Stevens Ferrone & Bailey
Engineering Company, Inc

Geotechnical Engineering
Engineering Geology
Storm Water Management
Construction Observation & Testing Services

March 20, 2014

Ms. Jenny Cherney
Daniel B. Stephens & Associates
P.O. Box 256
Petaluma, CA 94953

Re: Geotechnical Investigation
MacArthur Street Culvert, Sonoma, California
SFB Project No.: 621-1

Ms. Cherney:

As requested, Stevens, Ferrone & Bailey Engineering Company, Inc. has performed a geotechnical investigation for the MacArthur Street Culvert project in Sonoma, California. The accompanying report presents the results of our field investigation, laboratory tests, and engineering analysis. The geotechnical conditions are discussed, and recommendations for the geotechnical engineering aspects of the project are presented. Conclusions and recommendations contained herein are based upon applicable standards of our profession at the time this report has been prepared. Should you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,

Stevens, Ferrone & Bailey
Engineering Company, Inc.

Ken Ferrone
President

Copies: Addressee (1 by email)

1600 Willow Pass Court • Concord, CA 94520 • Tel 925.688.1001 • Fax 925.688.1005
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Construction Observation & Testing Services

March 20, 2014

GEOTECHNICAL INVESTIGATION
MACARTHUR STREET CULVERT
SONOMA, CALIFORNIA
SFB PROJECT NO. 168-60

Prepared For:

Daniel B. Stephens & Associates
P.O. Box 256
Petaluma, CA 94953

Prepared By:

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1.0 INTRODUCTION

This report presents the results of our geological and geotechnical investigation for the proposed MacArthur Street culvert improvement project located near the intersection of Amedeo Court and MacArthur Street in Sonoma, California as shown on the Site Plan, Figure 1. The purpose of our investigation was to evaluate the geological and geotechnical conditions at the site and provide recommendations regarding the geotechnical engineering aspects of the project.

Based on the information indicated on the Site Plan, as well as information provided by Ms. Jenny Cherney of Daniel B. Stephens & Associates, it is our understanding that the project will consist of improving the existing box culvert or completely removing and replacing the box culvert. Nominal grading is anticipated.

The conclusions and recommendations provided in this report are based upon the information presented above; Stevens, Ferrone & Bailey Engineering Company, Inc. (SFB) should be consulted if any changes to the project occur to assess if the changes affect the validity of this report.

2.0 SCOPE OF WORK

This investigation included the following scope of work:

- Reviewing available published and unpublished geotechnical and geological literature relevant to the site;
- Performing reconnaissance of the site and surrounding area;
- Reviewing two exploratory boring logs performed for the site that extended to a maximum depth explored of about 31-1/2 feet and associated laboratory testing results;
- Performing geotechnical engineering analysis of the field and laboratory data; and
- Preparing this report.

The data obtained and the analyses performed were for the purpose of providing geotechnical design and construction criteria for the box culvert improvement project. Assessment of flooding potential and toxicity potential of onsite materials or groundwater was beyond our scope of work.

3.0 SITE INVESTIGATION

Reconnaissance of the site and surrounding area was performed on December 19, 2013. Two exploratory borings were drilled on December 19, 2013, to a maximum depth of about 31-1/2 feet. The borings were logged by Daniel B. Stephens & Associates. The approximate locations of the borings are shown on the Site Plan, Figure 1. Logs of the borings are included in Appendix A. Laboratory testing was performed on select samples retrieved by Daniel B. Stephens & Associates and the results of the laboratory tests are presented in Appendix B. It should be noted that changes in the surface and subsurface conditions can occur over time as a result of either natural processes or human activity and may affect the validity of the conclusions and recommendations in this report.

3.1 Surface

At the time of our site reconnaissance and as shown on Figure 1, the existing box culvert was located directly below MacArthur Street. The water within Fryer Creek flowed southward through the culvert. Water was pooling adjacent the upstream side of the culvert, and was cascading downward a few feet adjacent the downstream side of the culvert. No apparent distress to the culvert was observed. The embankment slopes near the upstream side of the culvert were heavily vegetated and showed little evidence of erosion. The embankment slopes near the downstream side of the culvert appeared to be experiencing active erosion and were partially covered with shotcrete. Grasses and weeds, and a few trees and shrubs, were observed on the downstream slopes near the culvert.

3.2 Subsurface

The near-surface soil materials encountered in the exploratory borings generally consisted of hard sandy silts and medium dense to dense silty sands with variable amounts of gravels and clays. Occasional lenses of clayey sands and gravelly sands were encountered. Little gravel was encountered below 25 feet in Boring Mac-B-01 whereas abundant gravel was encountered below a depth of about 20 feet in Boring Mac-B-02. These soils extended to the maximum depth explored of about 31-1/2 feet. According to the results of the laboratory testing, the soils generally have a low plasticity and low expansion potential. Detailed descriptions of the materials encountered in the exploratory borings are presented on the boring logs in Appendix A. The attached boring logs and related information depict location specific subsurface conditions encountered during the field investigation.

3.3 Groundwater

The borings encountered groundwater at depths of 8 and 9.2 feet below the ground surface at the locations of the borings. The depth to groundwater measurements correspond well with the water levels observed in the adjacent creek. It should be noted that our borings might not have been left open for a sufficient period of time to establish equilibrium ground water conditions. In addition, fluctuations in the groundwater level could occur due to change in seasons, variations in rainfall, and other factors.

3.4 Geology and Seismicity

According to Graymer, et al (2006)[1], the site is underlain by Plio-Pleistocene undifferentiated sediments. Gutierrez (2010)[2] maps similar geologic conditions below the site and describes the sediments as clays, silts, sands, and gravels of early to late Pleistocene in age.

The project site is located in the San Francisco Bay Area that is considered one of the most seismically active regions in the United States. Significant earthquakes have occurred in the San Francisco Bay Area and are believed to be associated with crustal movements along a system of sub-parallel fault zones that generally trend in a northwesterly direction. The site is not located in an earthquake fault zone as designated by the State of California[3].

Earthquake intensities will vary throughout the San Francisco Bay Area, depending upon numerous factors including the magnitude of earthquake, the distance of the site from the causative fault, and the type of materials underlying the site. The U.S. Geological Survey (2008) indicated that there is a 63 percent chance of at least one magnitude 6.7 or greater earthquake striking the San Francisco Bay region between 2008 and 2037[4]. Therefore, the site will probably be subjected to at least one moderate to severe earthquake that will cause strong ground shaking.

According to the Probabilistic Seismic Hazard Analysis (NSHMP PSHA) interactive deaggregation model developed by U.S. Geological Survey (2008), the site has a 10% probability of exceeding a peak ground acceleration of about 0.45g in 50 years (design basis ground motion based on stiff to hard soil site condition; mean return time of 475 years). The

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[1] Graymer, et al, 2006, *Geologic Map of the San Francisco Bay Region*, U.S. Geological Survey Scientific Investigations Map 2918.

[2] Gutierrez, 2010, Geologic Map of the Napa 30' x 60' Quadrangle, California.

[3] Hart and Bryant, *Fault-Rupture Hazard Zones in California*, CDMG Special Publication 42, Interim Revision 2007.

[4] Field, Edward H., Milner, Kevin R., and the 2007 Working Group on California Earthquake Probabilities, 2008, *Forecasting California's earthquakes; what can we expect in the next 30 years?*: U.S. Geological Survey, Fact Sheet 2008-3027, 4 p.

actual ground surface acceleration might vary depending upon the local seismic characteristics of the underlying bedrock and the overlying soils.

3.5 Liquefaction

Soil liquefaction is a phenomenon primarily associated with saturated, cohesionless, soil layers located close to the ground surface. These soils lose strength during cyclic loading, such as imposed by earthquakes. During the loss of strength, the soil acquires mobility sufficient to permit both horizontal and vertical movements. Soils that are most susceptible to liquefaction are clean, loose, uniformly graded, saturated, fine-grained sands that lie close to the ground surface. According to ABAG and the U.S. Geological Survey, the site is located in an area mapped as having a very low likelihood of liquefaction in an earthquake and has been characterized as having very low liquefaction susceptibility[5,6]. As of the date of this report, the liquefaction potential of the site has not been evaluated by the State of California[7].

Based on our review of available literature and the results of exploratory borings at the site, it is our opinion that the potential for ground surface damage at the site resulting from liquefaction is low.

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[5]Association of Bay Area Governments, 1980, *Liquefaction Susceptibility, San Francisco Bay Region.*
[6]Knudsen, Sowers, Witter, Wentworth, and Helly, 2000, "*Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California*", USGS Open File Report 00-444.
[7]Seismic Hazards Mapping Act, 1990.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the site is suitable for the proposed project from a geotechnical engineering standpoint. The conclusions and recommendations presented in this report should be incorporated in the evaluation, design and construction of the project to reduce soil or foundation related issues. Detailed drainage, earthwork, and foundation recommendations for use in the evaluation, design and construction of the culvert project are presented below. We recommend SFB review the design and specifications to verify that the recommendations presented in this report have been properly interpreted and implemented in the design, plans, and specifications. We also recommend SFB be retained to provide consulting services and to perform construction observation and testing services during the construction phase of the project to observe and test the implementation of our recommendations, and to provide supplemental or revised recommendations in the event conditions different than those described in this report are encountered. We assume no responsibility for misinterpretation of our recommendations if we do not review the plans and specifications and are not retained during construction.

4.1 Earthwork

4.1.1 Clearing and Site Preparation

The site should be cleared of all obstructions including any existing designated structures and their entire foundation systems, designated utilities and pipelines and their associated backfill, designated trees and their associated entire root systems, and debris. Holes resulting from the removal of underground obstructions extending below the proposed finish grade should be cleared and backfilled with fill materials as specified in **Section 4.1.3, *Fill Material***, and compacted to the requirements in **Section 4.1.4, *Compaction***. Tree roots may extend to depths of about 3 to 4 feet.

From a geotechnical standpoint, any existing trench backfill materials, concrete slabs, or pavements that are removed can be used as new fill onsite provided debris is removed and it is broken up to meet the size requirement for fill material in **Section 4.1.3, *Fill Material***. We recommend fill materials composed of broken up concrete or pavement not be located within 3 feet of finished ground surface. We recommend backfilling operations for any excavations be performed under the observation and testing of SFB.

Areas within the work site containing heavy surface vegetation should be stripped to an appropriate depth to remove these materials. We anticipate average depths of about 6 inches will be needed to remove root masses other than roots from trees and shrubs. The amount of actual

vegetation removal should be determined in the field by SFB at the time of construction. Stripped materials should be removed from the site or stockpiled for later use in landscaping, if desired.

4.1.2 Subgrade Preparation

After the completion of clearing and site preparation, soil exposed in areas to receive improvements (such as structural fill, culvert foundations, and pavements) should be scarified to a depth of about 12 inches, moisture conditioned to approximately 2 to 3 percent over optimum water content, and compacted to the requirements for structural fill. If pavement subgrade is allowed to remain exposed to sun, wind or rain for an extended period of time, or are disturbed by borrowing animals, the exposed pavement subgrade may need to be reconditioned (moisture conditioned and/or scarified and recompacted) prior to foundation or pavement construction. SFB should be consulted on the need for subgrade reconditioning when the subgrade is left exposed for extended periods of time.

4.1.3 Fill Material

From a geotechnical and mechanical standpoint, onsite soils having an organic content of less than 3 percent by volume can be used as fill. Fill should not contain rocks or lumps larger than 6 inches in greatest dimension with not more than 15 percent larger than 2.5 inches. If required, imported fill should have a plasticity index of 15 or less and have a significant amount of cohesive fines.

In addition to the mechanical properties specifications, all imported fill material should have a resistivity (100% saturated) no less than the resistivity for the onsite soils, a pH of between approximately 6.0 and 8.5, a total water soluble chloride concentration less than 300 ppm, and a total water soluble sulfate concentration less than 500 ppm. We recommend import samples be submitted for corrosion and geotechnical testing at least two weeks prior to being brought onsite.

4.1.4 Compaction

Within the upper 5 feet of the finished ground surface, we recommend structural fill be compacted to at least 90 percent relative compaction, and structural fill below a depth of 5 feet be compacted to at least 95 percent relative compaction, as determined by ASTM D1557 (latest edition). We recommend the new fill be moisture conditioned approximately 2 to 3 percent over optimum water content. The upper 6 inches of subgrade soils beneath pavements should be compacted to at least 95 percent relative compaction. Fill material should be spread and compacted in lifts not exceeding approximately 8 to 12 inches in uncompacted thickness.

4.1.5 Utility Trench Backfill

Pipeline trenches should be backfilled with fill placed in lifts of approximately 8 inches in uncompacted thickness. Thicker lifts can be used provided the method of compaction is approved by SFB and the required minimum degree of compaction is achieved. Backfill should be placed by mechanical means only. Jetting is not permitted.

Onsite trench backfill should be compacted to at least 95 percent relative compaction. Imported sand trench backfill should be compacted to at least 95 percent relative compaction and sufficient water is added during backfilling operations to prevent the soil from "bulking" during compaction. To reduce piping and settlement of overlying improvements, we recommend rock bedding and rock backfill (if used) be completely surrounded by a filter fabric such as Mirafi 140N (or equivalent); alternatively, filter fabric would not be necessary if Caltrans Class 2 permeable material is used in lieu of rock bedding and rock backfill.

4.1.6 Engineered Slopes

We recommend cut and non-reinforced fill slopes not exceed an inclination of 2:1 (horizontal to vertical) if the slopes are less than 10 feet in height. Fill slopes steeper than 2:1 are feasible provided they are mechanically reinforced with geogrid; if requested, SFB can provide detailed designs of slope reinforcing if needed. We recommend all cut and fill slopes be constructed with surface drainage. Shallow slope movements such as surficial sloughing, toppling, and flows, however, could still occur as a result of erosion and unanticipated water infiltration. To decrease the potential for shallow slope movement, the drainage and erosion control recommendations presented in this report should be implemented in the design and construction of the site. The implemented drainage and erosion control measures should be maintained during and after construction. Slope maintenance may include re-establishing drainage patterns, controlling water infiltration, and repairing shallow slope movements.

We recommend that fill slopes be over-built approximately 2 feet horizontally and then trimmed back to finished grades. Slope construction should be observed and tested by SFB at the time of grading.

4.1.7 Setbacks

Where walkways or other improvements are located adjacent to cut, fill or native slopes, we recommend the walkways or other improvements be setback at least 5 feet from the top of the adjacent slope.

4.1.8 Flatwork

We recommend that new exterior slabs (such as walkways) be placed directly on the properly compacted fills. We do not recommend using aggregate base, gravel, or crushed rock below these improvements. If imported granular materials are placed below these elements, subsurface water can seep through the granular materials and cause the underlying soils to saturate or pipe. Prior to placing concrete, subgrade soils should be moisture conditioned to increase their moisture content to approximately 2 to 3 percent above laboratory optimum moisture (ASTM D-1557).

Consideration should be given to reinforcing exterior slabs with steel bars in lieu of wire mesh. To reduce potential crack formation, the installation of #4 bars spaced at approximately 24 inches on center in both directions should be considered. Score joints and expansion joints should be used to control cracking and allow for expansion and contraction of the concrete slabs. We recommend appropriate flexible, relatively impermeable fillers be used at all cold/expansion joints. The installation of dowels at all expansion and cold joints will reduce differential slab movements; if used, the dowels should be at least 30 inches long and should be spaced at a maximum lateral spacing of 24 inches. Although exterior slabs that are adequately reinforced will still crack, trip hazards requiring replacement of the slabs will be reduced if the slabs are properly reinforced.

4.1.9 Construction during Wet Weather Conditions

If construction proceeds during or shortly after wet weather conditions, the moisture content of the onsite soils could be significantly above optimum. Consequently, subgrade preparation, placement and/or reworking of onsite soil or fills as structural fill might not be possible. Alternative wet weather construction recommendations can be provided by our representative in the field at the time of construction, if appropriate. All the drainage measures recommended in this report should be implemented and maintained during and after construction, especially during wet weather conditions.

4.1.10 Surface Drainage and Landscaping

Ponding of surface water must not be allowed adjacent to structures, at the top or bottom of slopes, and at the top or adjacent to retaining walls. Ponding of water should also not be allowed on the ground surface adjacent to or near exterior slabs such as walkways. Surface water should not be allowed to flow over the top of slopes, down slope faces, or over retaining walls. We recommend positive surface gradients of at least 2 percent be provided adjacent to structures to direct surface water toward suitable discharge facilities. We recommend the surface drainage be designed in accordance with the latest edition of the California Building Code.

We recommend trees be no closer to planned structures or exterior slabs than half the mature height of the tree; in no case should tree roots be allowed to extend near or below the structures or exterior slabs.

Landscaping drainage swales should provided that adequately collect irrigation and storm water and direct the water onto pavement or into storm water collection systems. We recommend regular maintenance of the drainage systems be performed, including maintenance prior to rainstorms. The inspection should include checking drainage patterns to make sure they are performing properly, making sure drainage systems and inlets are functional and not clogged, and checking that erosion control measures are adequate for anticipated storm events. Immediate repairs should be performed if any of these measures appears to be inadequate.

4.1.11 Future Maintenance

In order to reduce water created issues, we recommend regular maintenance of the site be performed, including maintenance prior to rainstorms. Maintenance should include the recompaction of loosened soils, collapsing and infilling holes with compacted soils or low strength sand/cement grout, removal and control of digging animals, modifying storm water drainage patterns to allow for sheet flow into drainage inlets or ditches rather than concentrated flow or ponding, removal of debris within drainage ditches and inlets, and immediately repairing any erosion or soil flow. The inspection should include checking drainage patterns, making sure drainage systems are functional and not clogged, and erosion control measures are adequate for anticipated storm events. Immediate repair should be performed if any of these measures appears to be inadequate. Temporary and permanent erosion and sediment control measures should be installed over any exposed soils immediately after repairs are made.

Differential movement of exterior slabs can occur over time as a result of numerous factors. We recommend the owners perform inspections and maintenance of the slabs, including infilling significant cracks, providing fillers at slab offsets, and replacing slabs if severely damaged.

4.2 Foundation Support

4.2.1 Box Culvert

The following recommendations can be used to evaluate the structural integrity of the existing box culvert and can also be used to design and construct a new box culvert. We recommend the box culvert be aligned to discharge water along the centerline of the creek. Water should not be discharged toward wither downstream embankment.

The walls of the box culvert should be evaluated and designed to resist an at-rest, equivalent fluid pressure of 53 pounds per cubic foot (pcf) where backdrainage is provided for the walls. Where hydrostatic pressure can build up behind the walls, the walls should be evaluated and designed to resist a lateral at-rest equivalent fluid pressure of 89 pcf. The walls will be subjected to surcharge loads from auto and truck traffic and should be able to resist an additional uniform lateral pressure (psf) equal to one-half the anticipated surcharge load.

If the box culvert walls are also to resist seismic lateral forces from the retained soils, we recommend the walls also be designed to resist an equivalent fluid pressure of 42 pounds per cubic foot based on the ground acceleration from a design basis earthquake. This seismic pressure is in addition to the static pressures provided above. Due to the transient nature of the seismic loading, a factor of safety of at least 1.1 can be used in the evaluation or design of the walls when they resist seismic lateral loads. Some movement of the walls may occur during moderate to strong earthquake shaking and may result in distress as is typical for all structures within the San Francisco Bay Area subjected to earthquake shaking.

A passive resistance equal to an equivalent fluid weighing 400 pounds per cubic foot can be used to resist the lateral pressures. In addition, a friction coefficient of 0.40 can be used to resist sliding. Both the passive resistance and frictional resistance can be used in combination provided the concrete is poured neat against the soil.

From a geotechnical engineering standpoint, no baserock is needed below the box culvert structure. We recommend an allowable bearing pressure of 2,000 pounds per square foot be used in the evaluation and design of the box culvert slab-on-grade.

If footings are needed to support the box culvert walls, we recommend the footings be at least 12 inches wide and be founded at least 18 inches below lowest adjacent finished grade. Footings should be designed with steel reinforcing, both top and bottom, to provide structural continuity and permit spanning of local irregularities. The footings should be designed for an allowable bearing pressure of 2,000 pounds per square foot due to dead loads, 3,000 pounds per square foot due to dead plus live loads, and 4,000 pounds per square foot for all loads, including wind or seismic. These allowable bearing pressures are net values; therefore, the weight of the footing can be neglected for design purposes.

At least 10 feet of soil cover is needed in order to generate full vertical and passive resistance, as measured laterally between slope faces and edges of foundations or slabs. Where less than 10 feet of cover exists, deepening of the edge of the foundations or slabs may be necessary in order to achieve 10 feet of cover. The portion of the slab or foundation within 10 feet of the nearest slope face should be ignored in vertical or passive resistance.

Drainage behind the walls can be accomplished by using ½ to ¾ inch crushed, uniformly graded gravel entirely wrapped in filter fabric such as Mirafi 140N or equal (an overlap of at least 12 inches should be provided at all fabric joints). The gravel and fabric should be at least 8 inches wide and extend from the base of the wall to within 12 inches of the finished grade at the top (Caltrans Class 2 permeable material may be used in lieu of gravel and filter fabric). A 4-inch diameter, perforated pipe should be installed at the base and centered within the gravel. The perforated pipe should be connected to a solid collector pipe that transmits the water directly to a storm drain, drainage inlet, or onto pavement. If weep holes are used in the wall, the perforated pipe within the gravel is not necessary provided the weep holes are kept free of animals and debris, are located no higher than approximately 6 inches from the lowest adjacent grade, and are able to function properly. As an alternative to using gravel, drainage panels (such as AWD SITEDRAIN Sheet 90 for walls or equal) may be used behind the walls in conjunction with perforated pipe (connected to solid collector pipe), weep holes, or strip drains (such as AWD SITEDRAIN Strip 6000 or equal). If used, the drainage panels can be spaced on-center at approximately 2 times the panel width.

5.0 CONDITIONS AND LIMITATIONS

SFB is not responsible for the validity or accuracy of information, analyses, test results, or designs provided to SFB by others or prepared by others. The analysis, designs, opinions, and recommendations submitted in this report are based in part upon the data obtained from our field work and upon information provided by others. Site exploration and testing characterizes subsurface conditions only at the locations where the explorations or tests are performed; actual subsurface conditions between explorations or tests may be different than those described in this report. Variations of subsurface conditions from those analyzed or characterized in this report are not uncommon and may become evident during construction. In addition, changes in the condition of the site can occur over time as a result of either natural processes (such as earthquakes, flooding, or changes in ground water levels) or human activity (such as construction adjacent to the site, dumping of fill, or excavating). If changes to the site's surface or subsurface conditions occur since the performance of the field work described in this report, or if differing subsurface conditions are encountered, we should be contacted immediately to evaluate the differing conditions to assess if the opinions, conclusions, and recommendations provided in this report are still applicable or should be amended.

We recommend SFB be retained to provide geotechnical services during design, reviews, earthwork operations, paving operations, and foundation installation to confirm and observe compliance with the design concepts, specifications and recommendations presented in this report. Our presence will also allow us to modify design if unanticipated subsurface conditions are encountered or if changes to the scope of the project, as defined in this report, are made.

This report is a design document that has been prepared in accordance with generally accepted geological and geotechnical engineering practices for the exclusive use of Daniel B. Stephens & Associates and their consultants for specific application to the MacArthur Street Box Culvert project in Sonoma, California, and is intended to represent our design recommendations Daniel B. Stephens & Associates for specific application to the MacArthur Street Box Culvert project. The conclusions and recommendations contained in this report are solely professional opinions. It is the responsibility of Daniel B. Stephens & Associates to transmit the information and recommendations of this report to those designing and constructing the project. We will not be responsible for the misinterpretation of the information provided in this report. We recommend SFB be retained to review geological and geotechnical aspects of the construction calculations, specifications, and plans; we should also be retained to participate in prebid and preconstruction conferences to clarify the opinions, conclusions, and recommendations contained in this report.

It should be understood that advancements in the practice of geotechnical engineering and engineering geology, or discovery of differing surface or subsurface conditions, may affect the

validity of this report and are not uncommon. SFB strives to perform its services in a proper and professional manner with reasonable care and competence but we are not infallible. Geological engineering and geotechnical engineering are disciplines that are far less exact than other engineering disciplines; therefore we should be consulted if it is not completely understood what the limitations to using this report are.

In the event that there are any changes in the nature, design or location of the project, as described in this report, or if any future additions are planned, the conclusions and recommendations contained in this report shall not be considered valid unless we are contacted in writing, the project changes are reviewed by us, and the conclusions and recommendations presented in this report are modified or verified in writing. The opinions, conclusions, and recommendations contained in this report are based upon the description of the project as presented in the introduction section of this report.

This report does not necessarily represent all of the information that has been communicated by us to Daniel B. Stephens & Associates and their consultants during the course of this engagement and our rendering of professional services Daniel B. Stephens & Associates. Reliance on this report by parties other than those described above must be at their own risk unless we are first consulted as to the parties' intended use of this report and only after we obtain the written consent of Daniel B. Stephens & Associates to divulge information that may have been communicated to Daniel B. Stephens & Associates. We cannot accept consequences for use of segregated portions of this report.

Please refer to Appendix C for additional guidelines regarding use of this report.

FIGURE

KEY

MAC-B-02 — Approximate Location of Exploratory Boring by Daniel B. Stephens & Associates, inc. (12/19/13)

Approximate Project Boundary

N

APPROXIMATE SCALE: 1" = 40'

0 40' 80'

NOTE: Base map was provided by Daniel B. Stephens & Associates, inc. and dated 10/31/13. Aerial Photograph dated 4/16/13 from Google Earth.

DATE			SITE PLAN	FIGURE
March 2014	Stevens Ferrone & Bailey Engineering Company, Inc	1600 Willow Pass Court Concord, CA 94520 Tel 925.688.1001 Fax 925.688.1005 www.SFandB.com	MacArthur Street Culvert Sonoma, California	1
PROJECT NO.				
621-1				

APPENDIX A

Field Investigation

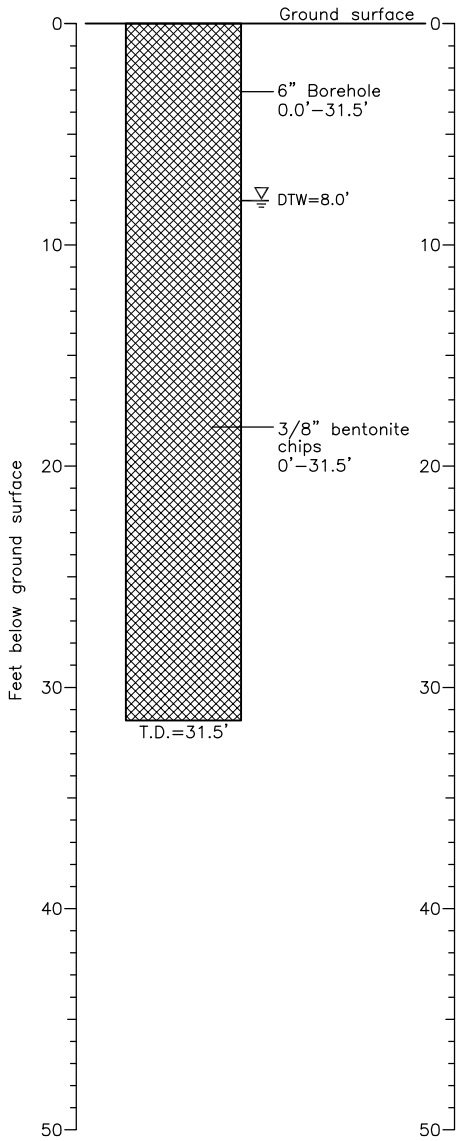
APPENDIX A

Field Investigation

The field investigation for the MacArthur Street Box Culvert project in Sonoma, California, consisted of surface reconnaissance and a subsurface exploration program. Geotechnical reconnaissance of the site and surrounding area was performed on December 19, 2013. Two exploratory borings were drilled on December 19, 2013. The logs of the borings are included as part of this appendix.

The attached boring logs and related information show interpretation of the subsurface conditions at the dates and locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times.

S:\Projects\WR10.0085_SCWA\VR_Drawings\WR10_0085_02B_borelogs.dwg



Blow Counts	Sampling Device	Sample Recovery (%)	Sample Interval (feet bgs)	Sample Depth (feet bgs)	Comments and Lithology
	HA/SS	100	0–5		Gravelly top soil with roots, brown (7.5YR 4/4), clay 5%, silt 20%, sand 25%, gravel 50%, rounded to subangular up to 3" diameter, most 1"–2", loose, slightly moist. Very difficult to hand auger. Hand augured (HA) to 3'–8", took ~1 hour, sonic (SS) below.
37/77/97	SS Grab @ 5'	100	5–10	5–6.5	Silty sand, dark grayish brown (10YR 4/2), clay 5%, silt 20%, sand 70%, gravel 5%, slightly moist.
17/26/48	SS Grab @ 10'	100	10–14	10–11.5	Silty sand with gravel, dark grayish brown (10YR 4/2), clay 10%, silt 10%, sand 30%, gravel 50%, rounded to subangular up to 2.5" diameter, crumbly, wet.
17/19/32	SS Grab @ 15'	100	14–17	15–16.5	Silty sand, dark grayish brown (10YR 4/2), clay 10%, silt 25%, sand 60%, gravel <5%, cohesive, wet.
		100	17–19		Silty sand with gravel, dark grayish brown (10YR 4/2), clay 10%, silt 20%, sand 30%, gravel 40%, cohesive, wet.
39/49/47	SS Grab @ 20'	100	19–25	20–21.5	Silt with sand, yellowish brown (10YR 5/3), clay 20%, silt 40%, sand 40% fine–grained, hard, very moist.
16/23/46	SS Grab @ 25'	100	25–27	25–26.5	Silt with sand, brown (10YR 4/3), clay 20%, silt 30%, sand 30%, gravel 20% up to 1/2" diameter, sloppy, wet.
		100	27–28.5		Silt with sand, yellowish brown (10YR 5/3), clay 20%, silt 40%, sand 40% fine–grained, compact, wet.
16/14/18	SS Grab @ 29'	100	28.5–31.5	30–31.5	Poorly–graded sand with silt and gravel, brown (10YR 4/3), clay 5%, silt 25%, sand 45%, gravel 25% up to 1" diameter, crumbly, wet.

Geologist: J. Cherney
Driller: National
Date completed: 12/19/13

Drilling method: Sonic
Diameter:
Sampling device:

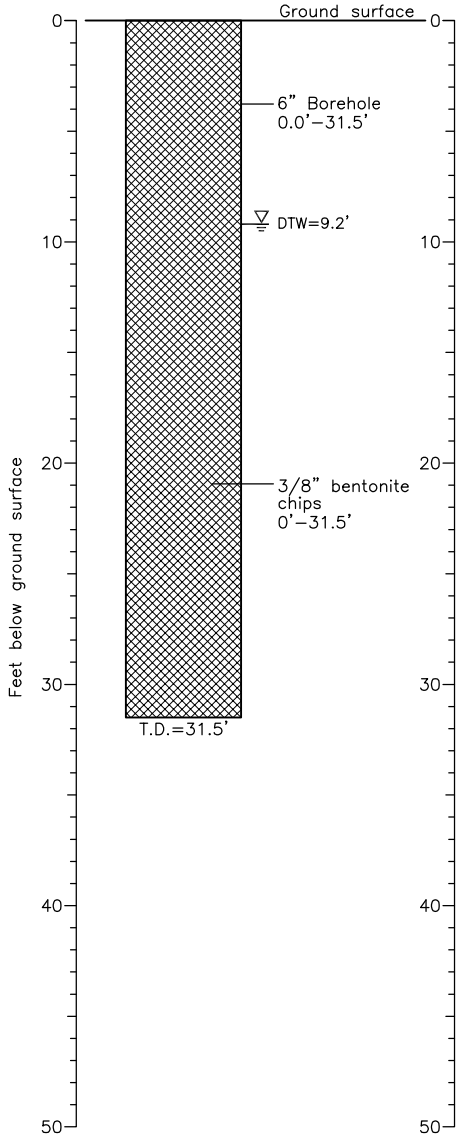
Northing:
Easting:
Elevation:

bgs = below ground surface
HA = hand auger
SS = split spoon

CITY WATERSHEDS OF
SONOMA VALLEY PHASE 1
Boring: Mac-B-01

Daniel B. Stephens & Associates, Inc.
3–06–14
JN WR10.0085.13

S:\Projects\WR10.0085_SCWA\VR_Drawings\WR10_0085_02B_borelogs.dwg



Blow Counts	Sampling Device	Sample Recovery (%)	Sample Interval (feet bgs)	Sample Depth (feet bgs)	Comments and Lithology
	HA/SS	100	0–5		Top soil, dark brown (10YR 3/3), clay 10%, silt 15%, sand 35%, gravel 40%, rounded to 2.5", wet, hand augured (HA) to 2.5', sonic (SS) below.
	Grab @ 5', 5.5'	100	5–6.5	30–31.5	Silty sand with gravel, brown (10YR 4/3), clay 10%, silt 25%, sand 50%, gravel 15%, rounded to 1/2", crumbly, moist.
		100	6.5–10		Sandy silt, brown (10YR 4/3), clay 25%, silt 45%, sand 30%, fine–grained, compact, moist.
	Grab @ 10', 10.5'	100	10–13		Sandy silt, dark yellowish brown (10YR 4/4) with weathered dark brown spots (10YR 3/6), clay 25%, silt 45%, sand 25%, gravel 5% up to 1/8" diameter, crumbly, moist.
		100	13–14.5		Sandy silt, light yellowish brown (10YR 6/4), clay 25%, silt 50%, sand 25% fine, compact, very moist.
	Grab @ 15', 15.5'	100	14.5–17		Silt with sand, brown (10YR 4/3), clay 15%, silt 35%, sand 35% coarse–grained, gravel 15% up to 1/2" diameter, compact, wet.
	Grab @ 20'	100	17–20		Sandy silt, brown (10YR 4/3), clay 30%, silt 45%, sand 25%, compact, hard, wet.
N/A Push		100		20–21.5	Sandy gravel, brown (10YR 5/3), clay 10%, silt 10%, sand 30% coarse–grained, gravel 50% up to 2.5" diameter, rounded to subangular, very wet.
N/A Push		100		22–24	Sample fell out.
N/A Push	Grab @ 25'	100		25–26	
N/A Push	Grab @ 29.5'	100	20–30		
N/A Push		100		30–31.5	

Geologist: J. Cherney
Driller: National
Date completed: 12/19/13

Drilling method: Sonic
Diameter:
Sampling device:

Northing:
Easting:
Elevation:

bgs = below ground surface
HA = hand auger
SS = split spoon

CITY WATERSHEDS OF SONOMA VALLEY PHASE 1

Boring: Mac-B-02

Daniel B. Stephens & Associates, Inc.

3–06–14

JN WR10.0085.13

APPENDIX B

Laboratory Investigation

APPENDIX B

Laboratory Investigation

The laboratory testing program for the MacArthur Street Box Culvert project in Sonoma, California was directed toward a quantitative and qualitative evaluation of the physical and mechanical properties of the soils underlying the site.

The attached sheets provide the results of both corrosivity testing and mechanical testing. Please refer to the data sheets for details.

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Chemical Analysis
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-01-5-5.5-Bag	X	X														X	X	X			X	X
MAC-B-01-5-5.5-SS																						
MAC-B-01-5.5-6-SS																						
MAC-B-01-6-6.5-SS																						
MAC-B-01-10-10.5-Bag																X	X	X			X	
MAC-B-01-10-10.5-SS	X	X																X				
MAC-B-01-10.5-11-SS																						
MAC-B-01-11-11.5-SS																						
MAC-B-01-15-15.5-Bag	X	X														X	X	X			X	
MAC-B-01-15-15.5-SS																						
MAC-B-01-15.5-16-SS																						
MAC-B-01-16-16.5-SS																						
MAC-B-01-20-20.5-Bag	X	X														X	X	X			X	
MAC-B-01-20-20.5-SS																						
MAC-B-01-20.5-21-SS																						

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall
[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Chemical Analysis
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-01-21-21.5-SS																						
MAC-B-01-25-25.5-Bag																X	X	X			X	
MAC-B-01-25-25.5-SS																						
MAC-B-01-25.5-26-SS	X	X																X				
MAC-B-01-26-26.5-SS																						
MAC-B-01-29-30-Bag																						
MAC-B-01-30-30.5-SS																						
MAC-B-01-30.5-31-SS	X	X														X	X	X			X	
MAC-B-01-31-31.5-SS																						
MAC-B-02-5-5.5-Bag																X	X				X	
MAC-B-02-5.5-6-Bag																						
MAC-B-02-10-10.5-Bag																X	X				X	
MAC-B-02-10.5-11-Bag																						
MAC-B-02-15-15.5-Bag																X	X				X	
MAC-B-02-15.5-16-Bag																						

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Chemical Analysis
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-02-20-20.5-Bag																X	X				X	
MAC-B-02-20-20.5-SS																						
MAC-B-02-20.5-21-SS																						
MAC-B-02-21-21.5-SS																						
MAC-B-02-25-25.5-Bag																X	X				X	
MAC-B-02-25-25.5-SS																						
MAC-B-02-25.5-26-SS																						
MAC-B-02-26-26.5-SS																						
MAC-B-02-29.5-30-Bag																X	X				X	
MAC-B-02-30-30.5-SS																						
MAC-B-02-30.5-31-SS																						
MAC-B-02-31-31.5-SS																						

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[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Forty-two samples were received on January 7, 2014. Twenty seven of the samples each arrived in a 2.5” x 6” stainless steel sleeve sealed with end caps and tape, and fifteen of the samples each arrived in 1-gallon Ziploc bags, double bagged.

Sample Preparation and Testing Notes:
A sub-sampled from the ‘MAC-B-01-5’-5.5’ bag’ sample was subjected to soil EC (Resistivity), Anions: Sulfate and Chloride, and pH testing. The soil EC (Resistivity), Anions: Sulfate and Chloride, and pH testing was performed by Hall Environmental Laboratory in Albuquerque, NM. The Redox testing was performed by ESC Lab Sciences in Juliet, TN.

Summary of Chloride Analysis

Sample Number	Chloride (mg/Kg)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	23	7.5	5

Analysis performed by Hall Environmental Analysis Laboratory

Summary of Sulfate Analysis

Sample Number	Sulfate (mg/Kg)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	8.7	7.5	5

Analysis performed by Hall Environmental Analysis Laboratory

Summary of Specific Conductance Analysis

Sample Number	Specific Conductance (µmhos/cm)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	480	1.0	1

Analysis performed by Hall Environmental Analysis Laboratory

Summary of pH Analysis

Sample Number	pH	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	7.29	1.68	1

Analysis performed by Hall Environmental Analysis Laboratory

Summary of ORP Analysis

Sample Number	ORP (mV)	Practical Quantitation Limit	Dilution Factor
MAC-B-01-5-5.5	140	---	1

ORP = Oxidation-Reduction Potential
Analysis performed by ESC Lab Sciences

Chemical Analysis

Summary of Chloride Analysis

Sample Number	Chloride (mg/Kg)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	23	7.5	5

Analysis performed by Hall Environmental Analysis Laboratory

Summary of Sulfate Analysis

Sample Number	Sulfate (mg/Kg)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	8.7	7.5	5

Analysis performed by Hall Environmental Analysis Laboratory

Summary of Specific Conductance Analysis

Sample Number	Specific Conductance (µmhos/cm)	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	480	1.0	1

Analysis performed by Hall Environmental Analysis Laboratory

Summary of pH Analysis

Sample Number	pH	Reporting Detection Limit	Dilution Factor
MAC-B-01-5-5.5	7.29	1.68	1

Analysis performed by Hall Environmental Analysis Laboratory

Summary of ORP Analysis

Sample Number	ORP (mV)	Practical Quantitation Limit	Dilution Factor
MAC-B-01-5-5.5	140	---	1

ORP = Oxidation-Reduction Potential
Analysis performed by ESC Lab Sciences

Analytical Report
Lab Order **1402028**
Date Reported: **2/13/2014**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc.
Client Sample ID: MAC-B-01-5-5.5
Project: DBS&A_SCWA City Water Sheds
Collection Date: 1/24/2014 4:00:00 PM
Lab ID: 1402028-001
Matrix: SOIL
Received Date: 1/30/2014 5:00:00 PM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 300.0: ANIONS						Analyst:	**JRR**
Chloride	23	7.5		mg/Kg	5	2/7/2014 11:37:29 AM	11622
Sulfate	8.7	7.5		mg/Kg	5	2/7/2014 11:37:29 AM	11622
CONDUCTANCE						Analyst:	**JML**
Specific Conductance	480	1.0		µmhos/cm	1	2/5/2014 7:03:00 PM	R16564
SM4500-H+B: PH						Analyst:	**TMG**
pH	7.29	1.68		pH Units	1	2/5/2014 7:50:00 AM	R16536

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		

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

REPORT OF ANALYSIS

Anne Thorne
Hall Environmental Analysis Laborat
4901 Hawkins NE
Albuquerque, NM 87109

February 12, 2014

ESC Sample # : L681471-01

Date Received : February 05, 2014
Description :

Site ID :

Sample ID : 1402028-001B MAC-B-01-5-5.5

Project # :

Collected By :
Collection Date : 01/24/14 16:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
ORP	140		mV	2580 B-2011	02/12/14	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.
This report shall not be reproduced, except in full, without the written approval from ESC.
.
Reported: 02/12/14 14:50 Printed: 02/12/14 14:50

ESC LAB SCIENCES
YOUR LAB OF CHOICE

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

Hall Environmental Analysis Laboratory
Anne Thorne
4901 Hawkins NE

Albuquerque, NM 87109

Quality Assurance Report
Level II

L681471

February 12, 2014

Analyte	Units	Duplicate Result	Duplicate	RPD	Limit	Ref Samp	Batch
ORP	mV	120.	120.	1.65	20	L681427-01	WG705707
ORP	mV	130.	130.	0.0	20	L682047-01	WG705707

Analyte	Units	Laboratory Control Sample Known Val	Result	% Rec	Limit	Batch
ORP	mV	100	110.	110.	90-110	WG705707

Analyte	Units	Laboratory Control Sample Duplicate Result	Ref	%Rec	Limit	RPD	Limit	Batch
ORP	mV	110.	110.	110.	90-110	0.0	20	WG705707

Batch number /Run number / Sample number cross reference

WG705707: R2884087: L681471-01

* * Calculations are performed prior to rounding of reported values.
* Performance of this Analyte is outside of established criteria.
For additional information, please see Attachment A 'List of Analytes with QC Qualifiers.'

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1402028**
13-Feb-14

Client: Daniel B. Stephens & Assoc.
Project: DBS&A_SCWA City Water Sheds

Sample ID **1402028-001AMS** SampType: **MS** TestCode: **EPA Method 300.0: Anions**
Client ID: **MAC-B-01-5-5.5** Batch ID: **11622** RunNo: **16637**
Prep Date: **2/7/2014** Analysis Date: **2/7/2014** SeqNo: **478838** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	37	7.5	15.00	22.96	93.3	71.3	115			
Sulfate	37	7.5	30.00	8.663	93.7	32.2	146			

Sample ID **1402028-001AMSD** SampType: **MSD** TestCode: **EPA Method 300.0: Anions**
Client ID: **MAC-B-01-5-5.5** Batch ID: **11622** RunNo: **16637**
Prep Date: **2/7/2014** Analysis Date: **2/7/2014** SeqNo: **478839** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	35	7.5	15.00	22.96	82.8	71.3	115	4.37	20	
Sulfate	37	7.5	30.00	8.663	93.0	32.2	146	0.572	20	

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		

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1402028**
13-Feb-14

Client: Daniel B. Stephens & Assoc.
Project: DBS&A_SCWA City Water Sheds

Sample ID	**1402028-001ADUP**	SampType:	**DUP**	TestCode:	**CONDUCTANCE**
Client ID:	**MAC-B-01-5-5.5**	Batch ID:	**R16564**	RunNo:	**16564**
Prep Date:		Analysis Date:	**2/5/2014**	SeqNo:	**476915** Units: **µmhos/cm**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Specific Conductance	490	1.0						1.62	20	

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		

Laboratory Tests and Methods

Tests and Methods

Soil pH:	SM4500-H+B: PH
Chloride:	EPA 300.0; EPA 9056A
Sulfate:	EPA 300.0; EPA 9056A
Saturated Paste EC:	Bureau of Soils Method; USDA. 1954. Diagnosis and improvement of saline and alkali soils. Agric. Handb. no. 60. UNited States Salinity Laboratory, Riverside, CA.
Oxidation-Reduction Potential (ORP):	2580 B-2011

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-01-5-5.5-Bag	X	X														X	X	X			X	
MAC-B-01-5-5.5-SS																						
MAC-B-01-5.5-6-SS																						
MAC-B-01-6-6.5-SS																						
MAC-B-01-10-10.5-Bag																X	X	X			X	
MAC-B-01-10-10.5-SS	X	X																X				
MAC-B-01-10.5-11-SS																						
MAC-B-01-11-11.5-SS																						
MAC-B-01-15-15.5-Bag	X	X														X	X	X			X	
MAC-B-01-15-15.5-SS																						
MAC-B-01-15.5-16-SS																						
MAC-B-01-16-16.5-SS																						
MAC-B-01-20-20.5-Bag	X	X														X	X	X			X	
MAC-B-01-20-20.5-SS																						
MAC-B-01-20.5-21-SS																						

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-01-21-21.5-SS																						
MAC-B-01-25-25.5-Bag																X	X	X			X	
MAC-B-01-25-25.5-SS																						
MAC-B-01-25.5-26-SS	X	X																X				
MAC-B-01-26-26.5-SS																						
MAC-B-01-29-30-Bag																						
MAC-B-01-30-30.5-SS																						
MAC-B-01-30.5-31-SS	X	X														X	X	X			X	
MAC-B-01-31-31.5-SS																						
MAC-B-02-5-5.5-Bag																X	X				X	
MAC-B-02-5.5-6-Bag																						
MAC-B-02-10-10.5-Bag																X	X				X	
MAC-B-02-10.5-11-Bag																						
MAC-B-02-15-15.5-Bag																X	X				X	
MAC-B-02-15.5-16-Bag																						

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Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
MAC-B-02-20-20.5-Bag																X	X				X	
MAC-B-02-20-20.5-SS																						
MAC-B-02-20.5-21-SS																						
MAC-B-02-21-21.5-SS																						
MAC-B-02-25-25.5-Bag																X	X				X	
MAC-B-02-25-25.5-SS																						
MAC-B-02-25.5-26-SS																						
MAC-B-02-26-26.5-SS																						
MAC-B-02-29.5-30-Bag																X	X				X	
MAC-B-02-30-30.5-SS																						
MAC-B-02-30.5-31-SS																						
MAC-B-02-31-31.5-SS																						

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[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
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Notes

Sample Receipt:
Forty-two samples were received on January 7, 2014. Twenty seven of the samples each arrived in a 2.5” x 6” stainless steel sleeve sealed with end caps and tape, and fifteen of the samples each arrived in 1-gallon Ziploc bags, double bagged.

Sample Preparation and Testing Notes:
Six samples were subjected to initial properties (bulk density, moisture content, and calculated total porosity) testing. For each specified depth interval, intact sub-samples were obtained for this testing by either (in order of preference): a testing ring with a known volume was advanced into an intact piece of material, if present, from the bag sample; or, an intact portion from a sleeve sample was extruded and measured; or, if homogeneity was in question (as was the case for one sample only), a full sample sleeve was used for the initial properties testing. Sub-samples were obtained from the bag sample for these intervals for particle size analysis, Atterberg limits, and specific gravity testing; except for the sample that the entire sleeve was used for initial properties testing, in this case the sleeve material was also used for the particle size analysis, Atterberg limits, and specific gravity testing.

Six additional particle size analysis tests and Atterberg limits tests were also performed, using material obtained by sub-sampling from bag samples.

All sample ID’s include the designation of ‘Bag’ or ‘SS’ to indicate that the material was received either in a bag or in a stainless steel sleeve.

Porosity calculations, and the particle diameter calculations in the hydrometer portion of the particle size analysis testing, are based on the use of a measured specific gravity value, if available, or an assumed specific gravity value of 2.65 if the specific gravity was not measured.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received, Gravimetric (%, g/g)	Moisture Content: As Received, Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded, Gravimetric (%, g/g)	Moisture Content: Remolded, Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
MAC-B-01-5-5.5-Bag	35.0	48.0	---	---	1.37	1.85	47.9
MAC-B-01-10-10.5-SS	23.6	34.7	---	---	1.47	1.82	44.1
MAC-B-01-15-15.5-Bag	26.8	37.6	---	---	1.40	1.78	47.0
MAC-B-01-20-20.5-Bag	33.7	42.1	---	---	1.25	1.67	53.6
MAC-B-01-25.5-26-SS	17.2	28.6	---	---	1.66	1.95	37.1
MAC-B-01-30.5-31-SS	17.6	33.0	---	---	1.87	2.20	29.9

NA = Not analyzed

--- = This sample was not remolded

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
MAC-B-01-5-5.5-Bag	0.0017	0.051	0.11	65	0.65	WS/H	Sandy silt s(ML)	Loam	
MAC-B-01-10-10.5-Bag	0.0012	0.047	0.085	71	1.2	WS/H	Sandy silt s(ML)	Loam	(Est)
MAC-B-01-15-15.5-Bag	0.0042	0.19	0.25	60	12	WS/H	Silty sand (SM)	Loamy Sand	
MAC-B-01-20-20.5-Bag	0.0022	0.089	0.21	95	1.4	WS/H	Silty sand (SM)	Loam †	
MAC-B-01-25-25.5-Bag	0.00046	0.017	0.030	65	2.5	WS/H	Silt with sand (ML)s	Silt Loam	(Est)
MAC-B-01-30.5-31-SS	0.097	1.9	3.0	31	0.55	WS/H	Poorly-graded sand with silt and gravel (SP-SM)g	Sand †	
MAC-B-02-5-5.5-Bag	0.0047	0.14	0.22	47	1.8	WS/H	Silty sand (SM)	Sandy Loam	
MAC-B-02-10-10.5-Bag	0.0022	0.10	0.14	64	2.4	WS/H	Silty sand (SM)	Sandy Loam	
MAC-B-02-15-15.5-Bag	0.045	2.8	3.9	87	9.6	WS/H	Poorly-graded sand with clay and gravel (SP-SC)g	Sandy Loam †	
MAC-B-02-20-20.5-Bag	0.0048	0.45	1.9	396	1.3	WS/H	Silty, clayey sand with gravel (SC-SM)g	Sandy Loam †	
MAC-B-02-25-25.5-Bag	0.0058	2.2	4.5	776	2.6	WS/H	Clayey sand with gravel (SC)g	Sandy Loam †	
MAC-B-02-29.5-30-Bag	0.0014	0.27	2.0	1429	0.39	WS/H	Silty sand with gravel (SM)g	Loam †	

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
MAC-B-01-5-5.5-Bag	0.1	44.4	44.6	10.9
MAC-B-01-10-10.5-Bag	0.7	42.1	45.1	12.1
MAC-B-01-15-15.5-Bag	0.0	75.5	19.8	4.8
MAC-B-01-20-20.5-Bag	12.1	41.1	37.2	9.6
MAC-B-01-25-25.5-Bag	2.8	23.8	55.1	18.3
MAC-B-01-30.5-31-SS	29.7	61.2	7.7	1.3
MAC-B-02-5-5.5-Bag	0.6	60.3	34.2	4.9
MAC-B-02-10-10.5-Bag	1.3	55.6	33.6	9.5
MAC-B-02-15-15.5-Bag	33.8	54.5	7.9	3.8
MAC-B-02-20-20.5-Bag	25.9	47.2	20.5	6.4
MAC-B-02-25-25.5-Bag	39.4	41.5	13.2	5.9
MAC-B-02-29.5-30-Bag	25.9	39.9	22.3	11.9

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
MAC-B-01-5-5.5-Bag	32	26	6	ML
MAC-B-01-10-10.5-Bag	27	23	4	ML
MAC-B-01-15-15.5-Bag	---	---	---	ML
MAC-B-01-20-20.5-Bag	38	26	12	ML
MAC-B-01-25-25.5-Bag	38	26	12	ML
MAC-B-01-30.5-31-SS	---	---	---	ML
MAC-B-02-5-5.5-Bag	---	---	---	ML
MAC-B-02-10-10.5-Bag	---	---	---	ML
MAC-B-02-15-15.5-Bag	38	22	16	CL
MAC-B-02-20-20.5-Bag	29	22	7	CL-ML
MAC-B-02-25-25.5-Bag	31	21	10	CL
MAC-B-02-29.5-30-Bag	40	26	14	ML

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Specific Gravity Tests

	Test Sample			Oversize Material			Bulk Sample
Sample Number	Specific Gravity	Particle Size	% of Bulk Sample	Specific Gravity	Particle Size	% of Bulk Sample	Specific Gravity*
MAC-B-01-5-5.5-Bag[1]	2.63	<4.75mm	99.9%	---	>4.75mm	0.1%	2.63
MAC-B-01-10-10.5-Bag[1]	2.63	<4.75mm	99.3%	---	>4.75mm	0.7%	2.63
MAC-B-01-15-15.5-Bag	2.66	<4.75mm	100.0%	---	>4.75mm	0.0%	2.66
MAC-B-01-20-20.5-Bag	2.70	<4.75mm	87.9%	2.65	>4.75mm	12.1%	2.69
MAC-B-01-25-25.5-Bag[1]	2.65	<4.75mm	97.2%	---	>4.75mm	2.8%	2.65
MAC-B-01-30.5-31-SS	2.68	<4.75mm	70.3%	2.71	>4.75mm	29.7%	2.69

[1]Based on the <4.75mm material

*Weighted average

--- = Unnecessary since specified fraction < 5% of composite mass

NA = Not analyzed

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received, Gravimetric (%, g/g)	Moisture Content: As Received, Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded, Gravimetric (%, g/g)	Moisture Content: Remolded, Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
MAC-B-01-5-5.5-Bag	35.0	48.0	---	---	1.37	1.85	47.9
MAC-B-01-10-10.5-SS	23.6	34.7	---	---	1.47	1.82	44.1
MAC-B-01-15-15.5-Bag	26.8	37.6	---	---	1.40	1.78	47.0
MAC-B-01-20-20.5-Bag	33.7	42.1	---	---	1.25	1.67	53.6
MAC-B-01-25.5-26-SS	17.2	28.6	---	---	1.66	1.95	37.1
MAC-B-01-30.5-31-SS	17.6	33.0	---	---	1.87	2.20	29.9

NA = Not analyzed

--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

	As Received	Remolded
Test Date:	24-Jan-14	---
Field weight of sample* (g):	416.44	
Tare weight, ring (g):	29.84	
Tare weight, pan/plate (g):	297.84	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	65.74	
Sample volume (cm^3):	47.99	
Measured particle density (g/cm^3):	2.63	
Gravimetric Moisture Content (% g/g):	35.0	
Volumetric Moisture Content (% vol):	48.0	
Dry bulk density (g/cm^3):	1.37	
Wet bulk density (g/cm^3):	1.85	
Calculated Porosity (% vol):	47.9	
Percent Saturation:	100.2	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-10-10.5-SS
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

	As Received	Remolded
Test Date:	27-Jan-14	---
Field weight of sample* (g):	351.33	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.37	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	54.18	
Sample volume (cm^3):	36.88	
Measured particle density (g/cm^3):	2.63	
Gravimetric Moisture Content (% g/g):	23.6	
Volumetric Moisture Content (% vol):	34.7	
Dry bulk density (g/cm^3):	1.47	
Wet bulk density (g/cm^3):	1.82	
Calculated Porosity (% vol):	44.1	
Percent Saturation:	78.7	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

	As Received	Remolded
Test Date:	27-Jan-14	---
Field weight of sample* (g):	335.92	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	270.28	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	51.78	
Sample volume (cm^3):	36.88	
Measured particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	26.8	
Volumetric Moisture Content (% vol):	37.6	
Dry bulk density (g/cm^3):	1.40	
Wet bulk density (g/cm^3):	1.78	
Calculated Porosity (% vol):	47.0	
Percent Saturation:	79.9	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

	As Received	Remolded
Test Date:	27-Jan-14	---
Field weight of sample* (g):	345.70	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	284.12	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	46.05	
Sample volume (cm^3):	36.88	
Measured particle density (g/cm^3):	2.69	
Gravimetric Moisture Content (% g/g):	33.7	
Volumetric Moisture Content (% vol):	42.1	
Dry bulk density (g/cm^3):	1.25	
Wet bulk density (g/cm^3):	1.67	
Calculated Porosity (% vol):	53.6	
Percent Saturation:	78.5	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-25.5-26-SS
Date Sampled: 12/19/2013
Depth (ft): 25.5-26

	As Received	Remolded
Test Date:	27-Jan-14	---
Field weight of sample* (g):	454.02	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	283.91	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	145.15	
Sample volume (cm^3):	87.25	
Measured particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	17.2	
Volumetric Moisture Content (% vol):	28.6	
Dry bulk density (g/cm^3):	1.66	
Wet bulk density (g/cm^3):	1.95	
Calculated Porosity (% vol):	37.1	
Percent Saturation:	77.1	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31

	As Received	Remolded
Test Date:	27-Jan-14	---
Field weight of sample* (g):	1521.50	
Tare weight, ring (g):	277.16	
Tare weight, pan/plate (g):	293.61	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	808.53	
Sample volume (cm^3):	431.48	
Measured particle density (g/cm^3):	2.67	
Gravimetric Moisture Content (% g/g):	17.6	
Volumetric Moisture Content (% vol):	33.0	
Dry bulk density (g/cm^3):	1.87	
Wet bulk density (g/cm^3):	2.20	
Calculated Porosity (% vol):	29.9	
Percent Saturation:	110.1	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Particle Size Analysis

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
MAC-B-01-5-5.5-Bag	0.0017	0.051	0.11	65	0.65	WS/H	Sandy silt s(ML)	Loam	
MAC-B-01-10-10.5-Bag	0.0012	0.047	0.085	71	1.2	WS/H	Sandy silt s(ML)	Loam	(Est)
MAC-B-01-15-15.5-Bag	0.0042	0.19	0.25	60	12	WS/H	Silty sand (SM)	Loamy Sand	
MAC-B-01-20-20.5-Bag	0.0022	0.089	0.21	95	1.4	WS/H	Silty sand (SM)	Loam †	
MAC-B-01-25-25.5-Bag	0.00046	0.017	0.030	65	2.5	WS/H	Silt with sand (ML)s	Silt Loam	(Est)
MAC-B-01-30.5-31-SS	0.097	1.9	3.0	31	0.55	WS/H	Poorly-graded sand with silt and gravel (SP-SM)g	Sand †	
MAC-B-02-5-5.5-Bag	0.0047	0.14	0.22	47	1.8	WS/H	Silty sand (SM)	Sandy Loam	
MAC-B-02-10-10.5-Bag	0.0022	0.10	0.14	64	2.4	WS/H	Silty sand (SM)	Sandy Loam	
MAC-B-02-15-15.5-Bag	0.045	2.8	3.9	87	9.6	WS/H	Poorly-graded sand with clay and gravel (SP-SC)g	Sandy Loam †	
MAC-B-02-20-20.5-Bag	0.0048	0.45	1.9	396	1.3	WS/H	Silty, clayey sand with gravel (SC-SM)g	Sandy Loam †	
MAC-B-02-25-25.5-Bag	0.0058	2.2	4.5	776	2.6	WS/H	Clayey sand with gravel (SC)g	Sandy Loam †	
MAC-B-02-29.5-30-Bag	0.0014	0.27	2.0	1429	0.39	WS/H	Silty sand with gravel (SM)g	Loam †	

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
MAC-B-01-5-5.5-Bag	0.1	44.4	44.6	10.9
MAC-B-01-10-10.5-Bag	0.7	42.1	45.1	12.1
MAC-B-01-15-15.5-Bag	0.0	75.5	19.8	4.8
MAC-B-01-20-20.5-Bag	12.1	41.1	37.2	9.6
MAC-B-01-25-25.5-Bag	2.8	23.8	55.1	18.3
MAC-B-01-30.5-31-SS	29.7	61.2	7.7	1.3
MAC-B-02-5-5.5-Bag	0.6	60.3	34.2	4.9
MAC-B-02-10-10.5-Bag	1.3	55.6	33.6	9.5
MAC-B-02-15-15.5-Bag	33.8	54.5	7.9	3.8
MAC-B-02-20-20.5-Bag	25.9	47.2	20.5	6.4
MAC-B-02-25-25.5-Bag	39.4	41.5	13.2	5.9
MAC-B-02-29.5-30-Bag	25.9	39.9	22.3	11.9

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 834.58
Weight Passing #10 (g): 831.06
Weight Retained #10 (g): 3.52
Weight of Hydrometer Sample (g): 62.04
Calculated Weight of Sieve Sample (g): 62.30

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	834.58	100.00
	2"	50	0.00	0.00	834.58	100.00
	1.5"	38.1	0.00	0.00	834.58	100.00
	1"	25	0.00	0.00	834.58	100.00
	3/4"	19.0	0.00	0.00	834.58	100.00
	3/8"	9.5	0.00	0.00	834.58	100.00
	4	4.75	1.03	1.03	833.55	99.88
	10	2.00	2.49	3.52	831.06	99.58
-10			(Based on calculated sieve wt.)			
	20	0.85	1.10	1.36	60.94	97.81
	40	0.425	5.14	6.50	55.80	89.56
	60	0.250	8.25	14.75	47.55	76.32
	140	0.106	10.26	25.01	37.29	59.85
	200	0.075	2.72	27.73	34.57	55.49
	dry pan		0.27	28.00	34.30	
	wet pan			34.30	0.00	

d_{10} (mm): 0.0017 d_{50} (mm): 0.051
d_{16} (mm): 0.0034 d_{60} (mm): 0.11
d_{30} (mm): 0.011 d_{84} (mm): 0.34

Median Particle Diameter --d_{50} (mm): 0.051
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 65
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 0.65
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.13

Classification of fines: ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Loam

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

Test Date: 29-Jan-14
Start Time: 9:42

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.63

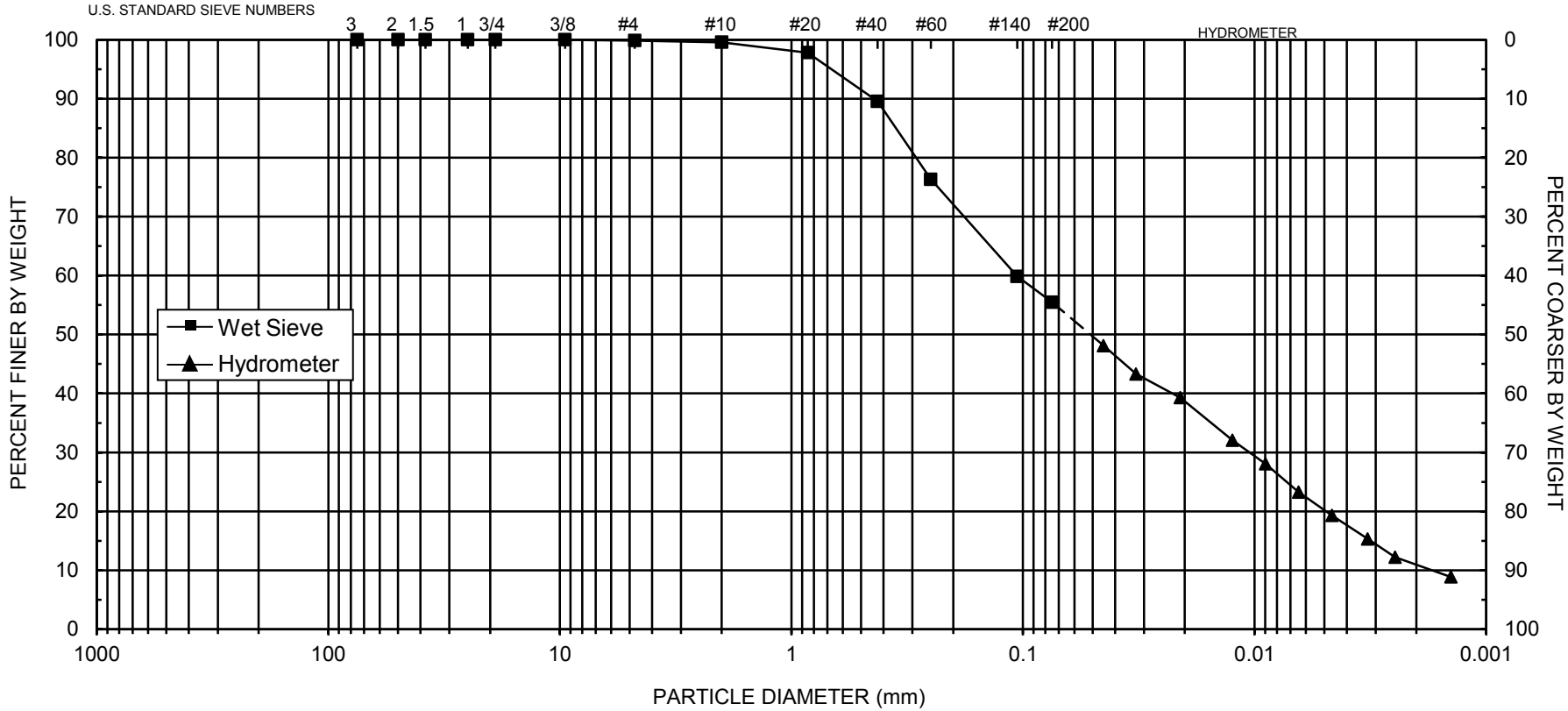
Initial Wt. (g)*:* 62.04
Total Sample Wt. (g)*:* 834.58
Wt. Passing #10 (g): 831.06

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	35.5	5.5	30.0	10.5	0.04486	48.3	48.1
	2	19.2	32.5	5.5	27.0	11.0	0.03246	43.5	43.3
	5	19.2	30.0	5.5	24.5	11.4	0.02091	39.4	39.3
	15	19.2	25.5	5.5	20.0	12.1	0.01246	32.2	32.1
	30	19.2	23.0	5.5	17.5	12.5	0.00896	28.2	28.0
	60	19.3	20.0	5.5	14.5	13.0	0.00645	23.4	23.3
	120	19.5	17.5	5.5	12.0	13.4	0.00462	19.4	19.3
	250	19.6	15.0	5.5	9.5	13.8	0.00324	15.4	15.3
	435	20.1	13.0	5.4	7.6	14.2	0.00247	12.3	12.2
30-Jan-14	1377	19.5	11.0	5.5	5.5	14.5	0.00142	8.9	8.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND				SILT			CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0017**	d_{30} = **0.011**	d_{50} = **0.051**	d_{60} = **0.11**	C_u = **65**	C_c = **0.65**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-5-5.5-Bag	**5-5.5**	**Sandy silt s(ML)**	**Loam**

Daniel B. Stephens & Associates, Inc.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 811.80
Weight Passing #10 (g): 798.12
Weight Retained #10 (g): 13.68
Weight of Hydrometer Sample (g): 112.60
Calculated Weight of Sieve Sample (g): 114.53

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	811.80	100.00
	2"	50	0.00	0.00	811.80	100.00
	1.5"	38.1	0.00	0.00	811.80	100.00
	1"	25	0.00	0.00	811.80	100.00
	3/4"	19.0	0.00	0.00	811.80	100.00
	3/8"	9.5	1.72	1.72	810.08	99.79
	4	4.75	3.64	5.36	806.44	99.34
	10	2.00	8.32	13.68	798.12	98.31
-10			(Based on calculated sieve wt.)			
	20	0.85	2.94	4.87	109.66	95.75
	40	0.425	4.38	9.25	105.28	91.92
	60	0.250	7.85	17.10	97.43	85.07
	140	0.106	23.38	40.48	74.05	64.66
	200	0.075	8.55	49.03	65.50	57.19
	dry pan		1.12	50.15	64.38	
	wet pan			64.38	0.00	

d_{10} (mm): 0.0012 d_{50} (mm): 0.047
d_{16} (mm): 0.0030 d_{60} (mm): 0.085
d_{30} (mm): 0.011 d_{84} (mm): 0.24

Median Particle Diameter --d_{50} (mm): 0.047
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 71
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.2
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.097

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Loam

Laboratory analysis by: J. Bray/C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

Test Date: 29-Jan-14
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.63

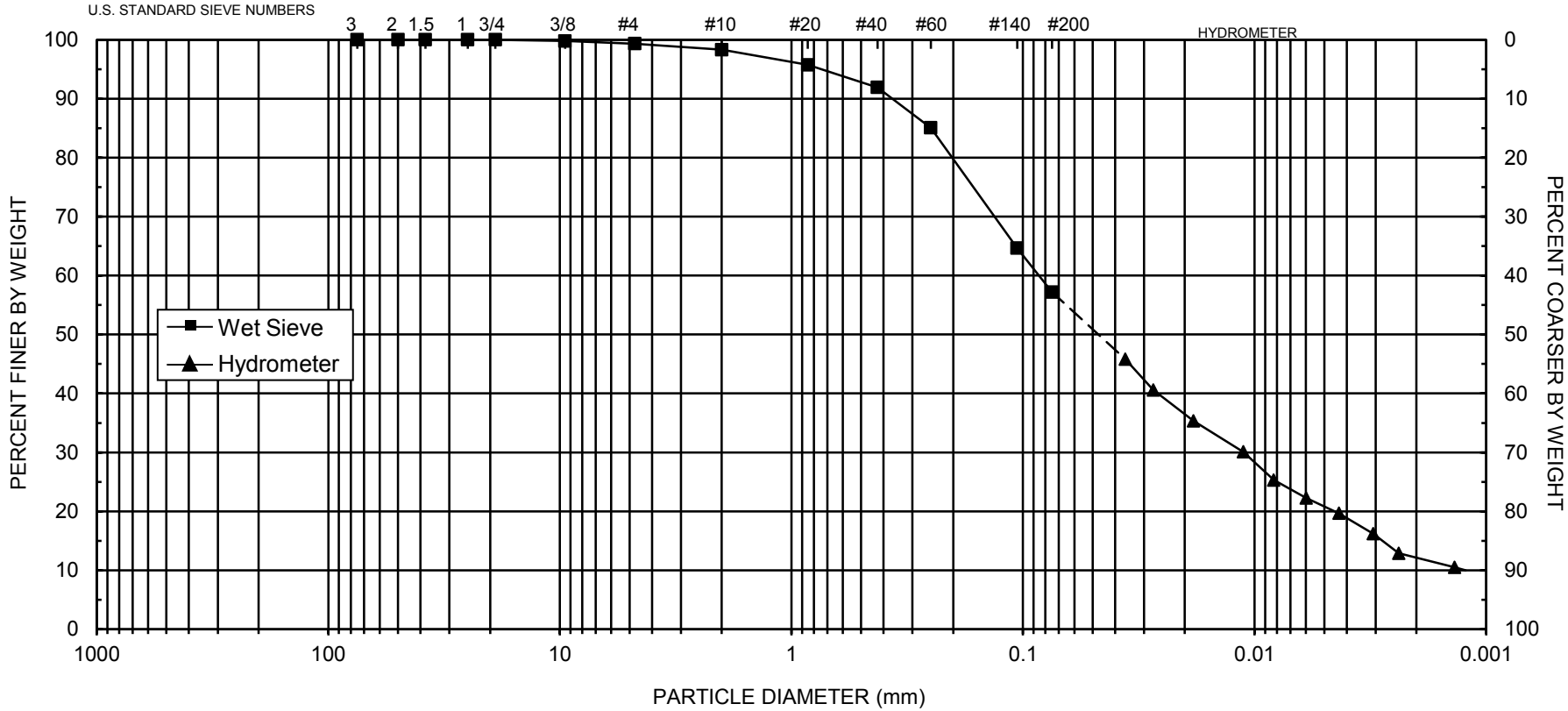
Initial Wt. (g)*:* 112.60
Total Sample Wt. (g)*:* 811.80
Wt. Passing #10 (g): 798.12

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	58.0	5.5	52.5	6.8	0.03615	46.6	45.8
	2	19.2	52.0	5.5	46.5	7.8	0.02735	41.3	40.6
	5	19.2	46.0	5.5	40.5	8.8	0.01836	35.9	35.3
	15	19.2	40.0	5.5	34.5	9.7	0.01118	30.6	30.1
	30	19.2	34.5	5.5	29.0	10.6	0.00826	25.7	25.3
	60	19.4	31.0	5.5	25.5	11.2	0.00598	22.6	22.3
	120	19.5	28.0	5.5	22.5	11.7	0.00432	20.0	19.7
	250	19.6	24.0	5.5	18.5	12.4	0.00307	16.5	16.2
	430	20.1	20.2	5.4	14.8	13.0	0.00238	13.1	12.9
30-Jan-14	1371	19.5	17.5	5.5	12.0	13.4	0.00137	10.7	10.5

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND				SILT			CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0012**	d_{30} = **0.011**	d_{50} = **0.047**	d_{60} = **0.085**	C_u = **71**	C_c = **1.2**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-10-10.5-Bag	**10-10.5**	**Sandy silt s(ML)**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5
Test Date: 3-Feb-14

Initial Dry Weight of Sample (g): 501.12
Weight Passing #10 (g): 501.03
Weight Retained #10 (g): 0.09
Weight of Hydrometer Sample (g): 65.37
Calculated Weight of Sieve Sample (g): 65.38

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	501.12	100.00
	2"	50	0.00	0.00	501.12	100.00
	1.5"	38.1	0.00	0.00	501.12	100.00
	1"	25	0.00	0.00	501.12	100.00
	3/4"	19.0	0.00	0.00	501.12	100.00
	3/8"	9.5	0.00	0.00	501.12	100.00
	4	4.75	0.00	0.00	501.12	100.00
	10	2.00	0.09	0.09	501.03	99.98
-10			(Based on calculated sieve wt.)			
	20	0.85	0.86	0.87	64.51	98.67
	40	0.425	5.56	6.43	58.95	90.16
	60	0.250	19.64	26.07	39.31	60.12
	140	0.106	20.80	46.87	18.51	28.31
	200	0.075	2.47	49.34	16.04	24.53
	dry pan		0.20	49.54	15.84	
	wet pan			15.84	0.00	

d_{10} (mm): 0.0042 d_{50} (mm): 0.19
d_{16} (mm): 0.016 d_{60} (mm): 0.25
d_{30} (mm): 0.11 d_{84} (mm): 0.38

Median Particle Diameter --d_{50} (mm): 0.19
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 60
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 12
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.20

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Loamy Sand

Laboratory analysis by: S. Hanhardt/C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

Test Date: 30-Jan-14
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.65

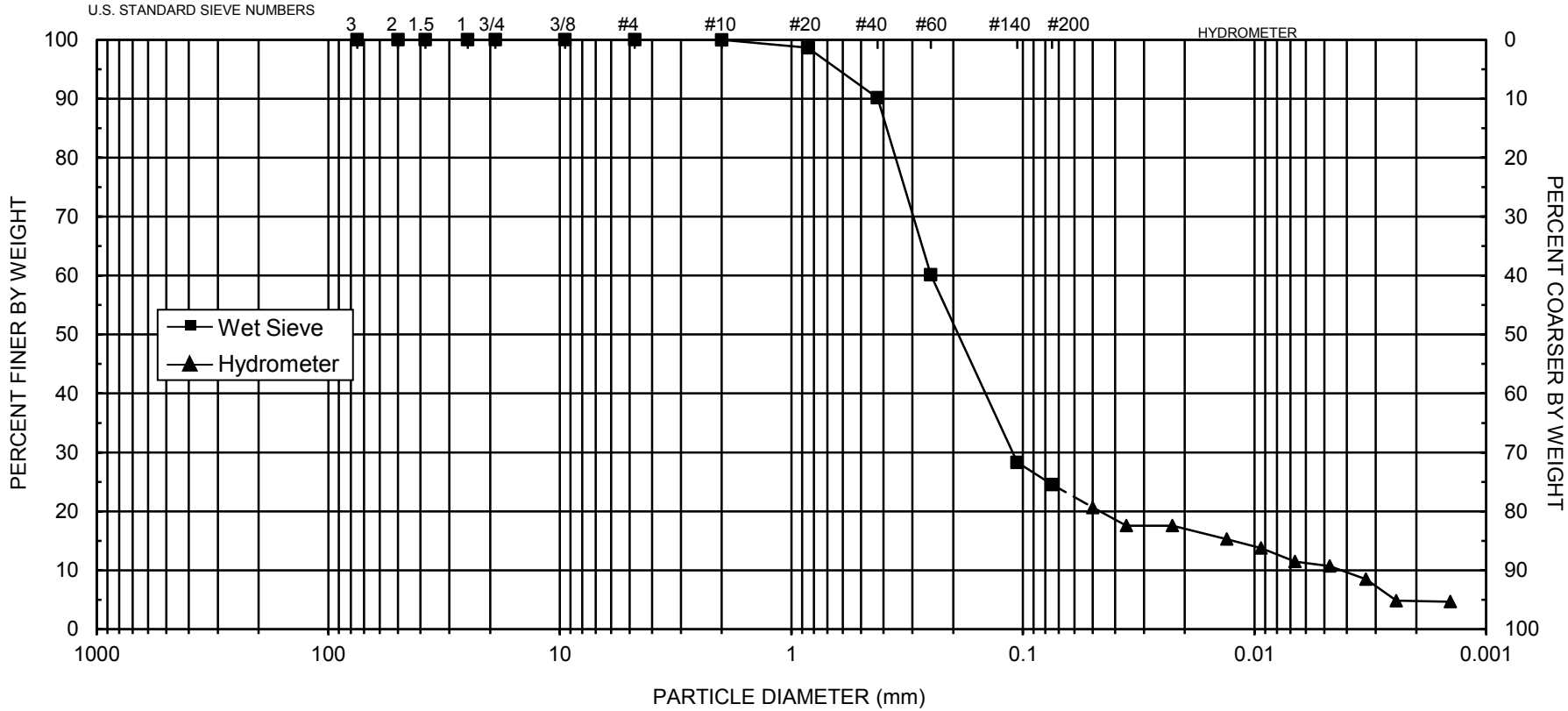
Initial Wt. (g)*:* 65.37
Total Sample Wt. (g)*:* 501.12
Wt. Passing #10 (g): 501.03

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
30-Jan-14	1	19.3	19.0	5.5	13.5	13.2	0.04992	20.6	20.6
	2	19.3	17.0	5.5	11.5	13.5	0.03573	17.6	17.6
	5	19.3	17.0	5.5	11.5	13.5	0.02260	17.6	17.6
	15	19.3	15.5	5.5	10.0	13.8	0.01317	15.3	15.3
	30	19.4	14.5	5.5	9.0	13.9	0.00936	13.8	13.8
	60	19.4	13.0	5.5	7.5	14.2	0.00668	11.5	11.5
	120	19.4	12.5	5.5	7.0	14.3	0.00473	10.7	10.7
	250	19.6	11.0	5.5	5.5	14.5	0.00330	8.5	8.5
	460	20.3	8.5	5.3	3.2	14.9	0.00244	4.8	4.8
31-Jan-14	1373	19.7	8.5	5.5	3.1	14.9	0.00143	4.7	4.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND					SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0042**	d_{30} = **0.11**	d_{50} = **0.19**	d_{60} = **0.25**	C_u = **60**	C_c = **12**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-15-15.5-Bag	**15-15.5**	**Silty sand (SM)**	**Loamy Sand**

Daniel B. Stephens & Associates, Inc.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5
Test Date: 3-Feb-14

Initial Dry Weight of Sample (g): 538.65
Weight Passing #10 (g): 427.78
Weight Retained #10 (g): 110.87
Weight of Hydrometer Sample (g): 64.64
Calculated Weight of Sieve Sample (g): 81.39

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	538.65	100.00
	2"	50	0.00	0.00	538.65	100.00
	1.5"	38.1	0.00	0.00	538.65	100.00
	1"	25	0.00	0.00	538.65	100.00
	3/4"	19.0	0.00	0.00	538.65	100.00
	3/8"	9.5	42.41	42.41	496.24	92.13
	4	4.75	22.50	64.91	473.74	87.95
	10	2.00	45.96	110.87	427.78	79.42
-10			(Based on calculated sieve wt.)			
	20	0.85	6.72	23.47	57.92	71.16
	40	0.425	4.80	28.27	53.12	65.26
	60	0.250	2.96	31.23	50.16	61.63
	140	0.106	6.98	38.21	43.18	53.05
	200	0.075	5.01	43.22	38.17	46.90
	dry pan		0.76	43.98	37.41	
	wet pan			37.41	0.00	

d_{10} (mm): 0.0022 d_{50} (mm): 0.089
d_{16} (mm): 0.0053 d_{60} (mm): 0.21
d_{30} (mm): 0.025 d_{84} (mm): 3.2

Median Particle Diameter --d_{50} (mm): 0.089
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 95
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.4
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 1.1

Classification of fines: ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: S. Hanhardt/C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

Test Date: 30-Jan-14
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.69

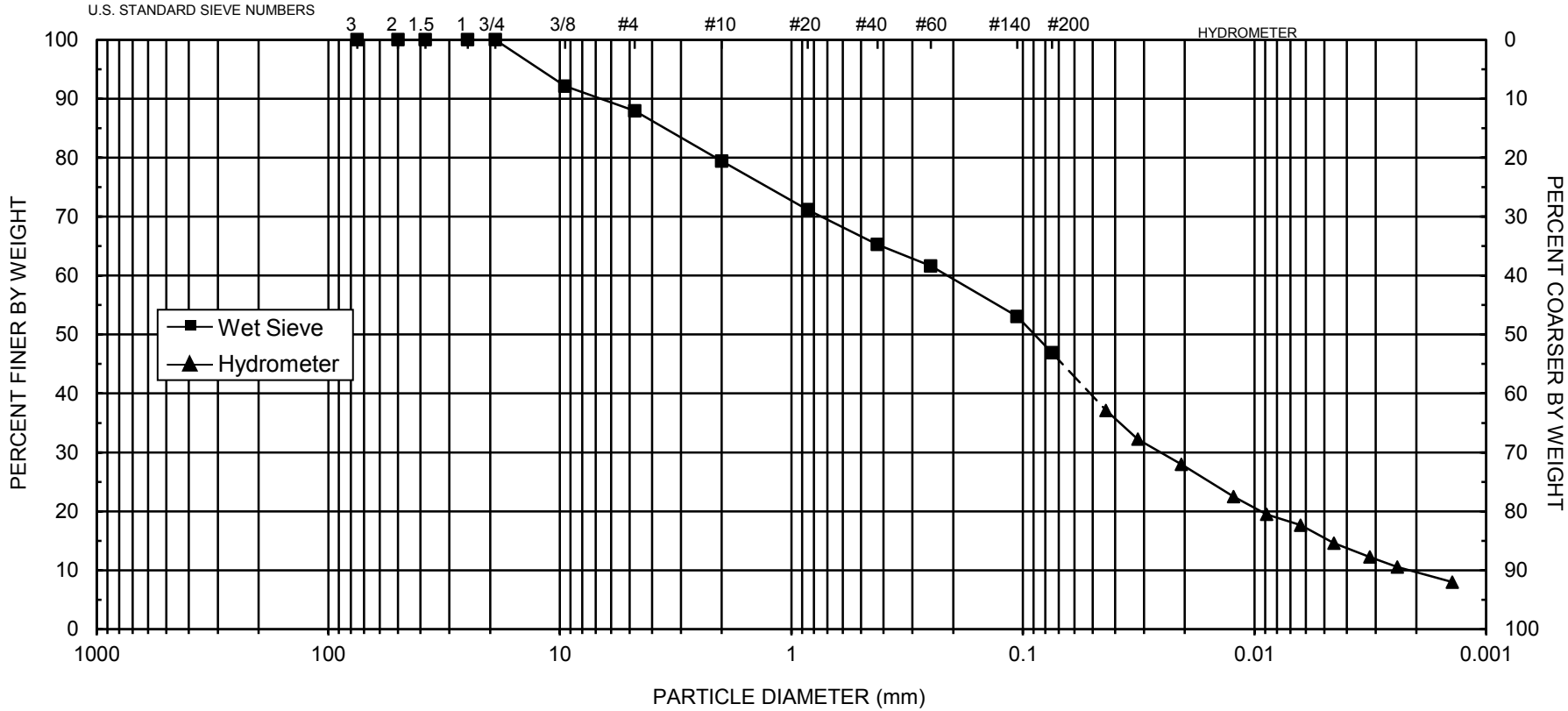
Initial Wt. (g)*:* 64.64
Total Sample Wt. (g)*:* 538.65
Wt. Passing #10 (g): 427.78

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
30-Jan-14	1	19.4	36.0	5.5	30.5	10.4	0.04376	46.7	37.1
	2	19.4	32.0	5.5	26.5	11.1	0.03190	40.6	32.2
	5	19.4	28.5	5.5	23.0	11.6	0.02069	35.2	28.0
	15	19.4	24.0	5.5	18.5	12.4	0.01232	28.3	22.5
	30	19.4	21.5	5.5	16.0	12.8	0.00885	24.5	19.5
	60	19.4	20.0	5.5	14.5	13.0	0.00632	22.2	17.6
	120	19.4	17.5	5.5	12.0	13.4	0.00454	18.4	14.6
	250	19.7	15.5	5.5	10.1	13.8	0.00317	15.4	12.2
	430	20.4	14.0	5.3	8.7	14.0	0.00242	13.3	10.5
31-Jan-14	1341	19.7	12.0	5.5	6.6	14.3	0.00140	10.0	8.0

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND				SILT			CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0022**	d_{30} = **0.025**	d_{50} = **0.089**	d_{60} = **0.21**	C_u = **95**	C_c = **1.4**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-20-20.5-Bag	**20-20.5**	**Silty sand (SM)**	**Loam †**

† Greater than 10% of sample is coarse material

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5
Test Date: 3-Feb-14

Initial Dry Weight of Sample (g): 437.34
Weight Passing #10 (g): 403.71
Weight Retained #10 (g): 33.63
Weight of Hydrometer Sample (g): 66.32
Calculated Weight of Sieve Sample (g): 71.84

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	437.34	100.00
	2"	50	0.00	0.00	437.34	100.00
	1.5"	38.1	0.00	0.00	437.34	100.00
	1"	25	0.00	0.00	437.34	100.00
	3/4"	19.0	0.00	0.00	437.34	100.00
	3/8"	9.5	4.11	4.11	433.23	99.06
	4	4.75	8.23	12.34	425.00	97.18
	10	2.00	21.29	33.63	403.71	92.31
-10			(Based on calculated sieve wt.)			
	20	0.85	3.09	8.61	63.23	88.01
	40	0.425	2.37	10.98	60.86	84.71
	60	0.250	2.83	13.81	58.03	80.77
	140	0.106	3.79	17.60	54.24	75.50
	200	0.075	1.51	19.11	52.73	73.39
	dry pan		0.17	19.28	52.56	
	wet pan			52.56	0.00	

d_{10} (mm): 0.00046 d_{50} (mm): 0.017
d_{16} (mm): 0.0013 d_{60} (mm): 0.030
d_{30} (mm): 0.0059 d_{84} (mm): 0.39

Median Particle Diameter --d_{50} (mm): 0.017
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 65
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.5
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.14

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: ML

ASTM Soil Classification: Silt with sand (ML)s
USDA Soil Classification: Silt Loam

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5

Test Date: 30-Jan-14
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.65

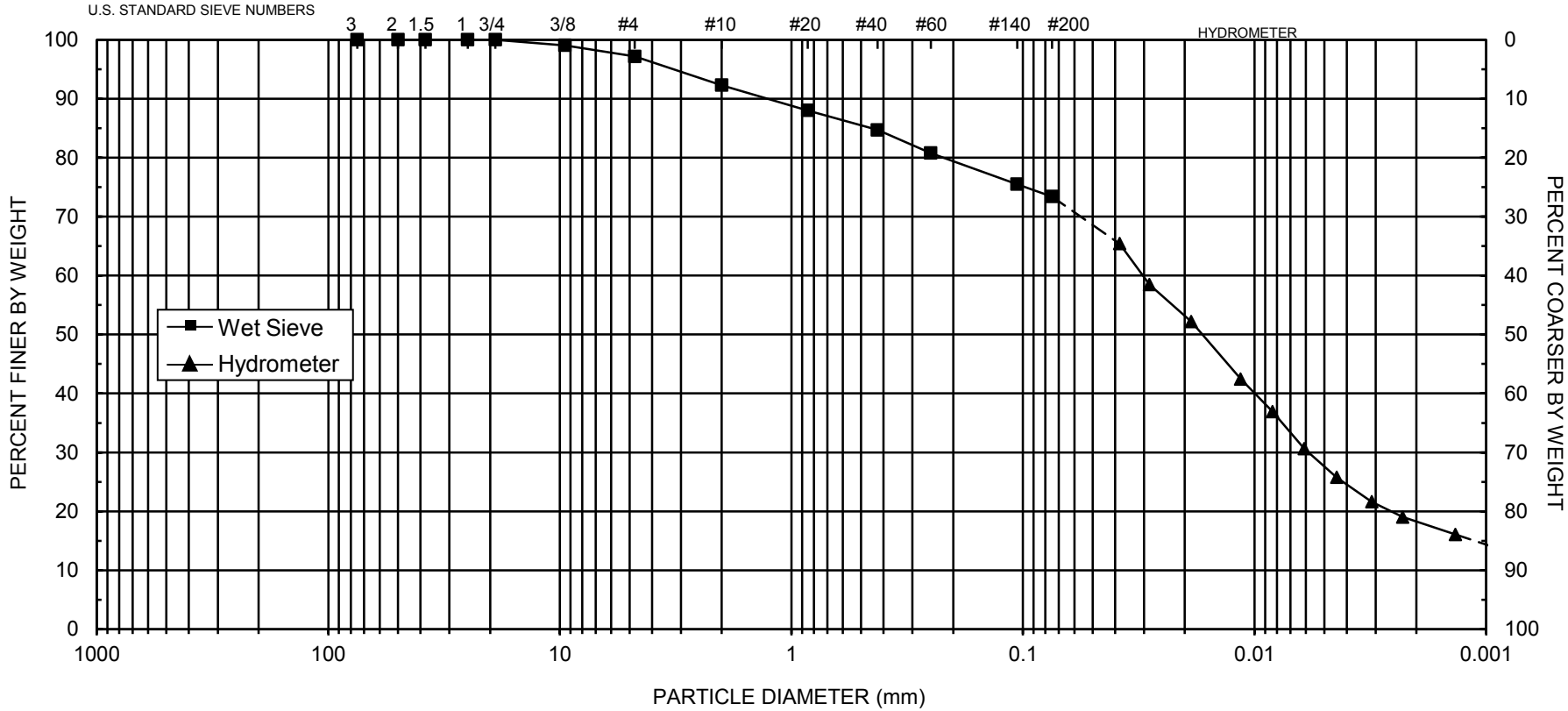
Initial Wt. (g)*:* 66.32
Total Sample Wt. (g)*:* 437.34
Wt. Passing #10 (g): 403.71

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
30-Jan-14	1	19.3	52.5	5.5	47.0	7.7	0.03820	70.9	65.4
	2	19.3	47.5	5.5	42.0	8.5	0.02841	63.3	58.4
	5	19.3	43.0	5.5	37.5	9.3	0.01873	56.5	52.2
	15	19.3	36.0	5.5	30.5	10.4	0.01147	46.0	42.4
	30	19.4	32.0	5.5	26.5	11.1	0.00835	40.0	36.9
	60	19.4	27.5	5.5	22.0	11.8	0.00610	33.2	30.6
	120	19.4	24.0	5.5	18.5	12.4	0.00442	27.9	25.8
	250	19.6	21.0	5.5	15.5	12.9	0.00311	23.4	21.6
	465	20.3	19.0	5.3	13.7	13.2	0.00229	20.6	19.0
31-Jan-14	1379	19.7	17.0	5.5	11.6	13.5	0.00136	17.4	16.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND					SILT		CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.00046**	d_{30} = **0.0059**	d_{50} = **0.017**	d_{60} = **0.030**	C_u = **65**	C_c = **2.5**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-25-25.5-Bag	**25-25.5**	**Silt with sand (ML)s**	**Silt Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 620.11
Weight Passing #10 (g): 312.41
Weight Retained #10 (g): 307.70
Weight of Hydrometer Sample (g): 62.39
Calculated Weight of Sieve Sample (g): 123.84

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	620.11	100.00
	2"	50	0.00	0.00	620.11	100.00
	1.5"	38.1	0.00	0.00	620.11	100.00
	1"	25	0.00	0.00	620.11	100.00
	3/4"	19.0	30.01	30.01	590.10	95.16
	3/8"	9.5	34.31	64.32	555.79	89.63
	4	4.75	120.16	184.48	435.63	70.25
	10	2.00	123.22	307.70	312.41	50.38
-10			(Based on calculated sieve wt.)			
	20	0.85	13.58	75.03	48.81	39.41
	40	0.425	10.39	85.42	38.42	31.02
	60	0.250	12.66	98.08	25.76	20.80
	140	0.106	12.98	111.06	12.78	10.32
	200	0.075	1.60	112.66	11.18	9.03
	dry pan		0.24	112.90	10.94	
	wet pan			10.94	0.00	

d_{10} (mm): 0.097 d_{50} (mm): 1.9
d_{16} (mm): 0.17 d_{60} (mm): 3.0
d_{30} (mm): 0.40 d_{84} (mm): 7.8

Median Particle Diameter --d_{50} (mm): 1.9
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 31
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 0.55
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 3.3

Classification of fines (visual method): ML

ASTM Soil Classification: Poorly-graded sand with silt and gravel (SP-SM)g
USDA Soil Classification: Sand †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31
Test Date: 30-Jan-14
Start Time: 9:30

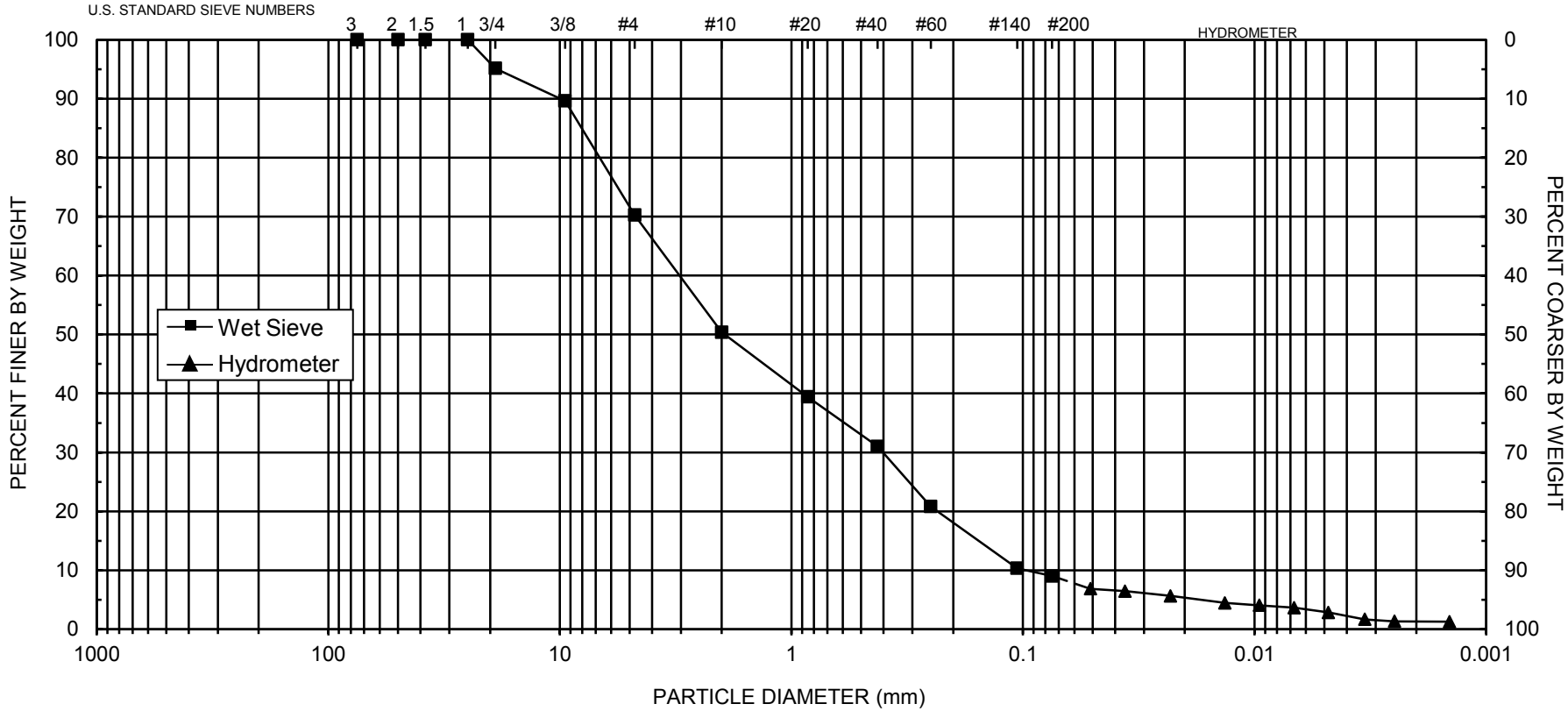
Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Measured particle density: 2.67
Initial Wt. (g)*:* 62.39
Total Sample Wt. (g)*:* 620.11
Wt. Passing #10 (g): 312.41

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
30-Jan-14	1	19.4	14.0	5.5	8.5	14.0	0.05106	13.6	6.9
	2	19.4	13.5	5.5	8.0	14.1	0.03621	12.8	6.5
	5	19.4	12.5	5.5	7.0	14.3	0.02304	11.2	5.7
	15	19.4	11.0	5.5	5.5	14.5	0.01341	8.8	4.4
	30	19.4	10.5	5.5	5.0	14.6	0.00951	8.0	4.0
	60	19.4	10.0	5.5	4.5	14.7	0.00674	7.2	3.6
	120	19.4	9.0	5.5	3.5	14.8	0.00479	5.6	2.8
	250	19.7	7.5	5.5	2.1	15.1	0.00334	3.3	1.7
	445	20.3	7.0	5.3	1.7	15.2	0.00249	2.7	1.3
31-Jan-14	1357	19.7	7.0	5.5	1.6	15.2	0.00144	2.5	1.3

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT		CLAY
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.097**	d_{30} = **0.40**	d_{50} = **1.9**	d_{60} = **3.0**	C_u = **31**	C_c = **0.55**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-01-30.5-31-SS	**30.5-31**	**Poorly-graded sand with silt and gravel (SP-SM)g**	**Sand †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 484.31
Weight Passing #10 (g): 450.66
Weight Retained #10 (g): 33.65
Weight of Hydrometer Sample (g): 60.02
Calculated Weight of Sieve Sample (g): 64.50

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	484.31	100.00
	2"	50	0.00	0.00	484.31	100.00
	1.5"	38.1	0.00	0.00	484.31	100.00
	1"	25	0.00	0.00	484.31	100.00
	3/4"	19.0	0.00	0.00	484.31	100.00
	3/8"	9.5	0.00	0.00	484.31	100.00
	4	4.75	2.99	2.99	481.32	99.38
	10	2.00	30.66	33.65	450.66	93.05
-10			(Based on calculated sieve wt.)			
	20	0.85	8.54	13.02	51.48	79.81
	40	0.425	6.10	19.12	45.38	70.35
	60	0.250	5.29	24.41	40.09	62.15
	140	0.106	11.13	35.54	28.96	44.90
	200	0.075	3.73	39.27	25.23	39.12
	dry pan		0.37	39.64	24.86	
	wet pan			24.86	0.00	

d_{10} (mm): 0.0047 d_{50} (mm): 0.14
d_{16} (mm): 0.011 d_{60} (mm): 0.22
d_{30} (mm): 0.043 d_{84} (mm): 1.1

Median Particle Diameter --d_{50} (mm): 0.14
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 47
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.8
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.42

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: J. Bray/C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

Test Date: 29-Jan-14
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

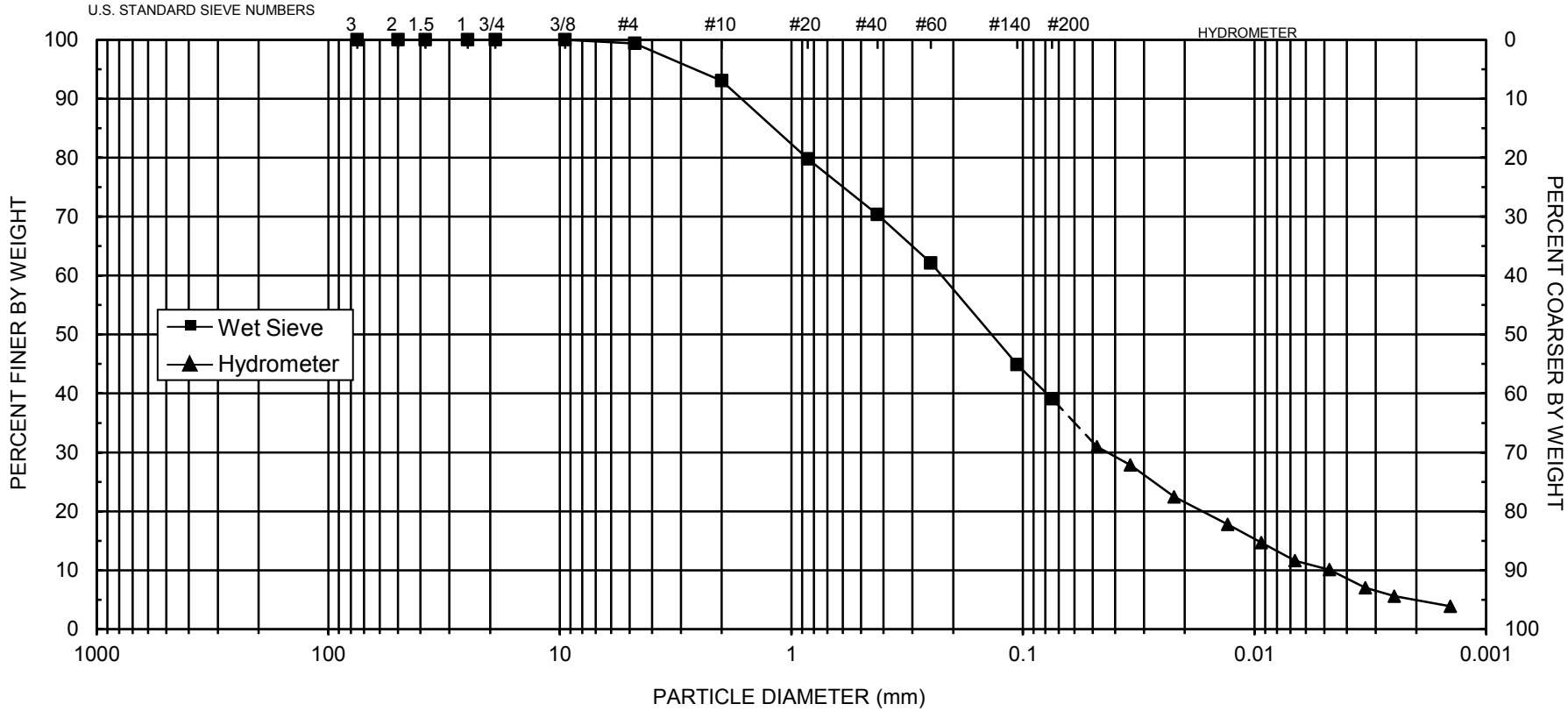
Initial Wt. (g)*:* 60.02
Total Sample Wt. (g)*:* 484.31
Wt. Passing #10 (g): 450.66

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	25.5	5.5	20.0	12.1	0.04794	33.3	31.0
	2	19.2	23.5	5.5	18.0	12.4	0.03435	29.9	27.9
	5	19.2	20.0	5.5	14.5	13.0	0.02222	24.1	22.4
	15	19.2	17.0	5.5	11.5	13.5	0.01307	19.1	17.8
	30	19.2	15.0	5.5	9.5	13.8	0.00935	15.8	14.7
	60	19.3	13.0	5.5	7.5	14.2	0.00668	12.5	11.6
	120	19.5	12.0	5.5	6.5	14.3	0.00474	10.8	10.1
	250	19.6	10.0	5.5	4.5	14.7	0.00332	7.5	7.0
	445	20.0	9.0	5.4	3.6	14.8	0.00249	6.0	5.6
30-Jan-14	1388	19.5	8.0	5.5	2.5	15.0	0.00143	4.2	3.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT		CLAY
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0047**	d_{30} = **0.043**	d_{50} = **0.14**	d_{60} = **0.22**	C_u = **47**	C_c = **1.8**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-5-5.5-Bag	**5-5.5**	**Silty sand (SM)**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

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Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 582.20
Weight Passing #10 (g): 558.16
Weight Retained #10 (g): 24.04
Weight of Hydrometer Sample (g): 69.46
Calculated Weight of Sieve Sample (g): 72.45

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	582.20	100.00
	2"	50	0.00	0.00	582.20	100.00
	1.5"	38.1	0.00	0.00	582.20	100.00
	1"	25	0.00	0.00	582.20	100.00
	3/4"	19.0	0.00	0.00	582.20	100.00
	3/8"	9.5	0.00	0.00	582.20	100.00
	4	4.75	7.66	7.66	574.54	98.68
	10	2.00	16.38	24.04	558.16	95.87
-10			(Based on calculated sieve wt.)			
	20	0.85	2.66	5.65	66.80	92.20
	40	0.425	1.98	7.63	64.82	89.47
	60	0.250	6.23	13.86	58.59	80.87
	140	0.106	22.01	35.87	36.58	50.49
	200	0.075	5.35	41.22	31.23	43.10
	dry pan		0.54	41.76	30.69	
	wet pan			30.69	0.00	

d_{10} (mm): 0.0022 d_{50} (mm): 0.10
d_{16} (mm): 0.0046 d_{60} (mm): 0.14
d_{30} (mm): 0.027 d_{84} (mm): 0.30

Median Particle Diameter --d_{50} (mm): 0.10
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 64
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.4
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.13

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: J. Bray/C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

Test Date: 29-Jan-14
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

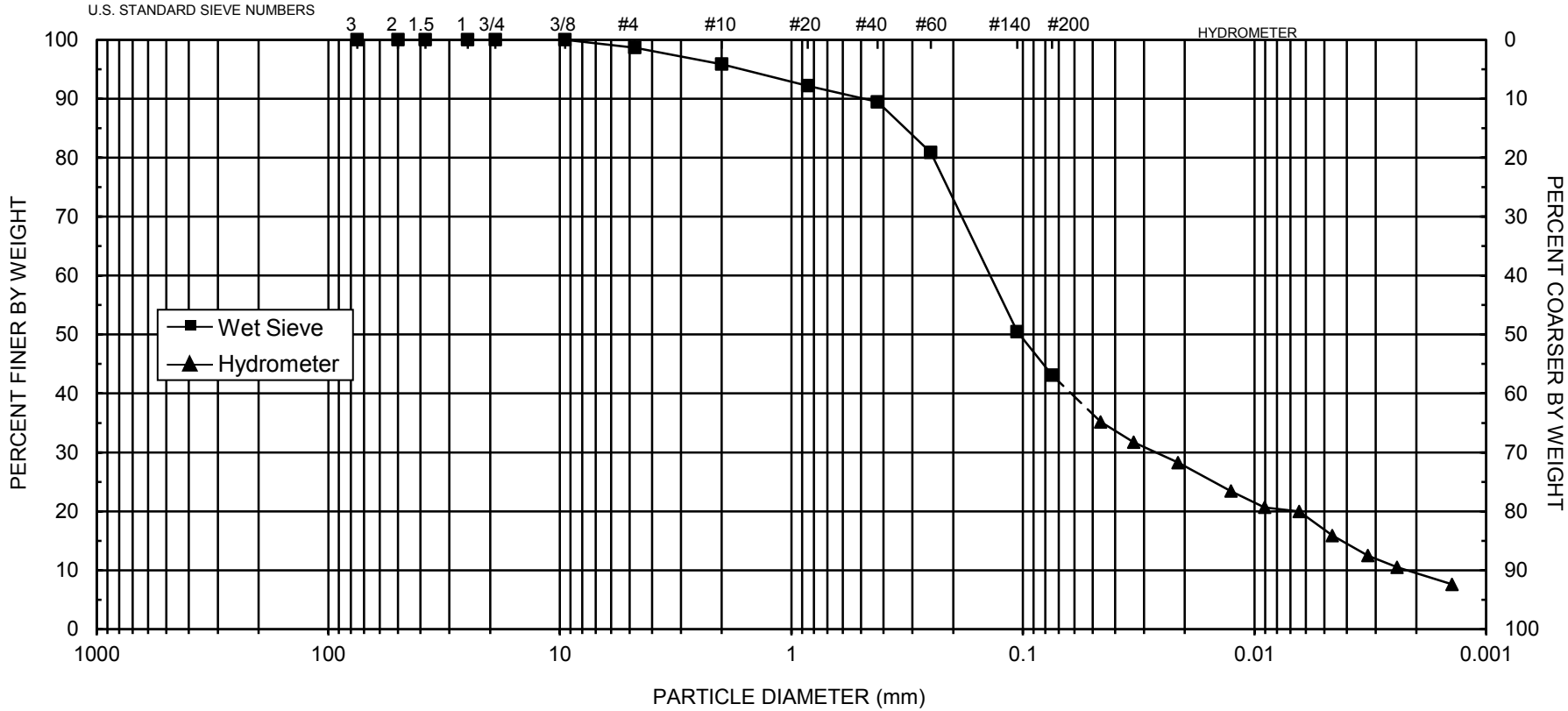
Initial Wt. (g)*:* 69.46
Total Sample Wt. (g)*:* 582.20
Wt. Passing #10 (g): 558.16

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	31.0	5.5	25.5	11.2	0.04612	36.7	35.2
	2	19.2	28.5	5.5	23.0	11.6	0.03320	33.1	31.7
	5	19.2	26.0	5.5	20.5	12.0	0.02137	29.5	28.3
	15	19.2	22.5	5.5	17.0	12.6	0.01263	24.4	23.4
	30	19.2	20.5	5.5	15.0	12.9	0.00904	21.6	20.7
	60	19.2	20.0	5.5	14.5	13.0	0.00641	20.8	20.0
	120	19.5	17.0	5.5	11.5	13.5	0.00461	16.6	15.9
	250	19.6	14.5	5.5	9.0	13.9	0.00324	13.0	12.5
	450	20.0	13.0	5.4	7.6	14.2	0.00242	11.0	10.5
30-Jan-14	1393	19.5	11.0	5.5	5.5	14.5	0.00140	7.9	7.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND					SILT		CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0022**	d_{30} = **0.027**	d_{50} = **0.10**	d_{60} = **0.14**	C_u = **64**	C_c = **2.4**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-10-10.5-Bag	**10-10.5**	**Silty sand (SM)**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 931.65
Weight Passing #10 (g): 363.62
Weight Retained #10 (g): 568.03
Weight of Hydrometer Sample (g): 67.29
Calculated Weight of Sieve Sample (g): 172.41

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	931.65	100.00
	2"	50	0.00	0.00	931.65	100.00
	1.5"	38.1	0.00	0.00	931.65	100.00
	1"	25	0.00	0.00	931.65	100.00
	3/4"	19.0	30.89	30.89	900.76	96.68
	3/8"	9.5	114.13	145.02	786.63	84.43
	4	4.75	169.77	314.79	616.86	66.21
	10	2.00	253.24	568.03	363.62	39.03
-10			(Based on calculated sieve wt.)			
	20	0.85	30.00	135.12	37.29	21.63
	40	0.425	7.80	142.92	29.49	17.10
	60	0.250	4.08	147.00	25.41	14.74
	140	0.106	4.15	151.15	21.26	12.33
	200	0.075	1.07	152.22	20.19	11.71
	dry pan		0.08	152.30	20.11	
	wet pan			20.11	0.00	

d_{10} (mm): 0.045 d_{50} (mm): 2.8
d_{16} (mm): 0.33 d_{60} (mm): 3.9
d_{30} (mm): 1.3 d_{84} (mm): 9.3

Median Particle Diameter --d_{50} (mm): 2.8
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 87
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 9.6
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 4.1

Classification of fines: CL

ASTM Soil Classification: Poorly-graded sand with clay and gravel (SP-SC)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

Test Date: 29-Jan-14
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

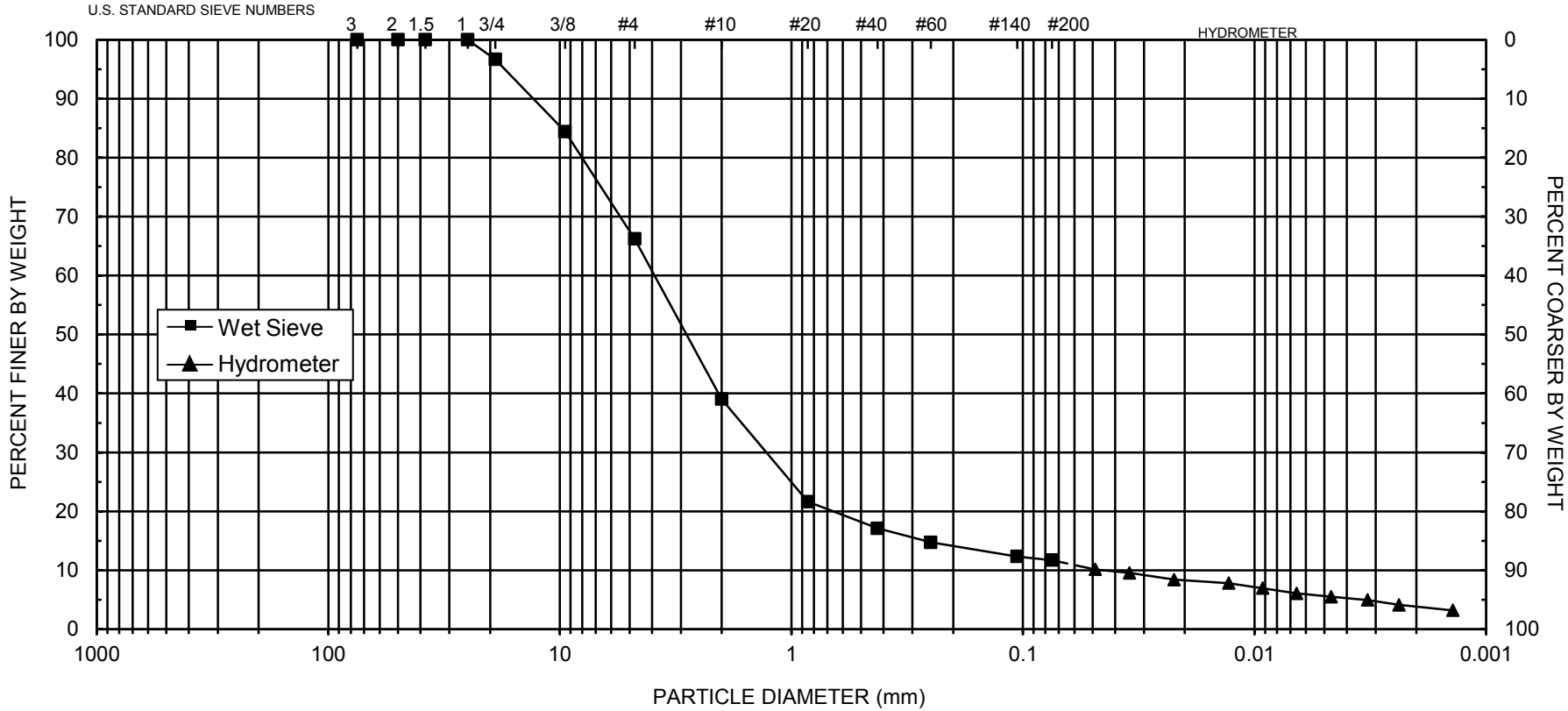
Initial Wt. (g)*:* 67.29
Total Sample Wt. (g)*:* 931.65
Wt. Passing #10 (g): 363.62

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	23.0	5.5	17.5	12.5	0.04874	26.0	10.1
	2	19.2	22.0	5.5	16.5	12.7	0.03469	24.5	9.6
	5	19.2	20.0	5.5	14.5	13.0	0.02222	21.5	8.4
	15	19.2	19.0	5.5	13.5	13.2	0.01291	20.0	7.8
	30	19.2	17.5	5.5	12.0	13.4	0.00921	17.8	6.9
	60	19.2	16.0	5.5	10.5	13.7	0.00657	15.6	6.1
	120	19.4	15.0	5.5	9.5	13.8	0.00466	14.1	5.5
	250	19.5	14.0	5.5	8.5	14.0	0.00325	12.7	4.9
	470	20.0	12.5	5.4	7.1	14.3	0.00237	10.6	4.1
30-Jan-14	1414	19.5	11.0	5.5	5.5	14.5	0.00139	8.2	3.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT	CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.045**	d_{30} = **1.3**	d_{50} = **2.8**	d_{60} = **3.9**	C_u = **87**	C_c = **9.6**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-15-15.5-Bag	**15-15.5**	**Poorly-graded sand with clay and gravel (SP-SC)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 751.33
Weight Passing #10 (g): 452.78
Weight Retained #10 (g): 298.55
Weight of Hydrometer Sample (g): 64.91
Calculated Weight of Sieve Sample (g): 107.71

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	751.33	100.00
	2"	50	0.00	0.00	751.33	100.00
	1.5"	38.1	0.00	0.00	751.33	100.00
	1"	25	0.00	0.00	751.33	100.00
	3/4"	19.0	0.00	0.00	751.33	100.00
	3/8"	9.5	61.54	61.54	689.79	91.81
	4	4.75	132.87	194.41	556.92	74.12
	10	2.00	104.14	298.55	452.78	60.26
-10			(Based on calculated sieve wt.)			
	20	0.85	6.76	49.56	58.15	53.99
	40	0.425	4.71	54.27	53.44	49.61
	60	0.250	7.53	61.80	45.91	42.62
	140	0.106	13.61	75.41	32.30	29.99
	200	0.075	3.30	78.71	29.00	26.92
	dry pan		0.25	78.96	28.75	
	wet pan			28.75	0.00	

d_{10} (mm): 0.0048 d_{50} (mm): 0.45
d_{16} (mm): 0.016 d_{60} (mm): 1.9
d_{30} (mm): 0.11 d_{84} (mm): 7.0

Median Particle Diameter --d_{50} (mm): 0.45
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 396
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.3
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 2.5

Classification of fines: CL-ML

ASTM Soil Classification: Silty, clayey sand with gravel (SC-SM)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

Test Date: 29-Jan-14
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

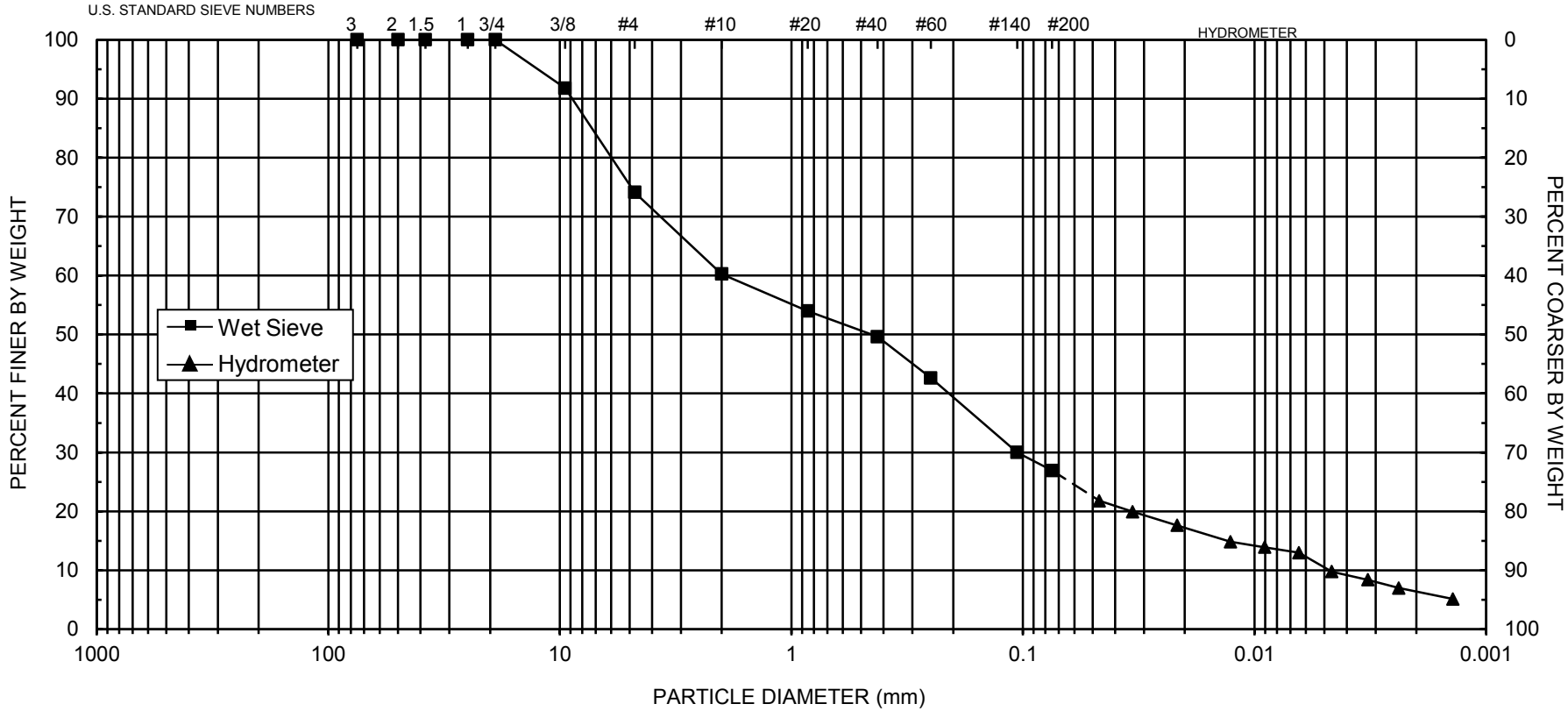
Initial Wt. (g)*:* 64.91
Total Sample Wt. (g)*:* 751.33
Wt. Passing #10 (g): 452.78

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	29.0	5.5	23.5	11.5	0.04679	36.2	21.8
	2	19.2	27.0	5.5	21.5	11.9	0.03355	33.1	19.9
	5	19.2	24.5	5.5	19.0	12.3	0.02158	29.2	17.6
	15	19.2	21.5	5.5	16.0	12.8	0.01271	24.6	14.8
	30	19.2	20.5	5.5	15.0	12.9	0.00904	23.1	13.9
	60	19.2	19.5	5.5	14.0	13.1	0.00643	21.5	13.0
	120	19.4	16.0	5.5	10.5	13.7	0.00464	16.2	9.7
	250	19.5	14.5	5.5	9.0	13.9	0.00324	13.9	8.4
	465	20.0	13.0	5.5	7.5	14.2	0.00238	11.6	7.0
30-Jan-14	1410	19.5	11.0	5.5	5.5	14.5	0.00139	8.5	5.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND				SILT		CLAY	
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0048**	d_{30} = **0.11**	d_{50} = **0.45**	d_{60} = **1.9**	C_u = **396**	C_c = **1.3**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-20-20.5-Bag	**20-20.5**	**Silty, clayey sand with gravel (SC-SM)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 763.95
Weight Passing #10 (g): 371.76
Weight Retained #10 (g): 392.19
Weight of Hydrometer Sample (g): 69.19
Calculated Weight of Sieve Sample (g): 142.18

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	763.95	100.00
	2"	50	0.00	0.00	763.95	100.00
	1.5"	38.1	0.00	0.00	763.95	100.00
	1"	25	40.94	40.94	723.01	94.64
	3/4"	19.0	36.43	77.37	686.58	89.87
	3/8"	9.5	115.99	193.36	570.59	74.69
	4	4.75	107.54	300.90	463.05	60.61
	10	2.00	91.29	392.19	371.76	48.66
-10			(Based on calculated sieve wt.)			
	20	0.85	10.28	83.27	58.91	41.43
	40	0.425	6.88	90.15	52.03	36.59
	60	0.250	10.32	100.47	41.71	29.34
	140	0.106	12.04	112.51	29.67	20.87
	200	0.075	2.48	114.99	27.19	19.12
	dry pan		0.18	115.17	27.01	
	wet pan			27.01	0.00	

d_{10} (mm): 0.0058 d_{50} (mm): 2.2
d_{16} (mm): 0.039 d_{60} (mm): 4.5
d_{30} (mm): 0.26 d_{84} (mm): 15

Median Particle Diameter --d_{50} (mm): 2.2
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 776
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.6
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 5.7

Classification of fines: CL

ASTM Soil Classification: Clayey sand with gravel (SC)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5

Test Date: 29-Jan-14
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

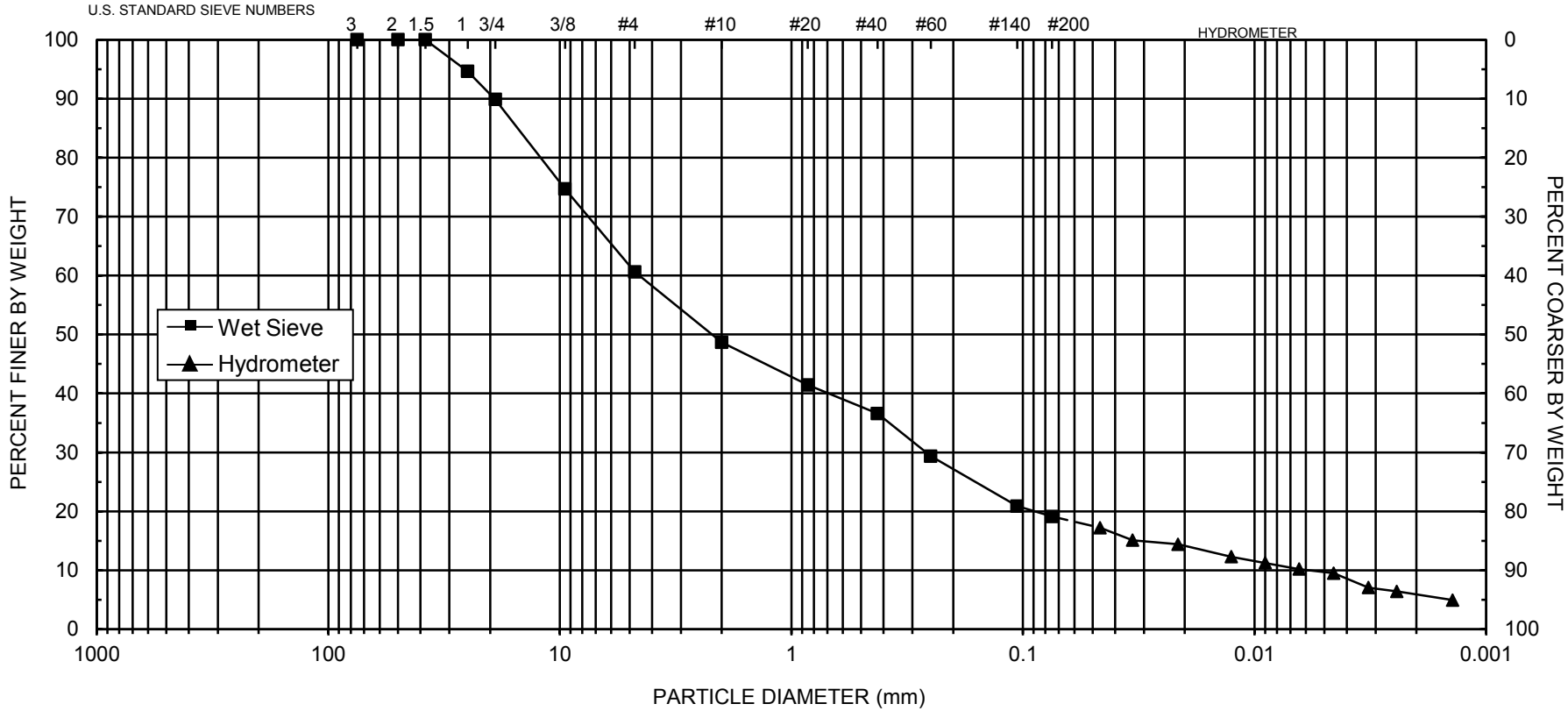
Initial Wt. (g)*:* 69.19
Total Sample Wt. (g)*:* 763.95
Wt. Passing #10 (g): 371.76

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	30.0	5.5	24.5	11.4	0.04646	35.4	17.2
	2	19.2	27.0	5.5	21.5	11.9	0.03355	31.0	15.1
	5	19.2	26.0	5.5	20.5	12.0	0.02137	29.6	14.4
	15	19.2	23.0	5.5	17.5	12.5	0.01258	25.2	12.3
	30	19.2	21.5	5.5	16.0	12.8	0.00899	23.1	11.2
	60	19.3	20.0	5.5	14.5	13.0	0.00641	20.9	10.2
	120	19.5	19.0	5.5	13.5	13.2	0.00455	19.5	9.5
	250	19.6	15.5	5.5	10.0	13.8	0.00322	14.5	7.1
	440	20.0	14.5	5.4	9.1	13.9	0.00243	13.2	6.4
30-Jan-14	1382	19.5	12.5	5.5	7.0	14.3	0.00139	10.1	4.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY				
		Coarse	Fine	Coarse	Medium	Fine					
USDA	COBBLES	GRAVEL		SAND				SILT			CLAY
				Very coarse	Coarse	Medium	Fine	Very fine			

d_{10} = **0.0058**	d_{30} = **0.26**	d_{50} = **2.2**	d_{60} = **4.5**	C_u = **776**	C_c = **2.6**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-25-25.5-Bag	**25-25.5**	**Clayey sand with gravel (SC)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-29.5-30-Bag
Date Sampled: 12/19/2013
Depth (ft): 29.5-30
Test Date: 4-Feb-14

Initial Dry Weight of Sample (g): 760.65
Weight Passing #10 (g): 454.33
Weight Retained #10 (g): 306.32
Weight of Hydrometer Sample (g): 82.90
Calculated Weight of Sieve Sample (g): 138.79

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	760.65	100.00
	2"	50	0.00	0.00	760.65	100.00
	1.5"	38.1	0.00	0.00	760.65	100.00
	1"	25	0.00	0.00	760.65	100.00
	3/4"	19.0	12.53	12.53	748.12	98.35
	3/8"	9.5	96.04	108.57	652.08	85.73
	4	4.75	88.36	196.93	563.72	74.11
	10	2.00	109.39	306.32	454.33	59.73
-10			(Based on calculated sieve wt.)			
	20	0.85	0.04	55.93	82.86	59.70
	40	0.425	0.07	56.00	82.79	59.65
	60	0.250	15.39	71.39	67.40	48.56
	140	0.106	16.17	87.56	51.23	36.91
	200	0.075	3.79	91.35	47.44	34.18
	dry pan		0.66	92.01	46.78	
	wet pan			46.78	0.00	

d_{10} (mm): 0.0014 d_{50} (mm): 0.27
d_{16} (mm): 0.0039 d_{60} (mm): 2.0
d_{30} (mm): 0.033 d_{84} (mm): 8.6

Median Particle Diameter --d_{50} (mm): 0.27
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 1429
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 0.39
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 3.0

Classification of fines: ML

ASTM Soil Classification: Silty sand with gravel (SM)g
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Bray/S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-29.5-30-Bag
Date Sampled: 12/19/2013
Depth (ft): 29.5-30
Test Date: 29-Jan-14
Start Time: 9:54

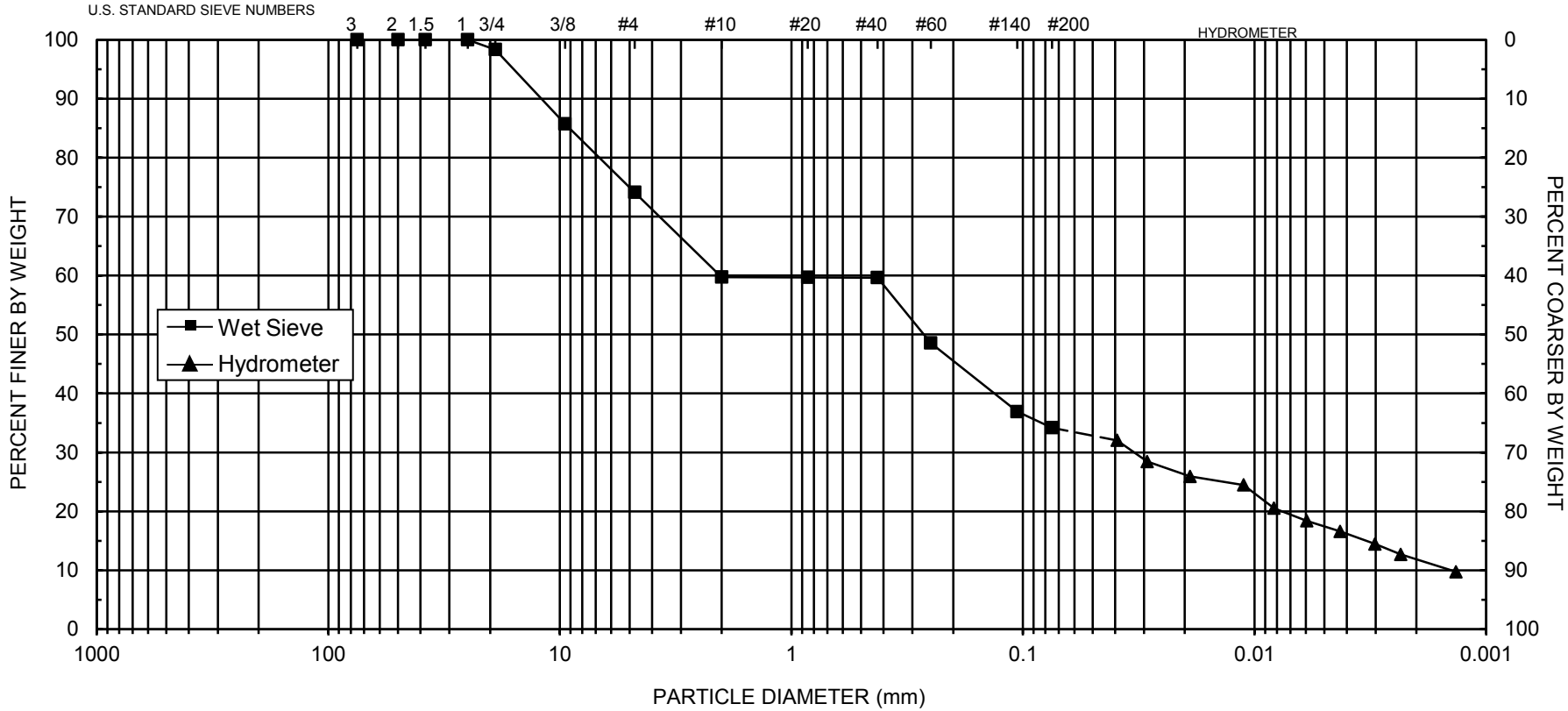
Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65
Initial Wt. (g)*:* 82.90
Total Sample Wt. (g)*:* 760.65
Wt. Passing #10 (g): 454.33

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
29-Jan-14	1	19.2	50.0	5.5	44.5	8.1	0.03920	53.6	32.0
	2	19.2	45.0	5.5	39.5	8.9	0.02909	47.6	28.4
	5	19.2	41.5	5.5	36.0	9.5	0.01898	43.4	25.9
	15	19.2	39.5	5.5	34.0	9.8	0.01114	41.0	24.5
	30	19.2	34.0	5.5	28.5	10.7	0.00823	34.3	20.5
	60	19.4	31.0	5.5	25.5	11.2	0.00594	30.8	18.4
	120	19.5	28.5	5.5	23.0	11.6	0.00427	27.8	16.6
	250	19.6	25.5	5.5	20.0	12.1	0.00302	24.2	14.4
	425	20.1	23.0	5.4	17.6	12.5	0.00234	21.2	12.7
30-Jan-14	1365	19.5	19.0	5.5	13.5	13.2	0.00135	16.3	9.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bisoglio
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND				SILT		CLAY
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0014**	d_{30} = **0.033**	d_{50} = **0.27**	d_{60} = **2.0**	C_u = **1429**	C_c = **0.39**

SAMPLE NUMBER	DEPTH (FT)	ASTM CLASSIFICATION	USDA CLASSIFICATION
MAC-B-02-29.5-30-Bag	**29.5-30**	**Silty sand with gravel (SM)g**	**Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Atterberg Limits/ Identification of Fines

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
MAC-B-01-5-5.5-Bag	32	26	6	ML
MAC-B-01-10-10.5-Bag	27	23	4	ML
MAC-B-01-15-15.5-Bag	---	---	---	ML
MAC-B-01-20-20.5-Bag	38	26	12	ML
MAC-B-01-25-25.5-Bag	38	26	12	ML
MAC-B-01-30.5-31-SS	---	---	---	ML
MAC-B-02-5-5.5-Bag	---	---	---	ML
MAC-B-02-10-10.5-Bag	---	---	---	ML
MAC-B-02-15-15.5-Bag	38	22	16	CL
MAC-B-02-20-20.5-Bag	29	22	7	CL-ML
MAC-B-02-25-25.5-Bag	31	21	10	CL
MAC-B-02-29.5-30-Bag	40	26	14	ML

--- = Soil requires visual-manual classification due to non-plasticity

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	32	22	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	127.41	120.38	122.67
Weight of pan plus dry soil (g)	124.72	118.00	119.43
Weight of pan (g):	116.00	110.60	109.63
Gravimetric moisture content (% g/g):	30.85	32.16	33.06
Liquid Limit:	32		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.84	119.20
Weight of pan plus dry soil (g)	121.56	117.86
Weight of pan (g):	116.69	112.64
Gravimetric moisture content (% g/g):	26.28	25.67
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 32
Plastic Limit: 26
Plasticity Index: 6

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	36	25	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.92	127.50	127.51
Weight of pan plus dry soil (g)	123.03	124.52	124.29
Weight of pan (g):	112.16	113.46	112.69
Gravimetric moisture content (% g/g):	26.59	26.94	27.76

Liquid Limit: 27

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	116.78	124.35
Weight of pan plus dry soil (g)	115.80	123.14
Weight of pan (g):	111.64	117.96
Gravimetric moisture content (% g/g):	23.56	23.36

Plastic Limit: 23

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 27
Plastic Limit: 23
Plasticity Index: 4

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

Test Date: 5-Feb-14

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Yellowish Brown (10YR 3/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: None

Preliminary Identification:

Dry Strength: None
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	31	25	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.14	121.42	130.53
Weight of pan plus dry soil (g)	123.49	118.46	126.55
Weight of pan (g):	116.31	110.68	116.42
Gravimetric moisture content (% g/g):	36.91	38.05	39.29
Liquid Limit:	38		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	120.04	123.80
Weight of pan plus dry soil (g)	118.86	122.48
Weight of pan (g):	114.40	117.49
Gravimetric moisture content (% g/g):	26.46	26.45
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 38
Plastic Limit: 26
Plasticity Index: 12

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	34	22	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	120.10	129.39	128.72
Weight of pan plus dry soil (g)	118.11	125.52	125.29
Weight of pan (g):	112.67	115.35	116.43
Gravimetric moisture content (% g/g):	36.58	38.05	38.71
Liquid Limit:	38		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	119.59	120.96
Weight of pan plus dry soil (g)	118.24	119.53
Weight of pan (g):	112.86	114.04
Gravimetric moisture content (% g/g):	25.09	26.05
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 38
Plastic Limit: 26
Plasticity Index: 12

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31

Test Date: 5-Feb-14

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Brown (10YR 3/3)
Odor: None
Moisture Condition: Moist
HCl Reaction: None

Preliminary Identification:

Dry Strength: None
Dilatency: Rapid
Toughness: Low
Plasticity: Non-Plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

Test Date: 5-Feb-14

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Yellowish Brown (10YR 3/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: None

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

Test Date: 5-Feb-14

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Yellowish Brown (10YR 3/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: None

Preliminary Identification:

Dry Strength: Low
Dilatency: Slow
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	37	29	27
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.49	128.93	127.08
Weight of pan plus dry soil (g)	124.17	126.09	123.09
Weight of pan (g):	117.69	118.39	112.56
Gravimetric moisture content (% g/g):	35.80	36.88	37.89
Liquid Limit:	38		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.92	121.11
Weight of pan plus dry soil (g)	121.82	120.04
Weight of pan (g):	116.86	115.10
Gravimetric moisture content (% g/g):	22.18	21.66
Plastic Limit:	22	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 38
Plastic Limit: 22
Plasticity Index: 16

Classification: CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	25	19
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	127.47	123.75	125.44
Weight of pan plus dry soil (g)	125.37	121.82	123.11
Weight of pan (g):	117.93	115.13	115.31
Gravimetric moisture content (% g/g):	28.23	28.85	29.87

Liquid Limit: 29

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	121.84	123.87
Weight of pan plus dry soil (g)	120.17	122.14
Weight of pan (g):	112.70	114.29
Gravimetric moisture content (% g/g):	22.36	22.04

Plastic Limit: 22

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 29
Plastic Limit: 22
Plasticity Index: 7

Classification: CL-ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	34	24	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.43	125.12	127.63
Weight of pan plus dry soil (g)	124.14	123.03	124.90
Weight of pan (g):	116.51	116.37	116.44
Gravimetric moisture content (% g/g):	30.01	31.38	32.27
Liquid Limit:	31		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.29	121.37
Weight of pan plus dry soil (g)	121.08	120.29
Weight of pan (g):	115.32	115.30
Gravimetric moisture content (% g/g):	21.01	21.64
Plastic Limit:	21	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 31
Plastic Limit: 21
Plasticity Index: 10

Classification: CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Atterberg Limits

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-02-29.5-30-Bag
Date Sampled: 12/19/2013
Depth (ft): 29.5-30

Test Date: 5-Feb-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	37	24	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.79	121.15	129.38
Weight of pan plus dry soil (g)	123.39	118.41	125.17
Weight of pan (g):	117.19	111.62	115.15
Gravimetric moisture content (% g/g):	38.71	40.35	42.02
Liquid Limit:	40		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	123.07	127.40
Weight of pan plus dry soil (g)	121.44	125.33
Weight of pan (g):	115.28	117.44
Gravimetric moisture content (% g/g):	26.46	26.24
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 40
Plastic Limit: 26
Plasticity Index: 14

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: S. Hanhardt
Checked by: J. Hines

Specific Gravity

Summary of Specific Gravity Tests

	Test Sample			Oversize Material			Bulk Sample
Sample Number	Specific Gravity	Particle Size	% of Bulk Sample	Specific Gravity	Particle Size	% of Bulk Sample	Specific Gravity*
MAC-B-01-5-5.5-Bag[1]	2.63	<4.75mm	99.9%	---	>4.75mm	0.1%	2.63
MAC-B-01-10-10.5-Bag[1]	2.63	<4.75mm	99.3%	---	>4.75mm	0.7%	2.63
MAC-B-01-15-15.5-Bag	2.66	<4.75mm	100.0%	---	>4.75mm	0.0%	2.66
MAC-B-01-20-20.5-Bag	2.70	<4.75mm	87.9%	2.65	>4.75mm	12.1%	2.69
MAC-B-01-25-25.5-Bag[1]	2.65	<4.75mm	97.2%	---	>4.75mm	2.8%	2.65
MAC-B-01-30.5-31-SS	2.68	<4.75mm	70.3%	2.71	>4.75mm	29.7%	2.69

[1]Based on the <4.75mm material

*Weighted average

--- = Unnecessary since specified fraction < 5% of composite mass

NA = Not analyzed

Data for Specific Gravity of Test Sample: MAC-B-01-5-5.5-Bag

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-5-5.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 5-5.5

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	99.88	
Percent of Bulk Sample (% g/g):	99.88	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	93.26	95.94
Weight of pycnometer filled w/soil (g):	138.91	144.73
Weight of pycnometer filled w/soil & water (g):	371.01	375.61
Weight of pycnometer filled w/water (g):	342.71	345.33
Specific Gravity (g/g):	2.63	2.64
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.63	2.64
Average Specific Gravity (g/g):	2.63	
Average Particle Density (g/cm^3):	2.63	

ASTM C127 (>4.75mm) Fraction

Test Date:	---	
Percent of Test Sample (% g/g):	0.12	
Percent of Bulk Sample (% g/g):	0.12	
Tare Weight (g):	---	
Saturated Surface Dry (SSD) mass in Air & Tare (g):	---	--- = Test unnecessary since
Saturated Apparent mass in Water & Tare (g):	---	specified fraction <5% of
Oven Dry (OD) mass in Air & Tare (g):	---	composite mass.
SSD Specific Gravity (g/g):	---	
Apparent Specific Gravity (g/g):	---	
OD Specific Gravity (g/g):	---	
Percent Absorption (%):	---	
Observed Temperature (°C):	---	
Density of water at observed temperature (g/m^3):	---	
Correction Factor, K:	---	
Specific Gravity (Apparent), Corrected to 20° C:	---	
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	---	

Specific Gravity (Apparent) at 20ºC*:	**2.63**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.63	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Data for Specific Gravity of Test Sample: MAC-B-01-10-10.5-Bag

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-10-10.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 10-10.5

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	99.34	
Percent of Bulk Sample (% g/g):	99.34	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	94.24	93.70
Weight of pycnometer filled w/soil (g):	141.07	139.29
Weight of pycnometer filled w/soil & water (g):	372.65	371.39
Weight of pycnometer filled w/water (g):	343.61	343.14
Specific Gravity (g/g):	2.63	2.63
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.63	2.63
Average Specific Gravity (g/g):	2.63	
Average Particle Density (g/cm^3):	2.63	

ASTM C127 (>4.75mm) Fraction

Test Date:	---	
Percent of Test Sample (% g/g):	0.66	
Percent of Bulk Sample (% g/g):	0.66	
Tare Weight (g):	---	
Saturated Surface Dry (SSD) mass in Air & Tare (g):	---	--- = Test unnecessary since
Saturated Apparent mass in Water & Tare (g):	---	specified fraction <5% of
Oven Dry (OD) mass in Air & Tare (g):	---	composite mass.
SSD Specific Gravity (g/g):	---	
Apparent Specific Gravity (g/g):	---	
OD Specific Gravity (g/g):	---	
Percent Absorption (%):	---	
Observed Temperature (°C):	---	
Density of water at observed temperature (g/m^3):	---	
Correction Factor, K:	---	
Specific Gravity (Apparent), Corrected to 20° C:	---	
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	---	

Specific Gravity (Apparent) at 20ºC*:	**2.63**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.63	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Data for Specific Gravity of Test Sample: MAC-B-01-15-15.5-Bag

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-15-15.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 15-15.5

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	100.00	
Percent of Bulk Sample (% g/g):	100.00	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	92.29	90.98
Weight of pycnometer filled w/soil (g):	139.00	136.75
Weight of pycnometer filled w/soil & water (g):	370.82	368.87
Weight of pycnometer filled w/water (g):	341.70	340.34
Specific Gravity (g/g):	2.66	2.66
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.66	2.66
Average Specific Gravity (g/g):	2.66	
Average Particle Density (g/cm^3):	2.65	

ASTM C127 (>4.75mm) Fraction

Test Date:	---	
Percent of Test Sample (% g/g):	0.00	
Percent of Bulk Sample (% g/g):	0.00	
Tare Weight (g):	---	
Saturated Surface Dry (SSD) mass in Air & Tare (g):	---	--- = Test unnecessary since
Saturated Apparent mass in Water & Tare (g):	---	specified fraction <5% of
Oven Dry (OD) mass in Air & Tare (g):	---	composite mass.
SSD Specific Gravity (g/g):	---	
Apparent Specific Gravity (g/g):	---	
OD Specific Gravity (g/g):	---	
Percent Absorption (%):	---	
Observed Temperature (°C):	---	
Density of water at observed temperature (g/m^3):	---	
Correction Factor, K:	---	
Specific Gravity (Apparent), Corrected to 20° C:	---	
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	---	
Specific Gravity (Apparent) at 20ºC*:	**2.66**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.65	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Data for Specific Gravity of Test Sample: MAC-B-01-20-20.5-Bag

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-20-20.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 20-20.5

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	87.95	
Percent of Bulk Sample (% g/g):	87.95	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	92.11	94.73
Weight of pycnometer filled w/soil (g):	143.55	151.64
Weight of pycnometer filled w/soil & water (g):	373.94	379.95
Weight of pycnometer filled w/water (g):	341.58	344.13
Specific Gravity (g/g):	2.70	2.70
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.70	2.70
Average Specific Gravity (g/g):	2.70	
Average Particle Density (g/cm^3):	2.69	

ASTM C127 (>4.75mm) Fraction

Test Date:	5-Feb-14
Percent of Test Sample (% g/g):	12.05
Percent of Bulk Sample (% g/g):	12.05
Tare Weight (g):	0.00
Saturated Surface Dry (SSD) mass in Air & Tare (g):	67.57
Saturated Apparent mass in Water & Tare (g):	40.22
Oven Dry (OD) mass in Air & Tare (g):	64.62
SSD Specific Gravity (g/g):	2.47
Apparent Specific Gravity (g/g):	2.65
OD Specific Gravity (g/g):	2.36
Percent Absorption (%):	4.4
Observed Temperature (°C):	20.0
Density of water at observed temperature (g/m^3):	0.9982
Correction Factor, K:	1.0000
Specific Gravity (Apparent), Corrected to 20° C:	2.65
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	2.64

Specific Gravity (Apparent) at 20ºC*:	**2.69**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.69	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Data for Specific Gravity of Test Sample: MAC-B-01-25-25.5-Bag

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-25-25.5-Bag
Date Sampled: 12/19/2013
Depth (ft): 25-25.5

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	97.18	
Percent of Bulk Sample (% g/g):	97.18	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	91.65	91.36
Weight of pycnometer filled w/soil (g):	136.34	137.32
Weight of pycnometer filled w/soil & water (g):	368.94	369.42
Weight of pycnometer filled w/water (g):	341.14	340.79
Specific Gravity (g/g):	2.65	2.65
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.65	2.65
Average Specific Gravity (g/g):	2.65	
Average Particle Density (g/cm^3):	2.65	

ASTM C127 (>4.75mm) Fraction

Test Date:	---	
Percent of Test Sample (% g/g):	2.82	
Percent of Bulk Sample (% g/g):	2.82	
Tare Weight (g):	---	
Saturated Surface Dry (SSD) mass in Air & Tare (g):	---	--- = Test unnecessary since
Saturated Apparent mass in Water & Tare (g):	---	specified fraction <5% of
Oven Dry (OD) mass in Air & Tare (g):	---	composite mass.
SSD Specific Gravity (g/g):	---	
Apparent Specific Gravity (g/g):	---	
OD Specific Gravity (g/g):	---	
Percent Absorption (%):	---	
Observed Temperature (°C):	---	
Density of water at observed temperature (g/m^3):	---	
Correction Factor, K:	---	
Specific Gravity (Apparent), Corrected to 20° C:	---	
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	---	

Specific Gravity (Apparent) at 20ºC*:	**2.65**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.65	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Data for Specific Gravity of Test Sample: MAC-B-01-30.5-31-SS

Job Name: SCWA - MacArthur
Job Number: WR10.0085.13
Sample Number: MAC-B-01-30.5-31-SS
Date Sampled: 12/19/2013
Depth (ft): 30.5-31

ASTM D854 (<4.75mm Fraction)

Test Date:	6-Feb-14	
Percent of Test Sample (% g/g):	70.25	
Percent of Bulk Sample (% g/g):	70.25	
	Trial 1	*Trial 2*
Weight of pycnometer filled w/air (g):	94.24	93.57
Weight of pycnometer filled w/soil (g):	143.80	152.19
Weight of pycnometer filled w/soil & water (g):	374.68	379.83
Weight of pycnometer filled w/water (g):	343.71	343.00
Specific Gravity (g/g):	2.67	2.69
Observed temperature (°C):	18.85	18.85
Density of water at observed temperature (g/cm^3):	0.9984	0.9984
Correction factor, K:	1.0002	1.0002
Specific Gravity at 20°C (g/g):	2.67	2.69
Average Specific Gravity (g/g):	2.68	
Average Particle Density (g/cm^3):	2.67	

ASTM C127 (>4.75mm) Fraction

Test Date:	5-Feb-14
Percent of Test Sample (% g/g):	29.75
Percent of Bulk Sample (% g/g):	29.75
Tare Weight (g):	0.00
Saturated Surface Dry (SSD) mass in Air & Tare (g):	192.81
Saturated Apparent mass in Water & Tare (g):	116.44
Oven Dry (OD) mass in Air & Tare (g):	184.68
SSD Specific Gravity (g/g):	2.52
Apparent Specific Gravity (g/g):	2.71
OD Specific Gravity (g/g):	2.42
Percent Absorption (%):	4.2
Observed Temperature (°C):	20.0
Density of water at observed temperature (g/m^3):	0.9982
Correction Factor, K:	1.0000
Specific Gravity (Apparent), Corrected to 20° C:	2.71
Particle Density (Apparent), Corrected to 20° C (g/cm^3):	2.70

Specific Gravity (Apparent) at 20ºC*:	**2.69**	** Weighted Average*
Particle Density (Apparent) at 20ºC (g/cm3) :*	2.68	

Laboratory analysis by: M. Nauck
Data entered by: S. Hanhardt / M. Nauck
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263
Calculated Porosity:	ASTM D7263
Specific Gravity Fine:	ASTM D854
Specific Gravity Coarse:	ASTM C127
Particle Size Analysis:	ASTM D422
USCS (ASTM) Classification:	ASTM D422, ASTM D2487
USDA Classification:	ASTM D422, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Visual-Manual Description:	ASTM D2488

APPENDIX C

ASFE Information

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/The Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE THE GEOPROFESSIONAL BUSINESS ASSOCIATION

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