88	100	85	70	53	50	47	48	46	44	180	180	8263H210	8263H333	5	❍	17.1/F	22.6/H
3/8	9/32	0.88	65	63	47	-	-	-	-	-	-	180	180	8263H125	8263H197	5	❍	10.1/F	-
3/8	9/32	0.88	35	32	21	27	23	21	24	22	20	180	180	8263H054	8263H196	6	❍	6.1/F	10.6/H

① Only available with UR disc, limits min. ambient temp. to 32˚F (0˚C); ● = General Purpose Valve, ❍ = Safety Shutoff Valve

Exhibit 20

ELECTRONIC PRESSURE MEASUREMENT PRODUCTS

Model 88 Pressure Transmitter

5-Year Warranty

DESCRIPTION

The Model 88 is the most durable, accurate and cost-effective pressure transmitter presently available. A full-featured, all stainless steel transmitter, it is designed for years of stable performance in even the toughest environmental and media conditions. Approvals include ratings for CSA, for both intrinsic safety and explosion-proof, and FM for explosion-proof only. The Model 88 also meets NACE standards for offshore applications. A five year warranty is standard for the 88C.

The small size and light weight of the Model 88 transmitter eliminates the need for complicated mounting hardware and mechanical supports, thereby reducing installation time substantially. The integral junction box permits simple field wiring without the need for additional hardware, adding to the speed and ease of installation.

A 4 to 20 mA output is standard with a 12 to 40 VDC power supply. With all 316 stainless steel welded construction, the Model 88 is compatible with corrosive media and hazardous environments. With the cover retained by a stainless steel chain and no internal jumpers for span turndown, losses due to misplaced or dropped parts are eliminated.

OPERATION

The heart of the Model 88 pressure transmitter is a silicon piezoresistive sensing chip. This miniature microetched semiconductor gives a voltage output proportional to the applied pressure. The chip is isolated from the process media by a stainless steel diaphragm. A silicone oil or other specified fill fluid is used to transmit the process pressure to the sensor.

An amplifier PCB enclosed in a sealed chamber is used to convert the millivolt signal from the sensor to a calibrated 4 to 20 mA transmitter output. Feedthroughs for EMI and RF protection are used between the amplifier board and the terminal housing.

Each transmitter is tested over both pressure and temperature ranges. A compensator circuit is used to bring the output of the sensor into specification. After compensation, every transmitter is tested a second time for pressure and temperature effects to ensure that it meets performance and specifications.

FEATURES

- A miniature, low-priced, full-featured transmitter – just 1.67 lb.
- All welded 316 stainless steel construction and wetted parts (no aluminum)
- Ranges from 0 to 3 through 0 to 5000 psig (0 to 0.2 to 0 to 350 bar)
- 0.25% accuracy
- Zero and span adjustability
- Full 5:1 range turndown
- Integral junction box
- FM for explosion-proof; CSA for explosion-proof and intrinsically safe
- 4 to 20 mA output at 12 to 40 VDC
- 5-year warranty

Model 88 Transmitters

AMETEK®
Sales/Technical Support Telephone: +1 215-355-6900
820 Pennsylvania Boulevard | Feasterville, PA 19053 U.S.A. | Fax: +1 215-354-1801

 Printed in the U.S.A. K796382 – Effective: 4-2013, Supersedes: New (110107)

Specifications are subject to change without notice. Visit our Web site for the most up-to-date information.

ISO 9001:2000 CERTIFIED

www.ametekpmt.com

Exhibit 20

ELECTRONIC PRESSURE MEASUREMENT PRODUCTS

Model 88 Pressure Transmitter

SPECIFICATIONS

Functional Specifications

Service: Liquid, gas or vapor

Range Limits:
0/3 to 0/6 psi (0/0.2 to 0/0.4 bar) consult factory
0/6 to 0/15 psi (0/0.4 to 0/1 bar)
0/15 to 0/30 psi (0/1 to 0/2 bar)
0/20 to 0/100 psi (0/1.4 to 0/7 bar)
0/60 to 0/300 psi (0/4 to 0/20 bar)
0/200 to 0/1000 psi (0/14 to 0/70 bar)
0/600 to 0/3000 psi (0/40 to 0/200 bar)
0/1000 to 0/5000 psi (0/70 to 0/350 bar)

Output: 4 to 20 mADC, limited to 30 mADC

Power Supply: 12 to 40 VDC with reverse polarity protection

Loop Resistance: 1400 ohms maximum at 40 volts

Turndown: 5:1

Zero Adjust: ±10%

Span Adjust: ±10%

Temperature Limits:
Electronics (Ambient): -40° to 140° F (-40° to 60° C)
Process Interface: -40° to 212° F (-40° to 100° C)
Storage: -40° to 212° F (-40° to 100° C)

Overrange: 300% upper range limit

Humidity Limits: 0 to 100% RH

Performance Specifications

Accuracy: ±0.25% of calibrated span including linearity, hysteresis and repeatability

Response Time: Time constant of 20 milliseconds

Stability: ±0.5% of upper range limit for six months

Temperature Effect (includes zero and span):
Compensated: -20° to 180° F (-29° and 82° C)
Between 30° and 130° F (-1° and 54° C): ±1% of URL per 50° F (28° C)
Between -20° and 180° F (-29° and 82° C): ±1.6% of URL per 50° F (28° C)

Power Supply Effect: ±0.005 full scale per volt

Surge Protection: Standard

Vibration Effect: ±0.1% of upper range limit for 3 g to 200 Hz

Position Effect: 0.05%/90° tilt

Overrange Effect: ±0.15% full scale per 200% of maximum range

Physical Specifications

Process Wetted Parts: 316 stainless steel

NonWetted Parts: 316 stainless steel

Cast Head: CF-8M (316 cast stainless steel)

O-ring: BUNA-N

Fill Fluid: DC 200 silicone (standard)

Process Connection: 1/2 NPTF

Electrical Connection: 1/2 NPTF

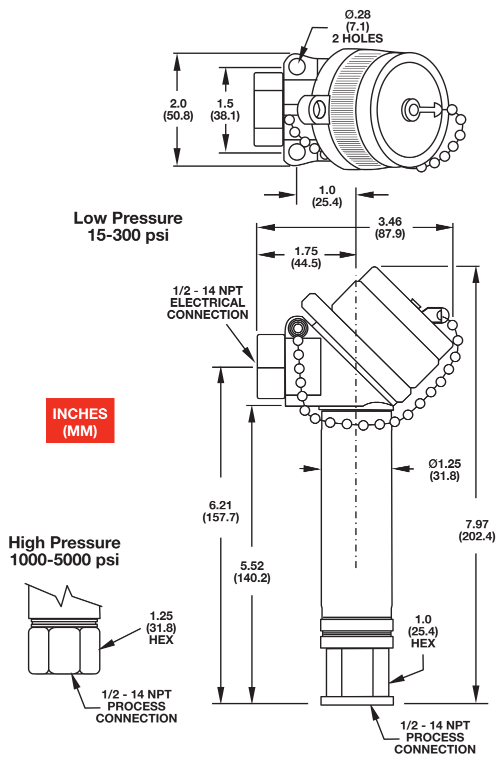
Weight: 1.67 lbs.

Classifications

Model 88C

Factory Mutual:
Explosion-proof for Class I, II, III, Division 1, Groups B, C, D, E, G for hazardous locations. NEMA 4 Enclosure.

Canadian Standards Association:
Exia-intrinsically safe for Class I, Division 1 and 2, Groups A, B, C, D; Class II, Groups E, F, G when connected per AMETEK Dwg. BK750483.
Explosion-proof for Class I, Division 1, Groups B, C, D; Class II, Groups E, F, G; Class III for hazardous locations. Enclosure 4, temperature Code T3C (160° C)



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Sales/Technical Support Telephone: +1 215-355-6900
820 Pennsylvania Boulevard | Feasterville, PA 19053 U.S.A. | Fax: +1 215-354-1801

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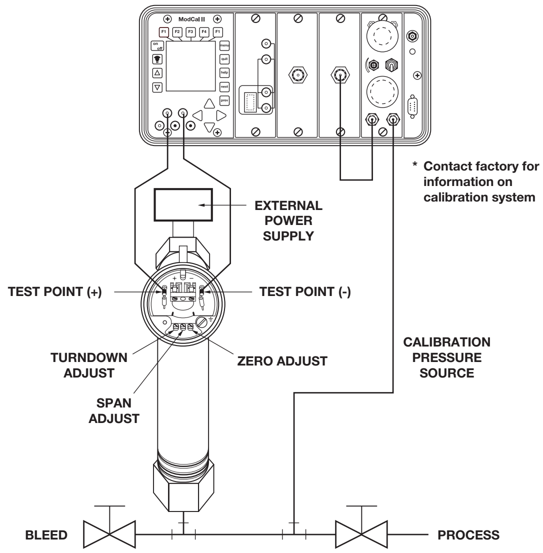
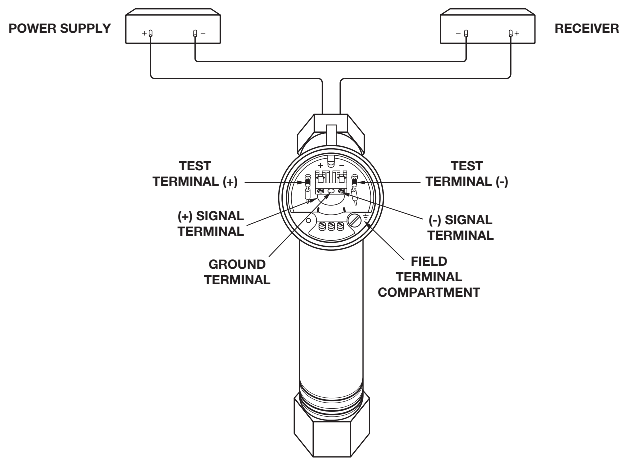
Exhibit 20

ELECTRONIC PRESSURE MEASUREMENT PRODUCTS

Model 88 Pressure Transmitter





Model Numbering:

88 Pressure Transmitter

88 Pressure transmitter

Approvals

C FM certified for explosion-proof and CSA certified for explosion-proof and intrinsic safety

Pressure ranges

001	3 to 15 psi (21 to 104 kPa)
002	0/6 to 0/15 psi (0/0.4 to 0/1 bar)
003	0/15 to 0/30 psi (0/1 to 0/2 bar)
004	0/20 to 0/100 psi (0/1.4 to 0/7 bar)
005	0/60 to 0/300 psi (0/4 to 0/20 bar)
006	0/200 to 0/1000 psi (0/14 to 0/70 bar)
007	0/600 to 0/3000 psi (0/40 to 0/200 bar)
008	0/1000 to 0/5000 psi (0/70 to 0/350 bar)
Non-std.	0/3 to 0/6 psi (0.2 to 0/0.4 bar) *Consult factory*

Material

A 316 SS (base), 316 SS (diaphragm), silicone (liquid fill)
Other Consult factory

Output

2 4 to 20 mADC

Calibration ranges

Will be calibrated at maximum range in psi if not specified

88 C 004 A 2 0-50 psi

** Consult factory for additional options*

Exhibit 21

Bourdon Tube Pressure Gauge
Type 111.12, Black Plastic or Painted Steel Case
Standard Series - Center Back Mount

Applications

- Hydraulic and pneumatic systems
- Pumps, compressors, water systems, regulators
- Suitable for fluid medium which does not clog connection port or corrode copper alloy

Product features

- Copper alloy wetted parts
- Black plastic or painted steel case
- Center back mount (CBM) process connection

Bourdon Tube Pressure Gauge Type 111.12

Specifications

Design
EN 837-1 & ASME B40.100

Sizes (All sizes not stocked)
1½", 2", 2½" and 4" (40, 50, 63, and 100 mm)
3½" (94 mm) with u-clamp only

Accuracy class
± 3/2/3% of span (ASME B40.100 Grade B)

Ranges (All ranges not stocked)
Vacuum/Compound to 30"Hg (-1 bar) / 0/ 200 psi (16 bar)
Pressure from 15 psi (1 bar) to 6,000 psi (400 bar)
or other equivalent units of pressure or vacuum
Receiver scales 3...15 psi (0.2 ... 1 bar)

Working pressure
Steady: 3/4 of full scale value
Fluctuating: 2/3 of full scale value
Short time: full scale value

Operating temperature
Ambient: -40°F to 140°F (-40°C to 60°C)
Media: 140°F (+60°C) maximum

Temperature error
Additional error when temperature changes from reference temperature of 68°F (20°C) ±0.4% of span for every 18°F (10°K) rising or falling.

Pressure connection
Material: copper alloy
Center back mount (CBM)
1/8" or 1/4" NPT

Bourdon Tube
Material: copper alloy
≤ 870 psi (60 bar): C-shape
> 870 psi (60 bar): Helical

Movement
Copper alloy

Dial
White plastic with stop pin (1½", 2", 2½")
White aluminum with stop pin (3½" & 4")
Black or black and red lettering

Pointer
Black ABS plastic (1½", 2", 2½")
Black aluminum (3½" & 4")

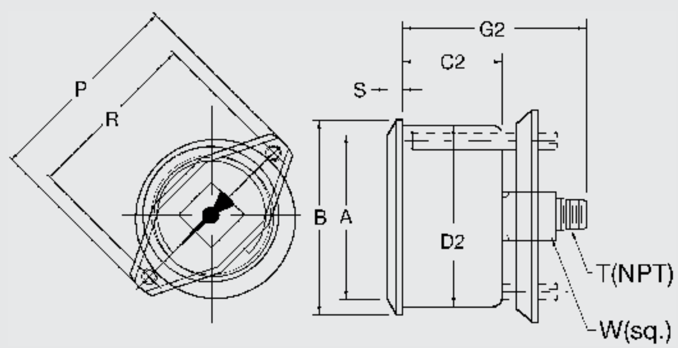
Case
Black plastic (1½", 2", 2½", & 4")
Black-painted steel (3½")

Window
Crystal-clear plastic, snap-fit (1½", 2", 2½", & 4")
Crystal-clear plastic, threaded (3½")

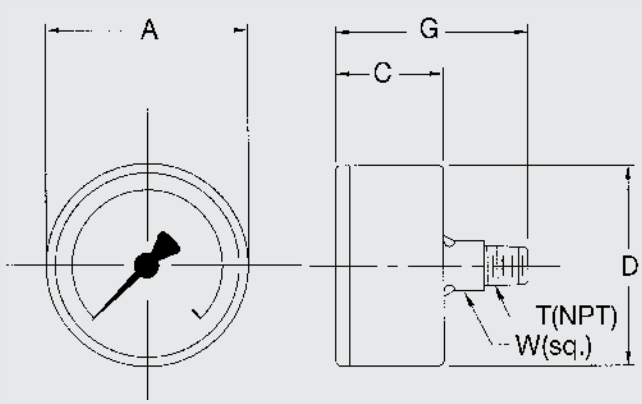
WIKA®

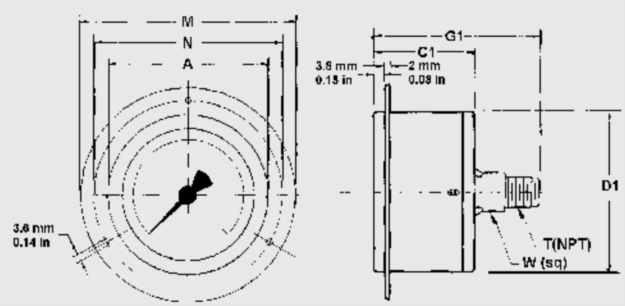
Optional Extras

- Accuracy ± 2/1/2% of span (ASME B40.100 Grade A)
- U-clamp panel mounting
- Front flange
- Slip-fit or friction ring
- Case with weep hole
- Glass window (requires slip-fit or profile ring)
- Black painted steel case
- Stainless steel case
- Special case colors
- Special connections (limited to wrench flat area)
- Cleaned for oxygen service
- Nickel plated connection
- Medical specification
- Rubber cover (2", 2½")
- Custom dial layout
- Other pressure scales available:
  bar, kPa, MPa, kg/cm^2 and dual scales
- EN standards
- Red set pointer on aluminum dial or on snap-on window
- External adjust red drag pointer
  (black steel - 2½" case only)



Dimensions





Recommended panel cutout is D, D1 or D2 + 1.5 mm (0.04in.)

Size		A	B[1]	C	C1	C2	D	D1	D2	G	G2	M	N	P	R	T	W	Weight[2]
	(Standard Version)																	
1.5"	**mm**	40	43.21	26	-	24	41	-	40	46.5	45	-	-	59	47		14	
	in	1.57	1.7	1.02	-	0.94	1.61	-	1.57	1.83	1.77	-	-	2.32	1.85	1/8"	0.55	0.16 lb.
2"	**mm**	50	54	26.5	28.5	24	49	55	49	47	47	71	60	70	57		14	
	in	1.97	2.12	1.04	1.12	0.94	1.93	2.17	1.93	1.85	1.85	2.80	2.36	2.76	2.24	1/4"	0.55	0.22 lb.
2.5"	**mm**	63	67.18	27.5	29.5	26	61.5	68	62	48	53	85	75	91	78		14	
	in	2.48	2.6	1.08	1.16	1.02	2.42	2.68	2.44	1.89	2.09	3.35	2.95	3.58	3.07	1/4"	0.55	0.29 lb.
3.5"	**mm**	80	99.3	-	-	36	-	-	93	-	57	-	-	-	-		14	
	in	3.15	3.9	-	-	1.42	-	-	3.66	-	2.24	-	-	-	-	1/4"	0.55	0.35 lb.
4"	**mm**	100	-	31	-	-	99	-	-	49	-	-	-	-	-		14	
	in	3.94	-	1.22	-	-	3.9	-	-	1.93	-	-	-	-	-	1/4"	0.55	0.46 lb.

[1] B dimension: outside dimension of profile ring.
[2] Weight is for base gauge without optional accessories.

Ordering information
Pressure gauge model / Nominal size / Scale range / Size of connection / Optional extras required
Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing.
Modifications may take place and materials specified may be replaced by others without prior notice.

WIKA Instrument Corporation
1000 Wiegand Boulevard
Lawrenceville, GA 30043
Tel (770) 513-8200 Toll-free 1-888-WIKA-USA
Fax (770) 338-5118
E-Mail info@wika.com
www.wika.com

Thrust Block Calculations

Thrust Block Calculations

Thrust Block Dimension Schedule (ft)

Pipe Location	Pipe Size	90° Bend (H x W)	Tee (H x W)
Reach 24.1 Surge Tank Site	14"	5' 0" x 5' 0"	4' 6" x 4' 6"
	10"	3' 6" x 3' 6"	N/A
Flush Valves	10" x 2" x 10"	N/A	1' 0" x 1 '0"

Thrust Block Calculations

Reach 24.1 JAN Surge Tank - 14" Piping

Line Diameter	13.5	in
Line Pressure	235.0	psi
Area	143.1	in^2
Flow Rate	966.0	GPM
Velocity	2.2	ft/sec
Density h20	62.3	lbm/ft^3
Mass Flow Rate	134.1	lbm/sec
Soil Bearing	2000	psf
1 lbf	32.2	$lbm*ft/sec^2$
Static Load on 90° Bend	47,571	lbs
	47.6	kips
Dynamic Load on 90° Bend	12.8	lbs
	0.0	kips
Total Load on 90° Bend	47.6	kips
Calculated Thrust Block Size at 90 if Square	4.9	ft
Design Thrust Block Size at 90 if Square	**5.0**	**ft**
Static Load on Tee	33,638	lbs
	33.6	kips
Dynamic Load on Tee	9.0	lbs
	0.0	kips
Total Load on Tee	33.6	kips
Calculated Thrust Block Size at Tee if Square	4.10	ft
Design Thrust Block Size at Tee if Square	**4.50**	**ft**

Note:
A soil bearing pressure for the surge tank site of 2000 psf was recommended in the final Geotechnical Investigation Report for NGWSP Reach 24.1 JAN, dated December 30, 2014.

Thrust Block Calculations

Reach 24.1 JAN Surge Tank - 10" Piping

Line Diameter	9.79	in
Line Pressure	235.0	psi
Area	75.3	in^2
Flow Rate	966.0	GPM
Velocity	4.1	ft/sec
Density h20	62.3	lbm/ft^3
Mass Flow Rate	134.1	lbm/sec
Soil Bearing	2000	psf
1 lbf	32.2	$lbm*ft/sec^2$
Static Load on 90° Bend	25,017	lbs
	25.0	kips
Dynamic Load on 90° Bend	24.3	lbs
	0.0	kips
Total Load on 90° Bend	25.0	kips
Calculated Thrust Block Size at 90 if Square	3.54	ft
Design Thrust Block Size at 90 if Square	**3.50**	**ft**

Note:
A soil bearing pressure for the surge tank site of 2000 psf was recommended in the final Geotechnical Investigation Report for NGWSP Reach 24.1 JAN, dated December 30, 2014.

Thrust Block Calculations

Reach 24.1 JAN Flush Valve Sta. 46+84 (Worst Case)

Line Diameter	1.94	in
Line Pressure	235.0	psi
Area	3.0	in^2
Maximum Flow Rate (without 20% reduction)	750	GPM
Velocity	81.4	ft/sec
Density h20	62.3	lbm/ft^3
Mass Flow Rate	104.1	lbm/sec
Soil Bearing	1500	psf
1 lbf	32.2	$lbm*ft/sec^2$
Static Load on Tee	695	lbs
	0.7	kips
Dynamic Load on Tee	263.4	lbs
	0.3	kips
Total Load on Tee	1.0	kips
Calculated Thrust Block Size at Tee if Square	0.80	ft
Design Thrust Block Size at Tee if Square	**1.00**	**ft**

Note:
A soil bearing pressure of 1500 psf was used as a conservative value at locations other than the surge tank site per recommendation from our geotechnical consultatants.

Restraint Length Calculations
Single and Multiple Fittings

Restraint Length Calculations

Calculations for required restraint lengths for valves, tees, reducers, and horizontal bends or sweeps were calculated utilizing the EBAA Restraint Calculator V7.1.2 software, see software inputs and summary table below.

Inputs for the software were as follows:

Pipe Materials: **PVC**

Soil Type: **SM** – The majority of the soils encountered while performing the rock and soil potholing were silty-sands.

Safety Factor: **2.0 to 1**

Trench Type: **3** – Trench Type 3 is the pipe bedded in 4 inches minimum loose soil. The backfill is lightly consolidated to the top of the pipe. This is the most conservative trench type available on the EBAA Restraint Calculator 6.

Depth of Bury: **4 feet** – This is the average minimum depth of pipe. This results in a more conservative restraint length for any pipe buried deeper than 4 feet.

Test Pressure: **235 psi**

Reach 24.1 JAN Minimum Required Restraint Lengths - 14", 10" & 2" DR18 PVC

Fitting	Pipe Size	Pipe DR	Test Pressure (psi)	Design Restraint Length (ft)
Isolation Valve/ Dead End	14	18	235	195
Isolation Valve/ Dead End	10	18	235	140
Isolation Valve/ Dead End	2	18	235	35
From End of Casing	10	18	235	85
Horizontal Bend or Sweep				
90°	10	18	235	65
45°	10	18	235	30
22.5°	14	18	235	20
22.5°	10	18	235	20
11.25°	10	18	235	20
90° (Flush Valve)	2	18	200	20
45° (Flush Valve)	2	18	200	20
Transition				
Reducer	10 x 8	18	235	50
Vertical Bend or Sweep				
22.5°, upper bend	10	18	235	30
22.5°, lower bend	10	18	235	20

alculations for the required restraint length for pipe exiting casings were determined by balancing the total force xerted on the pipe and the friction of the soil. Thermal Pullback was calculated using the Plastic Pipe Institute's PPI alculator. See calculations on the next page.

Minimum Required Restraint Length for Pipe Exiting Casing

			Reach 24.1 JAN 10" DR18
Poission Pullback			
Pressure	P	psi	235
Dimension Ratio	DR		18
Poisson Ratio	μ		0.38
Diameter	D	in	11.1
Internal Pressure Hoop Stress	Sp	psi	1997.5
Pullout Force	**F**	lb	**15415.9**
Elastic Modulus	E	psi	400000.0
Thermal Drop	ΔT	F	30.0
Thermal Expansion Coefficient	α	in/in/F	0.0
Thermal Pullback (PPI calculator)	**F**	lbs	**14673.0**
Total Force	**F**	lbs	**30088.9**
Pipe Depth	h	ft	4.0
Unit Weight of soil	W	psf	120.0
Earth Pressure on Pipe	Pe	lbs	480.0
Earth Pressure on Pipe	Pe	psi	3.3
Pipe Area per ft of pipe		ft^2	2.9
Safety Factor	SF		2.0
Pipe Fricton Force		lb/ft/psi	78.2
Friction Resistance Per foor of pipe		lbs/ft	757.1
Friction Resistance Per foor of pipe with SF		lbs/ft	378.6
Required Restraint Length		ft	**79.5**

Pipe Friction Force From Underground Solutions, Experimental Evaluation of Pipe Soil Friction Coefficients for FPVC Pipe, 2010

Reach 24.1 JAN Minimum Required Restraint Lengths for Multiple Fittings
14", 10" & 2" DR18 PVC

Fittings	Pipe Size	Pipe DR	Test Pressure (psi)	Beginning Station of Restraint	Ending Station of Restraint	Total Restraint Length (ft)
10" GV, 45˚ell, 80 LF casing, 45˚ell	10	18	235	13+38	19+15	577
Symmetric 22.5˚ vertical bends, 10 "GV	10	18	235	71+92	75+35	343
45˚ell, 10" GV, 80 LF casing, 10" GV, 60˚ell	10	18	235	96+55	102+26	571
10" GV, 60 LF casing, 70˚ell	10	18	235	138+85	143+50	465
45˚ell, dead end	10	18	235	157+24	159+63	239

Trench Type Calculations

SMA

Trench Type Calculations

Station (LF)	Test Pit/Bore Location	Depth (ft)	Test Type	In SITU Compaction %	USCS	SPT Blows/ foot	Trench Wall E'n (lb/in^2)	Minimum Required embedment E'b (lb/in^2)	80% Min Req'd Embedment E'b (lb/in^2)	Trench Wall E'n > 80% Min Req'd Embedment E'b?	Trench Type
00+00	VJ1	5	SPT	-	CL	22	5000	0	0	TRUE	Trench Type 1
		10	SPT	-	SM	9	3000	99	79.2	TRUE	Trench Type 1
		15	SPT	-	SM	14	3000	1101	880.8	TRUE	Trench Type 1
		20	SPT	-	SM	14	3000	1486	1188.8	TRUE	Trench Type 1
52+55	VJ5	3.5	Test Pit	72	SC	-	200	0	0	TRUE	Trench Type 1
		6	Test Pit	69	SC	-	200	0	0	TRUE	Trench Type 1
112+50	VJ9	4	Test Pit	90	SC	-	1000	0	0	TRUE	Trench Type 1
		6	Test Pit	-	Rock	-	3000	0	0	TRUE	Trench Type 1

Note: *Analysis is based on calculations and methods from USBR M-25, Appendix D and in-situ soils data provided by X8e Vinyard (see report no. 14-1-087). Trench Wall E'n values for the Standard Penetration Tests (SPT) based on USBR M-25, Table H-2. Trench Wall E'n values for the Test Pit Tests based on USBR M-25, Table D-1. Note that trench types shown on Table D-1 are not applicable, as these are applicable to Reclamation "standard installation method" only. Refer to USBR M-25, page 21, last paragraph.*

Minimum Required Embedment E'b values based on Reaches 24.1 and 25 Pipe Deflection Analysis performed by SMA were used.

According to our analysis below, all Reach 24.1 JAN 10" pipes up to a 20-ft bury depth require Trench Type 1, per USBR M-25.

All Reach 24.1 JAN pipes are 10" diameter. According to M-25, pg. 16 of Appendix B, all 10" diameter and smaller pipes do not require compaction. Thus, only Trench Type 1 soils are required since the in situ wall material will always be stronger or firmer than the dumped, uncompacted pipe embedment.

However, to be conservative in the event soils encountered are poorer than encountered at test pits, our design will require the contractor to install all piping with Trench Type 2. See trench detail on sheet DT-1.

Soil Resistivity Report

SMA

Navajo Gallup Water Supply Project Reach 24.1 JAN
Summary of Soil Resistivity Analysis

Location No.	Station (ft)	Min. Apparent Resistivity (ohm-cm)	Cathodic Protection Required	Affected Area Begin Station	Affected Area End Station
J1	00+00	11,200	No	-00+39	06+65
J2	13+30	3,400	No	06+65	20+85
J3	28+40	7,200	No	20+85	34+33
J4	40+25	11,300	No	34+33	47+35
J5	54+45	8,900	No	47+35	60+73
J6	67+00	28,200	No	60+73	72+98
J7	78+95	7,500	No	72+98	86+20
J8	93+45	5,600	No	86+20	401+30
J9	709+15	4,600	No	401+30	414+83
J10	120+50	3,200	No	414+83	127+43
J11	134+35	5,800	No	127+43	142+43
J12	150+50	8,000	No	142+43	150+50
J13	162+90	2,300	**Yes**	150+50	159+63

Zonge International, Inc.
9595 Prototype Court
Reno, NV 89521
phone: 775.355.7707

January 7, 2015
Ref: DAT-1401

Tory T. Tadano
Souder, Miller & Associates
3451 Candelaria Road NE, Suite D
Albuquerque, NM 87107

Subject: ***Data Report***
Interpreted Models of Wenner 4-pin Electrical Soundings
Reach 24.1 JAN, Navajo Gallup Water Supply Project

Dear Mr. Tadano,

Zonge International, Inc. (Zonge) presents this report presenting geoelectric models of Wenner 4-pin electrical sounding data which were acquired by Souder, Miller & Associates (SMA). Field data were acquired by SMA in November, 2014, on Reach 24.1 JAN of the Navajo Gallup Water Supply Project. The interpreted models are to be used by SMA for design of the cathodic protection system.

Figure 1, the project map for the Navajo Gallup Water Supply Project, shows the site location for Reach 24.1 JAN. Figures 2 is a site detail showing sounding locations.

Models are presented in tabular and graphical form following the text and Figures.

Electrical Resistivity

Wenner resistivity soundings, or 4-pin electrical soundings, are used to measure the electrical resistivity of the earth and variations of resistivity with depth. They are often used to obtain earth resistivities for the design of cathodic protection systems for pipelines and for the design of grounding grids for electrical substations or large antennas.

Resistivity soundings are conducted by injecting current into two electrodes (metal stakes driven into the ground), typically referred to as electrodes A and B, and by measuring the potential voltage across two additional electrodes, typically referred to as M and N. The arrangement and spacing of electrodes A and B, and M and N, is referred to as the electrode array. For the Wenner array the four electrodes and configured with a constant distance, referred to as the *a-spacing*, between the electrodes. The A and B electrodes are to the outside of the inner M and N electrodes. The approximate depth of investigation is controlled by the a-spacing. Different depths of investigation were achieved by increasing the distance between electrodes (the a-spacing).

A complete sounding consists of a series of measurements at increasing a-spacings. For this project data were acquired at a-spacings from 1 foot to 60 feet. Spacings are usually increased geometrically, increasing by a factor of 1.5 to 2.0 between readings.

Data Acquisition

Data were acquired by Souder Miller & Associates and conveyed to Zonge as a table of A-spacings and apparent conductivities.

Data Processing

Data were modeled as layered earth models which provided the best fit to the observed sounding data. Modeling was carried out using the IX1D software from Interpex Ltd. of Golden, Colorado. Two or three layer models were selected based on the nature of the sounding curves. In the tables with the model results we also show a *Model Fit Error*. This is the RMS error between the observed apparent resistivity and modeled apparent resistivity at each spacing. While a poorly constructed model can lead to a large misfit, it is more often the result of scatter in the observed data, as will be apparent in the data plots. We have omitted (masked) some outlying data points from the analysis. The masked points are shown with an “X” in the data plots.

Also shown in the model plots are dashed blue lines showing possible equivalent models. Those equivalent models are indicative of the resolution of the data. Equivalent models would fit the data as well as the modeled curve, increasing the misfit by less than 10% of its value.

Results

Figure 2 show the locations of the Wenner soundings acquired in November, 2014. Coordinates used in those figures were provided by SMA. Map coordinates are UTM Zone 13N, NAD83, meters.

Sounding models are presented on pages 6-12 following the figures with:

1. A table describing the final layered earth model,
2. A plot showing the observed apparent resistivities at varying a-spacings together with the curve predicted from the model, and
3. A depth plot showing the modelled variation of earth resistivity with depth, together with equivalent models.
4. Notes on anomalous quality of data and interpreted model.

If you have any questions regarding the analysis techniques, or the results and interpretations presented herein, please do not hesitate to contact us. We appreciate working with you and look forward to providing you with geophysical services in the future.

Respectfully,

Zonge International, Inc.

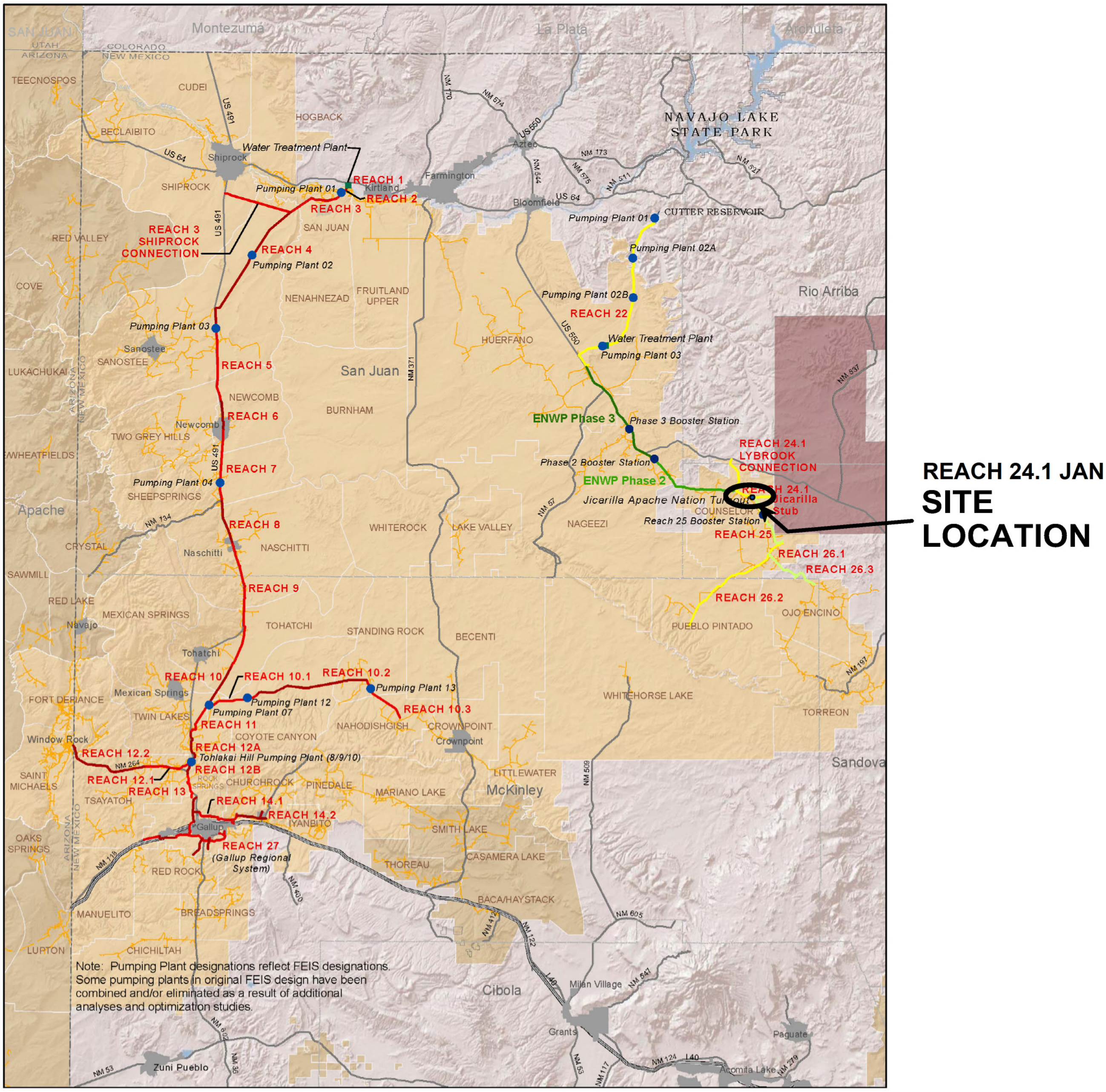
Rowland French, R.G.
Program Geophysicist

Restrictions

> **Note:** This geophysical analysis was conducted under Zonge International protocols and procedures using industry standard methods and equipment. Professional quality control standards were observed during each phase of this project, from field activities through data processing and reporting.

Filename: Zonge Wenner 24-1J rpt11.docx
Zonge Project: DAT 1401

ZONGE PROJECT: DAT 1401
FILE: Project Location-2.map
DATE: NOVEMBER 2014
REVISION: A-07-JAN-15



Navajo Gallup Water Supply Project

Legend

- Pumping Plants
- Water Treatment Plant
- San Juan Lateral
- Cutter Lateral
- Eastern Navajo Water Pipeline (ENWP) Phase 3
- Eastern Navajo Water Pipeline (ENWP) Phase 2
- Interstate
- State Highway
- US Highway
- NTUA Line
- Navajo Nation Non-Serviced Chapters
- Navajo Nation Serviced Chapters
- Jicarilla Apache Nation

RECLAMATION
Managing Water for the West

N
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BASEMAP FROM PROJECT WEB SITE
http://www.usbr.gov/uc/rm/navajo/nav-gallup/pdfs/ProjAlignment-map.pdf

0 5 10 20 30 Miles

FIGURE 1

PROJECT LOCATION

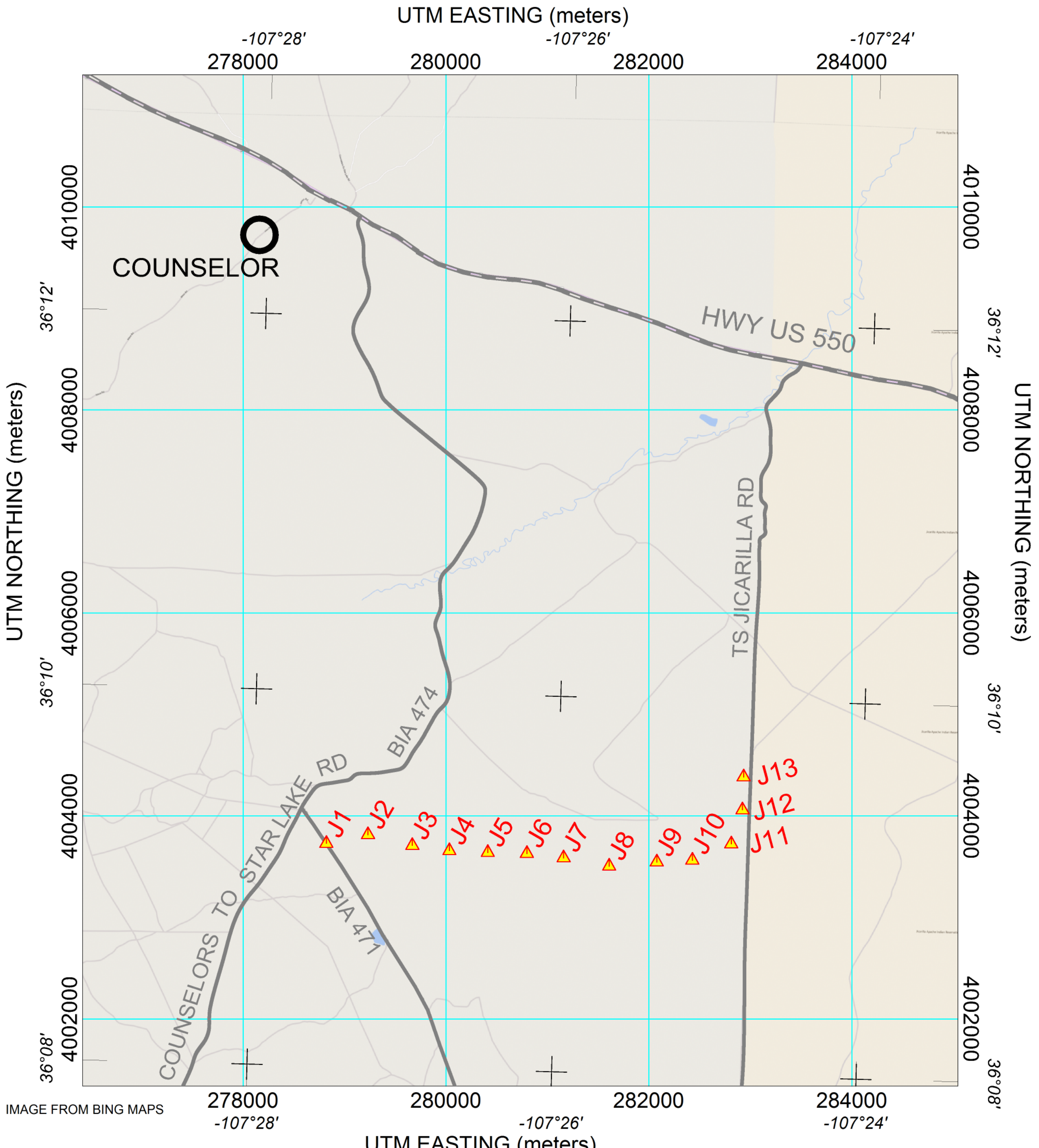
Wenner Resistivity Soundings
Reach 24.1 JAN
Navajo Gallup Water Supply Project
New Mexico

Prepared By:

Zonge
TRUSTED GEOPHYSICS.

Prepared For:

SOUDER, MILLER & ASSOCIATES



REVISION: A-25-NOV-14

DATE: NOVEMBER 2014

FILE: 60K MAP 24-1 JAN.map

ZONGE PROJECT: DAT 1401

LEGEND

RESISTIVITY SOUNDING LOCATIONS

13 2014 DATA ACQUISITION

Scale 1:60000

1000 0 1000

(meters)

NAD83 / UTM zone 13N

FIGURE 2

SITE PLAN

Wenner Resistivity Soundings
Reach 24.1 JAN
Navajo Gallup Water Supply Project
New Mexico

Prepared By:

Zonge
TRUSTED GEOPHYSICS.

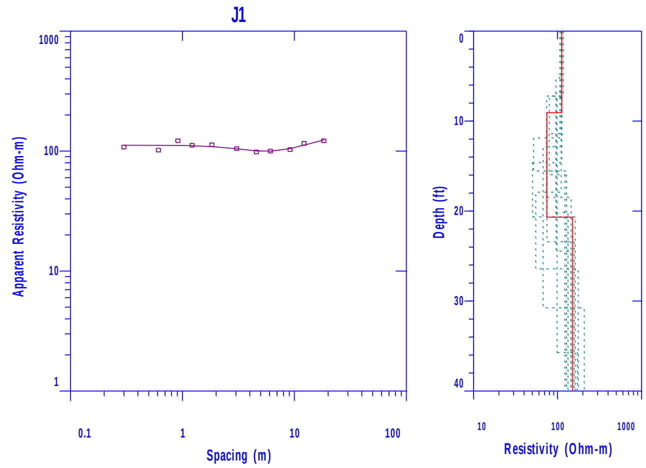
Prepared For:

SOUDER, MILLER & ASSOCIATES

Sounding 24.1 JAN - J1

DATASET: J1		NORTH:	4003732
		EAST:	278821
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	112	9.2	9.2
2	75	11.5	20.7
3	151		
Model Fit Error:		4.5%	

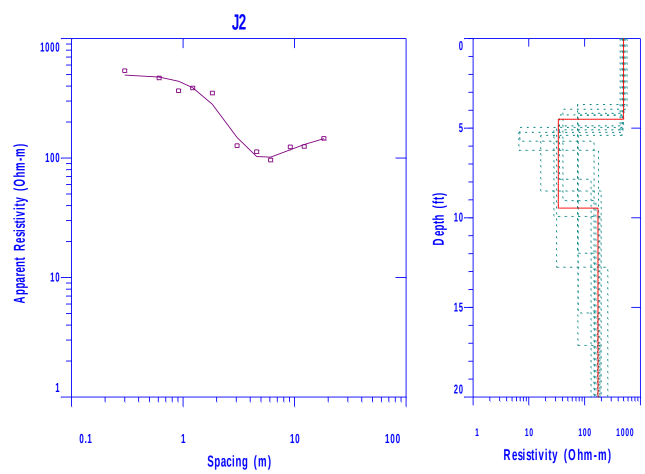
NOTES 24.1-J1:
This is essentially a one layer, uniform earth site with a resistivity of 80-150 ohm-m.



Sounding 24.1 JAN - J2

DATASET: J2		NORTH:	4003815
		EAST:	279231
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	497	4.6	4.6
2	34	4.9	9.5
3	173		
Model Fit Error:		11.4%	

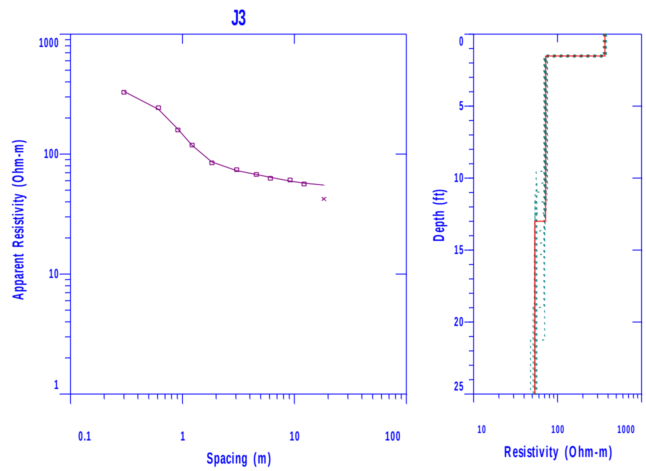
NOTES 24.1-J9:
High resistivity near surface with some scatter in data. Transitions between layers are not well defined and may be transitional.



Sounding 24.1 JAN - J3

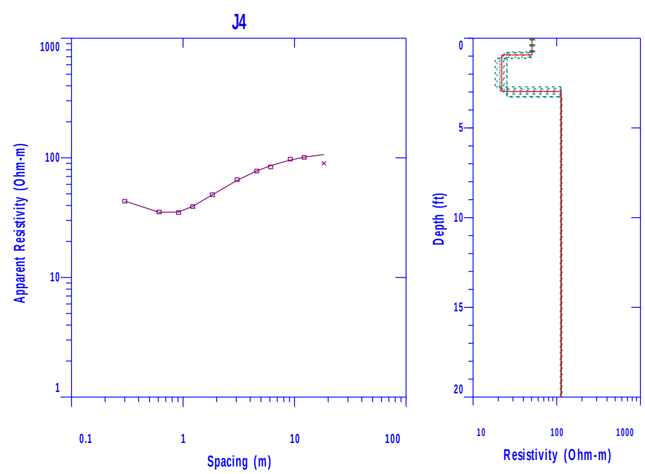
DATASET:	J3	NORTH:	4003711
		EAST:	279668
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	366	1.6	1.6
2	72	11.5	13.1
3	54		
Model Fit Error:		1.8%	

NOTES 24.1-J3:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J4

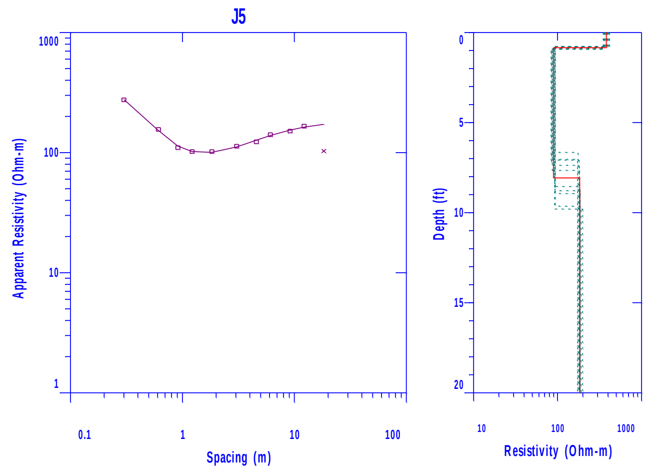
DATASET:	J4	NORTH:	4003660
		EAST:	280033
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	51	1.0	1.0
2	22	2.0	3.0
3	113		
Model Fit Error:		1.2%	



Sounding 24.1 JAN - J5

DATASET:	J5	NORTH:	4003640
		EAST:	280412
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	380	1.0	1.0
2	89	7.2	8.2
3	183		
Model Fit Error:		1.9%	

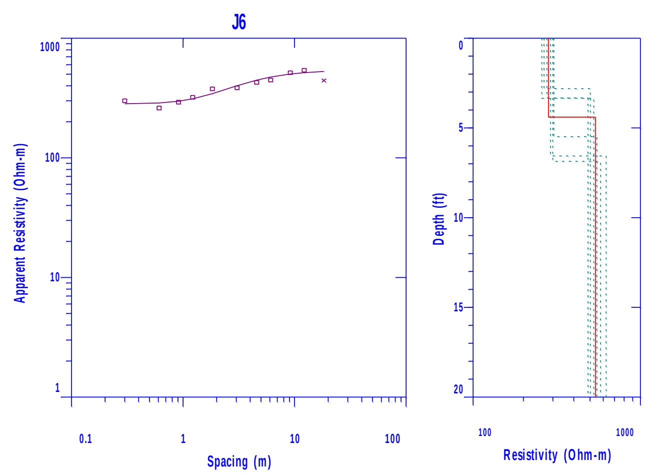
NOTES 24.1-J5:
Transition from Layer 2 to Layer 3 is ill defined and may be gradational.



Sounding 24.1 JAN - J6

DATASET:	J6	NORTH:	4003631
		EAST:	280797
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	282	4.3	4.3
2	539		
Model Fit Error:		5.9%	

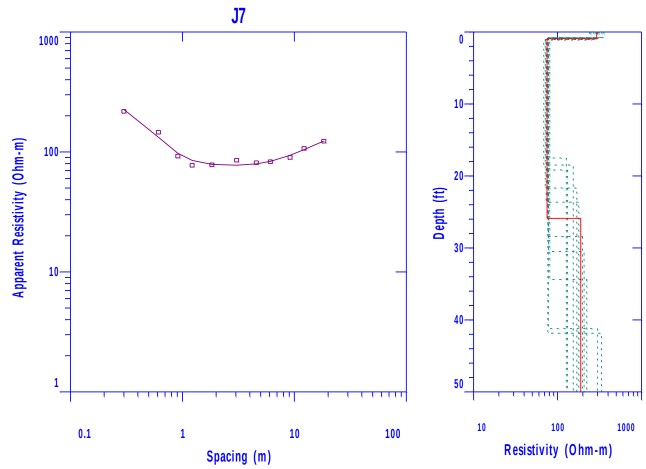
NOTES 24.1-J6:
Transition from Layer 1 to Layer 2 is ill defined and probably gradational.



Sounding 24.1 JAN - J7

DATASET:	**J7**	NORTH:	4003587
		EAST:	281159
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	293	1.0	1.0
2	75	24.9	25.9
3	188		
	Model Fit Error:	5.7%	

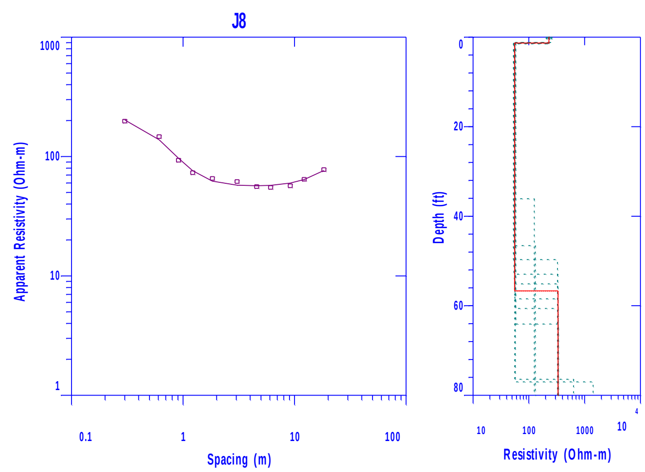
NOTES 24.1-J7:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J8

DATASET:	**J8**	NORTH:	4003506
		EAST:	281608
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	229	1.3	1.3
2	56	55.4	56.7
3	333		
	Model Fit Error:	4.4%	

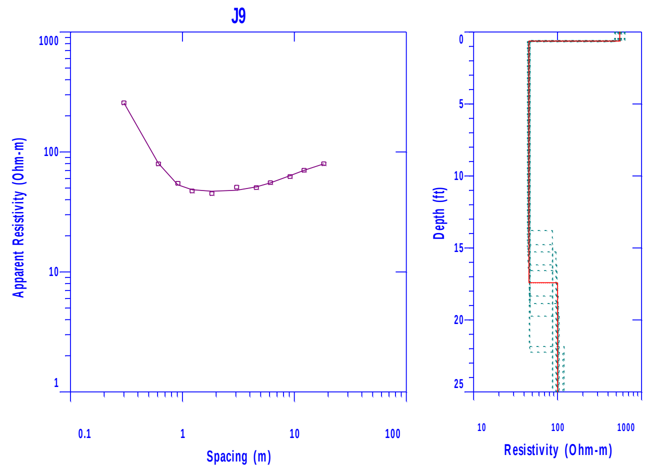
NOTES 24.1-J8:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J9

DATASET:	J9	NORTH:	4003546
		EAST:	282077
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	549	0.7	0.7
2	46	16.7	17.4
3	100		
Model Fit Error:		2.6%	

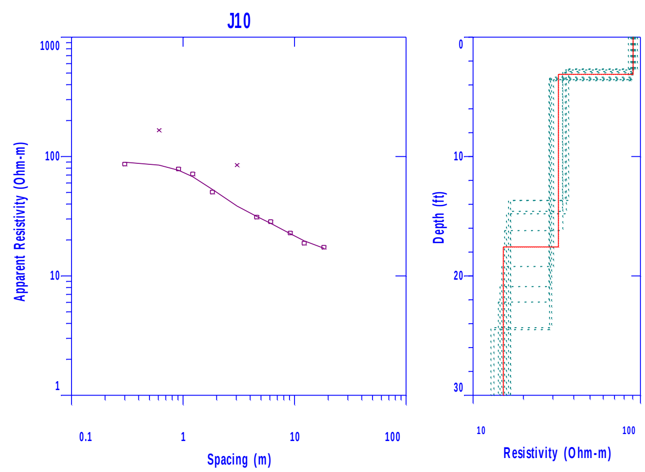
NOTES 24.1-J9:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J10

DATASET:	J10	NORTH:	4003564
		EAST:	282428
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	91	3.0	3.0
2	32	14.4	17.4
3	15		
Model Fit Error:		3.6%	

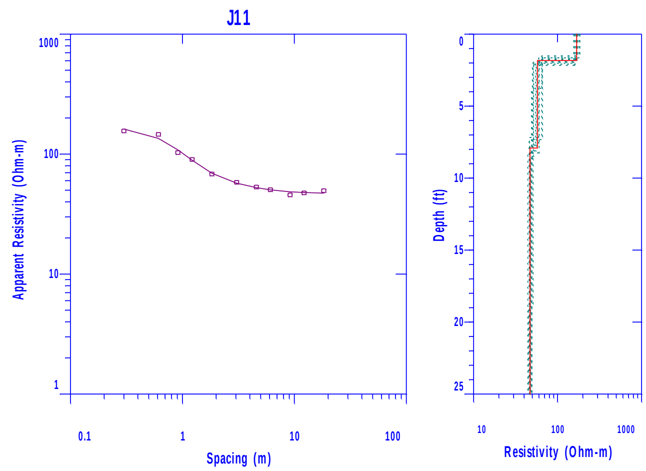
NOTES 24.1-J10:
Some scatter in data, two points not used for modeling, Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J11

DATASET:	**J11**	NORTH:	4003726
		EAST:	282811
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	169	2.0	2.0
2	58	6.2	8.2
3	47		
	Model Fit Error:	4.0%	

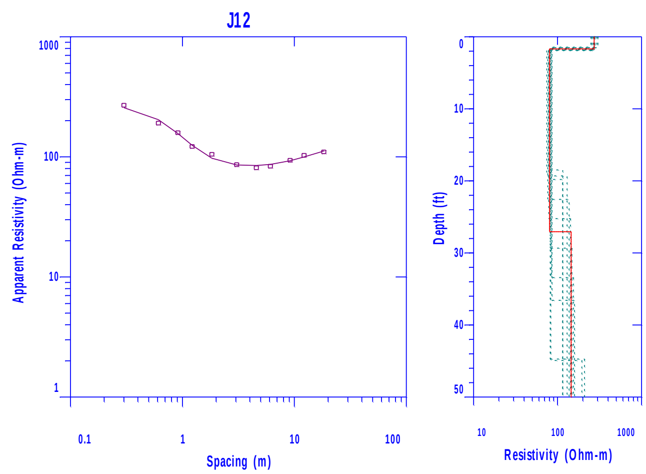
NOTES 24.1-J11:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN - J12

DATASET:	**J12**	NORTH:	4004062
		EAST:	282922
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	273	1.6	1.6
2	80	25.3	26.9
3	145		
	Model Fit Error:	4.0%	

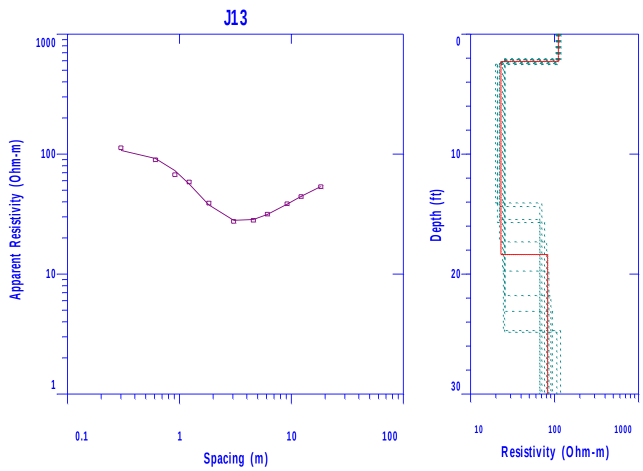
NOTES 24.1-J12:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Sounding 24.1 JAN – J13

DATASET:	J13	NORTH:	4004385
		EAST:	282932
LAYER	RESISTIVITY (ohm-m)	THICKNESS (feet)	DEPTH (feet)
1	111	2.3	2.3
2	23	16.1	18.4
3	83		
Model Fit Error:		3.5%	

NOTES 24.1-J13:
Transition from Layer 2 to Layer 3 is ill defined and probably gradational.



Soil and Rock Pot Holing Data

SMA

Navajo Gallup Water Supply Project
Reach 24.1 JAN Pot Holing Data

Hole #	Station	Latitude	Longitude	Subsurface Conditions	Depth to Refusal
VJ1	00+00	36.15322	-107.45826	Silty-sand underlain by sandy lean clay	None at 8 Feet
VJ2	13+50	36.15375	-107.45386	Silty-sand	None at 8 Feet
VJ3	26+00	36.15353	-107.44969	Silty-sand	None at 8 Feet
VJ4	36+75	36.15340	-107.44500	Silty-sand grading to lean clay with sand	None at 8 Feet
VJ5	52+55	36.15237	-107.44101	Silty-sand grading to clayey-sand	**6 Feet**
VJ6	66+05	36.15244	-107.43637	Silty-sand	**6.5 Feet**
VJ7	80+00	36.15233	-107.43189	Silty-sand grading to sandstone fragments	**7.5 Feet**
VJ8	94+30	36.15234	-107.42747	Silty-sand with fat clay	None at 8 Feet
VJ9	112+50	36.15227	-107.42285	Silty-sand underlain by sandstone fragments	**4.5 Feet**
VJ10	122+30	36.15271	-107.41827	Silty-sand underlain by sandstone fragments	**4.5 Feet**
VJ11	137+80	36.15428	-107.41371	Silty-sand with lean clay	None at 8 Feet

Please Note: Reach 24.1 JAN turnout to JAN Border, New Mexico
October 2, 2014 and November 24, 2014
All coordinates are in NAD83 system zone 12N

Soil Chemistry Analysis for Concrete Design

SMA

Soil Chemistry Analysis For Concrete Design

To determine the Type of cement to use, and if any extra provisions are required; soil from the Reach 24.1 surge tank site was analyzed for chloride, sulfate, and pH levels. The results were compared to the American Concrete Institute's Building Code Requirements for Structural Concrete (ACI 318-11) manual standards, pertinent pages of which are included after this summary. The Portland Cement Association was referenced for pH level limitations. The full results report from Hall Environmental Analysis Laboratory, Inc., is also included after this summary.

Type V concrete is required if the dissolved sulfate in water of the soil in which it is in contact with is between 1,500 and 10,000 ppm. The sulfate concentration at the Reach 24.1 surge tank site is 30 mg/Kg (or, 30 ppm). Type V concrete is not required.

Additional provisions are required for concrete if the chloride concentration of the contact soil is more than 0.15% by weight of cement. The Chloride concentration at the surge tank site was Not Detected; therefore, the concentration is below Hall's reporting limit of 30 mg/Kg. Additional provisions are not required.

Additional provisions are required for concrete if the pH level of the contact soil is less than 6.5. The pH at the surge tank site is 8.29. No additional provisions are required.

No additional provisions are needed for the concrete at the Reach 24.1 surge tank site. Type I/II cement should be used for concrete construction. A licensed structural engineer of SMA confirmed these results.

4

CODE

4.2.1 — The licensed design professional shall assign exposure classes based on the severity of the anticipated exposure of structural concrete members for each exposure category according to Table 4.2.1.

TABLE 4.2.1 — EXPOSURE CATEGORIES AND CLASSES

Category	Severity	Class	Condition	
F Freezing and thawing	Not applicable	F0	Concrete not exposed to freezing-and-thawing cycles	
	Moderate	F1	Concrete exposed to freezing-and-thawing cycles and occasional exposure to moisture	
	Severe	F2	Concrete exposed to freezing-and-thawing cycles and in continuous contact with moisture	
	Very severe	F3	Concrete exposed to freezing-and-thawing and in continuous contact with moisture and exposed to deicing chemicals	
S Sulfate			**Water-soluble sulfate (SO_4) in soil, percent by mass***	**Dissolved sulfate (SO_4) in water, ppm†**
	Not applicable	S0	$SO_4 < 0.10$	$SO_4 < 150$
	Moderate	S1	$0.10 \leq SO_4 < 0.20$	$150 \leq SO_4 < 1500$ Seawater
	Severe	S2	$0.20 \leq SO_4 \leq 2.00$	$1500 \leq SO_4 \leq 10{,}000$
	Very severe	S3	$SO_4 > 2.00$	$SO_4 > 10{,}000$
P Requiring low permeability	Not applicable	P0	In contact with water where low permeability is not required	
	Required	P1	In contact with water where low permeability is required.	
C Corrosion protection of reinforcement	Not applicable	C0	Concrete dry or protected from moisture	
	Moderate	C1	Concrete exposed to moisture but not to external sources of chlorides	
	Severe	C2	Concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources	

*Percent sulfate by mass in soil shall be determined by ASTM C1580.
†Concentration of dissolved sulfates in water in ppm shall be determined by ASTM D516 or ASTM D4130.

COMMENTARY

finishes. These items are beyond the scope of the Code and should be covered specifically in the project specifications. Concrete ingredients and proportions are to be selected to meet the minimum requirements stated in the Code and the additional requirements of contract documents.

R4.2.1 — The Code addresses four exposure categories that affect the requirements for concrete to ensure adequate durability:

Exposure Category F applies to exterior concrete that is exposed to moisture and cycles of freezing and thawing, with or without deicing chemicals.

Exposure Category S applies to concrete in contact with soil or water containing deleterious amounts of water-soluble sulfate ions as defined in Table 4.2.1.

Exposure Category P applies to concrete in contact with water requiring low permeability.

Exposure Category C applies to reinforced and prestressed concrete exposed to conditions that require additional protection against corrosion of reinforcement.

Severity of exposure within each category is defined by classes with increasing numerical values representing increasingly severe exposure conditions. A classification of "0" is assigned when the exposure severity has negligible effect or does not apply to the structural member.

Exposure Category F is subdivided into four exposure classes: **Exposure Class F0** is assigned to concrete that will not be exposed to cycles of freezing and thawing. **Exposure Class F1** is assigned to concrete exposed to cycles of freezing and thawing and that will be occasionally exposed to moisture before freezing. Examples of Class F1 are exterior walls, beams, girders, and slabs not in direct contact with soil. **Exposure Class F2** is assigned to concrete exposed to cycles of freezing and thawing that is in continuous contact with moisture before freezing. An example is an exterior water tank or vertical members in contact with soil. Exposure Classes F1 and F2 are conditions where exposure to deicing salt is not anticipated. **Exposure Class F3** is assigned to concrete exposed to cycles of freezing and thawing, in continuous contact with moisture, and where exposure to deicing chemicals is anticipated. Examples are horizontal members in parking structures.

Exposure Category S is subdivided into four exposure classes: **Exposure Class S0** is assigned for conditions where the water-soluble sulfate concentration in contact with concrete is low and injurious sulfate attack is not a concern. **Exposure Classes S1, S2, and S3** are assigned for structural concrete members in direct contact with soluble sulfates in soil or water. The severity of exposure increases

CODE

TABLE 4.3.1 — REQUIREMENTS FOR CONCRETE BY EXPOSURE CLASS

Exposure Class	Max. w/cm*	Min. f'_c, psi	Additional minimum requirements			
			Air content			Limits on cementitious materials
F0	N/A	2500	N/A			N/A
F1	0.45	4500	Table 4.4.1			N/A
F2	0.45	4500	Table 4.4.1			N/A
F3	0.45	4500	Table 4.4.1			Table 4.4.2
			Cementitious materials†—types			Calcium chloride admixture
			ASTM C150	ASTM C595	ASTM C1157	
S0	N/A	2500	No Type restriction	No Type restriction	No Type restriction	No restriction
S1	0.50	4000	II‡	IP(MS), IS (<70) (MS)	MS	No restriction
S2	0.45	4500	V§	IP (HS) IS (<70) (HS)	HS	Not permitted
S3	0.45	4500	V + pozzolan or slag‖	IP (HS) + pozzolan or slag‖ or IS (<70) (HS) + pozzolan or slag‖	HS + pozzolan or slag‖	Not permitted
P0	N/A	2500	None			
P1	0.50	4000	None			
			Maximum water-soluble chloride ion (Cl^-) content in concrete, percent by weight of cement#		Related provisions	
			Reinforced concrete	Prestressed concrete		
C0	N/A	2500	1.00	0.06	None	
C1	N/A	2500	0.30	0.06		
C2	0.40	5000	0.15	0.06	7.7.6, 18.16**	

*For lightweight concrete, see 4.1.2.

†Alternative combinations of cementitious materials of those listed in Table 4.3.1 shall be permitted when tested for sulfate resistance and meeting the criteria in 4.5.1.

‡For seawater exposure, other types of portland cements with tricalcium aluminate (C_3A) contents up to 10 percent are permitted is the *w/cm* does not exceed 0.40.

§Other available types of cement such as Type III or Type I are permitted in Exposure Classes S1 or S2 if the C_3A contents are less than 8 or 5 percent, respectively.

‖The amount of the specific source of the pozzolan or slag to be used shall not be less than the amount that has been determined by service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag to be used shall not be less than the amount tested in accordance with ASTM C1012 and meeting the criteria in 4.5.1.

#Water-soluble chloride ion content that is contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall be determined on the concrete mixture by ASTM C1218 at age between 28 and 42 days.

**Requirements of 7.7.6 shall be satisfied. See 18.16 for unbonded tendons.

COMMENTARY

content. For Exposure Class S1 (moderate exposure), Type II cement is limited to a maximum C_3A content of 8.0 percent under ASTM C150. The blended cements under ASTM C595 with the MS designation are appropriate for use in Exposure Class S1. The appropriate types under ASTM C595 are IP(MS) and IS(<70)(MS) and under C1157 is Type MS. For Exposure Class S2 (severe exposure), Type V cement with a maximum C_3A content of 5 percent is specified. Blended cements Types IP (HS) and IS (<70) (HS) under ASTM C595 and Type HS under ASTM C1157 can also be used. In certain areas, the C_3A content of other available types such as Type III or Type I may be less than 8 or 5 percent and are usable in moderate or severe sulfate exposures. Note that sulfate-resisting cement will not increase resistance to some chemically aggressive solutions, for example, sulfuric acid. The project specifications should cover all special cases.

The use of fly ash (ASTM C618, Class F), natural pozzolans (ASTM C618, Class N), silica fume (ASTM C1240), or ground-granulated blast-furnace slag (ASTM C989) also has been shown to improve the sulfate resistance of concrete.[4.1-4.3] ASTM C1012 can be used to evaluate the sulfate resistance of mixtures using combinations of cementitious materials as determined in 4.5.1. For Exposure Class S3, the alternative in ACI 318-05 allowing use of Type V plus pozzolan, based on records of successful service, instead of meeting the testing requirements of 4.5.1, still exists and has been expanded to consider the use of slag and the blended cements.

Table 4.2.1 lists seawater under Exposure Class S1 (moderate exposure), even though it generally contains more than 1500 ppm SO_4. Portland cement with higher C_3A content improves binding of chlorides present in seawater and the Code permits other types of portland cement with C_3A up to 10 percent if the maximum *w/cm* is reduced to 0.40.

In addition to the proper selection of cementitious materials, other requirements for durable concrete exposed to water-soluble sulfate are essential, such as low *w/cm*, strength, adequate air entrainment, adequate consolidation, uniformity, adequate cover of reinforcement, and sufficient moist curing to develop the potential properties of the concrete.

Exposure Class P1: The Code includes an Exposure Class P1 for concrete that needs to have a low permeability when in direct contact with water and where the other exposure conditions defined in Table 4.2.1 do not apply. The primary means to obtain low permeability is to use a low *w/cm*. Low permeability can be also achieved by optimizing the cementitious materials used in the concrete mixture. One standard method that provides a performance-based indicator of low permeability of concrete is ASTM C1202, which is more reliable in laboratory evaluations than for field-based acceptance.

CODE

COMMENTARY

4

Exposure Class C2: For reinforced and prestressed concrete in Exposure Class C2, the maximum *w/cm*, minimum specified compressive strength, and minimum cover are the basic requirements to be considered. Conditions in structures where chlorides may be applied should be evaluated, such as in parking structures where chlorides may be tracked in by vehicles, or in structures near seawater. Epoxy- or zinc-coated bars or cover greater than the minimum required in 7.7 may be desirable. Use of slag meeting ASTM C989 or fly ash meeting ASTM C618 and increased levels of specified compressive strength provide increased protection. Use of silica fume meeting ASTM C1240 with an appropriate high-range water reducer, ASTM C494, Types F and G, or ASTM C1017 can also provide additional protection.[4.4] The use of ASTM C1202[4.5] to test concrete mixtures proposed for use will provide additional information on the performance of the mixtures.

Exposure Classes C0, C1, and C2: For Exposure Classes C0, C1, and C2, the chloride ion limits apply. For reinforced concrete, the permitted maximum amount of water-soluble chloride ions incorporated into the concrete, measured by ASTM C1218 at ages between 28 and 42 days, depend on the degree of exposure to an anticipated external source of moisture and chlorides. For prestressed concrete, the same limit of 0.06 percent chloride ion by weight of cement applies regardless of exposure.

Additional information on the effects of chlorides on the corrosion of reinforcing steel is given in ACI 201.2R,[4.6] which provides guidance on concrete durability, and ACI 222R,[4.7] which provides guidance on factors that impact corrosion of metals in concrete. An initial evaluation of the chloride ion content of the proposed concrete mixture may be obtained by testing individual concrete ingredients for total chloride ion content. If total chloride ion content, calculated on the basis of concrete proportions, exceeds those permitted in Table 4.3.1, it may be necessary to test samples of the hardened concrete for water-soluble chloride ion content. Some of the chloride ions present in the ingredients will either be insoluble in water or will react with the cement during hydration and become insoluble under the test procedures described in ASTM C1218.

When concretes are tested for water-soluble chloride ion content, the tests should be made at an age of 28 to 42 days. The limits in Table 4.3.1 are to be applied to chlorides contributed from the concrete ingredients, not those from the environment surrounding the concrete. For reinforced concrete that will be dry in service (Exposure Class C0), a limit of 1 percent has been included to control the water-soluble chlorides introduced by concrete-making materials. Table 4.3.1 includes limits of 0.30 and 0.15 percent for reinforced concrete subject to Exposure Classes C1 and C2, respectively.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

January 07, 2015

Emily Sotelo
Souder Miller & Associates
3451 Candelaria, NE Suite D
Albuquerque, NM 87107
TEL: (505) 299-7246
FAX

RE: NGWSP Reaches 26.1 & 26.2 & 24.1 JAN OrderNo.: 1501020

Dear Emily Sotelo:

Hall Environmental Analysis Laboratory received 4 sample(s) on 1/5/2015 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Souder Miller & Associates
Project: NGWSP Reaches 26.1 & 26.2
Lab ID: 1501020-002 **Matrix:** SOIL

Client Sample ID: VJ1 Cuttings 14-1-087
Collection Date: 1/5/2015 11:15:00 AM
Received Date: 1/5/2015 11:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 300.0: ANIONS							Analyst: **lgp**
Chloride	ND	30		mg/Kg	20	1/6/2015 4:26:04 PM	17085
Sulfate	30	30		mg/Kg	20	1/6/2015 4:26:04 PM	17085
SM4500-H+B: PH							Analyst: **JRR**
pH	8.29	1.68		pH Units	1	1/6/2015 11:08:00 AM	R23497

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
O	RSD is greater than RSDlimit	P	Sample pH greater than 2.
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: SMA ABQ   Work Order Number: 1501020   RcptNo: 1

Received by/date: CS 01/05/14

Logged By: **Celina Sessa** 1/5/2015 11:15:00 AM *Celina Sessa*

Completed By: **Celina Sessa** 1/5/2015 11:30:56 AM *Celina Sessa*

Reviewed By: [signature] 01/05/15

Chain of Custody

1. Custody seals intact on sample bottles? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? Client

Log In

4. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
5. Were all samples received at a temperature of >0° C to 6.0°C Yes ☐ No ☑ NA ☐
   Not required
6. Sample(s) in proper container(s)? Yes ☑ No ☐
7. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
8. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
9. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
10. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
11. Were any sample containers received broken? Yes ☐ No ☑
12. Does paperwork match bottle labels? Yes ☑ No ☐
    (Note discrepancies on chain of custody)
13. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
14. Is it clear what analyses were requested? Yes ☑ No ☐
15. Were all holding times able to be met? Yes ☑ No ☐
    (If no, notify customer for authorization.)

# of preserved bottles checked for pH: ______ (<2 or >12 unless noted)
Adjusted? ______
Checked by: ______

Special Handling (if applicable)

16. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ______ Date ______
By Whom: ______ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ______
Client Instructions: ______

17. Additional remarks:

18. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	19.3	Good	Not Present			

Chain-of-Custody Record

Client: Souder, Miller & Associates

Emily Sotelo

Mailing Address: 3451 Candelaria Rd. NE

Phone #: 505-366-7246

email or Fax#: emily.sotelo@soudermiller.com

QA/QC Package:

☐ Standard ☐ Level 4 (Full Validation)

Accreditation

☐ NELAP ☐ Other ______

☐ EDD (Type) ______

Turn-Around Time:

☑ Standard ☐ Rush ______

Project Name: NGWSP Reaches 26.1 & 26.2

Project #:

Project Manager: Emily Sotelo

Sampler:

On Ice: ☐ Yes ☒ No

Sample Temperature: 9.3°C

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1501020	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH 8015B (GRO / DRO / MRO)	TPH (Method 418.1)	EDB (Method 504.1)	PAH's (8310 or 8270 SIMS)	RCRA 8 Metals	Anions (F, Cl, NO3, NO2, PO4, SO4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	pH				Air Bubbles (Y or N)
1/5/15	11:15	Soil	V3 @ 4ft 14-1-036	ziploc		-001								✓				✓				
↓	↓	↓	VJ1 Cuttings 14-1-087	↓		-002								✓				✓				
			4@ 15'-20' Cuttings 14-1-036, Water Tank			-003								✓				✓				
			3 @5' Cuttings 14-1-036, Water Tank			-004								✓				✓				
				cs 01/05/14																		

Date:	Time:	Relinquished by:	Received by:	Date	Time
1/5/15	11:15	Emily Sotelo	Celina Sosa	01/05/15	1115
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Geotechnical Report

Geotechnical Investigation

Navajo Gallup Water Supply Project (NGWSP) JAN 24.1 Sandoval County, New Mexico

Prepared for:
Souder, Miller & Associates

Project No.: 14-1-087

December 30, 2014

X8eVinyard

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CONTACTUS@X8EVINYARD.COM

TABLE OF CONTENTS

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NOTES - LOGS OF TEST HOLES

Test hole locations were determined by compass bearing and pacing distances from known topographic points.

"Drilling Method" refers to the equipment utilized to advance the test hole. A seven-inch outside diameter, continuous flight, hollowstem auger was utilized.

"S" under "Sample Type" indicates a Standard Penetration test (ASTM D-1586). The Standard Penetration sampler is 2 inches in outside diameter and 1 3/8 inches inside diameter.

"R" under "Sample Type" indicates a 3-inch outside diameter by 2.5-inch inside diameter sampler. The sampler is lined with 1-inch high brass rings.

"B" under "Sample Type" indicates a bulk sample.

"Blows Per Foot" indicates the number of blows of a 140-pound hammer falling 30 inches required to drive the indicated sampler 12 inches.

"NR" under "Blows/Foot" indicates that no sample was recovered.

"Dry Density PCF" indicates the laboratory determined soil dry density in pounds per cubic foot.

"Water Content %" indicates the laboratory determined soil moisture content in percent (ASTM D-2216).

"Unified Classification" indicates the field soil classification as per ASTM D-2488. When appropriate, the field classification is modified based upon subsequent laboratory tests.

Variations in soil profile, consistency, and moisture content may occur between test holes. Subsurface conditions may also vary between test holes and with time.

Figure No.: 13

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Navajo Gallup Water Supply Project (NGWSP) 24.1 JAN located in Sandoval County in New Mexico.

The investigation was performed to determine site subsurface conditions and, based upon the conditions observed in the test holes, to develop geotechnical recommendations for:

Foundation Design;
Slabs-on-Grade;
Lateral Earth Pressures;
Site Grading; and
Earthwork Construction.

The conclusions and recommendations presented are based on information provided to us regarding the proposed development, on subsurface conditions disclosed by the test holes, on laboratory testing, and upon the local standards of our profession at the time this report was prepared.

This investigation was not performed to determine the presence of potentially hazardous waste or radon gas. Determination of the presence of potentially hazardous materials was beyond the scope of this investigation and requires the use of exploration techniques and analytic testing which were not appropriate for this investigation. If desired, X8e Vinyard will perform an environmental audit of the site.

2.0 PROPOSED CONSTRUCTION

We anticipate that the proposed project will consist of a Surge Tank Building, and approximately 3.1 miles of 10-inch diameter pipeline. It is anticipated that the proposed Surge Tank will be housed in a single story pre-cast concrete building, approximately 160 square feet in plan. No basements or below grade structures are anticipated. Maximum exterior wall loads of up to 2.0 kips per lineal foot are anticipated at this time. If structure loads or configuration differ from those indicated in this report, this office should be notified.

3.0 SITE CONDITIONS

The project site is situated south of Counselors, New Mexico and east of the Jicarilla Apache Indian Reservation. The project site within the area of the proposed Surge Tank Building is bound to the north, east, and south by undeveloped land. The site is bound to the west by an existing dirt road. The site is relatively flat with a few weeds and shrubs.

The proposed waterline alignment passes through undeveloped land with sparse native grasses, numerous shrubs, including sage brush, scattered weeds and occasionally a few small junipers. Configuration of the site is indicated on the Site Plan, Figure 1.

4.0 SITE SUBSURFACE CONDITIONS

To explore the site subsurface conditions, one test hole was drilled and ten test pits were excavated at the approximate locations shown on the Site Plan, Figure 1. The test pits were excavated along the proposed waterline alignment and one test hole was drilled within the area of the proposed surge tank. The soils encountered at the surge tank site consisted of 5.0 feet of fine to medium grained, dense silty sand (SM) overlying 5.0 feet of very stiff, sandy lean clay (CL) with loose to medium dense silty sand extending from below the clay stratum and to the total depth investigated at this location of 21.5 feet. Along the proposed waterline alignment, the subsurface soils consisted predominantly of silty sand and occasionally a layer of clayey sand (SC) or lean clay with sand. A fat clay (CH), described as dry to slightly moist and soft to hard, was encountered between layers of silty sand in test hole VJ8. Test pits were excavated with a backhoe along the proposed waterline alignment as not all proposed test hole locations were readily accessible to a drill rig.

Neither flowing groundwater nor bedrock was encountered in the test hole to a depth of twenty one feet and six inches, the maximum depth of exploration. However, groundwater conditions may change with time due to precipitation, variations in groundwater level, seepage from ponding areas, or leaking utilities.

Most of the soils encountered in the test pits and test hole exhibit moderate consolidation potential under the anticipated structural loads. Slight to moderate consolidation (collapse) occurs when site soils increase in moisture content. Refer to Figures 14 and 15.

The test pits and test hole allow observation of a very small portion of the soils below the site. Significant variations in subsurface conditions may occur across the site, which were not disclosed by the test holes.

5.0 LABORATORY TESTING

A laboratory testing program was performed on samples obtained during the field investigation which appeared representative of the soils encountered in the test pits and test hole. The laboratory testing program was structured to determine the physical properties of the soils encountered in the test pits and test hole necessary for development of geotechnical recommendations.

The laboratory testing program included:

- Moisture Content;
- Dry Density;
- Sieve Analysis;
- Atterberg Limits;
- Consolidation/Collapse; and
- Standard Proctor.

Moisture Content and Dry Density tests were performed to evaluate the in-place soil density and moisture content. Test results help to evaluate settlement potential. Test results indicate the soils encountered in the test holes have an average dry density of approximately 109 pcf and

84.2 pcf at the proposed surge tank site and at selected test pit locations, respectively. Natural moisture content averaged approximately 4.7 percent and 8.3 percent at the proposed surge tank site and at selected test pit locations, respectively. Test results are presented on the Log of Test Hole VJ1, Figure 2 and are summarized on Table 1 for the proposed surge tank site. Logs of Test pits VJ2 through VJ11 are shown on Figures 3 through 12. Test results of field in-place density tests, including standard proctors are shown on Figures 16 through 19.

Sieve Analysis and Atterberg Limits tests were performed to confirm field soil classifications and to provide information on general physical soil properties. Test results are presented on Table 1.

Consolidation/Collapse tests were performed to evaluate structure settlement and to determine the effect of water on site soils. The results indicate that the tested soils are moderately compressible under anticipated loads. Slight to moderate additional settlement (collapse) occurred when the tested soils increased in moisture content. Test results are presented on Figures 14 and 15.

6.0 FOUNDATIONS

If the recommendations presented in this report are implemented particularly those regarding site grading and drainage, the proposed structure may be supported on conventional spread and strip footings. Foundations should bear on a minimum of 2.0 feet of structural fill. Structural fill should extend a minimum of two feet laterally beyond the edge of all footings. Foundations may be designed for an allowable bearing pressure of 2,000 pounds per square foot. This value may be increased by one-third for short-term loads due to wind and earthquakes. If it is not feasible to implement the site grading, drainage, and landscaping recommendations presented herein, an alternate foundation system may be required. This office should be contacted for additional recommendations.

The base of exterior footings should be embedded a minimum of three feet below lowest adjacent grade. The base of interior footings should be embedded a minimum of twenty-four inches below finish pad grade. Spread and strip footings should be a minimum of twenty-four and eighteen inches wide, respectively. However, local building codes may require greater dimensions.

Lateral foundation loads will be resisted by a combination of passive soil pressure against the sides of footings and friction along the base. A passive soil resistance of 300 pounds per cubic foot may be utilized for design. Frictional resistance may be determined by multiplying foundation dead load by a coefficient of friction of 0.40.

Prior to fill placement and following footing excavation, the natural soils should be scarified to a depth of eight inches and moistened to near optimum moisture content (±3%). The exposed soils should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. All fill below structures should be placed and compacted as detailed in the attached Appendix. Prior to pouring concrete footing excavations should be cleaned of any slough, loose soil, or debris. Footing excavations should be compacted as detailed in the attached Appendix.

Foundations designed and constructed as described herein are not anticipated to settle more than one inch. Differential settlement between adjacent column footings should not exceed one-half of the above value. Foundations should be designed and constructed to tolerate the above settlement. Foundations should be designed by a qualified structural engineer.

The site soils will consolidate if allowed to increase in moisture content. With appropriate landscape irrigation and site grading and drainage as detailed in this report the moisture content of the soils within five to seven feet of the ground surface may increase. The recommendations presented in this report for site preparation are the minimum we consider prudent to address this degree of moisture penetration. In the event moisture penetration to depths greater than seven feet occurs, movement substantially greater than quoted above will occur.

Based upon the results of this investigation and our previous experience in the site vicinity, an International Building Code Site Classification of "D" may be utilized for design.

7.0 CONCRETE SLABS-ON-GRADE

Concrete slabs-on-grade may be utilized. Slabs should bear on a minimum of three feet of structural fill. Minimum floor slab thickness, overall slab reinforcement, and sawed joints or control joints should be determined by a qualified structural engineer. Conventional slabs should be isolated from all foundations, stem walls, and utility lines. Monolithic slabs should be isolated from all utilities. Frequent joints should be scored or cut in slabs to control the location of cracks.

Thickened slabs may be utilized to support interior partitions. Thickened slabs should be a minimum of twelve inches in width and should be designed to exert a maximum earth pressure of 500 pounds per square foot. Wall loads on thickened slabs should not exceed 800 pounds per linear foot. The thickness and reinforcement should be determined by a qualified structural engineer.

Slabs should be adequately reinforced with steel. Slab reinforcement should be turned down into turned down edges.

For structural design of the floor slab, a modulus of subgrade reaction of 300 kips per cubic foot may be utilized. This value is for a 1' x 1' square or a 1' wide strip. The above value may be modified for various effective widths based upon the following equation:

$$K_s = 300\left[\frac{B+1}{2B}\right]^2$$

K_s = Modulus of subgrade reaction (kips per cubic foot)

B = Effective width of loaded area (feet)

If moisture-sensitive floor covering is utilized, the flooring manufacturer should be contacted to determine the necessity of a vapor barrier. The moisture barrier may consist of a 6-mil polyethylene film or equivalent. The barrier may be overlain with one or two inches of clean sand to provide a working surface and reduce shrinkage cracking.

Slabs should bear on a minimum of three feet of structural fill. Prior to placing slabs or structural fill, the natural soils should be stripped of vegetation, scarified to a depth of eight inches, and moistened to a near optimum (±3%) moisture content. The exposed soils should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. All fill below slabs should be placed and compacted as detailed in the attached Appendix.

8.0 EARTHWORK

8.1 General

The settlement estimates presented in this report are based upon the assumption that site earthwork will be performed as recommended in this report and the attached Appendix. Presented below is a summary of the site earthwork recommendations. Detailed earthwork procedures are presented in the attached Appendix.

Prior to commencing earthwork the Contractor should obtain appropriate Proctor tests. Field density testing and evaluation of the suitability of the proposed materials performed prior to completion of the Proctor is "Preliminary" and may change based upon the results of the Proctor testing.

8.2 Clearing and Grubbing

Prior to placing structural fill, all borrow and fill areas should be stripped of vegetation and deleterious materials. All strippings should be hauled off-site or utilized in landscaped areas.

All existing utilities, septic tanks, leach fields, and disturbed soil should be removed from below the proposed structures. The resulting excavations should be backfilled with compacted fill as detailed in the attached Appendix.

8.3 Excavation

We anticipate that on-site soils can be excavated with conventional earthwork equipment. Occasional cobbles or boulders may be encountered during excavation. Cobbles and boulders should be disposed of off-site or utilized for landscaping. Cobbles and boulders should not be placed within structural fills. Cobbles and boulders as defined in ASTM D-2487.

8.4 Natural Ground Preparation

Prior to placing structural fill and subsequent to final grading in cut areas, the exposed soils should be scarified to a depth of eight inches and moisture conditioned to a near optimum (±3%) moisture content. The exposed soils should then be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557. If vibratory compaction poses a threat to nearby structures, static compaction should be utilized.

8.5 Fill Placement and Compaction

Structural fill should be placed in horizontal lifts a maximum of eight inches in loose thickness, moisture conditioned to near optimum moisture content, and mechanically compacted. Fill below footings and slabs should be compacted to a minimum of 95% of maximum dry density as determined by ASTM D-1557. The upper five feet of subsurface soils at the site of the proposed surge tank are anticipated to be suitable for re-use as structural fill.

8.6 Observation and Testing

Placement and compaction of structural fill should be observed and tested by a qualified geotechnical engineer or his representative. The purpose of the observation and testing is to confirm that the recommendations presented herein are followed and to provide supplemental recommendations, if subsurface conditions differ from those anticipated.

Foundation excavations should be observed by a qualified geotechnical engineer, or his representative, prior to placement of reinforcement or concrete. The purpose of the observation is to determine if the exposed soils are similar to those anticipated.

8.7 Frequency of Testing

Earthwork should be tested periodically to confirm the fill is compacted to the criteria presented in this report. Prior to placing fill, the natural ground should be moisture conditioned, compacted, and tested to confirm it is properly compacted. Fill should be placed in maximum eight-inch thick loose lifts, but in no case thicker than can be compacted with the equipment being utilized. Fill should be moisture conditioned and compacted as detailed in this report. Fill areas should be tested at maximum one-foot vertical intervals. If fill areas are worked at different times, each individual area should be tested. Following finish grading, the final surface should be tested. Following foundation excavation, the footing excavations should be tested. Utility trench backfill should be tested as necessary.

9.0 SITE GRADING AND DRAINAGE

The settlement estimates presented in this report assume the site will be graded to drain properly. If the site does not drain properly, structure settlement substantially greater than quoted in this report will occur.

The site soils are slightly to moderately collapsible if allowed to increase in moisture content. To reduce the risk of structure settlement the site should be graded to rapidly drain away from structures. Splash blocks should be utilized below down spouts and canales.

If ponding areas are required, they should be located as far away from structures as possible, a minimum of ten feet. If this criteria cannot be met, this office should be contacted for supplemental recommendations.

Roof gutters and downspouts should be utilized. Roof gutters should discharge to a hard surface at the front of the structure. Water should run off rapidly.

10.0 LANDSCAPING

Landscaping adjacent to structures should be designed and constructed to minimize the potential for wetting of soils supporting the proposed facilities. If soils supporting the proposed facilities are allowed to increase in moisture content to a depth greater than seven feet settlement greater than quoted in this report will occur.

Trees and shrubs within five feet of structures should be hand watered or watered using controlled drip irrigation. If drip irrigation is used, emitters should discharge no more than one gallon per hour. If grass must be planted within five feet of structures, watering should be carefully controlled to prevent overwatering. Grassed areas adjacent to structures should be sloped so that excess irrigation water will run off promptly. Sprinkler lines and drip irrigation mains should be located a minimum of five feet away from foundations.

Mowing strips, planters and sidewalks should not "dam" water adjacent to structures. If necessary, mowing strips should be perforated to allow water to flow away from structures.

All interior planters should be closed bottom and watertight.

11.0 UTILITIES

The site soils are collapsible if allowed to increase in moisture content. If post-construction water or sewer line leaks occur, localized settlement will occur. Following installation, all water and sewer lines should be pressure checked for leaks. Any leaks found should be repaired.

Backfill in utility line trenches below slabs, driveways, and pavement should be compacted to a minimum of 90% of maximum density as determined by ASTM D-698. Backfill in pipe line trenches beyond these areas should be compacted to a minimum of 85% of maximum density as determined by ASTM D-698. Utility trenches should be as narrow as can be properly compacted. To reduce the possibility of breaking utility lines with compaction equipment, heavy compactors should not be utilized.

Utility trenches may not be compacted to the same degree as the remainder of the building pad. Therefore, wall footings, interior walls and thickened slabs should not be placed longitudinally over utility trenches. Column footings should not be placed over utility trenches.

12.0 TRENCHES AND EXCAVATIONS

All trenches greater than four feet in depth must be sloped, shored or braced or otherwise supported according to OSHA Construction and Safety Standards. Material excavated from the trench or spoil must be placed a minimum of two feet from the edge of the excavation. The spoil should be retained in an effective manner such that no loose material can fall into the excavation.

Temporary construction excavations less than eight feet deep should be sloped no steeper than 1½:1 (horizontal:vertical). If deeper excavations are required, this office should be contacted for supplemental recommendations. Limited raveling of slopes will occur particularly as the exposed soils dry out. Heavy equipment and material stockpiles should be located a minimum of five feet from the top of slope.

13.0 CLOSURE

This report was prepared for the exclusive use of our Client. The recommendations presented in this report are based upon the subsurface conditions disclosed by the test pits and test hole. Soil and groundwater conditions may vary between test pits and test hole and with time.

This report reflects our interpretation of the site subsurface conditions. We strongly recommend that prior to bidding all contractors perform their own subsurface investigation to form their own opinion of the site soil, rock, and groundwater conditions. Should contractors elect to use this report for construction, bidding or estimating purposes, they do so at their own risk.

In a southwest climate it is particularly important to protect the soils supporting the proposed structure from an increase in moisture content. If soils supporting the structure increase in moisture content due to any cause such as poor site drainage, ponding areas, or leaking utility lines, significant structural settlement and distress may occur.

If conditions are encountered during construction which differ from those presented herein, this office should be contacted for supplemental recommendations. The staff of X8e Vinyard is available for supplemental consultation as necessary.

This office would be pleased to review site grading and drainage plans to evaluate conformance with the recommendations presented herein. All site earthwork should be observed by a qualified geotechnical engineer or his representative. X8e Vinyard would be pleased to provide these services.

X8e Vinyard

Ralph L. Abeyta, P.E., M. ASCE

RALPH L. ABEYTA NEW MEXICO 10852 REGISTERED PROFESSIONAL ENGINEER

12/30/14

X8e Vinyard Project No.: 14-1-087

SITE PLAN
***Scale Unknown**

Test Pit Location

FIGURE 1A

LOG OF TEST HOLE NO. VJ1

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 11/24/2014
Drilling Method: 7" H.S.A.

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	SAND, silty, fine to medium grained, dense, slightly moist, light brown/khaki, caliche, roots
	34	R	115	3.4	1,2,5		
5							
	22	R	103	6.7	1,2,5	CL	CLAY, sandy lean, very stiff, slightly moist, light brown
10							
	9	S		4.7		SM	SAND, silty, fine grained, loose, slightly moist, light brown
15							
	14	S		4.6			Medium dense
20							
	14	S		4.2			Fine to medium grained
							Bottom of hole at 21½'
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 2

LOG OF TEST PIT NO. VJ2

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, slightly moist, brown
							Light brown
5							Dense
							Loose
							Dense
10							Bottom of pit at 8'
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 3

LOG OF TEST PIT NO. VJ3

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, light brown Dense, dry Loose
5							
10							Bottom of pit at 8'
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 4

LOG OF TEST PIT NO. VJ4

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, dry, light brown
							Damp
5							Medium dense
		B				CL	Lean CLAY with sand, stiff, moist, dark brown
							Bottom of pit at 8'
10							Note: Bulk sample for proctor.
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 5

LOG OF TEST PIT NO. VJ5

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, medium dense, medium moist, dark brown
5		B				SC	Clayey SAND, very loose, moist, dark brown
							Loose to medium dense, slightly moist to dry, light brown
							Bottom of pit at 6'
10							
							Note: Bulk sample for proctor.
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 6

LOG OF TEST PIT NO. VJ6

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
0–5						SM	Silty SAND, dense, slightly moist, brown Weathered sandstone fragments Light brown
5–35							Bottom of pit at 6½', refusal

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 7

LOG OF TEST PIT NO. VJ7

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, damp, reddish brown
							Slightly moist, light brown
							Weathered sandstone fragments, very dense, brown
							Very silty
5							Slightly moist
							Weathered sandstone fragments
							Dry, white
							Light brown
10							Bottom of pit at 7½'
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 8

LOG OF TEST PIT NO. VJ8

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, dry, light brown Organic debris (roots)
5		B				CH	Fat CLAY, dry, soft, brown Slightly moist, dark brown Hard
						SM	Silty SAND, dense, dry, light brown
10 15 20 25 30 35							Bottom of pit at 8' Note: Bulk sample for proctor.

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 9

LOG OF TEST PIT NO. VJ9

Vinyard

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, dense, dry, light brown
							Weathered sandstone fragments, very dense, damp, white
5							Bottom of pit at 4½'
10							
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

LOG OF TEST PIT NO. VJ10

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, dry, light brown
							Weathered sandstone fragments, very dense, gold, brown, white
5							Bottom of pit at 4½'
10							
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

Figure: 11

LOG OF TEST PIT NO. VJ11

Project: NGWSP 24.1 JAN
Elevation: N/A
Depth to Groundwater: Not Encountered

Project No.: 14-1-087
Date Drilled: 10/2/2014
Drilling Method: Backhoe

Depth, feet	Blows/Foot	Sample Type	Dry Density pcf	Water Content, %	Additional Testing	Unified Classification	Material Description
						SM	Silty SAND, loose, dry, light brown
						CL	Lean CLAY with sand, very stiff, slightly moist, dark brown
5						SM	Silty SAND, medium dense, damp, light brown Dry
10							Bottom of pit at 8'
15							
20							
25							
30							
35							

ADDITIONAL TESTS: 1= Sieve Analysis 2= Atterberg Limits 3=Direct Shear 4=R-Value 5=Other

NOTES - LOGS OF TEST HOLES

Test hole locations were determined by compass bearing and pacing distances from known topographic points.

"Drilling Method" refers to the equipment utilized to advance the test hole. A seven-inch outside diameter, continuous flight, hollowstem auger was utilized.

"S" under "Sample Type" indicates a Standard Penetration test (ASTM D-1586). The Standard Penetration sampler is 2 inches in outside diameter and 1 3/8 inches inside diameter.

"R" under "Sample Type" indicates a 3-inch outside diameter by 2.5-inch inside diameter sampler. The sampler is lined with 1-inch high brass rings.

"B" under "Sample Type" indicates a bulk sample.

"Blows Per Foot" indicates the number of blows of a 140-pound hammer falling 30 inches required to drive the indicated sampler 12 inches.

"NR" under "Blows/Foot" indicates that no sample was recovered.

"Dry Density PCF" indicates the laboratory determined soil dry density in pounds per cubic foot.

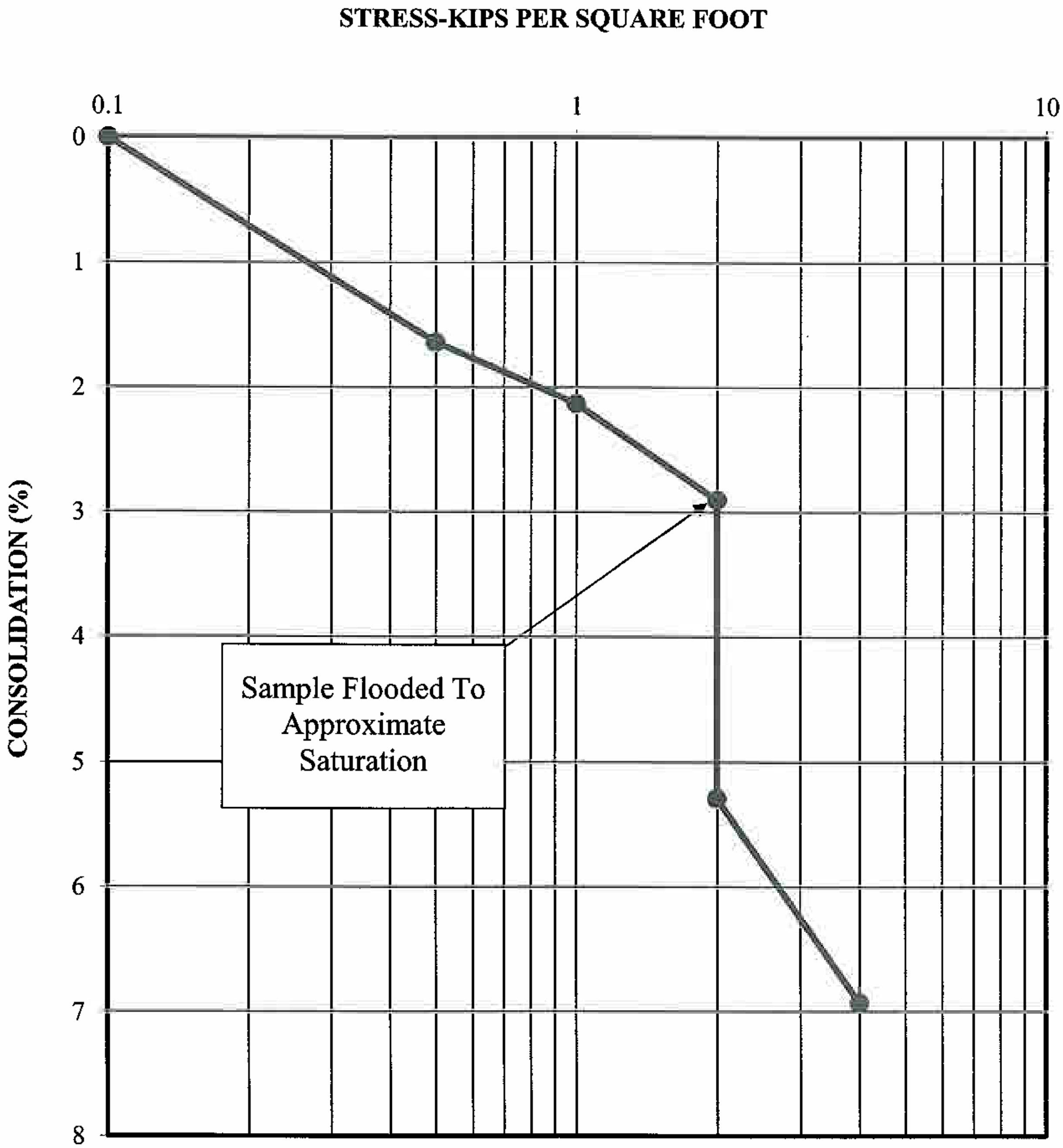
"Water Content %" indicates the laboratory determined soil moisture content in percent (ASTM D-2216).

"Unified Classification" indicates the field soil classification as per ASTM D-2488. When appropriate, the field classification is modified based upon subsequent laboratory tests.

Variations in soil profile, consistency, and moisture content may occur between test holes. Subsurface conditions may also vary between test holes and with time.

Figure No.: 13

CONSOLIDATION TEST RESULTS

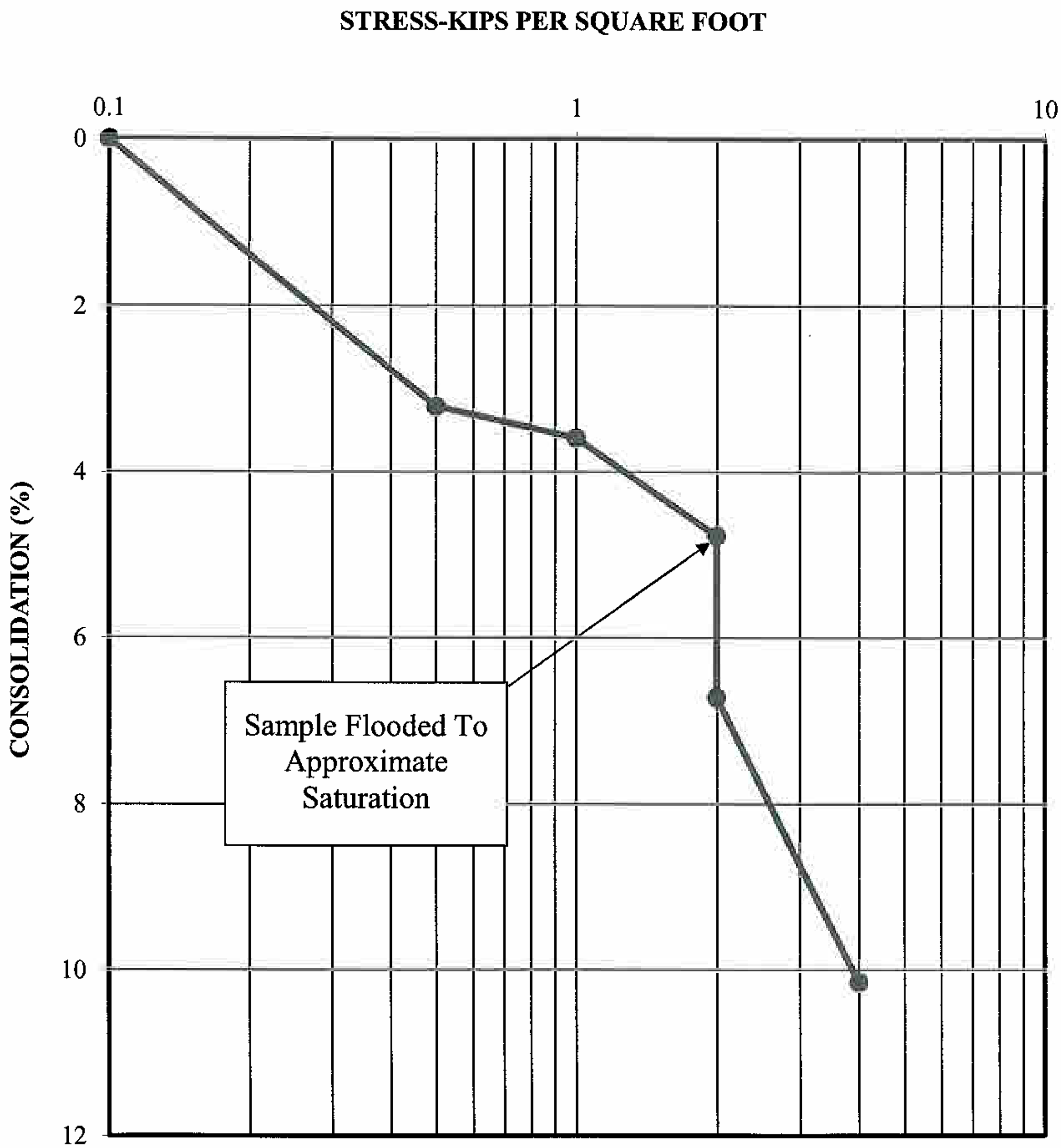


TEST HOLE NUMBER: 1
SAMPLE DEPTH: 2 FEET
SOIL DESCRIPTION: Silty SAND (SM)
MOISTURE CONTENT: 3.4 %
BULK UNIT WEIGHT: 115 pcf

PROJECT: Navajo Gallup Water Supply Project (NGWSP 24.1 JAN)
PROJECT NO.: 14-1-087

FIGURE NO.: 14

CONSOLIDATION TEST RESULTS



TEST HOLE NUMBER: 1
SAMPLE DEPTH: 5 FEET
SOIL DESCRIPTION: Sandy lean CLAY (CL)
MOISTURE CONTENT: 6.7 %
BULK UNIT WEIGHT: 103 pcf

PROJECT: Navajo Gallup Water Supply Project (NGWSP 24.1 JAN)
PROJECT NO.: 14-1-087

FIGURE NO.: 15

COMPACTION TEST RESULTS

PROJECT : NGWSP 24.1 JAN CLIENT: Souder, Miller & Associates
TECHNICIAN: Alex Abeyta
PROJECT NO.: 14-1-087 REPORT NO.: 1 DATE: 10/2/14
COA PROJECT NO.:

Test No.	Location	Elevation	Proctor Number	Field Moisture (%)	Field Dry Density (PCF)	Relative Compaction (%)	Specified Compaction (%)
1	Test pit VJ5	-3.5' FSG	3	7.1	78.7	72	NA
2	Test pit VJ5	-6' FSG	3	9.2	75.2	69	NA
3	Test pit VJ9	-4' FSG	3	8.6	98.6	90	NA
4	Test pit VJ9 (refusal at 4 1/2') No test taken	-6' FSG					

Proctor Test Utilized

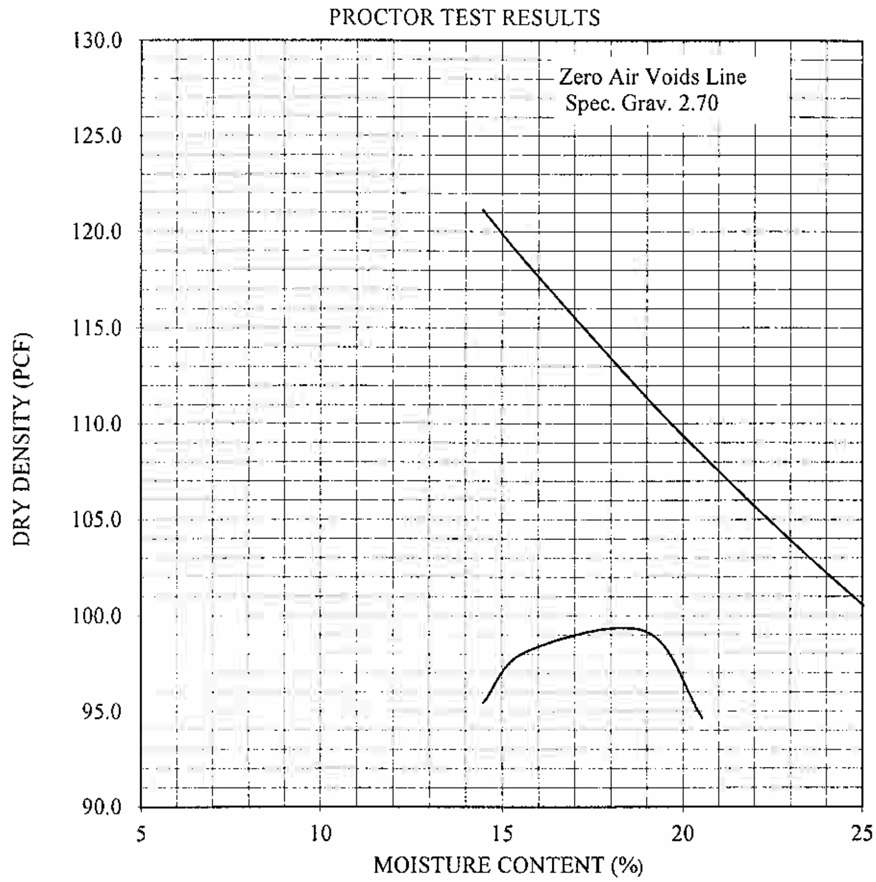
Proctor No.	Sample Location	Opt. Moisture Content (%)	Maximum Dry Dens (pcf)	Soil Description
3	NGWSP 24.1 JAN (14-431)	14.8	109.6	Clayey SAND

WEATHER: Cloudy, 42°, breezy

EQUIPMENT: Backhoe

REMARKS: Contracting personnel informed of the test results.

Figure 16



Max Dry Density= 99.3 PCF

Optimum Moist.= 17.4 %

Test Method : ASTM D698-A

X8eVinyard Project No.: **14-1-087**

COA Number:

Project Title : **NGWSP 24.1 Jan**

Date Sampled : **10/3/14**

Sample No. : **429**

Sample Location : **VJ4 @ 7' backhoe pit**

Sieve Analysis ASTM C-136

Sieve	mm	% Passing	Spec.
3"	75.0		
2"	50.0		
1 1/2"	37.5		
1"	25.0		
3/4"	19.0		
1/2"	12.5		
3/8"	9.5		
No. 4	4.75		
No. 8	2.36		
No. 10	2.00		
No. 16	1.18	100	
No. 30	0.60	99	
No. 40	0.425	98	
No. 50	0.300	97	
No. 80	0.180	94	
No. 100	0.150	93	
No. 200	0.075	86	

Atterberg Limits ASTM D4318

	Results	Spec.
LIQUID LIMIT	41	
PLASTIC LIMIT	13	
PLASTICITY INDEX	28	

ASTM D2487 USCS: **CL** **(Lean CLAY with sand.)**

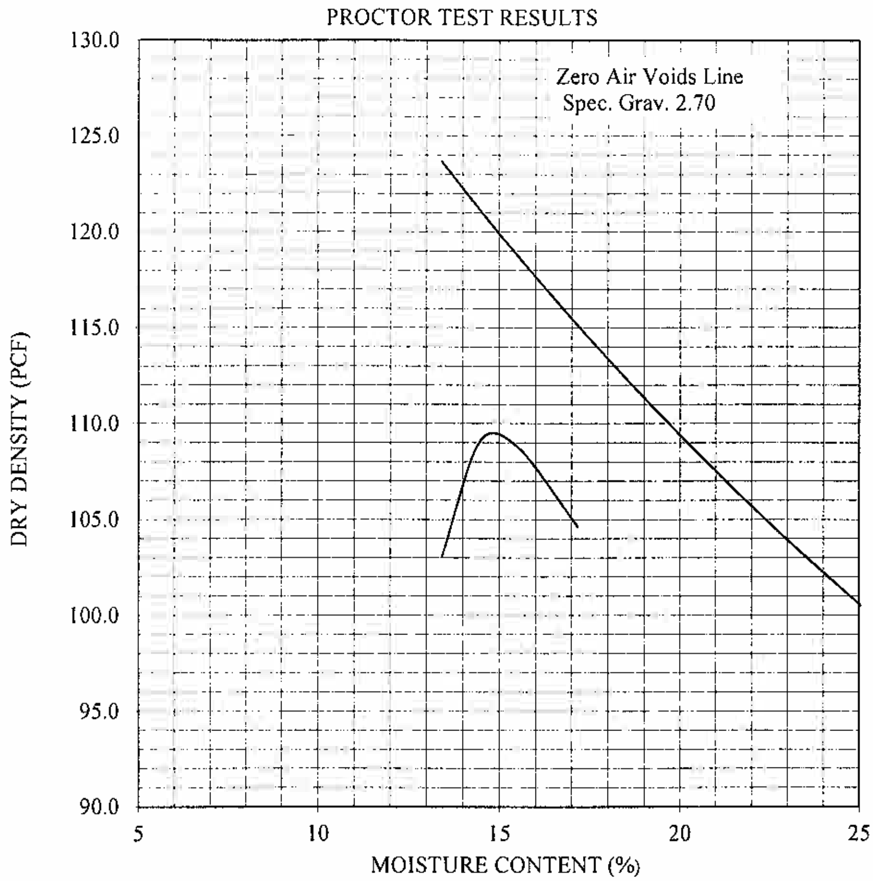
AASHTO M145 CLASS.: **A-7-6**

EST. R-VALUE: **5**
(Based on NMSHTD 97 Charts)

Specification Used : **None**

Figure: 17

Revision 11/21/12



Max Dry Density= 109.6 PCF

Optimum Moist.= 14.8 %

Test Method : ASTM D698-A

X8eVinyard Project No.: **14-1-087**

COA Number:

Project Title : **NGWSP 24.1 Jan**

Date Sampled : **10/3/14**

Sample No. : **431**

Sample Location : **VJ5 @ 3 1/2' backhoe pit**

Sieve Analysis ASTM C-136

Sieve	mm	% Passing	Spec.
3"	75.0		
2"	50.0		
1 1/2"	37.5		
1"	25.0		
3/4"	19.0		
1/2"	12.5		
3/8"	9.5		
No. 4	4.75		
No. 8	2.36		
No. 10	2.00		
No. 16	1.18	100	
No. 30	0.60	99	
No. 40	0.425	96	
No. 50	0.300	89	
No. 80	0.180	72	
No. 100	0.150	66	
No. 200	0.075	48	

Atterberg Limits ASTM D4318

	Results	Spec.
LIQUID LIMIT	28	
PLASTIC LIMIT	14	
PLASTICITY INDEX	14	

ASTM D2487 USCS: **SC** **(Clayey SAND.)**

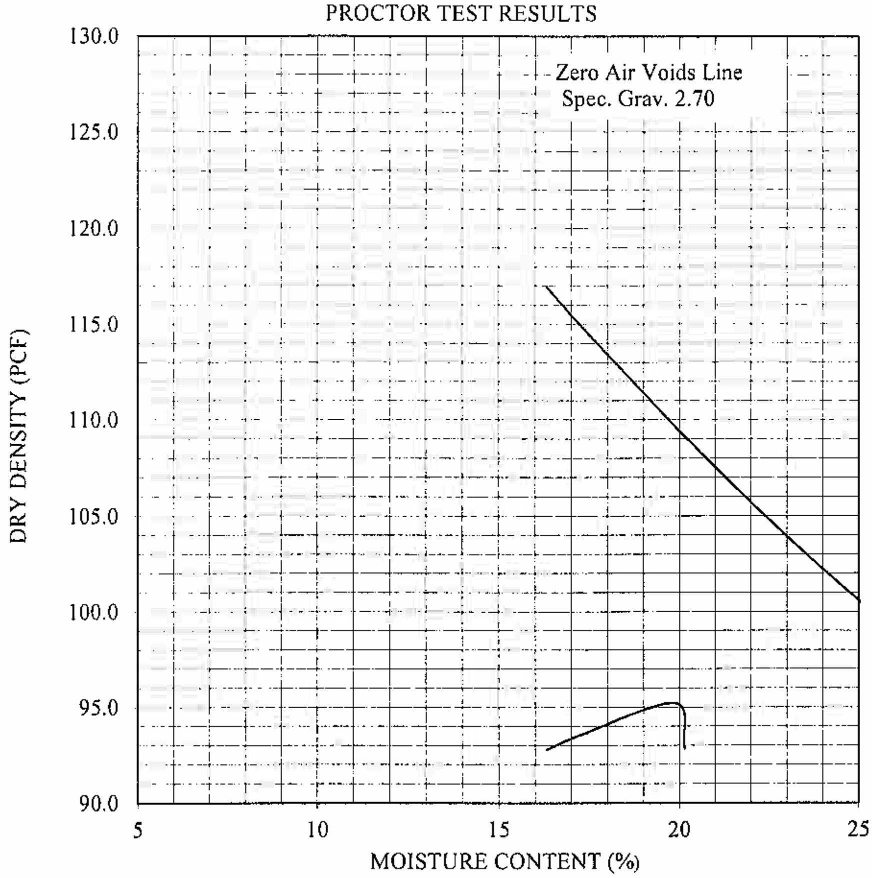
AASHTO M145 CLASS.: **A-6**

EST. R-VALUE: **12**
(Based on NMSHTD 97 Charts)

Specification Used : **None**

Figure: 18

Revision 11/21/12



Max Dry Density= 95.1 PCF

Optimum Moist.= 19.9 %

Test Method : ASTM D698-B

X8eVinyard Project No.: **14-1-087**

COA Number:

Project Title : **NGWSP 24.1 Jan**

Date Sampled : **10/3/14**

Sample No. : **430**

Sample Location : **VJ8 @ 4' backhoe pit**

Sieve Analysis ASTM C-136

Sieve	mm	% Passing	Spec.
3"	75.0		
2"	50.0		
1 1/2"	37.5		
1"	25.0		
3/4"	19.0		
1/2"	12.5		
3/8"	9.5		
No. 4	4.75		
No. 8	2.36		
No. 10	2.00		
No. 16	1.18		
No. 30	0.60	100	
No. 40	0.425	99	
No. 50	0.300	97	
No. 80	0.180	94	
No. 100	0.150	92	
No. 200	0.075	86	

Atterberg Limits ASTM D4318

	Results	Spec.
LIQUID LIMIT	56	
PLASTIC LIMIT	15	
PLASTICITY INDEX	41	

ASTM D2487 USCS: **CH** **(Fat CLAY with sand.)**

AASHTO M145 CLASS.: **A-7-6**

EST. R-VALUE: **3**
(Based on NMSHTD 97 Charts)

Specification Used : **None**

Figure: 19

Revision 11/21/12

SUMMARY OF LABORATORY TEST DATA

Test Hole	Depth (feet)	Unified Classification	Natural Dry Density (pcf)	Natural Moisture Content (%)	Atterberg Limits		SIEVE ANALYSIS-% PASSING BY WEIGHT										Description
					LL	PI	1 1/2"	3/4"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	
VJ1	2	SM	115	3.4	NV	NP					100	98	89	74	51	31.0	SAND, silty
VJ1	5	CL	103	6.7	30	14					100	99	96	91	83	67.5	CLAY, sandy lean
VJ1	10			4.7													
VJ1	15	SM		4.6	NV	NP						100	98	93	73	42.5	SAND, silty
VJ1	20			4.2													

X8e Vinyard Project No.: 14-1-087

Project: NGWSP 24.1 JAN

Table No.: 1

APPENDIX
EARTHWORK PROCEDURES

General

The Geotechnical Engineer shall be the Owner's representative to observe and evaluate the earthwork operations. The Contractor shall cooperate with the Geotechnical Engineer in the performance of the Engineer's duties.

Clearing and Grubbing

Prior to placing structural fill all borrow areas and areas to receive structural fill shall be stripped of vegetation and deleterious materials. Strippings shall be hauled off-site or stockpiled for subsequent use in landscaped areas or nonstructural fill areas as designated by the Owner or his representative and approved by the Geotechnical Engineer.

Site Preparation - Fill Areas

Prior to placing structural fill the areas to be filled shall be scarified to a depth of eight inches and moisture conditioned as described below. The area to be filled shall then be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557. If vibratory compaction techniques pose a threat to the structural integrity of nearby facilities a static compactor shall be used. Any soft or "spongy" areas shall be removed as directed by the Geotechnical Engineer and replaced with structural fill as described herein.

Site Preparation - Cut Areas

Following excavation to rough grade, all building and pavement areas shall be scarified to a depth of eight inches and moisture conditioned as described below. All building and paved areas shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-1557. If vibratory compaction techniques pose a threat to the structural integrity of nearby facilities, a static compactor shall be used. Any soft or "spongy" areas shall be removed as directed by the Geotechnical Engineer and replaced with structural fill as described herein.

Foundation, Slab and Pavement Subgrade Preparation

Prior to placing reinforcement, footings, slabs, or pavement, the supporting soils shall be prepared, moisture conditioned, and compacted as described herein.

Structural Fill Material

Structural fill material shall be nonexpansive soil which may be gravel, sand, silt or clay, or a combination there of.

Sieve Size	Percent Passing By Weight
4"	100
1"	90-100
No. 4	70-100
No. 200	10-40

Structural fill material shall exhibit a plasticity index of ten or less. No organic, frozen or decomposable material shall be utilized. All structural fill material shall be approved by the Geotechnical Engineer.

Structural Fill Placement

Structural fill material shall be blended as necessary to produce a homogeneous material. Fill material shall be spread in horizontal lifts no greater than eight inches in uncompacted thickness, but in no case thicker than can be properly compacted with the equipment to be utilized. If structural fill is to be placed on slopes steeper than 5:1 (horizontal:vertical) the natural ground shall be benched with minimum three foot wide benches at maximum two foot vertical intervals.

Moisture Conditioning

Structural fill material shall be dried or moistened as necessary, prior to compacting, to within ± three percent of optimum moisture content as determined by ASTM D-1557. Moisture shall be distributed uniformly throughout each lift.

Compaction

Structural fill shall be mechanically compacted to the following:

	Minimum Compaction ASTM D-1557
Foundation Support	95%
Slab Support	95%
Below Slab Utility Trenches	90%
General Site Grading	90%
Pavement Support	-
Upper 8" of Subgrade	95%
All other fill below pavement	90%

Aggregate Base Course shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-1557.

Asphaltic concrete shall be compacted to a range of 93% to 97% of the maximum Theoretical Unit Weight in accordance with ASTM D2041.

Compaction by flooding and jetting is specifically prohibited unless authorized in advance by the Owner or his representative and the Geotechnical Engineer.

Observation and Testing

The Geotechnical Engineer or his representative shall perform field density tests with a frequency and at the locations he feels appropriate. The Geotechnical Engineer or his representative will perform Proctor tests on representative samples of all structural fill material for compliance to structural fill requirements on page A-1. To minimize delays, the Earthwork Contractor is encouraged to submit soil samples prior to use for proctor testing.

Foundation Design Calculations

Souder, Miller & Associates
Civil/Environmental Scientists & Engineers
401 W. Broadway
Farmington, NM 87401
Phone (505) 325-7535
Fax (505) 326-0045

Navajo Gallup Water Supply
Reach 24.1 JAN
Surge Tank Building

Client: The Navajo Nation
Job# 6921307
March 2016

Calculations
Greta Y. Quintana P.E.

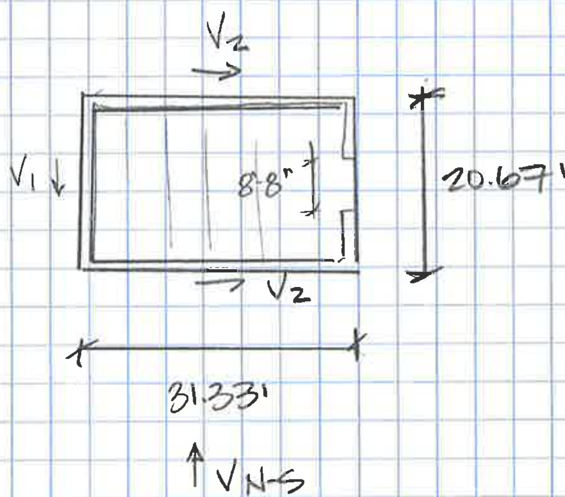
SUBJECT Reach 24.1 Surge Tank PROJECT PAGE

CLIENT DATE BY

CHECKED BY

Roof DL = 15psf
SL = 25psf

CMU wall wt = (61psf)(14') = 854plf



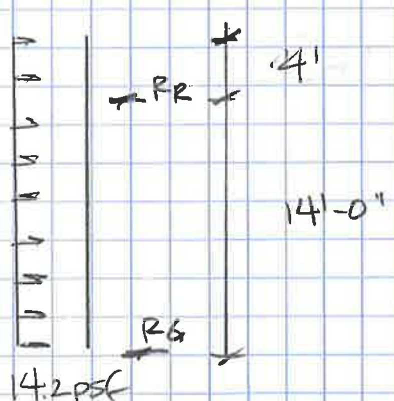
DL roof = (15psf)(20.67)(31.33)
= 9.7k

DL wall = (854plf)(31.33')(2)
= 53.5k

V_{N-S} = 0.1(9.7k + 53.5k) = 6.32k

take into "west wall"

Vwind =



RR = 160plf

V_{NS} = 4.9k

Wind Calculations
Method 2 - Low Rise Buildings ASCE 7-05
Cutter Lateral Reach 24.1

+ values act towards internal surface

- values act away from internal surface

Enter

Wind Speed	90	
Exposure	c	*Figure 6-2*
I	1	
K_z	0.85	*Table 6-3 change w/ exposure*
K_{zt}	1	*Figure 6-4*
K_d	0.85	*Table 6-4*
q_h	14.982 psf	

Low Rise Buildings EQN 6-18

		Gcpi(+)	Gcpi(-)
	0-5 deg	0.55	-0.55
Zone	GCpf	p (+Gcpi)	p (-Gcpi)
1	0.4	-2.24726	14.23267
2	-0.69	-18.5774	-2.09745
3	-0.37	-13.7832	2.696717
4	-0.29	-12.5847	3.895258
5	-0.45	-14.9818	1.498176
6	-0.45	-14.9818	1.498176
1E	0.61	0.898906	17.37884
2E	-1.07	-24.2705	-7.79052
3E	-0.53	-16.1803	0.299635
4E	-0.43	-14.6821	1.797811

Components/Cladding EQN 6-22

		Gcpi(+)	Gcpi(-)
		0.55	-0.55
Zone	GCp	p (+Gcpi)	p (-Gcpi)
1	-1.1	-24.7199	-8.23997
2	-1.22	-26.5177	-10.0378
2'	-1.55	-31.4617	-14.9818
3'	-2	-38.2035	-21.7236
3	-1.41	-29.3642	-12.8843
Walls 4	-1.1	-24.7199	-8.23997
Walls 5	-1.4	-29.2144	-12.7345
1	0.22	-4.94398	11.53596
2	0.22	-4.94398	11.53596
2'	0.22	-4.94398	11.53596
3'	0.22	-4.94398	11.53596
3	0.22	-4.94398	11.53596
Walls 4	1	6.741792	23.22173
Walls 5	1	6.741792	23.22173

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ASCE Seismic Base Shear

Seismic Calcs

Occupancy Category

Calculations per ASCE 7-05

Occupancy Category of Building or Other Structure : "II" : All Buildings and other structures except those listed as Category I, III, and IV — *ASCE 7-05, Page 3, Table 1-1*

Occupancy Importance Factor = 1 — *ASCE 7-05, Page 116, Table 11.5-1*

Gridded Ss & S1values from ASCE 7-05, 2006/09

ASCE 7-05 9.4.1.1

Max. Ground Motions, 5% Damping :

S_S = 0.180851 g, 0.2 sec response
S_1 = 0.064806 g, 1.0 sec response

Latitude = 36.204 deg North
Longitude = 107.494 deg West
Location : Counselor, NM 87018

Site Class, Site Coeff. and Design Category

Site Classification "D" : Shear Wave Velocity 600 to 1,200 ft/sec		=	D	*ASCE 7-05 Table 20.3-1*
Site Coefficients Fa & Fv	Fa	=	1.60	*ASCE 7-05 Table 11.4-1 & 11.4-2*
(using straight-line interpolation from table values)	Fv	=	2.40	
Maximum Considered Earthquake Acceleration	$S_{MS} = Fa * Ss$	=	0.289	*ASCE 7-05 Table 11.4-1*
	$S_{M1} = Fv * S1$	=	0.156	*ASCE 7-05 Table 11.4-2*
Design Spectral Acceleration	$S_{DS} = S_{MS} * 2/3$	=	0.193	*ASCE 7-05 Table 11.4-3*
	$S_{D1} = S_{M1} * 2/3$	=	0.104	*ASCE 7-05 Table 11.4-4*
Seismic Design Category		=	B	*ASCE 7-05 Table 11.6-1*

Resisting System

ASCE 7-05 Table 12.2-1

Basic Seismic Force Resisting System . . . **Bearing Wall Systems**
Ordinary reinforced masonry shear walls

Response Modification Coefficient " R "	=	2.00
System Overstrength Factor " Wo "	=	2.00
Deflection Amplification Factor " Cd "	=	1.75

NOTE! See ASCE 7-05 for all applicable footnotes.

Building height Limits :

Category "A & B" Limit:	No Limit
Category "C" Limit:	Limit = 160
Category "D" Limit:	Not Permitted
Category "E" Limit:	Not Permitted
Category "F" Limit:	Not Permitted

Redundancy Factor

ASCE 7-05 Section 12.3.4

Seismic Design Category of A, B, or C therefore Redundancy Factor " ρ " = 1.0

Lateral Force Procedure

ASCE 7-05 Section 12.8

Equivalent Lateral Force Procedure

The "Equivalent Lateral Force Procedure" is being used according to the provisions of ASCE 7-05 12.8

Determine Building Period

Use ASCE 12.8-7

Structure Type for Building Period Calculation : All Other Structural Systems

" Ct " value = 0.020 " hn " : Height from base to highest level = 25.0 ft
" x " value = 0.75
" Ta " Approximate fundemental period using Eq. 12.8-7 : Ta = Ct * (hn ^ x) = 0.224 sec
"TL" : Long-period transition period per ASCE 7-05 Maps 22-15 -> 22-20 8.000 sec

Building Period " Ta " Calculated from Approximate Method selected = 0.224 sec

" Cs " Response Coefficient

S_{DS}: Short Period Design Spectral Response	=	0.193	From Eq. 12.8-2, Preliminary Cs	=	0.096
" R " : Response Modification Factor	=	2.00	From Eq. 12.8-3 & 12.8-4 , Cs need not exceed	=	0.232
" I " : Occupancy Importance Factor	=	1	From Eq. 12.8-5 & 12.8-6, Cs not be less than	=	0.010

User has selected ASCE 12.8.1.3 : Regular structure,
Less than 5 Stories and with T <<= 0.5 sec, SO Ss <= 1.5 for Cs calculation

Cs : Seismic Response Coefficient = 0.0965

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ASCE Seismic Base Shear

Seismic Base Shear

ASCE 7-05 Section 12.8.1

Cs = 0.0965 from 12.8.3

W (see Sum Wi below) = 0.00 k

Seismic Base Shear V = Cs * W = 0.00 k

Vertical Distribution of Seismic Forces

ASCE 7-05 Section 12.8.3

" k " : hx exponent based on Ta = 1.00

Table of building Weights by Floor Level...

Level #	Wi : Weight	Hi : Height	(Wi * Hi) ^k	Cvx	Fx=Cvx * V	Sum Story Shear	Sum Story Moment

Sum Wi = 0.00 k

Sum Wi * Hi = 0.00 k-ft

Total Base Shear = 0.00 k

Base Moment = 0.0 k-ft

Diaphragm Forces : Seismic Design Category "B" to "F"

ASCE 7-05 12.10.1.1

Level #	Wi	Fi	Sum Fi	Sum Wi	Fpx

Wpx .... Weight at level of diaphragm and other structure elements attached to it.

Fi .... Design Lateral Force applied at the level.

Sum Fi .... Sum of "Lat. Force" of current level plus all levels above

MIN Req'd Force @ Level .... $0.20 * S_{DS} * I * Wpx$

MAX Req'd Force @ Level .... $0.40 * S_{DS} * I * Wpx$

Fpx : Design Force @ Level .... Wpx * SUM(x->n) Fi / SUM(x->n) wi, x = Current level, n = Top Level

SUBJECT PROJECT PAGE

CLIENT DATE BY

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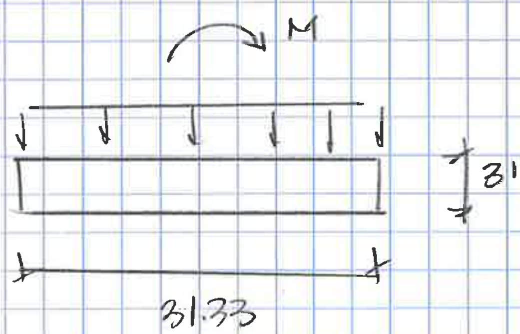
ck Footings w/ lateral loads - worst case

$M = (4.9^k)(14'/2) = 34.3^k\text{-ft}$

$W_{DL} = (15psf)(20.67'/2) = 155plf$

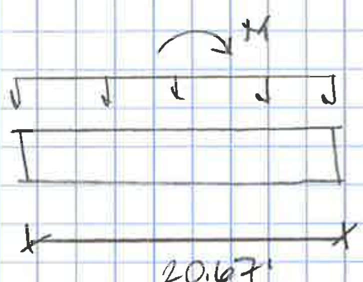
$W_{LL} = (25psf)(20.67'/2) = 258plf$



$V_{EW} = 0.1(9.7^k + 35.3^k) = 4.5^k$

$V/2 = 2.25^k$

$V_{wind} = (156plf)(31.33'/2) = 2.4^k$ ⇐ controls



$M = (2.4^k)(14'/2) = 16.8^k\text{-ft}$

$W_{DL} = (15psf)(2') = 30plf$

$W_{LL} = (25psf)(2') = 50plf$

$Q_a = 1500psf$

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General Footing

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Description : Footing 31.33' side (including M)

Code References

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05
Load Combinations Used : ASCE 7-05

General Information

Material Properties

f'c : Concrete 28 day strength	=	3.0 ksi
fy : Rebar Yield	=	60.0 ksi
Ec : Concrete Elastic Modulus	=	3,122.0 ksi
Concrete Density	=	145.0 pcf
φ Values Flexure	=	0.90
Shear	=	0.850

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.50 : 1
Min. Sliding Safety Factor	=	1.50 : 1
Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	1.50 ksf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.30

Increases based on footing Depth

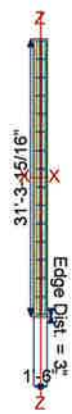
Footing base depth below soil surface	=	ft
Allow press. increase per foot of depth	=	ksf
when footing base is below	=	ft

Increases based on footing plan dimension

Allowable pressure increase per foot of depth	=	ksf
when max. length or width is greater than	=	ft

Dimensions

Width parallel to X-X Axis	=	1.50 ft
Length parallel to Z-Z Axis	=	31.330 ft
Footing Thickness	=	36.0 in



Pedestal dimensions...

px : parallel to X-X Axis	=	8.0 in
pz : parallel to Z-Z Axis	=	350.0 in
Height	=	in

Rebar Centerline to Edge of Concrete...

at Bottom of footing	=	3.0 in

Reinforcing

Bars parallel to X-X Axis

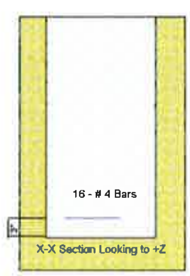
Number of Bars	=	16.0
Reinforcing Bar Size	=	# 4

Bars parallel to Z-Z Axis

Number of Bars	=	4.0
Reinforcing Bar Size	=	# 5

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation	ıg X-X Axis
# Bars required within zone	9.1 %
# Bars required on each side of zone	90.9 %



Applied Loads

		D	Lr	L	S	W	E	H	
P : Column Load	=	4.80			8.080				k
OB : Overburden	=								ksf
M-xx	=					34.30			k-ft
M-zz	=								k-ft
V-x	=								k
V-z	=								k

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Description : Footing 31.33' side (including M)

DESIGN SUMMARY

Design N.G.

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.5128	Soil Bearing	0.7692 ksf	1.50 ksf	+D+0.750L+0.750S+0.750W+H about X-)
PASS	6.917	Overturning - X-X	34.30 k-ft	237.257 k-ft	+0.60D+W+H
PASS	n/a	Overturning - Z-Z	0.0 k-ft	0.0 k-ft	No Overturning
PASS	n/a	Sliding - X-X	0.0 k	0.0 k	No Sliding
PASS	n/a	Sliding - Z-Z	0.0 k	0.0 k	No Sliding
PASS	n/a	Uplift	0.0 k	0.0 k	No Uplift
FAIL	As < Min	Z Flexure (+X)	0.01241 k-ft	15.122 k-ft	+1.40D
FAIL	As < Min	Z Flexure (-X)	0.01241 k-ft	15.122 k-ft	+1.40D
PASS	0.002472	X Flexure (+Z)	0.2960 k-ft	119.745 k-ft	+1.20D+1.60S+0.80W
PASS	0.001940	X Flexure (-Z)	0.2324 k-ft	119.745 k-ft	+1.20D+0.50L+1.60S
PASS	n/a	1-way Shear (+X)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (-X)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (+Z)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (-Z)	0.0 psi	93.113 psi	n/a
PASS	n/a	2-way Punching	0.0 psi	93.113 psi	n/a

temp/shrinkage As ok below frost

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc (in)	Zecc (in)	Actual Soil Bearing Stress @ Location Bottom, -Z	Top, +Z	Left, -X	Right, +X	Actual / Allow Ratio
X-X, D Only	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+L+H	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+Lr+H	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+S+H	1.50	n/a	0.0	0.7091	0.7091	n/a	n/a	0.473
X-X, +D+0.750Lr+0.750L+H	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+0.750L+0.750S+H	1.50	n/a	0.0	0.6661	0.6661	n/a	n/a	0.444
X-X, +D+W+H	1.50	n/a	16.306	0.3997	0.6746	n/a	n/a	0.450
X-X, +D+0.70E+H	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+0.750Lr+0.750L+0.750W+H	1.50	n/a	12.229	0.4341	0.6402	n/a	n/a	0.427
X-X, +D+0.750L+0.750S+0.750W+H	1.50	n/a	9.862	0.5630	0.7692	n/a	n/a	0.513
X-X, +D+0.750Lr+0.750L+0.5250E+H	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, +D+0.750L+0.750S+0.5250E+H	1.50	n/a	0.0	0.6661	0.6661	n/a	n/a	0.444
X-X, +0.60D+W+H	1.50	n/a	27.176	0.1848	0.4597	n/a	n/a	0.307
X-X, +0.60D+0.70E+H	1.50	n/a	0.0	0.3223	0.3223	n/a	n/a	0.215
X-X, D Only	1.50	n/a	0.0	0.5371	0.5371	n/a	n/a	0.358
X-X, Lr Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, L Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, S Only	1.50	n/a	0.0	0.1719	0.1719	n/a	n/a	0.115
X-X, W Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, E Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, H Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
Z-Z, D Only	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+L+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+Lr+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+S+H	1.50	0.0	n/a	n/a	n/a	0.7091	0.7091	0.473
Z-Z, +D+0.750Lr+0.750L+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+0.750L+0.750S+H	1.50	0.0	n/a	n/a	n/a	0.6661	0.6661	0.444
Z-Z, +D+W+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+0.70E+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+0.750Lr+0.750L+0.750W+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+0.750L+0.750S+0.750W+H	1.50	0.0	n/a	n/a	n/a	0.6661	0.6661	0.444
Z-Z, +D+0.750Lr+0.750L+0.5250E+H	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, +D+0.750L+0.750S+0.5250E+H	1.50	0.0	n/a	n/a	n/a	0.6661	0.6661	0.444
Z-Z, +0.60D+W+H	1.50	0.0	n/a	n/a	n/a	0.3223	0.3223	0.215
Z-Z, +0.60D+0.70E+H	1.50	0.0	n/a	n/a	n/a	0.3223	0.3223	0.215
Z-Z, D Only	1.50	0.0	n/a	n/a	n/a	0.5371	0.5371	0.358
Z-Z, Lr Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, L Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, S Only	1.50	0.0	n/a	n/a	n/a	0.1719	0.1719	0.115
Z-Z, W Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000

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General Footing

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Description : Footing 31.33' side (including M)

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc (in)	Zecc (in)	Actual Soil Bearing Stress @ Location: Bottom, -Z	Top, +Z	Left, -X	Right, +X	Actual / Allow Ratio
Z-Z, E Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, H Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000

Overturning Stability

Rotation Axis & Load Combination...	Overturning Moment	Resisting Moment	Stability Ratio	Status
X-X, D Only	None	0.0 k-ft	Infinity	OK
X-X, +D+L+H	None	0.0 k-ft	Infinity	OK
X-X, +D+Lr+H	None	0.0 k-ft	Infinity	OK
X-X, +D+S+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750Lr+0.750L+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750L+0.750S+H	None	0.0 k-ft	Infinity	OK
X-X, +D+W+H	34.30 k-ft	395.429 k-ft	11.529	OK
X-X, +D+0.70E+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750Lr+0.750L+0.750W+H	25.725 k-ft	395.429 k-ft	15.371	OK
X-X, +D+0.750L+0.750S+0.750W+H	25.725 k-ft	490.359 k-ft	19.062	OK
X-X, +D+0.750Lr+0.750L+0.5250E+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750L+0.750S+0.5250E+H	None	0.0 k-ft	Infinity	OK
X-X, +0.60D+W+H	34.30 k-ft	237.257 k-ft	6.917	OK
X-X, +0.60D+0.70E+H	None	0.0 k-ft	Infinity	OK
X-X, D Only	None	0.0 k-ft	Infinity	OK
X-X, Lr Only	None	0.0 k-ft	Infinity	OK
X-X, L Only	None	0.0 k-ft	Infinity	OK
X-X, S Only	None	0.0 k-ft	Infinity	OK
X-X, W Only	None	0.0 k-ft	Infinity	OK
X-X, E Only	None	0.0 k-ft	Infinity	OK
X-X, H Only	None	0.0 k-ft	Infinity	OK
Z-Z, D Only	None	0.0 k-ft	Infinity	OK
Z-Z, +D+L+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+Lr+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+S+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.70E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+0.750W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+0.750W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+0.5250E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+0.5250E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +0.60D+W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +0.60D+0.70E+H	None	0.0 k-ft	Infinity	OK
Z-Z, D Only	None	0.0 k-ft	Infinity	OK
Z-Z, Lr Only	None	0.0 k-ft	Infinity	OK
Z-Z, L Only	None	0.0 k-ft	Infinity	OK
Z-Z, S Only	None	0.0 k-ft	Infinity	OK
Z-Z, W Only	None	0.0 k-ft	Infinity	OK
Z-Z, E Only	None	0.0 k-ft	Infinity	OK
Z-Z, H Only	None	0.0 k-ft	Infinity	OK

All units k

Sliding Stability

Force Application Axis Load Combination...	Sliding Force	Resisting Force	Stability Ratio	Status
Footing Has NO Sliding				

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
X-X, +1.40D	0.08355	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.40D	0.08355	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50Lr+1.60L+1.60H	0.07162	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK

General Footing

Description : Footing 31.33' side (including M)

X-X, +1.20D+0.50Lr+1.60L+1.60H	0.07162	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60L+0.50S+1.60H	0.1218	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK

General Footing

Description : Footing 31.33' side (including M)

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
X-X, +1.20D+1.60L+0.50S+1.60H	0.1218	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60Lr+0.50L	0.07162	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60Lr+0.50L	0.07162	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60Lr+0.80W	0.1353	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60Lr+0.80W	0.007948	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+1.60S	0.2324	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+1.60S	0.2324	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60S+0.80W	0.2960	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+1.60S+0.80W	0.1687	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	0.1990	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	0.05572	-Z	Top	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+0.50S+1.60W	0.2492	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+0.50S+1.60W	0.005489	-Z	Top	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+0.20S+E	0.09171	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +1.20D+0.50L+0.20S+E	0.09171	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +0.90D+1.60W+1.60H	0.1810	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +0.90D+1.60W+1.60H	0.07362	-Z	Top	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +0.90D+E+1.60H	0.05371	+Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
X-X, +0.90D+E+1.60H	0.05371	-Z	Bottom	0.7776	Min Temp %	0.8267	119.745	OK
Z-Z, +1.40D	0.01241	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.40D	0.01241	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	0.01064	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	0.01064	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	0.01810	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	0.01810	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60Lr+0.50L	0.01064	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60Lr+0.50L	0.01064	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60Lr+0.80W	0.01064	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60Lr+0.80W	0.01064	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+1.60S	0.03451	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+1.60S	0.03451	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60S+0.80W	0.03451	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+1.60S+0.80W	0.03451	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	0.01064	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	0.01064	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	0.01810	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	0.01810	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+0.20S+E	0.01362	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +1.20D+0.50L+0.20S+E	0.01362	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +0.90D+1.60W+1.60H	0.007976	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +0.90D+1.60W+1.60H	0.007976	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +0.90D+E+1.60H	0.007976	-X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK
Z-Z, +0.90D+E+1.60H	0.007976	+X	Bottom	0.7776	Min Temp %	0.1021	15.122	OK

One Way Shear

Load Combination...	Vu @ -X	Vu @ +X	Vu @ -Z	Vu @ +Z	Vu:Max	Phi Vn	Vu / Phi*Vn	Status
+1.40D	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50Lr+1.60L+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60L+0.50S+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60Lr+0.50L	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60Lr+0.80W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+1.60S	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60S+0.80W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50Lr+0.50L+1.60W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+0.50S+1.60W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+0.20S+E	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+0.90D+1.60W+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+0.90D+E+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK

All units k

Punching Shear

Load Combination...	Vu	Phi*Vn	Vu / Phi*Vn	Status
+1.40D	0 psi	97.369 psi	0	OK
+1.20D+0.50Lr+1.60L+1.60H	0 psi	97.369 psi	0	OK

General Footing

Description : Footing 31.33' side (including M)

Punching Shear

All units k

Load Combination...	Vu	Phi*Vn	Vu / Phi*Vn	Status
+1.20D+1.60L+0.50S+1.60H	0 psi	97.369 psi	0	OK
+1.20D+1.60Lr+0.50L	0 psi	97.369 psi	0	OK
+1.20D+1.60Lr+0.80W	0 psi	97.369 psi	0	OK
+1.20D+0.50L+1.60S	0 psi	97.369 psi	0	OK
+1.20D+1.60S+0.80W	0 psi	97.369 psi	0	OK
+1.20D+0.50Lr+0.50L+1.60W	0 psi	97.369 psi	0	OK
+1.20D+0.50L+0.50S+1.60W	0 psi	97.369 psi	0	OK
+1.20D+0.50L+0.20S+E	0 psi	97.369 psi	0	OK
+0.90D+1.60W+1.60H	0 psi	97.369 psi	0	OK
+0.90D+E+1.60H	0 psi	97.369 psi	0	OK

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

11

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General Footing

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6

Lic. # : KW-06004473 **Licensee : SOUDER MILLER & ASSOCIATES**

Description : Footing 20.67' including M

Code References

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05
Load Combinations Used : ASCE 7-05

General Information

Material Properties

f'c : Concrete 28 day strength	=	3.0 ksi
fy : Rebar Yield	=	60.0 ksi
Ec : Concrete Elastic Modulus	=	3,122.0 ksi
Concrete Density	=	145.0 pcf
φ Values Flexure	=	0.90
Shear	=	0.850

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.50 : 1
Min. Sliding Safety Factor	=	1.50 : 1
Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	1.50 ksf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.30

Increases based on footing Depth

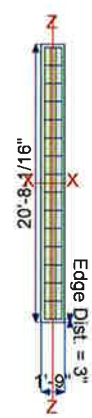
Footing base depth below soil surface	=	ft
Allow press. increase per foot of depth	=	ksf
when footing base is below	=	ft

Increases based on footing plan dimension

Allowable pressure increase per foot of depth	=	ksf
when max. length or width is greater than	=	ft

Dimensions

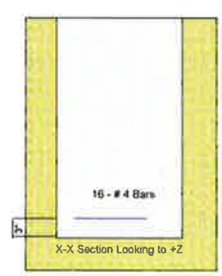
Width parallel to X-X Axis	=	1.750 ft
Length parallel to Z-Z Axis	=	20.670 ft
Footing Thickness	=	36.0 in



Pedestal dimensions...		
px : parallel to X-X Axis	=	8.0 in
pz : parallel to Z-Z Axis	=	248.0 in
Height	=	in
Rebar Centerline to Edge of Concrete... at Bottom of footing	=	3.0 in

Reinforcing

Bars parallel to X-X Axis		
Number of Bars	=	16.0
Reinforcing Bar Size	=	# 4
Bars parallel to Z-Z Axis		
Number of Bars	=	4.0
Reinforcing Bar Size	=	# 6



Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation	ıg X-X Axis
# Bars required within zone	15.6 %
# Bars required on each side of zone	84.4 %

Applied Loads

		D	Lr	L	S	W	E	H	
P : Column Load	=	0.620			1.030				k
OB : Overburden	=								ksf
M-xx	=					16.80			k-ft
M-zz	=								k-ft
V-x	=								k
V-z	=								k

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Project Title:
Engineer:
Project Descr:

Project ID: 12

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General Footing

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ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

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Description : Footing 20.67' including M

DESIGN SUMMARY

Design N.G.

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.3898	Soil Bearing	0.5847 ksf	1.50 ksf	+D+W+H about X-X axis
PASS	6.037	Overturning - X-X	16.80 k-ft	101.418 k-ft	+0.60D+W+H
PASS	n/a	Overturning - Z-Z	0.0 k-ft	0.0 k-ft	No Overturning
PASS	n/a	Sliding - X-X	0.0 k	0.0 k	No Sliding
PASS	n/a	Sliding - Z-Z	0.0 k	0.0 k	No Sliding
PASS	n/a	Uplift	0.0 k	0.0 k	No Uplift
FAIL	As < Min	Z Flexure (+X)	0.003518 k-ft	22.884 k-ft	+1.40D
FAIL	As < Min	Z Flexure (-X)	0.003518 k-ft	22.884 k-ft	+1.40D
PASS	0.0	X Flexure (+Z)	0.0 k-ft	0.0 k-ft	No Moment
PASS	0.0	X Flexure (-Z)	0.0 k-ft	0.0 k-ft	No Moment
PASS	n/a	1-way Shear (+X)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (-X)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (+Z)	0.0 psi	93.113 psi	n/a
PASS	n/a	1-way Shear (-Z)	0.0 psi	93.113 psi	n/a
PASS	n/a	2-way Punching	0.0 psi	93.113 psi	n/a

temp/shrinkage ok - below floor

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc (in)	Zecc (in)	Actual Soil Bearing Stress @ Location: Bottom, -Z	Top, +Z	Left, -X	Right, +X	Actual / Allow Ratio
X-X, D Only	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+L+H	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+Lr+H	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+S+H	1.50	n/a	0.0	0.4806	0.4806	n/a	n/a	0.320
X-X, +D+0.750Lr+0.750L+H	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+0.750L+0.750S+H	1.50	n/a	0.0	0.4735	0.4735	n/a	n/a	0.316
X-X, +D+W+H	1.50	n/a	12.326	0.3196	0.5847	n/a	n/a	0.390
X-X, +D+0.70E+H	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+0.750Lr+0.750L+0.750W+H	1.50	n/a	9.245	0.3527	0.5516	n/a	n/a	0.368
X-X, +D+0.750L+0.750S+0.750W+H	1.50	n/a	8.828	0.3741	0.5729	n/a	n/a	0.382
X-X, +D+0.750Lr+0.750L+0.5250E+H	1.50	n/a	0.0	0.4521	0.4521	n/a	n/a	0.301
X-X, +D+0.750L+0.750S+0.5250E+H	1.50	n/a	0.0	0.4735	0.4735	n/a	n/a	0.316
X-X, +0.60D+W+H	1.50	n/a	20.544	0.1387	0.4039	n/a	n/a	0.269
X-X, +0.60D+0.70E+H	1.50	n/a	0.0	0.2713	0.2713	n/a	n/a	0.181
Z-Z, D Only	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+L+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+Lr+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+S+H	1.50	0.0	n/a	n/a	n/a	0.4806	0.4806	0.320
Z-Z, +D+0.750Lr+0.750L+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+0.750L+0.750S+H	1.50	0.0	n/a	n/a	n/a	0.4735	0.4735	0.316
Z-Z, +D+W+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+0.70E+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+0.750Lr+0.750L+0.750W+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+0.750L+0.750S+0.750W+H	1.50	0.0	n/a	n/a	n/a	0.4735	0.4735	0.316
Z-Z, +D+0.750Lr+0.750L+0.5250E+H	1.50	0.0	n/a	n/a	n/a	0.4521	0.4521	0.301
Z-Z, +D+0.750L+0.750S+0.5250E+H	1.50	0.0	n/a	n/a	n/a	0.4735	0.4735	0.316
Z-Z, +0.60D+W+H	1.50	0.0	n/a	n/a	n/a	0.2713	0.2713	0.181
Z-Z, +0.60D+0.70E+H	1.50	0.0	n/a	n/a	n/a	0.2713	0.2713	0.181

Overturning Stability

Rotation Axis & Load Combination...	Overturning Moment	Resisting Moment	Stability Ratio	Status
X-X, D Only	None	0.0 k-ft	Infinity	OK
X-X, +D+L+H	None	0.0 k-ft	Infinity	OK
X-X, +D+Lr+H	None	0.0 k-ft	Infinity	OK
X-X, +D+S+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750Lr+0.750L+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750L+0.750S+H	None	0.0 k-ft	Infinity	OK
X-X, +D+W+H	16.80 k-ft	169.029 k-ft	10.061	OK
X-X, +D+0.70E+H	None	0.0 k-ft	Infinity	OK

General Footing

Description : Footing 20.67' including M

Overturning Stability

Rotation Axis & Load Combination...	Overturning Moment	Resisting Moment	Stability Ratio	Status
X-X, +D+0.750Lr+0.750L+0.750W+H	12.60 k-ft	169.029 k-ft	13.415	OK
X-X, +D+0.750L+0.750S+0.750W+H	12.60 k-ft	177.013 k-ft	14.049	OK
X-X, +D+0.750Lr+0.750L+0.5250E+H	None	0.0 k-ft	Infinity	OK
X-X, +D+0.750L+0.750S+0.5250E+H	None	0.0 k-ft	Infinity	OK
X-X, +0.60D+W+H	16.80 k-ft	101.418 k-ft	6.037	OK
X-X, +0.60D+0.70E+H	None	0.0 k-ft	Infinity	OK
Z-Z, D Only	None	0.0 k-ft	Infinity	OK
Z-Z, +D+L+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+Lr+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+S+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.70E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+0.750W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+0.750W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750Lr+0.750L+0.5250E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +D+0.750L+0.750S+0.5250E+H	None	0.0 k-ft	Infinity	OK
Z-Z, +0.60D+W+H	None	0.0 k-ft	Infinity	OK
Z-Z, +0.60D+0.70E+H	None	0.0 k-ft	Infinity	OK

All units k

Sliding Stability

Force Application Axis Load Combination...	Sliding Force	Resisting Force	Stability Ratio	Status
Footing Has NO Sliding				

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
X-X, +1.40D	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.40D	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50Lr+1.60L+1.60H	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50Lr+1.60L+1.60H	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60L+0.50S+1.60H	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60L+0.50S+1.60H	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60Lr+0.50L	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60Lr+0.50L	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60Lr+0.80W	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60Lr+0.80W	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+1.60S	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+1.60S	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60S+0.80W	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+1.60S+0.80W	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+0.50S+1.60W	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+0.50S+1.60W	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+0.20S+E	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +1.20D+0.50L+0.20S+E	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +0.90D+1.60W+1.60H	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +0.90D+1.60W+1.60H	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +0.90D+E+1.60H	0.0	+Z	Top	0.7776	Min Temp %	1.006	144.886	OK
X-X, +0.90D+E+1.60H	0.0	-Z	Top	0.7776	Min Temp %	1.006	144.886	OK
Z-Z, +1.40D	0.003518	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.40D	0.003518	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	0.003016	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	0.003016	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	0.005103	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	0.005103	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60Lr+0.50L	0.003016	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60Lr+0.50L	0.003016	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60Lr+0.80W	0.003016	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK

General Footing

Description : Footing 20.67' including M

Z-Z, +1.20D+1.60Lr+0.80W	0.003016	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID: 14a

Printed: 30 MAR 2016, 2:07PM

General Footing

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : Footing 20.67' including M

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
Z-Z, +1.20D+0.50L+1.60S	0.009696	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50L+1.60S	0.009696	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60S+0.80W	0.009696	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+1.60S+0.80W	0.009696	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	0.003016	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	0.003016	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	0.005103	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	0.005103	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50L+0.20S+E	0.003851	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +1.20D+0.50L+0.20S+E	0.003851	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +0.90D+1.60W+1.60H	0.002262	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +0.90D+1.60W+1.60H	0.002262	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +0.90D+E+1.60H	0.002262	-X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK
Z-Z, +0.90D+E+1.60H	0.002262	+X	Bottom	0.7776	Min Temp %	0.1548	22.884	OK

One Way Shear

Load Combination...	Vu @ -X	Vu @ +X	Vu @ -Z	Vu @ +Z	Vu:Max	Phi Vn	Vu / Phi*Vn	Status
+1.40D	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50Lr+1.60L+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60L+0.50S+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60Lr+0.50L	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60Lr+0.80W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+1.60S	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+1.60S+0.80W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50Lr+0.50L+1.60W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+0.50S+1.60W	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+1.20D+0.50L+0.20S+E	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+0.90D+1.60W+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK
+0.90D+E+1.60H	0 psi	0 psi	0 psi	0 psi	0 psi	93.113 psi	0	OK

All units k

Punching Shear

Load Combination...	Vu	Phi*Vn	Vu / Phi*Vn	Status
+1.40D	0 psi	99.12 psi	0	OK
+1.20D+0.50Lr+1.60L+1.60H	0 psi	99.12 psi	0	OK
+1.20D+1.60L+0.50S+1.60H	0 psi	99.12 psi	0	OK
+1.20D+1.60Lr+0.50L	0 psi	99.12 psi	0	OK
+1.20D+1.60Lr+0.80W	0 psi	99.12 psi	0	OK
+1.20D+0.50L+1.60S	0 psi	99.12 psi	0	OK
+1.20D+1.60S+0.80W	0 psi	99.12 psi	0	OK
+1.20D+0.50Lr+0.50L+1.60W	0 psi	99.12 psi	0	OK
+1.20D+0.50L+0.50S+1.60W	0 psi	99.12 psi	0	OK
+1.20D+0.50L+0.20S+E	0 psi	99.12 psi	0	OK
+0.90D+1.60W+1.60H	0 psi	99.12 psi	0	OK
+0.90D+E+1.60H	0 psi	99.12 psi	0	OK

SUBJECT PROJECT PAGE

CLIENT DATE BY

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5283 Gallon Tank

empty wt of tank = 25k
x 1.15 (misc) = 28.75k

wt of water = (5283 gallons)(ft³/7.48 gal)(62.4 lb/ft³)
= 44.1 k

Σ = 72.85k

V = 0.03 (72.85k) = 2.2k

A.B tension
T=C = (2.2k)(6')/(5.167') = 2.5 k

use Hilti 1"Φ HIT HY 200 9" embed F_{Tallow} = 23k ok

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 5 APR 2016, 11:47AM

General Footing

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

Lic. # : KW-06004473 **Licensee : SOUDER MILLER & ASSOCIATES**

Description : Thickened slab at tanks

Code References

Calculations per ACI 318-08, IBC 2009, CBC 2010, ASCE 7-05
Load Combinations Used : ASCE 7-05

General Information

Material Properties

f'c : Concrete 28 day strength	=	3.0 ksi
fy : Rebar Yield	=	60.0 ksi
Ec : Concrete Elastic Modulus	=	3,122.0 ksi
Concrete Density	=	145.0 pcf
φ Values Flexure	=	0.90
Shear	=	0.850

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.50 : 1
Min. Sliding Safety Factor	=	1.50 : 1
Add Ftg Wt for Soil Pressure	:	No
Use ftg wt for stability, moments & shears	:	No
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Soil Design Values

Allowable Soil Bearing	=	1.50 ksf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	250.0 pcf
Soil/Concrete Friction Coeff.	=	0.30

Increases based on footing Depth

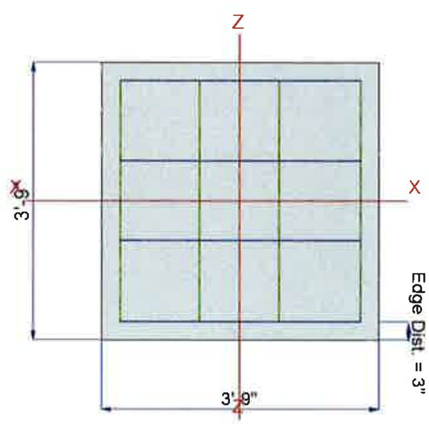
Footing base depth below soil surface	=	ft
Allow press. increase per foot of depth	=	ksf
when footing base is below	=	ft

Increases based on footing plan dimension

Allowable pressure increase per foot of depth	=	ksf
when max. length or width is greater than	=	ft

Dimensions

Width parallel to X-X Axis	=	3.750 ft
Length parallel to Z-Z Axis	=	3.750 ft
Footing Thickness	=	12.0 in



Pedestal dimensions...

px : parallel to X-X Axis	=	3.0 in
pz : parallel to Z-Z Axis	=	3.0 in
Height	=	in
Rebar Centerline to Edge of Concrete... at Bottom of footing	=	3.0 in

Reinforcing

Bars parallel to X-X Axis		
Number of Bars	=	4.0
Reinforcing Bar Size	=	# 5
Bars parallel to Z-Z Axis		
Number of Bars	=	4.0
Reinforcing Bar Size	=	# 5

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation	n/a
# Bars required within zone	n/a
# Bars required on each side of zone	n/a

Applied Loads

		D	Lr	L	S	W	E	H	
P : Column Load	=	18.20					2.50		k
OB : Overburden	=								ksf
M-xx	=								k-ft
M-zz	=								k-ft
V-x	=								k
V-z	=								k

General Footing

Description : Thickened slab at tanks

DESIGN SUMMARY

Design OK

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.9460	Soil Bearing	1.419 ksf	1.50 ksf	+D+0.70E+H about Z-Z axis
PASS	n/a	Overturning - X-X	0.0 k-ft	0.0 k-ft	No Overturning
PASS	n/a	Overturning - Z-Z	0.0 k-ft	0.0 k-ft	No Overturning
PASS	n/a	Sliding - X-X	0.0 k	0.0 k	No Sliding
PASS	n/a	Sliding - Z-Z	0.0 k	0.0 k	No Sliding
PASS	n/a	Uplift	0.0 k	0.0 k	No Uplift
PASS	0.2149	Z Flexure (+X)	2.774 k-ft	12.910 k-ft	+1.40D
PASS	0.2149	Z Flexure (-X)	2.774 k-ft	12.910 k-ft	+1.40D
PASS	0.2149	X Flexure (+Z)	2.774 k-ft	12.910 k-ft	+1.40D
PASS	0.2149	X Flexure (-Z)	2.774 k-ft	12.910 k-ft	+1.40D
PASS	0.1802	1-way Shear (+X)	16.777 psi	93.113 psi	+1.40D
PASS	0.1802	1-way Shear (-X)	16.777 psi	93.113 psi	+1.40D
PASS	0.1802	1-way Shear (+Z)	16.777 psi	93.113 psi	+1.40D
PASS	0.1802	1-way Shear (-Z)	16.777 psi	93.113 psi	+1.40D
PASS	0.2942	2-way Punching	54.787 psi	186.226 psi	+1.40D

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc (in)	Zecc (in)	Actual Soil Bearing Stress @ Location: Bottom, -Z	Top, +Z	Left, -X	Right, +X	Actual / Allow Ratio
X-X, D Only	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+L+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+Lr+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+S+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+0.750Lr+0.750L+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+0.750L+0.750S+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+W+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+0.70E+H	1.50	n/a	0.0	1.419	1.419	n/a	n/a	0.946
X-X, +D+0.750Lr+0.750L+0.750W+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+0.750L+0.750S+0.750W+H	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, +D+0.750Lr+0.750L+0.5250E+H	1.50	n/a	0.0	1.388	1.388	n/a	n/a	0.925
X-X, +D+0.750L+0.750S+0.5250E+H	1.50	n/a	0.0	1.388	1.388	n/a	n/a	0.925
X-X, +0.60D+W+H	1.50	n/a	0.0	0.7765	0.7765	n/a	n/a	0.518
X-X, +0.60D+0.70E+H	1.50	n/a	0.0	0.9010	0.9010	n/a	n/a	0.601
X-X, D Only	1.50	n/a	0.0	1.294	1.294	n/a	n/a	0.863
X-X, Lr Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, L Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, S Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, W Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
X-X, E Only	1.50	n/a	0.0	0.1778	0.1778	n/a	n/a	0.119
X-X, H Only	1.50	n/a	0.0	0.0	0.0	n/a	n/a	0.000
Z-Z, D Only	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+L+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+Lr+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+S+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+0.750Lr+0.750L+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+0.750L+0.750S+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+W+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+0.70E+H	1.50	0.0	n/a	n/a	n/a	1.419	1.419	0.946
Z-Z, +D+0.750Lr+0.750L+0.750W+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+0.750L+0.750S+0.750W+H	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, +D+0.750Lr+0.750L+0.5250E+H	1.50	0.0	n/a	n/a	n/a	1.388	1.388	0.925
Z-Z, +D+0.750L+0.750S+0.5250E+H	1.50	0.0	n/a	n/a	n/a	1.388	1.388	0.925
Z-Z, +0.60D+W+H	1.50	0.0	n/a	n/a	n/a	0.7765	0.7765	0.518
Z-Z, +0.60D+0.70E+H	1.50	0.0	n/a	n/a	n/a	0.9010	0.9010	0.601
Z-Z, D Only	1.50	0.0	n/a	n/a	n/a	1.294	1.294	0.863
Z-Z, Lr Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, L Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, S Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000
Z-Z, W Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID: 181

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ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

General Footing

Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : Thickened slab at tanks

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc (in)	Zecc (in)	Actual Soil Bearing Stress @ Location Bottom, -Z	Top, +Z	Left, -X	Right, +X	Actual / Allow Ratio
Z-Z, E Only	1.50	0.0	n/a	n/a	n/a	0.1778	0.1778	0.119
Z-Z, H Only	1.50	0.0	n/a	n/a	n/a	0.0	0.0	0.000

Overturning Stability

Rotation Axis & Load Combination...	Overturning Moment	Resisting Moment	Stability Ratio	Status

Footing Has NO Overturning

All units k

Sliding Stability

Force Application Axis Load Combination...	Sliding Force	Resisting Force	Stability Ratio	Status

Footing Has NO Sliding

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
X-X, +1.40D	2.774	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.40D	2.774	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50Lr+1.60L+1.60H	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50Lr+1.60L+1.60H	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60L+0.50S+1.60H	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60L+0.50S+1.60H	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60Lr+0.50L	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60Lr+0.50L	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60Lr+0.80W	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60Lr+0.80W	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+1.60S	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+1.60S	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60S+0.80W	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+1.60S+0.80W	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50Lr+0.50L+1.60W	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+0.50S+1.60W	2.378	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+0.50S+1.60W	2.378	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+0.20S+E	2.650	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +1.20D+0.50L+0.20S+E	2.650	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +0.90D+1.60W+1.60H	1.784	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +0.90D+1.60W+1.60H	1.784	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +0.90D+E+1.60H	2.056	+Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
X-X, +0.90D+E+1.60H	2.056	-Z	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.40D	2.774	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.40D	2.774	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50Lr+1.60L+1.60H	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60L+0.50S+1.60H	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60Lr+0.50L	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60Lr+0.50L	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60Lr+0.80W	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60Lr+0.80W	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+1.60S	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+1.60S	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60S+0.80W	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+1.60S+0.80W	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50Lr+0.50L+1.60W	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	2.378	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+0.50S+1.60W	2.378	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+0.20S+E	2.650	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +1.20D+0.50L+0.20S+E	2.650	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK

Souder Miller and Associates
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Farmington, NM 87401
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Title Block Line 6

General Footing

Description : Thickened slab at tanks

Z-Z, +0.90D+1.60W+1.60H	1.784	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +0.90D+1.60W+1.60H	1.784	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK
Z-Z, +0.90D+E+1.60H	2.056	-X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID: 201

Printed: 5 APR 2016, 11:47AM

General Footing

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : Thickened slab at tanks

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Which Side ?	Tension @ Bot or Top ?	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
Z-Z, +0.90D+E+1.60H	2.056	+X	Bottom	0.2592	Min Temp %	0.3307	12.910	OK

One Way Shear

Load Combination...	Vu @ -X	Vu @ +X	Vu @ -Z	Vu @ +Z	Vu:Max	Phi Vn	Vu / Phi*Vn	Status
+1.40D	16.777 psi	16.777 psi	16.777 psi	16.777 psi	16.777 psi	93.113 psi	0.1802	OK
+1.20D+0.50Lr+1.60L+1.60H	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+1.60L+0.50S+1.60H	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+1.60Lr+0.50L	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+1.60Lr+0.80W	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+0.50L+1.60S	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+1.60S+0.80W	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+0.50Lr+0.50L+1.60W	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+0.50L+0.50S+1.60W	14.38 psi	14.38 psi	14.38 psi	14.38 psi	14.38 psi	93.113 psi	0.1544	OK
+1.20D+0.50L+0.20S+E	16.026 psi	16.026 psi	16.026 psi	16.026 psi	16.026 psi	93.113 psi	0.1721	OK
+0.90D+1.60W+1.60H	10.785 psi	10.785 psi	10.785 psi	10.785 psi	10.785 psi	93.113 psi	0.1158	OK
+0.90D+E+1.60H	12.431 psi	12.431 psi	12.431 psi	12.431 psi	12.431 psi	93.113 psi	0.1335	OK

All units k

Punching Shear

Load Combination...	Vu	Phi*Vn	Vu / Phi*Vn	Status
+1.40D	54.787 psi	186.226 psi	0.2942	OK
+1.20D+0.50Lr+1.60L+1.60H	46.96 psi	186.226 psi	0.2522	OK
+1.20D+1.60L+0.50S+1.60H	46.96 psi	186.226 psi	0.2522	OK
+1.20D+1.60Lr+0.50L	46.96 psi	186.226 psi	0.2522	OK
+1.20D+1.60Lr+0.80W	46.96 psi	186.226 psi	0.2522	OK
+1.20D+0.50L+1.60S	46.96 psi	186.226 psi	0.2522	OK
+1.20D+1.60S+0.80W	46.96 psi	186.226 psi	0.2522	OK
+1.20D+0.50Lr+0.50L+1.60W	46.96 psi	186.226 psi	0.2522	OK
+1.20D+0.50L+0.50S+1.60W	46.96 psi	186.226 psi	0.2522	OK
+1.20D+0.50L+0.20S+E	52.336 psi	186.226 psi	0.281	OK
+0.90D+1.60W+1.60H	35.22 psi	186.226 psi	0.1891	OK
+0.90D+E+1.60H	40.596 psi	186.226 psi	0.218	OK

SUBJECT PROJECT PAGE

CLIENT DATE BY

CHECKED BY

Lintel

wall ↓

WDL = (15psf)(2') = 30plf + (62plf)(2.67') = 195.3plf
wLL = (25psf)(2') 50plf

wind load = (24.7psf)(2' + 11.33'/2) = 189.3plf

in Enercalc = 189.3plf / 2' = 95plf

Rxn = 0.9k / 0.23k

WL = (24.3psf)(9'/2)
= 109.4plf

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Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID: 221

Printed: 30 MAR 2016, 2:22PM

Masonry Beam

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18
Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : 8'-8" lintel

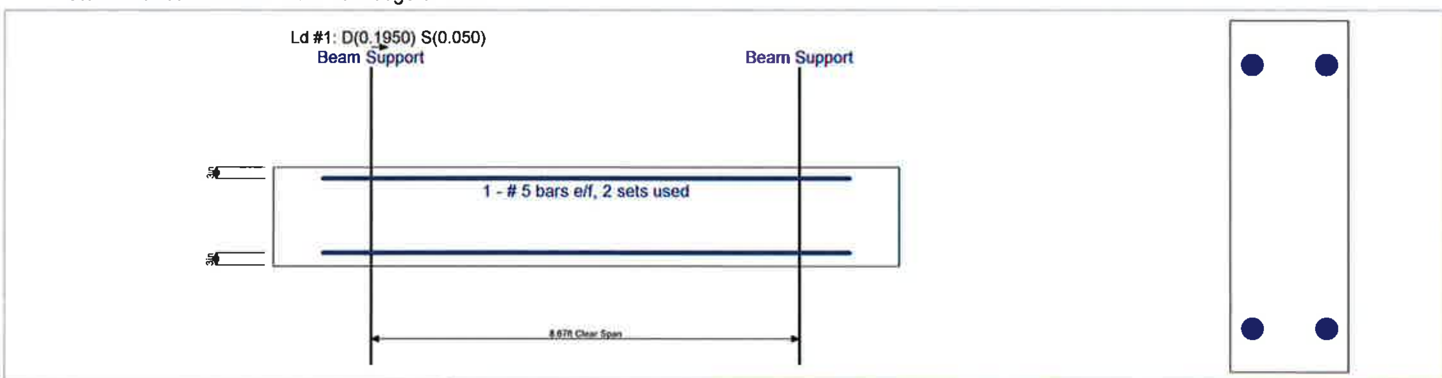
Code References

Calculations per ACI 530-08, IBC 2009, CBC 2010, ASCE 7-05
Load Combinations Used : ASCE 7-05

General Information

f'm	1,500.0 psi	Clear Span	8.670 ft	Rebar Size	5
Fs	24,000.0 psi	Beam Depth	2.0 ft	# Bars E/F	1
Em = f'm *	750.0	Thickness	8 in	Top Clear	3.0 in
Wall Wt Mult	1.0	End Fixity	Pin-Pin	Btm Clear	3.0 in
Block Type	Normal Wt	Equiv. Solid Thick	7.60 in	# Bar Sets	2
Lateral Wind Load	5.0 psf	Wall Weight	84.0 psf	Bar Spacing	5.0 in
Lateral Wall Weight Seismic Factor	0.330	E	1,125.0 ksi		
Calculate vertical beam weight ?	Yes	n	25.778		

Note! Shear calculated at "d/2" from edge of beam



Uniform Loads

	Start X	End X	Dead Load	L : Floor Live	Lr : Roof Live	S : Snow	W : Wind	E : Earthquake	
#1	ft	ft	0.1950			0.050			k/ft
#2	ft	ft							k/ft
#3	ft	ft							k/ft
#4	ft	ft							k/ft

DESIGN SUMMARY

Design OK

Maximum Stress Ratios...	Vertical	Lateral	Combined
fb/Fb	0.1775	0.05753	**0.1866** : 1.00
fv/Fv	0.2308	0.02867	**0.2326** : 1.00

Maximum Moment	Actual	Allowable k-ft
Vertical Loads for Load Combination : +D+S+H	3.881 k-ft	21.865 k-ft
Lateral Loads for Load Combination : +D+0.70E+H	0.3645 k-ft	6.335

Maximum Shear	Actual	Allowable
Vertical Loads for Load Combination : +D+S+H	8.938 psi	38.730 psi
Lateral Loads for Load Combination : +D+0.70E+H	1.110 psi	38.730 psi

Minimum Mn = 1.3 * Fcr * S = 7.930 k-ft

Vertical Strength

As	0.620 in^2
rho	0.003872
np	0.09981
k : ((np)^2+2np)^.5-np	0.3580
j = 1 - k/3	0.8807
M:mas=Fb k j b d^2/2	21.865 k-ft
M:Stl = Fs As j d	22.933 k-ft

Lateral Strength

(Checking lateral bending for span)

As	0.620 in^2
rho	0.004092
np	0.1055
k : (np^2+2np)^.5-np	0.3658
j = 1 - k/3	0.8781
M:mas=Fb k j b d^2/2	6.335 k-ft
M:Stl = Fs As j d	6.873 k-ft

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Project ID: 231

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Masonry Beam

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : 8'-8" lintel

Detailed Load Combination Results

Load Combination	Vertical				Lateral			
	Mmax k-ft	Mallow k-ft	fv : Vert psi	Fv : Vert psi	Mactual k-ft	Mallow k-ft	fv psi	Fv psi
D Only	3.41	21.87	7.86	38.73	0.00	6.34	0.00	38.73
+D+L+H	3.41	21.87	7.86	38.73	0.00	6.34	0.00	38.73
+D+Lr+H	3.41	21.87	7.86	38.73	0.00	6.34	0.00	38.73
+D+S+H	3.88	21.87	8.94	38.73	0.00	6.34	0.00	38.73
+D+0.750Lr+0.750L+H	3.41	21.87	7.86	38.73	0.00	6.34	0.00	38.73
+D+0.750L+0.750S+H	3.76	21.87	8.67	38.73	0.00	6.34	0.00	38.73
+D+W+H	3.41	21.87	7.86	38.73	0.09	6.34	0.29	38.73
+D-W+H	3.41	21.87	7.86	38.73	0.09	6.34	0.29	38.73
+D+0.70E+H	3.41	21.87	7.86	38.73	0.36	6.34	1.11	38.73
+D-0.70E+H	3.41	21.87	7.86	38.73	0.36	6.34	1.11	38.73
+D+0.750Lr+0.750L+0.750W+H	3.41	21.87	7.86	38.73	0.07	6.34	0.21	38.73
+D+0.750Lr+0.750L-0.750W+H	3.41	21.87	7.86	38.73	0.07	6.34	0.21	38.73
+D+0.750L+0.750S+0.750W+H	3.76	21.87	8.67	38.73	0.07	6.34	0.21	38.73
+D+0.750L+0.750S-0.750W+H	3.76	21.87	8.67	38.73	0.07	6.34	0.21	38.73
+D+0.750Lr+0.750L+0.5250E+H	3.41	21.87	7.86	38.73	0.27	6.34	0.83	38.73
+D+0.750Lr+0.750L-0.5250E+H	3.41	21.87	7.86	38.73	0.27	6.34	0.83	38.73
+D+0.750L+0.750S+0.5250E+H	3.76	21.87	8.67	38.73	0.27	6.34	0.83	38.73
+D+0.750L+0.750S-0.5250E+H	3.76	21.87	8.67	38.73	0.27	6.34	0.83	38.73
+0.60D+W+H	2.05	21.87	4.71	38.73	0.09	6.34	0.29	38.73
+0.60D-W+H	2.05	21.87	4.71	38.73	0.09	6.34	0.29	38.73
+0.60D+0.70E+H	2.05	21.87	4.71	38.73	0.36	6.34	1.11	38.73
+0.60D-0.70E+H	2.05	21.87	4.71	38.73	0.36	6.34	1.11	38.73

Masonry Slender Wall

Description : CMU wall

Code References

Calculations per ACI 530-08, IBC 2009, CBC 2010, ASCE 7-05
Load Combinations Used : ASCE 7-05

General Information

Calculations per ACI 530-08, IBC 2009, CBC 2010, ASCE 7-05

Construction Type : Grouted Hollow Concrete Masonry

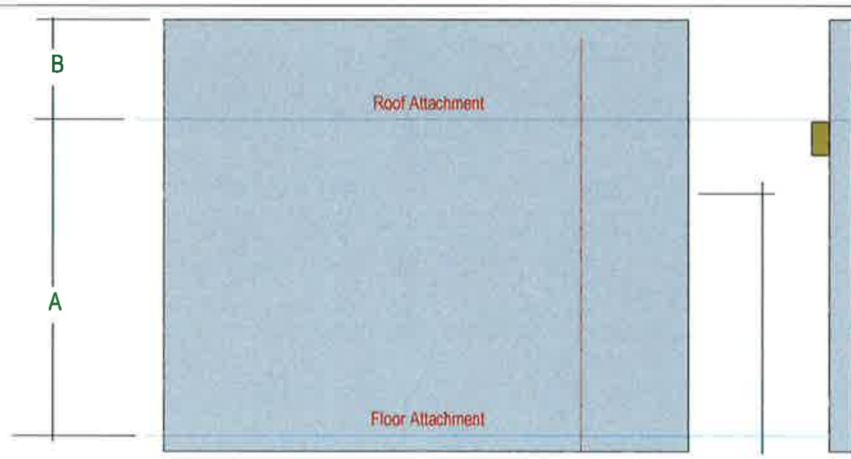
F'm = 1.50 ksi	Nom. Wall Thickness	8 in	Temp Diff across thickness =		deg F
Fy - Yield = 60.0 ksi	Actual Thickness	7.625 in	Min Allow Out-of-plane Defl Ratio =	0	
Fr - Rupture = 61.0 psi	Rebar "d" distance	3.750 in	Minimum Vertical Steel % =	0.0020	
Em = f'm * = 900.0	Lower Level Rebar . . .				
Max % of ρ bal. = 0.006833	Bar Size #	4			
Grout Density = 140 pcf	Bar Spacing	24.0 in			
Block Weight Normal Weight					
Wall Weight = 61.0 psf					

Wall is grouted at rebar cells only

One-Story Wall Dimensions

A Clear Height = 14.0 ft
B Parapet height = ft

Wall Support Condition Top & Bottom Pinned



Vertical Loads

Vertical Uniform Loads . . . *(Applied per foot of Strip Width)*

	Eccentricity	DL : Dead	Lr : Roof Live	Lf : Floor Live	S : Snow	W : Wind	
Ledger Load	6.750 in	0.210		0.350			k/ft
Concentric Load							k/ft

Lateral Loads

Wind Loads :
Full area WIND load 21.0 psf

Seismic Loads :
Wall Weight Seismic Load Input Method : Direct entry of Lateral Wall Weight
Seismic Wall Lateral Load 25.0 psf

Fp 1.0 = 25.0 psf

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Project Title:
Engineer:
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Project ID:

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Masonry Slender Wall

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Description : CMU wall

DESIGN SUMMARY

Results reported for "Strip Width" of 12.0 in

	Governing Load Combination . . .	Actual Values . . .		Allowable Values . . .	
PASS	Moment Capacity Check +1.20D+0.50Lr+0.50L+1.60W	Maximum Bending Stress Ratio =	0.5247		
		Max Mu	0.9895 k-ft	Phi * Mn	1.886 k-ft
PASS	Service Deflection Check E Only	Actual Defl. Ratio L/	901	Allowable Defl. Ratio	150
		Max. Deflection	0.1864 in		
PASS	Axial Load Check +1.20D+0.50Lr+0.50L+1.60W	Max Pu / Ag	15.054 psi	Max. Allow. Defl.	1.120 in
		Location	7.233 ft	0.2 * f'm	300.0 psi
PASS	Reinforcing Limit Check	Controlling As/bd	0.002151	As/bd@06833 rho bal	0.006833
PASS	Minimum Moment Check +1.40D	Mcracking	0.4715 k-ft	Minimum Phi Mn	1.839 k-ft

Maximum Reactions . . . *for Load Combination....*

Top Horizontal	E Only	0.1750 k
Base Horizontal	E Only	0.1750 k
Vertical Reaction	D Only	1.064 k

Design Maximum Combinations - Moments

Results reported for "Strip Width" = 12 in.

Load Combination	Axial Load Pu (k)	0.2*f'm*b*t (k)	Mcr (k-ft)	Mu (k-ft)	Phi	Phi Mn (k-ft)	As (in^2)	As Ratio	0.6 * rho bal
+1.40D at 13.53 to 14.00	0.334	18.720	0.47	0.17	0.90	1.74	0.100	0.0022	0.0068
+1.20D+0.50Lr+1.60L+1.60H at 13.53 to 14.	0.846	18.720	0.47	0.46	0.90	1.87	0.100	0.0022	0.0068
+1.20D+1.60L+0.50S+1.60H at 13.53 to 14.0	0.846	18.720	0.47	0.46	0.90	1.87	0.100	0.0022	0.0068
+1.20D+1.60Lr+0.50L at 13.53 to 14.00	0.461	18.720	0.47	0.24	0.90	1.77	0.100	0.0022	0.0068
+1.20D+1.60Lr+0.80W at 7.47 to 7.93	0.730	18.720	0.47	0.49	0.90	1.84	0.100	0.0022	0.0068
+1.20D+0.50L+1.60S at 13.53 to 14.00	0.461	18.720	0.47	0.24	0.90	1.77	0.100	0.0022	0.0068
+1.20D+1.60S+0.80W at 7.47 to 7.93	0.730	18.720	0.47	0.49	0.90	1.84	0.100	0.0022	0.0068
+1.20D+0.50Lr+0.50L+1.60W at 7.00 to 7.47	0.939	18.720	0.47	0.99	0.90	1.89	0.100	0.0022	0.0068
+1.20D+0.50L+0.50S+1.60W at 7.00 to 7.47	0.939	18.720	0.47	0.99	0.90	1.89	0.100	0.0022	0.0068
+1.20D+0.50L+0.20S+E at 7.47 to 7.93	0.905	18.720	0.47	0.76	0.90	1.89	0.100	0.0022	0.0068
+0.90D+1.60W+1.60H at 7.00 to 7.47	0.573	18.720	0.47	0.90	0.90	1.80	0.100	0.0022	0.0068
+0.90D+E+1.60H at 7.00 to 7.47	0.573	18.720	0.47	0.68	0.90	1.80	0.100	0.0022	0.0068

Design Maximum Combinations - Deflections

Results reported for "Strip Width" = 12 in.

Load Combination	Axial Load Pu (k)	Moment Values Mcr (k-ft)	Mactual (k-ft)	I gross (in^4)	Stiffness I cracked (in^4)	I effective (in^4)	Deflections Deflection (in)	Defl. Ratio
D Only at 7.93 to 8.40	0.580	0.47	0.07	353.60	23.43	353.600	0.005	31,186.2
	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.0
L Only at 7.93 to 8.40	0.350	0.47	0.12	353.60	22.77	353.600	0.009	18,736.7
	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.0
W Only at 7.00 to 7.47	0.000	0.47	0.51	353.60	21.75	36.300	0.067	2,519.6
E Only at 7.00 to 7.47	0.000	0.47	0.61	353.60	21.75	26.263	0.186	901.4
	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.0

Reactions - Vertical & Horizontal

Results reported for "Strip Width" = 12 in.

Load Combination	Base Horizontal	Top Horizontal	Vertical @ Wall Base
D Only	0.0 k	0.01 k	1.064 k
Lr Only	0.0 k	0.00 k	0.000 k
L Only	0.0 k	0.01 k	0.350 k
S Only	0.0 k	0.00 k	0.000 k
W Only	0.1 k	0.15 k	0.000 k
E Only	0.2 k	0.17 k	0.000 k

Masonry Slender Wall

Description : CMU wall

Reactions - Vertical & Horizontal

Results reported for "Strip Width" = 12 in.

Load Combination	Base Horizontal	Top Horizontal	Vertical @ Wall Base
H Only	0.0 k	0.00 k	0.000 k

Souder Miller and Associates
401 W. Broadway
Farmington, NM 87401
(505) 325-7535
Fax (505) 326-0045
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

271

Printed: 30 MAR 2016, 2:26PM

File = P:\6-CUTT~1.1_2\CAD\Calcs\STRUCT\REACH2~1.1\SURGET~1.EC6
ENERCALC, INC. 1983-2016, Build:6.16.2.18, Ver:6.16.2.18

Masonry Column

Lic. # : KW-06004473 Licensee : SOUDER MILLER & ASSOCIATES

Description : supporting lintel

Code References

Calculations per ACI 530-08, IBC 2009, CBC 2010
Load Combinations Used : ASCE 7-05

General Information

Material Properties

F'm	=	1,500.0 psi
Fr - Rupture	=	75.0 psi
Em = f'm *	=	900.0
Column Density	=	130.0 pcf
Rebar Grade	=	Grade 60
Fy - Yield	=	60000 psi
Fs - Allowable	=	24,000.0 psi
E - Rebar	=	29,000.0 ksi

Column Data

Column width along X-X	=	7.625 in
Column depth along Y-Y	=	23.625 in
Longitudinal Bar Size	=	# 4.0
Bars per side at +Y & -Y	=	1
Bars per side at +X & -X	=	1
Cover from ties	=	3.50 in
Actual Edge to Bar Center	=	4.125 in

Analysis Settings

Analysis Method	=	Strength Design
φ factor for Strength Design	=	0.90
End Fixity Condition	=	Top Pinned, Bottom Pinned
Overall Column Height	=	14.0 ft
Construction Type		Solid Grouted Hollow Concrete Masonry
Tie Bar Size	=	# 3
Tie Bar Spacing	=	8.0 in

Brace condition for deflection (buckling) along columns :

X-X (width) axis : Fully braced against buckling along X-X Axis
Y-Y (depth) axis : Fully braced against buckling along Y-Y Axis

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 2,276.78 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 14.0 ft, D = 1.0, S = 0.230 k
BENDING LOADS . . .
Lat. Uniform Load creating Mx-x, W = 0.490 k/ft

DESIGN SUMMARY

Bending Check Results

PASS **Maximum Bending Stress Ratio** = **0.835** : 1
- Load Combination: +0.90D+1.60W+1.60H
- Location of max.above base: 6.953 ft
- At maximum location values are . . .
  - Pu: 2.949 k
  - 0.9 * Pn: 3.672 k
  - Mu-x: 19.207 k-ft
  - 0.9 * Mn-x : 22.992 k-ft

FAIL **Reinforcing Area Check** *(ACI 530-08, Sec 3.3.4.*
- As : Actual Reinforcement: 0.400
- Min: 0.0025 * An: 0.450
- Max: 0.04 * An: 7.206

Dimensional Checks
- Min. Side Dim. >= 8" *(ACI 530-08, Sec 3.4.4.*

PASS Overall Height / Min Dim <= 30 *(ACI 530-08, Sec 3.4.4.*

Maximum SERVICE Load Reactions . .
- Top along X-X: 3.430 k
- Bottom along X-X: 3.430 k

Maximum SERVICE Load Deflections . . .
- Along x-x: 0.038 in at 7.047 ft above base
- for load combination : +D+W

Compressive Strength 172.576 k *(ACI 530-08, Sec 3.3.4.*
Pa = 0.80 [0.80 f'm (An - Ast) + FyAst) * [1-(h/(140*r))^2]

FAIL **Check Column Ties** *(ACI 530-08, Sec 2.1.6.*
- Min. Tie Dia. = 1/4", # 3 bar provided
- Max Tie Spacing = 7.63 in, Provided = 8.00 in

Load Combination Results

Load Combination	Maximum Bending Stress Ratios			Maximum Axial Load		Maximum Moments	
	Stress Ratio	Status	Location	Actual	Allow	Actual	Allow
+1.40D	0.02564	PASS	0.0 ft	4.587 k	172.540 k	0.0 k-ft	47.449 k-ft
+1.20D+0.50Lr+1.60L+1.60H	0.02197	PASS	0.0 ft	3.932 k	172.540 k	0.0 k-ft	47.449 k-ft
+1.20D+1.60L+0.50S+1.60H	0.02262	PASS	0.0 ft	4.047 k	172.540 k	0.0 k-ft	47.449 k-ft
+1.20D+1.60Lr+0.50L	0.02197	PASS	0.0 ft	3.932 k	172.540 k	0.0 k-ft	47.449 k-ft
+1.20D+1.60Lr+0.80W	0.3336	PASS	6.953 ft	3.932 k	11.898 k	9.604 k-ft	28.744 k-ft
+1.20D+0.50L+1.60S	0.02403	PASS	0.0 ft	4.30 k	172.540 k	0.0 k-ft	47.449 k-ft
+1.20D+1.60S+0.80W	0.3229	PASS	6.953 ft	4.30 k	13.328 k	9.604 k-ft	29.733 k-ft
+1.20D+0.50Lr+0.50L+1.60W	0.8040	PASS	6.953 ft	3.932 k	4.937 k	19.207 k-ft	23.881 k-ft
+1.20D+0.50L+0.50S+1.60W	0.7989	PASS	6.953 ft	4.047 k	5.144 k	19.207 k-ft	24.027 k-ft

Masonry Column

Description : supporting lintel

Load Combination Results

Load Combination	Maximum Bending Stress Ratios: Stress Ratio	Status	Location	Maximum Axial Load: Actual	Allow	Maximum Moments: Actual	Allow
+1.20D+0.50L+0.20S+E	0.02223	PASS	0.0 ft	3.978 k	172.540 k	0.0 k-ft	47.449 k-ft
+0.90D+1.60W+1.60H	0.8346	PASS	6.953 ft	2.949 k	3.672 k	19.207 k-ft	22.992 k-ft
+0.90D+E+1.60H	0.01648	PASS	0.0 ft	2.949 k	172.540 k	0.0 k-ft	47.449 k-ft

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	Y-Y Axis Reaction @ Base	Y-Y Axis Reaction @ Top	Axial Reaction @ Base
D Only	k	k	3.277 k
+D+L	k	k	3.277 k
+D+Lr	k	k	3.277 k
+D+S	k	k	3.507 k
+D+0.750Lr+0.750L	k	k	3.277 k
+D+0.750L+0.750S	k	k	3.449 k
+D+W	3.430 k	3.430 k	3.277 k
+D+0.70E	k	k	3.277 k
+D+0.750Lr+0.750L+0.750W	2.573 k	2.573 k	3.277 k
+D+0.750L+0.750S+0.750W	2.573 k	2.573 k	3.449 k
+D+0.750Lr+0.750L+0.5250E	k	k	3.277 k
+D+0.750L+0.750S+0.5250E	k	k	3.449 k
+0.60D+W	3.430 k	3.430 k	1.966 k
+0.60D+0.70E	k	k	1.966 k
D Only	k	k	3.277 k
Lr Only	k	k	k
L Only	k	k	k
S Only	k	k	0.230 k
W Only	3.430 k	3.430 k	k
E Only	k	k	k
H Only	k	k	k

Maximum Deflections for Load Combinations

Load Combination	Max. Y-Y Deflection	Distance
D Only	0.0000 in	0.000 ft
+D+L	0.0000 in	0.000 ft
+D+Lr	0.0000 in	0.000 ft
+D+S	0.0000 in	0.000 ft
+D+0.750Lr+0.750L	0.0000 in	0.000 ft
+D+0.750L+0.750S	0.0000 in	0.000 ft
+D+W	0.0378 in	7.047 ft
+D+0.70E	0.0000 in	0.000 ft
+D+0.750Lr+0.750L+0.750W	0.0284 in	7.047 ft
+D+0.750L+0.750S+0.750W	0.0284 in	7.047 ft
+D+0.750Lr+0.750L+0.5250E	0.0000 in	0.000 ft
+D+0.750L+0.750S+0.5250E	0.0000 in	0.000 ft
+0.60D+W	0.0378 in	7.047 ft
+0.60D+0.70E	0.0000 in	0.000 ft
D Only	0.0000 in	0.000 ft
Lr Only	0.0000 in	0.000 ft
L Only	0.0000 in	0.000 ft
S Only	0.0000 in	0.000 ft
W Only	0.0378 in	7.047 ft
E Only	0.0000 in	0.000 ft
H Only	0.0000 in	0.000 ft

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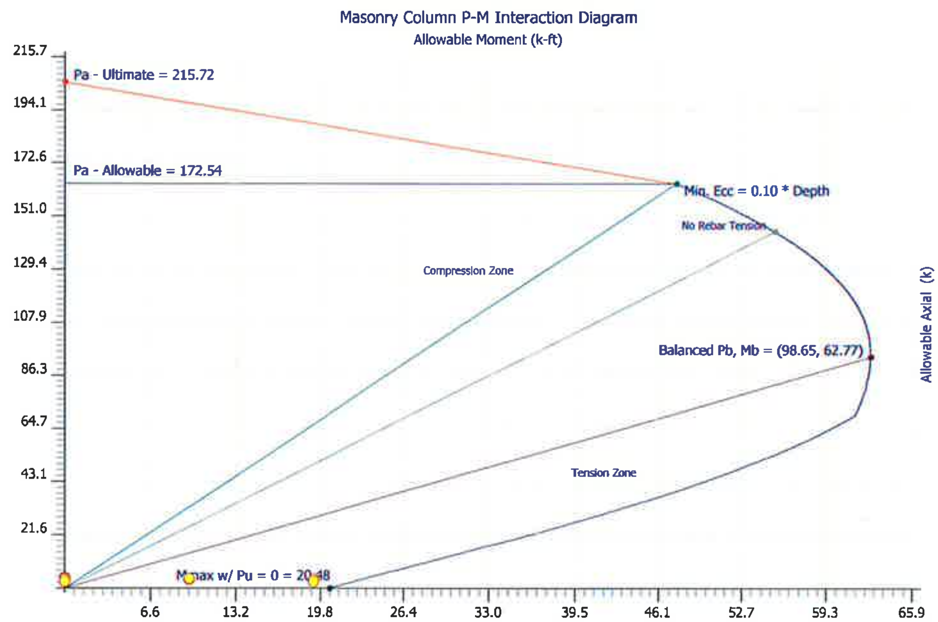
Title Block Line 6

Masonry Column

Description : supporting lintel

Cross Section

Interaction Diagram



Radio Survey Report

Radio Survey Report Summary

In January of 2015, a radio signal field survey was completed to verify signal strength of multiple proposed SCADA radio connections in the NGWSP system. The Surge Tank Site located at the beginning of Reach 24.1 JAN will require SCADA. No other facilities along Reach 24.1 JAN will require SCADA.

To simplify SCADA setup, simplify O&M, and minimize costs, it is preferable to limit the number of radio signal repeater sites within the NGWSP. The Reach 24.1 Counselor Tank Site was selected as the primary repeater site in the Reach 24.1, 25 & 26 system, receiving and sending signals to the other sites.

Prior to performing the radio survey in the field, topographic mapping software was used to evaluate line of sight between the various sites requiring SCADA connections. Line of sight is used in addition to radio signal strength to evaluate feasibility of the connection. The mapping software indicated that with typical antenna heights, there should be line of sight between the Counselor Tank Site and the Surge Tank Site on Reach 24.1 JAN. This and the short 2.6 mile straight line distance between the sites are indications that a radio connection between these two sites is highly feasible even without a field test.

In the field, the radio signal was tested between the Reach 24.1 Counselor Tank and the Reach Surge Tank Site. The test produced a solid radio signal with 2.2V (-93dB) strength, confirming a radio connection between the sites is feasible. As this is the preferred radio pathway for connecting the Surge Tank Site, no other pathways needed to be field tested for Reach 24.1 JAN.

PARAGON ELECTRIC, INC
License #81712
P.O. Box 8269 / Albuquerque, NM 87198
(505) 265-5883

Radio Survey Report

January 20, 2015

Radio Survey Report:

On 01/13/2015 Robert Lee visited the following sites to determine if good radio signals could be established between them; Reach 24.1 Counselor Tanks, Reach 24.1 Surge Tank, Reach 26.1 Surge Tank, Reach 26.3 Tank, Reach 26.2 PRV Vault Site and Reach 26.2 Pueblo Pintado Tank.

The radios that were used to conduct the radio path survey were Phoenix Contact #2867092. We also used directional Yagi antennas.

Note that Phoenix Contact recommends a minimum of -90dB (2.5V) for the RAD-ISM-900 radio series. Also, a solid RF light indicates good radio signal, fast flashing RF light indicates marginal radio signal and slow flashing RF light indicates no radio signal. The voltage reading helps determine how strong the RF signal is.

Please see table below for path results.

PATH	SITE	SITE	SIGNAL	STRENGTH
1	Reach 24.1 Counselor Tank	Reach 24.1 Surge Tank	Solid	2.2V (-93dB)
2	Reach 24.1 Counselor Tank	Reach 26.3 Tank	Solid	2.4V (-91dB)
3 (B)	Reach 24.1 Counselor Tank	Reach 26.2 PRV Vault	Fast Flash	2.2V (-93dB)
4	Reach 24.1 Counselor Tank	Reach 26.2 Pueblo Pintado Tank	Solid	2.5V (-90dB)
5 (A)	Reach 25 Ojo Encino North Tank	Reach 26.1 Surge Tank	LOS	Line of Sight
6 (C)	Reach 25 Ojo Encino North Tank	Reach 26.3 Tank	Not needed at this time.	
7 (C)	Reach 26.3 Tank	Reach 26.2 Pueblo Pintado Tank	Not needed at this time.	

The objective of performing the radio survey was to determine if a decent signal could be made from the listed sites above.

Please see notes below:

(A): We did not set up the radio there, Ryan wanted to show me how close the path was and confirm that there should not be a problem with radio signal. There is direct Line-of-Sight and it is probably less than a quarter mile between

(B): The results were 2.2 volts but not a solid RF light, which indicates a marginal signal. We discussed the situation and determined that we were kind of down in a hole, and once there is a more permanent site with the ability to install a taller mast, the signal would probably be ok.

(C): We did not test paths 6 and 7 because with the favorable results of the other path tests, Ryan determined that 6 and 7 would not be needed.

See below for additional information pertaining to each site:

- Reach 24.1 Counselor Tank
  - GPS Coordinates: N36.16746, E107.50081
  - Antenna Location (Feet Above Grade): 15’

- Reach 24.1 Surge Tank
  - GPS Coordinates: N36.15324, E107.45811
  - Antenna Location (Feet Above Grade): 10’
- Reach 25 Ojo Encino North Tank
  - GPS Coordinates: N36.06730, E107.39206
  - Antenna Location (Feet Above Grade): 10’
- Reach 26.1 Surge Tank
  - GPS Coordinates: N36.06389, E107.40216
  - LOS (Line of Sight)
- Reach 26.3 Tank
  - GPS Coordinates: N36.02505, E107.38377
  - Antenna Location (Feet Above Grade): 10’
- Reach 26.2 PRV Vault
  - GPS Coordinates: N36.00654, E107.50345
  - Antenna Location (Feet Above Grade): 10’
- Reach 26.2 Pueblo Pintado Tank
  - GPS Coordinates: N36.90904, E107.61491
  - Antenna Location (Feet Above Grade): 10’

If you have any more questions please feel free to call – **505 265-5883**.
Sincerely,

Robert Lee, Technician

Access Letter from
Jicarilla Apache Nation

SMA

The Jicarilla Apache Nation
EXECUTIVE OFFICES
P.O. Box 507 • Dulce, New Mexico • 87528-0507 • (575) 759-3242

Jicarilla Apache Reservation
February 11, 1887-1987

March 28, 2016

Walter Haase
General Manager
Navajo Tribal Utility Authority
P. O. Box 170
Ft. Defiance AZ, 86504-0170

Mr. Kontz,

The Jicarilla Apache Nation (Nation) as formal participant of the Navajo Gallup Water Supply Project (NGWSP) will receive 1,200 acre feet of its San Juan River Water through the project pipeline to the Nation's southeastern boundary. The Nation is concurrently developing a pipeline from the reservation boundary to the junction of Highway 550 and Highway 537. We acknowledge the agreement that the Navajo Tribal Utility Authority (NTUA) will provide operations and maintenance of the project pipelines and facilities.

The Nation is siting a storage tank near the southeastern boundary and NTUA has a facility in the area. We acknowledge that NTUA must have unfettered access to these areas to conduct operations and maintenance activity related to the project. Specifically, the Nation allows NTUA the following:

1. NTUA and its assigns and representatives will be able to drive along their ROW up to the Nation's border unimpeded.
2. NTUA and its assigns and representatives will be able to use the existing gas line roads to access their ROW.
    a. We understand the importance, as the road is the best way to access your proposed meter vault at the border.
3. NTUA and its assigns and representatives will be allowed access to the gates in the fence that run parallel to the road and arrangements will be made for keys or new locks.

It must be made clear that this granting of access is strictly for the intended purpose of NGWSP activity. If you require any further information please contact, Darlene Gomez, General Counsel or Darryl Vigil, Water Administrator.

Sincerely,

Ty Vicenti
President

Cc: Jicarilla Game and Fish
Jicarilla Oil and Gas Administration
Jicarilla Apache Police Department
Souder Miller and Associates ✓


KEEP
GATE
CLOSED
JICARILLA
PERMITS
REQUIRED
BEYOND THIS
POINT


JICARILLA
PERMITS
REQUIRED
BEYOND THIS
POINT