**PJC & Associates, Inc.**
*Consulting Engineers & Geologists*

September 21, 2010

Job No. S167.01

Philip Shepherd
4616 Abbott Avenue
Dallas, TX 75205

**Subject:** **Final Report**
**Geotechnical Observation & Density Testing Services**
**New Driveway Improvements**
**12121 Highway 128**
**Calistoga, California**

References:

Report titled, "Geotechnical Investigation, Proposed Private Driveway, 12121 Highway 128, Healdsburg, California," prepared by PJC & Associates, Inc., dated January 23, 2008.

Letter titled, "Geotechnical Plan Review, Proposed Private Driveway, 12121 Highway 128, Healdsburg, California," prepared by PJC & Associates, Inc., dated March 20, 2008.

Letter titled, "Proposed Interceptor Subdrain, Proposed Access Drive, 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated September 25, 2009.

Letter titled, "Proposed Material Substitution, 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated October 30, 2009.

Letter titled, "Driveway Realignment, Improvement Area "A", 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated November 3, 2009.

Letter titled, "Proposed Private Driveway, Improvement Area "B" 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated December 3, 2009.

Letter titled, "Proposed Private Driveway, "Existing Driveway", 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated December 22, 2009.

Letter titled, "Proposed Private Driveway, 12121 Highway 128, Calistoga, California," prepared by PJC & Associates, Inc., dated August 4, 2010.

Grading Plans, Sheets 1 through 15, prepared by Enterra Associates, Inc., dated June 29, 2008.

As-Built Plans, Sheets 1 through 3, prepared by H W B – P L S, INC., dated July 2010.

Dear Philip:

This report presents the results of the geotechnical observation and density testing services provided by PJC & Associates, Inc. (PJC) during the grading for the new driveway improvements located at 12121 Highway 128 in Calistoga, California. Our work was completed in accordance with our agreement and your authorization to proceed with the work. The results of the field density tests are summarized in Table 1. The results of the laboratory density tests are summarized in Table 2. The results of the aggregate baserock laboratory tests for the materials acceptance requirements are summarized in Tables 3 and 4.

## 1. PROJECT DESCRIPTION

The project consisted of improving the sections of the existing driveway for improvement area "A" between Stations 7+00 and 22+75 and improvement area "B" between Stations 30+00 and 33+85. The project also included the construction of a haul road (Stations 50+00 to 58+50) intersecting improvement area "A" at driveway Station 20+00 and extending to the borrow area.

## 2. SCOPE OF WORK

The work described in this report was performed between October 10, 2008 and August 31, 2010. The following scope of services was provided for the project during construction:

a. Observed the keyway excavations for the haul road and improvement area "A".

b. Observed the installation of the keyway subdrains.

c. Observed the installation of the interceptor subdrain for improvement area "A".

d. Observation and field density testing during placement and compaction of engineered fill for the keyways and fill slope areas for the haul road and improvement area "A".

e. Performed field density testing of the roadway subgrade for driveway improvement areas "A", "B" and the haul road.

f. Performed field density testing of the roadway aggregate baserock in driveway improvement areas "A" and "B".

g. Laboratory testing to determine the maximum dry density and optimum moisture content of the soils and aggregate baserock used as engineered fill on site.

h. Observed a proof roll of the driveway and haul road subgrade with fully loaded construction equipment.

i. Observed a proof roll of the driveway aggregate baserock with fully loaded construction equipment.

j. Materials testing for aggregate baserock.

k. Consultations during earthwork construction.

l. Preparation of this report.

Field density test locations were selected on a basis of random sampling and included those areas considered to be initially below average. Field density tests were performed in accordance with ASTM Test Designation D2922-81 and D3017-78 (nuclear methods). The results of the field density tests are summarized in Table 1.

The maximum laboratory dry density and optimum moisture content of the soils were determined in accordance with ASTM D1557. The results of the laboratory compaction tests are summarized in Table 2.

## 4. CONSTRUCTION OBSERVATION SERVICES

The driveway improvements for the subject driveway consisted of upgrading portions of the existing driveway for improvement area "A" and improvement area "B" and the construction of a haul road accessing the borrow area. The above mentioned driveway improvements and haul road were primarily constructed at or near the existing grade. However, a portion of improvement area "A" and portions of the haul road required fills of approximately 10 feet and less to achieve the desired subgrade elevations.

The portions of improvement area "A" addressed in this report included the new fill slope construction north of Stations 7+50 to 8+50 which included cuts of approximately five feet and less and fills of approximately 10 feet and less. Grading for the fill slope consisted of excavating a level keyway at the toe of the slope that extended through any weak soils and into competent bedrock. The exposed surface was scarified to minimum depth of eight inches, moisture conditioned and recompacted until a stable and firm surface was achieved for the placement of engineered fill. A subdrain was installed in the bottom of the keyway and additional subdrains were

installed in the subsequent benches where required. The native on-site soils used as engineered fill for the keyways and benches were moisture conditioned, placed in thin lifts and compacted to at least 90 percent relative compaction to finished subgrade elevations. Furthermore, an interceptor subdrain was installed in the vicinity of Station 10+00.

Grading for the haul road included the construction of new fill slopes west of Stations 50+50 to 53+00 and Stations 56+50 to 58+00. A level keyway that extended through any weak soils and into competent bedrock was subexcavated at the toe of fill slope areas. The exposed surfaces were scarified to minimum depth of eight inches, moisture conditioned and recompacted until a firm and stable surface was achieved for the placement of engineered fill. A subdrain was installed in the bottom of the keyway for the fill slope in the vicinity of Stations 50+50 to 53+00. A keyway subdrain for the fill slope in the vicinity of Stations 56+50 to 58+00 was not required due to the fill slope height of three feet or less. The native on-site soils used as engineered fill for the keyway and subsequent benches were moisture conditioned, placed in thin lifts and compacted to at least 90 percent relative compaction to finished subgrade elevation.

Improvement area "B" was revised and the turnout was removed. Furthermore, the slope failure in area "B" was repaired with the construction of a new retaining wall. However, the existing artificial fill in area "B" was not removed and recompacted as recommended in our geotechnical report.

After the initial grading was completed to achieve the desired subgrade elevations for the above mentioned improvement areas and haul road, the upper eight inches of the driveway and haul road subgrade was scarified, moisture conditioned and compacted to at least 95 percent relative compaction. After preparation of the driveway subgrade, aggregate baserock was moisture conditioned to within two percent of optimum moisture content, placed in thin lifts and compacted to at least 95 percent relative compaction for the driveway improvement areas. We observed a proof roll of the haul road and driveway subgrade and driveway aggregate baserock with fully loaded construction equipment. The haul road and driveway subgrade and the driveway aggregate baserock appeared firm and unyielding.

With the exception of the haul road, PJC did not provide geotechnical observation or density testing for the "existing driveway" portions of the project, utility improvements and backfill or any other grading activities performed at the site not specifically addressed in this report.

## 5. DISCUSSION

Based on the results of our geotechnical observations and testing and the contractor's construction procedures, we judge that the observed site grading was generally completed according to the recommendations of our

geotechnical reports and the minimum requirements of Appendix "J" of the California Building Code (CBC). However, as mentioned in our previous correspondence, the pre-existing artificial fill in improvement area "B" has not been removed and recompacted as recommended in our geotechnical report. It is our understanding that the pre-existing fill slopes have been present for many years and have performed relatively well. However, this does not guarantee future stability. The pre-existing fill slopes are overly steep and will be prone to distress and failure and may require new retaining wall construction and/or slope repairs. Furthermore, the pre-existing cut slopes on the uphill side in and around area "B" are overly steep, but have performed relatively well. However, we noted the presence of new nearly vertical cuts at the toe of the pre-existing cut slopes in some areas. The new cut slopes will have a destabilizing effect on the already overly steep cut slopes. This destabilizing effect will increase the likelihood of distress and failure to the existing cut slopes. Failures of the cut and fill slopes could impact the serviceability of the driveway and may require repair with new retaining wall construction. The owner must understand and accept the potential risk that future costs may be incurred to repair failed slopes. Also, we noted the presence of one foot or less of unengineered fill placed on an unprepared subgrade underlying the existing roadway shoulder in a 100 foot long section in the vicinity of Station 20+50 and Station 21+50 of improvement area "A". The paved roadway of this portion of improvement area "A" was constructed on compacted subgrade and baserock. Therefore, the serviceability of the pavement in this area should not be significantly impacted by the presence of unengineered fill underlying the shoulder of the pavement. However, the pavement will be more susceptible to edge cracking due to potential loss of lateral support from the presence of unengineered fill underlying the shoulder. Therefore, the owner should understand and accept the risk that cracking could develop in the future which may reduce the serviceability life of the pavement. The shoulder will also be more susceptible to sloughing and distress. As previously mentioned, areas in and around improvement area "B" traverse steeply sloping topography and portions of the roadway abut very steep slopes on the downhill side. The roadway in these areas does not have a gravel shoulder. Therefore, the roadway should be evaluated for safety by the project civil engineer. We also noted the presence of significant erosion of the existing aggregate on the haul road. This should be evaluated by the project civil engineer.

As previously mentioned in our correspondence letters dated November 3, 2009 and August 4, 2010, the existing drainage ditches upslope of improvement area "A" are in an overly steep configuration and have experienced slope failures over the past winter. The overly steep slopes will require continued maintenance and should be repaired with a new retaining structure. However, the ditches must be maintained to allow for flow of surface water. Blockage of the drainage ditches could lead to significant erosional failures potentially impacting the serviceability of the roadway.

The results of our materials testing for the aggregate baserock were generally within the contract compliance of the Cal Trans standard specifications. Based on our review of the materials testing, we judge that the aggregate baserock should provide adequate structural support for the pavements.

The presence of our field representative at the site was to provide a continuing source of professional advice, opinions and recommendations based upon the field representative's observations of the contractor's work and did not include any superintending, supervision or direction of the actual work of the contractor or the contractor's workers. No review was made of the adequacy of the contractor's safety measures on or near the site, since working conditions on any construction project are the sole responsibility of the contractor.

We appreciate this opportunity to be of service. If you need clarification of any of the information in this report, please do not hesitate to contact us.

Sincerely,

PJC & Associates, Inc.

Anthony J. DeMartini
Geotechnical Engineer
GE 2750, California


AJD/mf

| Test No. | Date of Test | Approx. Elevation* (feet) | Location$^{\Psi}$ | Field | | Max Lab Dry Density (pcf) | Relative Comp. (%) | Req'd. Comp. (%) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Water Content (%) | Dry Density (pcf) | | | | |
| 1[A] | 8/27/09 | -5.0' | Station:8+10 (2'N) | 12.1 | 122.7 | 133.0 | 92 | 90 | |
| 2[A] | 8/27/09 | -4.0' | Station:8+50 (3'N) | 11.7 | 126.4 | 134.0 | 94 | 90 | |
| 3[A] | 8/28/09 | -4.5' | Station:8+25 (2'N) | 12.4 | 124.3 | 134.0 | 93 | 90 | |
| 4[A] | 8/28/09 | -4.0' | Station:8+45 (3'N) | 12.0 | 122.7 | 134.0 | 92 | 90 | |
| 5[A] | 9/11/09 | -2.5' | Station:8+50 (4'N) | 13.1 | 121.3 | 133.0 | 91 | 90 | |
| 6[A] | 9/11/09 | -2.0' | Station:7+25 (1'N) | 12.7 | 119.9 | 133.0 | 90 | 90 | |
| 7[A] | 9/16/09 | -2.5' | Station:7+90 (3'N) | 14.1 | 125.1 | 134.0 | 93 | 90 | |
| 8[A] | 9/16/09 | -1.0' | Station:8+10 (4'N) | 10.9 | 124.4 | 134.0 | 93 | 90 | |
| 9[A] | 9/16/09 | -1.0' | Station:7+50 (2'N) | 12.5 | 126.6 | 134.0 | 94 | 95 | |
| 10[A] | 9/25/09 | SG | Station:20+25 (3'E) | 12.5 | 119.5 | 126.5 | 96 | 95 | |
| 11[A] | 9/25/09 | SG | Station:18+50 (CL) | 10.5 | 119.2 | 126.5 | 95 | 95 | |
| 12[A] | 9/25/09 | SG | Station:16+00 (4'W) | 10.0 | 128.4 | 134.0 | 96 | 95 | |
| 13[A] | 9/25/09 | SG | Station:13+00 (1'S) | 11.5 | 119.4 | 126.5 | 96 | 95 | |
| 14[A] | 9/25/09 | SG | Station:10+90 (2'N) | 11.0 | 127.6 | 134.0 | 95 | 95 | |
| 15[A] | 9/25/09 | SG | Station:9+50 (2'E) | 11.8 | 119.8 | 126.5 | 96 | 95 | |
| 16[H] | 11/2/09 | -4.5' | Station:51+25 (10'W) | 11.0 | 119.5 | 125.0 | 96 | 90 | |
| 17[H] | 11/2/09 | -4.0' | Station 52+00 (12'W) | 11.7 | 111.6 | 121.0 | 92 | 90 | |
| 18[H] | 11/3/09 | -2.5' | Station:51+40 (7'W) | 12.9 | 105.5 | 117.0 | 90 | 90 | |
| 19[H] | 11/3/09 | -2.5' | Station:52+25 (8'W) | 11.9 | 109.7 | 117.0 | 94 | 90 | |
| 20[H] | 11/4/09 | -1.0' | Station:51+00 (5'W) | 13.4 | 111.7 | 117.0 | 95 | 90 | |
| 21[H] | 11/4/09 | -1.0' | Station:52+00 (6'W) | 14.5 | 111.8 | 117.0 | 96 | 90 | |
| 22[H] | 11/9/09 | -2.0' | Station:57+75 (3'W) | 12.2 | 118.3 | 125.0 | 95 | 90 | |
| 23[H] | 11/9/09 | -2.0' | Station:57+25 (5'W) | 13.1 | 111.3 | 121.0 | 92 | 90 | |
| 24[H] | 11/9/09 | -1.0' | Station:56+50 (6'W) | 11.2 | 114.8 | 117.0 | 98 | 90 | |
| 25[H] | 11/9/09 | -1.0' | Station:57+85 (5'W) | 13.4 | 115.8 | 121.0 | 96 | 90 | |
| 26[H] | 11/9/09 | SG | Station:51+75 (CL) | 12.7 | 119.7 | 125.0 | 96 | 95 | |
| 27[H] | 11/9/09 | SG | Station: 53+55 (2'E) | 12.4 | 116.1 | 121.0 | 96 | 95 | |
| 28[H] | 11/9/09 | SG | Station: 55+35 (3'W) | 12.5 | 119.1 | 125.0 | 95 | 95 | |
| 29[H] | 11/9/09 | SG | Station: 57+75 (1'S) | 12.7 | 120.4 | 125.0 | 96 | 95 | |
| 30[B] | 1/14/10 | SG | Station:33+50 (3'E) | 9.4 | 134.1 | 141.0 | 95 | 95 | |
| 31[B] | 1/14/10 | SG | Station:32+00 (4'E) | 12.2 | 129.7 | 141.0 | 92 | 95 | |
| 32[B] | 1/14/10 | SG | Station:30+40 (2'W) | 14.1 | 131.5 | 141.0 | 93 | 95 | |
| 33[A] | 1/14/10 | AB | Station:21+75 (CL) | 9.4 | 139.7 | 141.0 | 99 | 95 | |
| 34[A] | 1/14/10 | AB | Station:20+00 (1'E) | 8.7 | 138.4 | 141.0 | 98 | 95 | |
| 35[A] | 1/15/10 | AB | Station:19+50 (3'W) | 8.6 | 139.2 | 141.0 | 99 | 95 | |
| 36[A] | 1/15/10 | AB | Station:17+50 (1'W) | 8.1 | 139.1 | 141.0 | 99 | 95 | |
| 37[A] | 1/15/10 | AB | Station:16+25 (4'E) | 8.0 | 139.4 | 141.0 | 99 | 95 | |
| 38[A] | 1/15/10 | AB | Station:14+00 (2'S) | 8.3 | 137.8 | 141.0 | 98 | 95 | |
| 39[A] | 1/15/10 | AB | Station:11+50 (3'E) | 8.5 | 138.8 | 141.0 | 98 | 95 | |
| 40[A] | 1/15/10 | AB | Station:9+50 (4'W) | 8.5 | 139.3 | 141.0 | 99 | 95 | |
| 41[B] | 8/5/10 | AB | Station:33+00 (1'W) | 6.0 | 133.5 | 141.0 | 95 | 95 | |

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**New Driveway Improvements**
**12121 Highway 128**
**Calistoga, California**

**SUMMARY OF FIELD DENSITY TEST RESULTS**

| Project No. | Date | Sheet No. | Table No. |
|---|---|---|---|
| S167.01 | 9/21/10 | 1 of 2 | 1 |

[A] Improvement Area "A", [B] Improvement Area "B", [H] Haul Road
* Elevations referenced from finished subgrade (SG=Subgrade, AB=Aggregate Baserock).
$^{\Psi}$ Locations referenced from Grading Plans, prepared by Enterra Associates, Inc., dated June 29, 2008.

| Test No. | Date of Test | Approx. Elevation* (feet) | Location$^{\Psi}$ | Field | | Max Lab Dry Density (pcf) | Relative Comp. (%) | Req'd. Comp. (%) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Water Content (%) | Dry Density (pcf) | | | | |
| 42[B] | 8/5/10 | AB | Station:32+00 (CL) | 5.7 | 135.4 | 141.0 | 96 | 95 | |
| 43[B] | 8/5/10 | AB | Station:31+25 (2'E) | 6.2 | 135.1 | 141.0 | 96 | 95 | |
| 44[B] | 8/5/10 | AB | Station:30+50 (2'E) | 6.2 | 135.1 | 141.0 | 96 | 95 | |
| 45[A] | 8/7/10 | AB | Station:21+50 (1'W) | 6.0 | 136.7 | 141.0 | 97 | 95 | |
| 46[A] | 8/7/10 | AB | Station:18+60 (3'E) | 5.9 | 134.1 | 141.0 | 95 | 95 | |
| 47[A] | 8/7/10 | AB | Station:16+50 (CL) | 7.1 | 134.3 | 141.0 | 95 | 95 | |
| 48[A] | 8/7/10 | AB | Station:14+75 (4'W) | 6.5 | 135.6 | 141.0 | 96 | 95 | |
| 49[A] | 8/7/10 | AB | Station:12+30 (2'N) | 5.8 | 133.9 | 141.0 | 95 | 95 | |
| 50[A] | 8/7/10 | AB | Station:10+05 (3'S) | 5.9 | 134.4 | 141.0 | 95 | 95 | |
| 51[A] | 8/7/10 | AB | Station:8+10 (2'S) | 6.0 | 135.6 | 141.0 | 96 | 95 | |

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**New Driveway Improvements**
**12121 Highway 128**
**Calistoga, California**

**SUMMARY OF FIELD DENSITY TEST RESULTS**

| Project No. | Date | Sheet No. | Table No. |
|---|---|---|---|
| S167.01 | 9/21/10 | 2 of 2 | 1 |

[A] Improvement Area "A", [B] Improvement Area "B", [H] Haul Road
* Elevations referenced from finished subgrade (SG=Subgrade, AB=Aggregate Baserock).
$^{\Psi}$ Locations referenced from Grading Plans, prepared by Enterra Associates, Inc., dated June 29, 2008.

## TABLE 2
## SUMMARY OF LABORATORY COMPACTION TESTS

| Material No. | Description | Optimum Moisture Content[N] (%) | Maximum Dry Density[N] (pcf) |
|---|---|---|---|
| 1 | Olive Brown Sandy Clay (CH) | 8.0 | 134.0 |
| 2 | Dark Gray Silty Clay (CH) | 8.0 | 133.0 |
| 3 | Pale Brown Sandy Clay (CL) | 9.0 | 126.5 |
| 4 | Grayish Brown Sandy Clay (CL) | 10.0 | 125.0 |
| 5 | Dark Brown Sandy Clay (CL) | 11.5 | 121.0 |
| 6 | Dark Brown Sandy Clay (CL) | 13.0 | 117.0 |
| 7 | Light Gray Sandy Gravel (GW) (Aggregate Baserock) | 5.5 | 141.0 |

[N] Optimum Moisture Content and Maximum Dry Density were determined in accordance with ASTM D 1557 test procedures

**TABLE 3**
**AGGREGATE GRADING REQUIREMENTS**

| Sieve Sizes | Suppliers Provided Materials Testing: Percent Passing 19-mm Maximum | Independent Laboratory Materials Testing: Percent Passing 19-mm Maximum | Operating Range |
|---|---|---|---|
| 1" | 100 | 100 | 100 |
| ¾" | 96.0 | 98.2 | 90-100 |
| #4 | 51.0 | 55.1 | 35-60 |
| #30 | 16.0 | 17.4 | 10-30 |
| #200 | 6.9 | 8.1 | 2-9 |

**TABLE 4**
**QUALITY REQUIREMENTS**

| Test | Supplier Provided Materials Testing | Independent Laboratory Materials Testing | Operating Range | Contract Compliance |
|---|---|---|---|---|
| Resistance (R-value) | 78 | 81 | ---- | 78 Min. |
| Sand Equivalent | 36 | 40 | 25 Min. | 22 Min. |
| Durability Index | 38 | 37 | ---- | 35 Min. |