GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY COUNTY SANITATION DISTRICT
SONOMA COUNTY WATER AGENCY
SEWER TRUNK REPLACEMENT PROJECT
REACHES A, B AND C
SONOMA COUNTY, CALIFORNIA
KLEINFELDER PROJECT NO.: 20143780.001A

APRIL 17, 2015

Copyright 2015 Kleinfelder
All Rights Reserved.

ONLY THE CLIENT OR ITS DESIGNATED REPRESENTATIVES MAY USE THIS DOCUMENT AND ONLY FOR THE SPECIFIC PROJECT FOR WHICH THIS REPORT WAS PREPARED.

© 2015 Kleinfelder

April 17, 2015
Kleinfelder Project No. 20143780.001A

Mr. Victor Swift
Sonoma Valley County Sanitation District
Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, California 95403-9019

SUBJECT: Groundwater Data Memorandum
Sonoma Valley County Sanitation District
Sonoma County Water Agency
Sewer Trunk Replacement Project - Reaches A, B, and C
Sonoma County, California

Mr. Swift,

Submitted herewith is a groundwater memorandum to supplement our geotechnical reports for the subject Sewer Trunk Replacement Project. This report contains updated groundwater data summaries, construction dewatering evaluations, and dewatering recommendations specifically related to Reaches A, B and C. Our services were authorized by your contract entitled "Agreement for Geotechnical Engineering Services for Replacement of Sonoma Valley Trunk Main," dated April 15, 2014.

We appreciate the opportunity to be of service on this project. Please contact the undersigned at 707.571.1883 if you have any questions regarding this report.

Sincerely,

KLEINFELDER, INC.

Phillip Rust, PG
Project Hydrogeologist

Martin Pucci, PE 78133
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
MARTIN J. PUCCI
C 78133
EXP. 9/30/15
CIVIL
STATE OF CALIFORNIA

Reviewed by:

Joe Zilles, PG
Principal Hydrogeologist

Terry Craven, PE, GE 2572
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
TERENCE CRAVEN
No. 2572
Exp. 6/30/16
GEOTECHNICAL
STATE OF CALIFORNIA

© 2015 Kleinfelder

TABLE OF CONTENTS

1 INTRODUCTION.....1
1.1 PROJECT DESCRIPTION.....1
1.2 PURPOSE AND SCOPE OF SERVICES.....2

2 GROUNDWATER CONDITIONS SUMMARY.....3
2.1 PREVIOUSLY REPORTED SOIL AND GROUNDWATER DATA.....3
2.2 SUMMARY OF PIEZOMETER OBSERVATIONS.....4

3 DEWATERING EVALUATIONS AND RECOMMENDATIONS.....6
3.1 REACH A – FLOW ESTIMATES.....6
3.1.1 STATION 10+00 to 39+00.....7
3.1.1.1 Assessment of Groundwater Conditions.....7
3.1.1.2 Conceptual Dewatering Model.....7
3.1.1.3 Hydraulic Conductivity Estimates.....7
3.1.1.4 Dewatering Pumping Flow Estimate.....7
3.1.1.5 Dewatering Approach.....8
3.1.2 STATION 39+00 to 46+19.....8
3.1.2.1 Assessment of Groundwater Conditions.....8
3.1.2.2 Conceptual Dewatering Model.....8
3.1.2.3 Hydraulic Conductivity Estimates.....9
3.1.2.4 Dewatering Pumping Flow Estimate.....9
3.1.2.5 Dewatering Approach.....10
3.2 REACH B.....10
3.2.1 From Reach A to Boring KB-8.....10
3.2.1.1 Assessment of Groundwater Conditions.....10
3.2.1.2 Conceptual Dewatering Model.....10
3.2.1.3 Hydraulic Conductivity Estimates.....11
3.2.1.4 Dewatering Pumping Flow Estimate.....11
3.2.1.5 Dewatering Approach.....12
3.2.2 KB-8 to Agua Caliente Creek Crossing.....12
3.2.2.1 Assessment of Groundwater Conditions.....12
3.2.2.2 Conceptual Dewatering Model.....12
3.2.2.3 Hydraulic Conductivity Estimates.....12
3.2.2.4 Dewatering Pumping Flow Estimate.....13
3.2.2.5 Dewatering Approach.....13
3.3 REACH C.....13
3.3.1 From Aqua Caliente Creek Crossing to Boring KB-14.....13
3.3.1.1 Assessment of Groundwater Conditions.....13
3.3.1.2 Conceptual Dewatering Model.....14
3.3.1.3 Hydraulic Conductivity Estimates.....14
3.3.1.4 Dewatering Pumping Flow Estimate.....14
3.3.1.5 Dewatering Approach.....15
3.3.2 Boring KB-14 to Beyond KB-16 (End of Reach C).....15
3.3.2.1 Assessment of Groundwater Conditions.....15
3.3.2.2 Conceptual Dewatering Model.....15

© 2015 Kleinfelder

3.3.2.3 Hydraulic Conductivity Estimates 16
3.3.2.4 Dewatering Pumping Flow Estimate 16
3.3.2.5 Dewatering Approach 16

4 ADDITIONAL CONSIDERATIONS 17
4.1 ADDITIONAL GROUNDWATER CONSIDERATIONS DURING CONSTRUCTION 17

5 LIMITATIONS 18

Attachments: Plate 1, Site Location
Plate 2, Site Plan
Plate 3, Cross Section of Planned Alignment
Plate 4, Measured Groundwater Levels

© 2015 Kleinfelder

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY COUNTY SANITATION DISTRICT
SONOMA COUNTY WATER AGENCY
SEWER TRUNK REPLACEMENT PROJECT
REACHES A, B AND C
SONOMA COUNTY, CALIFORNIA

1 INTRODUCTION

This report supplement presents findings, conclusions, and recommendations resulting from groundwater data obtained during our geotechnical investigations, and data provided by Sonoma County Water Agency (SCWA) for Reaches A, B, and C of the Sewer Trunk Replacement Project in Sonoma County, California. The approximate location of the site is shown on Plate 1, Site Location. Our understanding of the project is based on information received from the Sonoma Valley County Sanitation District / Sonoma County Water Agency (SVCSD/SCWA – herein referred to as the District) in email correspondence, telephone conversations and in meetings at the District's office. Information received from the District included the following:

- Geotechnical Investigation, Sonoma Valley County Sanitation District, Agua Caliente Creek, Bore and Jack Crossing, El Verano, Sonoma County, California, by Brunsing Associates, August 30, 2012.
- Initial and ongoing piezometer readings: Borings KB-4, KB-10, Aqua Caliente 1 (AC1) and Agua Caliente 2 (AC2).
- SVCSD Sewer Truck Replacement Phase IV-A (Reach A), Plan and Profiles, 60% submittal.

1.1 PROJECT DESCRIPTION

The project consists of approximately 9,250 lineal feet of new sewer pipeline. The pipeline alignment is divided into three reaches (A, B, and C), as shown on Plate 2, Site Plan.

- Reach A consists of approximately 3,700 lineal feet of new, approximately 27-inch ID (inside diameter) by 30-inch OD (outside diameter), thermoplastic (HDPE, PVC or similar) trunk sewer pipe and appurtenances. The pipeline will be installed at depths ranging from about 15 to 30 feet below site grades. Reach A is largely located beneath areas of heavily travelled city streets and within Caltrans and City of Sonoma rights-of-

© 2015 Kleinfelder

ways. The proposed alignment is roughly parallel to an existing 21-inch-diameter, reinforced concrete pipe (RCP) trunk sewer main.

- Reach B consists of approximately 3,300 lineal feet of new, approximately 27-inch ID (inside diameter) by 30-inch OD (outside diameter), thermoplastic trunk sewer pipe and appurtenances. The pipeline will be installed at depths ranging from about 10 to 30 feet below site grades. This reach replaces an existing 21-inch-diameter RCP trunk sewer main. Within this reach, this sewer line begins at a private mobile home park on the south end of the alignment and then is primarily located beneath the (public) Maxwell Recreational Park. The north end of this alignment crosses the County roadway at Verano Avenue and connects to an inverted siphon sewer that passes beneath Agua Caliente Creek. The crossing of Agua Caliente Creek has been investigated by others (Brunsing Associates) and is not included in this project.
- Reach C will replace approximately 2,500 lineal feet of existing 21-inch-diameter RCP trunk sewer pipeline and appurtenances with a new thermoplastic trunk sewer pipe that will be 27-inch ID (inside diameter) by 30-inch OD (outside diameter). This reach begins at the northern end of the Agua Caliente Creek crossing and follows public roadways and obtained public sewer easements through primarily residential neighborhoods within unincorporated Sonoma County, ending on Happy Lane.

It is our understanding that the project is in the preliminary design phase at this time. Information from the results of this groundwater investigation will be used to develop preliminary and final phases of design plans, specifications and construction cost estimates.

The information described above represents our understanding of the project. If this information is to be modified, we will need to review our conclusions and recommendations for applicability.

1.2 PURPOSE AND SCOPE OF SERVICES

The purposes of this study were to observe and report seasonal groundwater conditions along the proposed pipeline alignments, perform construction dewatering evaluations, and provide dewatering recommendations for conceptual design and construction of the sewer.

© 2015 Kleinfelder

2 GROUNDWATER CONDITIONS SUMMARY

2.1 PREVIOUSLY REPORTED SOIL AND GROUNDWATER DATA

Kleinfelder completed 16 geotechnical borings along the alignment. The initial field exploration program was conducted in July of 2014, with two supplemental explorations performed in December of 2014. Details of these borings are reported in separate geotechnical reports for Reaches A, B, and C. The approximate locations of the borings are shown on Plate 2. Two piezometers were installed at Borings KB-4 and KB-10. A cross section of the alignment showing boring log results and groundwater observations is presented on Plates 3A and 3B, Cross Section of Planned Alignment. Soils with predominantly high amounts of fine grains (clayey gravel, clayey sand, sandy silt, sandy clay, and clay) and of relatively low hydraulic conductivities were encountered along the alignment.

Seven borings encountered groundwater at the time of drilling. Depths to groundwater that were recorded during drilling varied from about 14 feet to 41 feet below the ground surface. Due to the high clay content of the soils, the groundwater depths that were recorded during drilling may not be representative of the true, stabilized groundwater levels. In Boring KB-4 groundwater was recorded at a depth of about 41 feet at the time of drilling, but at a depth of about 22 feet in a piezometer at this location approximately two weeks later (a rise of 19 feet). In Boring KB-10, a wet sample was noted at a depth of about 35 feet, indicating groundwater near that depth at the time of drilling. However, a groundwater depth of 22 feet was measured in a piezometer at this location approximately two weeks later (a rise of 13 feet). The groundwater readings that were recorded during drilling probably represent a lower bound on groundwater levels. If given more time to stabilize, groundwater levels in the borings may have risen higher than shown on the boring logs. Groundwater measurements are summarized in Table 2.1.

© 2015 Kleinfelder

TABLE 2.1
GROUNDWATER LEVEL MEASUREMENTS*

Boring Number	Approx. Ground Surface Elevation (feet)	Depth of Boring (feet)	Circumstance & Date	Approx. Depth to Pipeline Invert (feet)	Depth to Groundwater Below Adjacent Grade (feet)	Approx. Groundwater Elevation (feet)
KB-4	82.4	51.5	During drilling 7-16-14	16	41	41
KB-4	82.4	51.5	Piezometer 7-29-14	16	22	60
KB-4	82.4	51.5	Piezometer 12-20-14	16	11	71
KB-6	101.6	31.5	During Drilling 12-18-14	26	14.5	87
KB-9	90.0	21.5	During drilling 7-17-14	12	14	76
KB-10	94.0	51.5	During drilling 7-18-14	14	35	59
KB-10	94.0	51.5	Piezometer 7-29-14	14	22	72
KB-10	94.0	51.5	Piezometer 12-20-14	14	9.5	84.5
KB-11	104.5	26.0	During drilling 7-17-14	16	15	90
KDP-15	105.0	28	During drilling 7-24-14	12	16.5	89
KDP-16	106.8	21.5	During drilling 7-15-14	12	15.0	92

*As reported in Kleinfelder's Geotechnical Report dated (February 6, 2015)

In December, 2014 a supplemental exploration drilled in December, 2014 (KB-6) encountered a groundwater level that was more than 10 feet above the proposed pipeline invert. Piezometer readings in December, 2014 in KB-4 and KB-10 indicated a groundwater level that was approximately 5 feet above the pipeline invert.

2.2 SUMMARY OF PIEZOMETER OBSERVATIONS

Water levels in the KB-4 and KB-10 piezometers were recorded via vibrating wire piezometers from July 29, 2014 to April 2, 2015. Additionally, the District provided Kleinfelder with water level readings from three piezometers (Agua Caliente 1, Agua Caliente 2, and West Thompson) during the period from January 2012 through April 2, 2015. Although reported here in this report, the water level data for Agua Caliente 1 and 2 were not used in our dewatering

© 2015 Kleinfelder

evaluation calculations since the Agua Caliente Creek crossing is reported by others and since the "creek effect" on water levels is not representative of groundwater conditions for the remainder of the alignment. For the purposes of our evaluation this report looks specifically at the seasonal groundwater fluctuations between July 29, 2014 and April 2, 2015. Piezometer readings are summarized in Table 2.2. A graphical representation of all groundwater level data is shown on Plate 4.

TABLE 2.2
PIEZOMETER READINGS FROM 7/29/2014 to 4/2/2015

Location	Approx. Ground Surface Elevation (feet)	Minimum Elevation (feet)	Maximum Sustained Elevation (feet)	Approximate Water Level Above Pipe Invert in Feet (Maximum)
Agua Caliente 1	102.9	81.0	87.8	11
Agua Caliente 2	99.5	70.0	83.1*	12*
W. Thompson	105**	85.9	97.7	4
KB-4 (Napa Street)	82.4	58.8	70.9	5
KB-10 (West Verano)	94.0	67.8	84.4	5

*Monitoring was discontinued prior to maximum seasonal groundwater level rise.
**Approximate ground surface elevation was previously reported as 61.6 feet.

In general, the observed seasonal groundwater fluctuations outside of the Agua Caliente Creek crossing ranged from 12.1 (KB-4) to 16.6 feet (KB-10). Adjacent to Agua Caliente Creek water levels fluctuations ranged from 6.8 (Agua Caliente 1) to 13.1 feet (Agua Caliente 2), although monitoring in Agua Caliente 2 was terminated prior to maximum seasonal groundwater level rise. Groundwater levels reached their lowest values in early November 2014 and then rose quickly in response to precipitation to reach their highest observed values in mid-December 2014. Groundwater levels gradually decreased until falling below the pipe invert depth/elevation by early April, 2015.

© 2015 Kleinfelder

3 DEWATERING EVALUATIONS AND RECOMMENDATIONS

This section summarizes the results of Kleinfelder's recent hydrogeologic study, construction dewatering assessment, and recommended dewatering approach for the Sewer Trunk Replacement Project. It is our understanding that the construction approach for pipeline placement will be primarily open cut trenching. The dewatering evaluation in this report will be broken down by stretches that represent sections of similar groundwater conditions and recommended dewatering approach. Groundwater data along the alignment is limited but indicates that groundwater potentially lies near or above the pipe invert for half the year (November to April). Although our analysis is based upon groundwater data from one season, groundwater elevations should be anticipated to be a few feet higher during an exceptionally wet season. Actual dewatering flows will greatly depend upon the groundwater levels at the time of construction and the actual soil conditions encountered along the alignment. The type of dewatering approach best suited for an excavation depends on the soil to be dewatered, the relationship of the subgrade elevation to the base of the aquifer, the thickness of the aquifer, the length of dewatering and the amount of drawdown required. Subsurface information including boring logs and groundwater data used for this dewatering evaluation is presented in the Geotechnical Investigation Report for Reaches A, B, and C prepared by Kleinfelder, Inc. Our interpretations of soil and groundwater conditions in this report are based on data obtained from widely-spaced borings, geologic research, and laboratory test data collected for this study. The conclusions and recommendations that follow are based on interpretations and extrapolation of that data. It is likely that undetected variations in subsurface conditions exist at the site.

3.1 REACH A – FLOW ESTIMATES

Our dewatering evaluations for Reach A are separated by stretches of similar geologic and hydrogeologic conditions. These stretches are represented by station numbers described in SVCSD Sewer Truck Replacement Phase IV-A, Plan and Profiles (60% Submittal), provided to Kleinfelder by the District.

© 2015 Kleinfelder

3.1.1 STATION 10+00 to 39+00

3.1.1.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 5 feet during the peak of the wet season. Soil data from borings KB-1, KB-2, KB-3, KB-4, and KB-5 indicates generally fine-grained soils of clayey sand, clayey gravel, sandy silt, sandy clay and clay. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows.

3.1.1.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 55 and 71 feet
- Water table depth of 10 to 22 feet below the existing ground surface
- Required drawdown of up to 6 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

3.1.1.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based upon soil descriptions from borings KB-1, KB-2, KB-3, KB-4, and KB-5. We estimate a likely range of hydraulic conductivities from 1.0×10^{-6} to 1.0×10^{-3} feet/minute (5.1×10^{-7} to 5.1×10^{-4} cm/s).

3.1.1.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation should require some dewatering.
For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet, 3 feet, and 6 feet
- K = Hydraulic conductivity = 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet

© 2015 Kleinfelder

- R = Radius of influence (high) = 44 feet (L=89 feet)
- R = Radius of influence (low) = 5 feet (L=10 feet)
- x = trench length = 100 feet

TABLE 3.1
STATION 10+00 TO 39+00

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	6	<1 to 8
1.0E-06 to 1.0E-03	3	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

3.1.1.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which dominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

3.1.2 STATION 39+00 to 46+19

3.1.2.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 10 feet during the peak of the wet season. Soil data from borings KB-5 and KB-6 indicates generally fined grained soils of clayey sand, sandy clay, and clay. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows.

3.1.2.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 65 and 87 feet

© 2015 Kleinfelder

- Water table depth of 15 to 28 feet below the existing ground surface
- Required drawdown of up to 11 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of $1.0x10^{-6}$ to $1.0x10^{-3}$ feet/minute
- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

3.1.2.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based on soil descriptions from borings KB-5 and KB-6. We estimate a likely range of hydraulic conductivities from $1.0x10^{-6}$ to $1.0x10^{-3}$ feet/minute ($5.1x10^{-7}$ to $5.1x10^{-4}$ cm/s).

3.1.2.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation should require some dewatering.
For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet, 3 feet, and 11 feet
- K = Hydraulic conductivity = $1.0x10^{-6}$ to $1.0x10^{-3}$ feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet
- R = Radius of influence (high) = 78 feet (L=156 feet)
- R = Radius of influence (low) = 5 feet (L=11 feet)
- x = trench length = 100 feet

TABLE 3.2
STATION 39+00 TO 46+19

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	11	<1 to 10
1.0E-06 to 1.0E-03	3	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

© 2015 Kleinfelder

3.1.2.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which predominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

3.2 REACH B

Our dewatering evaluations for Reach B are separated by stretches of similar geologic and hydrogeologic conditions. A Plan and Profile of the alignment were not available at the time of this evaluation. In lieu of such plans, Kleinfelder's cross section of the alignment (Plates 3A and 3B) were used to estimate similar conditions and establish groundwater drawdown estimates.

3.2.1 From Reach A to Boring KB-8

3.2.1.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 9 feet during the peak of the wet season. Soil data from borings KB-6, KB-7, and KB-8 indicates generally fined grained soils of silty sand and sandy clay. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows. However boring KB-7 identified poorly graded sand at a depth of 20 feet bgs. Similar soils, if saturated, could be a greater source of flow into the excavation.

3.2.1.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 73 and 86 feet
- Water table depth of 10 to 22 feet below the existing ground surface
- Required drawdown of up to 10 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of 1.0×10^{-6} to 1.0×10^{-3} feet/minute

© 2015 Kleinfelder

- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

3.2.1.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based soil descriptions from borings KB-6, KB-7, and KB-8. We estimate a likely range of hydraulic conductivities from 1.0×10^{-6} to 1.0×10^{-3} feet/minute (5.1×10^{-7} to 5.1×10^{-4} cm/s).

3.2.1.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation should require some dewatering.
For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet, 3 feet, and 10 feet
- K = Hydraulic conductivity = 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet
- R = Radius of influence (high) = 71 feet (L=142 feet)
- R = Radius of influence (low) = 5 feet (L=10 feet)
- x = trench length = 100 feet

TABLE 3.3
REACH A TO BORING KB-8

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	10	<1 to 10
1.0E-06 to 1.0E-03	3	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

© 2015 Kleinfelder

3.2.1.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which predominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

3.2.2 KB-8 to Agua Caliente Creek Crossing

3.2.2.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 5 feet during the peak of the wet season. Soil data from borings KB-8, KB-9, KB-10, and KB-11 indicates generally fined grained soils of clayey sand, sandy clay, and clay. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows.

3.2.2.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 73 and 85 feet
- Water table depth of 12 to 20 feet below the existing ground surface
- Required drawdown of up to 6 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

3.2.2.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based on soil descriptions from borings KB-8, KB-9, KB-10, and KB-11. We estimate a likely range of hydraulic conductivities from 1.0×10^{-6} to 1.0×10^{-3} feet/minute (5.1×10^{-7} to 5.1×10^{-4} cm/s).

© 2015 Kleinfelder

3.2.2.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation should require some dewatering. For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet, 3 feet, and 6 feet
- K = Hydraulic conductivity = 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet
- R = Radius of influence (high) = 44 feet (L=87 feet)
- R = Radius of influence (low) = 4 feet (L=9 feet)
- x = trench length = 100 feet

TABLE 3.4
BORING KB-8 TO AGUA CALIENTE CREEK CROSSING

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	6	<1 to 8
1.0E-06 to 1.0E-03	3	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

3.2.2.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which predominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

3.3 REACH C

3.3.1 From Aqua Caliente Creek Crossing to Boring KB-14

3.3.1.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 3 feet during the peak of the wet season. Soil data from borings KB-12, KB-13, and KB-14 indicates generally fined grained soils of silty sand

© 2015 Kleinfelder

and sandy silt. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows.

3.3.1.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 87 and 96 feet
- Water table depth of 7 to 16 feet below the existing ground surface
- Required drawdown of up to 3 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of $1.0x10^{-5}$ to $1.0x10^{-3}$ feet/minute
- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

3.3.1.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based on soil descriptions from borings KB-12, KB-13, and KB-14. We estimate a likely range of hydraulic conductivities from $1.0x10^{-5}$ to $1.0x10^{-3}$ feet/minute ($5.1x10^{-6}$ to $5.1x10^{-4}$ cm/s).

3.3.1.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation could require some dewatering during the wet season.

For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet and 4 feet
- K = Hydraulic conductivity = $1.0x10^{-5}$ to $1.0x10^{-3}$ feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet
- R = Radius of influence (high) = 23 feet (L=46 feet)
- R = Radius of influence (low) = 5 feet (L=10 feet)
- x = trench length = 100 feet

© 2015 Kleinfelder

TABLE 3.5
AQUA CALIENTE CREEK CROSSING TO BORING KB-14

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	4	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

3.3.1.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which predominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

3.3.2 Boring KB-14 to Beyond KB-16 (End of Reach C)

3.3.2.1 Assessment of Groundwater Conditions

Groundwater data along this portion of the alignment is limited but indicates that groundwater lies near or above the pipe invert by as much as 4 feet during the peak of the wet season. Soil data from borings KB-14, KB-15, and KB-16 indicates generally fined grained soils of clayey gravel, sandy clay, and clay. These soil conditions typically possess relatively low hydraulic conductivities and are not expected to produce substantial groundwater flows.

3.3.2.2 Conceptual Dewatering Model

For our conceptual dewatering model(s), the following was assumed:

- Unconfined aquifer thickness of 40 feet
- Groundwater elevations between 88 and 98 feet
- Water table depth of 7 to 15 feet below the existing ground surface
- Required drawdown of up to 5 feet (to 1 foot below bottom of trench subgrade)
- Hydraulic conductivity ranging from of 1.0×10^{-6} to 1.0×10^{-3} feet/minute
- Specific yield of 0.15 (unitless)
- No positive or negative hydraulic barriers

© 2015 Kleinfelder

3.3.2.3 Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated based on soil descriptions from borings KB-14, KB-15, and KB-16. We estimate a likely range of hydraulic conductivities from $1.0x10^{-6}$ to $1.0x10^{-3}$ feet/minute ($5.1x10^{-7}$ to $5.1x10^{-4}$ cm/s).

3.3.2.4 Dewatering Pumping Flow Estimate

An open cut trench approach to pipeline installation should require some dewatering.
For our conceptual dewatering model, the following dewatering parameters were used:

- H = Aquifer thickness = 40 feet
- h_o = Required drawdown = 0 feet, 3 feet, and 5 feet
- K = Hydraulic conductivity = $1.0x10^{-6}$ to $1.0x10^{-3}$ feet/minute
- r_s = Equivalent radius (r_s) trench ends = 3.0 feet
- R = Radius of influence (high) = 37 feet (L=74 feet)
- R = Radius of influence (low) = 4 feet (L=8 feet)
- x = trench length = 100 feet

TABLE 3.6
BORING KB-14 TO BEYOND KB-16 (END OF REACH C)

Hydraulic Conductivity (ft/min)	Assumed Drawdown Required (ft)	Flow Estimates* (gpm)
1.0E-06 to 1.0E-03	5	<1 to 8
1.0E-06 to 1.0E-03	3	<1 to 7
1.0E-06 to 1.0E-03	0	-

* Flow estimates are for 100 feet of open trench.

3.3.2.5 Dewatering Approach

The dewatering of very fine soils, such as clays, which predominate the local stratigraphy, can be difficult, time consuming, and costly. Based on our analyses, if groundwater is present, a sump pumping dewatering system appears the most appropriate technology for dewatering the proposed excavations. However, if groundwater levels are more than 3 feet above the subgrade, excessive flows are encountered, or running (flowing) sands are encountered, another dewatering strategy may have to be employed.

© 2015 Kleinfelder

4 ADDITIONAL CONSIDERATIONS

4.1 ADDITIONAL GROUNDWATER CONSIDERATIONS DURING CONSTRUCTION

The contractor should retain the services of a dewatering expert to assist with the evaluation of an appropriate combination of dewatering methods for trenching and trenchless construction methods. An effective dewatering program takes time to dewater a site, so dewatering systems should be installed well in advance of construction. It has been our experience that several weeks may be needed to lower groundwater levels to acceptable levels. Piezometers should be installed and monitored to verify that groundwater levels have been lowered to acceptable levels before construction begins. Localized granular soil layers below or near the trench bottoms may also need to be dewatered.

We recommend that during wet weather, earthen berms or other controls be used to prevent surface runoff from entering excavations. Surface runoff water and groundwater pumped from excavations should be collected and disposed of outside of the construction limits.

© 2015 Kleinfelder

5 LIMITATIONS

This report presents information for planning, permitting, design, and construction of the Reaches A, B and C of the Ramon Street and Sonoma Highway Area Sewer Trunk Replacement Project, prepared for the Sonoma County Valley Sanitation District/Sonoma County Water Agency in Sonoma County, California. It is expected that information contained in this report will be used to help other design professionals select the ultimate location, length, and depth of the proposed pipeline crossings. However, this report should not be used to define site conditions for contractual purposes, and Kleinfelder will accept no liability for changed conditions claims based on this report.

Recommendations contained in this report are based on materials encountered in the borings drilled for this study and during previous studies along the project alignment, evaluation of existing geotechnical data from the project vicinity, geologic interpretation based on published articles and geologic literature, and our present knowledge of the proposed construction.

It is possible and likely that soil and groundwater conditions could vary between or beyond the points explored. If the scope of the proposed construction, including the proposed alignment locations, changes from that described in this report, we should be notified immediately in order that a review may be made and any supplemental recommendations provided.

We have prepared this report in substantial accordance with the generally accepted hydrogeologic practice as it exists in the site area at the time of our study. No warranty is expressed or implied.

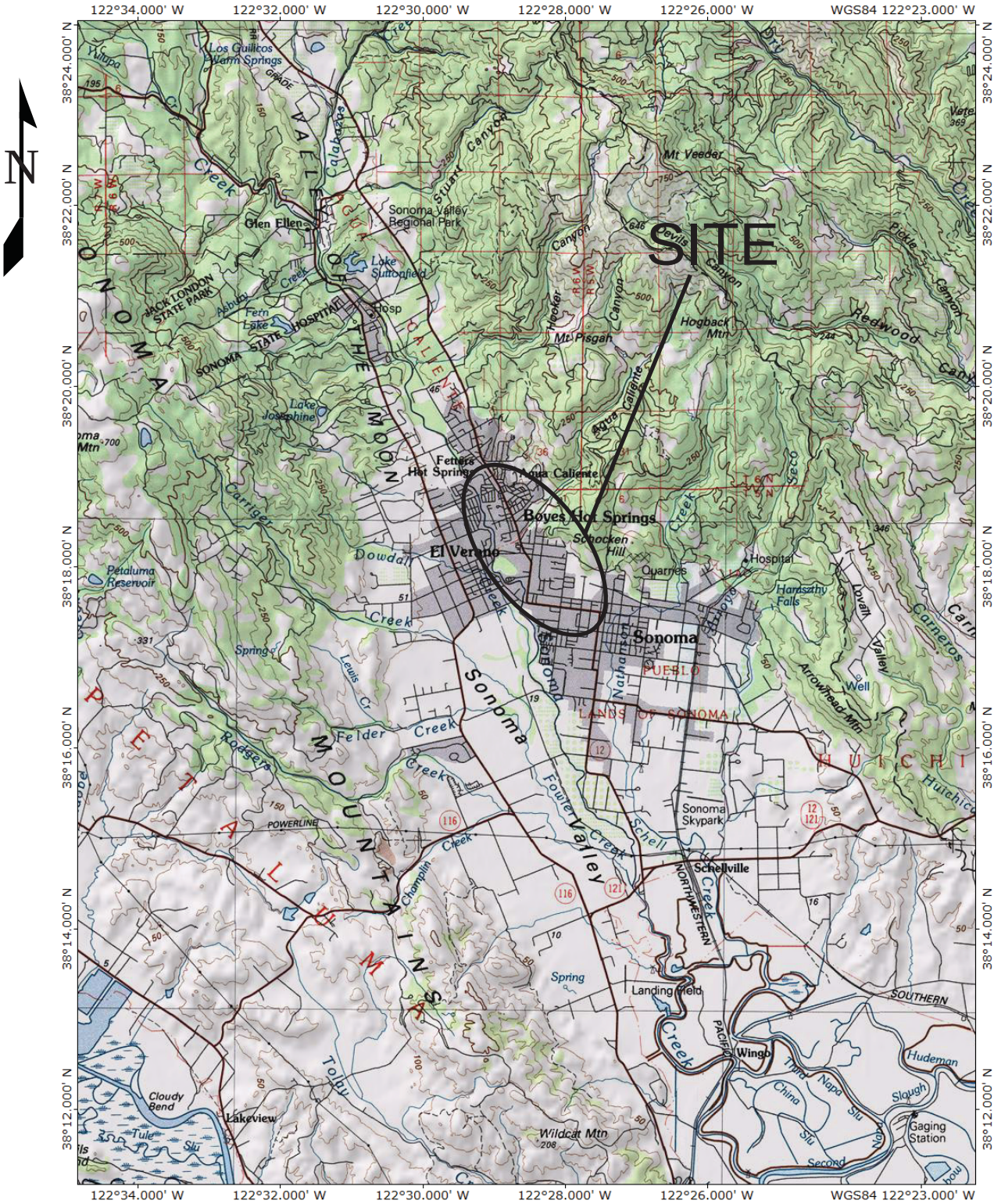
This report may be used only by the client and only for the purposes stated, within a reasonable time (2 years) from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

© 2015 Kleinfelder

KLEINFELDER

Bright People. Right Solutions.

Plates



Reference: TOPO! National Geographic Holdings, 2001

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

10,000 5,000 0 10,000

APPROXIMATE SCALE (feet)

ILLUSTRATOR FILE: U:\GEOTECH_PROJECTS\Projects\Active\20143780.001A SCWA HAPPY LANE\Groundwater Letter_4.17.15\graphics

Santa Rosa

KLEINFELDER

Bright People. Right Solutions.

www.kleinfelder.com

PROJECT NO.	20143780
DRAWN	APR 2015
DRAWN BY	MP
CHECKED BY	TC
FILE NAME	Site Location.ai

SITE LOCATION

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY TRUNK MAIN REPLACEMENT
REACH A , B AND C
SONOMA COUNTY, CALIFORNIA

PLATE

1

SOIL BORINGS DRILLED FOR REPLACEMENT OF SONOMA VALLEY TRUNK MAIN

REACH A

Boring Number[1]	Latitude	Longitude	Ground Surface Elevation (feet)	Date Drilled	Boring Depth (feet)	Approx. Depth to Sewer Invert (feet)
KB-1	38.29243°	-122.47052°	79.7	7/15/2014	31½	16
KDP-2	38.29288°	-122.47042°	82.3	7/23/2014	7[2]	19
KB-2	38.29288°	-122.47042°	82.3	12/17/14	31½	19
KB-3	38.29338°	-122.47280°	82.8	7/17/2014	26½	18
KB-4	38.29372°	-122.47550°	82.4	7/16/2014	51½	16
KB-5	38.29615°	-122.47558°	98	7/18/2014	31½	23
KDP-6	38.29817°	-122.47540°	101.6	7/24/2014	10[2]	26
KB-6	38.29817°	-122.47540°	101.6	12/18/2014	31½	26

REACH B

Boring Number[1]	Latitude	Longitude	Ground Surface Elevation (feet)	Date Drilled	Boring Depth (feet)	Approx. Depth to Sewer Invert (feet)
KB-7	38.29922°	-122.47731°	92	7/18/2014	26[2]	15
KB-8	38.30074°	-122.47823	99	7/18/2014	26½	21
KB-9	38.30059°	-122.47919°	90	7/17/2014	21½	12
KB-10	38.30156°	-122.48159°	94	7/18/2014	51½	14
KB-11	38.30295°	-122.48162°	104.5	7/17/2014	26	23

REACH C

Boring Number[1]	Latitude	Longitude	Ground Surface Elevation (feet)	Date Drilled	Boring Depth (feet)	Approx. Depth to Sewer Invert (feet)
KB-12	38.30505°	-122.48190°	102	7/17/2014	16½	10
KB-13	38.30632°	-122.48169°	108	7/16/2014	21½	16
KB-14	38.30716°	-122.48271°	100.7	7/15/2014	15	8
KDP-15	38.30841°	-122.48336°	105	7/24/2014	28	12
KB-16	38.31003°	-122.48421°	106.8	7/15/2014	21½	12

[1] Borings designated KB were drilled using Hollow Stem Auger methods. Borings designated KDP were drilled using direct push methods to aid in obtaining environmental samples. Ground elevations approximate.

[2] Boring terminated short of scheduled depth due to practical refusal of drilling method. Supplemental borings (KB-2 and KB-6) were later drilled at the locations of KDP-2 and KDP-6.

Basemap: Google Earth Pro
Alignment Locations provided by SCWA

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Reach A
Reach B
Reach C
Existing Sewer Main
Agua Caliente Creek Crossing
West Thompson Piezometer
KB-1 Hollow-Stem Auger Boring Location: Kleinfelder, 2014
KDP-2 Direct Push Boring Location: Kleinfelder, 2014
Miller Pacific: B-1 Miller Pacific Boring Location, 2013
Brunsing: B-1 Brunsing Boring Location, 2012
Lowney: B-18 Lowney Boring Location, 1977

N

200 100 0 200
APPROXIMATE SCALE (feet)

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

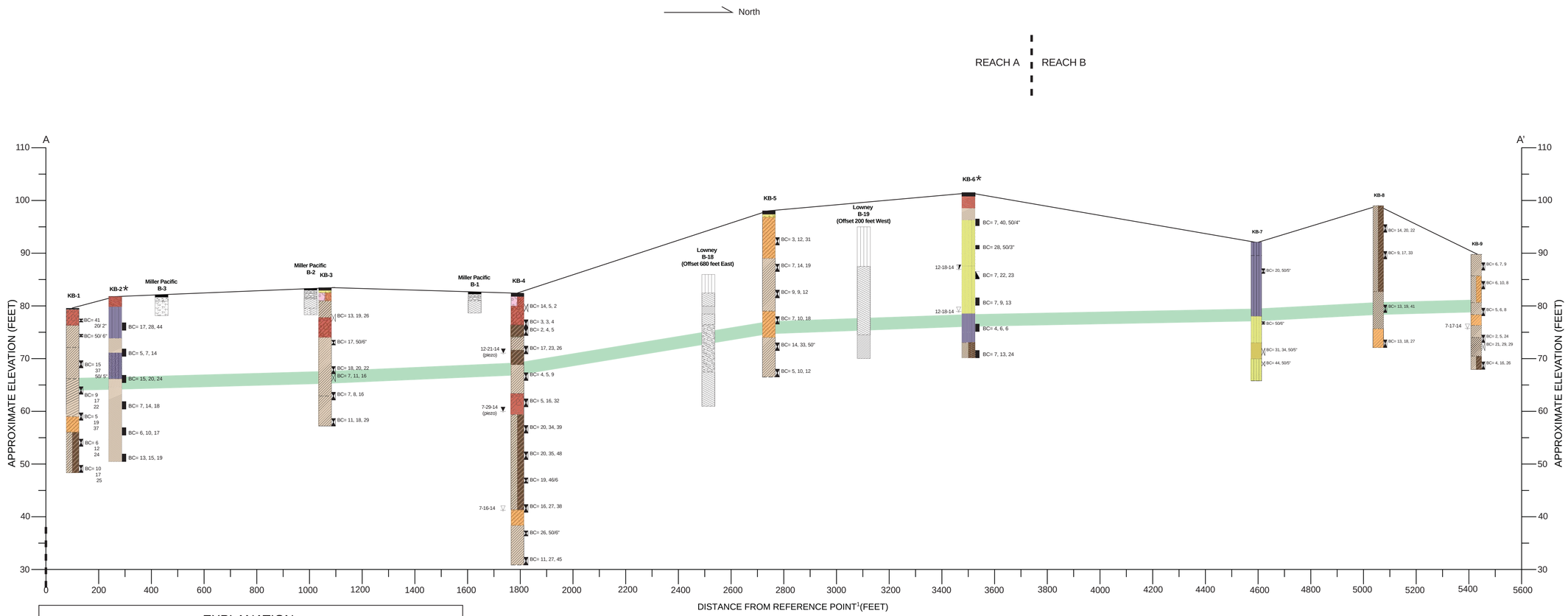
PROJECT NO.	20143780
DRAWN	APR 2015
DRAWN BY	EJ
CHECKED BY	MP
FILE NAME	Site Plan.ai

SITE PLAN

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY TRUNK MAIN REPLACEMENT
REACH A , B AND C
SONOMA COUNTY, CALIFORNIA

PLATE 2

Santa Rosa ILLUSTRATOR FILE: U:\GEOTECH_PROJECTS\Projects\Active\20143780.001A SCWA HAPPY LANE\Groundwater Letter_4.17.15\graphics



EXPLANATION

Ground Surface
Proposed Trunk

First Water Level Reading (during drilling)
Static Water Level Reading (short-term)
Static Water Level Reading (post-drilling)

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic / Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

* The graphics for direct push borings KDP-2 and KDP-6 have been removed from this cross section. These two borings encountered refusal at 7-feet and 10-feet-deep, respectively. Borings KB-2 and KB-6 were drilled to the planned depth of approximately 30-feet-deep after the direct push borings encountered refusal. See Appendix A for detailed logs of all borings.

Surface Elevations based on SCWA Cad File 7365TOPO_4
[1]Reference point: Survey Monument 20157 79.29 MON157

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Santa Rosa ILLUSTRATOR FILE: U:\GEOTECH PROJECTS\Projects\Active\201437780.001A SCWA HAPPY LANE\Groundwater Letter 4.17.15\graphics

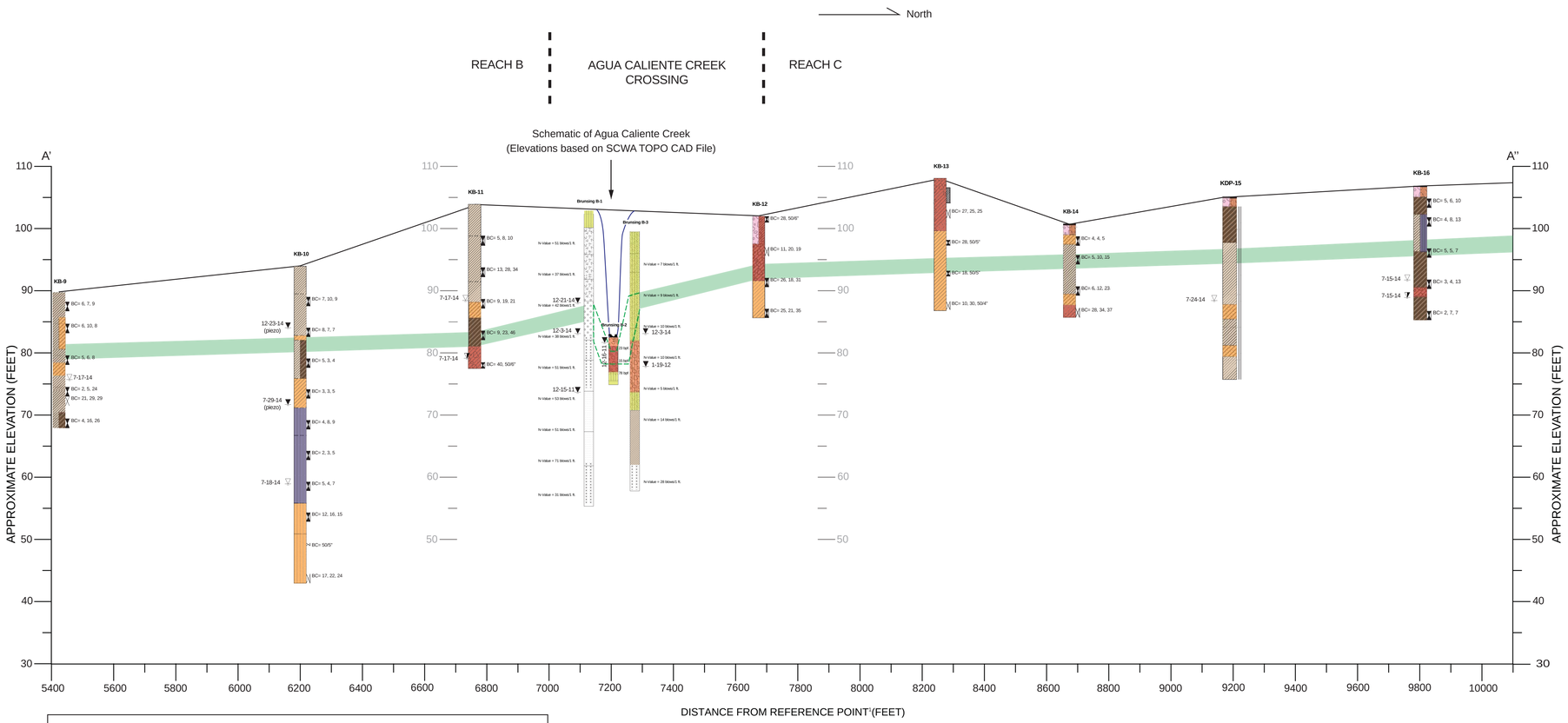
KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20143780
DRAWN	APR 2015
DRAWN BY	JC
CHECKED BY	TC
FILE NAME	Cross Section (3A and 3B).ai

CROSS SECTION OF PLANNED ALIGNMENT

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY TRUNK MAIN REPLACEMENT
REACH A, B AND C
SONOMA COUNTY, CALIFORNIA

PLATE
3A



EXPLANATION

Ground Surface
Proposed Trunk

First Water Level Reading (during drilling)
Static Water Level Reading (short-term)
Static Water Level Reading (post-drilling)

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

Direct Push Refusal

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names	Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

Surface Elevations based on SCWA Cad File 7365TOPO_4
[1]Reference point: Survey Monument 20157 79.29 MON157

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Santa Rosa ILLUSTRATOR FILE: U:\GEOTECH_PROJECTS\Projects\Active\20143780.001A SCWA HAPPY LANE\Groundwater Letter_4.17.15\graphics

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

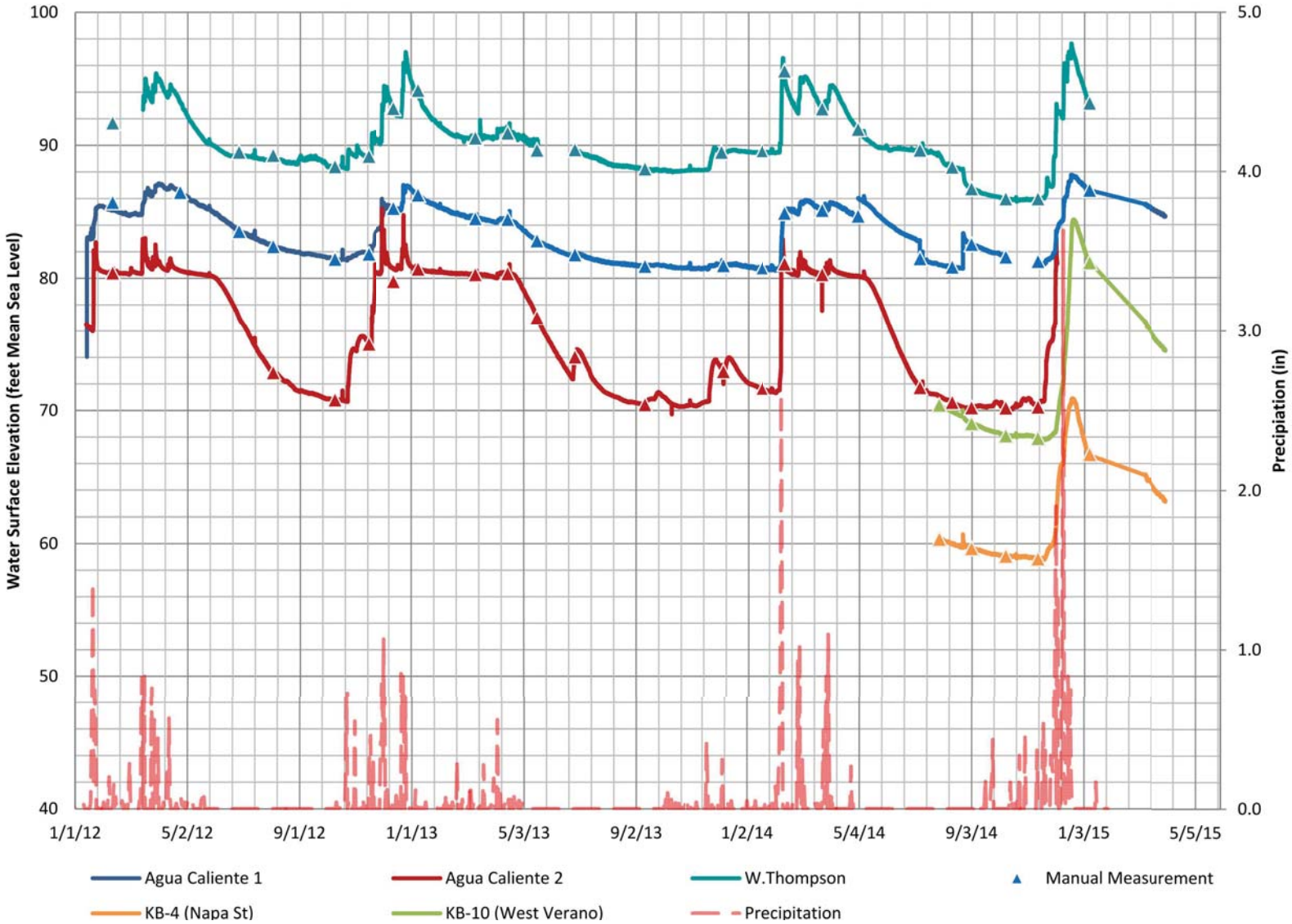
PROJECT NO.	20143780
DRAWN	APR 2015
DRAWN BY	JC
CHECKED BY	TC
FILE NAME	Cross Section (3A and 3B).ai

CROSS SECTION OF PLANNED ALIGNMENT

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY TRUNK MAIN REPLACEMENT
REACH A , B AND C
SONOMA COUNTY, CALIFORNIA

PLATE 3B

SVCSD - Sewer Trunk Replacement Project: Groundwater Level Hydrographs



*Note: Gaps in data occur when pressure transducer is temporarily out of service or removed for sampling

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it designed or intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	20143780-1
DRAWN:	04/16/2015
DRAWN BY:	D. Ross
CHECKED BY:	P. Rust
FILE NAME:	GW_Levels.dwg

GROUNDWATER LEVELS

GROUNDWATER DATA MEMORANDUM
SONOMA VALLEY TRUNK MAIN REPLACEMENT
REACH A , B AND C
SONOMA COUNTY, CALIFORNIA

PLATE
4