APPENDIX A-1

Proposed Rockfall Barrier Revised

Project No. 4031-01
June 21, 2012 (revised July 13, 2012)

BoDean Company, Inc.
1060 N. Dutton Avenue
Santa Rosa, California 95401

Attention: Charlie Young

Reference: ***Mark West Mine***
Sonoma County, California

Subject: ***Proposed Rock Fall Barrier***

Dear Mr. Young:

This letter and the attached figure present a proposed rock fall barrier system to be considered for installation below areas of future excavation at the Mark West Quarry site. The rock fall barrier is being proposed in an effort to mitigate the potential for rock fall during the course of excavation at the quarry and to reduce the risk to Porter Creek Road which is located downslope of the proposed quarry expansion area.

The recommendations presented are based on our meetings with you, observation of the surface conditions on the subject slopes above Porter Creek Road, rock fall analysis, and meetings with representatives of Maccaferri, Inc, a rock fall barrier system manufacturer. Based on the results of our review and analysis, we are recommending the installation of a barrier system that is intended to capture individual rocks. The barrier system is not intended to retain accumulated debris or reliably withstand large debris flows.

Project Background

We understand that the proposed expansion of the Mark West Quarry site would include phased excavation over the course of the next two decades. In general, the expansion would involve extending the existing excavation site to the west, generally following the trend of the existing ridgeline. The quarry expansion area is located above the Porter Creek Road alignment. Rock fall barriers are being considered at the site in an attempt to reduce the likelihood of rock fall due to excavation activities on the sloping site from impacting Porter Creek Road.

The approach to the phased excavation will make a significant difference in the likelihood of rock fall generation and the resulting hazard. Based on our conversations with representatives of the Bodean Company, we understand that the excavation will progress westward from the existing quarry pit, with material being removed by pulling it toward the existing excavation. As currently proposed, no operation of excavation equipment is proposed on the existing slope surface above Porter Creek Road. Our opinion is that this approach to the excavation will result in a significant reduction in the rock fall hazard to Porter Creek Road associated with quarry excavation.

However, the proposed excavation approach will still result in disturbance of potentially loose soil and rock at the edge of the excavation, and potential shaking due to blasting. Rock fall barriers will be required to mitigate the hazard to Porter Creek Road at locations below the excavation. We anticipate that the barriers may be installed in a phased approach, ahead of the excavation.

Observation of Site Conditions

A representative of Holdrege & Kull visited the site on May 11, 2012 to observe the surface soil and rock conditions on the slopes above Porter Creek Road and within the proposed excavation area. During our site visit, we were accompanied by Charlie Young of the Bodean Company who assisted us in accessing the steeply sloping areas.

The subject slopes are south facing, with significant vegetative cover in many locations. Vegetation on the slopes varied from thin grasses and surface vegetation, to dense chaparral, to open oak woodlands with significant tree canopy. During our site visit, we observed that the majority of the sloping area displayed significant soil development and accumulated organic material, which was not expected given the steeply sloping nature of the site. Existing cut slopes above the access road in the upper portion of the site revealed that the soil typically consisted of an approximate 12-inch to 17-inch thick horizon of dark brown, loose to medium dense, silty sand with clay and common subangular gravel. Where observed, the soil was underlain by weathered, highly fractured metamorphic rock. The fracture pattern in the weathered rock resulted in subangular to prismatic rock fragments typically ranging from 2 inches to 6 inches in dimension. Photograph 1 shows the soil profile observed in existing access road cuts within the proposed excavation area.

During our site visit, we traversed the slope and observed three locations where broad, seasonal drainage swales had developed, resulting in exposure of underlying weathered rock. These drainage areas appeared to be potential sources of natural rock fall under the current, pre-excavation conditions. In general, these swale areas were thinly vegetated, and contained accumulations of subangular and prismatic, gravel-size rock fragments. Intact, weathered rock outcrop was also observed, generally within the upper portions of these drainage swales. These rock outcrops were considered to be representative of the rock conditions likely to be encountered during future excavation of the shallow materials on the slope which would be a potential source of rock fall. Photographs 2 through 5 depict the drainage swale and rock outcrop conditions.

During our site visit, we also observed the conditions in the lower portion of the slope, as observed from the Porter Creek Road alignment. The western portion of the alignment contains a cut slope revealing weathered, highly fractured rock. This cut slope is outside the area of proposed excavation associated with the mine, but serves as an existing source of rock fall regardless of the quarry operation.

The eastern portion of the Porter Creek Road alignment within the vicinity of the proposed quarry expansion passes below a talus slope with accumulated rock fall debris. We understand that rock falling from this area has historically reached Porter Creek Road on occasion, typically in the form of rock fragments 8 inches or less in dimension. Our observation of the material on the surface of the talus slope indicated that the rock fall in this portion of the site typically consists of subangular gravel-size rock. A few, larger rocks up to an approximate dimension of 12 inches were also observed on the talus slope; however, the majority of the rocks in the lower portions of the slope were 8 inches or less in dimension.

Rock Fall Analysis

Following our site visit, we performed a computer-assisted rock fall analysis to evaluate the energy and potential bounce height expected to occur for rocks inadvertently dislodged from the upper portions of the slope during the course of excavation. The rock fall analysis was performed using the Colorado Rockfall Simulation Program Version 4 (CRSP) developed jointly by the Colorado Department of Transportation, the Colorado Geological Survey, and the Colorado School of Mines. The CRSP software is a useful tool to estimate the probable bounce height and velocity of rocks to facilitate the selection of rock fall protection barriers. CRSP analysis is based on field observations and data collected from studies of past rock fall events. CRSP uses empirically derived relationships for velocity, friction, and slope material properties to model interaction between the falling rock and the slope. Input parameters for CRSP software include the slope profile; surface roughness within each segment of the profile; coefficients defining energy loss during rock impact on the slope; rock size and shape, and the source location of the rock. Several rock fall events are modeled for each slope profile, with random variation of the rock impact angle within limits determined by rock size and the observed slope characteristics.

The rock fall analysis performed should be considered a tool to aid in the evaluation of potential rock energies and the selection of a barrier system. The rock fall analysis is based on several simplifying assumptions, and a cursory evaluation of surface conditions. Although the results of the rock fall analysis are not expected to be accurate in predicting the energy or trajectory of an individual rock fall event, the tool is helpful in establishing a range of probable results. For the purposes of our analysis, we considered the “rolling” of 1,000, 12-inch diameter spherical rocks for each of three modeled profiles. The following paragraphs summarize the parameters used in our rock fall analysis.

Rock Size Determination

Based on our observation of site conditions, particularly the weathered rock outcrop observed in broad intermittent drainage swales at the site and the accumulated talus in the lower portion of the slope, our opinion is that it is most likely that rock fall at the subject site would consist of materials of 8 inches in diameter or less. The largest rocks observed in the accumulated debris are often a good estimate of rock size for the purposes of modeling. We anticipate that most rocks larger than 8 inches would likely break up during the rock fall. For the purposes of our analysis, which was intended to facilitate the selection of an appropriate barrier system based on rock energy, we conservatively elected to consider a nominal 12-inch diameter rock.

Although the rocks observed onsite were typically subangular or prismatic, we conservatively elected to model the rocks at the site as spherical.

Slope Profile

We elected to consider three slope profiles for the purposes of our analysis, generally focusing on areas associated with the broad intermittent drainages anticipated to serve as potential sources for rock fall. Sheet 1 depicts the profiles and their locations.

The geometry of the slope profiles was based on topographic information provided for the quarry by EBA Engineering. The slope profiles considered 25-foot vertical increments, with an estimated base elevation of 872 feet at Porter Creek Road. Profiles A and B extended to the elevation of the existing upper access road near the top of the ridge. Profile C extended up to an irregular rock outcrop area near the proposed limit of future excavation.

Surface Roughness

Surface roughness, as used by CRSP, is a function of the irregularity of the ground surface relative to the selected rock size. Essentially, surface roughness is an estimate of how much the slope angle may vary within a length defined by the radius of the rock. For the purposes of our analysis, we selected surface roughness values ranging from 0.3 (on the relatively clean, soil slopes) to 0.5 (in irregular slope segments associated with rock outcrop and some areas of accumulated talus). For relatively smooth slopes, it is important to recognize that the roughness is governed more by the irregularity of the rock itself than the variability of the slope surface. For this reason, we elected to consider 0.3 as the minimum value for surface roughness, given the subangular nature of the rocks at the site.

Tangential Coefficient

The tangential coefficient is used by the model to estimate friction losses upon impact on the slope and their effect the velocity of the rock. Tangential coefficients are significantly influenced by the presence of vegetation on the slope. We selected tangential coefficients for our analysis based on the suggested values presented in CRSP manuals. Our analysis considered tangential coefficients ranging from 0.6 for soil slopes to 0.8 for talus and weathered rock outcrop.

Normal Coefficient

The normal coefficient represents the rigidity of the slope surface, and is a measure of the change in the velocity normal to the slope after impact. Using the suggested range of values presented in the CRSP manual, we elected to use normal coefficients ranging from 0.12 for soil slopes to 0.20 for talus and weathered rock outcrop.

The results of our CRSP analysis are summarized in the following table. In addition, more detailed information regarding the results of the CRSP analysis is presented in the software summary output reports attached to this letter.

Summary of CRSP Analysis

Analysis Point	Rocks Passing[1] (%)	Mean Bounce Height (feet)	Maximum Bounce Height (feet)	Mean Energy (Kilojoules)	Maximum Energy (Kilojoules)
Profile A, El 1050	100	3.2	10.6	5.1	10.5
Profile A, El. 975	**100**	**2.6**	**9.7**	**4.0**	**8.8**
Profile A, El. 872	96	1.5	6.7	1.8	7.4
Profile B El. 1050	88	3.9	14.1	6.1	11.0
Profile B, El. 875	**88**	**1.6**	**7.9**	**2.8**	**9.1**
Profile B, El. 872	8-	0.6	3.6	1.0	4.4
Profile C, El. 900	100	2.0	8.1	3.4	8.9
Profile C, El. 875	**100**	**1.7**	**7.0**	**2.8**	**7.7**

Notes:
Values in bold are for the approximate proposed barrier location.
1 Number of rocks passing the analysis point in the absence of barriers

The table results indicate that if spherical 12-inch diameter rocks leave the excavation area, the majority would reach the bottom of the slope in the absence of barriers. The majority of rocks are expected to travel close to the surface of the slope, with the vast majority of bounce calculated to be less than 5 feet. However, isolated, or outlier values of bounce heights indicate that, although unlikely, bounce heights in excess of 10 feet may occur.

Conclusions

The following section presents professional opinions based on our site observation and the results of our rock fall analysis.

Our primary concern regarding the project is the increased potential for relatively small dimension rock to be displaced during the course of excavation, and potentially reaching Porter Creek Road. Our site observations indicate that the majority of rock derived from excavation at the edge of the working slope and subject to fall would be relatively small, with dimensions of 8 inches or less. Observation of the rock accumulated near the Porter Creek Road alignment indicates that larger rocks usually break up into smaller fragments during rock fall events. However, because of the steepness and relatively smooth, uniform nature of the slope, we anticipate that even relatively small rocks may reach the Porter Creek Road alignment with significant velocity. Considering the relatively small dimensions of the rock likely to be associated with rock fall, our opinion is the use of relatively light rock fall barrier systems is appropriate for the site.

A secondary hazard associated with the proposed quarry excavation would be the possibility of dislodging a relatively large mass of rock during the course of excavation, potentially resulting in significantly larger dimension rocks. This risk can be mitigated to a very large degree through the approach taken in the quarry excavation. The excavation edge should be advanced from the existing quarry pit area. In addition, the excavation should progress by pulling the material toward the existing quarry pit or access benches. No excavation equipment should be operated on the south-facing slopes above Porter Creek Road. No loose soil or rock should be placed or stockpiled on the south-facing slopes.

A key element in reducing the rock fall hazard to Porter Creek Road is preventing the rock fall from occurring. The proposed rock fall barriers should be considered a backup system. The primary mitigation of rock fall hazard will be the approach taken during excavation. The secondary element to reduce rock fall hazard will be the placement of temporary, removable perimeter fencing near the working edge of the excavation. In general, the temporary fencing consisting of welded wire mesh supported on T-posts or similar materials should be placed within 50 feet of the active excavation. As a minimum, the perimeter fence should extend four feet above the ground surface. It is possible to include the use of filter fabrics or similar materials so that the temporary containment can also function as a part of the site erosion control and storm water pollution prevention. Sheet 1 depicts the perimeter fencing near the proposed excavation limits, which is expected to be the final configuration for the perimeter fencing reached at the end of quarry operations. During the initial stages of excavation expansion, the perimeter fencing would likely be located much further upslope, no further than 50 feet from the active edge of excavation.

The third element to reduce the rock fall hazard to Porter Creek Road is the phased installation of rock fall barriers in the lower portion of the slope. The rock fall barriers are intended to serve as a backup in the event that rock fall occurs despite a careful approach to excavation and the presence of the temporary perimeter fencing. For planning purposes, the suggested rock fall barrier locations are depicted on Sheet 1. Downslope Barrier A is proposed to be constructed near the base of the slope, along the edge of the Porter Creek Road alignment. Construction of post bases and anchors on the talus covered slope in this area may be problematic, and it may be preferable from an installation standpoint to build the barrier along the road shoulder within the County right-of-way if acceptable to Sonoma County. Debris Barrier B is located higher on the slope, above a change in the slope gradient in an effort to capture rocks prior to their rolling off the edge of the steepening slope. The actual locations of the barriers are expected to vary depending on access, site topography, potential foundation conditions, and conflicts with existing vegetation. It may be beneficial to construct the barrier higher on the slope, near the proposed limit of excavation. The selected locations should be reviewed in the field by a representative of Holdrege & Kull prior to installation.

Summary Description of Proposed Rock Fall Barrier

Several options exist for potential rock fall barriers including the construction of rigid retaining structures (e.g., freestanding gravity rock walls, concrete retaining structures, and sabo dams) or the placement of a relatively flexible rock fall barrier. We anticipate that the construction of a flexible rock fall barrier system would be more feasible and cost–effective, particularly when considering the limited site access and the restoration and revegetation efforts that would likely be required if temporary access for heavy construction equipment was created. In addition, significant excavation on the south-facing slopes above Porter Creek Road should be avoided to reduce inadvertent rock fall during construction.

For planning purposes, we recommend that a proprietary, flexible rock fall barrier system be employed at the site. As an example, we have included typical details for a 25 KJ system by Maccaferri which would, in our opinion, be appropriate for use at the site. The barrier is supported on 6-inch diameter posts and includes a cable-supported net structure capable of significant deformation.

For planning purposes, we recommend that the rock fall barrier be constructed to an approximate height of 10 feet. Because of variation in the topography of the slope, we recommend that a split barrier system be considered, focusing on the initial construction of an approximate 350 lineal-foot barrier in the lower portion of the slope adjacent to Porter Creek Road (Barrier A) to accommodate the initial phases of excavation. As quarry excavation progresses, the upslope barrier (Barrier B) would be constructed in phases to an expected build-out length of approximately 1,000 lineal feet, as depicted on Sheet 1. The location of Barrier B is intended to capture rocks above the existing Porter Creek Road cut slope.

If possible, we recommend that downslope Barrier A be constructed adjacent to the Porter Creek Road alignment, within approximately 20 feet of the road shoulder. We have not reviewed the location of the County right-of-way in this location, nor have we discussed the construction of a barrier with County representatives. However, our opinion is that a location in the lower portion of the slope would facilitate construction and future maintenance of the rock fall barrier.

We anticipate that the construction of Barrier B would be performed several years from now to accommodate future phases of excavation. Depending on the rate of quarry expansion, it may be reasonable to construct Barrier B in relatively short phases or increments (e.g., 250 feet of barrier length) as needed to accommodate the advancing quarry excavation. In general, the barrier should be extended by an additional phase of construction once the advancing edge of the excavation extends within 50 feet of the upslope projection of the edge of the barrier. Prior to the construction of Barrier B, we recommend that an engineering review of the performance of Barrier A, as well as the history of rock fall events, if any, be performed in an effort to confirm the appropriateness of the barrier design or explore alternative barrier systems, if appropriate.

It is important to note that the intent of the rock fall barriers is to capture individual rock falls and reduce the likelihood of rocks dislodged or displaced during quarry operations from reaching Porter Creek Road. The proposed rock fall barrier does not provide an improvement to the stability of the existing native slope configuration, nor is it intended to serve as a retaining structure for accumulated debris. Routine maintenance of the barriers would include annual observation and periodic removal of accumulated materials behind the barrier. Large impacts to the barrier may require retensioning of supporting cables, replacement of individual support posts, and the installation of additional or replacement cable anchors.

Limitations

The following limitations apply to the recommendations presented in this letter:

1. Our professional services were performed consistent with the generally accepted geotechnical engineering principles and practices employed in northern California. No warranty is expressed or implied.
2. If changes are made to the nature or design of the project as described in this letter, then the conclusions presented herein should be considered invalid by all parties. Only our firm can determine the validity of the conclusions and recommendations presented in this letter. Therefore, we should be allowed to review all project changes and prepare written responses regarding their impacts on our conclusions. Additional field work and laboratory tests may be required to develop additional recommendations.
3. The conclusions and recommendations presented in this letter are based on site conditions as they existed at the time we performed our observations. We have assumed that the soil conditions observed are generally representative of the subsurface conditions.

H&K appreciates the opportunity to provide services on this project.

Sincerely,

HOLDREGE & KULL

REGISTERED PROFESSIONAL ENGINEER
ROBERT E. FINGERSON
No. 2699
Exp. 12/2013
GEOTECHNICAL
STATE OF CALIFORNIA

Robert Fingerson, G.E. 2699
Senior Geotechnical Engineer

Attachments: Photographs
Sheet 1 – Proposed Rock Fall Barrier

F:\1 Projects\4031 Mark West Quarry\4031 Proposed Rockfall Barrier.doc

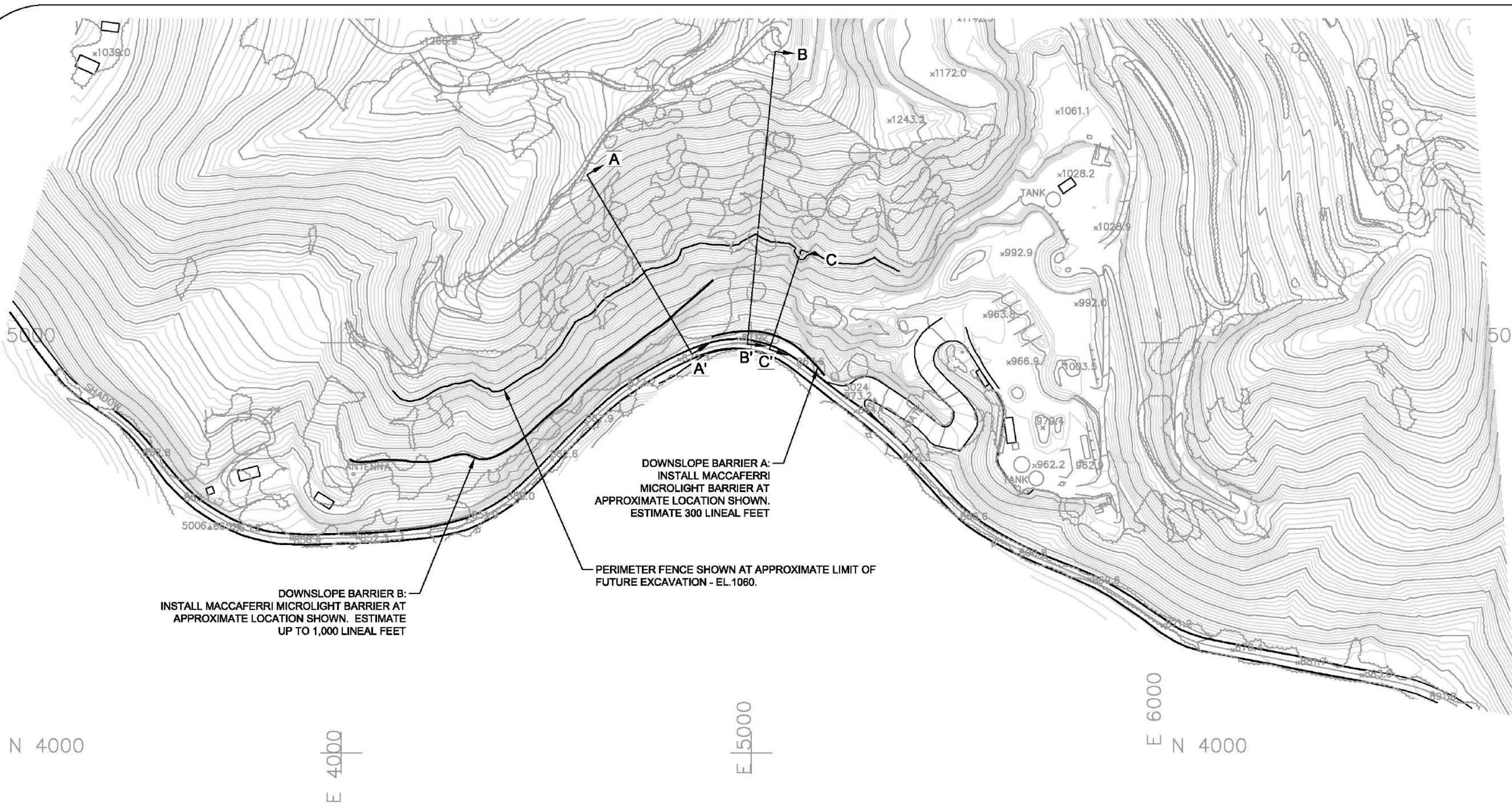
Photograph 1 Typical soil profile revealed in existing access road cut slopes.

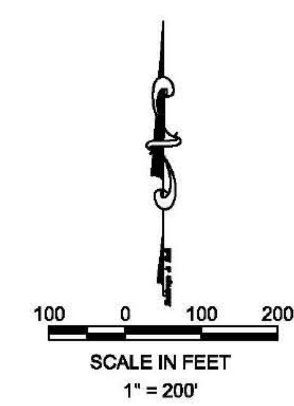
Photograph 2 Typical conditions in broad drainage swale on slope, approximate location of analysis profile 1. Swale surface contains thin vegetation, accumulated gravel-size rock fragments, and isolated areas of weathered rock outcrop.

Photograph 3 Lower portion of slope showing accumulated gravel-size rock fragments and very thin surface vegetation.

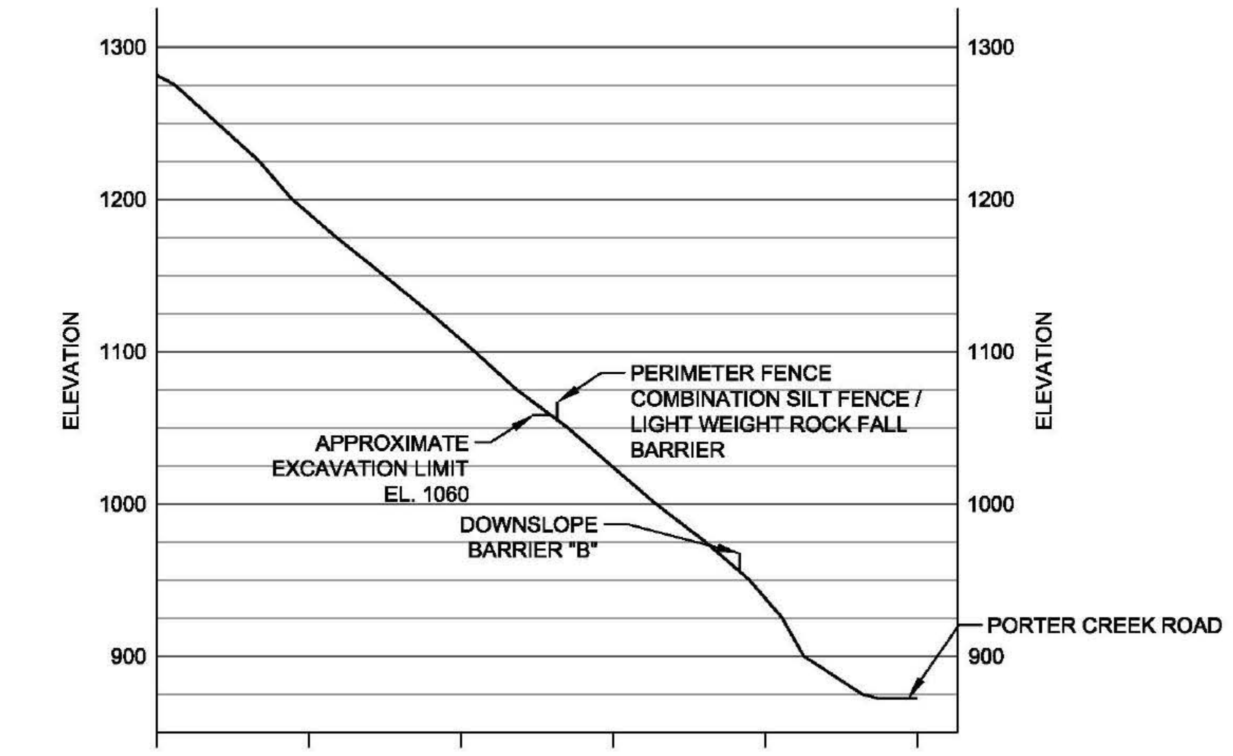
Photograph 4 Typical weathered rock outcrop in upper portions of slope.

Photograph 5 Close up view of typical weathered rock outcrop in the upper portions of the slope. Fracture spacing and orientation appears to result in the majority of rock fragments being 8 inches or less in maximum dimension.

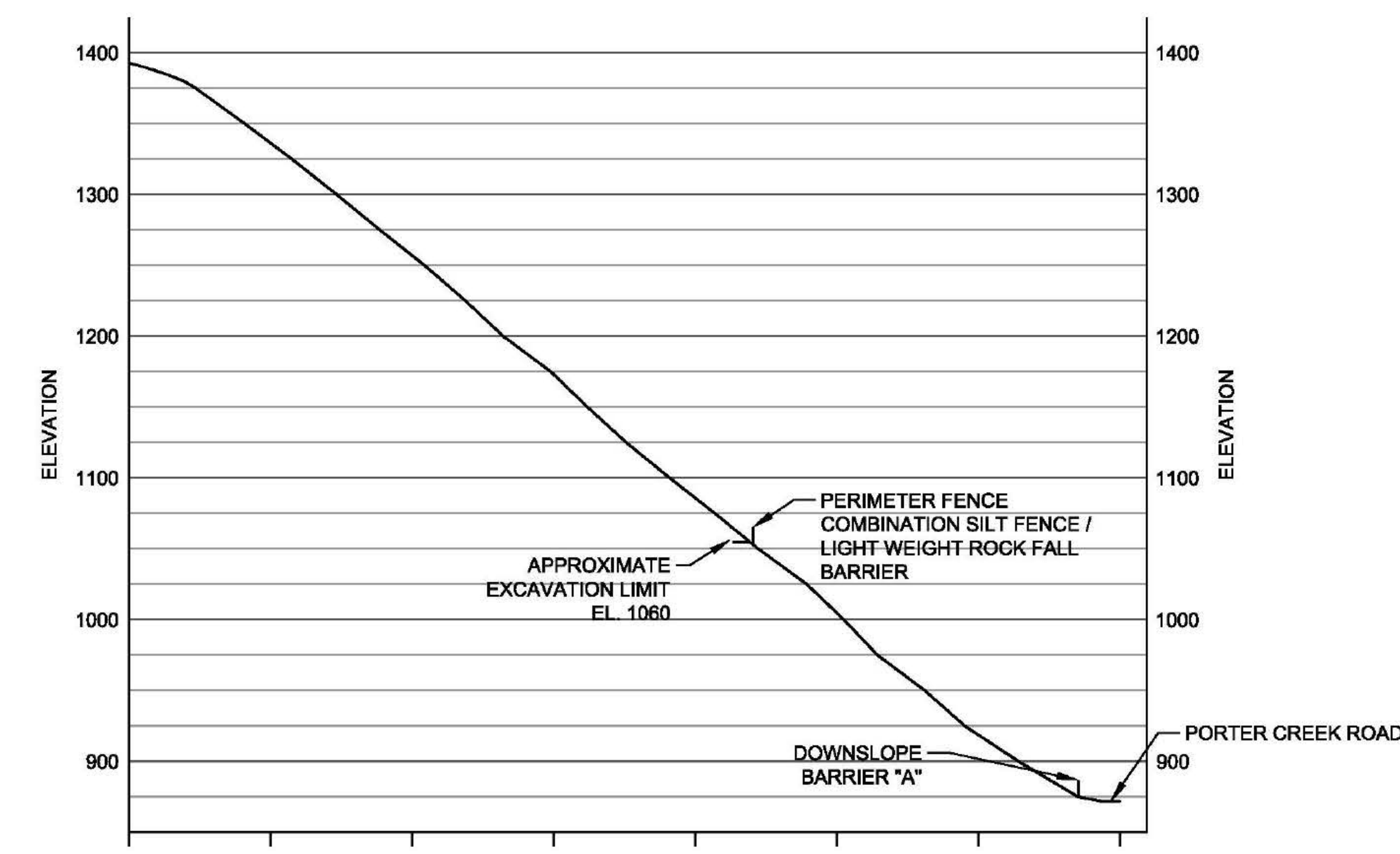




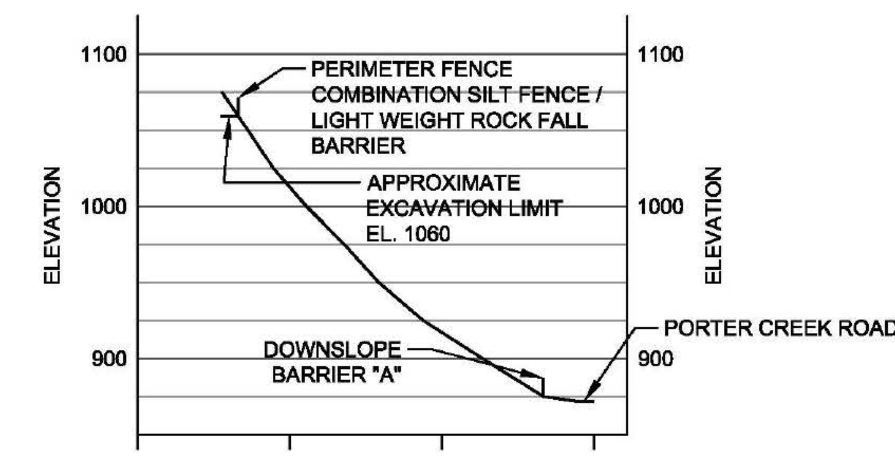
BASE MAP PROVIDED BY:
EBA ENGINEERING
(MAY 2012)



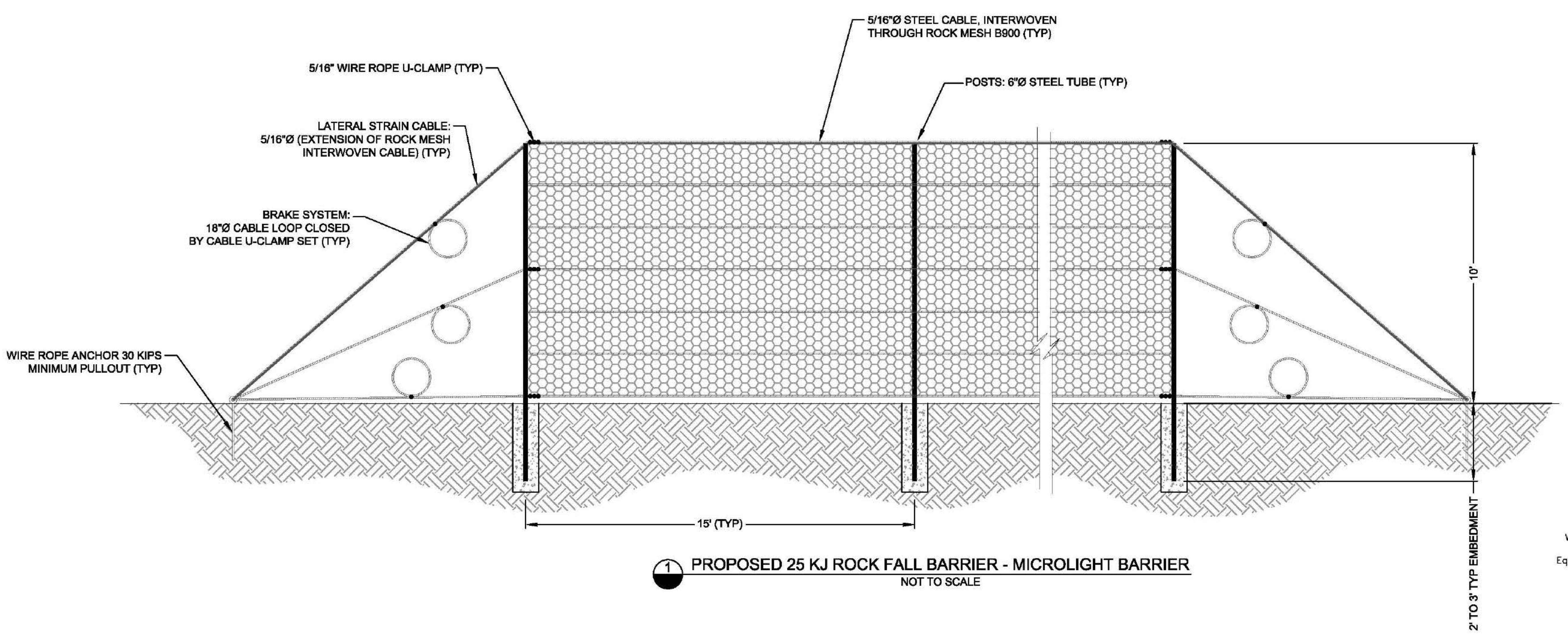
PROFILE A-A'
SCALE: 1 INCH = 100 FEET



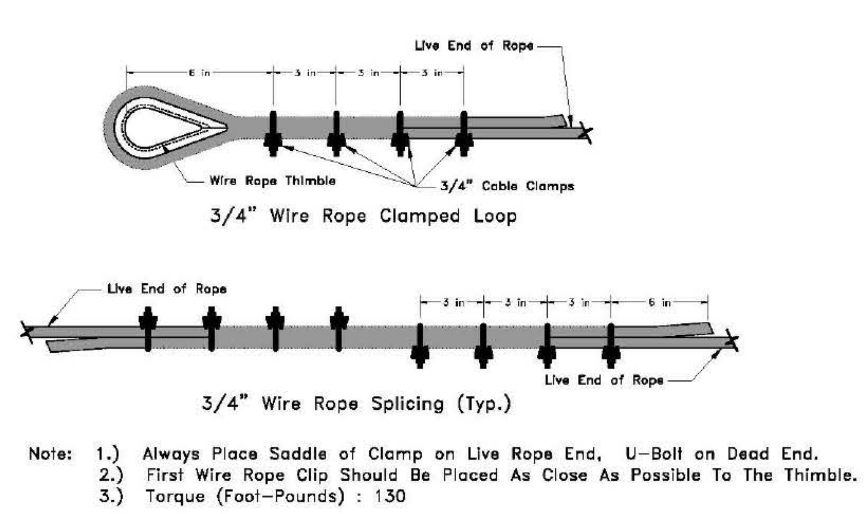
PROFILE B-B'
SCALE: 1 INCH = 100 FEET



PROFILE C-C'
SCALE: 1 INCH = 100 FEET

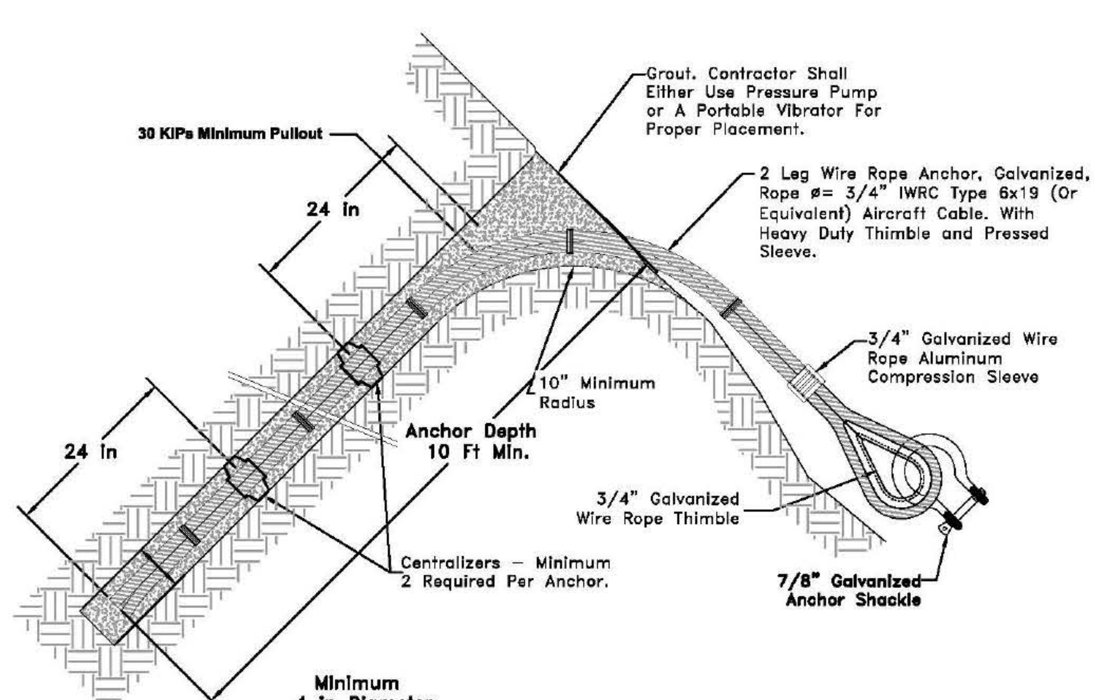


1 PROPOSED 25 KJ ROCK FALL BARRIER - MICROLIGHT BARRIER
NOT TO SCALE

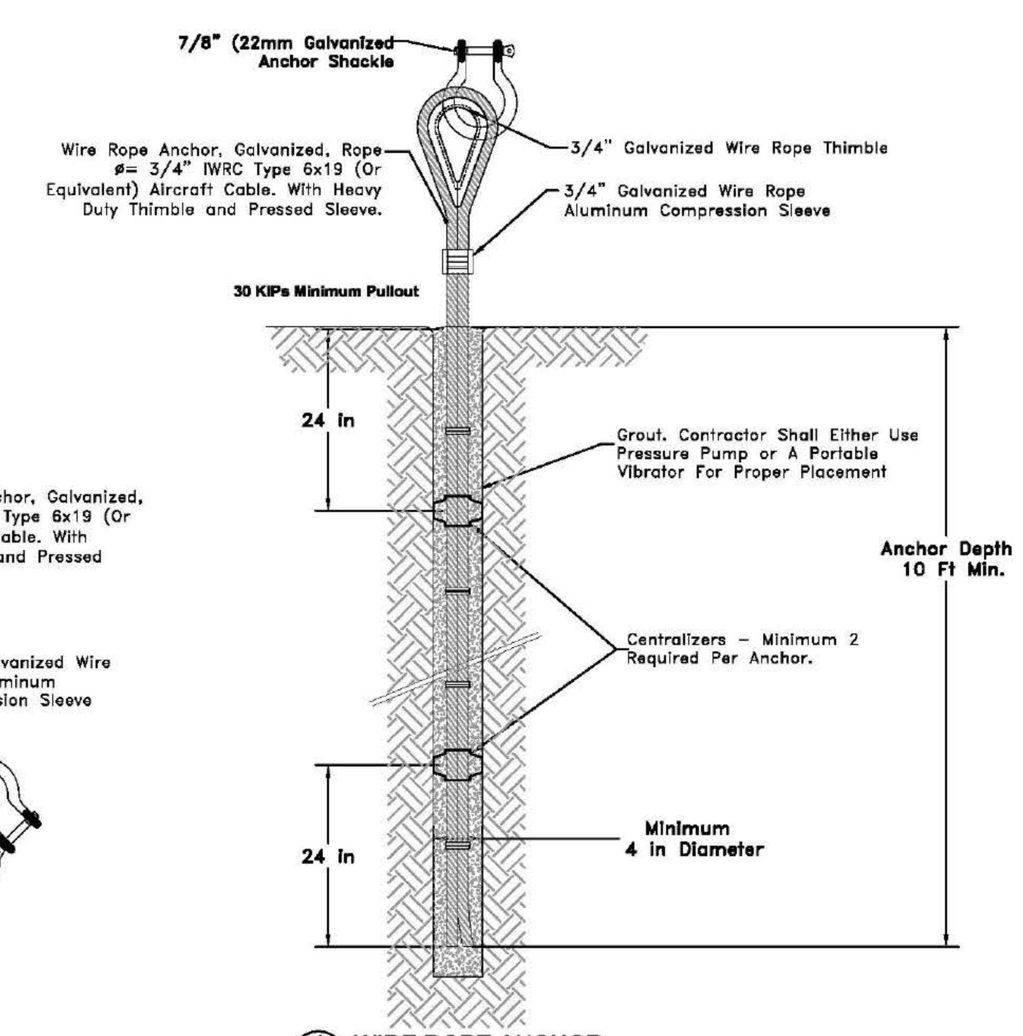


Note: 1.) Always Place Saddle of Clamp on Live Rope End, U-Bolt on Dead End.
2.) First Wire Rope Clip Should Be Placed As Close As Possible To The Thimble.
3.) Torque (Foot-Pounds) : 130

2 WIRE ROPE ENDS AND SPLICED CONNECTIONS
NOT TO SCALE



3 RADIAL WIRE ROPE ANCHOR
- COMPRESSED SLEEVE OPTION -
NOT TO SCALE



4 WIRE ROPE ANCHOR
- COMPRESSED SLEEVE OPTION -
NOT TO SCALE

DATE	DESIGNED BY:	REF
	DRAWN BY:	DFD
	DATE:	JUNE 2012
	DRAWING NAME:	4031-01-SHEET1
	PROJECT No.:	4031-01

NO.	REVISIONS

PROPOSED BARRIER PLAN
MARK WEST QUARRY
SONOMA COUNTY, CALIFORNIA

HK HOLDREGE & KULL
CONSULTING ENGINEERS • GEOLOGISTS
792 SEARLS AVENUE
NEVADA CITY, CA 95959
(530) 478-1305 FAX 478-1019

SHEET 1

APPENDIX A-2

Proposed Rockfall Barrier

Response to Comments

Project No. 4031-01
August 8, 2012

BoDean Company, Inc.
1060 N. Dutton Avenue
Santa Rosa, California 95401

Attention: Charlie Young

Reference: ***Mark West Quarry***
Sonoma County, California

Subject: ***Response to Review Comments***

Dear Mr. Young:

This letter presents Holdrege & Kull's response to review comments regarding the proposed Rock Fall Barrier described in our July 13, 2012 letter. The comments were presented to Holdrege & Kull in an undated correspondence. For reference, we have attached the comment correspondence to this letter.

To facilitate review, we are presenting our responses in the order that the comments were presented.

1. The intent of the proposed rock fall barriers is to eliminate rock fall hazards to the road as a result of routine mining operations. However, because of variability in the rock shapes, sizes, and slope paths, we are unable to state that all rock fall hazard would be eliminated. The design intent is to capture rock fall inadvertently caused by the mining operation. The design approach was based on the calculation of maximum bounce height and energy at the proposed barrier locations by numerical modeling and the selection of barriers which would capture these rocks. The design is intended to provide 100 percent capture of the rock fall incidents (based on calculated bounce heights and energies) revealed by the modeling software. No rock fall or debris volume resulting from the mining is expected to reach Porter Creek Road.

2. The design does not consider slope instability associated with seismic events. The proposed rock fall barriers are intended as a back-up or fail-safe to mitigate the hazard associated with the mining operations above the road. Although the barriers will not differentiate between the sources of rock fall, the proposed barriers are not intended to support large volumes of debris resulting from large scale, natural slope instability. In addition, the barriers are not an element which will improve the stability of the natural slopes. Once built, the presence of the barriers would increase the safety to travelers on Porter Creek Road with regard to naturally occurring rock fall; however, this is a secondary benefit, and not a part of the design intent. We also expect that, as the mining excavation proceeds over the course of the coming decades, the risk of naturally occurring rock fall or debris flow to the road alignment would decrease as a result of the reduction in slope height and the removal of potentially unstable materials.

3. The selected barrier system will possess a minimum energy rating of 25 kJ. In our ongoing discussions with Macafferri, the barrier system manufacturer, it appears that the described barrier would possess an energy rating of 50 kJ. Based on our modeling of rock fall on the slope, a 12-inch diameter, spherical rock traveling from the top of the slope (pre-mining or initial condition) would possess a maximum energy of 9 kJ, with average energies ranging from 2.8 kJ to 4 kJ depending on the fall path. Although the barrier is intended to capture individual rocks rather than debris flows, we estimate that the proposed barrier could accommodate the impact associated with between 0.5 to 1 cubic yards of loose debris containing a mix of loose rock, gravel, and soil. The actual capacity may be much larger, depending on the velocity of the debris flow. Typically, debris resulting from mixed materials is expected to move at a much lower velocity than an individual rock

4. The perimeter fence should be constructed within a maximum of 50 feet of the active edge of mining excavation, as measured on the slope (slope length). The perimeter fence is expected to capture relatively low velocity, rolling or sliding debris that has moved less than 50 feet on the slope, thus insignificant bounce heights are considered. The proposed four-foot fence height is intended to capture rolling or sliding rocks. T-posts are commonly available in light weight and heavy weight designations. We recommend the use of heavy weight T-posts with a nominal weight of 1.25 to 1.33 pounds per lineal foot. The T-Posts should be embedded to a minimum depth of 12 inches where resistant rock is encountered requiring predrilling, or to 24

inches where soil or weathered rock conditions allow driving of the post. The fencing, consisting of nominal 2 x 4 non-climb horse fence of 12 gauge steel or similar material, should be placed on the uphill side of the T-Posts and connected using conventional T-Post clips. A supplemental detail drawing for the proposed perimeter fence is attached.

5. The purpose of the proposed perimeter fence and rock fall barriers is to provide rock fall protection in the event that rock fall is triggered by the mining operation during the 20 year life of the permit. Although we do not know of past rock fall events triggered by excavation during the history of the existing operation, the suggested barriers are a redundant, safety feature in the event occasional rock dislodgements occur as a result of the excavation.

6. We anticipate that the construction of the perimeter fence and barriers would require the creation of trails to provide access for construction personnel and lightweight drilling equipment. Although we are not specifying the means and methods of construction, we anticipate that the construction will be performed using relatively lightweight, hand operated demolition hammers, drills, and limited access drilling equipment. If equipment pads or relatively wide access benches are required, it would be appropriate to install temporary perimeter fences immediately downslope of construction areas through the use of hand tools to reduce the likelihood of dislodging rock. At the contractor's option, it may be appropriate to utilize helicopters to deliver barrier materials to accessible areas on the slope. Furthermore, the statement on Page 7 limiting the operation of excavation equipment on the slopes above the road was intended to address the mining excavation, not to limit the approach to construction of the rock fall barriers.

7. It is important that the barriers not serve as long-term retaining devices holding accumulated cobbles and boulders. We recommend that on an approximate annual basis the barriers be observed by walking the upslope side of the barrier to confirm that significant debris (e.g. individual rocks over approximately 8 inches in size or soil and gravel accumulation over approximately 12 inches in depth) is not resting on the barrier. Small volumes of accumulated debris could be spread on the slope immediately above the barrier through the use of hand tools. Individual small boulders and cobbles should be broken into smaller fragments through the use of hand tools and placed on the slope immediately upslope from the barrier. In

the event that large boulders are retained on the barrier, it may be necessary to utilize hand drills and hydraulic splitting equipment to break the boulders into smaller, angular fragments which are not susceptible to future rolling. Should a significant rock fall event occur, it is conceivable that maintenance may require holding of traffic on Porter Creek Road to allow temporary disconnection of the lower portion of the barrier and removal of rock.

We hope that the statements presented in this letter provide the additional information needed to allow continued review of the project plans. We are also available to discuss the project during future meetings or conference calls if it is convenient for you. Please feel free to contact us with additional questions or comments.

Sincerely,

HOLDREGE & KULL

REGISTERED PROFESSIONAL ENGINEER
ROBERT E. FINGERSON
No. 2699
Exp. 12/13
GEOTECHNICAL
STATE OF CALIFORNIA

Robert Fingerson, G.E. 2699
Senior Geotechnical Engineer

Attachments: Review Comments
Perimeter Fence Details

F:\1 Projects\4031 Mark West Quarry\4031 Response to Comments.doc

1. The H&K report states the barrier design "is being proposed in an *effort* to mitigate the potential for rock fall…" onto Porter Creek Road. The word *effort* is not very definitive for a steep, high rock fall/rock slide prone slope above a narrow, winding, but well travelled County road. Therefore, what were the acceptable-risk assumptions or bases for the performance standards selected when developing the design? Is the barrier design intended to eliminate all rockfall onto the road caused by routine mining operations? If not, what *volume* of rockfall is expected and is it possible to reasonably predict how *often* it would be expected?

2. Seismic effects are not mentioned in the report. Does the design include restraint of dislodged materials from the combination of mining *and* seismic events? The active Maacama Fault is less than 2 miles from the slopes and has a maximum event potential of about 7.2 Mw. One would expect that this could result in displaced rock volumes higher than those associated only with mining activities.

3. Importantly, what amount of instantaneously displaced rock can the barrier design accommodate without failing and releasing rock onto the roadway? This is not commented on in the report. County road maintenance has stated that there have been occasions when one lane was impacted and one instance when both were impacted. This probably translates into a few to perhaps a few tens of cubic yards. Can the design accommodate the high end of this range if instantaneously released?

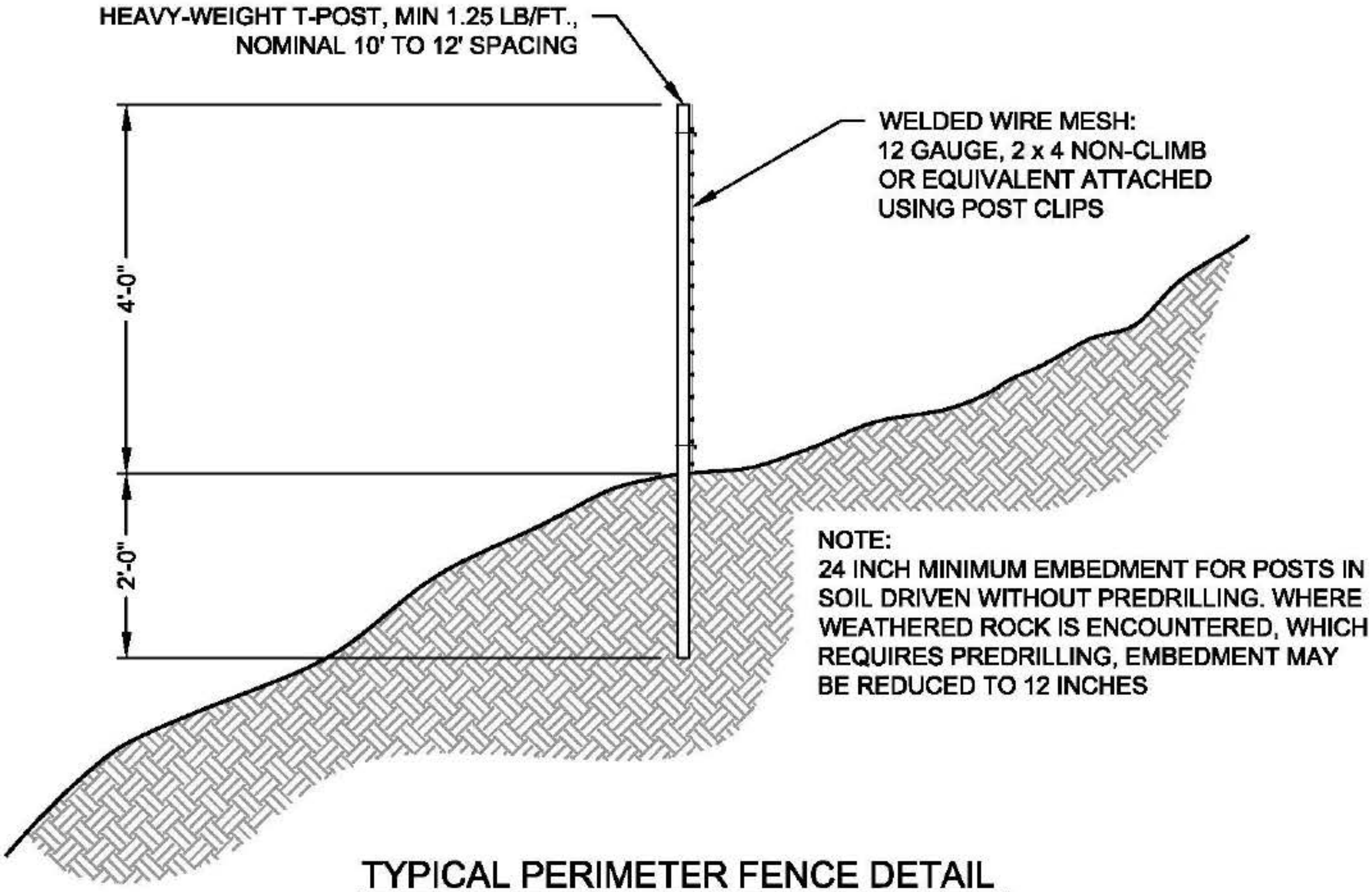
4. The "perimeter fence" needs additional discussion. The report says it will be within 50 feet of the active mining area - does this mean 50 feet on the slope, 50 feet vertical, or 50 feet horizontal? The report says that the fence will be supported by T-posts - how large, how far driven into the earth, how is the wire attached? What is the basis for the recommended minimum four foot height of the fence? Again, what kind of instantaneously imposed load can the fence accommodate without failure. A design drawing and specifications for this fence should be included in the report.

5. While we concur that the method of mining (prevention) is a key element in controlling the rate and volume of rockfall. However, is it safe to assume that proper mining activities will occur at all times during the 20 year life of the permit? The system should be robust enough to accommodate occasional rock dislodgments caused by operational mishap.

6. How will the fence and barrier system be constructed on the predominantly steep to very steep slopes? It would seem that some sort of access road or trail will be required for those components of the system that are well upslope of Porter Creek Road. This particularly seems to be the case when anchors are to be installed 10 feet into slopes with either minimal soil underlain by fractured, but generally hard rock; and with many intervening 6-inch diameter posts on 15-foot centers to be installed into rock to an unspecified depth. What will the dimensions of this trail or road be and how will it be constructed to avoid dislodging rock onto the road? How does this jibe with the statement in paragraph 2 on page 7 that states that no excavation equipment should be operated on the slopes above the road?

7. The report states that rock captured by the barriers will be periodically removed? How will this be accomplished if there is no access road to the fence/barriers? Also, it would seem reasonable to recommend the maintenance should include annual observation more often than just annually, given that the fence/barrier system is not intended to serve as retaining facility.

Adequate responses to these questions will allow us to once more continue our geologic analysis for the EIR.



TYPICAL PERIMETER FENCE DETAIL

NOT TO SCALE

HOLDREGE & KULL
CONSULTING ENGINEERS • GEOLOGISTS
792 SEARLS AVENUE
NEVADA CITY, CA 95959
(530) 478-1305 FAX 478-1019

TYPICAL PERIMETER FENCE

MARK WEST QUARRY

SONOMA COUNTY, CALIFORNIA

DRAWN BY: DFD	CHECKED BY: REF
PROJECT NO.: 4031-01	
DATE: AUGUST 2012	
FIGURE NO.: 1	

APPENDIX A-3

Final Peer Review of Rockfall Barrier

Project No. 4031-01
August 8, 2012

BoDean Company, Inc.
1060 N. Dutton Avenue
Santa Rosa, California 95401

Attention: Charlie Young

Reference: ***Mark West Quarry***
Sonoma County, California

Subject: ***Response to Review Comments***

Dear Mr. Young:

This letter presents Holdrege & Kull's response to review comments regarding the proposed Rock Fall Barrier described in our July 13, 2012 letter. The comments were presented to Holdrege & Kull in an undated correspondence. For reference, we have attached the comment correspondence to this letter.

To facilitate review, we are presenting our responses in the order that the comments were presented.

1. The intent of the proposed rock fall barriers is to eliminate rock fall hazards to the road as a result of routine mining operations. However, because of variability in the rock shapes, sizes, and slope paths, we are unable to state that all rock fall hazard would be eliminated. The design intent is to capture rock fall inadvertently caused by the mining operation. The design approach was based on the calculation of maximum bounce height and energy at the proposed barrier locations by numerical modeling and the selection of barriers which would capture these rocks. The design is intended to provide 100 percent capture of the rock fall incidents (based on calculated bounce heights and energies) revealed by the modeling software. No rock fall or debris volume resulting from the mining is expected to reach Porter Creek Road.

2. The design does not consider slope instability associated with seismic events. The proposed rock fall barriers are intended as a back-up or fail-safe to mitigate the hazard associated with the mining operations above the road. Although the barriers will not differentiate between the sources of rock fall, the proposed barriers are not intended to support large volumes of debris resulting from large scale, natural slope instability. In addition, the barriers are not an element which will improve the stability of the natural slopes. Once built, the presence of the barriers would increase the safety to travelers on Porter Creek Road with regard to naturally occurring rock fall; however, this is a secondary benefit, and not a part of the design intent. We also expect that, as the mining excavation proceeds over the course of the coming decades, the risk of naturally occurring rock fall or debris flow to the road alignment would decrease as a result of the reduction in slope height and the removal of potentially unstable materials.

3. The selected barrier system will possess a minimum energy rating of 25 kJ. In our ongoing discussions with Macafferri, the barrier system manufacturer, it appears that the described barrier would possess an energy rating of 50 kJ. Based on our modeling of rock fall on the slope, a 12-inch diameter, spherical rock traveling from the top of the slope (pre-mining or initial condition) would possess a maximum energy of 9 kJ, with average energies ranging from 2.8 kJ to 4 kJ depending on the fall path. Although the barrier is intended to capture individual rocks rather than debris flows, we estimate that the proposed barrier could accommodate the impact associated with between 0.5 to 1 cubic yards of loose debris containing a mix of loose rock, gravel, and soil. The actual capacity may be much larger, depending on the velocity of the debris flow. Typically, debris resulting from mixed materials is expected to move at a much lower velocity than an individual rock

4. The perimeter fence should be constructed within a maximum of 50 feet of the active edge of mining excavation, as measured on the slope (slope length). The perimeter fence is expected to capture relatively low velocity, rolling or sliding debris that has moved less than 50 feet on the slope, thus insignificant bounce heights are considered. The proposed four-foot fence height is intended to capture rolling or sliding rocks. T-posts are commonly available in light weight and heavy weight designations. We recommend the use of heavy weight T-posts with a nominal weight of 1.25 to 1.33 pounds per lineal foot. The T-Posts should be embedded to a minimum depth of 12 inches where resistant rock is encountered requiring predrilling, or to 24

inches where soil or weathered rock conditions allow driving of the post. The fencing, consisting of nominal 2 x 4 non-climb horse fence of 12 gauge steel or similar material, should be placed on the uphill side of the T-Posts and connected using conventional T-Post clips. A supplemental detail drawing for the proposed perimeter fence is attached.

5. The purpose of the proposed perimeter fence and rock fall barriers is to provide rock fall protection in the event that rock fall is triggered by the mining operation during the 20 year life of the permit. Although we do not know of past rock fall events triggered by excavation during the history of the existing operation, the suggested barriers are a redundant, safety feature in the event occasional rock dislodgements occur as a result of the excavation.

6. We anticipate that the construction of the perimeter fence and barriers would require the creation of trails to provide access for construction personnel and lightweight drilling equipment. Although we are not specifying the means and methods of construction, we anticipate that the construction will be performed using relatively lightweight, hand operated demolition hammers, drills, and limited access drilling equipment. If equipment pads or relatively wide access benches are required, it would be appropriate to install temporary perimeter fences immediately downslope of construction areas through the use of hand tools to reduce the likelihood of dislodging rock. At the contractor's option, it may be appropriate to utilize helicopters to deliver barrier materials to accessible areas on the slope. Furthermore, the statement on Page 7 limiting the operation of excavation equipment on the slopes above the road was intended to address the mining excavation, not to limit the approach to construction of the rock fall barriers.

7. It is important that the barriers not serve as long-term retaining devices holding accumulated cobbles and boulders. We recommend that on an approximate annual basis the barriers be observed by walking the upslope side of the barrier to confirm that significant debris (e.g. individual rocks over approximately 8 inches in size or soil and gravel accumulation over approximately 12 inches in depth) is not resting on the barrier. Small volumes of accumulated debris could be spread on the slope immediately above the barrier through the use of hand tools. Individual small boulders and cobbles should be broken into smaller fragments through the use of hand tools and placed on the slope immediately upslope from the barrier. In

the event that large boulders are retained on the barrier, it may be necessary to utilize hand drills and hydraulic splitting equipment to break the boulders into smaller, angular fragments which are not susceptible to future rolling. Should a significant rock fall event occur, it is conceivable that maintenance may require holding of traffic on Porter Creek Road to allow temporary disconnection of the lower portion of the barrier and removal of rock.

We hope that the statements presented in this letter provide the additional information needed to allow continued review of the project plans. We are also available to discuss the project during future meetings or conference calls if it is convenient for you. Please feel free to contact us with additional questions or comments.

Sincerely,

HOLDREGE & KULL

REGISTERED PROFESSIONAL ENGINEER ROBERT E. FINGERSON No. 2699 Exp. 12/13 ★ GEOTECHNICAL ★ STATE OF CALIFORNIA

Robert Fingerson, G.E. 2699
Senior Geotechnical Engineer

Attachments: Review Comments
Perimeter Fence Details

F:\1 Projects\4031 Mark West Quarry\4031 Response to Comments.doc

1. The H&K report states the barrier design "is being proposed in an *effort* to mitigate the potential for rock fall…" onto Porter Creek Road. The word *effort* is not very definitive for a steep, high rock fall/rock slide prone slope above a narrow, winding, but well travelled County road. Therefore, what were the acceptable-risk assumptions or bases for the performance standards selected when developing the design? Is the barrier design intended to eliminate all rockfall onto the road caused by routine mining operations? If not, what *volume* of rockfall is expected and is it possible to reasonably predict how *often* it would be expected?

2. Seismic effects are not mentioned in the report. Does the design include restraint of dislodged materials from the combination of mining *and* seismic events? The active Maacama Fault is less than 2 miles from the slopes and has a maximum event potential of about 7.2 Mw. One would expect that this could result in displaced rock volumes higher than those associated only with mining activities.

3. Importantly, what amount of instantaneously displaced rock can the barrier design accommodate without failing and releasing rock onto the roadway? This is not commented on in the report. County road maintenance has stated that there have been occasions when one lane was impacted and one instance when both were impacted. This probably translates into a few to perhaps a few tens of cubic yards. Can the design accommodate the high end of this range if instantaneously released?

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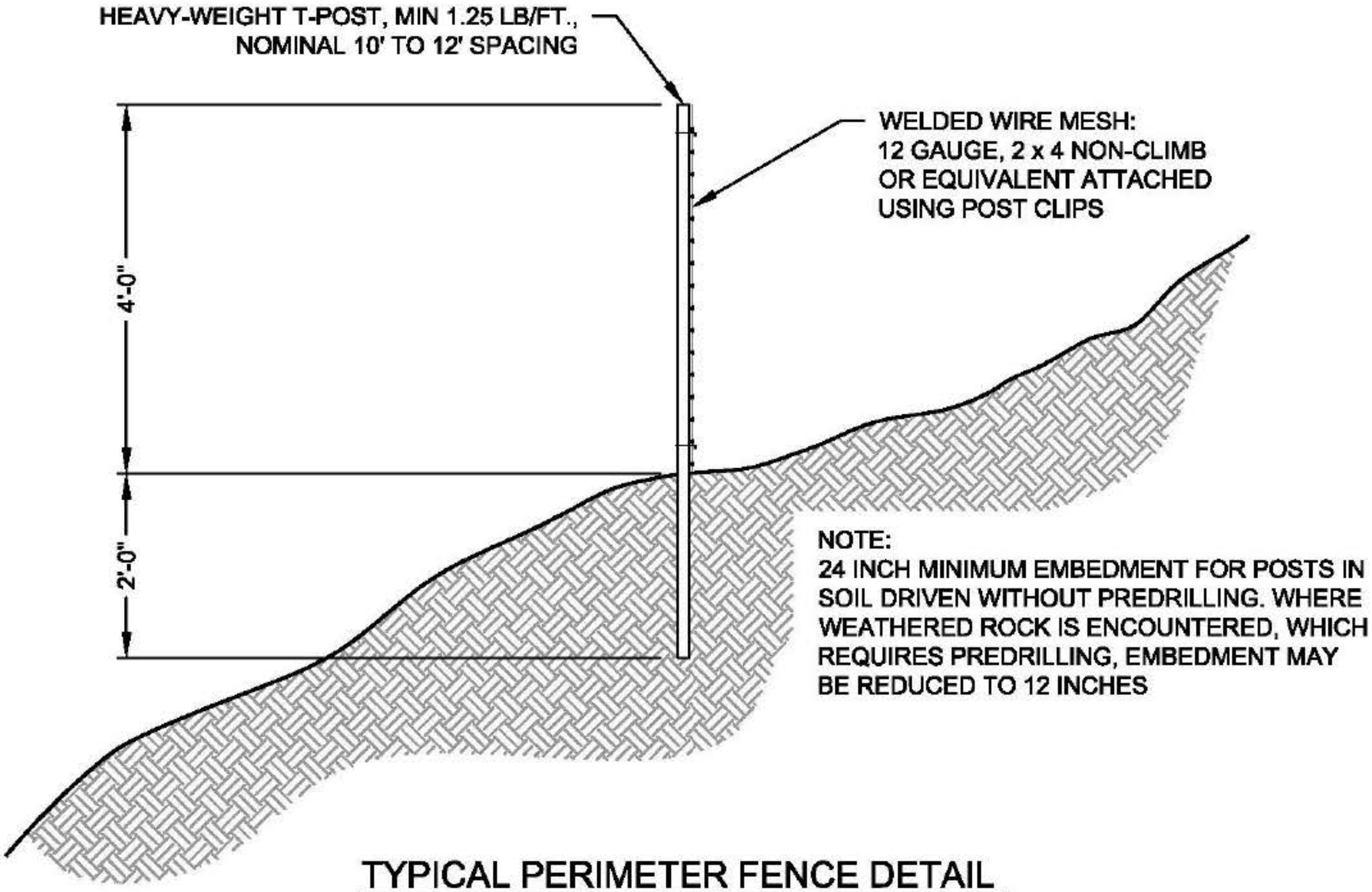

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TYPICAL PERIMETER FENCE

MARK WEST QUARRY

SONOMA COUNTY, CALIFORNIA

DRAWN BY: DFD	CHECKED BY: REF
PROJECT NO.: 4031-01	
DATE: AUGUST 2012	
FIGURE NO.: 1	

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APPENDIX B

Reclamation Plan

RECLAMATION PLAN

Plan Organization

This Reclamation Plan provides an overview of reclamation activities and specific reclamation descriptions organized around the "Reclamation Plan Review Checklist" of the California Department of Conservation's Office of Mine Reclamation (OMR), as referenced in Sonoma County's Surface Mining and Reclamation Ordinance # 5165.

This Reclamation Plan reflects the requirements associated with the reclamation of mined sites contained in the following:

- California Surface Mining and Reclamation Act (SMARA) of 1975 as amended and associated regulations (Revised July 2003).
- Sonoma County Surface Mining and Reclamation Ordinance # 5165, Sec. 26A-11-010: Item (c).

Area Covered Under Reclamation Plan

This Reclamation Plan covers all aspects of the existing and expanded mining areas, and the existing plant site (see Exhibit 8 [DEIR Fig 3-5}): Mining Plan and Setbacks for mining area).

Reclamation Overview

<u>Reclaimed Landscapes</u>

Mining and reclamation activities will be involved in creating five general landscapes. These are:

<u>Mined Rock Terraced Slopes</u>: Exposed terraced slopes with a gradient not steeper than 1:1 (horizontal: vertical) will be created directly through mining activities (see Exhibit G-2 {DEIR Fig 3-14}: Finish Grading Plan). Exposed slopes will be hydroseeded with a native herbaceous plant mixture suitable for erosion control and for colonizing in relatively thin or rocky soils and rock outcrop conditions.

<u>Filled Terraced Slopes</u>: Exposed terraced slopes with a gradient not steeper than 2:1 (horizontal: vertical) overall will be created directly through placement of overburden materials and topsoil (see Exhibit G-2 {DEIR Fig 3-14}): Finished Grading Plan). A minimum one foot of topsoil will be placed on all fill slopes that will then be hydroseeded with a native erosion control mixture of grasses and other herbaceous species.

<u>Filled Basin Floor</u>: An area where mined lands will be backfilled to create slopes on the south side of the basin that can be planted and a gently sloping center area culminating in two water storage / sediment separation ponds with an approximate maximum storage capacity of 25 and 49-acre-feet of water respectively. Planned slopes will vary from approximately a 3: 1 (horizontal:vertical) gradient on the south slopes of the basin to a relatively flat approximately 10:1 (horizontal:vertical) gradient that will support establishment of a willow thicket along the basin's drainage courses. Average depths of fill over the center of the mined basin floor are expected to be up to approximately 75 feet. The majority of runoff from the rock terraced slopes will be directed into the two ponds. A sub-surface drainage system , if necessary, will be installed to manage groundwater accumulation. The revegetation will consist of a native erosion control mix that would be suitable for future conversion to agricultural uses and willows along the drainage courses and around the ponds. Along the southern perimeter of the mined lands, woody vegetation will either be transplanted or planted as container stock to screen and soften the appearance of the new ridgeline created by mining as seen from Porter Creek Road.

To maintain the quality of water flowing into water storage ponds and out of the site, a series of sediment filter systems will be installed. These consist of sediment basins: (1) at the top of a drainage channel to intercept water draining from the mined rock terraced slopes prior to it flowing off-site or entering the ponds; (2) new sediment control / storm water discharge separation tank systems below each pond; and (3) the existing on-site sediment separation control features that ultimately drain into Porter Creek. Limited use of willow thickets along the drainages will also assist in controlling erosion. New on-site sediment control features will be installed for that portion of the reclaimed lands draining to the southwest of the project site.

Re-contoured Overburden Placement Area : The existing overburden placement area, as materials are relocated for reclamation elsewhere on site, will be recontoured to slopes that will generally be less than a 4:1 (horizontal: vertical). The revegetation will be to grasslands suitable for future conversion to agricultural uses.

Plant Site: The existing plant site will be expanded to approximately 10 acres. After mining is completed, the site will be cleared, ripped, and hydroseeded with an erosion control mix. A portion of the plant site will be reserved for later conversion to a general use area that will support agricultural operations.

In addition, a forest screening plant program will be initiated upon commencement of the mining permit (see Exhibit 9 {DEIR Fig 3-11}): Reclamation Plan - Revegetation) in the northeast portion of the project site. Plant types, densities, planting methods, and success criteria for different plant associations are provided in Tables 3, 4 and 5 below.

Overburden and Topsoil

Approximately 1,453,000 cubic yards of overburden and topsoil will be displaced by mining activities. Combined with existing stockpiled materials (see Exhibit 9 {DEIR Fig 3-11}) most of these materials will ultimately be placed in the mined basin floor and to backfill already mined lands within the project area to the north that will be reclaimed to shallow gradients (see Exhibit G-1 and Exhibit G-2 {DEIR Fig 3-12 and Fig. 3-14}).

Lands Included in Reclamation Plan

Exhibit 2 (DEIR Fig 3-3): Ownership illustrates parcels and owners within and adjacent to the project site.

Reclamation Sequencing

Reclamation will occur concurrently with mining activities. Exhibits 11, 12, 13, and 14 (DEIR Fig 3-7, 3-8, 3-9 and 3-10) illustrate the general direction of mining and reclamation through the project site. The steps illustrated in the exhibits and the associated reclamation activities are outlined in Table 3.

TABLE 3: Reclamation Sequence (also see Exhibits 12 through 14 {DEIR Fig. 3-8 through Fig. 3-10})

Reclamation Phase / Timing	Reclamation Activities
Step 1 • see Exhibit 12 (DEIR Fig 3-8) • Dry Season (May 1 through October 15) from approximately 2010 through approximately 2017	• Continued mining to the west (all year as weather permits) • Concurrent reclamation of terraced fill slopes to east • Construction of mitigation wetlands along eastern portion of lease area (see Exhibits 9 and 12 {(DEIR Fig 3-11 and 3-8}) • If required, seed collection for propagation of Napa false indigo (*Amorpha californica* var. *napensis* and any other special status species) and potentially initiating a transplanting program into area designated • Annual mitigation monitoring activities related to constructed wetlands and Napa false indigo • Construction of rock a catchment barrier / fencing adjacent to Porter Creek Road • Clearing and placement of topsoil and overburden from the Step 1 mining area into active reclamation areas or indicated overburden stockpile area to initiate expanded mining activities • Construction of mined basin sub-surface drain line • Interim hydroseeding/mulching of disturbed slopes and stockpiled materials per Reclamation Plan • Annual planting, irrigation, and plant maintenance programs • Inspections to determine the effectiveness of erosion control measures after first heavy rains of the season and monthly or as necessary during the rainy season • Annual reporting and inspections • Slope stability investigation report (2011 - year 2)
Step 2 • see Exhibit 13 (DEIR Fig 3-9) • Dry Season (May 1 through October 15) from approximately 2017 through 2023	• Continued mining to the west (all year as weather permits) • Concurrent reclamation of cut rock slopes, fill terraced slopes, and filled basin floor • Relocation of stockpiled materials for use in recontouring of completed terraced slopes and mined basin floor • Construction of sediment ponds, eastern water-storage ' sediment pond, and sediment control / storm water discharge separation tank systems • Extension of mined basin sub-surface drain line • Construction of maintenance access routes • Interim hydroseeding/mulching of east slopes and stockpiled materials per Reclamation Plan • Propagule collection for willow thicket plantings • Annual planting, irrigation, and plant maintenance programs • Inspections to determine the effectiveness of erosion control measures after first heavy rains of the season and monthly or as necessary during the rainy season • Annual reporting and inspections
Step 3 • see Exhibit 14 (DEIR Fig 3-10) • Dry Season (May	• Continued mining to the west (all year as weather permits) • Concurrent reclamation of cut rock slopes, fill terraced slopes, and filled basin floor • Construction / expansion of water storage / sediment ponds, and

1 through October 15) from approximately 2023 through 2030	sediment control / storm water discharge separation tank systems • Extension of mined basin sub-surface drain line • Construction of maintenance access routes • Propagule collection for willow thicket plantings • Interim hydroseeding/mulching of east slopes and stockpiled materials per Reclamation Plan • Annual planting, irrigation, and plant maintenance programs • Inspections to determine the effectiveness of erosion control measures after first heavy rains of the season and monthly or as necessary during the rainy season -
Step 4 • see Exhibit 9 (DEIR Fig 3-11) • Dry Season (May 1 through October 15) from approximately 2030 through 2033	• Upon completion of mining: - Removal of all structures and facilities except property line fencing, entrance gate and road, wells, sediment basins, water storage ponds, and drainage facilities, and existing cave. - Regrading, ripping and disking plant site - Hydroseeding/mulching all remaining disturbed lands per Reclamation Plan • Final planting, irrigation, and plant maintenance programs • Inspections to determine the effectiveness of erosion control measures after first heavy rains of the season and monthly or as necessary during the rainy season • Annual reporting and inspections (for 3 year period)

Revegetation Program

The following tables describe the revegetation program for disturbed lands as shown on Exhibit 9 (DEIR Fig 3-11): Reclamation Plan - Revegetation. These include:

- Table 4: Hydroseed Mix — specifying two native erosion control seed mixes and application rates to be hydroseeded on all disturbed lands.
- Table 5: Container Plants by Location — identifying the woody species to be planted (or transplanted) for each of the plant associations illustrated on Exhibit 9 (DEIR Fig 3-11).
- Table 6: Planting Schedule — identifying the woody species, density, propagule type of planting (cutting, container, transplant, etc.) spacing, and design notes for each of the plant associations illustrated on Exhibit 9 (DEIR Fig 3-11).

TABLE 4: Native Hydroseed Mix

SEED MIX A – Mined Rock Terrace Benches			
% of mix	species		PLS Pounds/acre
30%	*Bromus carinatus* (1)	California bromegrass (3)	15
37%	*Elymus glaucus* (1)	blue wild rye	18.5
3%	*Eschscholzia californica*	California Poppy	1.5
20%	*Nassella pulchra* (1)	purple needle grass	10
10%	*Trifolium willdenovii* (2)	tomcat clover	5
100%			**50**

SEED MIX B – Fill Slopes and Mined Basin Floor			
% of mix	species		PLS Pounds/acre
37%	*Elymus glaucus* (1)	blue wild rye	18.5
3%	*Eschscholzia californica*	California Poppy	1.5
13%	*Festuca rubra* (molate)	Molate red fescue	6.5
37%	*Hordeum brachyantherum* (1)	meadow barley	18.5
10%	*Trifolium wildenovii* (2)	tomcat clover	5
100%			**50**

Source: 2M Associates

Notes:
PLS = (pounds of pure live seed (PLS)
(1) coastal variety only
(2) pre-inoculated
(3) not 'Cucamonga' brome

Product Notes:

A. Straw: Certified weed free rice straw.
B. Hydromulch: Natural wood fiber (example: Conwed Fibers Hydromulch 1000).
C. Tachifier: Derived from guar of psillium seed (example: M-Binder).
D. Water: Clean and free of deleterious materials.
E. Inoculum: AM-120 (or equal) containing one or more species of mycorrhizal fungi at a minimum rate of 60 pounds per acre.
F. Fertilizer: No fertilizer is to be added.

TABLE 5: Container / Transplanted Plants by Location

PLANT		LOCATION		
Common Name	**Scientific Name**	**Drainages in Basin Floor**	**Northeast Screening Area**	**Mined Basin South Edge Screening**
14-inch Treepot™				
Coast live oak	*Quercus agrifolia*			X
Douglas fir	*Pseudotsuga menziesii*		X	X
Coastal Redwood	*Sequoia sempervirens*		X	
California bay	*Umbellularia californica*		X	
10-inch Deepot™				
Manzanita	*Arctostaphylos manzanita*			X
Coyote brush	*Baccharis pilularis*			X
Buckbrush	*Ceanothus cuneatus*			X
Parry Ceanothus	*Ceanothus parryi*			X
3 Ft. Sprigs				
Arroyo willow	*Salix lasiolepis*	X		
Narrow-leaved willow	*Salix exigua*	X		
Red willow	*Salix lucida*	X		
Freemont Cottonwood	*Populus fremontii* ssp *fremontii*			

Source: 2M Associates

* See also Exhibit 9 (DEIR Fig 3-11): Reclamation Plan - Revegetation and Table 5.

Table 6: Planting Schedule*

Scientific Name	Common Name	% within Total Planted Area	Propagule Type	Size	Spacing	Notes
Willow Thicket						
Salix lasiolepis	Arroyo willow	33.3 %	cuttings	sprig	8' o.c.	Plant in groups of 3 with each group spaced at an average 10' apart
Salix exigua	Narrow-leaved willow	33.3 %	cuttings	sprig	8' o.c.	Plant in groups of 3 with each group spaced at an average 10' apart
Salix lucida	Red willow	33.3 %	cuttings	sprig	8' o.c.	Plant in groups of 3 with each group spaced at an average 10' apart
Mixed Woodland / Screening						
Quercus agrifolia	Coast live oak	10%	container	*14" Treepot*	30' o.c.	Plant randomly
Pseudotsuga menziesii	Douglas fir	20 %	container	*14" Treepot*	20' o.c.	Plant randomly
Umbellularia californica	California bay	20 %	container	*14" Treepot*	15' o.c.	Plant randomly at 50' apart average
Arctostaphylos manzanita	Manzanita	10 %	container	*10" Deepot*	8' o.c.	
Baccharis pilularis	Coyote brush	10 %	container	*10" Deepot*	8' o.c.	
Ceanothus cuneatus	Buckbrush	5 %	container	*10" Deepot*	5' o.c.	
Ceanothus parryi	Parry Ceanothus	5 %	container	*10" Deepot*	5' o.c.	
Mixed Coniferous Forest / Screening						
Pseudotsuga menziesii	Douglas fir	70 %	container	*14" Treepot*	20' o.c.	
Sequoia sempervirens	Coastal Redwood	30 %	container	*14" Treepot*	20' o.c.	

Source: 2M Associates

* See also Exhibit 9 (DEIR Fig 3-11): Reclamation Plan - Revegetation

Planting Notes:

A. Plant Materials Source: The geographical source of all plant propagules shall be Sonoma County within the Mark West watershed.

B. Plant Propagation and Growth:

1. Tree species – Trees shall be grown from seed. All tree species shall be grown in 14-inch deep Treepots™ for at least nine months, shall have root systems which fill the containers but which are not root bound, and roots shall show active white growing tips. The minimum stem caliper of the main trunk shall be 0.2 inches at one inch above the crown. Tops shall be at least 6 inches tall and have healthy live buds and/or leaves, with no broken leaders.
2. Shrub and vine species – Shrubs and vines shall be grown from seeds or cuttings, except elderberry that shall be grown from seed. Shrubs and vines shall be grown in 10-inch deep Deepots™ for at least nine months, shall have root systems which fill the containers but which are not root bound, and roots shall show active white growing tips. The minimum stem caliper of the main trunk of elderberries shall be 0.2 inches at one inch above the root crown. All other species shall either have a similar caliper or have sufficient number of stems of a sufficient size to be equivalent to a 0.2 caliper single stem.
3. Plants shall show no signs of deleterious infection from bacteria, fungus, or insects. Plants showing signs of deleterious infection shall be rejected and placed back on the delivery truck for return to the nursery.
4. Willow Sprigs shall be local native sprigs. Sprigs shall be cut clean with sharp hand saws. Branches shall be pruned off with sharp shears close to the main stem of the sprig but just outside the branch collar. Sprigs with swelling, scar tissue, boring insects, or disease shall be rejected. Sprigs shall be cut from live healthy vigorously growing shrubs or trees. The bottom end of the sprig shall be cut at a 45 degree angle (approximately) and the top shall be cut flat, straight across (90 degrees to the length of the sprig). No more than 50% of an existing willow clump or cottonwood stand shall be removed for sprigs, unless the plants are scheduled to be destroyed by grading. No collection of sprigs shall be from within 20 feet of an active bird nest.
5.. Fascines, if required for erosion control, shall be made by forming the bundles 8-15 feet long, 4 inches minimum in diameter, from stems no more than 1 inch in diameter. Fascines should be overlapped at the tapered ends a minimum of 1-foot.

A. Related Products:
   1. Vispore™, WeedBlock™, or approved equivalent-type degradable 3-foot weed mats and 6-inch metal staples will be used round all container plants. Weed mats shall be UV-stabilized 2.5 mil thick black polyethylene with approximately 400 heat-molded micro-funnels per square inch.
   2. Seedling protectors will be used round all container plants and shall be photo-degradable rigid diamond mesh plastic protectors 36 inches tall and 4 inches wide or wider supported by two 4-foot long 7/16-inch diameter bamboo stakes.
   3. Mycorrhizal inoculant packs will be used for each plant and shall contain one or more species of endo-mycorrhizal inoculum including *Glomus intraradices* at a minimum of 100 propagules per pack and a suite of the follow ectomyhccorrhizal species: *Pisolithus tinctorius* and four species of *Rhizopogon* & *Scleroderma* at a minimum quantity of 800,000 spores.

B. Scheduling:
   1. Willow sprigs shall be installed between December 1 and January 15.
   2. Container-grown plants shall be installed between December 1 and January 15.
   3. Weed mats shall be installed between November 1 and March 31.
   4. Plant protectors shall be installed before April 15.
   5. If needed, replacement planting will be performed between November 1 and January 15.

SURFACE MINING AND RECLAMATION ACT CHECKLIST

SMARA 2772(c)(1) Name and address of operator/agent.

Project: Mark West Quarry Expansion
Location: 4611 Porter Creek Road (also see Exhibit 1: Regional Location **{this exhibit is part of the project application on file with the PRMD}**
Owner: BoDean Co., Inc.
Address: 1060 N. Dutton Ave., Santa Rosa, CA 95401-5038

Mining Operations and Closure

SMARA 2770.5 100-year flood, Caltrans contact.

The project site is located in the Porter Creek and Franz Creek watersheds. The entire project site is located outside of the 100-year floodplain of these creeks.

SMARA 2772(c)(2) Quantity & type of minerals to be mined.

Mining will produce up to approximately 15,000,000 tons of Greenstone-related aggregate materials over the life of the project (see Appendix A: Geologic & Geotechnical Report) **All Appendices for this report are on file with the PRMD**.

SMARA 2772(c)(3) Initiation and termination date.

Based on the estimate of reserves available and the assumption that 750,000 tons of material per year would be processed, mining would be completed in approximately 2030 (assuming a start date of 2010 and maximum production each year). Reclamation activities are currently underway. Future reclamation will be conducted concurrently with mining activities (see Exhibits 12 through 14 {DEIR Figs 3-8 through 3-10}). Final reclamation activities are expected to be completed within 3 years after mining ceases. Monitoring of revegetated areas will extend for a period of 3 to 5 years. Reclamation is expected to be completed by about 2033, based on previously mentioned assumptions.

SMARA 2772(c)(4) Maximum anticipated depth of mining.

Mining will be conducted below final mined floor elevations The mining elevations will range from approximately 1407 feet to 945 feet MSL (see Exhibit G-1 and G3 {DEIR Figs 3-12 and 3-13}). It is possible that mining count extend down to 900 feet MSL. The finished mined floor elevations will range from approximately 975 feet to 945 feet MSL (see Exhibit G-2 {DEIR Fig 3-14} that presents the finish grading plan).

SMARA 2772(c)(5) Size, legal description, including map with boundaries, topography, geology, streams, channel cross-sections, topsoil stockpiles, roads, equipment storage, RR, utilities within or adjacent to mine.

Existing mining operations occur within APN 120-210-048 (see Exhibit 2 {DEIR Fig 3-3}: Ownership). A mining lease exists on parcels APN 120-210-031 and APN 120-210-032. Additionally mining is proposed on APN 120-210-009 owned by BoDean. See Appendix H of the Permit Application for copies of Assessor's Parcel Maps for affected parcels.

SMARA 2772(c)(6) Mining plan and time schedule that provides for completion of mining on each segment so that reclamation can be concurrent or phased as soon as possible.

Mining and reclamation sequencing is described in Table 3 and illustrated in Exhibits 9 through 14 (DEIR Fig 3-6 through 3-11).

SMARA 2772(c)(9) Impact of reclamation on future mining.

As part of the Reclamation Plan, all mining facilities with the exception of property line fencing, entrance gate and road, wells, water storage / sediment ponds, and drainage facilities, and existing caves that are used as the processing plant's shop will be dismantled and removed from the project site. Reclamation of the property would not preclude future onsite mining.

CCR 3502 (b)(2) Public health and safety (exposure).
CCR 3713(b) All portals, shafts, tunnels, or openings, gated or protected from public entry, but preserve access for wildlife.

The site is accessed from the south via Porter Creek Road and is gated and locked when not operational. "No Trespassing" signs are located at the gate. Upon completion of mining activities, signed gates and fences to prevent vehicular access will be located at other private access points around the property.

CCR 3502 (b)(5) Disposition of old equipment.
CCR 3709(a) Equipment stored in designated area and waste disposed of according to ordinance.
CCR 3509(b) Structures and equipment dismantled and removed.

All on-site equipment and facilities will be removed upon completion of mining activities in compliance with the County disposal requirements, with the exception of:

- property line fencing
- entrance gate and road
- wells
- storm water discharge facilities and sediment basins
- water storage ponds and related features
- existing caves now used as the processing plant's shop.

CCR 3713(a) Drill holes, water wells, monitoring wells completed or abandoned in accordance with laws.

Four wells exist on the site and will be retained as part of the Reclamation Plan. (see Exhibit 3B) **{this exhibit is part of the project application on file with the PRMD}**. As stated in CCR 3509(b) above, these wells will be retained as part of the Reclamation Plan.

End Land Use

SMARA 2772(c)(7) Description of proposed subsequent use or potential use.

Sonoma County's land use designation for the project area is Resources and Rural Development 100 (RRD 100). The proposed reclaimed end land use is general agriculture. As used here, the end use of agriculture could include vineyards, orchards, a Christmas tree farm, or grazing/pasture.

This Reclamation Plan does not preclude future consideration for other allowable uses based on Sonoma County's land use designation for the site. However, any subsequent consideration for other types of site use as may be allowed under the Sonoma County General Plan designation would require an amendment to this Reclamation Plan.

SMARA 2772(c)(8) Description of reclamation measures adequate for proposed end use.

The following reclamation measures related to agricultural use of the project site will be implemented:

- Protecting and preserving existing native trees and shrubs outside the mining limit line and overburden placement areas to every extent possible.

- Dismantling and removing all existing facilities on the property with the exception of property line fencing, entrance gate and road, wells, sediment basins and storm water discharge facilities, and existing caves that are used as the processing plant's shop.
- Stockpiling, placement, and recontouring soils on the mined basin floor to achieve a landscape with functional components useful for agricultural operations. These include, but are not limited to, a relatively open landscape with functional gradients, water storage facilities for potential irrigation and frost protection purposes, and runoff controls for on and offsite water quality purposes. On foot of topsoil will be spread over all such areas.
- Ripping and aerating soil to a depth of one foot within the plant site area and in any other areas where buildings and pavement will be removed. One foot of topsoil or amended overburden soils will be spread over all such areas.
- Hydroseeding/mulching all disturbed areas with appropriate erosion control seed mixes.

Additionally, the following reclamation measures, though not directly related to agriculture, will be implemented:

- Contouring and tapering the edges of terraced slopes to meet safe slope stability requirements and blend into the existing setting as seen from middle ground views.
- Implementing a forest planting program outside of the area to be mined along the northeast portion of the project site to screen views of mined slopes as seen from the north.
- Installing effective erosion control measures to prevent onsite surface erosion and manage on and offsite water quality to minimize potential impacts to Porter Creek.

CCR 3707 Performance Standards for Prime Agricultural Land.

Not applicable.

CCR 3708 Performance Standards for Other Agricultural Land

The project site is not designated as agricultural land. However the defined end use is agriculture and common crops and agricultural uses in nearby areas include: vineyards, orchards, Christmas trees, or pasturelands for a variety of animals. All lands identified for potential use as agriculture will be covered with a minimum one-foot topsoil layer.

Geotechnical Requirements

CCR 3502(b)(3) Final slopes: consider physical properties and landscaping. Stability analysis for final slopes that approach critical gradient.

The site may be characterized as comprising five general zones. These are:

- Area #1: Mined rock terraced slope areas ranging from 2:1 to 1:1 gradients. See Appendix A: Geologic & Geotechnical Report. The area is approximately 19.3 acres in size.
- Area #2: Filled terrace slope areas ranging an average 2:1 (horizontal to vertical) gradient. These include existing reclaimed areas and new fill slopes. These areas are approximately 26.4 acres in extent.
- Area #3: Filled basin floor and slope areas ranging from 50:1 (horizontal to vertical) to areas with a 3:1 (horizontal to vertical) gradient.
- Area #4: Re-contoured lands within the existing overburden placement area that will be recontoured to slopes not steeper than will be recontoured to slopes that will generally be less than a 4:1 (horizontal: vertical) gradient. This areas are approximately 24.4 acres in extent.
- Area #5: The reclaimed existing plant site (not including the main entrance road) that is relatively level and is approximately 4.7 acres in extent.

Prior to the start of the second year of grading in the quarry expansion area, and annually thereafter, a licensed Geotechnical Engineer and Certified Engineering Geologist will inspect the slopes of the quarry expansion area and perform a slope stability evaluation. Subsurface investigations will be conducted as determined necessary by the geologist to determine whether the rock properties of newly exposed rock are as described in the report *Geologic & Geotechnical Report Mining and Reclamation Plan Mark West Quarry Expansion, 4611 Porter Creek Road, Santa Rosa, California* *(December 22, 2003)* and to evaluate the stability of future excavations. The geologist will prepare a written report describing the results of the monitoring and any subsurface investigations, and will specifically note any observed changes in the properties of newly exposed rock that might indicate that large slope failures (meaning any failure that could impact adjacent properties) could occur. In the event that such changes in rock properties are observed, the geologist will make recommendations for such revisions to the final grading plan as may be required to protect adjacent properties. The geologist's report will be submitted to the Sonoma County Permit and Resource Management Department by June 30th of each year. If the geologist recommends changes to the final grading plan in any area of the quarry, the quarry operator shall submit to the County a revised final grading plan and receive County approval before revising the Reclamation Plan that depicts revised appropriate design slopes and setbacks from the property line to ensure protection of adjacent properties prior to making further excavations in that area.

CCR 3704(f) Final cut slopes have minimum factor of safety for end use and conform to surrounding topography.

Final cut slopes will be created through the mining process (see Exhibit G3 and Exhibit 10 {DEIR Fig 3-13 and Fig. 3-6}) and are based on the recommendations made in Appendix A: Geologic & Geotechnical Report. These slopes will not exceed a 1:1 gradient (see Exhibit G4). **{this exhibit is part of the project application on file with the PRMD}** The uppermost 25 foot quarry cut shall be sloped no steeper than 2:1 (horizontal:vertical).

CCR 3502(b)(4) Disposition of fill materials considered. Foundation fills for end use in conformance with current engineering technology.

All fill materials will be used for revegetation purposes. The proposed end use is agriculture. No structures are proposed as part of this reclamation plan.

CCR 3704(a) For urban use, fill compacted in accordance with UBC, local grading ordinance, or other methods approved by the lead agency.

The end use is agriculture; no urban uses are proposed.

CCR 3704(b) For resource conservation, compact to standard for that end use.

All materials would be compacted and sloped in a manner to ensure drainage, slope stability, and erosion control consistent with the Finish Grading Plan. The end use is agriculture. The reclamation intent is to create safe, stable, functionally accessible slopes that can support crop or pasture uses. In some areas reclamation includes planting of native plants for screening purposes. Fill material shall be compacted with equipment of such weight and design as necessary to obtain from 85 to 90 percent relative compaction in areas to be planted within the top 12 inches of subgrade. Compaction will not exceed 90%.

CCR 3704(d) Final reclamation fill slopes not to exceed 2:1, except when allowed by site-specific engineering analysis, and can be revegetated.

As depicted on Exhibit G-2 (DEIR Fig 3-14), the fill slope areas to be created will not exceed a 2:1 (horizontal:vertical) gradient, and will often be much flatter.

CCR 3704(e) At closure, final landforms of fills conform to surrounding topography or end use.

The general angles and edges of cut slopes will be contoured to blend naturally with the existing topography and avoid sharp-appearing angles (see Exhibit G-2 {DEIR Fig 3-14}: Finished Grading Plan). There may exist some rock outcroppings at the edges of the mined area. If discovered these will be shaped to visually conform with the edge conditions between the mined slopes and the natural landscape

Hydrology and Water Quality

CCR 3710(a) Surface and groundwater protected in accordance with Porter-Cologne and Clean Water Acts (RWQCB/SWRCB).

No pollutants are involved with reclamation activities. Sediment basins and sediment control / storm water discharge separation tank systems have been incorporated into the Reclamation Plan to prevent siltation into natural drainages. Surface waters and wetlands subject to Corps of Engineers jurisdiction under Section 404 of the Clean Water Act have been identified; appropriate mitigation will be developed through required permit reviews. See Appendix B: Surface and Ground Water Hydrology and Appendix D: Preliminary Wetlands Assessment for additional information.

CCR 3706(b) Water quality, recharge, and groundwater storage that is accessed by others shall not be diminished, except as allowed by plan.

CCR 3706(b)(2) Substantially prevent siltation of groundwater recharge areas.

During mining, move-out, and dismantling activities, if contaminated soils are discovered, such soils will be removed to an approved offsite disposal area.

Other reclamation activities will not result in any negative effect on the quality of water. Reclamation activities, in terms of the shallow gradient drainages and water storage pond within the mined basin, will likely increase area recharge potential and storage capacity of ground water aquifers.

SMARA 2773(a) Site-specific sediment and erosion control criteria for monitoring compliance with approved reclamation plan.

CCR 3503(a)(3) Erosion control facilities constructed and maintained where necessary.

The Mining and Reclamation Plans indicate a comprehensive series of sediment and erosion control features including: constructed drainage channels, sediment ponds, water storage ponds that will also essentially act as sediment ponds, sediment control / storm water discharge separation tank systems, and erosion control hydroseeding/mulching (see Exhibits G-2 and 9 {DEIR Fig 3-14 and 3-11}). In addition the applicant will undertake the following measures:

<u>Stormwater / Water Quality Protection Program</u>

Prior to the initiation of mining outside of the vested rights area, the applicant will prepare a Stormwater / Water Quality Protection Program. The program shall be submitted to the County, the Regional Water Quality Control Board (RWQCB), and the California Department of Fish and Game (CDFG) for review and comment, and shall be subject to approval by the County.

The program shall include water quality performance criteria that define levels of sediment, turbidity, iron, and other factors that will be allowed in the stormwater that leaves the quarry. The amount of total suspended sediment (TSS), Total Petroleum Hydrocarbons as Diesel (TPH), iron, specific conductance, or pH in the stormwater leaving the site will not be allowed to exceed the levels coming off the site under baseline conditions.

The water quality benchmarks will be based on the State Stormwater Pollutant Benchmark levels. The benchmarks are used by the RWQCB to determine when additional pollution control may be required for a project. For this project, they include:

- pH B should be between 6.5 to 8.5;
- Total Suspended Solids (TSS) B not greater than 100 mg/L;
- Specific Conductance B not greater than 200 uS/cm;
- Iron B not greater than 300 ug/L; and
- Total Petroleum Hydrocarbons as Diesel (TPH) B not greater than 15 mg/L.

<u>Source Control Measures to Prevent Erosion</u>

The program will emphasis source control measures designed to prevent erosion. Specific measures cited below are taken from the Stormwater Best Management Practice Handbook for Construction, published by the California Stormwater Quality Association (CASQA). Equivalent measures described in the Erosion Control Manual (San Francisco Bay Regional Water Quality Control Board) or other measures deemed suitable by the North Coast Regional Water Quality Control Board may be substituted.

a) The program will include measures to preserve existing vegetation to the extent practical. When vegetation clearing takes place in the expansion area, small trees, shrubs and groundcover will be left in place until the area is ready for mining.

b) In areas not being actively mined, bare soil will be protected from erosion with the application of hydraulic mulch or hydroseeded.

c) In areas not being actively mined where it is not practical to establish a grass cover, soil binders will be applied to exposed soil to prevent erosion.

d) In areas requiring temporary protection until a permanent vegetative cover can be established, bare soil will be protected by the application of straw mulch, wood mulch, or mats.

e) To the extent practical, benches will be back sloped or provided with rock or straw bale checks so that sediment is trapped on the benches rather than washed into the sediment ponds.

f) Benches will drain into adequately sized pipes that convey the runoff to the quarry floor. Outlets of pipes will have appropriate energy dissipaters to prevent erosion at the outfall.

g) Reclamation or stabilization of all quarry slopes and the quarry floor (excluding the working/processing/stockpile/loading/access areas and the acreage of the sedimentation ponds) will be completed each year prior to the rainy season. Stabilization measures including hydraulic application of surface stabilizing compounds, hydroseeding, mulching, or other measures to prevent erosion. The program will include a detailed description of annual stabilization measures, including specifications of the types of seeding and mulching that will be applied to slopes that can be revegetated and the types of polymers (chemical soil binders) that will be applied to other slopes where revegetation is not practical. The program will describe proposed application rates for the erosion control materials. A schedule for completion of stabilization will be included, and the stabilization will be completed by October 15th each year.

h) The applicant will submit to the County a site plan or aerial photograph clearly depicting the extent of mining and reclamation on the site every year during mining and reclamation and at the completion of reclamation. The site plan will show previously mined and reclaimed areas, indicating the year the initial reclamation occurred, active mining, stockpiling, work areas, and areas to be mined the following year. The site plan will show erosion and drainage problem areas, proposed stormwater runoff flow directions, and ponding and treatment areas.

Operational Measures to Prevent Erosion

During mining and reclamation activities, the following measures will be implemented to reduce the potential for erosion and sediment discharge:

a) Topsoil suitable for use in revegetation will be stockpiled for use in reclamation and replanting of fill slopes. Prior to October 15th of each year, all topsoil stockpiled for future use in revegetation will be seeded and mulched in order to prevent soil loss through erosion. Topsoil, if stored, will be in the area indicated on Exhibit 3B that and not immediately adjacent to sediment ponds. **{this exhibit is part of the project application on file with the PRMD}**

b) Mining activities and the operation of heavy equipment on site will be done in such a manner as to avoid repeated crossing of open drainageways or ponded areas.

c) Measures will be included to prevent the inadvertent side casting of soil from the quarry benches.

d) All roads and work areas in the quarry will be stabilized surfaces or engineered with aggregate base fill thicknesses adequate to withstand heavy equipment and truck traffic. These roads will be constructed with culverts and energy dissipation structures to convey runoff under the roads, as necessary. Areas on the quarry floor other than roads and active work areas will be stabilized by the stabilization techniques described above.

Measures to Retain Sediment On-site

a) Silt fences, fiber rolls, and straw bale barriers will be used on bare slopes not being actively mined to intercept and trap sediment carried by sheet flow.

b) The design storm for spillways or other structures that convey storm water will not be less than the 20 year, 1 hour intensity event.

c) Water storage / sediment ponds will be designed to the maximum size practical for the available space. New ponds will include a forebay to trap coarse soil particles before the runoff enters the main sediment ponds. Recognizing that sediment ponds may be large enough to trap very fine particles, the design will include the use of chemical treatment to cause the fine particles to settle or filters to remove them from the water.

d) All runoff from areas being mined or previously mined areas will be directed through one of the sediment ponds or sediment control / storm water discharge separation tank systems.

e) The design of water storage / sediment ponds will be completed by a professional civil engineer experienced in sediment detention basin design. The design will meet the standards of SMARA. All hydrologic and engineering calculations, including sediment trap efficiency, will be submitted to the County for review and approval.

f) Ongoing Maintenance. Routine inspection and maintenance of the drainage system and sediment ponds site will be made to identify and correct problems.

g) A schedule and procedures for monitoring and maintaining the sediment ponds will be provided to the County. This will include monitoring storage capacity and loss of storage, sediment removal and deposition, and the safe storage, mixing, use, and disposal of any polymers and coagulants or flocculants.

Measures to Prevent Discharge of Other Pollutants

The program will specify BMPs to reduce the potential for discharge of contaminants to stormwater runoff. The following measures will be included:

a) Fueling and maintenance of all rubber tired loading, grading and support equipment will be prohibited within 50 feet of drainageways unless physical barriers are in place to prevent accidental discharges to waterways. Fueling and maintenance activities associated with other less mobile equipment will be conducted with proper safeguards to prevent hazardous material releases. All refueling and maintenance of mobile vehicles and equipment will take place in a designated area with an impervious surface and berms to contain any potential spills.

b) Any slope stabilization chemicals or polymers, and sediment detention basin enhancement chemicals or polymers that may be used will be EPA approved and will be used strictly according to the manufacturer's specifications.

c) If chitosan is used, a residual chitosan test will be used (available from Natural Site Solutions or the equivalent) to check residual chitosan in water leaving the site. Residual chitosan in discharge water will not exceed 1.1 mg/L.

d) The site will be controlled by maintaining locking gates and a no trespass signs posted at the main entrance to the site.

e) Runoff from the internal access roads will be collected and passed through the water storage /sediment ponds or the sediment control / storm water discharge separation tank systems on site.

On-going Maintenance

The stormwater / water quality protection program will describe specific measures to ensure routine inspection and maintenance of the drainage system and sediment ponds site to identify and correct problems during mining and through the completion of reclamation.

a) The program will describe a schedule and procedures for inspecting and maintaining the sediment ponds. This will include inspections to determine the sediment pond storage capacity and need for sediment removal, inspections to confirm the safe storage, mixing, use, and disposal of any polymers and coagulants or flocculants, and maintenance as needed to ensure that the sediment ponds and drainage structures perform as intended. During the period between September 1 and May 31 the inspections and maintenance will be performed at least once each month.

b) The program will include measures to ensure prompt identification and repair of storm damage. Following storm events which cause significant damage to the reclamation areas or sediment controls (e.g., erosion or landslides), the operator will have a qualified professional conduct a damage survey of the reclamation improvements, and recommend remedial actions as necessary to assure that the performance criteria will be met. A report will be submitted to the Sonoma County Permit and Resource Management Department regarding the effects of such damage, including recommendations for repair and/or replanting.

CCR 3503(b)(1) Settling ponds used where they will provide significant benefit to water quality.

Runoff from the terraced slopes will be collected and diverted into the sediment / irrigation ponds (Exhibits G-2 and 9 {DEIR Fig 3-14 and 3-11}). Water storage ponds and new sediment control / storm water discharge separation tank systems will be constructed at the lower elevations of the reclaimed basin floor. In addition, sediment basins and sediment control / storm water discharge separation tank systems associated with the existing plant site will be retained. See also response to CCR 3503(a)(3) above.

CCR 3503(e) Grading and revegetation to minimize erosion and convey surface runoff to natural drainage courses or interior basins. Spillway protection.

Mining and reclamation will cover an approximately 93-acre area. A portion of the drainage will be diverted to the north into the Franz Creek watershed. The remaining area will continue to be directed to Porter Creek. Drainage control structures with appropriately sized outlet pipes will be installed to regulate storm runoff from the basin.

Grading and erosion control plans for the reclaimed basin floor are presented in Exhibit G-2 (DEIR Fig 3-14): Finished Grading Plan and Exhibit 9 (DEIR Fig 3-11): Reclamation Plan - Revegetation. Appendix B: Surface and Ground Water Hydrology describes the hydrological characteristics of the area and general design parameters for the storm drainage facilities.

The applicant will prepare, for the review and approval by the Sonoma County Permit and Resource Management Department, a drainage plan (including appropriate hydrologic and hydraulic information) that manages on site sediment basins as stormwater detention basins to prevent peak stormwater flows from exceeding the calculated baseline levels. The drainage plan will be prepared by a Registered Civil Engineer and in conformance with the Sonoma County Water Agency's Flood Control Design Criteria.

All on site drainage facilities will be constructed according to Sonoma County Water Agency's Flood Control Design Criteria and the County of Sonoma Permit and Resource Management Department standards and requirements, and will be operated in accordance with the prepared drainage plan. Appendix G: Detention Basin / Sediment Pond Sizing provides calculations for the minimum size sediment ponds indicated on Exhibit G-2 and Exhibit 9 (DEIR Fig 3-14 and Fig 3-11).

See also response to CCR 3503(a)(3) above.

CCR 3706(c) Erosion and sedimentation controlled during all phases of construction, operation, reclamation, and closure of surface mining operation to minimize siltation of lakes and water courses per RWQCB/SWRCB.

All runoff from areas being mined or previously mined areas will be directed through one of the existing or proposed sediment ponds, water storage ponds, or sediment control / storm water discharge separation tank systems.

Proposed water storage / sediment ponds will be constructed to the maximum size practical for the available space. New ponds will include a forebay to trap coarse soil particles before the runoff enters the main sediment ponds. Recognizing that the ponds cannot be large enough to trap very fine particles, the design will include the use of chemical treatment to cause the fine particles to settle or filters to remove them from the water. See also Appendix G: Detention Basin / Sediment Pond Sizing

Ongoing erosion control measures also include:

- Newly disturbed areas not within active mining areas to receive annual hydroseeding/mulching with an erosion control mix.
- Use of Silt fences, fiber rolls, straw bale barriers, and erosion control blankets where necessary to intercept and trap sediment carried by sheet flow (see also Table 7 and Table 8 below for erosion control criteria and remedial measures)
- The overflows and discharge points would be protected from erosion by use of rip-rap rock and straw bales. To prevent escape of silt or sediment, silt fences or equivalent structures would be placed around all interim soil and silt stockpiles and at the overflow and discharge points of the sediment ponds.

To further prevent erosion and sedimentation during reclamation, all reclamation grading activities will be limited to the dry season (May 15 through October 15). All areas disturbed by reclamation activities will be hydroseeded prior to October 15 of that year.

For inspection purposes, performance criteria for erosion control is as follows: Any area larger than 500 square feet on the site that receives an average evaluation score of Class 2 as stated in Table 4 (or higher) that persists for more than one year will be investigated. The investigator will determine the need for remedial measures. Areas receiving an average score of Class 3 or higher will receive treatment to correct the problem as set forth in the discussion or remedial measures (Table 5). Any observable reason for failure will be noted and the appropriate remedial measure stated as part of the annual monitoring report.

Table 7: Qualitative Descriptions of Soil Surface Status

CLASS 1:	No soil loss or erosion; topsoil layer intact, vegetation established.
CLASS 2:	Soil movement slight and difficult to recognize; small deposits of soil in form of fans or cones at end of small gullies or fills, or as accumulations back of grass plugs.
CLASS 3:	Soil movement of loss more noticeable; topsoil loss evident, with some plants on pedestals or in hummocks; rill marks evident. Poorly dispersed litter and bare spots nor protected by litter.
CLASS 4:	Soil movement and loss readily recognizable; topsoil remnants with vertical sides and exposed plant roots, roots frequently exposed, litter in relatively small amounts and washed into erosion protected patches.
CLASS 5:	Advanced erosion; active gullies and rills greater in cross section than 12 square inches exceeding 10 feet in length, steep sidewalls on active gullies; well-developed erosion pavement on gravelly soils, litter mostly washed away.

Table 8: Remedial Measures For Erosion Control

CLASS 1:	No action required. Continue observation.
CLASS 2:	Document and continue observation. Mulch limited critical areas with weed-free straw or rice mix @ 2000 lbs per acre on slopes less than a 3:1 gradient or at rate of 3000 lbs. per acre on 3:1 gradient slopes or steeper. Use of straw bales, straw rolls, and erosion control blankets where necessary.
CLASS 3:	Mulch entire area with weed-free straw or rice mix @ 3000 lbs per acre. Use of straw bales, straw rolls, and erosion control blankets where necessary.
CLASS 4:	Regrade area to distribute and prevent concentration of surface flows. Direct runoff to established swales. Mulch intervening bare areas. Use of straw bales, straw rolls, and erosion control blankets where necessary.
CLASS 5:	Regrade area to distribute and prevent concentration of surface flows. Direct runoff to established swales. Arrest gully development by placement of graded rock interceptors or straw bales to slow concentrated runoff within 1 week following any rainfall event. Mulch intervening bare areas and heavy equipment-impacted areas. Use of straw bales, straw rolls, and erosion control blankets where necessary.

See also response to CCR 3503(a)(3) above.

CCR 3706(d) Surface runoff and drainage controlled to protect surrounding land and water resources. Erosion control methods designed for not less than 20 year/1 hour intensity storm event.

Capacity will be retained in the reclaimed basin area to retain runoff from the 100-year storm event. Drainage control structures on the water storage ponds with an appropriately sized outlet pipe will be installed to regulate storm runoff out of the basin into the existing drainage facilities that service the site and which, in turn, drain into Porter Creek.

Grading and erosion control plans for the reclaimed basin floor are presented in Exhibit G-2 (DEIR Fig 3-14). Appendix B: Surface and Ground Water Hydrology describes the general hydrological characteristics of the area and design parameters for the storm drainage facilities. Appendix G presents calculations for minimum sizing of detention basin / sediment ponds.

See also response to CCR 3503(a)(3) above.

CCR 3706(e) Altered drainages shall not cause increased erosion or sedimentation.

The sediment ponds and erosion control structures within the reclaimed basin are designed to reduce erosion potential and sedimentation into Porter Creek. Elsewhere, the existing drainage patterns on the property will be retained. Additionally, a Certified Engineering Geologist or Registered Geotechnical Engineer will review the maximum working slopes of the mine face so that the slope or height of the active working face shall not exceed the safety standards established by CalOSHA and MSHA.

SMARA 2773(a) Sediment and erosion control monitoring plan specific to property.

The stormwater management program shall include on-going water quality monitoring and reporting during the life of the permit. During the period when reclamation activities occur, site inspections will be made after the first heavy rains of the season to determine the effectiveness of erosion control measures and if any remedial actions are warranted. Afterward, inspections will be made monthly or as necessary during the rainy season.

Monitoring activities include:

- Samples will be collected from the following locations: the pipes that discharge storm runoff from the quarry property.
- Samples will be collected while discharges are occurring in compliance with the requirements of General Permit (No. CAS000001) for Discharges of Storm Water associated with Industrial Activities. Samples will be taken at least twice each year; one set of samples will be taken during a significant rain event and one set of samples will be taken during a moderate rain event. Significant rain events are storms or rainfall events that produce at least 3-inches of rain in a period of 48-hours and create a brown (muddy) color in the roadside ditch. Moderate rain events are storms or rainfall events that produce less than 3-inches of rain in a period of 48-hours and water within the roadside ditch maintains a semi-clear to cloudy appearance. If requested by the County or the RWQCB, samples will also be collected during a period having no rain. This is a period in which no rainfall has occurred during the 48-hour period immediately preceding the sampling, and surface waters are semi-clear to cloudy and flowing at all surface water sampling points and site discharges.
- More frequent sampling will be done if requested by the County or the RWQCB.

If any monitoring report indicates that the quarry did not meet the water quality performance criteria, the quarry operator will take actions to bring the discharges into compliance. Corrective actions may include, but are not limited to, additional source control BMPs, expansion of the existing sediment ponds, chemical flocculation, and mechanical filtration of the discharge. The quarry operator will report the corrective actions to the County, collect another set of water samples, have the samples analyzed, and submit a follow-up written report to the County. If the follow-up report indicates that discharges from the quarry still do not meet the water quality performance criteria, the quarry operator will propose changes to the sediment control program that will improve its performance sufficiently to meet the criteria. The proposed changes will be submitted to the RWQCB for comment, revised as needed to address their comments, and then implemented by the quarry operator.

If the monitoring reports show at least one constituent consistently fails to meet its performance criteria for two consecutive years, despite any improvements implemented by the quarry, the quarry operator will confer with the County and the RWQCB to determine whether further changes in the water quality protection program are likely to result in compliance.

The performance criteria are intended for the County's use in determining compliance with this condition of approval. They are not intended to supersede any standards that may be used independently by the RWQCB.

See also response to CCR 3503(a)(3) above.

SMARA 2772(c)(8)(A) Description of contaminant control and mine waste disposal.

CCR 3503(d) Disposal of mine waste and overburden shall be stable and not restrict natural drainage without suitable provisions for diversion.

CCR 3503(a)(2) Overburden stockpiles managed to minimize water and wind erosion.

CCR 3712 Mine waste and tailings, and mine waste disposal units governed by SWRCB/IWMB (Article 1, Subchapter 1, Chapter 7, Title 27, CCR).

The mining of the project site will not generate any new mining waste. Initial overburden and topsoil to be removed for mining will be stockpiled and hydroseeded/mulched to minimize water and wind erosion. All reclamation grading activities will occur during the dry summer months. All hydroseeding/mulching will occur prior to October 15 of each year. Fill used within the basin floor will be track walked using heavy equipment (D-6 or larger) with tracks perpendicular to the direction of the slope.

Existing and new detention basins and sediment control / storm water discharge separation tank systems will facilitate the removal of suspended sediment from storm water runoff generated at the project site. Thee features are not intended to retain all runoff from the site during the rainy season. Periodically, the basins and tanks will be drained to ensure that there is sufficient capacity to detain runoff generated in subsequent storm events. Two factors were considered to minimize the potential for the project to exacerbate existing flooding problems: 1) the increase in volume of runoff from the project site, and 2) the timing of the release of runoff from the project site relative to peak flood flows in Porter Creek during a storm event. Appendix G: Detention Basin / Sediment Pond Sizing

The sediment basins and other drainage features shall be maintained (e.g., accumulated sediment shall be removed) pursuant to the standards stated in the approved sediment and erosion control plan. The basins and drainage systems will adequately maintained by October 15th of each year. Additionally, inspections of the drainage system shall be conducted during the rainy season following one inch or more of rain in a 24-hour period to ensure that the drainage system is directing the flow properly.

See also response to CCR 3503(a)(3) above.

CCR 3710(b) In-stream mining conducted in accordance with Fish and Game Code Section 1600 et seq, Section 404 of the Clean Water Act, and Section 10 of the Rivers and Harbors Act of 1899.

Not applicable.

Environmental Setting and Protection of Fish and Wildlife Habitat

CCR 3502(b)(1) Environmental setting and impact of reclamation on surrounding land uses. (Identify sensitive species, wildlife habitat, sensitive natural communities, e.g. wetlands, riparian zones, etc.)

Exhibit 2 (DEIR Fig 3-3): Ownership illustrates surrounding land ownership and uses. The environmental setting and biological resources of the project site are described in Appendix C: Vegetation Analysis, Appendix D: Preliminary Wetlands Assessment, and Appendix E: Biological Constraints Analysis. The reclamation of the site to agriculture will not impact any surrounding land uses.

CCR 3705(a) Vegetative cover, suitable to end use, self-sustaining. Baseline studies documenting cover, density and species richness.

Botanical resources of the project site are described in Appendix D. Areas to be reclaimed are illustrated on Exhibit 9 (DEIR Fig 3-11): Reclamation Plan - Revegetation. Reclaimed lands will be returned to a mixture of grassland, willow scrub, or woodland communities. Tables 3, 4, and 5 provide details for seeding and planting associated with reclamation. Seed compositions were chosen to be self-regenerating. No dependence on fertilizer or soil amendments is anticipated. Irrigation of woody species will occur for a minimum three-year period or until plants are established and self-sustaining without irrigation.

CCR 3503(c) Protection of fish and wildlife habitat (all reasonable measures).
CCR 3703(a) Sensitive species conserved or mitigated.

One sensitive plant species (Napa false indigo) was identified in the proposed expansion area, and the potential exists on site for outplanting or transplanting. See also Appendix C for mitigation options.

CCR 3703(b) Wildlife habitat at least as good as pre-project, if approved end use is habitat.

The proposed end land use, following conclusion of the quarrying operations and implementation of the reclamation measures, is agriculture.

CCR 3703(c) Wetlands avoided or mitigated at 1:1 minimum.

Exhibit 6 **(This exhibit is part of the project application on file with the PRMD**): Potential Jurisdictional Wetlands illustrates potential "Waters of the United States". Mitigation of surface waters and wetlands subject to Corps of Engineers jurisdiction under Section 404 of the Clean Water Act will be developed through required permit reviews. One perched wetland measuring 0.02 acres in size will be mitigated on-site at a ratio of 2:1 (see also Exhibit 9 {DEIR Fig 3-11}).

CCR 3704(g) Piles or dumps not placed in wetlands without mitigation.

Surface waters and wetlands subject to Corps of Engineers jurisdiction under Section 404 of the Clean Water Act have been identified and are illustrated in Figure 6. Appropriate mitigation will be developed through required permit reviews.

CCR 3710(d) In-stream mining not cause fish to be trapped in pools or off-channel pits, or restrict migratory or spawning activities.

Not applicable.

CCR 3713(b) All portals, shafts, tunnels, openings, gated or protected from public entry, but preserve access for wildlife.

The site is accessed from the south via Porter Creek Road and is gated and locked when not operational. "No Trespassing" signs are located at the gate. Signed gates and fences to prevent vehicular access will be located at other private access points around the property as appropriate. The remainder of the site will not be fenced, but posted with "No Trespassing" signs periodically along property boundary.

Resoiling and Revegetation

CR 3503(f) Resoiling (fine material on top plus mulches).

A one-foot topsoil layer will be installed on all fill slopes and areas to be planted with woody vegetation. Areas to be hydroseeded will include a mulch component. Weed control fabric will be used around individual plants in place of mulch.

CCR 3704(c) Mine waste stockpiled to facilitate phased reclamation and separate from growth media.

Some initial stockpiling of mine waste may continue in the area designated in Exhibit 3B. **{this exhibit is part of the project application on file with the PRMD}** Generally, as mining proceeds through completion of the project, topsoil and overburden will be removed and used directly for reclamation of mined lands. A one-foot topsoil layer will be installed on all mined areas to be planted with container stock and the mined basin floor being reclaimed to agriculture.

CCR 3711(a) All salvageable topsoil removed. Topsoil and vegetation removal not precede mining by more than one year.

Topsoil will be removed annually during the summer months for the area that is to be mined the following year. As mining proceeds during completion of the project, topsoil will be removed and used directly in areas being reclaimed concurrently with mining.

CCR 3711(b) **Topsoil resources mapped prior to stripping, locations of stockpiles on map. Topsoil and growth media in separate stockpiles.**
CCR 3711(c) **Soil salvage and phases set forth in plan, minimize disturbance, designed to achieve revegetation success.**
CCR 3711(d) **Topsoil phased ASAP. Topsoil stockpiles not be disturbed until needed. Topsoil stockpiles clearly identified and planted with vegetation or otherwise protected.**
CCR 3711(e) **Topsoil redistributed in**(DEIR Fig 3-11) **stable site and consistent thickness.**
CCR 3707(b) **Segregate and replace topsoil by horizon.**

Much of the existing area to be mined is vegetated. The top one-foot of soil will be used directly in reclamation activities. Existing vegetation (except Napa false indigo and other identified special status species) will be stripped and, where possible, mulched. As mining proceeds through completion of the project, topsoil and overburden will be removed and used directly in areas being reclaimed concurrently with mining. Vegetation will be stripped and mulched, topsoil will be stripped, and the two combined and replaced as the final layer of fill on fill-slopes being created. Should topsoil layers be thin, overburden materials will be amended as necessary to encourage herbaceous plant growth.

CCR 3705(e) **Soil altered or other than native topsoil, requires soil analysis. Amend if necessary.**

The soil around the plant site will be in a compacted state. It will be ripped to a depth of one foot and disked prior to adding topsoil and seeding as identified in Table 4. The choice of the species mix called for in the areas around the plant site assumes that the quality of the soil will be minimal and was chosen for the species' nitrogen-fixing capabilities.

CCR 3707(d) **Fertilizers and amendments not contaminate water.**

No fertilizers will be used in the site reclamation. A mycorrhizal inoculant will be used in all hydroseeding applications and plantings to stimulate plant productivity. An organic-based biostimulant and humus builder will be applied to stimulate soil microorganisms.

SMARA 2773(a) **Revegetation plan specific to property. Monitoring plan.**

The revegetation plan has been developed to reflect the slope, aspect, soil and hydrologic conditions of the property after mining has been completed. It is designed to achieve a landscape with functional components useful to agriculture. These include, but are not limited to, maximizing slopes suitable for agriculture production, and creating an access route system to support operations. The monitoring includes test plots and a five-year monitoring period for all vegetation types (see Exhibits 9 {DEIR Fig 3-11} and Table 4, 5, and 6)

CCR 3503(a)(1) **Removal of vegetation and overburden preceding mining kept to a minimum.**

Existing vegetation, topsoil, and overburden will be removed annually during the summer months for the area that is to be mined the following year. These materials will be placed and hydroseeded prior to October 15 (See Exhibit 12 {DEIR Fig 3-8}). Where possible, existing vegetation (except Napa false indigo and other special-status species) will be mulched for use as a soil amendment. Initially, the mulch will be stockpiled adjacent to the topsoil (but segregated from it). As mining proceeds during Step 2 through completion of the project (See Exhibits 13 and 14 {DEIR Fig 3-9 and 10}), vegetation will be stripped and mulched, topsoil will be stripped, and the two combined and replaced as the final layer of fill on mined lands being reclaimed.

CCR 3503(g) Revegetation and plant survival (use available research).
Reclamation of the eastern portion of the property is underway. Observations have shown that hydroseeding has been effective. Additionally, though not part of the reclamation plan, Redwood and Douglas fir have been successfully transplanted onto fill benches along the eastern portions of the property.

CCR 3705(a) Vegetative cover, suitable end use, self-sustaining. Baseline studies documenting cover, density and species richness.
The site will not be reclaimed to conditions that existed prior to mining activities. Revegetation of disturbed areas consists of hydroseeding grasses and herbaceous plants (see Table 6). Planting of willows and planting or transplanting of native screening vegetation will take place (see Tables 6 and 7). Species selection was based on anticipated soil conditions, functional qualities to provide erosion control, similar native woody vegetation that exists within the general region, and ability to be self-generating without dependence on long-term irrigation, soil amendments, or fertilizers.

CCR 3705(b) Test plots if success has not been proven previously.
As illustrated on Exhibit 9 (DEIR Fig 3-11), a test plot measuring 100 feet x 100 feet on a mined rock slope will be developed for Seed Mixture A (see Table 4). Seeding of the existing topsoil stockpile area will be used as a test plot for fill slopes employing Seed Mixture B. Initial planting of mixed forests for screening will also serve as test plots for future plantings.

CCR 3705(c) Decompaction of site.
The soil around the plant site will be ripped to a depth of one foot and disked prior to seeding. The choice of the species mix called for in the hydroseed specifications (see Table 4) for the areas around the plant site assumes that the quality of the soil will be minimal and was chosen for the species' nitrogen-fixing capabilities.

CCR 3705(d) Roads stripped of road base materials, resoiled and revegetated, unless exempted.
With the exception of the main entrance route, all road materials within the project area will be removed and/or relocated for use in the service access route system to support agriculture operations (see Exhibit 9 {DEIR Fig 3-11}). Where not used, subgrade soils will be ripped, disked, and reseeded.

CCR 3705(f) Temporary access not bladed. Barriers installed.
No temporary access routes are proposed as part of reclamation. Access routes that lead off of the project area will be gated and locked.

CCR 3705(g) Use native plant species, unless exotic species meet end use.
The planned reclamation use is agriculture. Revegetation of areas within the basin floor and other fill areas will use a combination of native and non-native grasses. Benched slopes will be hydroseeded with a native erosion control mix. Willows around drainages and screening vegetation will use species native to the region.

CCR 3705(h) Plant during correct season.

Hydroseeding will occur in the late summer / early fall of each year following site grading. All hydroseeding will be completed prior to October 15. Planting of willows and other woody vegetation will occur after the beginning of the rainy season, generally between December 1 and December 31 of each year.

CCR 3705(i) Use soil stabilizing practices and irrigation when necessary to establish vegetation.

Fill used within the basin floor will be track walked using heavy equipment (D-6 or larger) with tracks perpendicular to the direction of the slope. Soils around the drainage control structures or other facilities will be based on geotechnical recommendations (see Appendix A: Geologic & Geotechnical Report). Willow cuttings and woody plants will be irrigated, if necessary, for a three-year establishment period.

Fill slopes needed to complete reclamation will be track walked using heavy equipment (D-6 or larger) with tracks perpendicular to the direction of the slope. All slopes will be seeded with a native erosion control mix. Willow thicket and mixed evergreen communities will receive irrigation for an establishment period of up to three years (see Tables 3, 4, and 5).

CCR 3705(j) If irrigated, demonstrate self-sustaining without irrigation for two-year minimum.

The established plant monitoring period is five years with irrigation anticipated for woody vegetation for up to a three-year period. This will allow determination of whether plantings are self-sustaining over a two-year minimum period.

CCR 3705(k) Weeds managed.

Reclamation areas shall be inspected regularly for presence of invasive plants, such as French and Scotch Broom and other noxious weed species. All plants observed shall be removed by pulling, digging, or other approved invasive plant control methods. Such material would be disposed of either through burning (on-site or off-site), or off-site in another manner as appropriate.

CCR 3705(l) Plant protection measures, fencing, caging.

Individual plant protection is described in Table 6.

CCR 3705(m) Success quantified by cover, density, and species richness. Standards proposed in plan. Sample method set forth in plan and sample sizes provide 80 percent confidence level, as minimum.

SMARA performance standards for revegetation require that vegetative cover, density, and species richness shall be used as success standards for revegetation. The end use of mined lands has been identified as agriculture.

<u>Success Criteria - Hydroseeding and Erosion Control</u>: Success criteria are described in Tables 3 and 4.

<u>Success Criteria - Cuttings and Container Stock</u>: Table 9 presents performance criteria for plant associations proposed to be used on different soil and slope conditions. These criteria will be refined and submitted to Sonoma County based on the results of test plots to be planted and evaluated prior to final reclamation.

Statement of Reclamation Responsibility

A signed Statement of Reclamation Responsibility is provided in Appendix F.

Financial Assurance

A detailed financial assurance estimate will be provided following approval of the final mining and reclamation plan by the County. Mining and reclamation activities approved by the County as a result of this application for expansion of Mark West Quarry will not be initiated until financial assurances are approved and secured by the County as lead agency under SMARA.

Table 9: Success Criteria (1)

HYDROSEED MIX	VEGETATIVE COVER (2)	DENSITY (2)	PLANT SPECIES COMPOSITION / SPECIES RICHNESS (2)
Seed Mix A – Mined terraced benches Soil Condition: Level to slightly sloping areas	See Tables 3 and 4		
Seed Mix B – Basin and fill slopes Soil Condition: Level to moderately sloping (2:1) slopes	See Tables 3 and 4		
Willow Thickets Soil Condition: Level to slightly sloping areas	Target goal (year 3): 40% of area covered Monitoring plot size: 10,000 square feet	Target goal (year 3): 62 plants per plot size average Monitoring plot size: 10,000 square feet	Target goal (year 3): 1 of 3 species present Monitoring plot size: 10,000 square feet
Mixed Coniferous Forest / Screening Level to moderately sloping areas in northeast of property Soil Condition: Moderately sloping areas	Target goal (year 3): 10% of area covered Monitoring plot size: 100' x 100'	Target goal (year 3): 50 plants per plot size average Monitoring plot size: 100' x 100'	Target goal (year 3): 2 of 2 Monitoring plot size: 100' x 100'

(1) Prior to reclamation, test plots will be established to determine optimal seeding and planting mixtures to be used to ensure species success and diversity. Success criteria may be adjusted based on the results of the test plot program.

(2) Definitions:

- Vegetative Cover - the vertical projection of the crown or shoot area of a species to the ground surface expressed as a percentage of the reference area (percentage can be greater than 100 percent).
- Vegetative Density - the number of individuals or stems of each species rooted within the given reference area.
- Vegetative Species Richness - the number of different plant species within the given reference area.

Source: 2M Associates

APPENDIX C-1

Geologic and Geotechnical Report

GEOLOGIC & GEOTECHNICAL REPORT
MINING AND RECLAMATION PLAN
MARK WEST QUARRY EXPANSION
4611 PORTER CREEK ROAD
SANTA ROSA, CALIFORNIA

December 22, 2003

Project 1070.01

Prepared For:
BoDean Company, Inc.
1060 Maxwel Drive
Santa Rosa, CA 95401

Attn: Dean Soiland

CERTIFICATION

This document is an instrument of service, prepared by or under the direction of the undersigned professionals, in accordance with the current ordinary standard of care. The service specifical y excludes the investigation of radon, asbestos, toxic mold and other biological pol utants, and other hazardous materials. The document is for the sole use of the client and consultants on this project. Use by third parties or others is expressly prohibited without written permission. If the project changes, or more than two years have passed since issuance of this report, the findings and recommendations must be reviewed by the undersigned.

MILLER PACIFIC ENGINEERING GROUP
(a California corporation)

REVIEWED BY:

Nathan C. Soule
Project Geologist

Michael J. Dwyer
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GEOLOGIC & GEOTECHNICAL REPORT
MINING AND RECLAMATION PLAN
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I. INTRODUCTION

A. Purpose and Scope of Services

The purpose of this report is to provide detailed recommendations for the geologic and geotechnical aspects of the mining and reclamation plan for Mark West Quarry, located at 4611 Porter Creek Road near Santa Rosa, California. These services are required by the California Surface Mining and Reclamation Act of 1975 and the Sonoma County Surface Mining and Reclamation Ordinance #5165. Our work was performed as outlined in our Agreement for Professional Services dated July 29, 2003. The specific subjects covered in this report are:

1. A select review of pertinent published literature including geologic maps, soil surveys, the pre-existing reclamation plan, and governmental ordinances/regulations that affect the project.

2. A review and interpretation of stereo-paired aerial photographs covering the site.

3. The results of geologic reconnaissance and filed mapping of the site.

4. Detailed descriptions of the regional and site specific geology including the preparation of a site geologic map covering the existing mining operation and the planned expansion area.

5. Preliminary geotechnical engineering recommendations for the working and reclaimed slopes of the quarry.

B. Background

Mark West Quarry is located approximately half a mile northwest of the intersection of Porter Creek Road and Calistoga Road in Sonoma County, California. The area was first quarried in 1910, and has been in continuous operation since then. BoDean Company Inc. took over operation of the quarry in 1989 and has been mining continuously to the present day. Currently, the operation covers about 34 acres of an 87 acre parcel. The planned expansion area is primarily to the west with a small section to the north of the current operation, and will increase the total mined area to about 99 acres. The expanded area will be on land that is leased from a private land owner. The location of the quarry expansion area is shown on Figure 1, Site Location Map.

C. Geologic Reconnaissance

The majority of the field mapping was done on August 16, October 1, October 16, and October 28, 2003. Brelje & Race Civil Engineers prepared a site topographic map at a scale of 1 inch = 100 feet with 25-foot contours in areas of heavy vegetation and 5-foot contours in more exposed areas. We used this map as a base for our field work. Our completed geologic map is shown on Figure 2 and the soils map is shown on Figure 3. We used standard geologic mapping techniques with locations determined from map features, posted survey control points, and aerial photographs.

Field mapping was supplemented by a review of 5 sets of stereo-paired aerial photographs. A list of the photographs reviewed is shown below.

Date	**Scale**	**ID Number**	**Source**
7/2/2003	1:7200	03159 1-1, 1-2, &1-3	Kellogg Aerial Surveys
6/26/1990	1:34,800	15A-27&29	Sonoma County Tax Assessors
5/4/1980	1:24,000+	BW-SON-19-9&10	Sonoma County Tax Assessors
5/22/1971	1:24,000+	3088-168&169	Sonoma County Tax Assessors
5/3/1961	1:24,000±	CSH 2BB-12&13	Sonoma County Tax Assessors

II. REGIONAL GEOLOGY & SEISMICITY

A. Regional Geology

Mark West Quarry is located within the Coast Range Geomorphic Province of California. Topographically, the Province is characterized by northwest-southeast trending mountain ranges of moderate relief, with intervening deep canyons, or narrow stream valleys. The province is known for its active seismicity, landsliding and erosion. Within the Province there are occasional larger, alluvium-filled, basin-shaped valleys. In Sonoma County, these include the Santa Rosa Plain and Sonoma, Rincon and Bennet Valleys. Most of these valleys are associated with known or suspected active faults and have formed in part by down-dropping associated with movement along these faults.

The Franciscan Complex is the baserock of the Province and it consists of a diverse assemblage of rock units, including sandstone, shale, greenstone (altered, submarine volcanic rocks), chert, and lesser amounts of conglomerate, and hard schistose rocks of the Jurassic-Cretaceous Age (65-190 million years ago) (Huffman & Armstrong, 1980). Of these rock types, the most prevalent is sandstone, which is massively bedded and has occasional shale interbeds. Masses of serpentinite of various dimensions are locally present. The serpentinite has been intruded and faulted into the Complex during long and ongoing tectonic processes.

Locally mantling the Franciscan basement rocks are geologically younger formations consisting of continental, marine and igneous rocks. The continental and marine formations were deposited in basins formed by down warping and faulting. Many of these basins are tectonically active, and contain or are bordered by active faults.

Overlying much of the Franciscan rock in eastern Sonoma County are the Sonoma Volcanics. The volcanics in the area of the quarry are characterized as pumicitic ash-flow tuff, local y or partly welded with zones of agglomeritic tuff, andesitic or basaltic lava flows and tuff breccia (Huffman & Armstrong, 1980). Sonoma Volcanics elsewhere also include rhyolitic to basaltic ash-flow tuffs. The sequence is the result of volcanism in the Pliocene Epoch (1.6 to 5 mil ion years ago) that extends from Mt. St. Helena in the north to Val ejo in the south (Wagner & Bortugno, 1982). In the area of Mark West Quarry, the ash-flows have been dated to between 2.28 and 3.4 mil ion years old (McLaughlin, verbal communication 2003).

B. Seismicity

The project site is located within a seismical y active area and wil therefore experience the effects of future earthquakes. Earthquakes are the product of the build-up and sudden release of strain along a “fault” or zone of weakness in the earth's crust. Stored energy may be released as soon as it is generated or it may be accumulated and stored for long periods of time. Individual releases may be so smal that they are detected only by sensitive instruments, or they may be violent enough to cause destruction over vast areas. Faults are seldom single cracks in the earth's crust but typical y are braids of breaks that comprise shatter zones which regional y link to form networks of major and minor faults. Within the Bay Area, active faults are associated with the San Andreas fault zone.

An “active” fault is one that shows displacement within the last 11,000 years and, therefore, is considered more likely to generate a future earthquake than a fault that shows no sign of geological y recent rupture. The locations of the currently known active faults relative to the project site are shown on Figure 4, Fault Map. No known active faults pass through the Mark West Quarry. The nearest major fault to the quarry is the Maacama Fault, which is approximately 1.5 miles to the west. The southern Maacama Fault is characterized as a predominately strike-slip fault with a maximum potential earthquake magnitude of 6.9 and a slip rate of 9 mm/yr. The 1997 Uniform Building Code (UBC) classifies the south Maacama Fault as a Type B fault, which means the fault is capable of generating large magnitude earthquakes *or* a high rate of seismic activity.

Located 0.15 miles to the south of the quarry is the unofficial y named Petrified Forest Thrust Fault (McLaughlin, verbal communication 2003). The fault trends WNW–ESE, dips to the northeast, and is identified by the thrusting of Franciscan greenstone over the much younger Sonoma Volcanics. The 1997 UBC does not classify it as an active fault, nor do the Alquist-Priolo maps produced by the California Geological Survey (CGS). However, recent mapping by the United States Geological Survey (USGS) indicates that the fault may be actively accommodating minor amounts of compression (McLaughlin, verbal communication 2003). Based on this information, and the lack of major seismic activity, the fault does not appear to pose a significant geologic hazard either for the proposed mining expansion or for post reclamation use.

Based on probabilities of future fault rupture that have been published by the USGS, the Rodgers

Creek Fault wil likely be the most significant risk of future ground shaking (USGS, 2002). The fault lies approximately 6 miles to the west. It is a northwest–southeast trending strike-slip fault with a maximum potential earthquake magnitude of 7.1 and a slip rate of 9 mm/yr. The 1997 UBC classifies it as a Type A fault, which means the fault is capable of generating large magnitude earthquakes *and* a high rate of seismic activity.

Historic Fault Activity

Numerous earthquakes have occurred in the region within historic times. The results of our computer database search indicate that 21 earthquakes (Richter Magnitude 5.0 or larger) have occurred within 100 kilometers of the site area between 1735 and 2003. Using empirical attenuation relationships, the maximum historic bedrock acceleration (median peak) within the site is approximately 0.17g. The four most significant historic earthquakes to affect the project site are summarized in Table A.

TABLE A
SIGNIFICANT EARTHQUAKE ACTIVITY
MARK WEST QUARRY EXPANSION

Fault	Richter Magnitude	Year	Distance	Maximum Peak Bedrock Acceleration
Rodgers Creek	5.7	1969	10 km	0.17 g
Rodgers Creek	5.6	1969	9 km	0.17 g
San Andreas	8.3	1906	95 km	0.09 g
Unnamed/Mt. Veeder	5.2[1]	2000	28 km	0.03 g

1. Moment Magnitude

Sources: USGS (2001), Abrahamson and Silva (1997)

The calculated bedrock accelerations should only be considered as reasonable estimates. Many factors (soil/rock conditions, orientation to the fault, etc.) can influence the actual ground surface accelerations. Significant deviation from the values presented are possible due to geotechnical and geologic variations from the typical conditions used in the empirical correlations.

Probability of Future Earthquakes

The historical records do not directly indicate either the maximum credible earthquake or the probability of such a future event. To evaluate earthquake probability in this region, the USGS has assembled a group of researchers into the "Working Group on California Earthquake Probabilities" to estimate the probabilities of earthquakes on active faults. Potential sources were analyzed considering fault geometry, geologic slip rates, geodetic strain rates, historic activity, and micro-seismicity, to arrive at estimates of probabilities of earthquakes with a Moment Magnitude greater than 6.7 by 2032.

The probability studies focus on seven "fault systems" within the Bay Area. Fault systems are composed of different, interacting fault segments capable of producing earthquakes within the individual segment or in combination with other segments of the same fault system. The probabilities for the individual fault segments in the San Francisco Bay Area are presented on Figure 4, Fault Map.

In addition to the seven fault systems, the studies included probabilities of "background earthquakes." These earthquakes are not associated with the identified fault systems and may occur on lesser faults (i.e., West Napa) or previously unknown faults (i.e., the 1989 Loma Prieta and 2000 Mt. Veeder Earthquake, Napa). When the probabilities on all seven fault systems and the background earthquakes are combined mathematically, there is a 62 percent chance for a magnitude 6.7 or larger earthquake to occur in the Bay Area by the year 2032. Smaller earthquakes (between magnitudes 6.0 and 6.7), capable of considerable damage depending on proximity to urban areas, have about an 80 percent chance of occurring in the Bay Area by 2032 (USGS, 2002).

Additional studies by the USGS regarding the probability of large earthquakes in the Bay Area are ongoing. These current evaluations include data from additional active faults and updated geological data.

Earthquake Ground Motion

The intensity of earthquake ground motion wil depend on the characteristics of the generating fault, distance to the fault and rupture zone, earthquake magnitude, earthquake duration, and site-specific geologic conditions. Hard rock deposits underlie the site. Empirical relations developed for rock sites (Abrahamson & Silva, 1997) provide approximate estimates of median peak ground accelerations. A summary of the principal active faults affecting the site, their closest distance to the quarry, moment magnitude of characteristic earthquake and probable peak ground accelerations which a quake on the fault could generate at the site are shown in Table B.

TABLE B
ESTIMATED PEAK GROUND ACCELERATION
FOR PRINCIPAL ACTIVE FAULTS
MARK WEST QUARRY EXPANSION

Fault	Moment Magnitude for Characteristic Earthquake	Closest Estimated Distance (kilometers)	Median Peak Ground Acceleration (g)[1]
Maacama	6.9	3	0.70
Rodgers Creek	7.1	10	0.39
San Andreas	7.9	42	0.13
West Napa	6.5	30	0.11

(1) Determined from attenuation relationship by Abrahamson & Silva (1997) for rock sites

Source: USGS (1996)

The potential for strong seismic shaking at the project site is high. Due to their close proximity, the Maacama and the Rodgers Creek faults present the highest potential for severe ground shaking. The significant adverse impact associated with strong seismic shaking is potential damage to working and reclaimed slopes and quarry processing equipment. Additional recommendations to minimize the effects of earthquake shaking on working and reclaimed slopes are presented in Section IV of this report.

III. SITE GEOLOGY

A. General

The geology of the quarry area can be differentiated into two units separated by an east-west trending contact. The northern unit is Sonoma Volcanics (tst) and the southern unit is the Franciscan greenstone (gs). Greenstone is the target material for mining. Three less extensive surficial units were also mapped on the site. They are, Artificial Fill (Qaf), Colluvium (Qc), and Landslides (Qls & Qlsd). For locations of the geologic units see Figure 2, Site Geologic Map.

The attitude of the contact between the Sonoma Volcanics and the Franciscan greenstone can only be approximately defined from surface observation. Subsurface exploration would be necessary to more accurately determine its dip (inclination) and variability. Based on its surface expression, the contact dips steeply to the north at an angle between 25 and 50 degrees. In the area of the quarry, it appears to be a depositional contact created from a volcanic ash-fall that was deposited over the Franciscan greenstone. This type of contact is typically non-planar as it conforms to the surface of the land prior to the deposition of the volcanic ash. Recent geologic mapping by the USGS (McLaughlin, verbal communication 2003) suggests that some normal faulting along the contact may have occurred to the west of the site nearer the Maacama Fault. This is suggested by the presence of hydrothermal alteration along the contact.

B. Geomorphology

The geomorphology of the site is controlled by variations in the resistance to erosion of the bedrock and the regional tectonics active in the area. The principle landform is the prominent east-west ridge located along the south side of the expansion area directly above Porter Creek. The overall topography of the site is very rugged with slopes ranging from steeper than 1:1 (horizontal:vertical) to near horizontal below narrow ridgetops. The greatest relief is 550 feet, between Porter Creek and the top of the prominent east-west ridge. Slopes to the north of the ridge are less abrupt with an average inclination between 3:1 and 2:1, which is largely due to the presence of more easily eroded volcanic rock. The east-west trend of the valleys and ridges is created by regional tectonic compression (McLaughlin, verbal communication 2003).

A major drainage divide runs east-west along the northern portion of the site. Water to the north of the divide flows to Franz Creek while water to the south flows into Porter Creek. A seasonal, well incised, active stream dominates the topography in the west central section of the expansion area. The stream drains water to the west and off the property, before bending south and emptying into Porter Creek a few thousand feet away.

Past and present mining operations have modified the geomorphology of the quarry. Prior to major mining operations, a south facing ridge existed that was bounded on either side by minor south flowing drainages. Quarrying was concentrated on this ridge, creating the large depression that exists today. In general, the direction and volume of surface water runoff does not appear to have been significantly altered by mining.

C. Bedrock Geology

Franciscan Greenstone

Field observations indicate the greenstone unit is generally consistent in composition and character across the existing quarry and the expansion area. Greenstone is oceanic basalt that has been altered by low grade metamorphism. Large "pillows" ranging from less than a foot in diameter to about three feet across are locally visible in the quarry cuts indicating the basalt's submarine origin. The unit is bounded on the north by its east-west trending contact with the Sonoma Volcanics where it dips beneath the volcanics to the north. Greenstone is exposed throughout the rest of the existing quarry and the expansion area.

Based on observations from within the existing quarry, the weathered rock zone extends between 10 and 50 feet below the original ground surface. The weathered greenstone is oxidized to a tan and rust color and occasionally dark purple. Locally, it is closely to intensely fractured and exhibits a blocky habit. Near the surface the weathered rock is moderately strong and moderately hard and rapidly increases in strength and hardness with depth. The near surface weathered rock is of poorer quality and considered to be overburden. It is stripped off and stockpiled for reclamation purposes. BoDean informed us that some of the weathered greenstone encountered at depth is competent enough to be sold as general fill. Many of the joints (fractures) in the greenstone have been injected with secondary quartz and calcite, and on the western side of the southern ridge vesicles (small voids) have also been filled with quartz.

Unweathered greenstone is gray and faintly green in color and is hard and very strong. The groundmass of the rock is primarily composed of very fine grained clinopyroxene, plagioclase, magnetite, and calcite. The rock ranges between intensely fractured and widely fractured with the majority of the fracturing spaced approximately 1 to 2 feet apart. Fractures are typically tight, and a few have been in-filled and healed with secondary calcite and sometimes with quartz up to 1/8-inch thick. Between fractures, the rock is massive with no visible orientation of vesicles or layering. A complete petrographic description of the greenstone is included in Appendix A of this report.

Sonoma Volcanics

The Sonoma Volcanics vary widely in character and geomorphic expression across the site. In the northwestern section of the expansion area, the volcanics are moderately to highly welded (hardened by fusion of individual lithic fragments of ash immediately following deposition). They form the knobby peaks of the ridgeline and have near-vertical exposures up to 20 feet in height. In the northeastern section of the quarry, the unit has little or no welding and is not exposed in bold outcrops. The thickness of the unit is expected to vary considerably due to the irregular nature of its contact with the greenstone. In general it thickens quickly toward the north. This is demonstrated by the presence of the volcanics in the deep canyon bottoms at the northern extent of the site. The dip of this contact as measured by others in the general vicinity of the quarry range between 20° (Huffman & Armstrong, 1980) and 40 to 60° (McLaughlin, verbal communication 2003) to the north.

The volcanics in the area of the quarry are described by the CGS as locally welded or partly welded pumicitic ash-flow tuff (Huffman & Armstrong, 1980). Our field observations of the unit generally concur with this description. The outcrops in the northwest have a bluish gray to light purple matrix consisting mainly of volcanic glass. Inclusions consist of about 10% white, tan and brown lithic fragments composed of pumice, glass, hematite and hematized volcanic rock. The rock is moderately fractured, averaging 1 to 2 foot spacing and exhibits an irregular to slightly rounded habit. Depending on the degree of welding and weathering, the rock ranges from weak to moderately strong, and from low hardness to moderately hard.

The volcanics in the northeastern section of the site typically have a white, beige, and light rust colored matrix surrounding about 10 to 15% white and black lithic inclusions with the same composition as the northwestern rocks. The inclusions are locally preferentially oriented parallel to the ground surface. Larger exposures in road cuts show rounded agglomerate surrounded by weakly welded ash. The agglomerate is weak to moderately strong, and is moderately hard to hard. The ash in this area generally behaves more like soil than rock and is friable, weak, and exhibits low hardness. A black and dark brown andesitic outcrop was observed on one ridgeline to the northeast of the existing quarry. The dark matrix of plagioclase and quartz surrounds about 10% lithic inclusions composed primarily of pumice up to 3/8-inch in diameter. The rock is moderately strong, moderately hard, and is highly welded. This location is the only place this rock type was observed. Petrified wood is also present in small pieces throughout the volcanics.

Based on surficial exposures and discussions with BoDean, the Sonoma Volcanics does not appear be a marketable product at this time. Volcanic rock to be removed to gain access greenstone beneath it is considered overburden. Quarry personnel report that even samples of highly welded agglomerate that are exposed to surface conditions for an extended length of time dry out and become weak and friable. The best usage for any excavated volcanic rock will likely be for fill during reclamation.

Geologic Structure

Bedrock structure within the quarry is difficult to interpret due to the massive nature of the greenstone. McLaughlin (verbal communication, 2003) explained the structure in the general area of the quarry as being the northern limb of an anticline that has been truncated by the Petrified Forest Thrust Fault just south of the site. Uplift along the thrust fault accelerated erosion of the volcanics and exposed the greenstone in an east-west trending band that parallels the fault. On this basis, both the greenstone and the volcanics dip to the north. This is the result of folding from compression east of the Maacama Fault that created the anticlines and synclines in the Sonoma Volcanics to the north of the quarry. Cross sections showing our interpretation of the subsurface geology are shown on Figures 5 and 6, Geologic Cross Sections.

We measured 65 joint orientations from across the expansion area and in the existing quarry. Spacing of the joints ranges from less than one inch to up to 3 feet. The majority of the joints observed were less than 10 feet in length. They are typically tight in the fresh greenstone and separated by open spaces up to 1/8-inch wide in weathered greenstone and volcanics. Based on our review of the attitudes of the fractures, the rock does not appear to have any consistent major joint sets or discernable layers that would increase the potential for wedge type failures. A representative number of the joints measured are shown on Figure 2, Site Geologic Map.

D. Soils

Vegetation and soils cover most of the bedrock underlying the expansion area of the quarry. The thickness of the soil was observed in road cuts and hand dug pits to be between 0 and 36 inches, and may be deeper in areas of dense vegetation and colluvial filled swales and landslides. Organic rich topsoil is generally present throughout the area in varying thicknesses between 0 and 24 inches. Topsoil is minimal on the southern exposure where slopes are very steep. Soils are thicker in flatter areas of dense tree cover where up to 6 inches of organic detritus overlie the topsoil.

Soils covering the greenstone are silty clays with gravel, gravelly clays and silty clays. They are dark brown, stiff to very stiff, appear to be low plasticity and generally non-expansive. Percentages of greenstone rock fragments range from 5 to 30 percent.

Soils covering the volcanics are silty clays, sandy clays, and occasionally silty clays with gravel. They are light brown and beige to dark brown, stiff, medium to high plasticity and appear to be moderately to highly expansive. Rock fragments of more resistant welded tuff occasionally exist, but typically the surface volcanics have weathered to sand or silt sized particles.

In general, the soils observed match the Soil Survey for Sonoma County of 1972. A map showing the locations of soils identified by the Soil Survey is shown on Figure 3, Soils Map. Descriptions of the soils identified by the Survey are included below with slight modifications to reflect the presence of the quarry. Note that the soil thicknesses are based on regional information and local conditions in the quarry may not reflect those of the Soil Survey.

The Forward series consists of well-drained gravelly loams that have a gravelly sandy clay loam subsoil. At a depth of 20 to 40 inches these soils are underlain by rhyolite and soft rhyolitic tuff. A typical profile of the surface layer is about 6 inches of gray neutral gravelly loams and about 4 inches of light-gray, very strongly acid gravelly clay loam. The subsoil is white medium acid gravelly sandy clay loam, about 11 inches thick. At a depth of about 21 inches is weathered rhyolite.

Forward gravelly loam (FoG) –The soil is generally found on 9 to 30 percent slopes with a depth to bedrock from 25 to 30 inches. Rhyolite outcrops are exposed in some areas. Runoff is rapid to very rapid, and the hazard of erosion is high to very high. The available water capacity is 3 to 4 inches.

Forward-Kidd complex. (FrG) – Forward and Kidd soils each make up about 45 percent of the complex. The remaining 10 percent is made up of Toomes soils and Rock land. The Forward soils are similar to the FoG soils but have a depth of only 9 to 15 inches. The Kidd soils are found on 9 to 50 percent slopes with a depth to bedrock of 5 to 15 inches.

The Goulding series consists of well-drained clay loams. These soils are underlain at a depth of 12 to 24 inches by metamorphosed basic igneous and weathered andesitic basalt of old volcanic formations. In a typical profile the surface layer is brown and dark-brown, slightly acid and medium acid clay loam to about 11 inches thick. The subsoil is dark-brown, slightly acid very gravelly clay loam that is about 11 inches thick. Fractured basalt occurs at a depth of about 22 inches.

Goulding clay loam (GgF) – This soil is about 16 to 20 inches thick and found on slopes between 30 and 50 percent. Runoff is rapid and the hazard of erosion is high.

Goulding cobbly clay loam (GIF) – This soil is about 16 to 20 inches thick and found on slopes between 30 and 50 percent. The surface layer contains about 25 percent cobblestones and stones by volume. Outcrops of basaltic rock are scattered throughout areas of this soil. Runoff is rapid, and the hazard of erosion is high.

Rock land (RoG) – The soil consists of stony steep slopes and ridges that generally are in rough mountainous areas where there is little soil material.

Spreckels loam (SkE) – This soil is well drained with a clay subsoil. It is underlain at a depth of 22 to 60 inches by volcanic tuffs mixed with uplifted river sediment and weathered basic igneous rock. It is found on slopes between 18 and 25 percent in most places. The A horizon is from 18 to 26 inches thick and is light brownish gray to gray or grayish brown. Gravel content ranges from 0 to 20 percent by volume. The B horizon is between 18 to 34 inches thick and has a distinct spreckled appearance because of decomposed and scattered light-colored andesititc basalt fragments and tuffaceous sediment. Permeability is slow and runoff is medium to rapid. The hazard for erosion is moderate to high.

E. Landslides and Slope Stability

The Franciscan greenstone and Sonoma Volcanics in the area of the quarry do not appear to be highly prone to frequent landsliding events. The shallow soil development limits the potential for debris flows and major surficial slides. Areas of surface instability do exist on the south facing slope above Porter Creek Road. This is especially evident just above the existing entrance road where quarrying decades earlier has left a steep unvegetated slope that periodically undergoes minor rock raveling and sloughing. While this does not pose a broad instability issue, it will need to be mitigated as discussed further in Section IV B Mining Methods and Operation—Public Roadway Safety.

In the volcanic unit, we observed only a few small insignificant failures located in the steeper drainage channels. In the greenstone unit we identified two bowl or swale-shaped landforms that appear to be large ancient slides. The first is at the southwestern corner of the expansion area and extends across the southern property line. The second is on the northern side of the prominent east-west trending greenstone ridge. The locations of the slides are shown on Figure 2, Site Geologic Map. Both slides appear dormant, that is, not grossly active at this time. The depth, rate of movement if any, and confirmation of slide origin would require detailed investigation that does not appear necessary at this time.

The landslides do not appear to present a hazard to mining if the recommendations presented in this report are implemented. However, the passage of time and modifications of drainage patterns may affect the slope stability and future evaluations may be necessary. The southwestern slide should be avoided because there is a residence present on its lower slopes. This should not constrain proposed mining because the slide mass appears to be just beyond the expansion area. As the more northerly slide is exposed by mining, it may be found to contain deeply weathered slide material, probably predominately rock, and likely thicker overlying soils.

According to BoDean, wedge type failures in the rock cuts of the existing quarry occasionally occur. Three thin wedge failures were observed by us on the northeast side of the quarry. They were roughly equal in size, steeply inclined, about 20 to 25 feet across and about 20 feet long and ranged in volume from 25 to 75 cubic yards. The thickness of the failures is between 1 and 5 feet. The failures reportedly occur seasonally, typically during the wet season when exposed joints become saturated. Rock debris from all of the failures has been contained on the working bench immediately below. The stability of the rock and likelihood of future wedge failures is discussed further in Section IV C, Mining Methods and Operation—Working Slope Recommendations of this report.

F. Springs and Seepage

During our site reconnaissance in August and October only minor seepage was observed in the active quarry. It was located at elevation 1030 feet by the primary rock crusher and totaled less than a gallon a minute. BoDean reported that during the winter months, seepage is greater and occurs over a much wider area. A small area of seepage exists on the western side of the site. It is on a north facing slope at elevation 1200 feet. A small embankment was constructed at this location to collect the seepage.

IV. MINING PLAN GEOTECHNICAL CONSIDERATIONS & RECOMMENDATIONS

A. General

Based on our work we conclude that, with the incorporation of the recommendations provided in this report, the planned expansion to the Mark West Quarry is feasible from a geologic and geotechnical standpoint. The primary geotechnical issues are: stability of working cuts and reclaimed slopes, seismicity, and erosion of temporary stockpiles.

B. Depth, Quantity, and Type of Minerals to be Mined

The target resource of the quarry is Franciscan greenstone. The processed rock is sold as high quality aggregate in various forms described in Section C below. Based on logs from three water wells drilled onsite, the greenstone exists to a bottom elevation of at least 650 feet above sea level just east of the expansion area. The bottom elevation proposed for the quarry expansion is 945 feet above sea level. Thus, greenstone persists for at least 290 feet below the maximum depth of proposed mining. Observations of continuously exposed greenstone along Porter Creek Road lend support to the conclusion that the greenstone also extends to at least this depth beneath the expansion area.

Based on this available depth and the mining plan prepared by Sandine and Associates, Inc., the estimated total volume of material to be removed will be 28 million cubic yards. The mining plan has been overlain on our Site Geologic Map on Figure 2A to show the geology that is expected to be encountered over the course of the mining operation. This consists of approximately 3 million cubic yards of greenstone overburden, 3 million cubic yards of volcanics, and 22 million cubic yards of marketable greenstone. This volume assumes an average greenstone overburden thickness of thirty feet and an inclination of about 45° for the contact between the volcanics and the greenstone. Based on a conversion factor of one cubic yard equals 1.8 tons of in place greenstone and 1.5 tons of in place greenstone overburden and volcanics, these volumes convert to approximately 39.6 million tons of marketable greenstone, 9 million tons of greenstone overburden and 9 million tons of volcanics. BoDean reported that, on average, they sell about 20% of the greenstone overburden material as general fill. This amounts to 600,000 cubic yards and 900,000 tons for the expansion area.

C. Mining Methods and Operation

Current Operations

Mining operations consist of blasting approximately twice per month on the average, and up to 3 times a week during peak production. Following blasting, the broken rock is dumped over the operational face to a lower bench and then transported a short distance to the crusher. Track or wheel-mounted mining equipment consists of bulldozers, front-end loaders, backhoes, and a blast hole drill rig. A sheeps-foot compactor is used for on-going slope reclamation. Processing consists of reducing the rock size to the required diameter using primary and secondary crushers, and by screening. Conveyor belt systems transport partially processed materials and stockpile final products. The rock is dry-processed and water is used only for dust suppression and to moisture condition products prior to sale. During peak usage in the summer, approximately 10,000 gallons of water per day are used. The water is supplied by three on-site wells. Ground seepage occurs at locations in the quarry face year-round, but primarily during the winter months. The seepage plus storm runoff is directed into siltation ponds to prevent off-site erosion and siltation impacts.

Both fresh and moderately weathered greenstone is sold. The weathered rock is primarily sold as general fill and the fresh rock is sold as aggregate baserock, aggregate sub-base, permeable rock, and open graded crushed rock. Overburden is currently stockpiled to the north of the quarry and is used for reclamation, which is currently occurring on the eastern slopes of the quarry.

Working Slope Recommendations

In general, the existing working slopes of the quarry are performing well from a stability standpoint. As previously discussed, we measured 65 joint orientations from across the expansion area and in the existing quarry. A representative number of the joints measured are shown on Figure 2, Site Geologic Map. Based on our analysis of the fracture attitudes, the rock does not appear to have any consistent major joint sets or other discontinuities that would increase the potential for wedge type failures. However, this does not imply that all joints in the rock do not intersect at an angle that could produce a wedge failure and it should be expected that wedge failures will occasionally occur in the future as they have in the past.

The existing slopes consist of 45 foot wide benches and vertical cuts up to 90 feet in height with 60 feet being the average. We judge that this ratio should continue to be effective in fresh and slightly weathered greenstone.

Working slope recommendations are as follows:

- In order to reduce the size and damage created by a rock failure, benching must also be implemented in the expansion area.
- The width of the benches should be no less than half the height of the face that is directly adjacent it.
- Vertical cuts should generally be kept to 60 feet in height, and 90-foot vertical cuts should only be excavated if the rock appears highly stable and shows no signs of sloughing or failure.
- Overburden at the top of working slopes consisting of soil and highly weathered rock should be sloped no steeper than 2:1.
- Minimum 10-foot wide benches should be constructed every 30 vertical feet or at the middle of the slope, whichever is less.
- All working slopes must conform to the applicable requirements and guidelines set forth in the most current versions of the Federal Mine Safety and Health Administration Program (MSHA) and the California Division of Occupation Safety and Health (OSHA).

A majority of the northeastern section of the expanded quarry will be in the Sonoma Volcanics. Since major excavations into the volcanics have not yet occurred, it is not possible to accurately assess the stability of this material. It is understood that the unit dips steeply to the north, which is a favorable stability orientation for the Sonoma Volcanics as a whole. However, the variability in the strength of the volcanics is such that areas of it may not be stable at the same excavated slope angles as the greenstone.

Recommendations for excavating Sonoma Volcanics are as follows:

- When blasting and excavation of the volcanics commences, the slopes should be observed by a Certified Engineering Geologist or licensed Geotechnical Engineer to assess their stability and to make further recommendations as needed.
- Working slopes in the volcanics should be regularly inspected by experienced, onsite quarry personnel to identify any potential areas of instability and as necessary, take steps to improve stability and maintain safe working conditions.

Identified landslides (see Figure 2) will not likely pose a significant hazard to the expansion of the quarry. The probable landslide on the northern greenstone slope may have produced a thicker than usual weathered zone of rock and overlying soil. These materials may not be stable at working slope ratios and heights. The planned direction of mining from east to west and south to north should result in the upslope parts of the landslide being removed first, which should not create destabilizing effects. If however, removal of toe (downslope extremity of the landslide) material occurs prior to the mining of the upper area, the slope could potentially become unstable. Also, care should be taken during blasting and rock removal in this area. It is not possible to evaluate the extent of the weathered zone in the slide mass or predict the stability of the slope without subsurface investigation.

Public Roadway Safety

An issue requiring careful attention is preventing any rock debris from falling onto Porter Creek Road as the southern ridge is mined. The current mining method employed at the quarry of cutting faces and benches and pulling the material back from the slope should reduce the potential of debris from falling onto the roadway.

Recommendations for protection of the roadway are as follows:

- A temporary and substantial rock catchment barrier should be installed along that part of the southern property line to be mined in order to catch any debris that might accidentally be released down the slope. The catchment should be carefully selected to afford maximum protection and be securely installed.
- An access road or other flattened setback should also be maintained along the top of quarry on the southern side to prevent a sharp ridge being formed that could be susceptible to rock release or accelerated erosion.

Equipment Safety—Seismic Shaking Considerations

Quarry processing equipment, especially conveyors that have a high center of gravity, pose a safety hazard during strong seismic shaking. Quarry processing equipment should be designed according to current building code standards and should take into consideration the potential for strong seismic shaking at the site.

D. Mine Waste Disposal

Due to the nature of the mining operation, there is no waste generated. Overburden will be stripped, stockpiled onsite, and used in reclamation. The greenstone resource will be sold. Volcanic rock that will be removed as the quarry expands to the north will likely be treated as overburden and stockpiled accordingly for use in continuous reclamation processes.

V. RECLAMATION

A. Area Covered Under Reclamation Plan

Currently, the mining operation covers about 34 acres of an 87-acre parcel. The planned expansion area is primarily to the west and slightly north of the current mining operation. This will increase the minable area to about 99 acres. The expansion area will be on land owned by BoDean and land that is leased from a private land owner. The reclamation plan covers the entire 99 acres as shown on Figure 1, Site Location Map. The end use of the quarry is proposed to be general agriculture.

B. Reclamation Methodology and Sequence Phasing

Phasing

The expansion of the quarry is expected to occur in two major phases. In the first phase, the present western face of the quarry will be mined and the quarry will gradually expand to the west. Mining will take place on the prominent east-west trending ridge above Porter Creek Road. Phase 2 will begin once the western extent of the property is reached. Mining will then progress north up to the northern ridgeline. Reclamation will occur concurrently with mining. Working slopes will be converted to less steep reclaimed cut slopes as part of the mining process. A diagram showing a schematic representation of the conversion of working slopes to reclaimed slopes is shown on Figure 7, Conversion of Working Slopes to Reclaimed Slopes.

Soil Types and Salvage

The thickness of organic rich topsoil (A and AB horizons) varies across the site from 0 to about 24 inches with an average depth of about 12 inches. Silty, sandy and gravelly clays make up the subsoil and were generally observed to be up to 40 inches thick.

The recommendations provided below are intended to limit erosion and instability of reclaimed fills over an extended period of time. If some soil stockpiles will not remain in place through a wet season, certain recommendations may not be practical, such as the installation of subdrains or the effort put into compaction. It should be noted though, that the performance of the stockpile fills are ultimately the responsibility of BoDean or any future quarry owner and, if there is any question about fill construction, a Geotechnical Engineer should be consulted.

We anticipate that overburden for use in reclamation could be stockpiled for up to 10 years or more. During this time interval there is the potential for a few winters with heavy storms and greater than average rainfall. Also, the probability of a moderate earthquake in the next 10 to 20 years on a nearby active fault, such as the Rodgers Creek Fault, is moderate to high (USGS, 2002). Therefore, care should be taken when stockpiles are constructed in order to prevent slope failures and siltation damage to drainage systems and neighboring property. A cross section detailing a typical fill slope is shown on Figure 8, Typical Hillside Fill Construction.

Recommendations for the construction of long-term stockpiles are as follows:

- Temporary stockpile fill slopes should be no steeper than 2:1.
- Minimum 10-foot wide benches should be constructed no greater than 30 vertical feet apart and should be sloped to convey surface water away from the slope and into an approved drainage system.
- If possible, stockpiles should be placed on level ground. Stockpiles placed on slopes greater than 5:1 should be placed on benches that are cut to dip into the slope at an angle of 2% or greater.
- Keyways should be constructed at the base of the fills to found the stockpile into the slope.
- Fill materials should be placed with reasonable effort using onsite equipment. Note that low compaction and steeper slopes increase the potential for erosion and landsliding. In general, the longer a stockpile will be in place, and the steeper the slope, the more effort should be put into compaction of the stockpile. At the time of fill placement, a Certified Engineering Geologist or licensed Geotechnical Engineer should provide specific recommendations for compaction of stockpiles.
- Perforated subdrains should be placed in keyways and on benches to prevent the stockpiles from becoming saturated and unstable. The subdrains should outlet into an approved surface drainage system.
- To prevent surface erosion and gullying of the slopes, the surfaces of stockpiles should be vegetated by hydroseeding or an alternative method.

Slope Stability and Reclaimed Slope Recommendations

Existing reclaimed fill slopes constructed from overburden material are reportedly up to 100 feet thick on the slopes above the north face of the present quarry, and up to 50 feet thick on the eastern slope. The average slope inclination of the reclaimed fills is 2:1 (horizontal:vertical), and some sections are inclined slightly steeper due to slope limitations imposed by pre-BoDean mining. BoDean reportedly began placing the reclamation fills in 1998. Based on our observations, the slopes appear to be performing well with no significant failures or slides. Based on our present knowledge, the existing stockpiles and reclaimed slope fills are undocumented, that is, we have no record of compaction effort or benching procedures. Representatives from BoDean stated that subdrains were installed at the bases of the reclaimed slopes and that no failures have occurred in these slopes. However, if moderate to severe earthquake shaking occurs, it should be expected that some deflection or possible sliding of the fills could result.

Based on the height and large area of final slopes created at the completion of mining compared to the limited amount of overburden that will be generated, the final reclaimed slopes will be predominately rock cut slopes rather than fill slopes.

Recommendations for final reclaimed cut slopes in greenstone are as follows:

- Based on our geologic observations of the existing cuts and analysis of joint data collected, we recommend that final reclaimed cut slopes in greenstone should average no steeper than 1.5:1 from the base of the cut to the top of the marketable rock.
- 15-foot wide drainage/catchment benches should be constructed every 30 vertical feet and intermediate cut slopes should have a maximum inclination of 1:1. Final reclaimed slope inclinations are schematically shown on Step 4 of Figure 7.

We anticipate that these recommendations will also be suitable for reclaimed slopes in the Sonoma Volcanics. However, as discussed in the section on Working Slopes, there is little data available at the time of this report to determine the long-term stability of slopes in the volcanics.

Recommendations for final reclaimed cut slopes in volcanics are as follows:

- When working slopes in the volcanics begin to be converted to final reclaimed slopes they should be inspected by a Certified Engineering Geologist or licensed Geotechnical Engineer to determine the stability of the slopes and to make recommendations for enhancing stability if necessary.

Recommendations for final reclaimed slopes in greenstone overburden are as follows:

- Final reclaimed slopes in the overburden should have a maximum inclination of 2:1.
- Minimum 10-foot wide benches should be constructed every 30 vertical feet.
- If the height of the slope requires benches, intermediate slopes should not be steeper than 2:1. If the slope is greater than 30 feet high, but less than 60 feet, construct one bench in the middle of the slope.
- The top of the overall cut slope should be rounded off to prevent a sharp edge that will be susceptible to accelerated erosion or rockfall.

A permanent reclaimed fill slope or berm will be constructed on the south side of the mining area to minimize the visual impact of the completed quarry. The thickness of the fill will be approximately 40 feet.

Recommendations for final reclaimed fill slopes are as follows:

- Permanent reclaimed slopes should be no steeper than 2:1.
- Minimum 10-foot wide benches should be constructed no greater than 30 vertical feet apart.
- Fill will likely be placed on completed rock cut benches. The benches should be cut to dip into the slope at an angle of 2% or greater.
- Keyways should be constructed at the base of the fills to buttress the fill into the slope.
- Perforated subdrains should be placed in keyways and on benches to reduce the risk the fills from becoming saturated and unstable. The subdrains should outlet into an approved surface drainage system.
- To prevent surface erosion and gullying of the slopes, the surfaces of the fills should be vegetated by hydroseeding or an alternative method.
- The berm on the south side of the mining area will be located above Porter Creek Road and should be compacted to a minimum of 85% relative compaction to minimize the risk of sloughing or sliding onto the roadway.
- If fill slopes other than the planned berm become necessary, a Certified Engineering Geologist or licensed Geotechnical Engineer should provide specific recommendations for compaction of fill slopes.

A cross-section detailing a typical fill slope is shown on Figure 8, Typical Hillside Fill Construction. Other reclaimed fill slopes are not expected to be needed due to the relatively small amount of overburden generated compared to the final size of the quarry. However, if future changes to the reclamation plan require fill slopes they should be constructed according to the recommendations described immediately above.

Quarry Floor Reclamation

Reclamation of the final quarry floor will include filling with overburden to create soil cover and a medium for agricultural usage. The thickness of the fill will depend on the amount of overburden available, but will likely average approximately 20 feet. For the proposed end use of general agriculture, where settlement will not pose any significant problems or hazards, compaction of the fill on the relatively flat quarry floor is not considered to be a major concern.

Recommendations for reclamation of the quarry floor are as follows:

- Fill with a plasticity index (PI) of less than 30 (non-expansive) may be placed at slopes no steeper than 3:1.
- Fill with a PI of greater than 30 (moderately to highly expansive) may be placed at slopes no steeper than 4:1.
- All quarry floor fills should be moisture conditioned to near optimum and track-walked in lifts to provide initial compaction that will decrease the erosion potential.
- Any fills that are steeper than the inclinations stated immediately above should be constructed based on the recommendations for final reclaimed fill slopes presented on the previous page.
- Where catchment dams, subdrains, or other structures used for drainage or water retention are either buried in or rest on top of reclaimed fill on the quarry floor, the compaction of the fill under and around these structures should be designed to minimize the settlement of the fill to limit damage or decreased performance over the long term.
- Gravity flow storm drains, open channels, or other improvements with minimal slopes toward outfalls may be adversely impacted by settlement of loosely compacted fill and should be designed accordingly

Currently the proposed end use does not call for any structures to be built on the site and our recommendations for reclamation of the quarry floor reflect this. Fill placed as described above for agricultural use will not be suitable for the construction of buildings. If structures are ever proposed on the site, a complete geotechnical and geologic evaluation must be conducted to determine feasibility and provide design recommendations.

Slope Drainage

- In order to prevent accelerated erosion of permanent reclaimed slopes, intermediate benches should be angled back into the slope at a minimum of 2%.
- Rock-lined v-ditches or earth swales should be built along the tops of all slopes to collect any runoff from continuing down the cut or fill slopes.
- The benches and v-ditches should be sloped to convey the collected runoff into an approved drainage system.

Monitoring

The services of a Certified Engineering Geologist should be retained on an annual basis to assess the success of the recommendations set forth in this report, especially with respect to the stability of the final reclaimed cut slopes, and to make recommendations for changes as necessary.

Following the occurrence of an earthquake, an inspection should be made of all working and reclaimed slopes, and large stockpiles of overburden. The inspections should be done by experienced, onsite mining personnel. The intent shall be to identify any failure or incipient failures that require correction for safety or ongoing mining. In the event of large failures, a Certified Engineering Geologist or licensed Geotechnical Engineer should be retained to recommend repair procedures.

The end land use of the quarry is proposed to be general agriculture. When reclamation is completed and the quarry is to be converted to its final end use, a Certified Engineering Geologist or licensed Geotechnical Engineer should evaluate the conditions of the reclaimed slopes. If the end use is changed in the future from general agriculture, such as any type with public access or the construction of buildings, the recommendations of this report must be re-evaluated to ascertain their application to the revised end use.

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APPENDIX C-2

Slope Stability Investigation

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SLOPE STABILITY INVESTIGATION
MARK WEST QUARRY EXPANSION
SANTA ROSA, CALIFORNIA

December 13, 2011

Project 1442.02

Prepared for:
Michael J. Dwyer, Consulting Geologist
2475 Burnt Oak Drive
Santa Rosa, California 95401

CERTIFICATION

This document is an instrument of service, prepared by or under the direction of the undersigned professionals, in accordance with the current ordinary standard of care. The service specifically excludes the investigation of radon, asbestos, toxic mold and other biological pollutants, and other hazardous materials. The document is for the sole use of the client and consultants on this project. Use by third parties or others is expressly prohibited without written permission. If the project changes, or more than two years have passed since issuance of this report, the findings and recommendations must be reviewed by the undersigned.

MILLER PACIFIC ENGINEERING GROUP
(a California corporation)

REVIEWED BY:

Benjamin Pappas
Geotechnical Engineer No. 2786
(Expires 9/30/12)

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Geotechnical Engineer No. 2398
(Expires 6/30/13)

Miller Pacific ENGINEERING GROUP

SLOPE STABILITY INVESTIGATION
MARK WEST QUARRY EXPANSION
SANTA ROSA, CALIFORNIA

TABLE OF CONTENTS

I. Introduction

We understand Bodean (the Applicant) is planning to expand the area of their existing mining operations at Mark West Quarry (20-year mining plan). Prior to approval of this expansion, an Environmental Impact Report (EIR) is required as part of the permitting and approval process (Sonoma County PRMD). The purpose of Miller Pacific Engineering Group's (MPEG) work, as described herein, was to provide geotechnical analyses for incorporation into the Geology, Seismicity and Soils section of the EIR. This work was necessary because there are existing and future slope conditions at the quarry that required more detailed geotechnical characterization and stability analysis to adequately identify impacts and develop appropriate mitigations. Our work consisted of three tasks, which are:

- Slope stability analyses to develop factors of safety for the large ravine fill area comprised of mining overburden and slide debris.
- Slope stability analyses to develop factors of safety of the 2004 landslide area. The landslide was caused by excessive overburden stockpiling in the early 2000s. Following failure, the stockpile was removed to decrease continued movement and the ravine (ravine fill) became the disposal destination for the removed slide debris.
- Stability analysis and development of factors of safety for the high wall area rock slopes that will remain adjacent Porter Creek Road at the completion of mining (20-year mining plan).

II. Field Exploration and Laboratory Testing

Soil Exploration – We explored subsurface conditions at the ravine fill and previous landslide with a total of seven soil borings drilled with truck mounted equipment on October 21st, 22nd and 27th of 2010. The locations of the borings are approximately shown on Figure 1. The purpose of our exploration was to assist in better defining the fill/bedrock contact in these areas and to collect select soil and rock samples to determine their pertinent engineering properties. The subsurface exploration program is discussed in more detail and presented with the boring logs and laboratory testing in Appendix A.

During our exploration, the borings were logged in the field and select soil samples were collected for laboratory testing to determine their pertinent engineering properties, including, moisture content, dry density, sieve analyses, percent passing the #200 sieve, unconfined compressive strength (UC), unconsolidated undrained triaxial compressive strength (TXUU), and consolidated undrained triaxial compression tests with pore pressure measurements (TXCU-p).

The borings were drilled to depths between 12.0 to 66.5-feet below the ground surface. A Soil Classification Chart and a Rock Classification Chart are presented along with the boring logs on Figures A-1 through A-20. The results of moisture content, dry density, percent passing #200 sieve, unconfined compressive strength, TXUU, and TXCU-p tests are presented on the boring logs. Additionally, plots of the shear strength profiles based on the UC, TXUU and TXCU-p test results are presented on Figures A-21 and A-22. The results of the sieve analyses are presented on Figures A-23 and A-24.

To reduce sample disturbance the soil samples were reconsolidated to about 120% of their calculated overburden pressure. The sample was then given time to consolidate under load and pore water pressures were allowed to dissipate. Vertical load was then applied until the sample sheared and pore water pressures were measured during the shearing process. In addition to TXCU-p tests, we performed UC tests on samples of the fill material.

Rock Mass Characterization – Michael J. Dwyer, CEG measured existing bedrock discontinuities (joints, faults and shear zones) within greenstone bedrock (mined rock) in the existing quarry and expansion area where rock outcrops were visible and readily accessible. This was done as part of the third bulleted task above. Over 200 such measurements were taken. The measurements for each discontinuity included, azimuth, dip, joint persistence (lateral extent of the joint), and Barton's Joint Roughness Coefficient (JRC). Field estimates of JRC values were made in general accordance with the procedures outlined by Hoek (2000). The results of Mr. Dwyer's field measurements are presented in the attached Table A.

III. Subsurface Conditions

The subsurface conditions at the ravine fill and prior landslide are generally consistent with the mapped geology as shown on Figure 1. The borings were drilled in the existing fill, prior landslide areas and underlying bedrock at the approximate locations shown on Figure 1. The fill materials observed during our exploration consists of medium dense to very dense clayey gravels and clayey sand. This fill is greenstone overburden and minor filter press material, both of which are by products of the mining operation, and the material from the prior landslide consists of pale-colored volcanic ash/ash flow. Based on our review of the 2003, 2007, and 2010 topographic maps provided by Bodean, the fill thickness varies and is approximately 125-feet at its deepest. Highly weathered volcanic tuff was observed between 2 and 27-feet below the ground surface during our exploration. The weathered tuff is less weathered and harder with depth.

We did not observe groundwater during our subsurface exploration. Groundwater levels typically fluctuate with the seasons and may be nearer to the ground surface during the winter months and/or periods of intense rainfall as the surficial fill soils saturate. However, subdrains were installed as the fill buttress was constructed. Therefore, we anticipate much of the collected rainwater will percolate through the predominately granular fill and be collected in the underlying subdrain system.

IV. Stability Analyses

Stability analyses were performed on the current ravine overburden stockpile area, the old overburden/2004 landslide area, and the proposed quarry walls for the expansion. Our analyses were performed with limited exploration and laboratory testing. Additional exploration and testing could provide additional data that might refine the resulting strength parameters utilized.

Input Parameters – Various rock and soil properties were analyzed to develop strength profiles for stability analyses. The parameters chosen for our analyses are discussed below:

Greenstone Quarry Faces – Rock formations located in the California Coast Ranges are typically pervasively fractured and folded by extensive, long term tectonism. The greenstone resource rock at the quarry reflects these conditions with its dense pattern of short, irregular, tight fractures (nonsystematic joints), punctuated by well defined, more widely spaced, more linear, joints, faults and shear zones. These latter features are referred as bedrock discontinuities. Depending on their orientation, persistence and other related features, the discontinuities can have a negative influence on the stability of bedrock slopes. For this reason, measuring and characterizing discontinuities is an important task in the overall analysis of rock slope stability. All the discontinuity measurements taken in the field were input into the stereonet program Dips (Ver 5.108) produced by Rocscience. Based on the results of our analyses, only 5% or less of the observed discontinuities contained similar orientations as shown on Figure 2. Therefore, there does not appear to be any predominate joint sets from the data collected in the field.

All discontinuity sets were categorized by their persistence values and grouped into three persistency sets. The persistency sets included all discontinuities with a persistence of 5 (joints >65-feet), all discontinuities with a persistence of 5 and 4 (between 35 and 65>feet), and all discontinuities with a persistence of 5, 4, and 3 (discontinuities between 10 and 65>feet). Discontinuities with persistence values of 2 and 1 (joints < 10-feet) were considered small and were not included in our analyses.

The discontinuity shear strength utilized in our quarry face analyses was based on the Barton-Brandis failure criteria that include the base friction angle, Joint Roughness Coefficient (JRC), and the Joint Compressive Strength (JCS). The Barton-Brandis values utilized in our analyses is discussed below:

- Base Friction Angle –Research by Wines & Lilly, (2003) and Hoek & Brown, (1997) indicates the base friction angle, ϕ, for similar rock material to greenstone ranges from 31 to 38 degrees. For our analyses we utilized a conservative estimate of the base friction angle of 30 degrees.
- JRC – As previously discussed, field estimates of the rock joint JRC values were recorded in general accordance with the procedures outlined by Hoek (2000). An average JRC value of approximately 8.0 was calculated based on the results of our field measurements and was utilized as our JRC value in our analyses.
- JCS – Based on our research (Wines & Lilly, 2003 and Hoek & Brown, 1997) JCS values for similar rock type ranges from approximately 250 to 1,000 tons per square foot (tsf). To account for the variability of the joint strength observed in the field and lack of expensive laboratory testing we utilized a conservative value of 100 tsf in our analyses.

Fill Slopes – As previously mentioned we performed laboratory testing to determine the strength envelope for use in our analyses. The results of the laboratory strength tests are presented on the boring logs and graphically on Figure A-21. The total and effective stress failure envelopes are shown graphically on Figures A-21 & A-22 and are briefly discussed below:

- Total Stress – The total stress failure envelope was developed utilizing the UC, TXUU and TXCU-p test results. A plot of the failure envelope utilized in our analyses is presented on Figure A-21. These values were utilized in our slope stability analyses under short term seismic conditions.
- Effective Stress – The effective stress failure envelope was calculated by subtracting the measured pore water pressure from the total shear stresses. The soil strength includes cohesion of 300 psf and a friction angle of 30 degrees, as

shown graphically on Figure A-22. These values were utilized for long term static conditions.

Seismic Coefficients – Two separate pseudo-static seismic coefficients were selected based on the stability analyses performed. Each seismic coefficient was based on a 10% in 50 year (475 year return interval) probabilistic peak ground acceleration of 0.44 g. The quarry face seismic coefficient was modified to 0.28 g per the methods outlined by Ashford & Sitar (2002) to account for the relatively tall and steep quarry face. The fill slope seismic coefficient was modified to 0.25 g per the procedures outlined by Pyke (2004).

Section A-A': Current Overburden Stockpile Area (Ravine Fill) – The current stockpile area is located to the west of the old overburden storage area (prior landslide). The ravine site was utilized to stockpile the material removed to mitigate the 2004 landslide and to accept new overburden and filter press materials from the ongoing quarry operations.

Cross section A-A' and soil/rock properties obtained from our laboratory testing were input into the limit equilibrium slope stability computer program SLIDE (version 5.043) produced by RocScience to determine both the static and pseudo-static factors of safety utilizing Spencer's Method for calculating the factor of safety. In addition to the current conditions, we also analyzed the anticipated increase in volume of the overburden during the quarry expansion. The cross sections analyzed, soil properties and calculated factors of safety are presented on Figure 3 and the results are outlined below:

CROSS SECTION A-A'
STABILITY RESULTS
Mark West Quarry Expansion
Santa Rosa, California

	Pseudo-Static Acceleration	Calculated F.S.
2011 Conditions, Static	-	1.68
Proposed Max. Fill, Static	-	1.69
2011 Conditions, Pseudo-Static	0.15 g	0.76
Proposed Max. Fill, Pseudo-Static	0.15 g	0.73
2011 Conditions, Pseudo-Static	0.25 g	0.63
Proposed Max. Fill, Pseudo-Static	0.25 g	0.61

Notes:

1. Initial screening performed utilizing a 0.15 g seismic acceleration. Since the calculated factor of safety is less than 1.15, a pseudo-static analysis was performed with average peak accelerations to estimate seismic displacements.
2. Design seismic coefficient calculated utilizing the procedures outlined by Pyke 2004.

Based on the results of our analyses the slope may displace under seismic conditions. Slope failures can result in displacement of sizable soil masses. During a maximum credible earthquake the predicted slope displacement is approximately 1.2 to 4.5-feet. However, our analyses are based on a 2-Dimensional slope stability analysis that analyzes the "worst case scenario" cross section down the middle of the existing fill slope. Since the fill slope was constructed in a ravine, the center of the ravine will have the deepest fill with the depth of fill significantly reducing toward the outer edges of the fill area. Therefore our analyses likely provide lower factors of safety and higher displacement estimates compared to a 3-Dimensional analysis of the site conditions.

Section B-B': Old Stockpile/2004 Landslide Area – The old overburden area (prior landslide) was utilized to stockpile the soil and rock material that overlies the quarry source material. A relatively large landslide occurred in 2004 on the northern portion of the overburden area. The weight of the overburden material caused the mobilization of the landslide that sheared through the overburden material and the underlying volcanic ash/ash flow bedrock. Overburden material was removed in 2004 to reduce the driving force of the landslide and reduce the potential for future significant movement. Visual observations made at the time indicated that the removal appeared to bring slide movement to a halt, but the factory of safety under static and dynamic were not calculated at that time.

To determine the current factor of safety of the existing site conditions we first "back calculated" the strength properties of the overburden and bedrock materials by developing a cross section of the landslide area prior to the failure, as shown on Figure 4. The cross section, soil and rock properties were input into the slope stability computer program SLIDE (version 5.043, produced by RocScience). Soil and rock properties were adjusted until a failure plane (factor of safety = 1.0) of similar size observed in field was developed in SLIDE. The resulting failure plane and back-calculated strength is presented on Figure 4.

To determine the factor of safety of existing conditions (after removal of landslide/overburden material) we input the current cross section into SLIDE and utilized the back calculated peak rock strengths and estimated residual strength. The same failure circles were then analyzed to determine the existing factors of safety. The existing cross section, the soil properties and failure circles utilized to determine the existing static and seismic factors of safety are presented on Figure 4 and the results of our analyses are outlined below:

CROSS SECTION B-B"
STABILITY RESULTS
Mark West Quarry Expansion
Santa Rosa, California

	Seismic Acceleration	Calculated F.S.
Static Conditions	-	3.35
Psuedo-Static Conditions	0.25 g	1.32

Section C-C' Proposed Quarry Highwall (20-year mining plan) – When future mining is completed (20-year mining plan), the ridge top comprising the expansion area will be reduced in height by up to 400 feet and the final highwall will be in benched rock for its full height (up to 300 feet). The planned quarry excavation will include 1:1 cut slopes 30-feet in height with 15-foot wide level benches between cutes.

When inherent discontinuities within the rock mass intersect they form wedges. Wedges become unstable if their inclination is sufficiently steep in the downslope direction and discontinuity strength is sufficiently low. The rock discontinuity orientations measured in the field were grouped into categories based on the persistence of the various discontinuities. The discontinuities where then input into a rock slope analysis program, SWedge (ver 5.013) to determine the factors of safety of every wedge formation possible based on the intersections of the discontinuities and strength parameters input.

We analyzed two separate conditions, the possibility of a global failure of the entire (~300-foot) final slope and of the individual benched slopes (~30-feet) for 5-separate slope faces under both static and seismic conditions. The potential wedge sizes were limited based on the smallest persistence value of each group. The approximate locations of the quarry slope analyses are shown on Figures 1 and 5 and the results of our analyses are presented below:

SWEDGE STABILITY RESULTS
Mark West Quarry Expansion
Santa Rosa, California

Quarry Face	Persistence	Calculated Static F.S.		Calculated Seismic F.S.	
		Bench	Overall	Bench	Overall
NW Slope	5	4.52	6.51	2.70	3.14
NW Slope	5 & 4	1.87	3.94	1.11	2.16
NW Slope	5, 4, & 3	1.95	3.32	1.16	1.87
NE Slope	5	3.97	6.69	2.24	3.57
NE Slope	5 & 4	1.87	3.78	1.12	1.89
NE Slope	5, 4, & 3	1.91	3.57	1.13	1.97
SW Slope	5	3.97	6.08	2.42	3.26
SW Slope	5 & 4	1.87	3.48	1.12	2.00
SW Slope	5, 4, & 3	3.18	3.83	1.90	2.19
SE Slope	5	3.40	4.98	1.93	2.65
SE Slope	5 & 4	1.95	3.40	1.11	1.85
SE Slope	5, 4, & 3	1.98	3.49	1.18	1.99
W Slope	5	3.27	4.50	1.89	2.54
W Slope	5 & 4	1.87	3.56	1.11	1.83
W Slope	5, 4, & 3	1.90	3.57	1.13	1.97

Based on our analyses, the factors of safety of the potential large (global) quarry slope failures (analyzed with the rock discontinuity orientations measured in the field) are above the minimum static and seismic factors of safety of 1.5 and 1.1, respectively. However, it is not feasible to measure every rock discontinuity located within the potential rock quarry expansion area. Additionally, the field-measured shear strength of individual rock discontinuities can vary from point to point along the surface of the discontinuity. Based on information provided by Mr. Dwyer, the quarry walls that are being actively mined have, over the years, undergone a moderate number of small to moderate rockslides. One very large failure occurred beneath reclaimed slopes in the early 2000's. These failures (possibly including the large slide) appear to be caused by adverse discontinuities in the bedrock. Therefore, we anticipate some similar, predominantly small to moderate rock slope failures will occur during the planned mining process and possibly in the final, reclaimed rock slopes. We anticipate these failures may become more prevalent in response to seismic events, or in response to unusually high and prolonged rainfall. Placement of the planned reclamation fill will improve stability and buttress the lower portion of the mined slopes. The fill shall placed is properly keyed, benched, drained and compacted to the current standards of practice.

SWEDGE only analyzes failure wedges formed when two planar rock discontinuities intersect. Additionally, SWEDGE will not analyze failure planes that fail below the quarry pit bottom. Therefore, to supplement our SWEDGE analyses we performed a SLIDE analysis of the proposed, final, reclaimed rock slopes. The cross section analyzed, rock properties and factors of safety results are presented on Figure 5 and the results are outlined below:

CROSS SECTION C-C"
SLOPE STABILITY RESULTS
Mark West Quarry Expansion
Santa Rosa, California

	Seismic Acceleration	Calculated F.S.
Static Conditions	N/A	1.80
Seismic Conditions	0.25 g	1.11

V. Conclusions

Stockpile Area (Ravine Fill): Based on our analyses it appears the current and future fill slopes are stable under static conditions. The on-going addition of fill to these slope areas will result in lower factors of safety. However, under seismic conditions the ravine fill slopes appear to be below a 1.0 factor of safety and will most likely undergo some seismic deformation, as discussed earlier in this report.

Old Stockpile/2004 Landslide: Based on our analysis, the unloaded (all previous overburden removed) landslide appears to be stable under both static and seismic conditions. The placement of any permanent or temporary fill on the landslide or immediately adjacent slopes will reduce the stability and should be avoided.

Quarry Highwall (20-year mining plan): The proposed rock faces of the quarry appear to have acceptable factors of safety against large failures under both static and seismic conditions. The stability is enhanced by the fact the final reclaimed rock slopes will be lower than present and will have equal or flatter slope angles.

However, as previously stated, we analyzed only large scale failures within each bench level and the entire quarry face (global). Also, the properties of individual rock discontinuities properties can vary and it is not feasible to measure all discontinuities present. Additionally, our analyses are based on limited laboratory testing and field exploration. For these reasons, we anticipate smaller to moderate-scale failures may occasionally occur, both during mining and following final reclamation.

A significant risk associated with the proposed quarry expansion is inducing slope failures or rock falls on the slope south of the proposed quarry expansion. This is the area above Porter Creek Road. There are several locations on this existing slope where natural stability appears marginal. Vibrations from quarry construction equipment and/or blasting could initiate slope instability. Mitigation measures to protect Porter Creek Road from landslides or rock fall should be carefully developed and implemented during the mining process.

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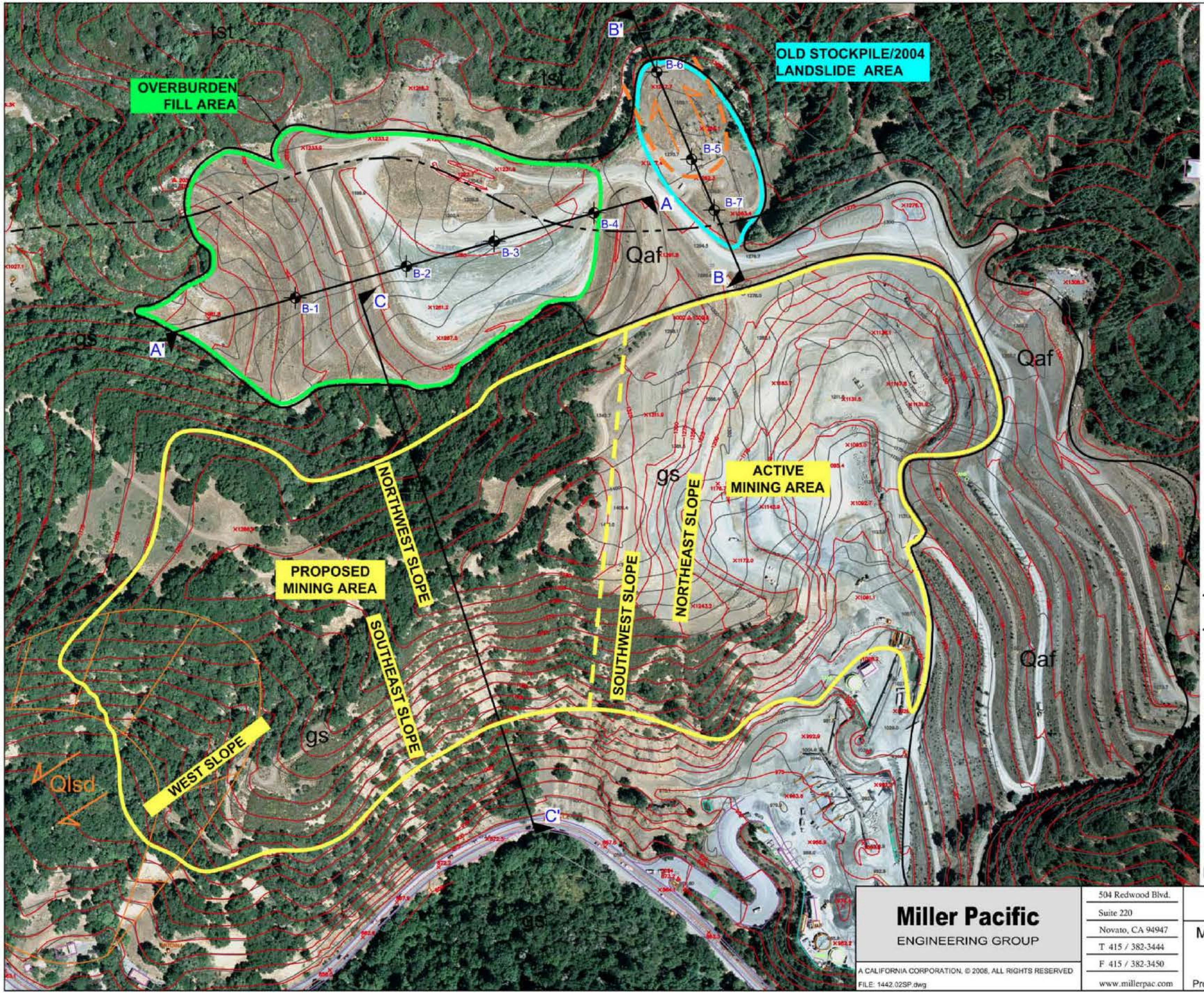

LEGEND

- 2003 Topographic Elevations
- 2010 Topographic Elevations
- B B' Geologic Cross Section
- Boring Performed by MPEG, October 2010
- Geologic Contact
- Buried Geologic Contact
- tst - Sonoma Volcanics - Tuff
- gs - Franciscan Greenstone
- Qaf - Artificial Fill
- Qlsd - Quaternary Landslide - Dormant

SCALE

0 125 250 500 FEET

NORTH

REFERENCE: Green Valley Consulting Engineers

Miller Pacific ENGINEERING GROUP	504 Redwood Blvd. Suite 220 Novato, CA 94947 T 415 / 382-3444 F 415 / 382-3450 www.millerpac.com	SITE PLAN		
		Mark West Quarry Expansion Santa Rosa, California	Drawn BSP Checked	1 FIGURE
		Project No. 1442.02 Date: 12/28/10		

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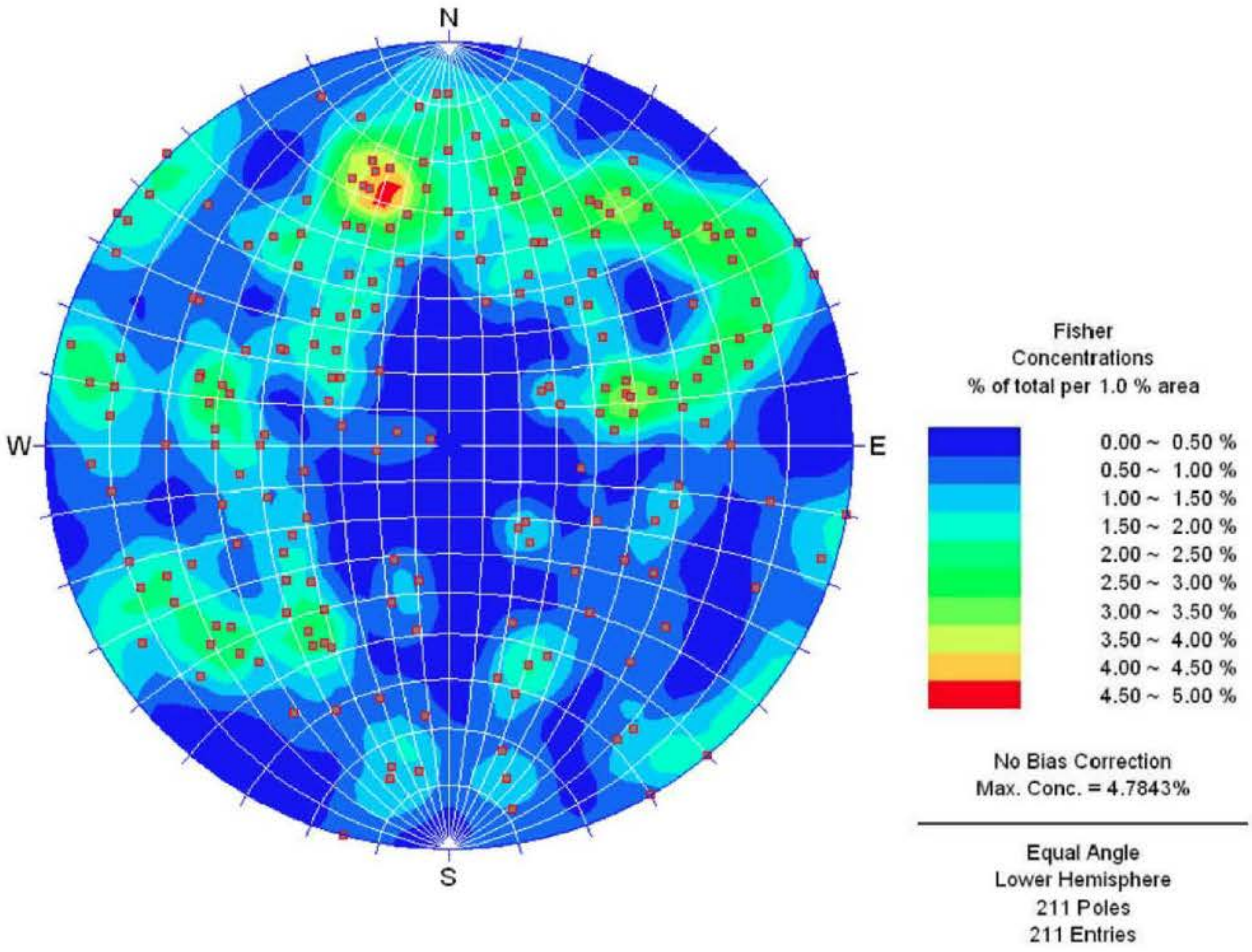

Miller Pacific ENGINEERING GROUP	504 Redwood Blvd. Suite 220 Novato, CA 94947 T 415 / 382-3444 F 415 / 382-3450 www.millerpac.com	STEREONET PLOT		
		Mark West Quarry Expansion Santa Rosa, California	Drawn BSP Checked	2 FIGURE
		Project No. 1442.02 Date: 1/05/11		

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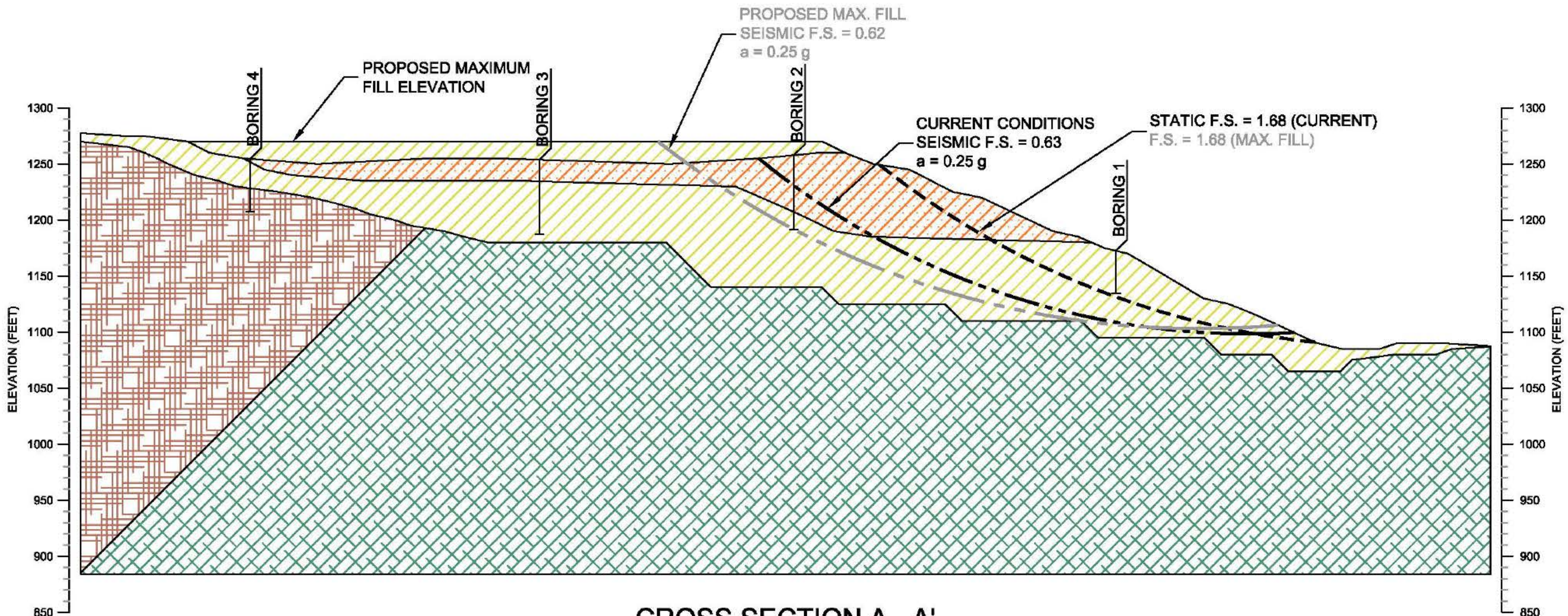

CROSS SECTION A - A'

SCALE: 1" = 100'

UNDOCUMENTED FILL

STATIC	SEISMIC
γ = 120 pcf	γ = 120 pcf
c' = 270 psf	c = 540 psf
ϕ' = 27°	ϕ = 11°
	τ ≥ 1,800 psf

WEATHERED TUFF

STATIC & SEISMIC
γ = 90 pcf
c' = 0 psf
ϕ' = 42°

ENGINEERED & PROPOSED FILL

STATIC	SEISMIC
γ = 120 pcf	γ = 120 pcf
c' = 300 psf	c = 600 psf
ϕ' = 30°	ϕ = 12°
	τ ≥ 2,000 psf

GREENSTONE

STATIC & SEISMIC
γ = 135 pcf
c' = 1000 psf
ϕ' = 42°

SCALE
0 50 100 200 FEET

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FILE: 1442.02XSecAA.dwg

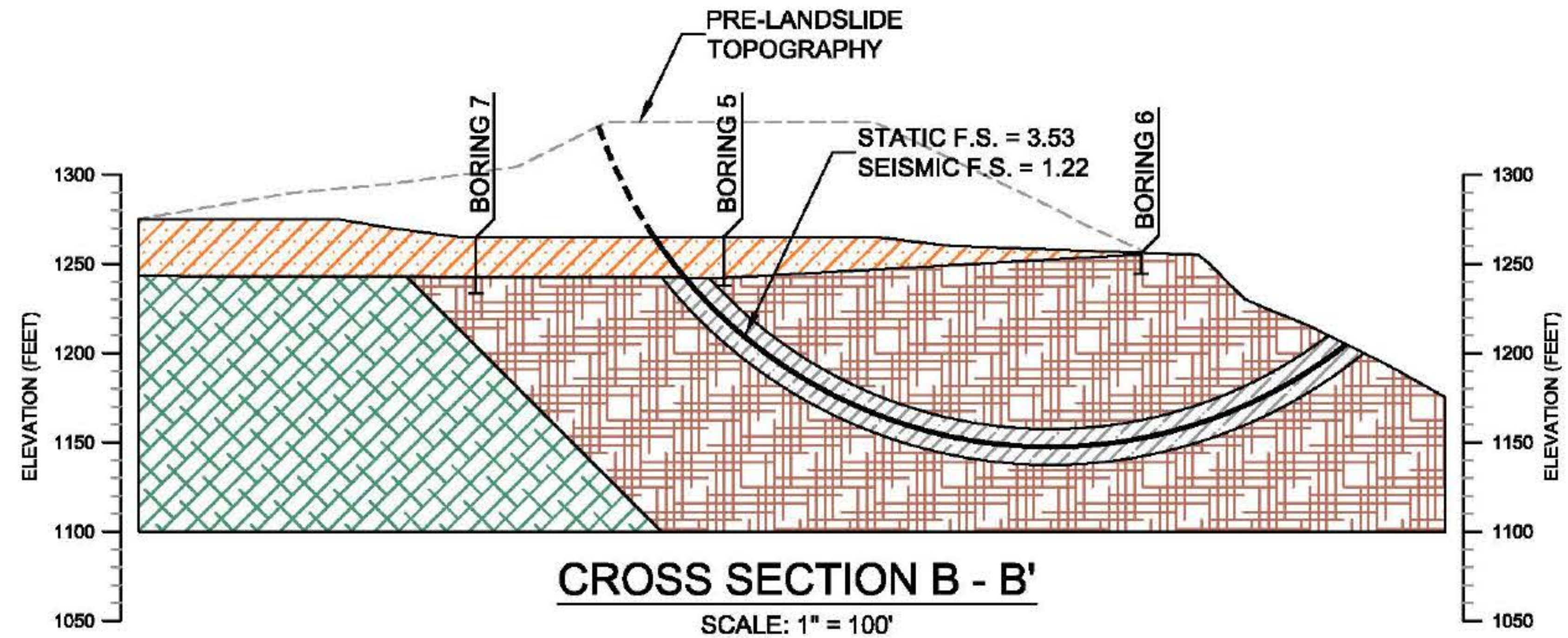
CROSS SECTION A - A'

Mark West Quarry Expansion
Santa Rosa, California

Drawn BSP
Checked

Project No. 1442.02 Date: 12/28/10

3
FIGURE



CROSS SECTION B - B'

SCALE: 1" = 100'

UNDOCUMENTED FILL

STATIC	SEISMIC
γ = 120 pcf	γ = 120 pcf
c' = 270 psf	c = 540 psf
ϕ' = 27°	ϕ = 12°
	τ ≥ 1,350 psf

WEATHERED TUFF

STATIC & SEISMIC
γ = 90 pcf
c' = 0 psf
ϕ' = 42°

RESIDUAL SOIL

STATIC & SEISMIC
γ = 120 pcf
c = 0 psf
ϕ = 25°

GREENSTONE

STATIC & SEISMIC
γ = 135 pcf
c' = 1000 psf
ϕ' = 42°

SCALE
0 50 100 200 FEET

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CROSS SECTION B - B'

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Santa Rosa, California

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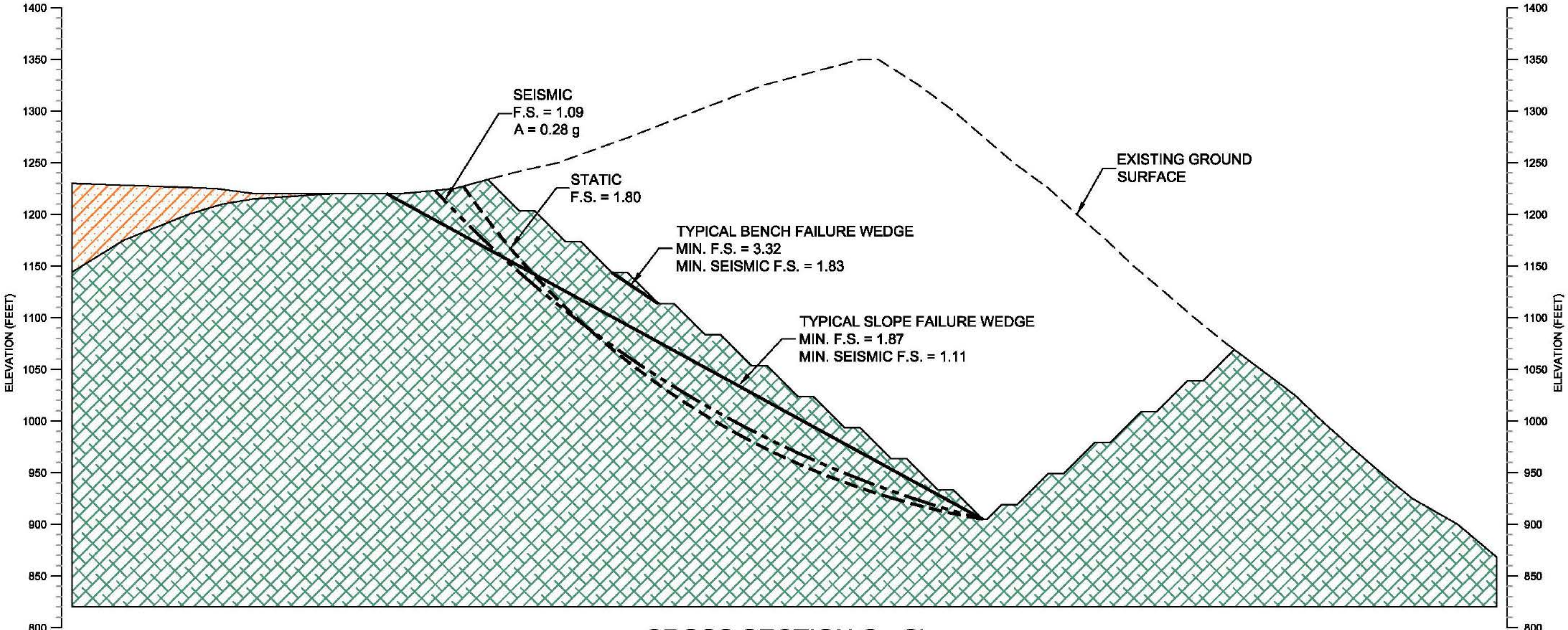
4
FIGURE



CROSS SECTION C - C'

SCALE: 1" = 100'

UNDOCUMENTED FILL

STATIC	SEISMIC
γ = 120 pcf	γ = 120 pcf
c' = 270 psf	c = 540 psf
ϕ' = 27°	ϕ = 12°
	τ ≥ 1,350 psf

GREENSTONE

STATIC & SEISMIC
γ = 135 pcf
c' = 1000 psf
ϕ' = 42°

SCALE
0 50 100 200 FEET

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CROSS SECTION C - C'

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5
FIGURE

APPENDIX A
SUBSURFACE EXPLORATION AND LABORATORY TESTING

1.0 Subsurface Exploration – Auger Borings

We explored subsurface conditions at the site by drilling 7 test borings on October 21st, 22nd, and 27th of 2010 utilizing a truck mounted drilling rig with 6-inch solid flight augers. The boring locations are shown on Figure 1. Test borings were drilled to depths of up to 66.5-feet below the ground surface.

We obtained "undisturbed" samples using a 3-inch (75-mm) diameter, split-barrel California sampler with 2.5 by 6-inch brass tube liners. The 2-inch Standard Penetration Test (SPT) split-barrel sampler was intermittently used to aid in soil property indexing, identification, and liquefaction analysis. The samplers were driven with a 140-pound (63.5-kg) hammer falling 30 inches (760 mm). The number of blows required to drive the samplers 18 inches (460 mm) was recorded and is reported on the boring logs as blows per foot for the last 12 inches (305 mm) of driving. The samples obtained were examined in the field, sealed to prevent moisture loss, and transported to our laboratory.

The soils encountered were logged and identified in general accordance with ASTM Standard D 2487, "Field Identification and Description of Soils (Visual-Manual Procedure)." This standard is briefly explained on Figure A-1, Soil Classification Chart and Figure A-2, Rock Classification Chart. The exploratory boring logs are presented on Figures A-3 to A-20.

2.0 Laboratory Testing

We conducted laboratory tests on selected intact and bulk samples to verify field identifications and to evaluate engineering properties. The following laboratory tests were conducted in general accordance with the ASTM standard test method cited:

- Laboratory Determination of Water (Moisture Content) of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D 2216;
- Density of Soil in Place by the Drive-Cylinder Method, ASTM D 2937;
- Unconfined Compressive Strength of Cohesive Soil, ASTM D 2166;
- Amount of Material in Soils Finer Than the No. 200 (75 µm) Sieve, ASTM D 1140;
- Sieve Analysis, ASTM D 451;
- Unconsolidated Undrained Compression Test, ASTM D 2850,and;
- Consolidated Undrained Triaxial Compression Test, ASTM D 4767.

The moisture content, dry density, percent finer than #200 sieve, unconfined compression test, the consolidated undrained triaxial compression (TXCU) test results are shown on the exploratory boring logs. Additionally, the TXCU tests results are shown graphically on Figures A-21 and A-22. The results of the sieve analyses are presented on Figures A-23 and A-24.

The exploratory boring logs, description of soils encountered and the laboratory test data reflect conditions only at the location of the boring at the time they were excavated or retrieved. Conditions may differ at other locations and may change with the passage of time due to a variety of causes including natural weathering, climate and changes in surface and subsurface drainage.

MAJOR DIVISIONS		SYMBOL		DESCRIPTION
COARSE GRAINED SOILS over 50% sand and gravel	CLEAN GRAVEL	GW		Well-graded gravels or gravel-sand mixtures, little or no fines
		GP		Poorly-graded gravels or gravel-sand mixtures, little or no fines
	GRAVEL with fines	GM		Silty gravels, gravel-sand-silt mixtures
		GC		Clayey gravels, gravel-sand-clay mixtures
	CLEAN SAND	SW		Well-graded sands or gravelly sands, little or no fines
		SP		Poorly-graded sands or gravelly sands, little or no fines
	SAND with fines	SM		Silty sands, sand-silt mixtures
		SC		Clayey sands, sand-clay mixtures
FINE GRAINED SOILS over 50% silt and clay	SILT AND CLAY liquid limit <50%	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL		Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
		OL		Organic silts and organic silt-clays of low plasticity
	SILT AND CLAY liquid limit >50%	MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
		CH		Inorganic clays of high plasticity, fat clays
		OH		Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS		PT		Peat, muck, and other highly organic soils
ROCK				Undifferentiated as to type or composition

KEY TO BORING AND TEST PIT SYMBOLS

CLASSIFICATION TESTS

PI	PLASTICITY INDEX
LL	LIQUID LIMIT
SA	SIEVE ANALYSIS
HYD	HYDROMETER ANALYSIS
P200	PERCENT PASSING NO. 200 SIEVE
P4	PERCENT PASSING NO. 4 SIEVE

SAMPLER TYPE

- MODIFIED CALIFORNIA
- STANDARD PENETRATION TEST
- THIN-WALLED / FIXED PISTON
- HAND SAMPLER
- ROCK CORE
- X DISTURBED OR BULK SAMPLE

STRENGTH TESTS

TXCU	CONSOLIDATED UNDRAINED TRIAXIAL
(XXXX)	CONFINING PRESSURE IN PSF
TV	FIELD TORVANE (UNDRAINED SHEAR)
UC	LABORATORY UNCONFINED COMPRESSION
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL
	UC, CU, UU = 1/2 Deviator Stress

SAMPLER DRIVING RESISTANCE

Modified California and Standard Penetration Test samplers are driven 18 inches with a 140-pound hammer falling 30 inches per blow. Blows for the initial 6-inch drive seat the sampler. Blows for the final 12-inch drive are recorded onto the logs. Sampler refusal is defined as 50 blows during a 6-inch drive. Modified California blow counts are multiplied by .65 to be equivalent to Standard Penetration Test blow counts. Examples of blow records are as follows:

25	sampler driven 12 inches with 25 blows after initial 6-inch drive
85/7"	sampler driven 7 inches with 85 blows after initial 6-inch drive
50/3"	sampler driven 3 inches with 50 blows during initial 6-inch drive or beginning of final 12-inch drive

NOTE: Test boring and test pit logs are an interpretation of conditions encountered at the excavation location during the time of exploration. Subsurface rock, soil or water conditions may vary in different locations within the project site and with the passage of time. Boundaries between differing soil or rock descriptions are approximate and may indicate a gradual transition.

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SOIL CLASSIFICATION

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A-1
FIGURE

FRACTURING AND BEDDING

Fracture Classification	Spacing	Bedding Classification
Crushed	less than 3/4 inch	Laminated
Intensely fractured	3/4 to 2-1/2 inches	Very thinly bedded
Closely fractured	2-1/2 to 8 inches	Thinly bedded
Moderately fractured	8 to 24 inches	Medium bedded
Widely fractured	2 to 6 feet	Thickly bedded
Very widely fractured	greater than 6 feet	Very thickly bedded

HARDNESS

Low	Carved or gouged with a knife
Moderate	Easily scratched with a knife, friable
Hard	Difficult to scratch, knife scratch leaves dust trace
Very hard	Rock scratches metal

STRENGTH

Friable	Crumbles by rubbing with fingers
Weak	Crumbles under light hammer blows
Moderate	Indentations <1/8 inch with moderate blow with pick end of rock hammer
Strong	Withstands few heavy hammer blows, yields large fragments
Very strong	Withstands many heavy hammer blows, yields dust, small fragments

WEATHERING

Complete	Minerals decomposed to soil, but fabric and structure preserved
High	Rock decomposition, thorough discoloration, all fractures are extensively coated with clay, oxides or carbonates
Moderate	Fracture surfaces coated with weathering minerals, moderate or localized discoloration
Slight	A few stained fractures, slight discoloration, no mineral decomposition, no affect on cementation
Fresh	Rock unaffected by weathering, no change with depth, rings under hammer impact

NOTE: Test boring and test pit logs are an interpretation of conditions encountered at the location and time of exploration. Subsurface rock, soil and water conditions may differ in other locations and with the passage of time.

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ROCK CLASSIFICATION

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A-2
FIGURE

BORING 1

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/21/10

ELEVATION: 1173-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						0	0			CLAYEY GRAVEL WITH SAND (GC) Medium brown, dry to moist, medium dense, fine to coarse subangular gravels up to 1.5in., ~25-35% fine to coarse subangular sand, ~15-20% low to medium plasticity clay. [Fill]
						1				
							5			
			25	16.9	109					Gravels up to 4in. from 5 to 9 feet.
						2				
						3	10			Easier Drilling at 10.5 feet.
										CLAYEY SAND WITH GRAVEL (SC) Medium brown to mottled gray, moist to wet, loose, fine to coarse subangular sand, ~25-35% medium plasticity clay, ~15-20% fine to medium subangular gravels. [Fill]
						4				
							15			
		1210 TXCU (2300)	6	28.3	94.1	5				
										CLAYEY SAND (SC) Brownish gray, moist, medium dense, fine to medium subangular sand, ~25-35% medium plasticity clay, trace gravels. [Fill]
						6	20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

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A-3
FIGURE

BORING 1 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
							20			CLAYEY SAND (SC) Brownish gray, moist, medium dense, fine to medium subangular sand, ~25-35% medium plasticity clay, trace gravels. [Fill]
						7				Drilling stiffens at 23.5 feet.
P200 26.3%	SA		33	20.5	106	8	25			grades to medium brown to mottled orange and gray, moist, medium dense to dense, ~10% fine to coarse angular gravels up to 2in., ~25% medium plasticity clay. [Fill]
						9				
			36/6	15.6 14.0	104		30			WELL GRADED GRAVELS WITH CLAY & SAND (GW/GC) Reddish brown to tan, moist, very dense, fine to coarse angular gravels,~30-40% fine to coarse angular sand, ~5-10% medium plasticity clay. [Fill]
						10				
			82	19.8		11	35			Drilling Refusal due to gravels at 35 feet.
										Bottom of boring at 36 feet. No groundwater observed during drilling.
						12				
							40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
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BORING LOGS

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Project No. 1442.02 Date: 11/8/10

BORING 2

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1258-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						0 / 0			**CLAY WITH SAND (CL)** Greenish gray, moist, soft to medium stiff, medium plasticity clay, ~10-20% fine to medium subangular sand. [Fill]
		1500 UC	10	22.1	105		■		
						1 / 5			**CLAYEY SAND WITH GRAVEL (SC)** Medium brown, moist to wet, medium dense, fine to coarse subangular sand, ~20-30% medium plasticity clay, ~15-20% fine to coarse subangular gravels. [Fill]
						2			Grades to ~25-35% fine to coarse angular gravels at 4.5 to 5.5 feet. Easier Drilling at 7 feet. Drilling stiffens at 7.5 feet.
						3 / 10			Color change to gray at 11 feet.
						4 / 15			**CLAYEY SAND (SC)** Medium brown to mottled blue and green, moist, med dense to dense, ~10% fine to coarse angular gravel, ~10-15% medium plasticity clay. [Fill]
P200 12.4%	SA		24	6.9	125	5	■		
						6 / 20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

BORING 2 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						20			CLAYEY SAND (SC) Medium brown to mottled blue and green, moist, med dense to dense, ~10% fine to coarse angular gravel, ~10-15% medium plasticity clay. [Fill]
						7			
									CLAYEY SAND WITH GRAVEL(SC) Medium brown to bluish green, moist, medium dense, fine to medium subangular sand, ~20-30% medium plasticity clay, ~15-20% fine to coarse angular gravels. [Fill]
						25			
		1680 TXCU (3750)	22	26.2	88	8			
						9			
						30			
						10			
						35			
						11			
		1800 UC	24	53.6	67	12			
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING 2 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						40 ft			CLAYEY SAND WITH GRAVEL(SC) Medium brown to bluish green, moist, medium dense, fine to medium subangular sand, ~20-30% medium plasticity clay, ~15-20% fine to coarse angular gravels. [Fill]
						13 m			
						45 ft / 14 m			CLAYEY SAND (SC) Medium brown to tan, moist, medium dense, fine to coarse subangular sand, ~10% fine to medium angular gravels, ~15-20% medium plasticity clay. [Fill]
						15 m			
						50 ft			
P200 18.5	SA		22	26.7	96		■		
						16 m			
						55 ft / 17 m			Stiff Drilling at 55.5 feet.
						18 m			Very Stiff Drilling from 58.5 to 65 feet.
						60 ft			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

BORING 2 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						60 ft			CLAYEY SAND (SC) Medium brown to tan, moist, medium dense, fine to coarse subangular sand, ~10% fine to medium angular gravels, ~15-20% medium plasticity clay. [Fill]
						19 m			
						65 ft / 20 m			
		3210 TXCU (9500)	27	11.8	110				
									Bottom of boring at 66.5 feet. No groundwater observed during drilling.
						21 m			
						70 ft			
						22 m			
						75 ft / 23 m			
						24 m			
						80 ft			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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A-8
FIGURE

BORING 3

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1246-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						0 – 0			CLAY WITH SAND (CL) Greenish gray, moist, soft to medium stiff, medium plasticity clay, ~10-20% fine to medium subangular sand. [Fill]
		1080 UC	18	10.6	124	1	■		CLAYEY SAND WITH GRAVEL (SC) Medium brown to olive gray, moist, medium dense, fine to coarse subangular sand, ~15-25% medium plasticity clay, ~15-25% fine to coarse subangular gravels. [Fill]
		1230 TXCU (1850)	9	23.4	105	4	■		
									CLAY WITH SAND (CL) Olive gray, moist, medium stiff, medium plasticity clay, ~15-25% fine to medium sand. [Fill]
									CLAYEY SAND WITH GRAVEL (SC) Medium brown to olive gray, moist, medium dense, fine to coarse subangular sand, ~20 to 30% fine to coarse angular gravels, ~10-20% medium plasticity clay. [Fill]

Depth scale: meters 0, 1, 2, 3, 4, 5, 6; feet 0, 5, 10, 15, 20.

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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A-9
FIGURE

BORING 3 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						20			CLAYEY SAND WITH GRAVEL (SC) Medium brown to olive gray, moist, medium dense, fine to coarse subangular sand, ~20 to 30% fine to coarse angular gravels, ~10-20% medium plasticity clay. [Fill]
						7			
			23	11.4	131				
						25 / 8			
						9			
						30			grades to medium brown to mottled blue gray, moist, medium dense, ~30% fine to coarse angular gravel, ~20% medium plasticity clay. [Fill]
						10			
P200 20.6%	SA		23	23.5	93				Stiffer Drilling at 34.5 feet.
						35 / 11			
						12			
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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A-10
FIGURE

BORING 3 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
							40			CLAYEY SAND with GRAVEL (SC) Medium brown to mottled blue gray, moist, medium dense, ~30% fine to coarse angular gravel, ~20% medium plasticity clay. [Fill]
						13				
							45			grades to medium brown to olive green, moist, dense, fine to coarse subangular sand, ~20-30% fine to medium angular gravels, ~10-20% medium plasticity clay. [Fill]
			35	25.9	89	14		■		
						15				
							50			
						16				
							55			
		2680 TXCU (8050)	21	20.2	104	17		■		
						18				
							60			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING 3 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						60			CLAYEY SAND WITH GRAVEL (SC) medium brown to olive green, moist, dense, fine to coarse subangular sand, ~20-30% fine to medium angular gravels, ~10-20% medium plasticity clay. [Fill]
						19			
						65			Drilling Refusal at 65 feet.
		2910 TXUU (8250)	23	12	115	20			
									Bottom of boring at 66.5 feet. No groundwater observed during drilling.
						21			
						70			
						22			
						75 / 23			
						24			
						80			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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Project No. 1442.02 Date: 10/27/10

A-12
FIGURE

BORING 4

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1254-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)
			18	13.1	116
P200 30.8%	SA	2390 UC	20	31.5	87
		3060 TXCU (2800)	14	37.1	80

DEPTH: meters 0–6; feet 0–20

CLAYEY GRAVEL WITH SAND (GC)
Medium brown to mottled orange, dry to moist, loose, fine to coarse angular gravels up to 2in., ~20-30% fine to coarse angular sands, ~10-20% medium plasticity clay. [Fill]
Color Change to medium brown to blue gray, moist, medium dense at 3.0 feet.

Drilling stiffens from gravels encountered at 6.0 to 9.0 feet.

CLAYEY SAND with GRAVEL (SC)
Brownish gray, moist, medium dense, fine to coarse subrounded sand, ~30% medium plasticity clay, ~30% fine to coarse subangular gravels, trace rootlets. [Fill]

CLAYEY SAND WITH GRAVEL (SC)
Medium brown to mottled orange, moist, medium stiff, fine to coarse subangular sands, ~15-20% subangular gravles, ~10-20% medium plasticity clay. [Fill]

NOTES:
(1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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FILE: 1442.02 BL.dwg

BORING LOG

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

Drawn JBG Checked

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	BORING 4 (CONTINUED)
						20			CLAYEY SAND WITH GRAVEL (SC) Medium brown to mottled orange, moist, medium stiff, fine to coarse subangular sands, ~15-20% subangular gravles, ~10-20% medium plasticity clay. [Fill}
						7			Stiffer Drilling at 23.0 feet.
						25			
		2240 UC	27	24.0	101	8			As above alternating amounts of clay and angular gravels up to 4in., ~20-30% of each from 25 to 35.5 feet.
						9			
						30			VOLCANIC TUFF Tan to banded orangish brown, widly fractured, thick bedding, moderate hardness, weak to moderated strength, slight to moderated weathering. [Bedrock]
						10			
									Stiffer Drilling at 34.5 feet.
						35 11			
			32/4						
						12			Large Cobble in Sample form 38.0- 38.5 feet.
			33	38.0					
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING LOGS

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

Drawn JBG
Checked

BORING 4 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						40 ft			**VOLCANIC TUFF** Tan to banded orangish brown, widely fractured, thick bedding, moderate hardness, weak to moderated strength, slight to moderate weathering. [Bedrock]
						13 m			
						45 ft / 14 m			
			64	36.8					
									Bottom of boring at 46.5 feet. No groundwater observed during drilling.
						15 m			
						50 ft			
						16 m			
						55 ft / 17 m			
						18 m			
						60 ft			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOGS

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

Drawn ABC
Checked

A-15
FIGURE

BORING 5

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1261-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						0	0			CLAY WITH SAND (CL) Medium brown to dark gray, dry to moist, soft, low plasticity clay, ~15-20% fine to medium subangular sands, ~10-20% organics (bark). [Top Soil]
						1				
			9	19.4	92		5			CLAYEY SAND WITH GRAVEL (SC) Medium brown to mottled orange, moist, loose to medium dense, fine to coarse subrounded sand, ~15-25% low to medium plasticity clay, ~10-20% fine to coarse subangular gravels up to 1.5 in. [Fill]
						2				
		5200 TXCU (1500)	21	45.6	70	3	10			Grades tan to blue gray, moist, medium dense to dense, fine to medium subangular sand, ~15-20% low plasticity clay, ~10% fine to med subangular gravels at 9feet.
						4				grades to medium brown to reddish brown, moist, medium stiff, ~40-45% medium plasticity clay, ~20% fine to coarse subangular gravels up to 1.5 in. [Fill]
P200 46.2%	SA		25	18.8	108		15			
						5				
						6	20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

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Checked

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FIGURE

BORING 5 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH feet (meters)	SAMPLE	SYMBOL (3)	DESCRIPTION
						20			**CLAYEY SAND WITH GRAVEL (SC)** Medium brown to reddish brown, moist, medium stiff, ~40-45% medium plasticity clay, ~20% fine to coarse subangular gravels up to 1.5 in. [Fill]
						(7)			**VOLCANIC TUFF** Tan to banded orangish brown, widely fractured, thick bedding, moderate hardness, weak to moderated strength, slight to moderate weathering. [Bedrock]
			25	45.4	72	25 (8)			
			14	61.3					
						27.5			Bottom of boring at 27.5 feet. No groundwater observed during drilling
						(9)			
						30			
						(10)			
						35 (11)			
						(12)			
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOGS

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Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

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Checked

BORING 6

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1256-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)
			19	40.4	68
			20	41.0	72
			17	43.6	

DEPTH: meters 0, 1, 2, 3, 4, 5, 6; feet 0, 5, 10, 15, 20

SAMPLE | SYMBOL (3)

SANDY CLAY (CL)
Light brown to tan, moist, medium stiff, low to medium plasticity clay, ~30-40% fine sands, trace angular gravels. [Fill]

VOLCANIC TUFF
Tan to banded orangish brown, widely fractured, thick bedding, moderate hardness, weak to moderated strength, slight to moderate weathering. [Bedrock]

Bottom of boring at 12.0 feet.
No groundwater observed during drilling

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

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Checked

A-18
FIGURE

BORING 7

EQUIPMENT: Truck Mounted B-53 Drill Rig with 6in. Hollow Steam Flight Auger.

DATE: 10/27/10

ELEVATION: 1265-Feet*

*REFERENCE: Green Valley Consulting Engineers

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						0	0			SANDY CLAY (CL) Medium brown to mottled light tan, moist, medium stiff, low to medium plasticity clay, ~20-30% fine to coarse subangular sands. [Top Soil/Fill]
						1				CLAYEY SAND WITH GRAVEL (SC) Medium brown to mottled olive gray, moist, medium dense, fine to coarse subangular sand, ~20-25% medium plasticity clay, ~15-25% fine to coarse angular gravels. [Fill]
		1120 TXUU (750)	12				5	■		
						2				
		1600 TXCU (1450)	19	20.3	104	3	10	■		
						4				Grades to ~20-30% medium to coarse angular gravels at 13.5 feet.
		2350 TXUU (1800)	22				15	■		
						5				
						6	20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

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Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

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A-19
FIGURE

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	BORING 7 (CONTINUED)
						20			**CLAYEY SAND WITH GRAVEL (SC)** Medium brown to mottled olive gray, moist, medium dense, fine to coarse subangular sand, ~20-25% medium plasticity clay, ~15-25% fine to coarse angular gravels. [Fill]
						7			
									VOLCANIC TUFF Tan to banded orangish brown, widly fractured, thick bedding, moderate hardness, weak to moderated strength, slight to moderated weathering. [Bedrock]
			25			25 / 8	■		
						9			
			33			30	■		
						10			Bottom of boring at 27.5 feet. No groundwater observed during drilling
						35 / 11			
						12			
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING LOGS

Dwyer- Mark West Quarry
Santa Rosa, California

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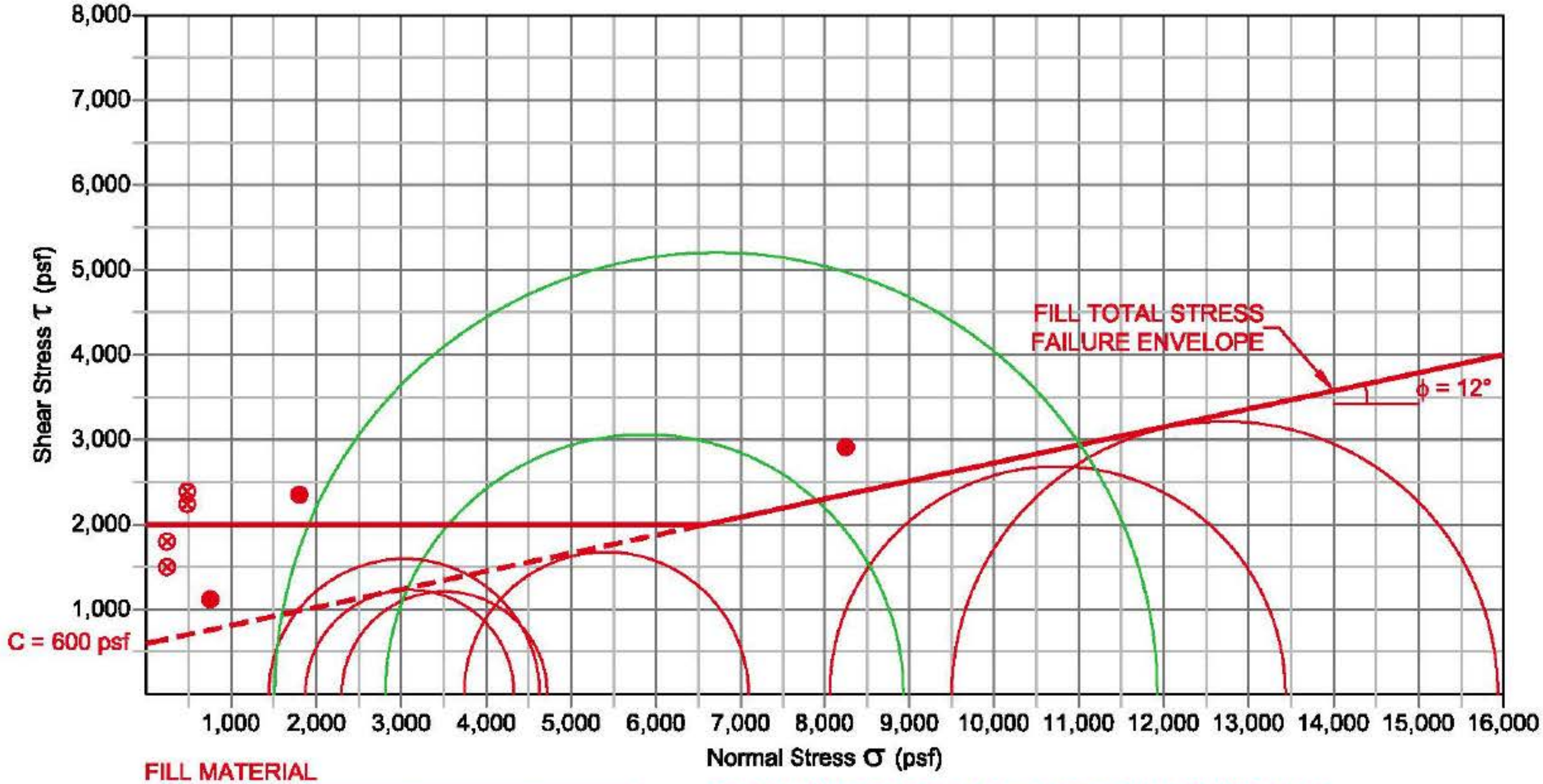
Checked

Project No. 1442.02 Date: 11/8/10

A-20
FIGURE

TOTAL STRESS



⊗ - Data from UC tests. Normal stress was calculated by multiplying the depth of the sample by the unit weight (120 pcf).

● - Data from TXUU tests.

FILL MATERIAL

Boring	Depth	σ_1	σ_3	u_e
1	15.5 ft	4,720 psf	2,300 psf	1,480 psf
2	25.5 ft	7,090 psf	3,740 psf	2,690 psf
2	66.0 ft	15,930 psf	9,500 psf	7,230 psf
3	13.0 ft	4,330 psf	1,870 psf	1,280 psf
3	55.0 ft	13,430 psf	8,060 psf	6,110 psf
7	9.5 ft	4,630 psf	1,440 psf	810 psf

WEATHERED TUFF

Boring	Depth	σ_1	σ_3	u_e
4	19.0 ft	8,930 psf	2,810 psf	1,280 psf
5	10.0 ft	11,920 psf	1,510 psf	-790 psf

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FILE: 1442.02TXCU.dwg

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TOTAL STRESS LAB STRENGTH

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Santa Rosa, California

Drawn BSP
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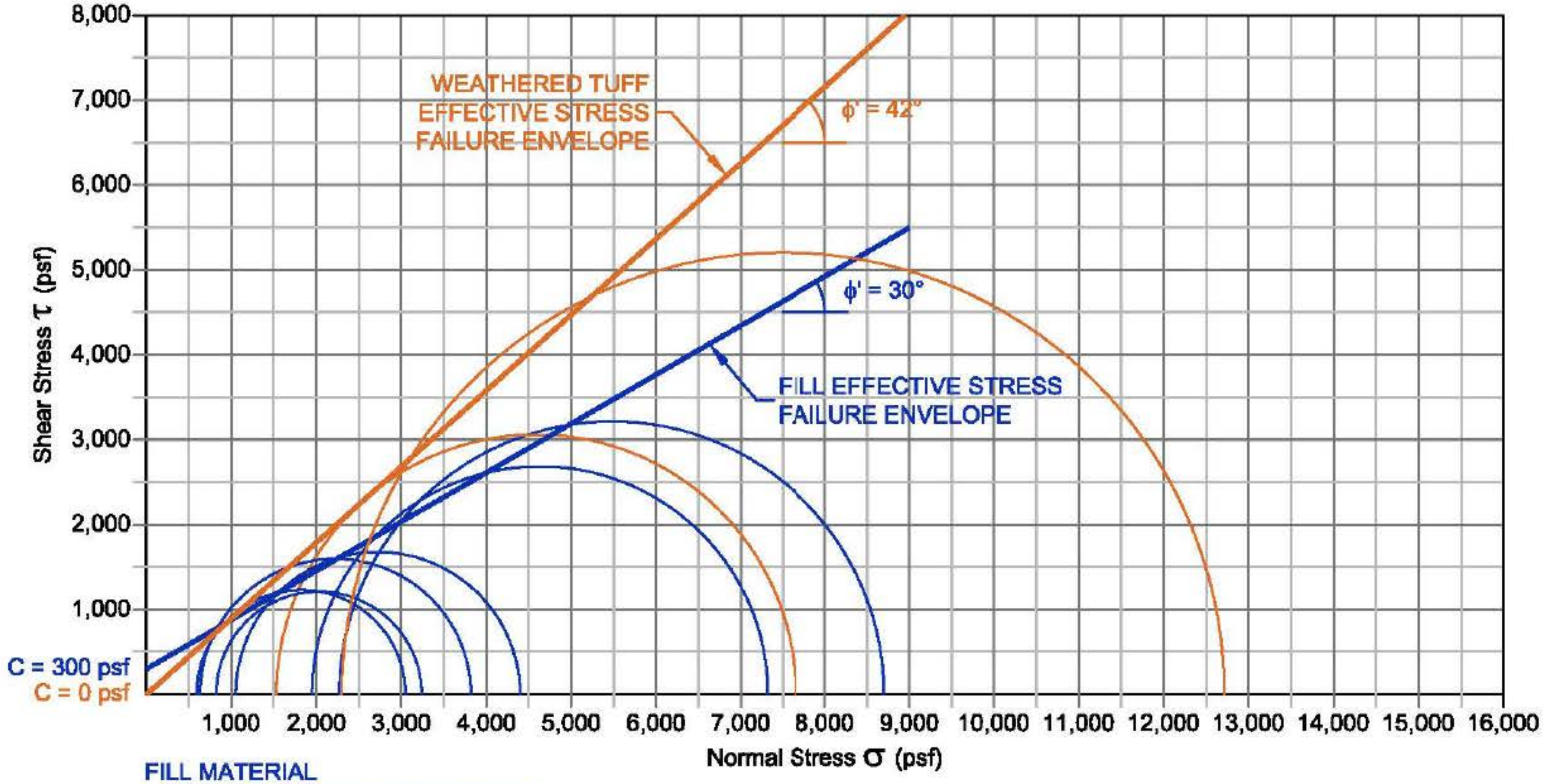
Project No. 1442.02 Date: 12/22/10

A-21
FIGURE

EFFECTIVE STRESS



FILL MATERIAL

Boring	Depth	σ'_1	σ'_3
1	15.5 ft	3,240 psf	820 psf
2	25.5 ft	4,400 psf	1,050 psf
2	66.0 ft	8,700 psf	2,270 psf
3	13.0 ft	3,050 psf	590 psf
3	55.0 ft	7,320 psf	1,950 psf
7	9.5 ft	3,820 psf	630 psf

WEATHERED TUFF

Boring	Depth	σ'_1	σ'_3
4	19.0 ft	7,650 psf	1,530 psf
5	10.0 ft	12,710 psf	2,300 psf

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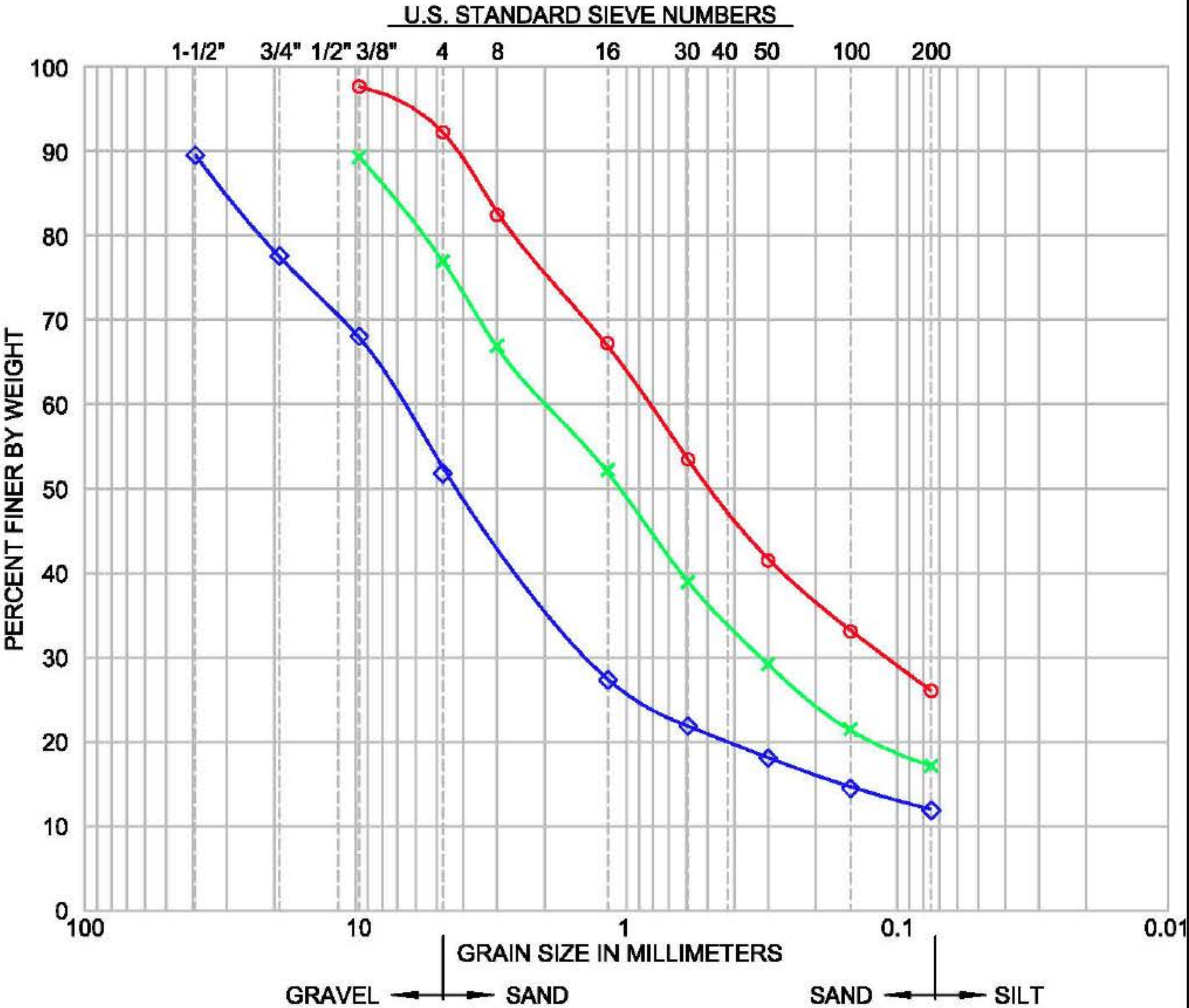
TXCU - EFFECTIVE STRESS

Mark West Quarry Expansion
Santa Rosa, California

Drawn BSP
Checked

Project No. 1442.02 Date: 12/22/10

A-22
FIGURE



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
red line, circle (o)	Boring 1 @ 26.0 feet	Clayey Sand (SC)
blue line, diamond (◇)	Boring 2 @ 16.0 feet	Clayey Sand (SC)
green line, cross (x)	Boring 2 @ 51.0 feet	Clayey Sand (SC)

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SIEVE ANALYSES RESULTS

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Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

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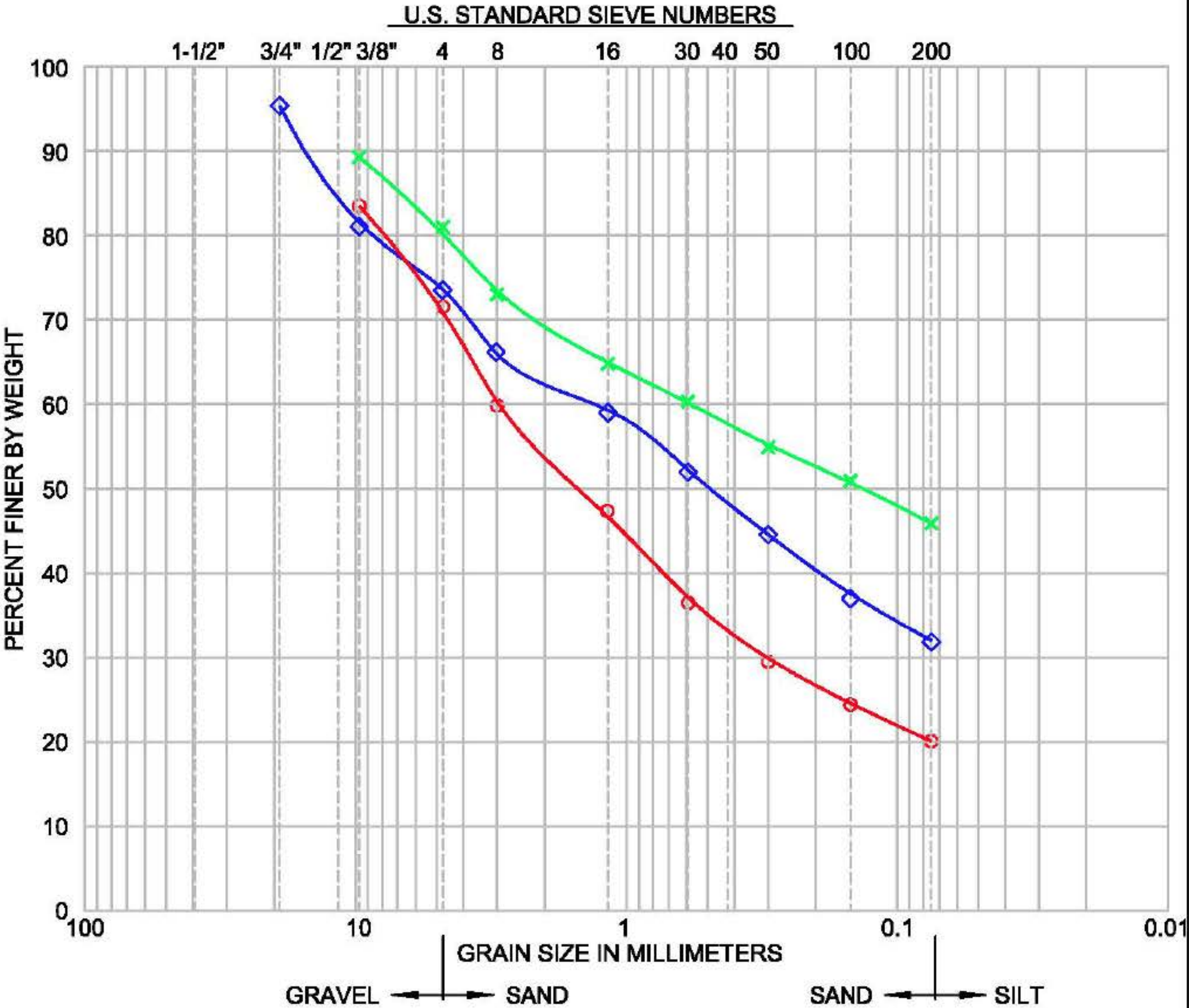
Checked

A-23
FIGURE



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
red line, circle	Boring 3 @ 33.0 feet	Clayey Sand with Gravel (SC)
blue line, diamond	Boring 4 @ 12.5 feet	Clayey Sand with Gravel (SC)
black line, green x	Boring 5 @ 14.5 feet	Clayey Sand with Gravel (SC)

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SIEVE ANALYSES RESULTS

Mark West Quarry Expansion
Santa Rosa, California

Project No. 1442.02 Date: 11/8/10

Drawn JBG
Checked

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FIGURE

APPENDIX D-1

Surface and Groundwater Evaluation for CEQA

Surface-Water and Groundwater Evaluation for CEQA, Mark West Quarry Proposed Expansion and Reclamation, Sonoma County, California

Prepared for:

BoDean Company

Prepared by:

Balance Hydrologics, Inc.

Mark Woyshner

Barry Hecht

August 2011

A report prepared for:

BoDean Company
Attention: Bill Williams
1060 N. Dutton Avenue
Santa Rosa, California 95401
(707) 576-8205

Surface-Water and Groundwater Evaluation for CEQA, Mark West Quarry Proposed Expansion and Reclamation, Sonoma County, California

Balance Project Assignment 211046 (updated from December 2003 draft 203114)

by

Mark Woyshner,
Hydrologist/Hydrogeologist

Barry Hecht,
Principal Hydrogeologist, CHg, CEG

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August 22, 2011

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APPENDICES

1. INTRODUCTION

1.1 Background and Objectives

BoDean Company intends to expand Mark West Quarry to include a larger area to the west. The vested right limit for production purposes, determined in 1981, is “subject to fluctuations in local demand.” While operating under this vested right, the Mark West Quarry has from time to time produced at a level of 750,000 tons per year, which shall serve as the maximum permitted limit. The quarry expects to again produce at this level, given the market demand, but for purposes of this study, the existing production level of 457,500 tons per year shall serve as a baseline for comparison to a proposed production level of 750,000 tons per year.

Water for the quarry operations is proposed to increase from an existing 21.6 acre-feet per year to approximately 30 acre-feet per year at the maximum production limit. Water is supplied by four on-site wells and by capture of reclamation sub-drain seepage. The wash plant also recycles nearly all of its water for reuse.

The goal of our work includes the following objectives:

a) to gather baseline hydrologic and hydrogeologic information;

b) to assess potential effects of the increased groundwater pumping to other wells in the vicinity;

c) to assess potential effects to Porter Creek to the south, and to Franz Creek to the north; and

d) to provide hydrologic components for the conceptual-level mining and reclamation plan.

1.2 Prior Work

The existing quarry is approved by Sonoma County. The existing reclamation plan was developed by Sandine & Associates (1988). The existing StormWater Pollution Prevention Plan (SWPPP), StormWater Monitoring Program (SWMP), and Spill Prevention Control and Countermeasure (SPCC) plan for above-ground fuel storage were developed by Environet Consulting.

This report summarizes the hydrologic setting of the quarry and presents results of groundwater testing and analysis. Hydrologic effects of quarry expansion and reclamation are discussed using independent lines of evidence – geologic (physical), water quality (chemical), and modeling (theoretical).

Specific field components of our field work included:

1) a water well, seep and spring inventory;

2) sampling and analysis of surface water and groundwater quality; and

3) an evaluation of the properties of the fractured bedrock aquifer and capacity of existing wells.

Estimation of groundwater recharge utilizing a water balance method was carried out for four site conditions: pre-mined, existing quarry, expanded quarry, and expanded-quarry reclaimed landscape. Evaluation of well capture and groundwater drawdown from of pumping the water supply wells was assessed utilizing three methods for existing production rates and for the proposed increased production and related water demand.

2.1 Geographic Description

Mark West Quarry is situated in the northern Sonoma Mountains about nine miles north-northeast of Santa Rosa, or about midway between Santa Rosa and Mount St. Helena (Figure 1). It is located on Porter Creek Road about one mile west of its intersection with Calistoga Road. The existing quarry extends northward from Porter Creek, a tributary of Mark West Creek, into the ridge forming the divide with the headwaters of Franz Creek.

The expansion area includes permitted lands within the existing BoDean holdings, and a leased area of similar size immediately to the west. Elevations range from about 900 feet at creek level to above 1,200 feet at the rim of the quarry, and to 1,400 feet on the highest hill on the leased area. The existing quarry occupies about 34 acres, which comprises an actively mined area of about 19 acres, a 7.5-acre processing and truck loading area, and about 7.5 acres of other existing disturbed areas in reclamation. Additional non-mined lands are in the northern part of this parcel and around its periphery. The proposed expanded-quarry reclamation area is estimated at 100 acres, which is roughly divided into 50 percent gently sloping floor proposed for agricultural use, and 50 percent reclaimed quarry slopes, up to a 1.5:1 benched cut slope and 2:1 fill slope.

2.2 Climatic Characteristics

The area encompassing Mark West Quarry is located in the Mediterranean climate zone typical of central coastal California. This climate zone is characterized by cool, wet winters and hot, dry summers. The quarry receives a mean annual precipitation of approximately 47 inches (Sonoma County Water Agency, 1983), a marked increase from an average of 30 inches at Santa Rosa, owing to orographic (mountain-induced) precipitation. The average rainfall value is a statistical mean of rainfall totals that show a wide range of values strongly influenced by global weather patterns, such as the El Nino Southern Oscillation and prolonged periods of drought. Appendix D presents a long-term regional precipitation record for Santa Rosa station SRO.

Influenced by marine air about 85 percent of the time, the region is generally protected from the hot weather of the Central Valley by the Interior Coast Ranges. The Pacific Ocean provides a source of cool moist air that moderates temperatures, but which have a wider range than along the coast, occasionally exceeding 100 degrees Fahrenheit and sometimes falling as low as several degrees below freezing for several consecutive nights at a time. The region is moist enough for coast redwood and Douglas fir to thrive, yet exposed aspects may be warm and dry enough for agave or succulents.

The mountainous areas of the region – characteristic of the quarry site – are slightly more humid, cooler in the summer, and milder in the winter than surrounding interior valleys, such as Alaxander, Knights or Napa Valleys. However, fruits that need winter chilling and summer heat (a typical microclimate for valley areas) are found in the vicinity of the quarry; vineyards are common along Calistoga Road, as are apple and stone-fruit orchards.

2.3 Geology and Soils

The quarry site has evolved geologically as part of the regional Maacama fault zone, east of the Rodgers Creek-Healdsburg fault zones. While the entire region is underlain by Franciscan basement rocks and overlain by Pliocene Sonoma Volcanics and Quarternary sediments, Franciscan mélange terrain is generally mapped along much of the Maacama fault (Wagner and Bortugno, 1982). In the vicinity of the quarry, the Maacama fault thrusts north-northeast and has apparently uplifted and exposed a massive block of Franciscan greenstone (Fox and others, 1973; Graymer and others, 2007) (Figure 4). Greenstone outcrops across most of the south and center portions of the site, and overlying Sonoma Volcanics tuff across the northern portion of the site (Dwyer, 2003; MPEG, Figure 2). Ravines formed by the headwaters of Franz Creek have eroded southward into the watershed divide crossing the site, exposing 50 to 75 feet of tuff just north of the greenstone contact on site. The Franz Creek headwaters have not yet exposed the underlying greenstone. Drillers logs for all wells in the quarry processing area, extending to a maximum depth of 720 feet (Appendix A), indicate fractured greenstone throughout the column and evidence of chert at depth.

Surficial soils at the quarry site (Figure 3) reflect the geologic parent material from which they have developed (Figure 2). Soils in the northern portion of the site – derived from geologically recent deposits of Sonoma Volcanic tuffs – are mapped as Forward (FoG) and Forward-Kidd (FrG) series by the agency that is now the USDA Natural Resources Conservation Service (Miller, 1972). Forward soils average 21 inches deep and are typically well-drained gravelly loams with a gravelly, sandy clay loam subsoil. Available water capacity of the soils is commonly about 2.3 inches (Table 8). The moderately high permeability and moderately low water-holding capacity generally promote recharge to groundwater. At depth, bedrock is typically weathered rhyolitic tuff of the Sonoma Volcanics with a substantially lower permeability, distributed mainly within the fractures. Runoff and erosion hazard may be high to very high, particularly on steeper slopes with shallower soils, as commonly associated with the Forward-Kidd soil complex.

Older soils on the greenstone ridge in the center portion of the site are mapped as Spreckles loam (SkE). Ranging from 22 to 60 inches in depth, the soils are deeper than the Forward soils and have a developed clay subsoil with moderately low permeability, approaching that of the fractured bedrock. The available water capacity is moderate, typically about 6.3 inches. Runoff and erosion potential of Spreckles soil are moderate to high.

Goulding soils (GgF, GiF) are mapped on the greenstone slopes, and are mainly found in the south portion of the site. These loam soils are similar in depth and permeability as Forward soils, but are characterized by having less gravel and more clay at depth. Therefore, water holding capacity is higher, and recharge less. As with Forward soils, infiltrating water may temporarily perch during storms, increasing runoff and erosion hazard from moderate to high.

Due to their limited infiltration rates, mainly from the clay layers impeding percolation, soils on the site are either classed in hydrologic group C or D (Table 8). Existing artificial fill on the reclaimed fill slopes of the east portion of the site is estimated to also have low range of permeabilities. In addition, about twenty-five percent of the site, including the expansion area, is mapped as either steep-sloped rock land or actively mined area, which is estimated to have very low permeability and high runoff. Overall, recharge on the site is moderately low, and runoff and erosion potential moderately high.

2.4 Surface Water and Drainage

The property is situated on a ridge that divides the Porter Creek and Franz Creek watersheds (Figure 5). Four small headwater streams on the property drain west and north from the divide (drainages A, B, C and D). Drainages 'B', 'C', and 'D' are regularly-spaced, equal-order steep ravines formed in Sonoma Volcanics that carry seasonal flows northward to Franz Creek, where streamflow continues on to the Russian River. Drainage 'A' is a seasonal stream flowing to Porter Creek, draining the northern slopes of the greenstone ridge, the southern side of Chalk Mountain and the overburden fill area.[1]

Porter Creek flows west to Mark West Creek, passing the quarry property on the south boundary, and then continues to join the Russian River. About a half mile upstream of the confluence of Porter Creek and drainage 'A', the existing quarry extends north from Porter Creek into the ridge forming the divide. Regional runoff is estimated to average about 18 inches per year (Rantz, 1974), but existing site runoff should be somewhat higher, given the area

[1] Sub-drain ouflow from drainage 'A' generally flows subsurface downstream of the site during the dry season.

of quarry and exposed rock slopes. We estimate existing runoff to be 25 inches per year, given 25 percent rock land onsite.

The quarry area is designated as drainages 'E' and 'F' (Figure 6). Drainage 'E' is mostly the reclaimed 2:1 fill slopes, and drainage 'F' is the actively mined area. Drainage 'E' is divided into three sub-drainages (E1, E2, and E3), where flows during storms drain south along the reclamation benches, and then to Porter Creek. Small detention ponds and siltation boxes are situated in the outfall channels from the quarry and reclaimed-slope areas. Others ponds and sediment traps are located onsite along dirt road switchbacks. Drainage 'E1' captures runoff from the lower slopes and east portion of the yard, including seepage from the reclamation sub-drain outflow. Seepage from the existing reclamation sub-drains is routed to a pond, where some water is pumped to a 20,000 gallon tank and used to spray on roads for dust control. The pond drains to four siltation boxes (in series), where water is pumped to the 100,000 gallon tank supplying the wash plant. Outflow from the fourth sediment trap flows to Porter Creek via a steep boulder-bedded outfall channel. Drainages 'E2' and 'E3' capture runoff from the upper reclaimed slopes.

On the site there is a small dug-out pond called the "greenstone spring" (about 500 square feet area, and 4,000 cubic feet when full) that apparently perches water through the summer (Figure 9). We observed standing water on October 30, 2003. It is unclear whether this pond is spring fed, but we suspect not since there is no inflow and outflow wetland, and water levels were about 3.3 feet below the obvious seasonal high-water mark – approximately the water-level decline that might be expected from evaporation alone. We understand that pond was lined with fines from the settling pond when constructed in about 1996.

2.5 Groundwater Occurrence, Water Supply and Use

Four (4) wells are currently located on the quarry processing yard and used for quarry operations (Figure 9; see Appendix A for the detailed well logs). Well specifications are summarized in Table 1.

- Well #1 (212074[2]) is located near the shaker, drilled and completed in 1982 to a depth of 190 feet and screened from 140 to 190 feet.

- Well #2 (433700) is located near the truck-wash area, drilled and completed in 1991 to a depth of 400 feet and screened from 25 feet to 400 feet.

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[2] Well numbers refer to California Department of Water Resources well-completion reports, or 'driller's logs' located in Appendix A.

- Well #3 (548113) is located near the crusher, drilled to a depth of 720 feet, completed to 420 feet in 1984, and screened from 80 to 420 feet. BoDean staff report that this well exhibits artesian conditions during the wet season.

- Well #4 (1078646) is located near the crusher, completed in 2005 to a depth of 640 feet, and screened from 80 to 100 feet and from 160 to 640 feet. BoDean staff report that this well also exhibits artesian conditions during the wet season.

Groundwater occurs throughout the portions of the site underlain by greenstone and the wells all draw groundwater from the fractured greenstone aquifer on days the quarry operates and/ or processes rock. Groundwater is generally at substantial depths during the dry months; static groundwater levels ranged from 22 to 70 feet below ground surface during the dry season when the wells were drilled (Table 1). The static groundwater flow gradient is 0.09, southward from the Franz Creek watershed divide to Porter Creek (Figure 10). Groundwater local to the quarry flows toward the quarry floor (Figure 11). Both the vegetation and static water levels in the wells suggest that the water table is only slightly elevated above the levels of the nearby streams during the summer. Drawdown in the wells can range 50 to 100 feet when pumped a couple of hours (Figures 12 and 13), and rebounds considerably when not pumped. Water levels reportedly rise considerably during the winter months with artesian conditions in the deeper wells. No 'true' springs were found on the site, though the existing reclamation sub-drains (outflow from drainages E1, E2, and E3) and overburden stockpile area sub-drains (outflow from drainage A) discharge shallow groundwater year-round.

Water is used on site for increasing aggregate saturation, the aggregate wash plant, dust control, equipment rinse and office use. Two 100,000 gallon water supply tanks are on site: one in the upper portion of the yard near the crusher, and one in the lower portion of the yard near the wash plant. The aggregate wash plant captures nearly all of the rinse water (at approximately 1,800 gallons per minute) and routes it through a clarifier for reuse. Rinse water not recycled by the wash plant is captured by a sump pump and reused in the wash plant. Reclamation sub-drain outflow is also ponded and pumped to a 20,000 gallon tank for road dust control.

Annual water usage is summarized in Table 2 for each water source. Wells #3 and #4 are metered and provide about 60 percent of the water used for operations. Other sources are estimated by BoDean staff. Existing water use is estimated at 21.6 acre-feet per year, 83 percent of which comes from the four wells. Water consumption was also estimated by BoDean staff with an independent method utilizing the annual production total, moisture content of the products produced, and nominal water consumption rates (Appendix E). Water consumption for existing production rates was estimated at 20.8 acre-feet per year. This method was used to estimate water use for the proposed increased production rate – approximately 30 acre-feet per year.

The average monthly water used was estimated in Table 3 based on the quantity of product produced and water application needed for dust control.[3] The average rate of use was then estimated for the months June through October, when water use is highest.

- For existing production rates, the average water consumption rate is estimated at 26 gallons per minute (if continuous from June through October).
- For proposed increased production rates, the average water consumption rate is estimated at 35 gallons per minute (if continuous from June through October).

These water use rates were proportioned among each water source based on current usage in Table 2. Average pumping rates for each well were utilized in the drawdown analysis (below).

2.6 Septic System and Wastewater Management

Human waste is discharged to an approved septic tank and leach field located near the office at the quarry entrance. Portable toilets are used at other locations and the waste is transported off site by a disposal company.

[3] The need for dust control was estimated as a function moisture deficit, which was estimated by subtracting precipitation and runoff from reference evapotranspiration (ETo). ETo is fundamentally a function of air temperature and humidity, solar radiation, and wind. During the wet season, when precipitation is higher than evapotranspiration and runoff, there is no deficit.

3. EFFECTS OF QUARRY EXPANSION AND RECLAMATION

3.1 Runoff

The proposed quarry expansion extends westward, initially expanding drainage 'F' and capturing a portion of drainage 'G' during the first 10-years of expansion (Figure 7). After 20 years of expansion (Figure 8), drainage 'F' continues to expand westward, capturing more of drainage 'G' and the headwaters of drainages 'H' and 'A', and a very small portion of drainage 'B'. Drainage 'B' drains to Franz Creek, otherwise runoff from the expanded and reclaimed quarry will continue to drain to Porter Creek with proportionally more draining out the quarry entrance. The drainage areas are summarized in Table 9 for existing conditions and the proposed 10 and 20 year expansion plan.

Surface drainage off the proposed reclaimed slopes of drainages 'F' and 'H' will traverse benches to a culvert or open boulder channel that transmits storm runoff to retention ponds on the quarry floor (Figure 8). A main pond is proposed for each drainage with smaller detention ponds located at the toe of the benched slopes. Outflow from the main ponds will flow to a final sediment-removal feature before flowing to Porter Creek. We estimate runoff from the reclaimed quarry to be about 60 percent of annual rainfall (see modeling discussion below), an increase of about 7 inches per year (Table 11), or 129 percent of the existing conditions.

Preliminary peak runoff estimates and retention pond criteria are shown in Table 10. Runoff computations for the proposed reclaimed landscape estimate a 1.5 acre-foot retention pond for drainage 'F' and a 0.7 acre-foot retention pond for drainage 'H'. Specific pond designs should be finalized based on the final reclaimed landscape outcome, incorporating the actual depth, permeability and moisture storage capacity of the overburden fill placed on the quarry floor.

3.1.1 Runoff Modeling

Balance utilized a spreadsheet-based rainfall-runoff model using historical rainfall data in order to estimate the percentage of mean annual runoff. A key feature of the model structure is the ability to use hourly rainfall data as input. Inclusion of one or more years of hourly rainfall data allows the model to explicitly incorporate variables such as storm intensity, storm duration and inter-event time. We utilized hourly event data from the Oakland Airport (Cooperative ID #6335). Mean annual rainfall at this gage is approximately 18.2 inches, based on rainfall records extending from 1949 to 1985.[4] A continuous record of hourly rainfall for the nine water years

[4] Records for this station are incomplete due to the lack of rainfall data for WY1982 and WY1983. Since these were two of the wettest years on record at most locations, mean annual rainfall at the Oakland Airport gage is likely slightly higher than calculated for this report.

1968 through 1976 was selected as input for the model. This interval is representative of the range of annual rainfall totals, and includes dry years (e.g. WY1976), as well as the notably wet year of WY1973.

Model runs were carried out for the reclaimed Mark West Quarry site using the following additional assumptions:

- Rainfall at the Mark West Quarry site can be reasonably approximated by prorating the actual hourly rainfall recorded at Oakland Airport by a scaling factor that takes into account the difference in mean annual rainfall between the two locations. Once scaled to the site, mean annual rainfall at the Oakland Airport is 49.1 inches over the nine-year period of record used as input to the hydrologic model, as compared to the long-term estimate of 47 inches annually at the project site (SCWA, 1983). This assumption is reasonable given the close proximity of the two locations.

- Infiltration rates for a 49-acre, 30-foot pervious fill on the quarry floor were assumed to be on the order of 0.2 inches/ hour, the mean infiltration rate from the local USDA NRCS soil survey for the Goulding and Spreckles soils.

- The quarry walls were assumed to have no infiltration (100 percent runoff).

- A small detention pond will be sited in the quarry upstream of the outfall to Porter Creek.

- Runoff can be approximated by using the Rational Formula for the 80-acre drainage area of the quarry walls and floor, and historical hourly rainfall.

Peak instantaneous rainfall intensities are clearly higher than those captured by the existing rainfall record, with one-hour resolution. Thus, peak runoff will be underestimated if times of concentration in the drainage network are less than one hour. The model, however, does not adjust for losses at the beginning of each storm or variations in antecedent moisture conditions. Therefore, runoff is likely overestimated for small storm events, but the effects should be compensating to estimate site runoff.

3.2 Groundwater Recharge

We used the water balance method for estimating annual recharge to groundwater under four conditions for the site (Table 11): 1) non-mined (unimpaired) conditions; 2) existing quarry; 3) expanded quarry; and 4) the reclaimed expanded-quarry.

Precipitation at the quarry site was estimated at 47 inches per year by using the Sonoma County Water Agency isoheytal map (1983). Regional runoff (Rantz, 1974) and evapotranspiration for interior Douglas fir forest (van der Leeden and others, 1990) was subtracted to estimate an average site recharge of 8 inches, or 67 acre-feet per year for the unimpaired expanded 100-acre site (drainages A, E1, E2, E3, F, G, and H, draining to Porter Creek). Average annual recharge for the site encompassing the existing quarry was similarly estimated at 7 inches, or about 60 acre-feet, and for the expanded quarry, groundwater recharge was estimated at 6 inches, or 53 acre-feet per year. These recharge estimates exceed existing and proposed groundwater pumping rates. Existing groundwater pumping from the four on-site wells is estimated at 18 acre-feet per year (Table 1 and 2), and pumping is proposed to increase to 25 acre-feet per year (Table 2). The decreased recharge is largely a result of increased runoff from cut-rock slopes on site.[5]

Once the site is reclaimed, its proposed end use is agriculture. Agriculture will likely include up to 30 acres of vineyards on the valley floor, requiring about 15 to 20 acre-feet of irrigation during August and September, or 56 to 75 gallons per minute. For the future reclaimed site with potentially 30 acres of vineyards[6], recharge from the 100-acre site was estimated at 4 inches or 34 acre-feet per year (Table 11). The existing on-site wells can meet this need if augmented by a 15 to 20 acre-foot pond, which could also meet occasional seasonal frost protection needs. Recharge from the pond could potentially increase recharge an additional 15 acre-feet, to about 46 acre-feet of recharge for the reclaimed quarry site.

3.3 Well Capacity and Bedrock Permeability

We conducted well pumping tests to evaluate the capacity of the wells located onsite, and the permeability (transmissivity and hydraulic conductivity) of the aquifer from which groundwater is extracted. Quarry operations were shut down for four days over the Thanksgiving holiday weekend, from the evening of November 26 to the morning of December 1, 2003, which provided the longest continuous period of non-use for the season (and since commencement of our work). Prior to the tests, on November 25, water-level monitoring equipment was set up in the wells and remained in operation until December 1. On November 29, we conducted a 4-hour pump test on well #1 (212074) and on November 30, a 2-hour test on well #3 (548113). Well #2 (433700) was not tested due to well casing constrictions at the 140-foot

[5] To assist runoff estimates for the reclaimed site we utilized runoff modeling based on a 9-year hourly record of rainfall and percolation estimates.

[6] The proposed end use for the reclaimed expanded mine site is agriculture. We use the water demand for a 30-acre vineyard as a typical example for agriculture of the region. Other crops may use more or less irrigation; vineyards are among the few crops also requiring winter storage for frost protection.

depth that prevented depth-to-water measurements. At the time of the well testing, Well #4 (1078646) had not been drilled. It was completed in July of 2006. Air lift tests were conducted on wells #2, #3, and #4 by the driller after each well was completed. Results are reported on the drillers logs (Appendix A). Test results are summarized in Table 1.

Computed hydraulic conductivities of the aquifer from each well were similar in magnitude, about $1x10^{-5}$ centimeters per second (Figures 12 and 13; and Table 1), with the shallower Well #1 being slightly more permeable. Specific capacity was measured to be 0.09 gpm per foot of drawdown in Well #1, and 0.13 gpm per foot of drawdown in Well #3. Drawdown effects from pumping each well were not observed in the other wells. These results are similar to the results reported on the well logs (Table 1).

During each aquifer test, we monitored specific conductance[7] (SC) and temperature (T) of the groundwater extracted (Figure 14). The shallow Well #1 was slightly warmer and lower in SC than the deeper Well #3, and both wells responded similarly as pumping progressed: T gradually increased and SC gradually decreased. These results indicate that deeper waters are warmer and have fewer dissolved solids, and suggest that sustained pumping draws groundwater from considerable depth, perhaps beneath the bottom of the well. These results are corroborated in the water quality section (below).

3.4 Water Quality

Water samples were initially collected from six sites and tested for general mineral and Title 22 inorganic composition:

- Well #1 (212074) located near the shaker;
- Well #2 (433700) located near the truck-wash area;
- Well #3 (548113) located near the crusher;
- The reclamation subdrain outfall located near the crusher;
- The “greenstone spring” pond located in drainage ‘A’, northeast of the active quarry; and
- Porter Creek just below the drainage ‘A’ confluence.

[7] Specific conductance (SC) of water is a metric for the property of a particular water to conduct an electrical current, and is a proxy for salinity or dissolved solids. The SC of rain is about 50 micro-umhos per centimeter (umhos/cm), and seawater is about 53,000 umhos/cm.

The six initial samples were collected on October 30, 2003, immediately prior to the first significant storms of the wet season, the optimal time to characterize stream, well and spring chemical composition. At that time, 1) Porter Creek was flowing at an estimated 50 to 100 gallons per minute, 2) drainage ‘A’ was dry at its confluence with Porter Creek, 3) the reclamation subdrain was flowing at about one-quarter gallon per minute, and 4) the “greenstone spring” had no surface flow, and was ponded at a level about 3 feet below its seasonal high. A month later, we re-sampled groundwater from the Well #1 and Well #3 when conducting the aquifer testing. We sampled Well #4 in February 2007 and three off-site domestic wells in July 2011, and tested them for general minerals only. Laboratory results are found in Appendix B and summarized in Table 12.

An often used method to illustrate the dissolved mineral composition of specific water samples is by plotting the results on a Piper Diagram (Figure 15), which is useful to identify and differentiate water sources. Based on this method, three types of water are characterized on and in the vicinity of the quarry site:

1. Calcium-magnesium bicarbonate surface waters, found in Porter Creek and in on-site ponds and near-surface drains (for example, samples from the reclamation subdrain outflow and the greenstone spring), which are influenced by bedrock weathering and decomposition of soil organic material;

2. Sodium bicarbonate groundwater, found in the on-site wells furthest well from the creek during dry-season pumping, such as the on-site 420-foot deep Well #3 and, to a somewhat lesser extent, the 190-foot deep Well #1 (and most probably also in Well #4, if it were sampled in the dry season); and

3. Groundwater illustrating a blend of surface water recharge and deeper groundwater, found in the dry-season sample from the 400-foot deep Well #2, which is located nearest the Porter Creek, and in the domestic wells sampled.

Cardwell (1959) attributes regionally soft groundwaters to a process of base cation exchange of calcium and magnesium for sodium as surface waters percolate and recharge groundwaters. Note on Figure 15 that the samples from October, when wells were operating at full production and water level were at their lowest levels, showed more sodium bicarbonate water than in those taken in November, when operations had been shut down for several days and water levels had recovered to higher levels. The site had also received several inches of rain by then.

We also sampled the 640-foot deep Well #4 in the wet season and results were similar to the November sample from Well #3, validating this process.

Of the three off-site domestic wells sampled during the dry season, the samples from the 320-foot deep well at 4500 Porter Creek Road and form the 600-foot deep well at 4512 Porter Creek Road are characterized in Figure 15 as calcium bicarbonate surface waters, similar to Porter Creek and the on-site "greenstone spring" pond. The well located below the drainage 'A' outflow showed a blend of calcium and sodium bicarbonate surface waters, likely influenced by recharge from the drainage 'A' outflow.

In summary, based on the ionic signatures of well water and surface water samples, on-site wells #1, #3 and #4 all draw on a groundwater source unique from Porter Creek and the groundwater supplying the domestic wells in the vicinity.

Regarding the post-mined end-use for agriculture, the amount of dissolved solids and concentration of boron are important metrics.

- High quantities of dissolved solids in irrigated water promote mineral precipitation and levels of salts in the surface soils that may reduce texture. Levels of dissolved solids tested moderately low and, particularly relative to rainfall, do not constrain the type of, or otherwise pose a fatal flaw for, reclamation by agriculture.

- At levels approaching 1 mg/L, boron inhibits growth of boron-sensitive plants (including grapes, citrus and walnut trees) and is toxic to most plants at levels exceeding 0.75 to 3 mg/L, depending upon their intrinsic sensitivity. Boron was measured at 0.2 mg/L in groundwaters underlying the quarry.

3.5 Well Capture and Groundwater Drawdown

Well capture and groundwater drawdown from pumping the on-site water supply wells was assessed for the existing annual water use and for the proposed (maximum) annual water use by utilizing three methods. Refer to Appendix F for diagrams of the theoretical capture zone models.

- An analytical groundwater flow model (calculations) based on the Theis (1935) equation[8] was used to estimate theoretical aquifer the drawdown for existing and proposed production rates at the end of a 5 month dry season (June through October). This is a

[8] Refer to Driscoll, F.G., 1986, Groundwater and Wells, 2nd Ed., p. 219 for explanation

standard 'cone-of-depression' analysis that does not include influences by regional groundwater flow.

- Theoretically, the capture zone of a well is skewed towards the flow of groundwater, resembling a parabola rather than forming a circle. The dimensions of the zone groundwater capture – such as the distance from the well to the downgradient flow stagnation point and the lateral width of capture – was estimated using uniform flow equations (e.g., Todd, 1980).

- California Department of Health Services Drinking Water Source Assessment and Protection Program (1999)[9] calculated fixed radius method was used to approximate the zone influence of each well for a 2-year travel time. This method is typically used for determining response times for spill events and thus can be thought of as an estimate the theoretical recharge area for a given travel time.

Given that many of the method assumptions are not satisfied in the fractured bedrock aquifer from which the wells draw water, the groundwater modeling results should be viewed as an indicator of groundwater conditions and not for quantitative accuracy.

Estimated groundwater drawdown for each well was calculated for the average pumping rate for the period June through October (Table 2), when production rates, water use, and groundwater drawdown would be highest, and groundwater recharge from precipitation would be negligible. An average aquifer transmissivity value of 53 gallons per day per foot, tested at the on-site wells (Table 1), and a nominal aquifer storativity value of 0.02 for fracture bedrock was used in the calculations.

Drawdown was calculated for the following distances from each water supply well:

- 0.1 feet, 1 foot, 10 feet, 100 feet, and 300 feet;

- half the distance to each water supply well;

- the total distance to each water supply well;

- the distance to Porter Creek; and,

- the distance to the off-site wells.

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[9] http://www.cdph.ca.gov/certlic/drinkingwater/pages/dwsap.aspx

Cumulative drawdown was then calculated for the distance to each on-site and off-site well and for the distance to Porter Creek. Results for existing water use is shown in Table 4 and for proposed water use in Table 5. Results suggest that groundwater drawn from Well #2 may be marginally influenced by recharge from Porter Creek, otherwise effects to the creek from the other three wells are unlikely. Effects to offsite wells from pumping the on-site wells under existing and proposed water usage are also unlikely.

Groundwater capture from the water supply wells is likely skewed northerly into the flow of groundwater (see cross section A-A' in Figure 10). Based on uniform flow equations (adapted from Todd, 1980), the estimated dimensions of groundwater capture was calculated for each water supply well and summarized in Table 6. The distance to the downgradient stagnation point by pumping Well #2 at an average dry-season rate (for June through October) was estimated at 200 feet for existing pumping and at 275 feet for the proposed increased pumping. A well theoretically does not capture groundwater downgradient of the stagnation point, and the distance from Well #2 to Porter Creek is 300 feet, beyond the stagnation point. The distance to the downgradient stagnation point by pumping Well #2 at a maximum monthly rate (for August) was estimated at 262 feet for existing pumping and at 365 feet for the proposed increased pumping. These results, which include influences by regional groundwater flow gradient, also suggest that groundwater drawn from Well #2 may be marginally influenced by recharge from Porter Creek, particularly during the months of highest use and for the proposed increased pumping rates.

The third method, the California Department of Health Services Drinking Water Source Assessment and Protection Program calculated fixed radius method approximates the theoretical radius of influence based on pumping rate and travel time. We chose a 2-year travel time as an estimate of theoretical area of recent recharge. The calculation is inversely related to effective porosity and screen length (or well depth); thus deeper wells exhibit less surface influence than shallower wells (if fully screened) for a given travel time. Results for pumping Well #2 under existing and proposed production rates indicate a 2-year capture area that is less that the distance from the well to Porter Creek, suggesting its effect to the creek is negligible.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Runoff

The proposed quarry expansion increases the size of the drainage area of the active quarry (drainage F) from 18.5 acres to 34.2 acres by mining westward and reducing the areas of adjacent drainages (G and H). A very minor change of about 0.3 acres is proposed to the watershed divide separating Porter Creek from Franz Creek. Runoff from the active quarry will continue to drain south to Porter Creek under the proposed 20-year expansion plan, with proportionally more runoff routed through the quarry entrance. The overburden storage area (drainage B) continues to drains north to Franz Creek.

Using a 9-year hourly rainfall record, we estimate the average runoff of the proposed reclaimed site to be 60 percent of rainfall, or 31 inches of the mean annual rainfall total. Existing annual runoff was estimated at 24 inches, and unimpaired runoff at 18 inches annually.

The project proposes to offset potential hydromodification effects from increased runoff rates and loss of tributary low flow by directing runoff from the benched reclaimed slopes into detention and recharge basins at the foot of the slopes and on the quarry floor. The ponds should be designed to meet both detention and irrigation/ frost-protection requirements. Augmented groundwater recharge through the ponds will also help replenish aquifer and water well levels.

4.2 Groundwater

Average annual groundwater recharge for the 100-acre portion of the site draining to Porter Creek (drainages A, E1, E2, E3, F, G, and H) was estimated at 60 acre-feet. For the expanded quarry, groundwater recharge for the same area was estimated at 53 acre-feet per year. The decreased recharge is largely a result of increased runoff from cut-rock slopes on site. These recharge estimates exceed existing and proposed annual groundwater pumping of 18 acre-feet and 25 acre-feet, respectively. The potential for diminished percolation as a result of mining will be [partly; largely] offset by recharge through proposed ponds used both for detention and recharge, and by percolation through the flatter backfill placed on the quarry floor. Post-reclamation recharge will be appreciably more than the estimated end-use agricultural needs.

Based on the ionic signatures of well water and surface water samples, the on-site water supply wells #1, #3 and #4 apparently all draw on a unique deeper groundwater source than Porter Creek and the groundwater supplying the off-site domestic wells in the vicinity. The 400-foot deep Well #3 and the 620-foot deep Well #4 are reportedly artesian during the wet-season, indicating upwelling groundwater and supporting the concept of a deeper groundwater source. Groundwater drawdown and capture modeling indicates no negative effects to Porter Creek and to the off-site domestic wells by the proposed maximum pumping rates of these wells.

Water quality results from Well #2, however, suggests a mix of surface water and groundwater; this well is the closest to Porter Creek (300 feet), which may likely be the source of dry-season recharge. In support of this understanding, groundwater drawdown and capture modeling indicates that Well #2 may be marginally influenced by recharge from Porter Creek, particularly during the months of highest use. The proposed maximum pumping rates make this concept more plausible. We recommend limiting increased use of Well #2, particularly during drought years.

4.3 Water Quality

The fractured greenstone aquifer underlying the expanded quarry site typically yields soft sodium bicarbonate groundwater, with temperatures observed of up to 24°C (76°F) after several hours of pumping. Trace element concentrations are below detection levels for most constituents. The quality of water is suitable for all candidate agricultural end uses.

Surface waters tend to be slightly harder, with higher concentrations of calcium and magnesium and lower levels of sodium, and are also well suited for agricultural uses. Following wet-season recharge or groundwater recharge from stream channels, the quality of groundwater comprises a mix of surface water and groundwater constituents, particularly at shallow depths.

Groundwater samples tested for Title 22 California State drinking water standards are usable as potable water, and are expected to be so following reclamation.

4.4 Post-Reclamation Water Supply

Cumulative capacity of the four on-site wells is estimated at about 170 gallons per minute (gpm), based on driller's air-lift estimates following completion of each well. A 'rule of thumb' estimate of short-term pumping capacity is half of the driller's air-lift estimates, which is 85 gpm and adequate for existing quarry operations but may pose limits to agricultural irrigation and frost protection. Supplemented by about 15 acre feet per year from the ponds, supplies from the wells will be adequate for potential agricultural end uses. Additional wells can be drilled should less use of the ponds be desired.

5. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing for CEQA evaluation of projects of comparable size and complexity in Northern California at the time the investigation was performed. No other warranties, expressed or implied, are made. It should be recognized that interpretation and evaluation of subsurface conditions is a difficult and inexact art. Judgment leading to conclusions and recommendations presented above were based on existing information and personnel communications which in total represent an incomplete picture of the site. More extensive studies, including those recommended above, can reduce some of the uncertainties associated with this study.

Balance Hydrologics has prepared this report for the client's exclusive use on this particular CEQA level evaluation. Analyses and information included in this report are intended for use at the watershed scale and for the planning purposes described above. Analyses of channels and other water bodies, rocks, earth properties, topography and/ or environmental processes are generalized to be useful at the scale of a watershed, both spatially and temporally. Information and interpretations presented in this report should not be applied to specific projects or parcels other than the Mark West Quarry site without the expressed written permission of the authors, nor should they be used beyond the particular area to which we have applied them.

This study was conducted partly to help interpret work done by others, portions of which have not been independently verified. Our conclusions and any implied or inferred recommendations are based on a limited range of surface water and groundwater data in a region of relatively complex geology. They are limited to planning purposes and should not be used for design or site-specific work. If readers are aware of additional data, observations, conditions, or forthcoming changes to the bases of our decisions, please let us know at the first opportunity, such that this report may be promptly revised.

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TABLES

Table 1. Specifications of wells located at Mark West Quarry, Sonoma County, California.

	Units	Well #4	Well #3	Well #2	Well #1
Site locators:					
Assessors parcel number		120-210-048	120-210-048	120-210-048	120-210-02
DWR well report number		1078646	548113	433700	212074
Latitude (NAD27)	degrees	N38.55528	N38.55545	N38.55386	N38.55472
Longitude (NAD27)	degrees	W122.65511	W122.65449	W122.65454	W122.65460
Elevation (approx.)	feet	995	1028	970	992
Drilling and well construction descriptors [1] :					
Well driller		Peterson	Fisch Bros.	Fisch Bros.	Fisch Bros.
Depth of boring		645	720	400	190
Depth of well	feet	640	420	400	190
Depth of surface seal	feet	50	22	20	20
Depth of perforations	feet	80-100, 160-640	80 to 420	25 to 400	140 to 190
Well diameter	inches	5	8	4.5	5
Date of well completion		7/5/2005	10/5/1994	8/23/1991	9/16/1982
Depth of static water level	feet	30	70	70	22
Estimated yield (air-lift test), q	gpm	60	70	20	20
Length of air-lift test	hours	2	2	4	--
Total drawdown, s	feet	620	400	360	--
Specific capacity, Cs=q/s	gpm/ft	0.10	0.21	0.069	--
Estimated transmissivity[2], T=1860*Cs	gpd/ft	189	395	128	--
Primary rock types		greenstone with sandstone and quartz	greenstone 0-680 feet, chert 680-720 feet	greenstone with quartz; chert 300-315 feet	greenstone
Yield testing [3] :					
Date of test		not tested	11/30/1003	not tested	11/29/1003
Pumping duration	hours	--	2	--	4
Pumping rate, q	gpm	--	6	--	9
Total drawdown, s	feet	--	48	--	100
Specific capacity, Cs=q/s	gpm/ft	--	0.13	--	0.090
Transmissivity, T	gpd/ft	--	58.7	--	47.5
Hydraulic conductivity, K	gpd/ft^2	--	0.21	--	0.29
Hydraulic conductivity, K	cm/s	--	9.70E-06	--	1.40E-05
Recovery	%	--	75% after 2 hours 100% after 6 hours	--	87% after 4 hours 96% after 20 hours
5-year usage:					
Installed flow meter	--	Summer 2006	Summer 2006	none	none
Mean monthly water production	gallons	162,738	182,133	94,444	47,222
Annual water production [4]	gallons	1,952,856	2,185,596	1,133,333	566,667
Annual water production	acre-feet	6.0	6.7	3.5	1.7
Average pumping rate (if continuous)	gpm	3.7	4.2	2.2	1.1

Notes:

1. Drilling and well descriptors were transcribed from driller's well comple ion reports filed at the Department of Water Resources.
2. Estimated transmissivity, T = 1860 Cs (gpd/ft) after DWR Bulletin No. 118-2, June 1974.
3. Constant-rate pumping tests were conducted by Balance Hydrologics' staff.
4. An additional 1,000,000 gallons per year (gpy) is collected from the sub drains underneath the existing reclamation, and 200,000 gpy from a sump pump that retrieves all the processed water from the wash plant.

Table 2. Water sources and usage at Mark West Quarry, Sonoma County, California.

	Units	Well #4 #1078646	Well #3 #548113	Well #2 #433700	Well #1 #212074	Reclamation Subdrains[1]	Wash Plant Sump Pump	TOTAL
Existing water usage [2]								
Installed flow meter	--	summer 2006	summer 2006	none	none	none	none	--
Mean monthly water production	gallons	162,738	182,133	94,444	47,222	141,667	16,667	644,871
Annual water production	gallons	1,952,856	2,185,596	1,133,333	566,667	1,000,000	200,000	7,038,452
Annual water production	acre-feet	6.0	6.7	3.5	1.7	3.1	0.6	21.6
Percent of total annual water production	--	28%	31%	16.1%	8.1%	14.2%	2.8%	--
Average annual pumping rate (if continuous)	gpm	3.7	4.2	2.2	1.1	1.9	0.4	13
Average pumping rate Jun through Oct[3]	gpm	7.2	8.0	4.2	2.1	3.7	0.7	26
Proposed water usage [4]								
Annual water production	gallons	2,715,719	3,039,376	1,576,058	788,029	1,390,639	278,128	9,787,949
Annual water production	acre-feet	8.3	9.3	4.8	2.4	4.3	0.9	30
Average annual pumping rate (if continuous)	gpm	5.2	5.8	3.0	1.5	2.6	0.5	19
Average pumping rate Jun through Oct[3]	gpm	9.8	11.0	5.7	2.9	5.0	1.0	35

Notes:

1. Drainage from the existing reclamation subdrains is routed to a pond, where some water is pumped to a 20,000 gallon tank and used to spray on roads for dust control. The pond drains to four sediment traps (in series), where water is pumped to the 100,000 gallon tank supplying the wash plant. Additional water is available for capture that currently flows from the retention ponds and to Porter Creek.
2. Five year average water production data available for the Wells #3 and #4 wells. The use of other sources estimated by BoDean Co., Inc.
3. The average pumping rate June through October for the total of all sources was estimated in Table 3. Distribution among sources was based on the percent of total annual production of water.
4. The proposed water usage is based on an estimated 750,000 tons of product produced per year (an increase from the existing 457,500 tpy). Proportioning the total annual water production among the water sources was based on existing conditions.

Table 3. Estimated monthly water consumption for existing and proposed conditions, Mark West Quarry, Sonoma County, California.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Approach: Water consumption is largely influenced by 1) the quantity of product produced, and 2) water application is need for dust control. Accordingly, the estimated annual consumption of water was proportioned for each month based on a moisture deficit index and product sales.													
Monthly moisture deficit [1]													
Average precipitation at Santa Rosa[2], inches	6.26	5.28	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.66	5.71	30.19
Average precipitation at MWQ (P)[3], inches	9.74	8.22	6.24	3.09	1.48	0.44	0.05	0.12	0.54	2.49	5.70	8.89	47
Approximate runoff (R = P x C)[4], inches	4.87	4.11	3.12	1.55	0.74	0.22	0.02	0.06	0.27	1.24	2.85	4.44	23.50
Average reference evapotranspiration (ETo)[5], inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21
Mean monthly moisture deficit (ETo - P - R), inches	0.00	0.00	0.00	0.00	3.24	5.81	6.46	5.69	3.54	0.00	0.00	0.00	24.75
Monthly moisture deficit (W), percent of annual	0.0%	0.0%	0.0%	0.0%	13.1%	23.5%	26.1%	23.0%	14.3%	0.0%	0.0%	0.0%	100%
Monthly product sales [6]													
Average monthly product sales (S), percent of annual	2.0%	2.0%	2.0%	2.0%	2.0%	5.0%	10.0%	20.0%	20.0%	20.0%	10.0%	5.0%	100%
Monthly water consumption [7]													
Water consumption index [(W+S)/2], percent of annual	1.0%	1.0%	1.0%	1.0%	7.6%	14.2%	18.0%	21.5%	17.2%	10.0%	5.0%	2.5%	100%
Monthly water consumption for <u>existing</u> conditions, acre-feet	0.22	0.22	0.22	0.22	1.63	3.08	3.90	4.64	3.71	2.16	1.08	0.54	21.6
Pumping rate (if continuous), gallons per minute	1.6	1.7	1.6	1.6	12	23	28	34	28	16	8.1	3.9	13
Average pumping rate (if continuous) Jun through Oct, gpm	--	--	--	--	--	26	26	26	26	26	--	--	--
Monthly water consumption for <u>proposed</u> conditions, acre-feet	0.30	0.30	0.30	0.30	2.27	4.28	5.42	6.46	5.15	3.00	1.50	0.75	30
Pumping rate (if continuous), gallons per minute	2.2	2.2	2.2	2.2	17	31	40	47	38	22	11	5.5	18
Average pumping rate (if continuous) Jun through Oct, gpm	--	--	--	--	--	35	35	35	35	35	--	--	--

Notes:

1. Moisture deficit is estimated by subtracting precipitation and runoff from evapotranspiration; it was used as an index for water application needs. During the wet season, when precipitation is higher than evapotranspiration and runoff, there is no deficit.

2. Precipitation data source: Sonoma County Station SRO (http://cdec.water.ca.gov/snow_rain.html) and US National Climatic Data Center (NCDC) station #7965, Santa Rosa (http://www.ipm.ucdavis.edu/calludt.cgi/WXSTATIONDATA?STN=SNTAROSA.C)

3. Monthly precipitation on site was proportioned based on SCWA isohyet map mean annual precipitation.

4. To approximate runoff, a coefficient (C) of 0.5 was multiplied to precipitation (plate B-1, SCWA).

5. Evapotranspiration is the amount of water that evaporates from vegetation (transpiration) and from the underlying soil. ETo is evapotranspiration from a well-watered area of clipped grass and is typically used as a reference standard in agriculture to calculate crop evapotranspiration. Average monthly ETo data source: California Irrigation Management Information System (CIMIS) station #103 Windsor (http://wwwcimis.water.ca.gov/cimis/frontStationDetailInfo.do?stationId=103).

6. Monthly product sales estimates were provided by BoDean Co., Inc.

7. The water consumption index for each month is the average of the monthly moisture deficit (as a percentage of annual) and the monthly aggregate sales (as a percentage of annual total); it was used to proportion the estimated annual consumption of water to each month. The total annual consumption of water was estimated in Table 2.

Table 4. Estimated groundwater drawdown from pumping water supply wells for existing production rates, Mark West Quarry, Sonoma County, California.

1) Method

Theoretical drawdown was calculated for each well using Cooper and Jacob modified nonequil brium Theis equation.[1]
The modified nonequilibrium equation is valid for values of u less than about 0.05, otherwise values are approximate.
Theis' nonequil brium equation is based on the following assumptions:

a) The water-bearing formation is uniform in character and the hydraulic conductivity is the same in all directions.
b) The formation is uniform in thickness and infinite in areal extent.
c) The formation receives no recharge from any source.
d) The pumped well penetrates, and receives water from, the full thickness of the water-bearing formation.
e) The water removed from storage is discharged instantaneously when the head is lowered.
f) The pumping well is 100 percent efficient.
g) All water removed from the well comes from aquifer storage.
f) Laminar flow exists throughout the well and aquifer.
i) The water table or potentiometric surface has no slope.

Given that many of these above assumptions are not satisfied in the fractured bedrock aquifer and on-site wells, results should be viewed as an indicator of groundwater conditions and not for quantitative accuracy.
Cumulative drawdown is estimated at nearby wells and for Porter Creek.

2) Well data	Well #1	Well #2	Well #3	Well #4	Remarks
Total depth of well (feet)	190	400	420	640	Table 1 well and yield specifications
Transmissivity, T (gpd/ft)	53	53	53	53	Table 1 average of wells #1 and #3 yield tests
Storativity, S	0.02	0.02	0.02	0.02	Fractured bedrock norm
Pumping rate, Q (gpm)	2.1	4.2	8.0	7.2	Table 2 average pumping rate Jun through Oct
Pumping duration, t (days)	153	153	153	153	Jun through Oct
Total volume pumped (acre-feet)	1.4	2.8	5.4	4.9	15 acre-feet cumulative for all wells

3) Distance (feet) from pumped well

Feature	Well #1	Well #2	Well #3	Well #4
no feature	0.1	0.1	0.1	0.1
no feature	1	1	1	1
no feature	10	10	10	10
no feature	100	100	100	100
no feature	300	300	300	300
1/2 the distance to Well #1	0	195	140	140
Well #1	0	390	280	280
1/2 the distance to Well #2	195	0	335	330
Well #2	390	0	670	660
1/2 the distance to Well #3	140	335	0	85
Well #3	280	670	0	170
1/2 the distance to Well #4	140	330	85	0
Well #4	280	660	170	0
Porter Creek	700	300	980	970
Well at 4500 Porter Cr. Rd.	1730	1570	1930	1840
Well at 4512 Porter Cr. Rd.	1980	1960	2100	1940
Well below Subdrain A	2500	2730	2430	2290
Residential Well NE of Site	1830	2150	1580	1650

4) u = (1.87*r^2*S) / (T*t)

Well #1	Well #2	Well #3	Well #4
valid	valid	valid	valid
valid	valid	valid	valid
valid	valid	valid	valid
valid	valid	valid	valid
approx.	approx.	approx.	approx.
	approx.	approx.	approx.
	approx.	approx.	approx.
approx.		approx.	approx.
approx.		approx.	approx.
approx.	approx.		valid
approx.	approx.		approx.
approx.	approx.	valid	
approx.	approx.	approx.	
approx.	approx.	approx.	approx.
approx.	approx.	approx.	approx.
approx.	approx.	approx.	approx.
approx.	approx.	approx.	approx.
approx.	approx.	approx.	approx.

5) Drawdown (feet), s = (264*Q/T) * log [(0.3*T*t) / (R2*S)]

Distance	Well #1	Well #2	Well #3	Well #4	**Cumulative Drawdown**
0.1	73.47	146.93	283.36	253.18	**--**
1	52.73	105.46	203.37	181.71	**--**
10	31.99	63.98	123.38	110.24	**--**
100	11.25	22.50	43.40	38.77	**--**
300	1.36	2.71	5.23	4.67	**--**
1/2 the distance to Well #1		10.47	31.71	28.33	**--**
Well #1		0.00	7.63	6.82	**14.44**
1/2 the distance to Well #2	5.24		1.40	1.72	**--**
Well #2	0.00		0.00	0.00	**0.00**
1/2 the distance to Well #3	8.22	0.73		43.82	**--**
Well #3	1.98	0.00		22.30	**24.28**
1/2 the distance to Well #4	8.22	1.00	49.04		**--**
Well #4	1.98	0.00	24.96		**26.94**
Porter Creek	0.00	2.71	0.00	0.00	**2.71**
Well at 4500 Porter Cr. Rd.	0.00	0.00	0.00	0.00	**0.00**
Well at 4512 Porter Cr. Rd.	0.00	0.00	0.00	0.00	**0.00**
Well below Subdrain A	0.00	0.00	0.00	0.00	**0.00**
Residential Well NE of Site	0.00	0.00	0.00	0.00	**0.00**

Notes:

1. Driscoll, F.G., 1986, Groundwater and Wells, 2nd Ed., p. 219.

Table 5. Estimated groundwater drawdown from pumping water supply wells for proposed production rates, Mark West Quarry, Sonoma County, California.

1) Method

Theoretical drawdown was calculated for each well using Cooper and Jacob modified nonequilibrium Theis equation.[1]
The modified nonequilibrium equation is valid for values of u less than about 0.05, otherwise values are approximate.
Theis' nonequilibrium equation is based on the following assumptions:

a) The water-bearing formation is uniform in character and the hydraulic conductivity is the same in all directions.
b) The formation is uniform in thickness and infinite in areal extent.
c) The formation receives no recharge from any source.
d) The pumped well penetrates, and receives water from, the full thickness of the water-bearing formation.
e) The water removed from storage is discharged instantaneously when the head is lowered.
f) The pumping well is 100 percent efficient.
g) All water removed from the well comes from aquifer storage.
f) Laminar flow exists throughout the well and aquifer.
i) The water table or potentiometric surface has no slope.

Given that many of these above assumptions are not satisfied in the fractured bedrock aquifer and on-site wells, results should be viewed as an indicator of groundwater conditions and not for quantitative accuracy.
Cumulative drawdown is estimated at nearby wells and for Porter Creek.

2) Well data	Well #1	Well #2	Well #3	Well #4	Remarks
Total depth of well (feet)	190	400	420	640	Table 1 well and yield specifications
Transmissivity, T (gpd/ft)	53	53	53	53	Table 1 average of wells #1 and #3 yield tests
Storativity, S	0.02	0.02	0.02	0.02	Fractured bedrock norm
Pumping rate, Q (gpm)	2.9	5.7	11.0	9.8	Table 2 average pumping rate Jun through Oct
Pumping duration, t (days)	153	153	153	153	Jun through Oct
Total volume pumped (acre-feet)	1.9	3.9	7.5	6.7	20 acre-feet cumulative for all wells

3) Distance (feet) from pumped well					***4) u = (1.87*r² *S) / (T*t)***			
Feature	Well #1	Well #2	Well #3	Well #4	Well #1	Well #2	Well #3	Well #4
no feature	0.1	0.1	0.1	0.1	valid	valid	valid	valid
no feature	1	1	1	1	valid	valid	valid	valid
no feature	10	10	10	10	valid	valid	valid	valid
no feature	100	100	100	100	valid	valid	valid	valid
no feature	300	300	300	300	approx.	approx.	approx.	approx.
1/2 the distance to Well #1	0	195	140	140		approx.	approx.	approx.
Well #1	0	390	280	280		approx.	approx.	approx.
1/2 the distance to Well #2	195	0	335	330	approx.		approx.	approx.
Well #2	390	0	670	660	approx.		approx.	approx.
1/2 the distance to Well #3	140	335	0	85	approx.	approx.		valid
Well #3	280	670	0	170	approx.	approx.		approx.
1/2 the distance to Well #4	140	330	85	0	approx.	approx.	valid	
Well #4	280	660	170	0	approx.	approx.	approx.	
Porter Creek	700	300	980	970	approx.	approx.	approx.	approx.
Well at 4500 Porter Cr. Rd.	1730	1570	1930	1840	approx.	approx.	approx.	approx.
Well at 4512 Porter Cr. Rd.	1980	1960	2100	1940	approx.	approx.	approx.	approx.
Well below Subdrain A	2500	2730	2430	2290	approx.	approx.	approx.	approx.
Residential Well NE of Site	1830	2150	1580	1650	approx.	approx.	approx.	approx.

5) Drawdown (feet), s = (264*Q/T) * log [(0.3*T*t) / (R2*S)]					**Cumulative**
Distance	Well #1	Well #2	Well #3	Well #4	**Drawdown**
0.1	100.85	201.71	388.99	347.57	--
1	72.38	144.77	279.18	249.45	--
10	43.92	87.83	169.38	151.34	--
100	15.45	30.89	59.57	53.23	--
300	1.86	3.72	7.18	6.42	--
1/2 the distance to Well #1		14.38	43.53	38.89	--
Well #1		0.00	10.47	9.36	**19.83**
1/2 the distance to Well #2	7.19		1.92	2.36	--
Well #2	0.00		0.00	0.00	**0.00**
1/2 the distance to Well #3	11.29	1.00		60.15	--
Well #3	2.72	0.00		30.62	**33.33**
1/2 the distance to Well #4	11.29	1.37	67.32		--
Well #4	2.72	0.00	34.27		**36.98**
Porter Creek	0.00	3.72	0.00	0.00	**3.72**
Well at 4500 Porter Cr. Rd.	0.00	0.00	0.00	0.00	**0.00**
Well at 4512 Porter Cr. Rd.	0.00	0.00	0.00	0.00	**0.00**
Well below Subdrain A	0.00	0.00	0.00	0.00	**0.00**
Residential Well NE of Site	0.00	0.00	0.00	0.00	**0.00**

Notes:

1. Driscoll, F.G., 1986, Groundwater and Wells, 2nd Ed., p. 219.

Table 6. Estimated dimensions of groundwater capture from water supply wells, Mark West Quarry, Sonoma County, California.

(including influences by regional groundwater flow gradient)

	Well #1	Well #2[3]	Well #3	Well #4	Remarks
Aquifer specifications:					
Aquifer transmissivity, T (gallons per day per foot)	53	53	53	53	Average of wells #1 and #3 yield tests (Table 1)
Regional groundwater gradient, i	0.09	0.09	0.09	0.09	Based on drillers logs static water level (Figure 10)
Distance from well to Porter Creek (feet)	700	300	980	970	
Calculated capture zone dimensions for existing water use[1]:					
Average pumping rate, Q (gallons per day)	2,998	5,995	11,562	10,331	Dry season daily average Jun - Oct (Table 2)
Stagnation point downgradient distance[2] (feet), $x_o = Q/(2\pi Ti)$	100	200	386	345	
Width at well perpendicular to regional groundwater flow (feet), $w_o = Q/(2Ti)$	314	628	1,212	1,083	
Upgradient width perpendicular to regional groundwater flow (feet), $w = Q/(Ti)$	628	1,257	2,424	2,166	
Maximum monthly pumping rate, Q (gallons per day)	3,930	7,861	15,159	13,545	Dry season daily average (Table 2) factored higher using the daily average for August (Table 3)
Stagnation point downgradient distance[2] (feet), $x_o = Q/(2\pi Ti)$	131	262	506	452	
Width at well perpendicular to regional groundwater flow (feet), $w_o = Q/(2Ti)$	412	824	1,589	1,420	
Upgradient width perpendicular to regional groundwater flow (feet), $w = Q/(Ti)$	824	1,648	3,178	2,840	
Calculated capture zone dimensions for proposed water use[1]:					
Average pumping rate, Q (gallons per day)	4,115	8,230	15,872	14,182	Dry season daily average Jun - Oct (Table 2)
Stagnation point downgradient distance[2] (feet), $x_o = Q/(2\pi Ti)$	137	275	530	473	
Width at well perpendicular to regional groundwater flow (feet), $w_o = Q/(2Ti)$	431	863	1,664	1,487	
Upgradient width perpendicular to regional groundwater flow (feet), $w = Q/(Ti)$	863	1,725	3,327	2,973	
Maximum monthly pumping rate, Q (gallons per day)	5,465	10,931	21,080	18,835	Dry season daily average (Table 2) factored higher using the daily average for August (Table 3)
Stagnation point downgradient distance[2] (feet), $x_o = Q/(2\pi Ti)$	182	365	703	628	
Width at well perpendicular to regional groundwater flow (feet), $w_o = Q/(2Ti)$	573	1,146	2,210	1,974	
Upgradient width perpendicular to regional groundwater flow (feet), $w = Q/(Ti)$	1,146	2,292	4,419	3,949	

Notes:

1. Uniform flow equations for determining area of contr bution to a pumping well adapted from Todd (1980).
2. Groundwater capture from the water supply wells is theoretically skewed northerly into the flow of groundwater and away from Porter Creek. A well theoretically does not capture groundwater down gradient of the stagnation point.
3. Well #2 is the closest well to Porter Creek and a "stagnation point down gradient distance" that is less than this distance suggests a negligible well capture of groundwater underlying the creek. Boxes identify these estimates. Refer to diagrams of theoretical capture-zone models in Appendix F for explanatory illustrations.

Table 7. Estimated radius of influence of water supply wells, Mark West Quarry, Sonoma County, California.

	Well #1	Well #2	Well #3	Well #4	Remarks
Aquifer specifications:					
Time of travel (years), t	2	2	2	2	Estimated recharge area
Effective porosity (storativity), n	0.02	0.02	0.02	0.02	Fractured bedrock norm
Screened interval of well (feet), H	50	375	340	560	Based on gravel pack interval on drillers logs
Distance from well to Porter Creek (feet)	700	300	980	970	
Existing water usage:					
Average pumping rate (gallons per minute), Q	2.1	4.2	8.0	7.2	Dry season average rate Jun - Oct (Table 2)
Radius of influence[1] (feet), R=SQRT(Qt/πnH)	305	158	230	169	
Maximum monthly pumping rate (gallons per minute), Q	2.7	5.5	10.5	9.4	Dry-season average rate (Table 2) factored higher using the average rate for August (Table 3)
Radius of influence[1] (feet), R=SQRT(Qt/πnH)	349	180	263	194	
Proposed production rates:					
Average pumping rate (gallons per minute), Q	2.9	5.7	11.0	9.8	Dry season average rate Jun - Oct (Table 2)
Radius of influence[1] (feet), R=SQRT(Qt/πnH)	358	185	269	198	
Maximum monthly pumping rate (gallons per minute), Q	3.8	7.6	14.6	13.1	Dry-season average rate (Table 2) factored higher using the average rate for August (Table 3)
Radius of influence[1] (feet), R=SQRT(Qt/πnH)	412	213	310	229	

Notes:
1. California Department of Health Services Drinking Water Source Assessment and Protection Program calculated fixed radius method is used to approximate the zone influence of each well. This method is typically used for determining response times for spill events and thus can be thought of as an estimate the theoretical recharge area for a given travel time. Refer to radius of influence diagram in Appendix F for explanatory illustration.

Table 8. Recharge and water-holding properties of surficial soils,
Mark West Quarry, Sonoma County, California

Map Symbol	Soil Series[1]	Parent Material	Taxonomy	Hydrologic Soil Group	Project Area Coverage (% estimated)	Depth Zone (inches)	USCS[2]	Attenberg Limits: Liquid	Attenberg Limits: Plastic	Permeability (inches/hour)	Available Water Capacity[3]: Per Inch (in /in. of soil)	Available Water Capacity[3]: Profile (total, in)	Reaction (pH) (pH)	Remarks
Fo, Fr	Forward, Forward-Kidd	Rhyolite rock and soft rhyolitic tuff	Inceptisols	C	40	0 to 21	SM, SC	15-25	10-20	0.63 to 2.0	0.10 to 0.12	2.3	4.5-7.3	Soil type at site on the northern portion of the site
			Typic Vitrandepts											
			Ashy, mesic								*Total*	*2.3*		
Gg, Gl	Goulding	Metamorphosed basic igneous and weathered andesitic basalt of old volcanic	Inceptisols	D	10	0 to 11	CL	30-40	15-30	0.63 to 2.0	0.19 to 0.21	2.2	5.6-6.5	Main soil type on the southern portion of the site; located on mountainous uplands over fracture rock
			Lithic Xerochrepts			11 to 22	GC	30-40	15-30	0.63 to 2.0	0.09 to 0.11	1.1	6.1-6.5	
			Loamy-skeletal, mixed, mesic								*Total*	*3.3*		
Sk	Spreckles	Volcanic tuffs and weathered basic igneous rock.	Alfisols	C	10	0 to 18	CL/ML	30-40	10-25	0.2 to 0.63	0.17-0.21	3.4	6.1-6.5	Located on ridge in center portion of property
			Ultic Palexeralfs			18 to 37	CL	40-50	20-30	0.06-0.2	0.14-0.16	2.9	5.1-5.5	
			Fine, mixed, thermic								*Total*	*6.3*		
Qaf	Artificial fill	Site overburden engineered on reclaimed slopes		C	15	36				0.63 to 2.0	0.16 to 0.20	6.5		Mainly located on the east and north slopes of existing quarry
											Total	*6.5*		
RoG, Rck	Rock land	Stony steep slopes and ridges, and actively mined areas			25	0				0.01	0	0		Mainly located in the central portion of existing quarry
											Total	*0*		

Notes

1) Information taken from the most-recent USDA soil survey for the area (1972), and/or Soil Survey Laboratory Data for Some Soils of California (Soil Survey Investigations Report No. 24), 1973. This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 acres will not be mapped.

2) USCS = Unified Soils Classification System, commonly used in geotechnical or soil-foundation investigations, and in routine engineering geologic logging.

3) Avaiable Water Capacity = Held water available for use by most plants, usually defined as the difference between the amount of soil water at field capacity (one day of drainage after a rain or recharge event) and the amount at the wilting point.

Table 9. On-site drainage areas, Mark West Quarry, Sonoma County, California.

Watershed	Drainage	Existing Condition (acres)	10-Year Expansion (acres)	20-Year Expansion (acres)
Porter Cr.	A	17.8	17.8	*12.6*
Franz Cr.	B	14.2	14.2	*13.9*
Franz Cr.	C	10.5	10.5	10.5
Franz Cr.	D	13.5	13.5	13.5
Porter Cr.	E1	17.1	17.1	17.1
Porter Cr.	E2	12.6	12.6	12.6
Porter Cr.	E3	2.4	2.4	2.4
Porter Cr.	F	18.5	*22.0*	*34.2*
Porter Cr.	G	16.2	*12.8*	*7.0*
Porter Cr.	H	13.2	13.2	*14.6*
Porter Cr.	Subtotal	98	98	100
Franz Cr.	Subtotal	38	38	38
	Total	136	136	138

Notes:
Red italicized font indicates a change in area.

Table 10. Estimated peak runoff and retention pond criteria for proposed reclaimed quarry, Mark West Quarry, Sonoma County, California

	Drainage F			Drainage H		
	Slopes	Floor	Total	Slopes	Floor	Total
Site data						
Runoff coefficient, C (plate B-1, SCWA)	0.90	0.30	0.60	0.90	0.30	0.60
Watershed area, A (acres)	17.1	17.1	34.2	7.3	7.3	14.6
K factor (plates B-3, B-4, SCWA)	1.5	1.5	1.5	1.5	1.5	1.5
Detention pond outfall for a minor waterway (cfs) (p10, SCWA)						
Rainfall frequency (years)	10	10	10	10	10	10
Rainfall duration (minutes)	15	15	15	15	15	15
Rainfall intensity, I (inches/hour) (plate B-2, SCWA)	1.7	1.7	1.7	1.7	1.7	1.7
Discharge, Q=CIAK (cfs)	40	13	**53**	17	6	**23**
Detention pond outfall, bankfull peak (cfs)						
Rainfall frequency (years)	1.8	1.8	1.8	1.8	1.8	1.8
Rainfall duration (minutes)	15	15	15	15	15	15
Rainfall intensity, I (inches/hour) (plate B-2, SCWA)	1.3	1.3	1.3	1.3	1.3	1.3
Discharge, Q=CIAK (cfs)	31	10	**41**	13	4	**18**
Retention pond size (acre-feet), outflow open						
Rainfall frequency (years)	100	100	100	100	100	100
Rainfall duration (minutes)	15	15	15	15	15	15
Rainfall intensity, I (inches/hour) (plate B-2, SCWA)	2.4	2.4	2.4	2.4	2.4	2.4
Discharge, Q=CIAK (cfs)	56	19	74	24	8	32
Volume, V=Q*duration (acre-feet)	1.1	0.4	**1.5**	0.5	0.2	**0.7**

Notes:

These preliminary computations are based on nominal runoff guidelines. Infiltration rates for a 30-foot pervious fill on the quarry floor were assumed to be on the order of 0.2 inches/hour, the mean infiltration rate from the local USDA NRCS soil survey for the Goulding and Spreckles soils. Final runoff computations and design criteria are largely dependent on thickness, permeability and moisture storage of overburden fill placed on quarry floor.

Table 11. Pre- and post-project annual water-balance and recharge estimates, Mark West Quarry, Sonoma County, California.

	Annual Total	Source
Pre-mined water balance (unimpaired site)		
Rainfall (inches)	47	SCWA, April 1983
Runoff (inches)	18	Rantz, 1974
Evapotranspiration - Interior Douglas Fir Forest (inches)	21	Leeden and others, 1990
Recharge (inches)	8	Rainfall - Runoff - Evapotranspiration
Site recharge (acre-feet)	67	Site area = 100 acres
Water balance with existing mine		
Rainfall (inches)	47	SCWA, April 1983
Runoff (inches)	24	Undisturbed (75%) by Rantz, 1974; 25% rock land
Evapotranspiration - 75% Interior Douglas Fir Forest (inches)	16	van der Leeden and others, 1990
Recharge (inches)	7	Rainfall - Runoff - Evapotranspiration
Site recharge (acre-feet)	60	Site area = 100 acres
Water balance with expanded mine		
Rainfall (inches)	47	SCWA, April 1983
Runoff (inches)	30	Undisturbed (50%) by Rantz, 1974; 50% rock land
Evapotranspiration - 50% Interior Douglas Fir Forest (inches)	11	van der Leeden and others, 1990
Recharge (inches)	6	Rainfall - Runoff - Evapotranspiration
Site recharge (acre-feet)	53	Site area = 100 acres
Post-mined water balance (reclaimed site) [1]		
Rainfall (inches)	47	SCWA, April 1964
Runoff (inches)	31	60% of rainfall (per runoff modeling results)
Evapotranspiration (inches)	12	2/3 grass and shrub and 1/3 grapes
ET - Semiarid grass and shrub (inches)	10	van der Leeden and others, 1990
ET - Aggreiculture (assume grapes) (inches)	17	adapted from Leeden and others, 1990
Recharge without pond recharge (inches)	4	Rainfall - Runoff - Evapotranspiration
Site recharge (acre-feet)	34	Site area = 100 acres
Site recharge with pond recharge (acre-feet)	49	Site recharge + 15 acre-feet

Notes:

1. The reclaimed site water balance will largely be dependent on final land use and thickness, permeability and moisture storage of the overburden fill placed on quarry floor.

Table 12. Summary of field parameters and water-quality analyses, Mark West Quarry, Sonoma County, CA

PARAMETER	UNITS	MCL	On-Site Water Supply Wells						Off-Site Wells			Surface Water		
DESCRIPTORS														
Sample I.D.			Well #1 (Shaker Well)	Well #1 (Shaker Well)	Well #2 (Truckwash Well)	Well #3 (Crusher Well)	Well #3 (Crusher Well)	Well #4 (Crusher Well #2)	Well below Subdrain A	4500 Porter Creek Road	4512 Porter Creek Road	Greenstone Spring	Reclamation Subdrain	Porter Creek below Quarry
DWR well number			212074	212074	433700	548113	548113	1078646	--	561468	946729	--	--	--
Depth of well perforations	feet		140 to 190	140 to 190	25 to 400	80 to 420	80 to 420	80-100, 160-640	--	50-90, 230-320	80 to 600	--	--	--
Coordinates (WGS84)	degrees		N38.55472 W122.65460	N38.55472 W122.65460	N38.55386 W122.65454	N38.55545 W122.65449	N38.55545 W122.65449	N38.55528 W122.65511	38°33'29.85"N 122°39'43.07"W	38°33'5.93"N 122°39'33.44"W	38°33'12.94"N 122°39'40.67"W	N38.55747 W122.65906	N38.55589 W122.65434	N38.55435 W122.66422
Elevation (approx.)	feet		992	992	970	1028	1028	995	1006	1124	893	1190	1280	
Lab used			Caltest	Caltest	Caltest	Caltest	Caltest	Caltest	Soil Control	Soil Control	Soil Control	Caltest	Caltest	Caltest
Lab number			D101008-4	D120046-2	D101008-3	D101008-2	D120046-1	H020233011	1070611-01	1070611-02	1070611-03	D101008-1	D101008-5	D101008-6
Sample collected by			mw, bh	mw, gp	mw, bh	mw, bh	mw, gp	mw	mw	mw	mw	mw, bh	mw, bh	mw, bh
Sample filtering			field filtered	field filtered	field filtered	field filtered	field filtered	field filtered	none	none	none	field filtered	field filtered	not filtered
FIELD MEASUREMENTS														
Date	MM/DD/YY		10/30/2003	12/1/2003	10/30/2003	10/30/2003	11/30/2003	2/6/2007	7/21/2011	7/21/2011	7/21/2011	10/30/2003	10/30/2003	10/30/2003
Time	HH:MM		16:00	06:25	15:45	15:20	15:05	14:00	10:15	11:00	11:15	14:30	16:20	16:50
Specific conductance (@ 25 C°)	umhos/cm		*416*	*524*	*451*	*305*	*417*	*423*	*465*	*421*	*591*	*440*	*466*	*429*
Conductance (@ field temp)	umhos/cm		378	457	432	322	407	410	380	335	495	315	368	315
Temperature	deg C		20.2	18.6	22.5	27.0	23.3	23	16	15	17	11.0	14.7	12
WATER QUALITY INDICATORS														
Alkalinity (total)	mg/L CaCO3		180	170	190	160	150	150	200	250	250	210	150	200
Hardness (total)	mg/L CaCO3		61	180	110	10	92	98	120	200	180	180	170	180
Hydroxide	mg/L CaCO3		0	0	0	0	0	0	0	0	0	0	0	
pH	pH Units		8.6	8.0	8.2	9.4	8.7	8.0	7.6	7.5	7.8	7.7	8.4	
Specific conductance (@ 25 C°)	umhos/cm	1600	420	500	440	310	430	430	380	500	480	410	440	410
Total dissolved solids (TDS)	mg/L	1000							240	300	300			
GENERAL MINERALS														
Bicarbonate (as CaCO3)	mg/L		180	170	190	120	140	180	*205*	*254*	*254*	210	150	200
Bicarbonate (HCO3)	mg/L		*219*	*207*	*232*	*146*	*171*	*219*	250	310	310	*256*	*183*	*244*
Calcium (Ca)	mg/L		16	34	29	2.3	17	24	31	45	36	52	35	51
Carbobate (as CaCO3)	mg/L		0	0	0	40	10	0	*0*	*0*	*0*	0	0	0
Carbonate (CO3)	mg/L		*0*	*0*	*0*	*24*	*6*	*0*	0	0	0	*0*	*0*	*0*
Chloride (Cl)	mg/L	500	5	8	4	5	8	15	4.8	4.7	5.6	5	8	5
Iron (Fe)	mg/L	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg)	mg/L		5.2	23	8.4	1	12	9.4	9.1	22	22	13	21	14
Manganese (Mn)	mg/L	0.05	0	0	0	0	0	0.032	0.056	0	0.046	0.36	0	0
Potassiuim (K)	mg/L			2			2	2.3	0.94	1.2	0.65			
Sodium (Na)	mg/L		68	19	54	67	39	52	34	26	30	11	21	12
Sulfate (SO4)	mg/L	500	34	98	29	8.4	55	56	6.2	21	10	3.7	57	11

PARAMETER	UNITS	MCL	On-Site Water Supply Wells						Off-Site Wells			Surface Water		
DESCRIPTORS														
Sample I.D.			Well #1 (Shaker Well)	Well #1 (Shaker Well)	Well #2 (Truckwash Well)	Well #3 (Crusher Well)	Well #3 (Crusher Well)	Well #4 (Crusher Well #2)	Well below Subdrain A	4500 Porter Creek Road	4512 Porter Creek Road	Greenstone Spring	Reclamation Subdrain	Porter Creek below Quarry
TITLE 22 PRIMARY STANDARDS, INORGANIC														
Aluminum (Al)	mg/L	1	0	0	0	0	0					0	0	
Antimony (Sb)	mg/L	0.006	0	0	0	0	0					0	0	
Arsenic (As)	mg/L	0.050	0	0	0	0	0	0				0	0	
Barium (Ba)	mg/L	1	0	0	0	0	0					0	0	
Beryllium (Be)	mg/L	0.004	0	0	0	0	0					0.001	0	
Cadmium (Cd)	mg/L	0.005	0	0	0	0	0					0	0	
Chromium (Cr)	mg/L	0.05	0	0	0	0	0					0	0	
Fluoride (F)	mg/L	2	0	0.1	0.1	0.1	0.1	0	0.11	0.14	0.16	0.2	0.2	0.1
Mercury (Hg)	mg/L	0.002	0	0	0	0	0					0	0	
Nickel (Ni)	mg/L	0.1	0	0	0	0	0					0	0	
Nitrate as (NO3)	mg/L	45	0.00	0.00	0.00	14.17	0.00	0.00	0.00	0.00	0.00	0.00	15.94	0.00
Selenium (Se)	mg/L	0.05	0	0	0	0	0					0	0	
Thallium (Tl)	mg/L	0.002	0	0	0	0	0					0	0	
OTHER CONSTITUENTS														
Boron (B)	mg/L		0.1	0	0.2	0.2	0	0				0	0	0
Copper (Cu)	mg/L	1	0	0	0	0	0		0	0	0	0	0	0
Lead (Pb)	mg/L	0.015	0	0	0	0	0					0	0	
Silica (Si)	mg/L		39	30	26	37	42	58				12	33	25
Sliver (Ag)			0	0	0	0	0					0	0	
Zinc (Zn)	mg/L	5	0	0	0	0	0	0.17	0	0	0.095	0	0	0
LAB CHECK														
Major Cations (Ca+Mg+K+Na+Fe+Mn)	meq/L		4.18	4.47	4.49	3.11	3.58	4.29	3.80	5.22	4.93	4.16	4.39	4.22
Major Anions (HCO3+CO3+Cl+SO4+F+NO3)	meq/L		4.45	5.67	4.52	3.75	4.37	5.19	4.37	5.66	5.46	4.42	4.68	4.37
Ion Balance (Cations/Anions)	--		0.94	0.79	0.99	0.83	0.82	0.83	0.87	0.92	0.90	0.94	0.94	0.97

NOTES

Observer key: mw = Mark Woyshner; bh = Barry Hecht; gp = Gustavo Porras

Lab results: 0 = not detected; blank value = not tested

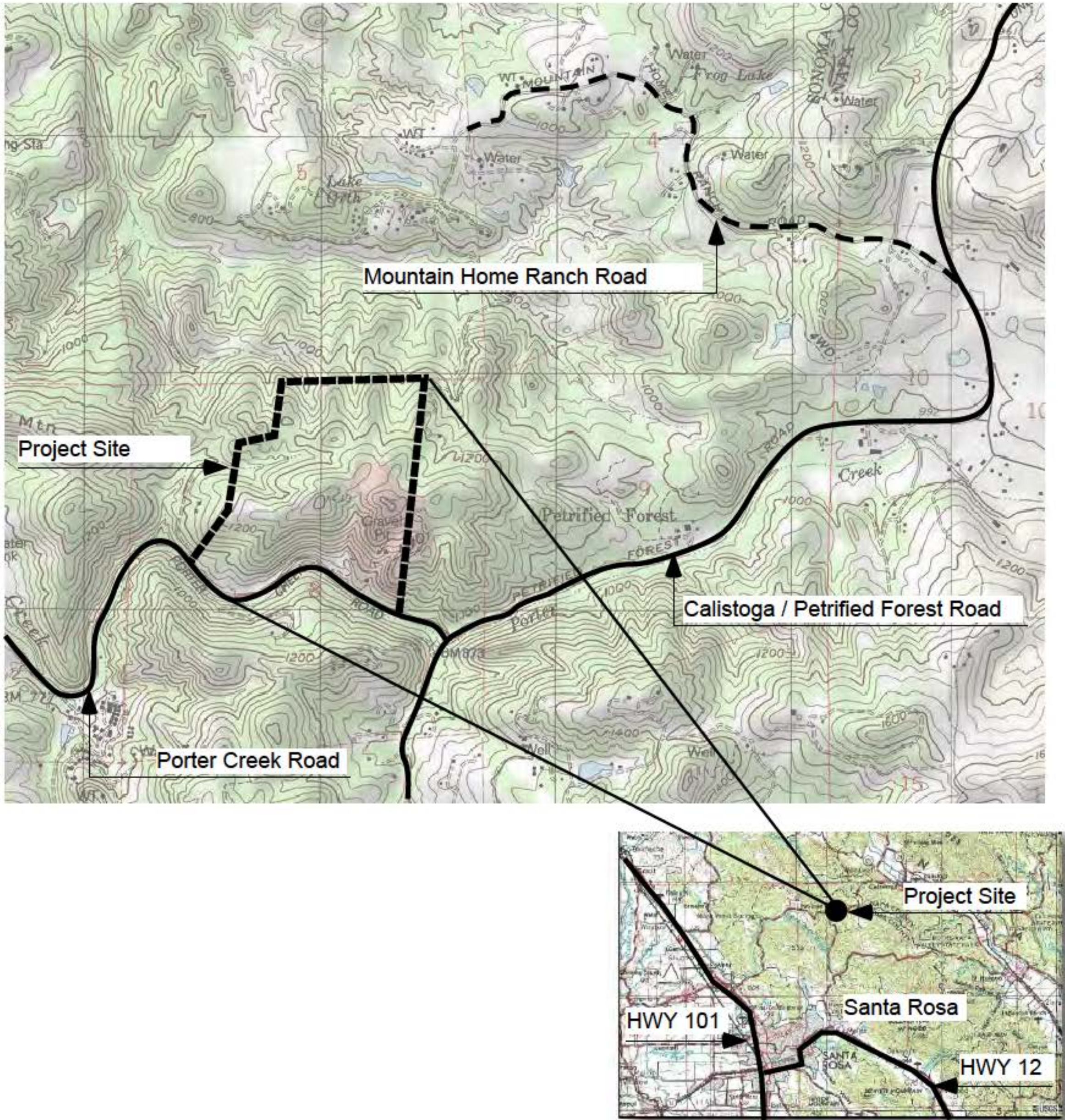
MCL = California Title 22 Maximum Contaminant Level

FIGURES

Mark West Quarry Expansion

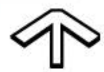
BoDean Company, Inc
1060 North Dutton Avenue
Santa Rosa, CA 95401

Figure 1
Regional Location



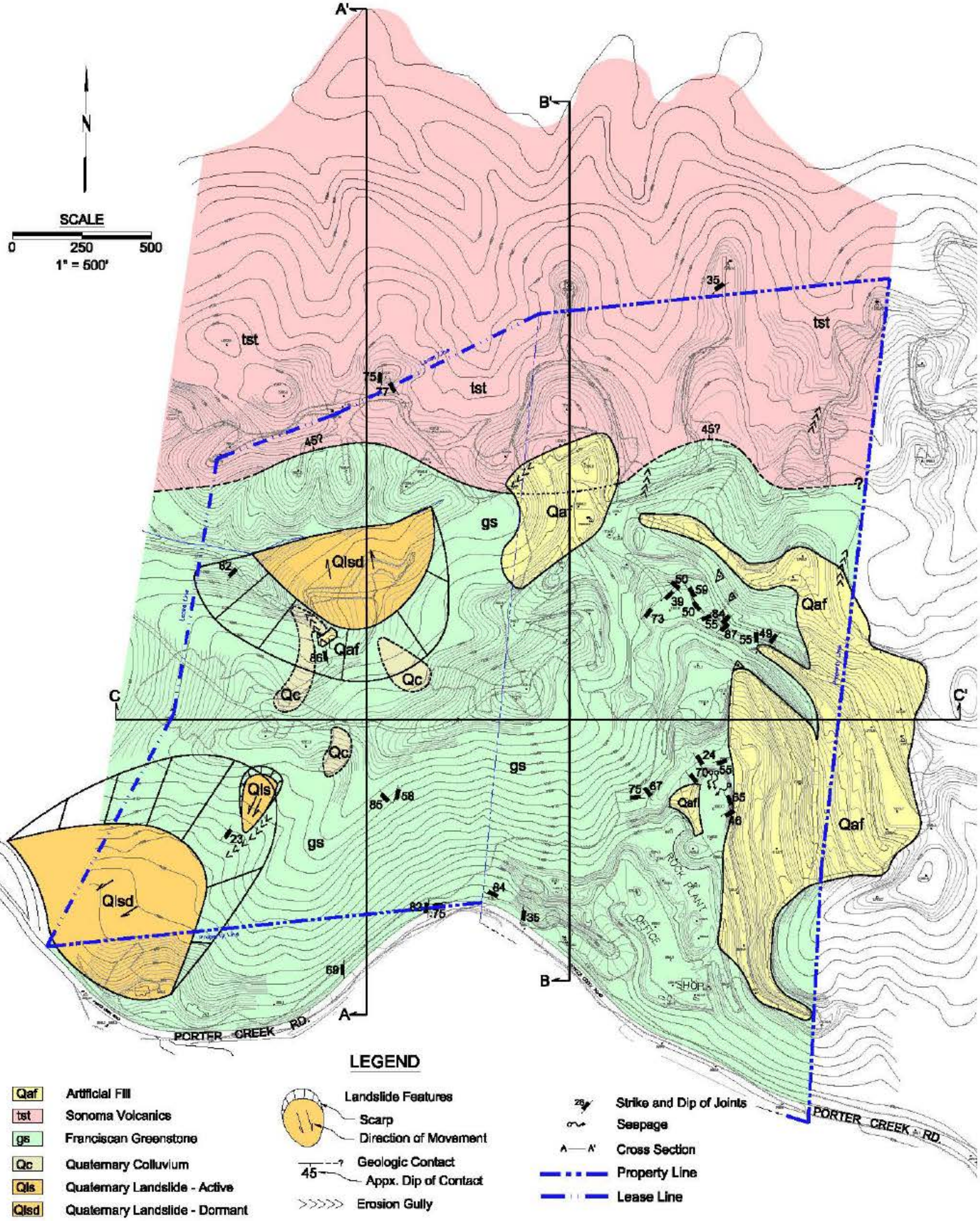
Date: 1/12/09

North



Not to Scale

This drawing is conceptual and for planning and permit-processing purposes only. Program information, scale, location of areas, and other information shown are subject to field evaluation and modification.



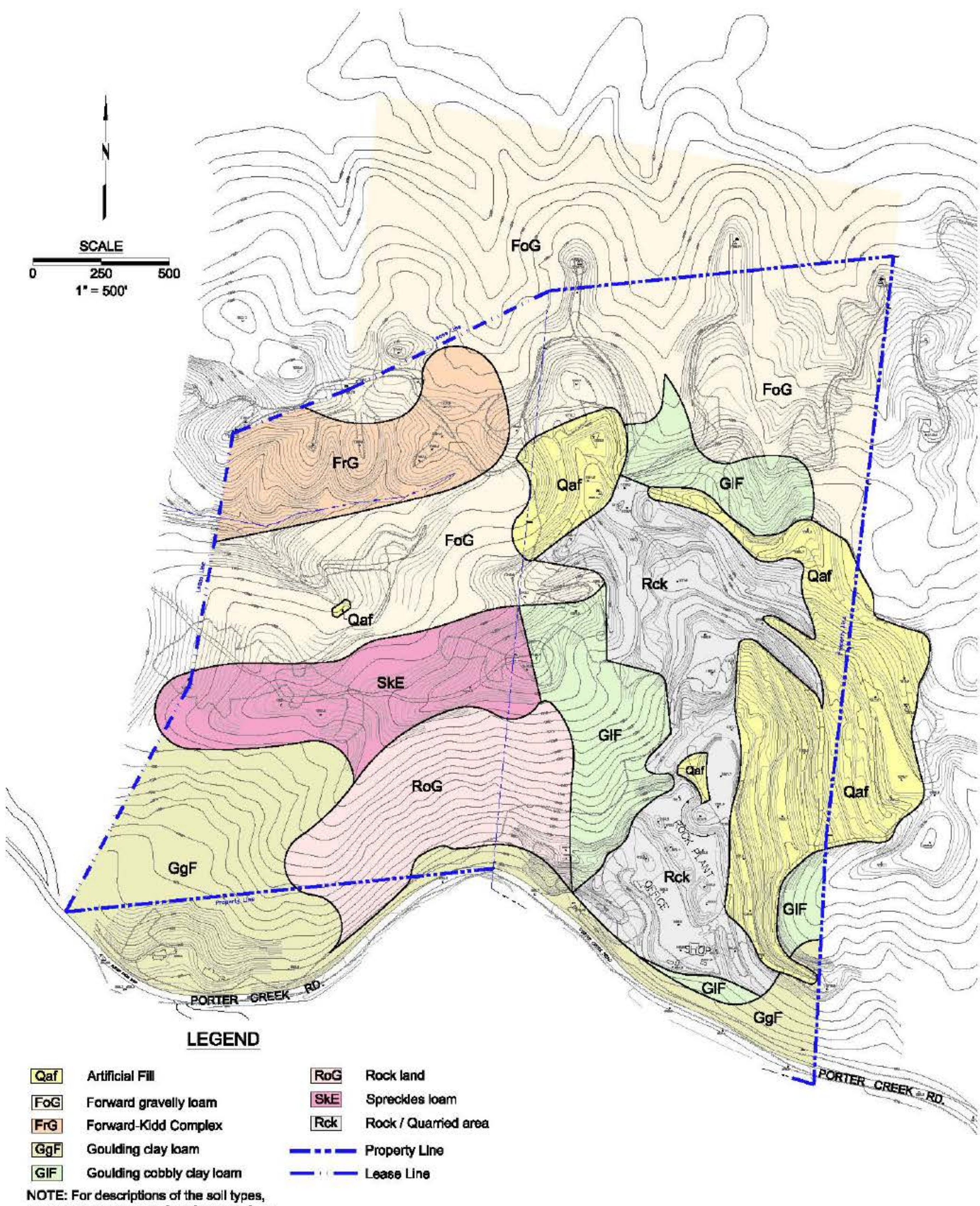
REFERENCE: MARK WEST QUARRY, TOPOGRAPHIC MAP - 2003 FOR BODEAN COMPANY, BY BRELJE & RACE, 6/16/03
FILE: zz2552.1.dwg

Miller Pacific
ENGINEERING GROUP

GEOLOGIC MAP
Mark West Quarry Expansion
Santa Rosa, California

2

Project No.	1070.01	Date	12/8/03	Approved By:		Figure



REFERENCES: MARK WEST QUARRY, TOPOGRAPHIC MAP - 2003 FOR BODEAN COMPANY, BY BRELJE & RACE, 8/18/03
SOIL SURVEY OF SONOMA COUNTY, US DEPARTMENT OF AGRICULTURE, 1972
FILE: zz2552.1.dwg

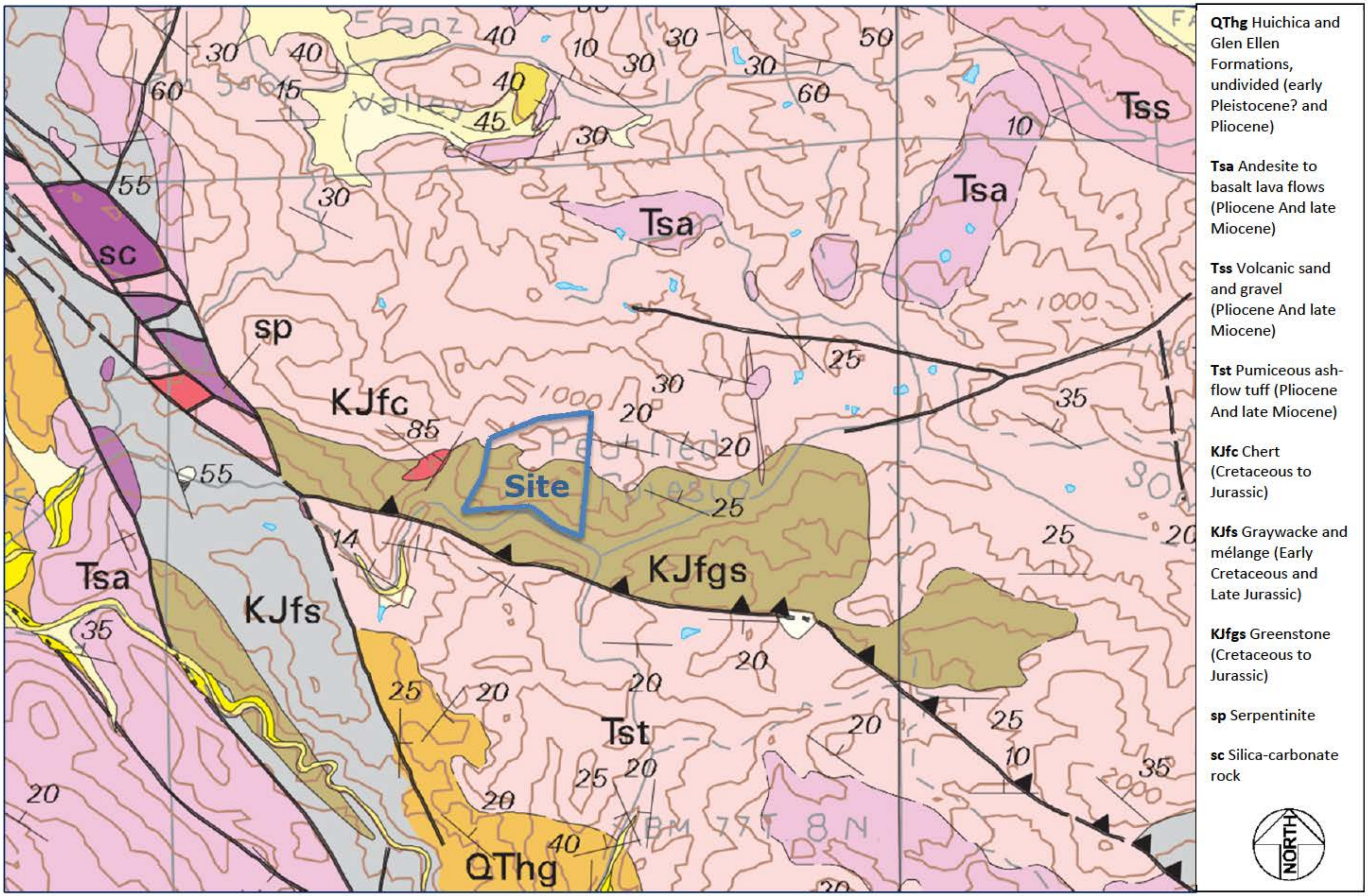
Miller Pacific
ENGINEERING GROUP

SOILS MAP
Mark West Quarry Expansion
Santa Rosa, California

3

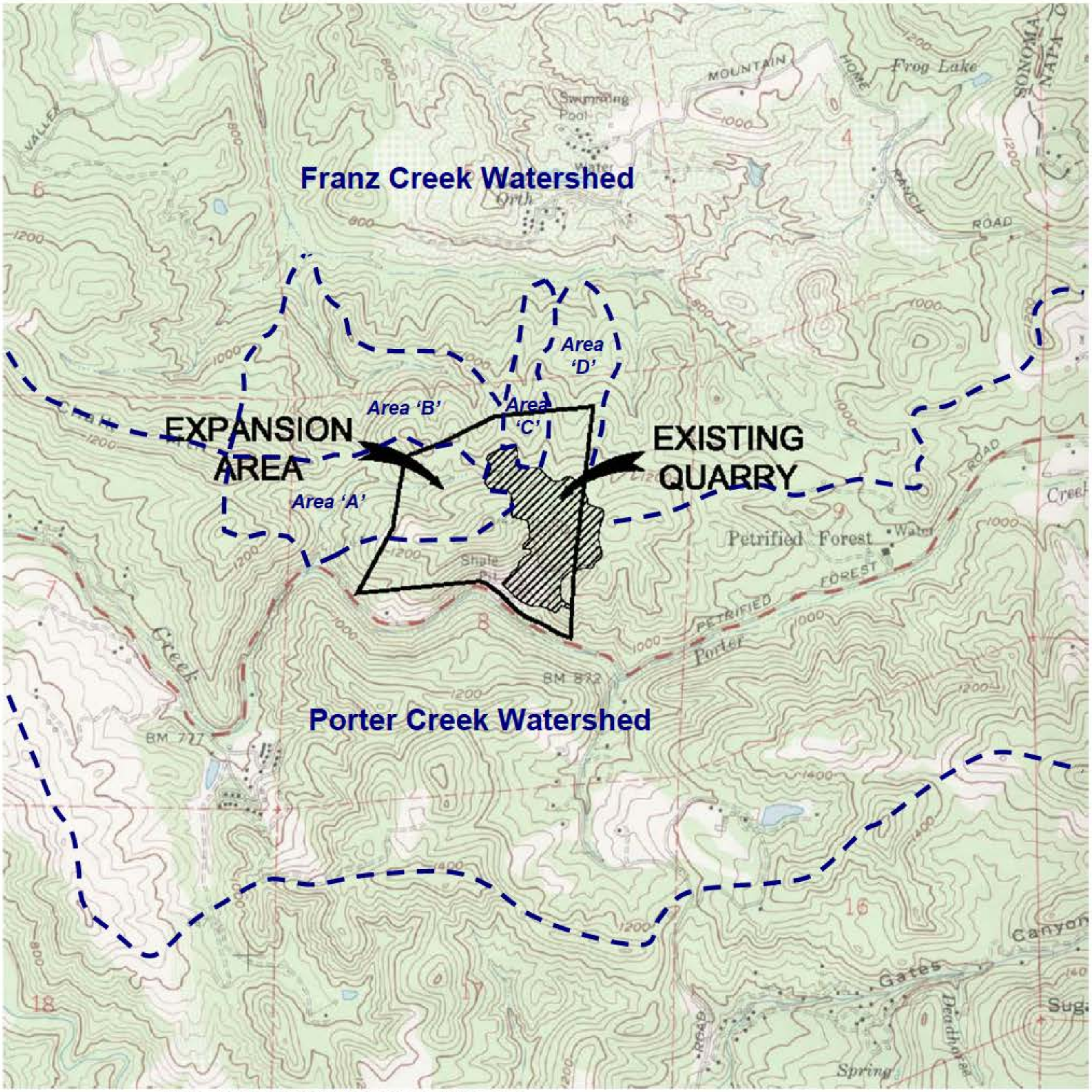
Project No. 1070.01 Date 12/8/03 Approved By:

Figure



Balance Hydrologics, Inc.®

Figure 4. Regional Geology, Mark West Quarry, Sonoma County, California.
Source: Graymer and others, 2007, Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California: USGS Scientific Investigations Map 2956



Property boundary for expansion area
Existing watershed boundary

SCALE

0 1000 2000 4000 FEET

0 500 1000 METERS

NORTH

Balance Hydrologics, Inc.®

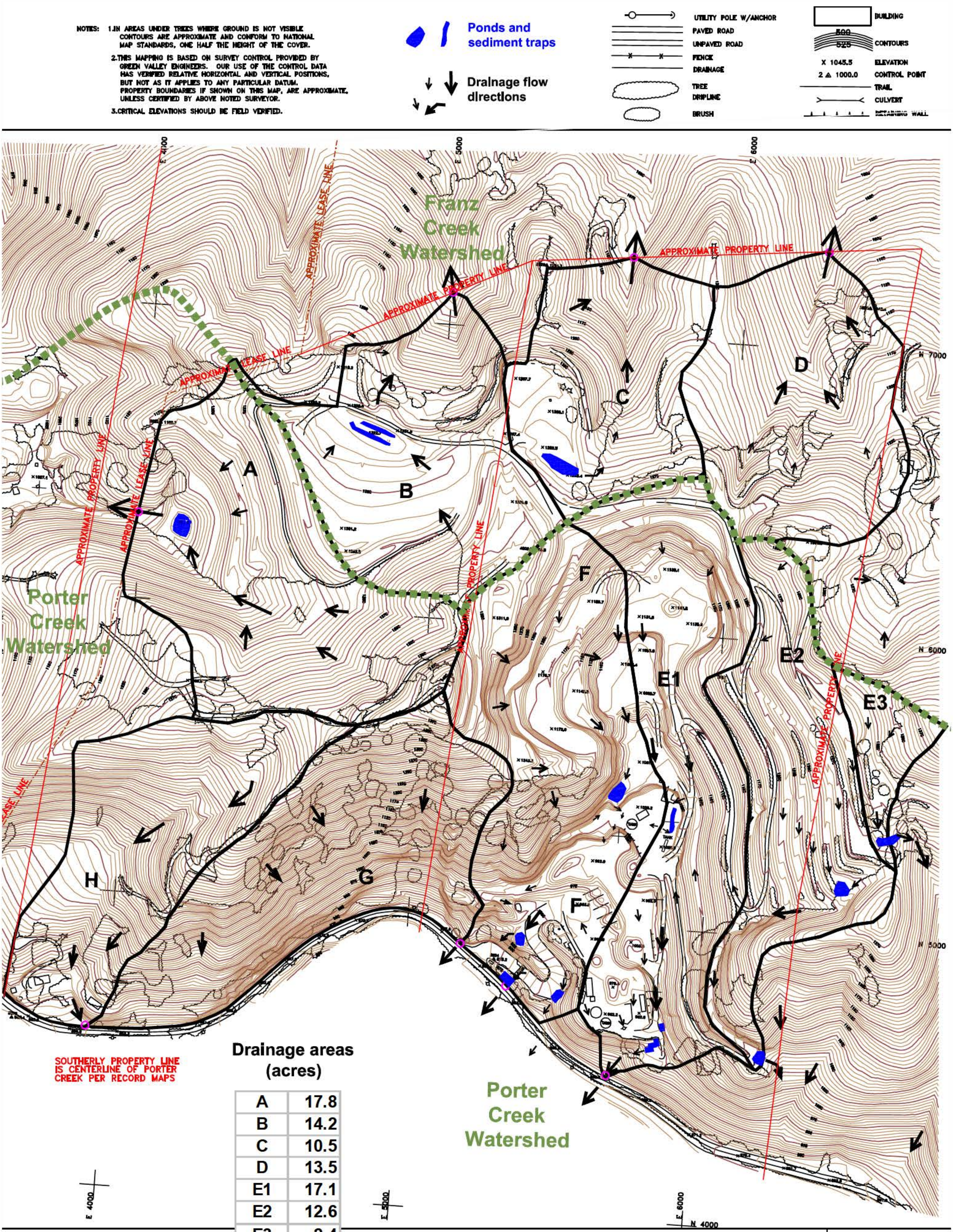
Figure 5. Watershed boundaries, Mark West Quarry, Sonoma County, California.

Topographic map: USGS Mark West Springs Quadrangle

NOTES: 1. IN AREAS UNDER TREES WHERE GROUND IS NOT VISIBLE CONTOURS ARE APPROXIMATE AND CONFORM TO NATIONAL MAP STANDARDS, ONE HALF THE HEIGHT OF THE COVER.

2. THIS MAPPING IS BASED ON SURVEY CONTROL PROVIDED BY GREEN VALLEY ENGINEERS. OUR USE OF THE CONTROL DATA HAS VERIFIED RELATIVE HORIZONTAL AND VERTICAL POSITIONS, BUT NOT AS IT APPLIES TO ANY PARTICULAR DATUM. PROPERTY BOUNDARIES IF SHOWN ON THIS MAP, ARE APPROXIMATE, UNLESS CERTIFIED BY ABOVE NOTED SURVEYOR.

3. CRITICAL ELEVATIONS SHOULD BE FIELD VERIFIED.



Drainage areas (acres)

A	17.8
B	14.2
C	10.5
D	13.5
E1	17.1
E2	12.6
E3	2.4
F	18.5
G	16.2
H	13.2

200 0 200 400 600

DELTA GEOMATICS CORPORATION
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DATE:	8/4/10
SCALE:	1" = 200'
CONTOUR INTERVAL:	5'
PHOTO DATE:	7/23/10
JOB NO.:	2010-009
SHEET	1 OF 1

Basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

Figure 6. Existing Surface Water Drainage, Mark West Quarry, Sonoma County, California.

211046 drainage.dwg 08-08-2011

NOTES: 1. IN AREAS UNDER TREES WHERE GROUND IS NOT VISIBLE CONTOURS ARE APPROXIMATE AND CONFORM TO NATIONAL MAP STANDARDS, ONE HALF THE HEIGHT OF THE COVER.

2. THIS MAPPING IS BASED ON SURVEY CONTROL PROVIDED BY GREEN VALLEY ENGINEERS. OUR USE OF THE CONTROL DATA HAS VERIFIED RELATIVE HORIZONTAL AND VERTICAL POSITIONS, BUT NOT AS IT APPLIES TO ANY PARTICULAR DATUM. PROPERTY BOUNDARIES IF SHOWN ON THIS MAP, ARE APPROXIMATE, UNLESS CERTIFIED BY ABOVE NOTED SURVEYOR.

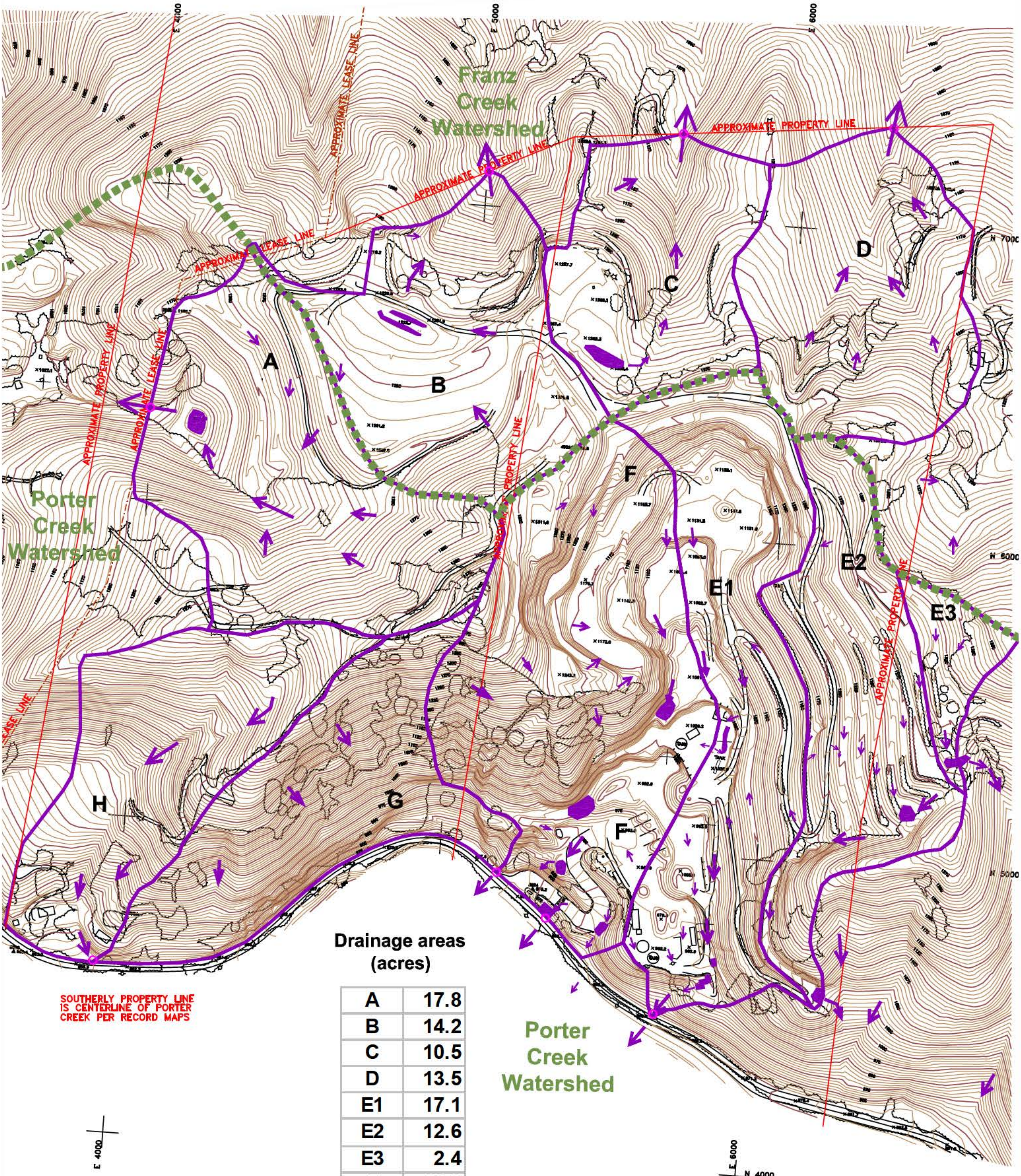
3. CRITICAL ELEVATIONS SHOULD BE FIELD VERIFIED.

Ponds and sediment traps

Drainage flow directions

UTILITY POLE W/ANCHOR
PAVED ROAD
UNPAVED ROAD
FENCE
DRAINAGE
TREE DRIPLINE
BRUSH

BUILDING
500 525 CONTOURS
X 1045.5 ELEVATION
2 ▲ 1000.0 CONTROL POINT
TRAIL
CULVERT
RETAINING WALL



Drainage areas (acres)

A	17.8
B	14.2
C	10.5
D	13.5
E1	17.1
E2	12.6
E3	2.4
F	22.0
G	12.8
H	13.2

200 0 200 400 600

DELTA GEOMATICS CORPORATION
837 FIFTH STREET
SANTA ROSA, CA 95404
707 525-9721 FAX 707 525-9729
DIGITAL MAPPING ORTHOPHOTO
AERIAL PHOTOGRAPHY GIS LOADING
WWW.DELTAGEOMATICS.COM

DATE: 8/4/10
SCALE: 1" = 200'
CONTOUR INTERVAL: 5'
PHOTO DATE: 7/23/10
JOB NO.: 2010-009

Basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

Figure 7. 10-year Expansion Surface Water Drainage, Mark West Quarry, Sonoma County, California.

211046 drainage.dwg 08-08-2011

NOTES: 1. IN AREAS UNDER TREES WHERE GROUND IS NOT VISIBLE CONTOURS ARE APPROXIMATE AND CONFORM TO NATIONAL MAP STANDARDS, ONE HALF THE HEIGHT OF THE COVER.

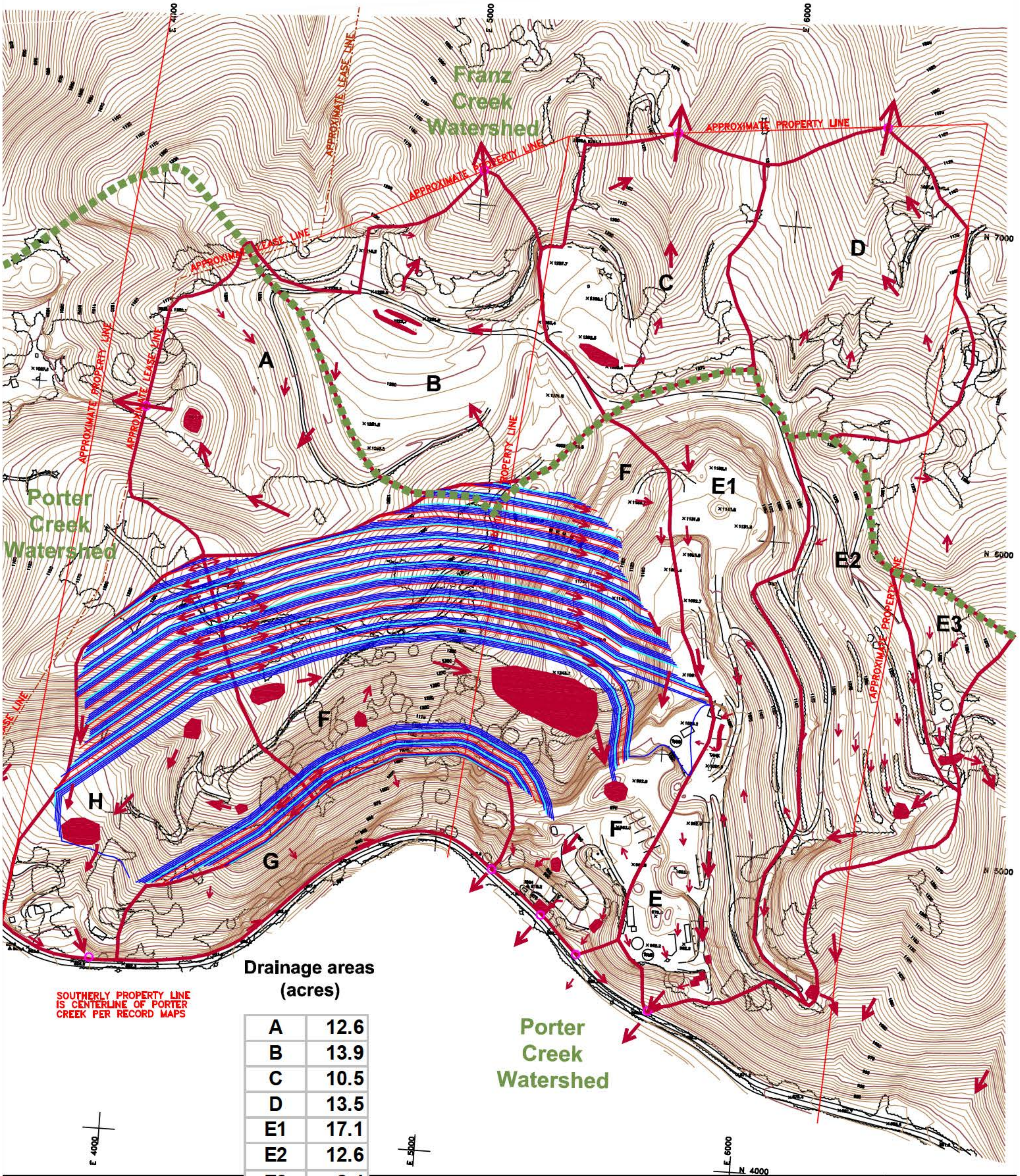
2. THIS MAPPING IS BASED ON SURVEY CONTROL PROVIDED BY GREEN VALLEY ENGINEERS. OUR USE OF THE CONTROL DATA HAS VERIFIED RELATIVE HORIZONTAL AND VERTICAL POSITIONS, BUT NOT AS IT APPLIES TO ANY PARTICULAR DATUM. PROPERTY BOUNDARIES IF SHOWN ON THIS MAP, ARE APPROXIMATE, UNLESS CERTIFIED BY ABOVE NOTED SURVEYOR.

3. CRITICAL ELEVATIONS SHOULD BE FIELD VERIFIED.

Ponds and sediment traps

Drainage flow directions

UTILITY POLE W/ANCHOR
PAVED ROAD
UNPAVED ROAD
FENCE
DRAINAGE
TREE DRIPLINE
BRUSH
BUILDING
CONTOURS
X 1045.5 ELEVATION
2 △ 1000.0 CONTROL POINT
TRAIL
CULVERT
RETAINING WALL



Drainage areas (acres)

A	12.6
B	13.9
C	10.5
D	13.5
E1	17.1
E2	12.6
E3	2.4
F	34.2
G	7.0
H	14.6

200 0 200 400 600

DELTA GEOMATICS CORPORATION
837 FIFTH STREET
SANTA ROSA, CA 95404
707 525-9721 FAX 707 525-9729
DIGITAL MAPPING ORTHOPHOTO
AERIAL PHOTOGRAPHY GIS LOADING
WWW.DELTAGEOMATICS.COM

DATE: 8/4/10
SCALE: 1" = 200'
CONTOUR INTERVAL: 5'
PHOTO DATE: 7/23/10
JOB NO.: 2010-009
SHEET 1 OF 1

Basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

Figure 8. 20-year expansion surface water drainage, Mark West Quarry, Sonoma County, California.

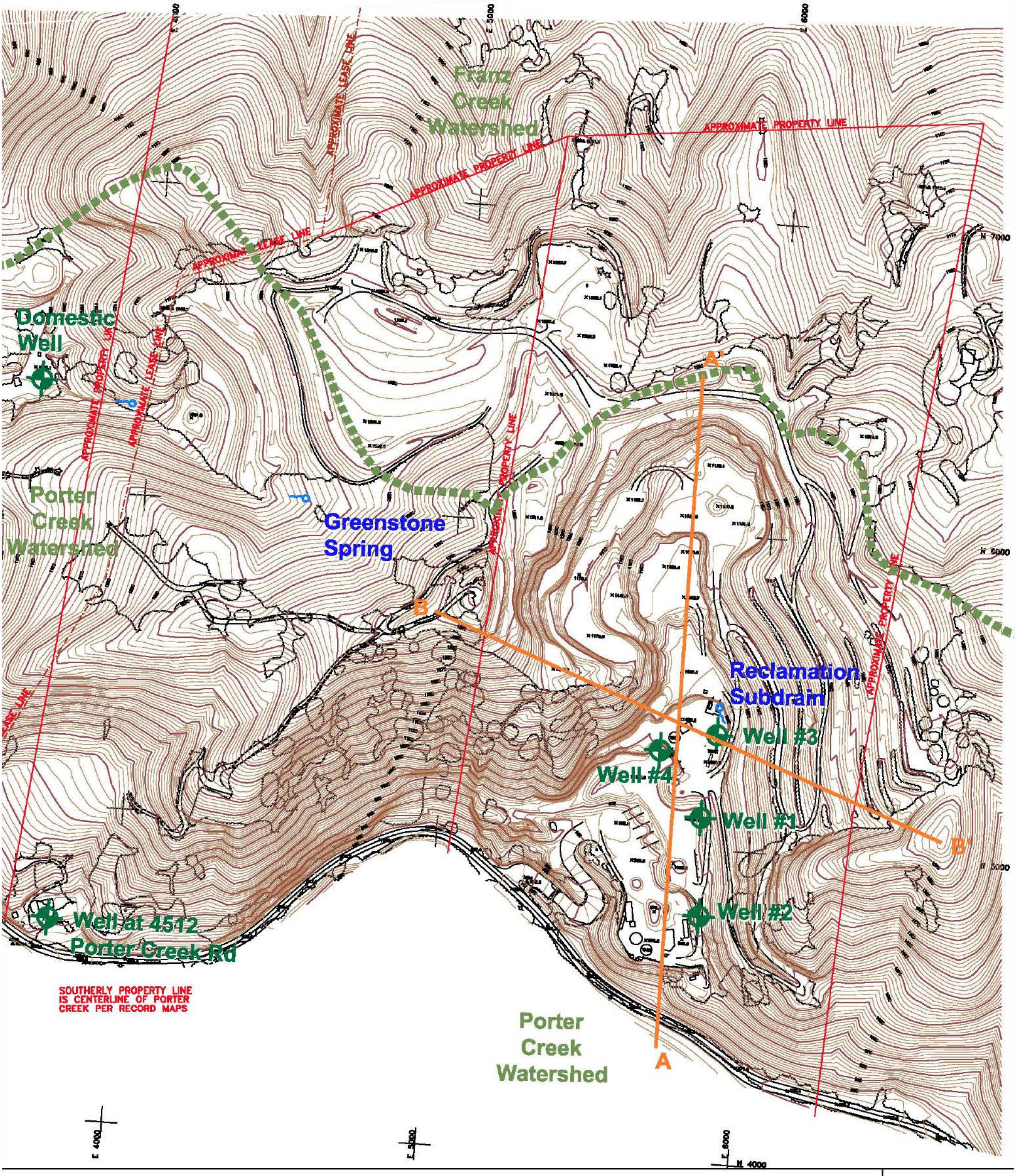
211048 drainage.dwg 08-08-2011

NOTES: 1. IN AREAS UNDER TREES WHERE GROUND IS NOT VISIBLE CONTOURS ARE APPROXIMATE AND CONFORM TO NATIONAL MAP STANDARDS, ONE HALF THE HEIGHT OF THE COVER.

2. THIS MAPPING IS BASED ON SURVEY CONTROL PROVIDED BY GREEN VALLEY ENGINEERS. OUR USE OF THE CONTROL DATA HAS VERIFIED RELATIVE HORIZONTAL AND VERTICAL POSITIONS, BUT NOT AS IT APPLIES TO ANY PARTICULAR DATUM. PROPERTY BOUNDARIES IF SHOWN ON THIS MAP, ARE APPROXIMATE, UNLESS CERTIFIED BY ABOVE NOTED SURVEYOR.

3. CRITICAL ELEVATIONS SHOULD BE FIELD VERIFIED.

UTILITY POLE W/ANCHOR
PAVED ROAD
UNPAVED ROAD
FENCE
DRAINAGE
TREE DRIPLINE
BRUSH
BUILDING
500 525 CONTOURS
X 1045.5 ELEVATION
2 ▲ 1000.0 CONTROL POINT
TRAIL
CULVERT
RETAINING WALL



200 0 200 400 600

DELTA GEOMATICS CORPORATION
837 FIFTH STREET
SANTA ROSA, CA 95404
707 525-9721 FAX 707 525-9729
DIGITAL MAPPING ORTHOPHOTO
AERIAL PHOTOGRAPHY GIS LOADING
WWW.DELTAGEOMATICS.COM

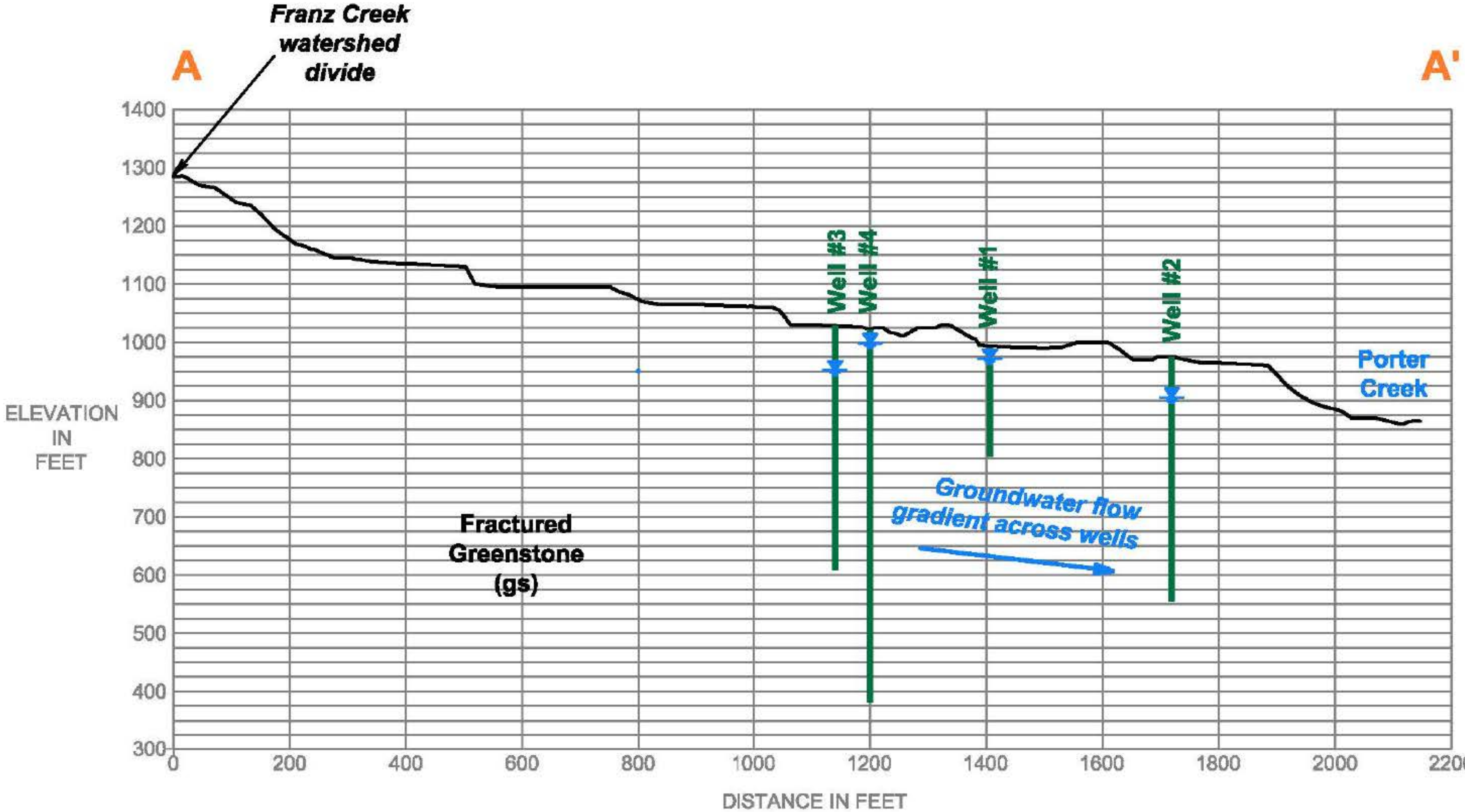
Basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

DATE:	8/4/10
SCALE:	1" = 200'
CONTOUR INTERVAL:	5'
PHOTO DATE:	7/23/10
JOB NO.:	2010-009
SHEET 1	OF 1

Balance Hydrologics, Inc.

Figure 9. Springs and Water Well Locations, Mark West Quarry, Sonoma County, California

211046 drainage.dwg 08-08-2011



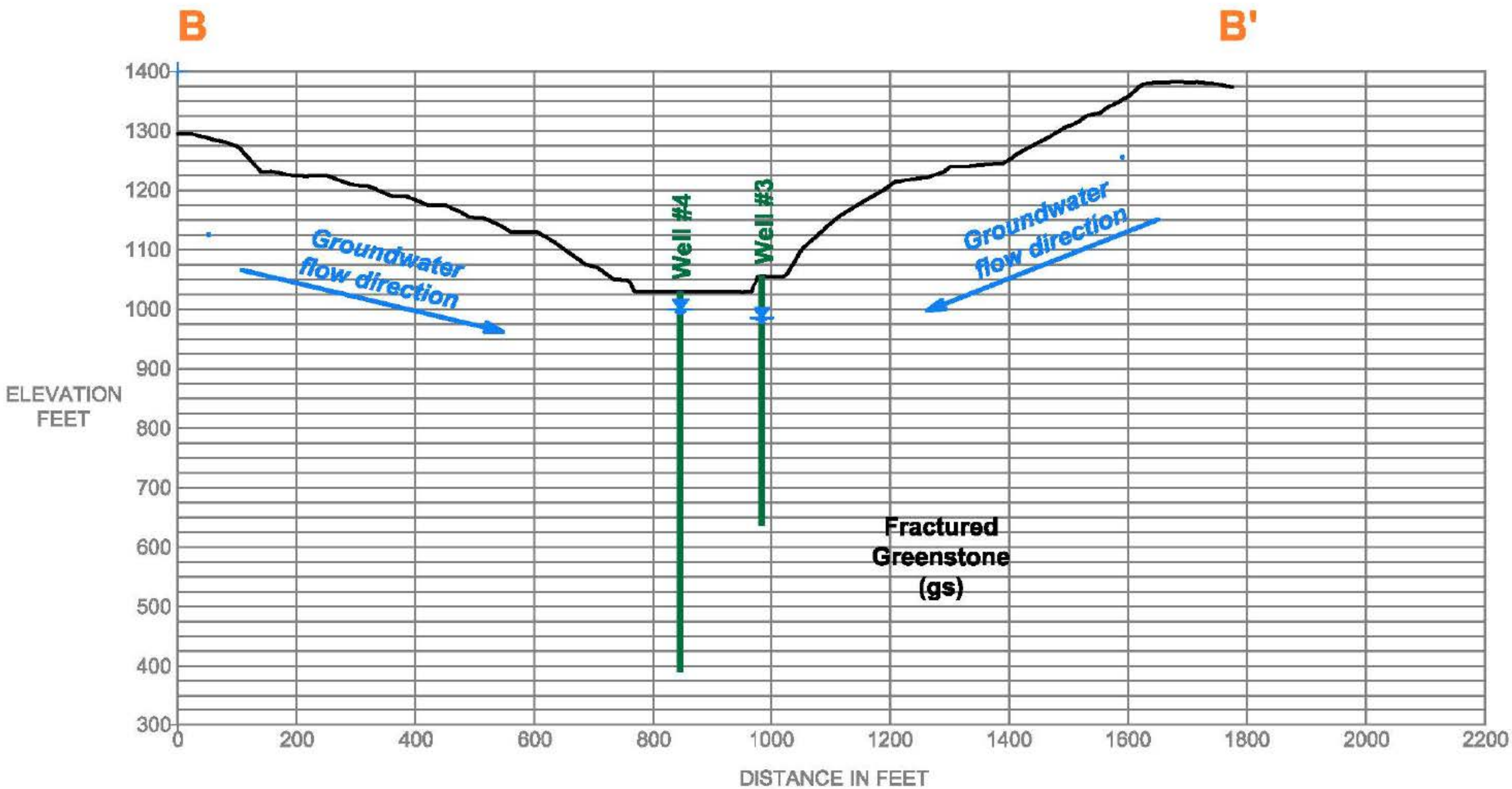
See Figure 9 for cross-section locations.

Elevations from basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

Figure 10. Cross Section A - A', Mark West Quarry, Sonoma County, California

211046 drainage.dwg 08-08-2011



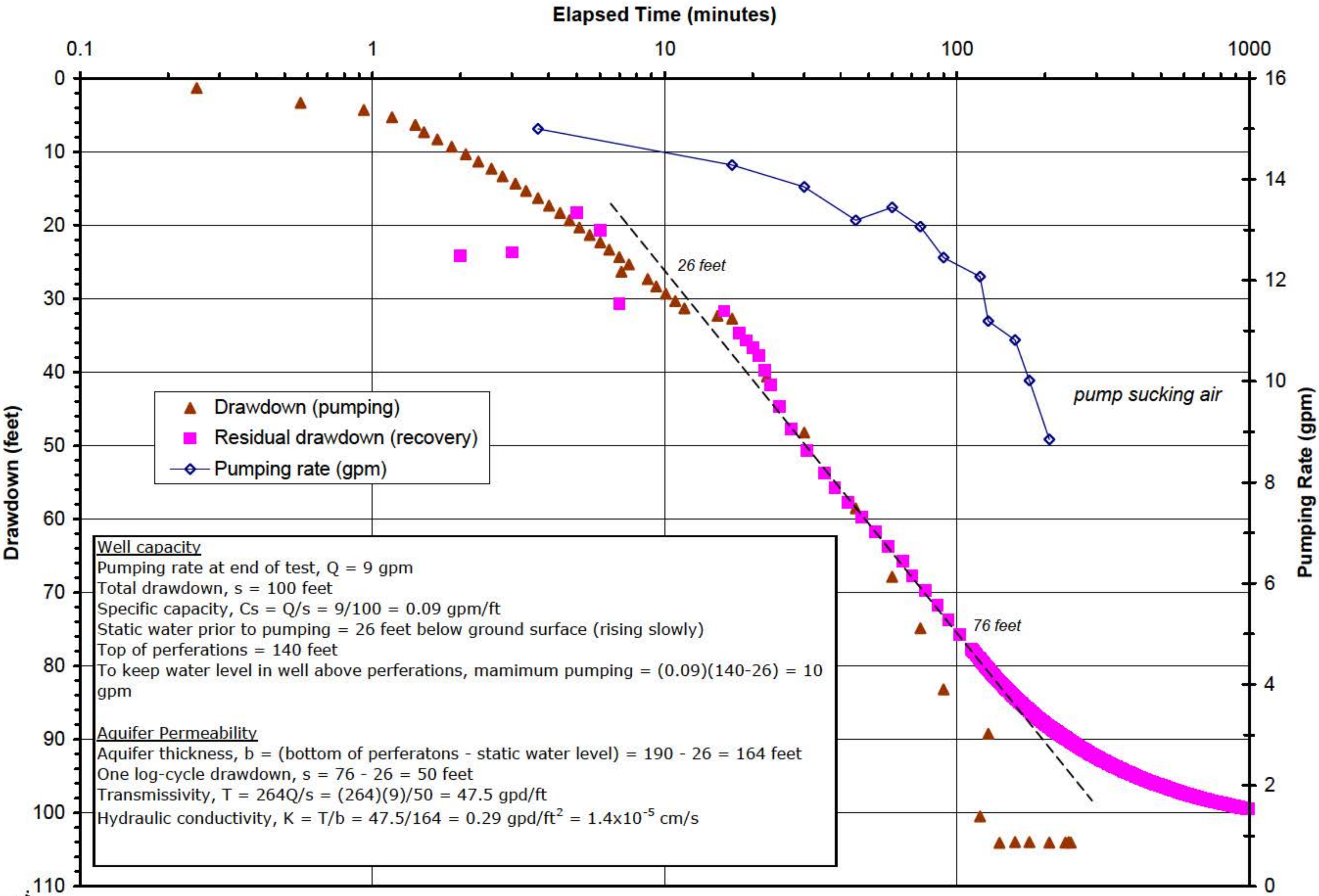
See Figure 9 for cross-section locations.

Elevations from basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

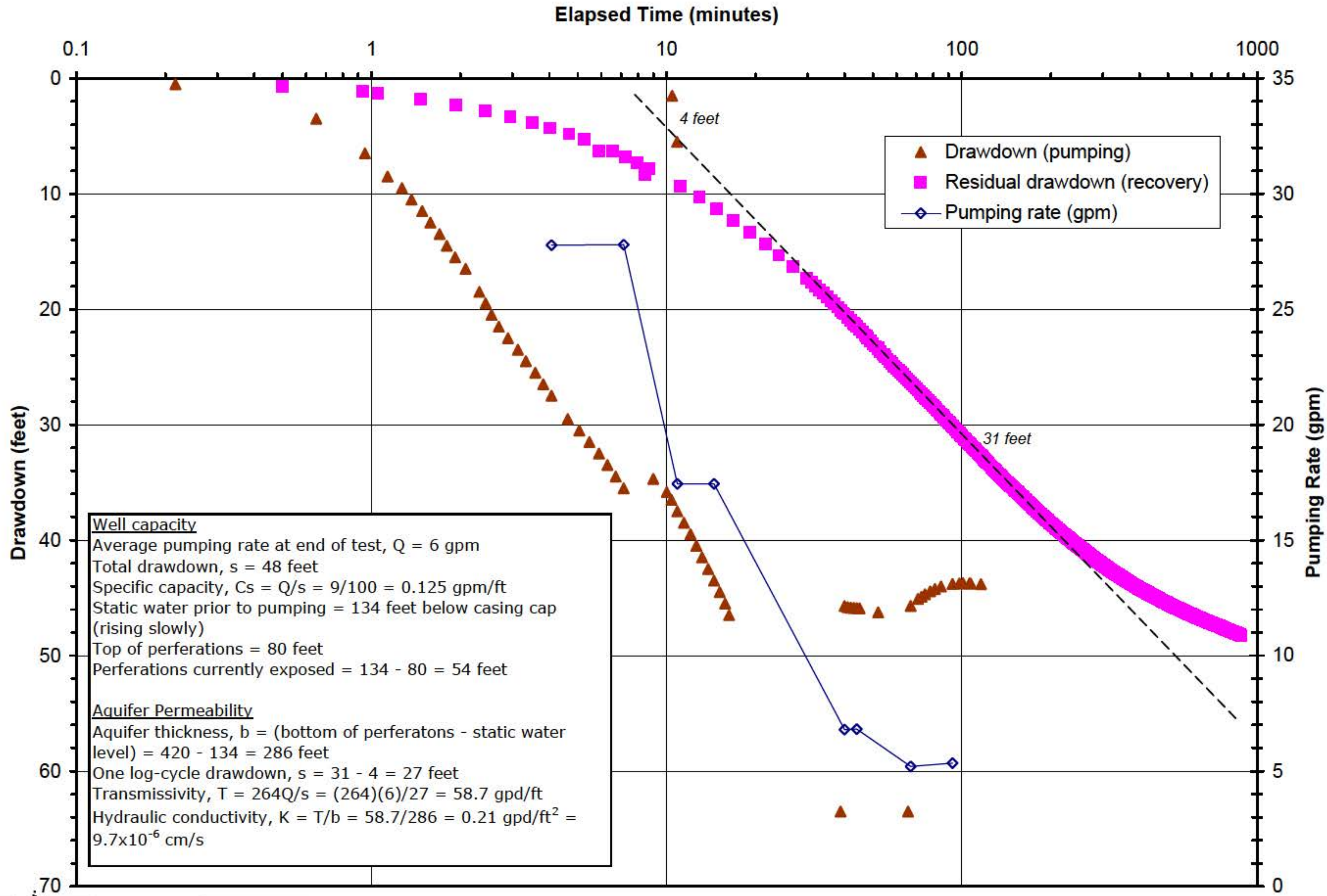
Figure 11. Cross Section B - B', Mark West Quarry, Sonoma County, California

211046 drainage.dwg 08-08-2011



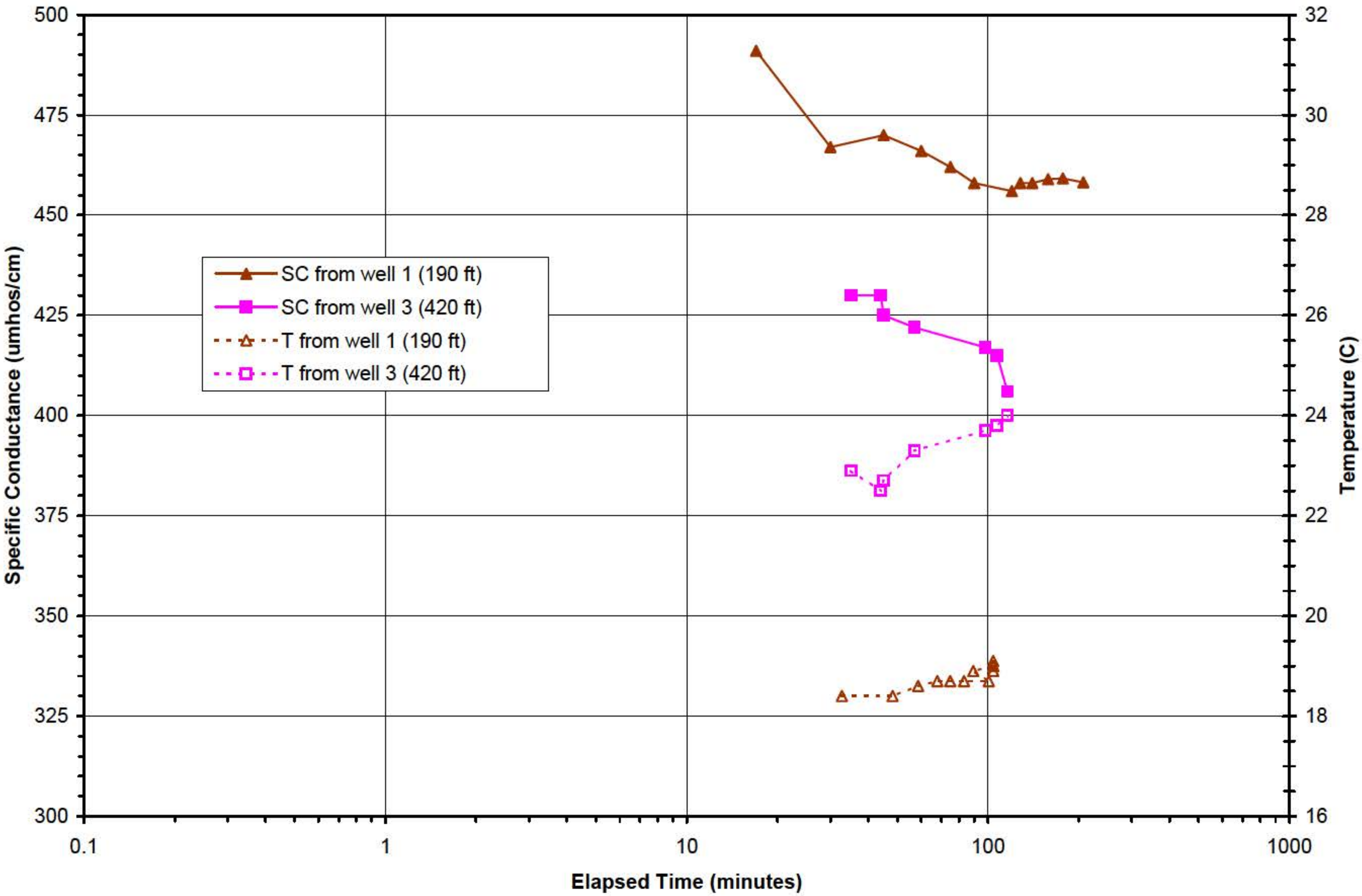
Balance Hydrologics, Inc.

Figure 12. Results of pumping Well #1 (212074) on November 29, 2003, Mark West Quarry, Sonoma County, California.
Well coordinates: N38.55472 W122.65460



Balance Hydrologics, Inc.

Figure 13. Results of pumping Well #3 (548113) on November 30, 2003, Mark West Quarry, Sonoma County, California.
Well coordinates: N38.55545 W122.65449

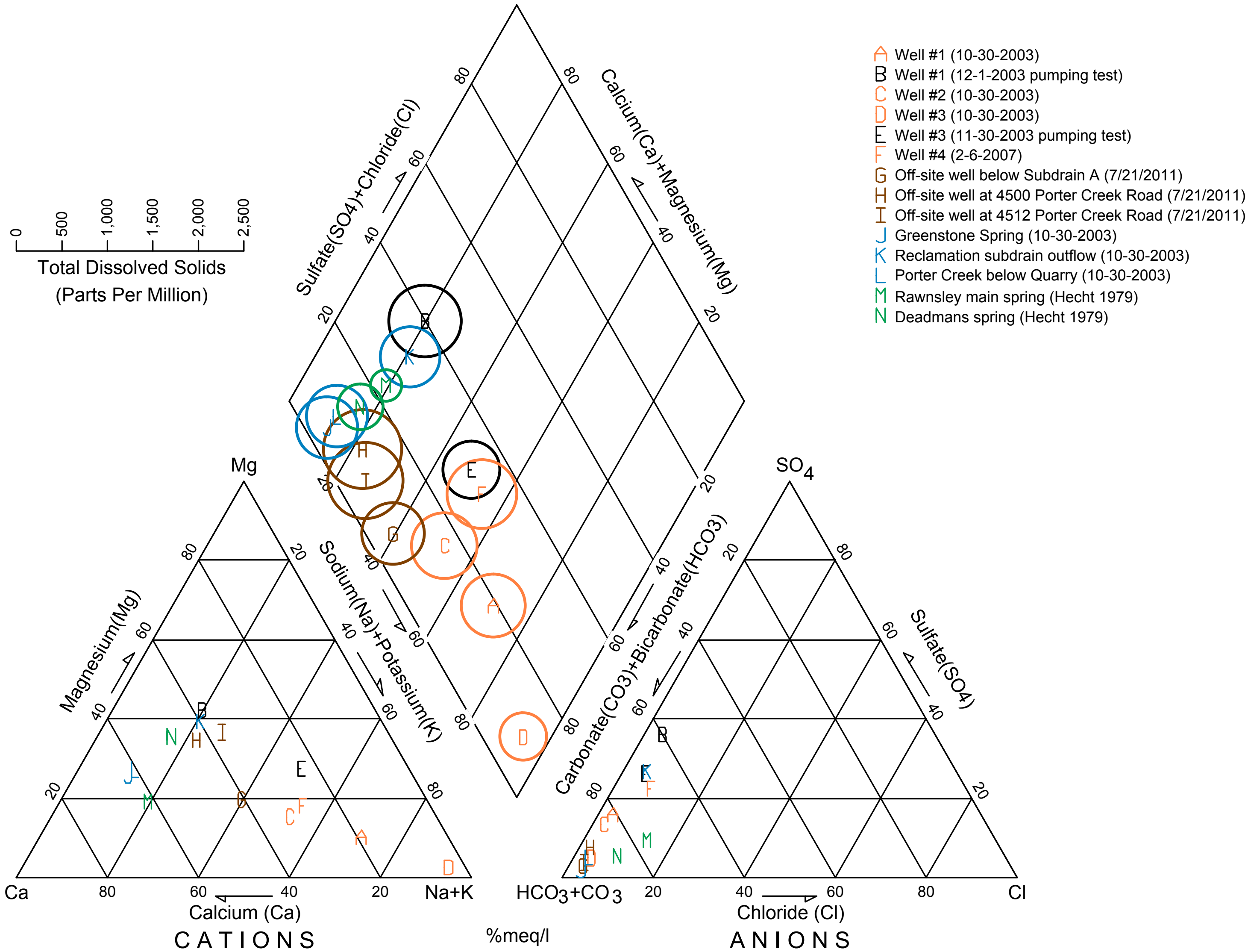


Balance Hydrologics, Inc.

Figure 14. Specific conductance and temperature of ground water pumped during aquifer tests, Mark West Quarry, Sonoma County, California.

Mark West Quarry

Sonoma County, California



This diagram shows cations in the ternary graph on the left and anions on the right graph. The diamond graph in the center illustrates both cations and anions. Hardness dominated water plots to the left and top of the diamond graph, soft monovalent-salt dominated water to the right, and soft alkaline water towards the bottom. The radius of circle around the plotted points represents the concentration of dissolved solids, calibrated to the scale shown.

Figure 15. Piper diagram illustrating ionic signatures of water samples collected at Mark West Quarry, Sonoma County, California.

Balance Hydrologics, Inc.®

APPENDICES

APPENDIX A

Site water-well logs

near shaker

To Mark

DUPLICATE
Driller's Copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 212074

Notice of Intent No. ______
Local Permit No. or Date ______

State Well No. ______
Other Well No. ______

(1) OWNER: Name Ken Ford
Address 4611 Porter Creek Rd.
City Santa Rosa, Ca. Zip 95404

(2) LOCATION OF WELL (See instructions):
County Sonoma Owner's Well Number ______
Well address if different from above same
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc.
A.P. # 120-210-02

WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size 3/8
Diameter of bore ______
Packed from 20 to 190 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen ______

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	190	5"	c160 psi	140	190	1/8

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing cement

(10) WATER LEVELS:
Depth of first water, if known ______ ft.
Standing level after well completion 22 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 22 ft. At end of test ______ ft
Discharge 20 gal/min after ______ hours Water temperature ______
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth ______ ft. Depth of completed well ______ ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	190	blue rock

Work started 9-16 1982 Completed 9- 19

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED JOHN FISCH by kathy baker
(Well Driller)
NAME FISCH BROS. DRILLING INC.
(Person, firm, or corporation) (Typed or printed)
Address 5001 Gravenstein Hwy.N.
City Sebastopol, Ca. Zip 95472
License No. 399226 Date of this report ______

near truck wash area

DUPLICATE
Driller's Copy
Page ___ of ___
Owner's Well No. 2566
Date Work Began 8-23-91, Ended 8-23-91
Local Permit Agency Sonoma
Permit No. 10772 Permit Date 7-21-91

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 433700

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) XX VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER 70 (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	1	top soil
1	110	Green stone
110	300	green stone with quartz
300	315	churt
315	400	green stone

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name Mark West Quarry
Mailing Address 4611 Porter Creek Rd.
Santa Rosa, CA 95404
CITY STATE ZIP

WELL LOCATION

Address 4611 Porter Creek Rd.
City Santa Rosa, CA
County Sonoma
APN Book 120 Page 210 Parcel 48
Township ___ Range ___ Section ___
Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST EAST
SOUTH
Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

XX NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
XX Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Rotary Air FLUID ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 70 (Ft.) & DATE MEASURED 8-23-91
ESTIMATED YIELD* 20 (GPM) & TEST TYPE air lift
TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 360 (Ft.)
* May not be representative of a well's long-term yield.

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	25	12"	x				Steel	6.25	.156	1/8
25	140	"		x			"	"	.156	1/8
80										
0	400	6.75		x			PVC	4.5	160 PSD	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	25	x			
25	400				3/8" pea

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fisch Bros. Drilling Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
5001 Grav. Hwy. N., Sebastopol, CA 95472
ADDRESS CITY STATE ZIP

Signed Brian Burnham by Deborah Klein 8-23-91 399226
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Near crusher

DUPLICATE
Driller's Copy

Page 1 of 1

Owner's Well No. 94-3194

Date Work Began Sept 94, Ended Oct 94

Local Permit Agency Sonoma Cty

Permit No. 940 4565 Permit Date 9-7-94

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 548113

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION *Describe material, grain size, color, etc.*
0	680	greenstone
680	720	chert

TOTAL DEPTH OF BORING 720 (Feet)

TOTAL DEPTH OF COMPLETED WELL 720 (Feet)

WELL OWNER

Name Mark West Springs Quarry

Mailing Address 4611 Porter Creek Rd.

Santa Rosa Ca. 95404

CITY STATE ZIP

WELL LOCATION

Address 4611 Porter Creek Rd.

City Santa Rosa Ca.

County Mendocino

APN Book 120 Page 210 Parcel 48

Township ___ Range ___ Section ___

Latitude ___ NORTH Longitude ___ WEST

DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

Well Sit#1

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Rotary Air FLUID ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 70 (Ft.) & DATE MEASURED ___

ESTIMATED YIELD* 70 (GPM) & TEST TYPE air lift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 400 (Ft.)

* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
~~XXXXXXXXXXXXX~~										
0	80	13	X				F480	8	c200	
80	220	13		X			F480	8	"	factory
220	420	"			X		"	"	"	1/8
~~420~~	~~720~~	~~7.5~~	~~X~~				~~"~~	~~"~~	~~"~~	
420	720			Uncased						

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	22		X		
22	420			X	3/8pea

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 GRAVENSTEIN HWY NO. Sebastopol Ca. 95472
ADDRESS CITY STATE ZIP

Signed Ed Fisch by c.j.usher 10-5-94 399226
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

WELL COMPLETION REPORT - STATE OF CALIFORNIA

Page 1 of 1 No# 1078646

Owner's Well No. 1

Permit Date: 6/2/05 Permit # WEL05-0228 State Well No./Station No.

Date Work Began 6/29/05 Ended 7/5/05

Permit Agency Dept of Permits & Resource Management APN/TRS/Other

GEOLOGIC LOG

ORIENTATION: Vertical

DRILLING METHOD: Rotary

FLUID: Air

Ft	to Ft	DESCRIPTION
0	4	Clay with rock
4	44	Sandstone with greenstone
44	325	Green stone sandstone shale and quartz
325	645	Green stone with sandstone quartz

TOTAL DEPTH OF BORING (FT): 645

TOTAL DEPTH OF COMPLETED WELL (FT): 640

WELL OWNER

Name: BoDean Company, Inc

Mailing Address: 1060 North Dutton Ave,
Santa Rosa, CA 95401

WELL LOCATION

Address: 4611 Porter Creek Road

City: Santa Rosa

County: Sonoma

APN Book 120 - 210 - 048

Latitude Longitude

LOCATION SKETCH

ACTIVITY

XX New Well

Modification/Repair
Deepen
Other (Specify)

DESTROY (Describe) Procedures and Materials Under "Geologic Log")

PLANNED USES:

Monitoring
Test well
Cathodic Protection
Heat Exchange
Direct Push
Injection
Vapor Extraction
Sparging
Remediation
Other (specify)

PLANNED USES

Water Supply

XX Domestic Public

Irrigation Industrial

WATER LEVEL & YIELD OF COMPLETED WELL

Depth to First Water (ft.) BELOW SURFACE

Depth of Static Water Level (Ft) 30 Date Measured: 7/5/05

Test Length/Test type: 2 hr / Air lift

Estimate Yield (GPM)* 60 Total draw 620

*May not be representative of a well's long-term yield

Depth from surface Ft	to Ft	Bore-hole diameter Inches	Type Blank	Type Screen	Material Grade	Diameter	Gauge	Slot Size	Depth From Surface Ft	to Ft	Annular Material Seal Material
0	80	8	XX		PVC	5	200		0	50	Bentonite
80	100	8		XX	PVC	5	200	0.032	50	640	1/4 x 1/8
100	160	8	XX		PVC	5	200				
160	640	8		XX	PVC	5	200	0.032			

ATTACHMENTS

No Geologic Log
No Well Construct Diagram
No Geophysical Log(s)
No Soil/Water Chemical Analyses
No Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

NAME: LES PETERSEN DRILLING AND PUMP, INC

ADDRESS: 5434 OLD REDWOOD HWY, SANTA ROSA, CA 95403

SIGNED: Ray Petersen/ 7/5/05 261084

Well Driller/Authorized Representative (Lupe) Date C-57 License #

DWR Driller Owner Local

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. 1

Date Work Began 3/25/96 Ended 4/2/96

Local Permit Agency DEPARTMENT OF PERMIT & RESOURCE MGM.

Permit No. 96-0029 Permit Date 2/20/96

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 561468

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) XX VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION *Describe material, grain size, color, etc.*
0	5	TOP SOIL
5	20	BROWN CLAY W/ CEMENTED GRAVEL
20	30	CEMENTED GRAVEL
30	55	GRAVEL/ROCK/W/BROWN CLAY
55	75	GREEN & PURPLE VOLC. ROCK
75	235	BLACK/GREEN & PURPLE VOLC. ROCK
235	245	PURPLE CLAY W/PURPLE ROCK
245	265	HARD GRAY ROCK
265	275	PURPLE & GREY CLAY & ROCK
275	280	GRAY FREE ROCK
280	295	PURPLE & GRAY CLAY W/ VOLC. ROCK
295	320	HARD GRAY ROCK
320	330	GRAY ROCK W/GRAY CLAY

TOTAL DEPTH OF BORING 330 (Feet)

TOTAL DEPTH OF COMPLETED WELL 320 (Feet)

WELL OWNER

Name MARK WEST QUARRY

Mailing Address 4500 PORTER CREEK ROAD

SANTA ROSA, CA.

CITY STATE ZIP

WELL LOCATION

Address

City SAME

County SONOMA

APN Book 120 Page 210 Parcel 09

or Township ___ Range ___ Section ___

or Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

XX NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

XX Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD ROTARY FLUID

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 200' (Ft.) & DATE MEASURED 4/2/96

ESTIMATED YIELD* 15 (GPM) & TEST TYPE ~~AIR LIFT~~

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 310 (Ft.)

* *May not be representative of a well's long-term yield.* 5 GPM @200'

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	50	8 3/4	XX				F480	5"	200#	
50	90	"		X			"	"	"	.032
90	230	"	X				"	"	"	
230	320	"		X			"	"	"	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20	XX	(SEE AMMENDMENT ATTCHD)		
~~20~~	~~320~~				~~1/4 X 1/8~~

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME LES PETERSEN DRILLING & PUMP, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5434 OLD REDWOOD HIGHWAY SANTA ROSA, CA. 95403
ADDRESS CITY STATE ZIP

Signed LUPE VASQUEZ 4/2/96 261084
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

WELL COMPLETION REPORT - STATE OF CALIFORNIA

Page 1 of 1 No# 946729

Owner's Well No. 1

Permit Date: 9/17/09 Permit # WEL09 0285 State Well No./Station No.

Date Work Began 09/09/09 Ended 10/06/09

Permit Agency Dept of Permits & Resource Management APN/TRS/Other

GEOLOGIC LOG

ORIENTATION: Vertical
DRILLING METHOD: Rotary
FLUID: Mud

Ft	to Ft	DESCRIPTION
0	4	top soil
4	34	brown clay
34	110	green stone soft
110	144	hard green stone with soft streaks
144	150	green stone with some clay
150	164	clay volcanic
164	168	clay with green stone
168	180	soft green stone
180	254	hard green stone with clay streaks
254	390	hard green stone with some face
390	404	hard green stone with some clay
404	444	hard green stone
444	464	sand stone, green stone, with some face
464	470	hard green stone with some face
470	494	sand stone with some face
494	524	hard green stone with some black rock
524	564	hard black rock and green stone and face
564	584	hard black green rock wth face
584	604	clay with green black rock

TOTAL DEPTH OF BORING (FT): 600

TOTAL DEPTH OF COMPLETED WELL (FT): 604

WELL OWNER

Name: New Resources LLC
Mailing Address: 1060 North Dutton Ave.
Santa Rosa, CA 95401

WELL LOCATION

Address: 4512 Porter Creek Rd.
City: Santa Rosa, CA 95401
County: Sonoma
APN Book 120 - 210 - 006
Latitude Longitude

LOCATION SKETCH

ACTIVITY

xx New Well

Modification/Repair
Deepen
Other (Specify)

DESTROY (Describe) Procedures and Materials Under "Geologic Log")

PLANNED USES:
Monitoring
Test well
Cathodic Protection
Heat Exchange
Direct Push
Injection
Vapor Extraction
Sparging
Remediation
Other (specify)

PLANNED USES
Water Supply
xx Domestic Public
Irrigation Industrial

WATER LEVEL & YIELD OF COMPLETED WELL

Depth to First Water (ft.) BELOW SURFACE

Depth of Static Water Level (Ft) 40 Date Measured: 10/06/09

Test Length/Test type: 2 hr Air Lift

Estimate Yield (GPM)* 11 Total draw 590

*May not be representative of a well's long-term yield

Depth from surface Ft	to Ft	Bore-hole diameter Inches	Type Blank	Screen	Material Grade	Diameter	Gauge	Slot Size	Depth From Surface Ft	to Ft	Annular Material Seal Material
0	80	7 7/8	XX		PVC	5	200		0	80	Bentonite
80	600	7 7/8		XX	PVC	5	200	0.032	80	600	1/8 x 1/4

ATTACHMENTS

No Geologic Log
No Well Construct Diagram
No Geophysical Log(s)
No Soil/Water Chemical Analyses
No Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

NAME: LES PETERSEN DRILLING AND PUMP, INC

ADDRESS: 5434 OLD REDWOOD HWY, SANTA ROSA, CA 95403

SIGNED: Matt Petersen/ Matt Petersen/ 10/06/09 261084

Well Driller/Authorized Representative/Lupe / LP Date C-57 License #

DWR Driller (Owner) Local

APPENDIX B

Analytical laboratory reports of water-quality samples

NELAP Accreditation 01103CA

Caltest ANALYTICAL LABORATORY

ELAP Certification 1664

ENVIRONMENTAL ANALYSES

LAB ORDER No.: D101008

REPORT of ANALYTICAL RESULTS

Report Date: 21 NOV 2003
Received Date: 31 OCT 2003

Client: Mark Woyshner
Balance Hydrologics, Inc.
841 Folger Ave
Berkeley, CA 94710

Purchase Order: 203114

Project: MARK WEST QUARRY

Sampled by: MARK WOYSHNER

Lab Number	Sample Identification	Matrix	Sampled Date/Time
D101008-1	SPRING	DRINKING WATER	30 OCT 03 14:30
D101008-2	CRUSHER WELL	DRINKING WATER	30 OCT 03 15:20
D101008-3	WASH-TRUCK WELL	DRINKING WATER	30 OCT 03 15:45
D101008-4	SHAKER WELL	DRINKING WATER	30 OCT 03 16:00
D101008-5	SHAKER SPRING	DRINKING WATER	30 OCT 03 16:20
D101008-6	PORTER CR	DRINKING WATER	30 OCT 03 16:50

William Svoboda
Project Manager

Christine Horn
Laboratory Director

Results are specific to the sample as submitted and only to the parameters reported.
All analyses performed by EPA Methods or Standard Methods (SM) 18th Ed. except where noted.
Caltest certifies that test results meet all applicable NELAC requirements unless stated otherwise.
Results of 'ND' mean not detected at or above the listed Reporting Limit (R.L.).
'D.F.' means Dilution Factor and has been used to adjust the listed Reporting Limit (R.L.).
Acceptance Criteria for all Surrogate recoveries are defined in the QC Spike Data Reports.
Caltest collects samples in compliance with CFR 40, EPA Methods, Cal. Title 22, and Standard Methods.

1885 North Kelly Road • Napa, California 94558
(707) 258-4000 • Fax: (707) 226-1001 • e-mail: caltest@caltestlab.com

LAB ORDER No.: 0101008

INORGANIC ANALYTICAL RESULTS

LAB NUMBER: D101008-1
SAMPLE ID: SPRING
SAMPLED: 30 OCT 03 14:30

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	1	200.8	11.07.03	A031174UND	
Antimony	ND	6.	ug/L	1	200.8	11.07.03	A031174UND	
Arsenic	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Barium	ND	100.	ug/L	1	200.7	11.06.03	A031170UND	
Beryllium	1.	1.	ug/L	1	200.7	11.06.03	A031170UND	
Boron	ND	0.1	mg/L	1	6010B	11.06.03	A031170UND	1,2
Cadmium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Calcium	52.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,3
Chromium	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,4
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1,5
Lead	ND	5.	ug/L	1	200.7	11.06.03	A031170UND	
Magnesium	13.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,6
Manganese	0.36	0.03	mg/L	1	200.7	11.06.03	A031170UND	1,7
Mercury	ND	1.	ug/L	1	245.2	11.07.03	A031171MER	8
Nickel	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Selenium	ND	5.	ug/L	1	200.8	11.07.03	A031174UND	
Silica, total	12.	1.	mg/L	1	6010B	11.06.03	A031170UND	1,9
Silver	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Sodium	11.	1.	mg/L	1	200.7	11.06.03	A031170UND	1,10
Thallium	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Total Cations	4.1		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,11
pH	7.7		Units	1	150.1	10.31.03	B030309PH	1,12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
3) Calcium and Magnesium are related to water hardness. See Hardness remarks.
4) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
5) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
6) Magnesium and Calcium are related to water hardness. See Hardness remarks.
7) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
8) Sample Preparation on 11-06-03 using 245.2
9) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
10) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
11) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
12) Suggested pH is 6.5 - 8.5.

LAB ORDER No.: D101008

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-1 (continued)								
ALKALINITY				1	SM2320B	11.10.03	I030046ALK	1,2
Bicarbonate as CaCO3	210.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	210.	10.	mg/L					
Chloride	5.	1.	mg/L	1	300.0	11.01.03	I030179IC	1,3
Electrical Conductance	410.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1,4
Fluoride	0.2	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,5
Hardness	180.	3.	mg/L	1	SM2340B	11.10.03		1,6
Nitrate as N	ND	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,7
Sulfate	3.7	0.5	mg/L	1	300.0	11.01.03	I030179IC	1,8
Total Anions	4.4		meq/L	1	CALC	11.21.03		

LAB NUMBER: D101008-2
SAMPLE ID: CRUSHER WELL
SAMPLED: 30 OCT 03 15:20

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	2	200.8	11.10.03	A031174UND	
Antimony	ND	6.	ug/L	1	200.8	11.07.03	A031174UND	
Arsenic	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Barium	ND	100.	ug/L	1	200.7	11.06.03	A031170UND	
Beryllium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
3) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
4) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
5) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
6) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
7) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.
8) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.

NELAP Accreditation 01103CA

Caltest
ANALYTICAL LABORATORY

ELAP Certification 1664

ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-2 (continued)								
Boron	0.2	0.1	mg/L	1	6010B	11.06.03	A031170UND	1,2
Cadmium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Calcium	2.3	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,3
Chromium	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,4
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1,5
Lead	ND	5.	ug/L	1	200.7	11.06.03	A031170UND	
Magnesium	1.0	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,6
Manganese	ND	0.03	mg/L	1	200.7	11.06.03	A031170UND	1,7
Mercury	ND	1.	ug/L	1	245.2	11.07.03	A031171MER	8
Nickel	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Selenium	ND	5.	ug/L	1	200.8	11.07.03	A031174UND	
Silica, total	37.	1.	mg/L	1	6010B	11.06.03	A031170UND	1,9
Silver	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Sodium	67.	1.	mg/L	1	200.7	11.06.03	A031170UND	1,10
Thallium	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Total Cations	3.1		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,11
pH	9.4		Units	1	150.1	10.31.03	B030309PH	1,12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
3) Calcium and Magnesium are related to water hardness. See Hardness remarks.
4) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
5) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
6) Magnesium and Calcium are related to water hardness. See Hardness remarks.
7) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
8) Sample Preparation on 11-06-03 using 245.2
9) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
10) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
11) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
12) Suggested pH is 6.5 - 8.5.

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
ALKALINITY				2	SM2320B	11.10.03	I030046ALK	1,2
Bicarbonate as CaCO3	120.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	40.	20.	mg/L					
Total Alkalinity as CaCO3	160.	20.	mg/L					
Chloride	5.	1.	mg/L	1	300.0	11.01.03	I030179IC	1,3
Electrical Conductance	310.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1,4
Fluoride	0.1	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,5
Hardness	10.	3.	mg/L	1	SM2340B	11.10.03		1,6
Nitrate as N	3.2	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,7
Sulfate	8.4	0.5	mg/L	1	300.0	11.01.03	I030179IC	1,8
Total Anions	3.8		meq/L	1	CALC	11.21.03		

LAB NUMBER: D101008-3
SAMPLE ID: WASH-TRUCK WELL
SAMPLED: 30 OCT 03 15:45

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	1	200.8	11.07.03	A031174UND	
Antimony	ND	6.	ug/L	1	200.8	11.07.03	A031174UND	
Arsenic	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Barium	ND	100.	ug/L	1	200.7	11.06.03	A031170UND	
Beryllium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Boron	0.2	0.1	mg/L	1	6010B	11.06.03	A031170UND	1,9

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
3) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
4) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
5) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
6) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
7) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.
8) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
9) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-3 (continued)								
Cadmium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Calcium	29.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1.2
Chromium	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1.3
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1.4
Lead	ND	5.	ug/L	1	200.7	11.06.03	A031170UND	
Magnesium	8.4	0.5	mg/L	1	200.7	11.06.03	A031170UND	1.5
Manganese	ND	0.03	mg/L	1	200.7	11.06.03	A031170UND	1.6
Mercury	ND	1.	ug/L	1	245.2	11.07.03	A031171MER	7
Nickel	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Selenium	ND	5.	ug/L	1	200.8	11.07.03	A031174UND	
Silica, total	26.	1.	mg/L	1	6010B	11.06.03	A031170UND	1.8
Silver	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Sodium	54.	1.	mg/L	1	200.7	11.06.03	A031170UND	1.9
Thallium	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Total Cations	4.5		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1.10
pH	8.2		Units	1	150.1	10.31.03	B030309PH	1.11
ALKALINITY				2	SM2320B	11.10.03	I030046ALK	1.12
Bicarbonate as CaCO3	190.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	ND	20.	mg/L					
Total Alkalinity as CaCO3	190.	20.	mg/L					
Chloride	4.	1.	mg/L	1	300.0	11.01.03	I030179IC	1.13

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Calcium and Magnesium are related to water hardness. See Hardness remarks.
3) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
4) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
5) Magnesium and Calcium are related to water hardness. See Hardness remarks.
6) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
7) Sample Preparation on 11-06-03 using 245.2
8) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
9) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
10) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
11) Suggested pH is 6.5 - 8.5.
12) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
13) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-3 (continued)								
Electrical Conductance	440.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1,2
Fluoride	0.1	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,3
Hardness	110.	3.	mg/L	1	SM2340B	11.10.03		1,4
Nitrate as N	ND	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,5
Sulfate	29.	0.5	mg/L	1	300.0	11.01.03	I030179IC	1,6
Total Anions	4.5		meq/L	1	CALC	11.21.03		

LAB NUMBER: D101008-4
SAMPLE ID: SHAKER WELL
SAMPLED: 30 OCT 03 16:00

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	2	200.8	11.10.03	A031174UND	
Antimony	ND	6.	ug/L	1	200.8	11.07.03	A031174UND	
Arsenic	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Barium	ND	100.	ug/L	1	200.7	11.06.03	A031170UND	
Beryllium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Boron	0.1	0.1	mg/L	1	6010B	11.06.03	A031170UND	1,7
Cadmium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Calcium	16.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,8
Chromium	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,9
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1,10

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
3) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
4) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
5) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.
6) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
7) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
8) Calcium and Magnesium are related to water hardness. See Hardness remarks.
9) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
10) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.

INORGANIC ANALYTICAL RESULTS

LAB ORDER No.: D101008

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-4 (continued)								
Lead	ND	5.	ug/L	1	200.7	11.06.03	A031170UND	
Magnesium	5.2	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,2
Manganese	ND	0.03	mg/L	1	200.7	11.06.03	A031170UND	1,3
Mercury	ND	1.	ug/L	1	245.2	11.07.03	A031171MER	4
Nickel	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Selenium	ND	5.	ug/L	1	200.8	11.07.03	A031174UND	
Silica, total	39.	1.	mg/L	1	6010B	11.06.03	A031170UND	1,5
Silver	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Sodium	68.	1.	mg/L	1	200.7	11.06.03	A031170UND	1,6
Thallium	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Total Cations	4.2		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,7
pH	8.6		Units	1	150.1	10.31.03	B030309PH	1,8
ALKALINITY				2	SM2320B	11.10.03	I030046ALK	1,9
Bicarbonate as CaCO3	180.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	ND	20.	mg/L					
Total Alkalinity as CaCO3	180.	20.	mg/L					
Chloride	5.	1.	mg/L	1	300.0	11.01.03	I030179IC	1,10
Electrical Conductance	420.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1,11
Fluoride	ND	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Magnesium and Calcium are related to water hardness. See Hardness remarks.
3) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
4) Sample Preparation on 11-06-03 using 245.2
5) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
6) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
7) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
8) Suggested pH is 6.5 - 8.5.
9) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
10) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
11) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
12) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).

INORGANIC ANALYTICAL RESULTS

LAB ORDER No.: D101008

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-4 (continued)								
Hardness	61.	3.	mg/L	1	SM2340B	11.10.03		1.2
Nitrate as N	ND	0.1	mg/L	1	300.0	11.01.03	I030179IC	1.3
Sulfate	34.	5.	mg/L	10	300.0	11.01.03	I030179IC	1.4
Total Anions	4.5		meq/L	1	CALC	11.21.03		

LAB NUMBER: D101008-5 crusher
SAMPLE ID: ~~SHAKER~~ SPRING
SAMPLED: 30 OCT 03 16:20

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	2	200.8	11.14.03	A031174UND	
Antimony	ND	6.	ug/L	1	200.8	11.07.03	A031174UND	
Arsenic	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Barium	ND	100.	ug/L	1	200.7	11.06.03	A031170UND	
Beryllium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Boron	ND	0.1	mg/L	1	6010B	11.06.03	A031170UND	1.5
Cadmium	ND	1.	ug/L	1	200.7	11.06.03	A031170UND	
Calcium	35.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1.6
Chromium	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1.7
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1.8
Lead	ND	5.	ug/L	1	200.7	11.06.03	A031170UND	
Magnesium	21.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1.9
Manganese	ND	0.03	mg/L	1	200.7	11.06.03	A031170UND	1.10
Mercury	ND	1.	ug/L	1	245.2	11.07.03	A031171MER	11
Nickel	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
3) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.
4) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
5) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
6) Calcium and Magnesium are related to water hardness. See Hardness remarks.
7) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
8) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
9) Magnesium and Calcium are related to water hardness. See Hardness remarks.
10) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
11) Sample Preparation on 11-06-03 using 245.2

INORGANIC ANALYTICAL RESULTS

LAB ORDER No.: D101008

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-5 (continued)								
Selenium	ND	5.	ug/L	1	200.8	11.07.03	A031174UND	
Silica, total	33.	1.	mg/L	1	6010B	11.06.03	A031170UND	1,2
Silver	ND	10.	ug/L	1	200.7	11.06.03	A031170UND	
Sodium	21.	1.	mg/L	1	200.7	11.06.03	A031170UND	1,3
Thallium	ND	2.	ug/L	1	200.8	11.07.03	A031174UND	
Total Cations	4.4		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,4
pH	8.4		Units	1	150.1	10.31.03	B030309PH	1,5
ALKALINITY				2	SM2320B	11.10.03	I030046ALK	1,6,7
Bicarbonate as CaCO3	150.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	ND	20.	mg/L					
Total Alkalinity as CaCO3	150.	20.	mg/L					
Chloride	8.	1.	mg/L	1	300.0	11.01.03	I030179IC	1,8
Electrical Conductance	440.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1,9
Fluoride	0.2	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,10
Hardness	170.	3.	mg/L	1	SM2340B	11.10.03		1,11
Nitrate as N	3.6	0.1	mg/L	1	300.0	11.01.03	I030179IC	1,12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
3) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
4) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
5) Suggested pH is 6.5 - 8.5.
6) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
7) A "J" flagged result indicates an estimated concentration above the Method Detection Limit (MDL) and below the RL/ML (Reporting Limit/Minimum Level). The 'J' flag is equivalent to the DNQ Estimated Concentration flag.
8) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
9) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
10) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
11) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
12) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D101008-5 (continued)								
Sulfate	57.	5.	mg/L	10	300.0	11.01.03	I030179IC	1,2
Total Anions	4.7		meq/L	1	CALC	11.21.03		

LAB NUMBER: D101008-6
SAMPLE ID: PORTER CR
SAMPLED: 30 OCT 03 16:50

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Boron	ND	0.1	mg/L	1	6010B	11.06.03	A031170UND	1,3
Calcium	51.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,4
Copper	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,5
Iron	ND	0.1	mg/L	1	200.7	11.06.03	A031170UND	1,6
Magnesium	14.	0.5	mg/L	1	200.7	11.06.03	A031170UND	1,7
Manganese	ND	0.03	mg/L	1	200.7	11.06.03	A031170UND	1,8
Silica, total	25.	1.	mg/L	1	6010B	11.06.03	A031170UND	1,9
Sodium	12.	1.	mg/L	1	200.7	11.06.03	A031170UND	1,10
Total Cations	4.2		meq/L	1	CALC	11.10.03		
Zinc	ND	0.05	mg/L	1	200.7	11.06.03	A031170UND	1,11
pH	7.6		Units	1	150.1	10.31.03	B030309PH	1,12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
3) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
4) Calcium and Magnesium are related to water hardness. See Hardness remarks.
5) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
6) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
7) Magnesium and Calcium are related to water hardness. See Hardness remarks.
8) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
9) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
10) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
11) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
12) Suggested pH is 6.5 - 8.5.

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
ALKALINITY				2	SM2320B	11.10.03	I030046ALK	1.2
Bicarbonate as CaCO3	200.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	ND	20.	mg/L					
Total Alkalinity as CaCO3	200.	20.	mg/L					
Chloride	5.	1.	mg/L	1	300.0	11.01.03	I030179IC	1.3
Electrical Conductance	410.	10.	umhos/cm	1	SM2510B	11.11.03	I030051CON	1.4
Fluoride	0.1	0.1	mg/L	1	300.0	11.01.03	I030179IC	1.5
Hardness	180.	3.	mg/L	1	SM2340B	11.10.03		1.6
Nitrate as N	ND	0.1	mg/L	1	300.0	11.01.03	I030179IC	1.7
Sulfate	11.	0.5	mg/L	1	300.0	11.01.03	I030179IC	1.8
Total Anions	4.4		meq/L	1	CALC	11.21.03		

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
3) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
4) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
5) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
6) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
7) Nitrate as Nitrogen has a drinking water Maximum Contaminant Level (MCL) of 10 mg/L.
8) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.

NELAP Accreditation 01103CA

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

ELAP Certification 1664

LAB ORDER No.: D101008

SUPPLEMENTAL QUALITY CONTROL (QC) DATA REPORT

Report Date: 21 NOV 2003
Received Date: 31 OCT 2003

Client: Mark Woyshner
Balance Hydrologics, Inc.
841 Folger Ave
Berkeley, CA 94710

Project: MARK WEST QUARRY

QC Batch ID	Method	Matrix
A031170UND	200.7	DRINKING WATER
A031170UND	6010B	DRINKING WATER
A031171MER	245.2	DRINKING WATER
A031174UND	200.8	DRINKING WATER
B030309PH	150.1	DRINKING WATER
I030046ALK	SM2320B	DRINKING WATER
I030051CON	SM2510B	DRINKING WATER
I030179IC	300.0	DRINKING WATER

William Svoboda
Project Manager

Christine Horn
Laboratory Director

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All analyses performed by EPA Methods or Standard Methods (SM) 18th Ed. except where noted.
Caltest certifies that test results meet all applicable NELAC requirements unless stated otherwise.
Results of 'ND' mean not detected at or above the listed Reporting Limit (R.L.).
Analyte Spike Amounts reported as 'NS' mean not spiked and will not have recoveries reported.
'RPD' means Relative Percent Difference and RPD Acceptance Criteria is stated as a maximum.
'NC' means not calculated for RPD or Spike Recoveries.

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LAB ORDER No.: D101008

METHOD BLANK ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	ANALYZED	NOTES
QC BATCH: A031170UND					
Barium	ND	100.	ug/L	11.06.03	
Beryllium	ND	1.	ug/L	11.06.03	
Boron	ND	0.1	mg/L	11.06.03	
Cadmium	ND	1.	ug/L	11.06.03	
Calcium	ND	0.5	mg/L	11.06.03	
Chromium	ND	10.	ug/L	11.06.03	
Copper	ND	0.05	mg/L	11.06.03	
Iron	ND	0.1	mg/L	11.06.03	
Lead	ND	5.	ug/L	11.06.03	
Magnesium	ND	0.5	mg/L	11.06.03	
Manganese	ND	0.03	mg/L	11.06.03	
Nickel	ND	10.	ug/L	11.06.03	
Silica, total	ND	1.	mg/L	11.06.03	
Silver	ND	10.	ug/L	11.06.03	
Sodium	ND	1.	mg/L	11.06.03	
Zinc	ND	0.05	mg/L	11.06.03	
QC BATCH: A031171MER					
Mercury	ND	0.05	ug/L	11.07.03	
QC BATCH: A031174UND					
Aluminum	ND	50.	ug/L	11.07.03	
Antimony	ND	0.5	ug/L	11.10.03	
Arsenic	ND	0.5	ug/L	11.07.03	
Selenium	ND	2.	ug/L	11.07.03	
Thallium	ND	0.1	ug/L	11.07.03	
QC BATCH: I030046ALK					
ALKALINITY				11.10.03	
Bicarbonate as CaCO3	ND	10.	mg/L		
Hydroxide as CaCO3	ND	10.	mg/L		
Carbonate as CaCO3	ND	10.	mg/L		
Total Alkalinity as CaCO3	ND	10.	mg/L		

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

LAB ORDER No.: D101008

METHOD BLANK ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	ANALYZED	NOTES
QC BATCH: I030051CON					
Electrical Conductance	ND	10.	umhos/cm	11.11.03	
QC BATCH: I030179IC					
Chloride	ND	1.	mg/L	11.01.03	
Fluoride	ND	0.1	mg/L	11.01.03	
Nitrate as NO3 [5945]	ND	0.1	mg/L	10.31.03	
Sulfate	ND	0.5	mg/L	11.01.03	

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LAB ORDER No.: D101008

LABORATORY CONTROL SAMPLE ANALYTICAL RESULTS

ANALYTE	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031170UND							
Barium	200.	196.\	98\	80-120\20		11.06.03	
Beryllium	200.	206.\	103\	80-120\20		11.06.03	
Boron	0.200	0.213\	106\	80-120\20		11.06.03	
Cadmium	200	202.\	101\	80-120\20		11.06.03	
Calcium	20.0	20.2\	101\	80-120\20		11.06.03	
Chromium	200.	202.\	101\	80-120\20		11.06.03	
Copper	0.200	0.200\	100\	80-120\20		11.06.03	
Iron	2.00	2.07\	104\	80-120\20		11.06.03	
Lead	200.	199.\	100\	80-120\20		11.06.03	
Magnesium	20.0	19.2\	96\	80-120\20		11.06.03	
Manganese	0.200	0.201\	100\	80-120\20		11.06.03	
Nickel	200.	204.\	102\	80-120\20		11.06.03	
Silica, total	45.0	43.4\	96\	80-120\20		11.06.03	
Silver	100.	96.1\	96\	80-120\20		11.06.03	
Sodium	20.0	20.7\	104\	80-120\20		11.06.03	
Zinc	0.200	0.203\	102\	80-120\20		11.06.03	
QC BATCH: A031171MER							
Mercury	1.00	1.05\	105\	80-120\20		11.07.03	
QC BATCH: A031174UND							
Aluminum	40.0	J43.5\	109\	80-120\20		11.07.03	1
Antimony	20.0	20.9\	104\	80-120\20		11.10.03	
Arsenic	20.0	21.0\	105\	80-120\20		11.07.03	
Selenium	20.0	22.5\	112\	80-120\20		11.07.03	
Thallium	20.0	20.8\	104\	80-120\20		11.07.03	
QC BATCH: I030046ALK							
ALKALINITY						11.10.03	
Bicarbonate as CaCO3	100.	96.\	96\	75-125\20			
Hydroxide as CaCO3		ND\		75-125\20			
Carbonate as CaCO3		ND\		75-125\20			
Total Alkalinity as CaCO3	100.	96.\	96\	75-125\20			

1) A "J" flagged result indicates an estimated concentration above the Method Detection Limit (MDL) and below the RL/ML (Reporting Limit/Minimum Level). The 'J' flag is equivalent to the DNQ Estimated Concentration flag.

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LAB ORDER No.: D101008

LABORATORY CONTROL SAMPLE ANALYTICAL RESULTS

ANALYTE	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: I030051CON							
Electrical Conductance	1412.	1360.\	96\	75-125\20		11.11.03	
QC BATCH: I030179IC							
Chloride	10.0	11.5\	115\	75-125\20		11.01.03	
Fluoride	2.50	2.82\	113\	75-125\20		11.01.03	
Nitrate as NO3 [5945]	6.25	7.18\	115\	75-125\20		10.31.03	
Sulfate	20.0	23.0\	115\	75-125\20		11.01.03	

NELAP Accreditation 01103CA

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DUPLICATE SAMPLES ANALYTICAL RESULTS

ANALYTE	R.L.	ORIGINAL RESULT	DUPLICATE RESULT	REL% DIFF	ACCEPT LIMIT	ANALYZED	NOTES
QC BATCH: B030309PH QC SAMPLE LAB NUMBER: D100001-30							
pH		9.94	9.95	0.1	20	10.31.03	
QC BATCH: I030046ALK QC SAMPLE LAB NUMBER: D100986-1							
ALKALINITY						11.10.03	
Bicarbonate as CaCO3	20.	140.	140.	0.0	20		
Hydroxide as CaCO3	20.	ND	ND	NC	20		
Carbonate as CaCO3	20.	ND	ND	NC	20		
Total Alkalinity as CaCO3	20.	140.	140.	0.0	20		
QC BATCH: I030051CON QC SAMPLE LAB NUMBER: D100890-1							
Electrical Conductance	10.	153.	154.	0.7	20	11.11.03	

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MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031170UND QC SAMPLE LAB NUMBER: D101008-1								
Barium	ND	200.	210.\208.	105\104	80-120\20	1	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Beryllium	1.2	200.	181.\189.	90\94	80-120\20	4.3	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Boron	ND	0.200	0.224\0.226	112\113	80-120\20	0.9	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Cadmium	ND	200.	182.\190.	91\95	80-120\20	4.3	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Calcium	52.1	20.0	70.2\72.4	90\102	80-120\20	3.1	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Chromium	ND	200.	183.\192.	92\96	80-120\20	4.8	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Copper	ND	0.200	0.188\0.194	94\97	80-120\20	3.1	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Iron	ND	2.00	1.93\1.95	96\98	80-120\20	1.0	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Lead	ND	200.	184.\185.	92\92	80-120\20	0.5	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Magnesium	13.3	20.0	31.8\34.2	92\104	80-120\20	7.3	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Manganese	0.363	0.200	0.545\0.564	91\100	80-120\20	3.4	11.06.03	

LAB ORDER No.: D101008

MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031170UND (continued)								
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Nickel	ND	200.	184.\192.	92\96	80-120\20	4.3	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Silica, total	12.2	45.0	52.7\54.2	90\93	80-120\20	2.8	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Silver	ND	100.	90.8\89.2	91\89	80-120\20	1.8	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Sodium	11.0	20.0	32.4\32.6	107\108	80-120\20	0.6	11.06.03	
QC BATCH: A031170UND (continued) QC SAMPLE LAB NUMBER: D101008-1								
Zinc	ND	0.200	0.181\0.190	90\95	80-120\20	4.9	11.06.03	
QC BATCH: A031171MER QC SAMPLE LAB NUMBER: D101008-1								
Mercury	ND	1.00	1.08\1.08	108\108	80-120\20	0.0	11.07.03	
QC BATCH: A031174UND QC SAMPLE LAB NUMBER: D101017-1								
Aluminum	ND	40.0	J41.8\J41.3	104\103	80-120\20	1.2	11.07.03	1
QC BATCH: A031174UND (continued) QC SAMPLE LAB NUMBER: D101017-1								
Antimony	ND	20.0	18.7\19.3	94\96	80-120\20	3.2	11.10.03	
QC BATCH: A031174UND (continued) QC SAMPLE LAB NUMBER: D101017-1								
Arsenic	ND	20.0	19.1\19.2	96\96	80-120\20	0.5	11.07.03	

1) A "J" flagged result indicates an estimated concentration above the Method Detection Limit (MDL) and below the RL/ML (Reporting Limit/Minimum Level). The 'J' flag is equivalent to the DNQ Estimated Concentration flag.

LAB ORDER No.: D101008

MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031174UND (continued)								
QC BATCH: A031174UND (continued) QC SAMPLE LAB NUMBER: D101017-1								
Selenium	ND	20.0	19.6\19.1	98\96	80-120\20	2.6	11.07.03	
QC BATCH: A031174UND (continued) QC SAMPLE LAB NUMBER: D101017-1								
Thallium	ND	20.0	19.3\18.8	96\94	80-120\20	2.6	11.07.03	
QC BATCH: I030179IC QC SAMPLE LAB NUMBER: D101000-1								
Chloride	61.7	80.0	132.\131.	88\87	75-125\20	0.8	11.01.03	
QC BATCH: I030179IC (continued) QC SAMPLE LAB NUMBER: D101000-1								
Fluoride	0.47	20.0	17.2\17.2	84\84	75-125\20	0.0	11.01.03	
QC BATCH: I030179IC (continued) QC SAMPLE LAB NUMBER: D101000-1								
Nitrate as NO3 [5945]	18.4	50.0	60.6\60.0	84\83	75-125\20	1.0	10.31.03	
QC BATCH: I030179IC (continued) QC SAMPLE LAB NUMBER: D101000-1								
Sulfate	27.0	160.	162.\160.	84\83	75-125\20	1.2	11.01.03	

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LAB ORDER No.: D120046

REPORT of ANALYTICAL RESULTS

Report Date: 19 DEC 2003
Received Date: 01 DEC 2003

Client: Mark Woyshner
Balance Hydrologics, Inc.
841 Folger Ave
Berkeley, CA 94710

Purchase Order: 203114

Project: MARK WEST QUARRY

Sampled by: MARK WOYSHNER

Lab Number	Sample Identification	Matrix	Sampled Date/Time
D120046-1	CRUSHER WELL	DRINKING WATER	30 NOV 03 15:05
D120046-2	SHAKER WELL	DRINKING WATER	01 DEC 03 16:25

William Svoboda
Project Manager

Christine Horn
Laboratory Director

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Results are specific to the sample as submitted and only to the parameters reported.
All analyses performed by EPA Methods or Standard Methods (SM) 18th Ed. except where noted.
Caltest certifies that test results meet all applicable NELAC requirements unless stated otherwise.
Results of 'ND' mean not detected at or above the listed Reporting Limit (R.L.).
'D.F.' means Dilution Factor and has been used to adjust the listed Reporting Limit (R.L.).
Acceptance Criteria for all Surrogate recoveries are defined in the QC Spike Data Reports.
Caltest collects samples in compliance with CFR 40, EPA Methods, Cal. Title 22, and Standard Methods.

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LAB ORDER No.: D120046

INORGANIC ANALYTICAL RESULTS

LAB NUMBER: D120046-1
SAMPLE ID: CRUSHER WELL
SAMPLED: 30 NOV 03 15:05

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	2	200.8	12.08.03	A031293UND	
Antimony	ND	6.	ug/L	1	200.8	12.05.03	A031293UND	
Arsenic	ND	2.	ug/L	1	200.8	12.05.03	A031293UND	
Barium	ND	100.	ug/L	1	200.7	12.05.03	A031292UND	
Beryllium	ND	1.	ug/L	1	200.7	12.05.03	A031292UND	
Boron	ND	0.1	mg/L	1	6010B	12.05.03	A031292UND	1,2
Cadmium	ND	1.	ug/L	1	200.7	12.05.03	A031292UND	
Calcium	17.	0.5	mg/L	1	200.7	12.05.03	A031292UND	1,3
Chromium	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Copper	ND	0.05	mg/L	1	200.7	12.05.03	A031292UND	1,4
Iron	ND	0.1	mg/L	1	200.7	12.05.03	A031292UND	1,5
Lead	ND	5.	ug/L	1	200.7	12.05.03	A031292UND	
Magnesium	12.	0.5	mg/L	1	200.7	12.05.03	A031292UND	1,6
Manganese	ND	0.03	mg/L	1	200.7	12.05.03	A031292UND	1,7
Mercury	ND	1.	ug/L	1	245.2	12.05.03	A031290MER	8
Nickel	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Potassium	2.	1.	mg/L	1	200.7	12.05.03	A031292UND	
Selenium	ND	5.	ug/L	1	200.8	12.06.03	A031293UND	
Silica, total	42.	1.	mg/L	1	6010B	12.05.03	A031292UND	1,9
Silver	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Sodium	39.	1.	mg/L	1	200.7	12.05.03	A031292UND	1,10
Thallium	ND	2.	ug/L	1	200.8	12.05.03	A031293UND	
Total Cations	3.5		meq/L	1	CALC	12.08.03		
Zinc	ND	0.05	mg/L	1	200.7	12.05.03	A031292UND	1,11

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
3) Calcium and Magnesium are related to water hardness. See Hardness remarks.
4) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
5) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
6) Magnesium and Calcium are related to water hardness. See Hardness remarks.
7) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
8) Sample Preparation on 12-04-03 using 245.2
9) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
10) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
11) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.

LAB ORDER No.: D120046

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D120046-1 (continued)								
pH	8.7		Units	1	150.1	12.01.03	B030340PH	1,2
ALKALINITY				1	SM2320B	12.05.03	I030049ALK	1,3
Bicarbonate as CaCO3	140.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	10.	10.	mg/L					
Total Alkalinity as CaCO3	150.	10.	mg/L					
Chloride	8.	1.	mg/L	1	300.0	12.16.03	I030207IC	1,4
Electrical Conductance	430.	10.	umhos/cm	1	SM2510B	12.09.03	I030056CON	1,5
Fluoride	0.1	0.1	mg/L	1	300.0	12.17.03	I030207IC	1,6
Hardness	92.	3.	mg/L	1	SM2340B	12.08.03		1,7
Nitrate as N	ND	0.1	mg/L	1	300.0	12.17.03	I030207IC	1,8
Sulfate	55.	5.	mg/L	10	300.0	12.17.03	I030207IC	1,9
Total Anions	4.4		meq/L	1	CALC	12.18.03		

LAB NUMBER: D120046-2
SAMPLE ID: SHAKER WELL
SAMPLED: 01 DEC 03 16:25

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Aluminum	ND	50.	ug/L	2	200.8	12.08.03	A031293UND	
Antimony	ND	6.	ug/L	1	200.8	12.05.03	A031293UND	
Arsenic	ND	2.	ug/L	1	200.8	12.05.03	A031293UND	
Barium	ND	100.	ug/L	1	200.7	12.05.03	A031292UND	
Beryllium	ND	1.	ug/L	1	200.7	12.05.03	A031292UND	

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Suggested pH is 6.5 - 8.5.
3) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
4) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
5) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
6) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
7) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
8) NO3-N,HOMEZ The sample was analyzed out of holdtime due to lab error.
9) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.

LAB ORDER No.: D120046

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: D120046-2 (continued)								
Boron	ND	0.1	mg/L	1	6010B	12.05.03	A031292UND	1.2
Cadmium	ND	1.	ug/L	1	200.7	12.05.03	A031292UND	
Calcium	34.	0.5	mg/L	1	200.7	12.05.03	A031292UND	1.3
Chromium	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Copper	ND	0.05	mg/L	1	200.7	12.05.03	A031292UND	1.4
Iron	ND	0.1	mg/L	1	200.7	12.05.03	A031292UND	1.5
Lead	ND	5.	ug/L	1	200.7	12.05.03	A031292UND	
Magnesium	23.	0.5	mg/L	1	200.7	12.05.03	A031292UND	1.6
Manganese	ND	0.03	mg/L	1	200.7	12.05.03	A031292UND	1.7
Mercury	ND	1.	ug/L	1	245.2	12.05.03	A031290MER	8
Nickel	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Potassium	2.	1.	mg/L	1	200.7	12.05.03	A031292UND	
Selenium	ND	5.	ug/L	1	200.8	12.05.03	A031293UND	
Silica, total	30.	1.	mg/L	1	6010B	12.05.03	A031292UND	1.9
Silver	ND	10.	ug/L	1	200.7	12.05.03	A031292UND	
Sodium	19.	1.	mg/L	1	200.7	12.05.03	A031292UND	1.10
Thallium	ND	2.	ug/L	1	200.8	12.05.03	A031293UND	
Total Cations	4.4		meq/L	1	CALC	12.08.03		
Zinc	ND	0.05	mg/L	1	200.7	12.05.03	A031292UND	1.11
pH	8.0		Units	1	150.1	12.01.03	B030340PH	1.12

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Boron has an agricultural recommended limit and a state drinking water Action (Advisory) Limit of 1.0 mg/L. Boron effects the health and production of boron sensitive plants. Drinking water with greater than 10 times the Action Limit Level are recommended for removal from service.
3) Calcium and Magnesium are related to water hardness. See Hardness remarks.
4) Copper has a drinking water Maximum Contaminant Level (MCL) of 1.0 mg/L.
5) Iron has a drinking water Maximum Contaminant Level (MCL) of 0.3 mg/L.
6) Magnesium and Calcium are related to water hardness. See Hardness remarks.
7) Manganese has a drinking water Maximum Contaminant Level (MCL) of 0.05 mg/L.
8) Sample Preparation on 12-04-03 using 245.2
9) Silica has a recommended limit of 70 mg/L. Silica in water may etch various household materials such as leaded crystal, marble, tile, windows, and porcelain.
10) Sodium has a recommended limit of 100 mg/L. According to the American Heart Association, water containing more than 270 mg/L should not be consumed by those on a moderately restricted sodium diet.
11) Zinc has a drinking water Maximum Contaminant Level (MCL) of 5.0 mg/L.
12) Suggested pH is 6.5 - 8.5.

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LAB ORDER No.: D120046

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
ALKALINITY				2	SM2320B	12.05.03	I030049ALK	1,2
Bicarbonate as CaCO3	170.	20.	mg/L					
Hydroxide as CaCO3	ND	20.	mg/L					
Carbonate as CaCO3	ND	20.	mg/L					
Total Alkalinity as CaCO3	170.	20.	mg/L					
Chloride	8.	1.	mg/L	1	300.0	12.16.03	I030207IC	1,3
Electrical Conductance	500.	10.	umhos/cm	1	SM2510B	12.09.03	I030056CON	1,4
Fluoride	0.1	0.1	mg/L	1	300.0	12.17.03	I030207IC	1,5
Hardness	180.	3.	mg/L	1	SM2340B	12.08.03		1,6
Nitrate as N	ND	0.1	mg/L	1	300.0	12.17.03	I030207IC	1,7
Sulfate	98.	5.	mg/L	10	300.0	12.17.03	I030207IC	1,8
Total Anions	5.7		meq/L	1	CALC	12.18.03		

1) The following information is from California Code of Regulations Title 22; Napa County Env. Health "Interpreting Drinking Water Test Results"; UC Davis Department of Land, Air, and Water Resources - Cooperative Extension. This information is provided for your convenience. Caltest does not provide consultation regarding the suitability of water for a given purpose.
2) Alkalinity has no regulatory, or recommended level. However, higher alkalinity waters may have a distinctly unpleasant taste. Alkalinities of natural waters rarely exceed 400 to 500 mg/L (as CaCO3).
3) Chloride has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.
4) Electrical Conductance has a drinking water Maximum Contaminant Level (MCL) of 1,600 umhos/cm, with a recommended level of 900 umhos/cm and a short term limit of 2,200 umhos/cm. Electrical Conductance is a measure of the ability of a water to conduct an electrical current and is expressed in micromhos per centimeter at 25 degrees C.
5) Fluoride has a recommended level of 1.0 mg/L in temperate climates. Fluoride in concentrations greater than 3 mg/L can cause dental fluorosis (a brownish discoloration of the teeth).
6) Hardness is due primarily to calcium and magnesium carbonates and bi-carbonates. Up to 60 mg/L is SOFT. Between 60 to 120 mg/L is MODERATE (typically most desireable). Between 120 to 180 mg/L is HARD. Over 180 mg/L is VERY HARD.
7) NO3-N,HOME2 The sample was analyzed out of holdtime due to lab error.
8) Sulfate has a drinking water Maximum Contaminant Level (MCL) of 500 mg/L, with a recommended level of 250 mg/L and a short term limit of 600 mg/L.

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LAB ORDER No.: D120046

SUPPLEMENTAL QUALITY CONTROL (QC) DATA REPORT

Report Date: 19 DEC 2003
Received Date: 01 DEC 2003

Client: Mark Woyshner
Balance Hydrologics, Inc.
841 Folger Ave
Berkeley, CA 94710

Project: MARK WEST QUARRY

QC Batch ID	Method	Matrix
A031290MER	245.2	DRINKING WATER
A031292UND	200.7	DRINKING WATER
A031292UND	6010B	DRINKING WATER
A031293UND	200.8	DRINKING WATER
B030340PH	150.1	DRINKING WATER
I030049ALK	SM2320B	DRINKING WATER
I030056CON	SM2510B	DRINKING WATER
I030207IC	300.0	DRINKING WATER

William Svoboda
Project Manager

Christine Horn
Laboratory Director

Results are specific to the sample as submitted and only to the parameters reported.
All analyses performed by EPA Methods or Standard Methods (SM) 18th Ed. except where noted.
Caltest certifies that test results meet all applicable NELAC requirements unless stated otherwise.
Results of 'ND' mean not detected at or above the listed Reporting Limit (R.L.).
Analyte Spike Amounts reported as 'NS' mean not spiked and will not have recoveries reported.
'RPD' means Relative Percent Difference and RPD Acceptance Criteria is stated as a maximum.
'NC' means not calculated for RPD or Spike Recoveries.

METHOD BLANK ANALYTICAL RESULTS

LAB ORDER No.: D120046

ANALYTE	RESULT	R.L.	UNITS	ANALYZED	NOTES
QC BATCH: A031290MER					
Mercury	ND	0.05	ug/L	12.05.03	
QC BATCH: A031292UND					
Barium	ND	100.	ug/L	12.05.03	
Beryllium	ND	1.	ug/L	12.05.03	
Boron	ND	0.1	mg/L	12.05.03	
Cadmium	ND	1.	ug/L	12.05.03	
Calcium	ND	0.5	mg/L	12.05.03	
Chromium	ND	10.	ug/L	12.05.03	
Copper	ND	0.05	mg/L	12.05.03	
Iron	ND	0.1	mg/L	12.05.03	
Lead	ND	5.	ug/L	12.05.03	
Magnesium	ND	0.5	mg/L	12.05.03	
Manganese	ND	0.03	mg/L	12.05.03	
Nickel	ND	10.	ug/L	12.05.03	
Potassium	ND	1.	mg/L	12.05.03	
Silica, total	ND	1.	mg/L	12.05.03	
Silver	ND	10.	ug/L	12.05.03	
Sodium	ND	1.	mg/L	12.05.03	
Zinc	ND	0.05	mg/L	12.05.03	
QC BATCH: A031293UND					
Aluminum	ND	50.	ug/L	12.08.03	
Antimony	ND	6.	ug/L	12.05.03	
Arsenic	ND	2.	ug/L	12.05.03	
Selenium	ND	5.	ug/L	12.05.03	
Thallium	ND	2.	ug/L	12.05.03	
QC BATCH: I030049ALK					
ALKALINITY				12.05.03	
Bicarbonate as CaCO3	ND	10.	mg/L		
Hydroxide as CaCO3	ND	10.	mg/L		
Carbonate as CaCO3	ND	10.	mg/L		
Total Alkalinity as CaCO3	ND	10	mg/L		

NELAP Accreditation 01103CA

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LAB ORDER No.: D120046

METHOD BLANK ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	ANALYZED	NOTES
QC BATCH: I030056CON					
Electrical Conductance	ND	10.	umhos/cm	12.09.03	
QC BATCH: I030207IC					
Chloride [1950]	ND	0.5	mg/L	12.16.03	
Fluoride [4825]	ND	0.05	mg/L	12.16.03	
Nitrate as N [5895]	ND	0.1	mg/L	12.16.03	
Sulfate [8025]	ND	1.	mg/L	12.16.03	

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LAB ORDER No.: D120046

LABORATORY CONTROL SAMPLE ANALYTICAL RESULTS

ANALYTE	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031290MER							
Mercury	1.00	0.941\	94\	80-120\20		12.05.03	
QC BATCH: A031292UND							
Barium	200.	199.\	100\	80-120\20		12.05.03	
Beryllium	200.	207.\	104\	80-120\20		12.05.03	
Boron	0.200	0.197\	98\	80-120\20		12.05.03	
Cadmium	200.	198.\	99\	80-120\20		12.05.03	
Calcium	20.0	19.9\	100\	80-120\20		12.05.03	
Chromium	200.	200.\	100\	80-120\20		12.05.03	
Copper	0.200	0.199\	100\	80-120\20		12.05.03	
Iron	2.00	2.08\	104\	80-120\20		12.05.03	
Lead	200.	194.\	97\	80-120\20		12.05.03	
Magnesium	20.0	19.6\	98\	80-120\20		12.05.03	
Manganese	0.200	0.198\	99\	80-120\20		12.05.03	
Nickel	200.	192.\	96\	80-120\20		12.05.03	
Potassium	22.0	21.1\	96\	80-120\20		12.05.03	
Silica, total	45.0	45.1\	100\	80-120\20		12.05.03	
Silver	100.	96.6\	97\	80-120\20		12.05.03	
Sodium	20.0	20.1\	100\	80-120\20		12.05.03	
Zinc	0.200	0.199\	100\	80-120\20		12.05.03	
QC BATCH: A031293UND							
Aluminum	40.0	J42.6\	106\	80-120\20		12.05.03	1
Antimony	20.0	20.7\	104\	75-125\20		12.05.03	
Arsenic	20.0	19.9\	100\	75-125\20		12.05.03	
Selenium	20.0	21.3\	106\	80-120\20		12.05.03	
Thallium	20.0	21.2\	106\	75-125\20		12.05.03	

1) A "J" flagged result indicates an estimated concentration above the Method Detection Limit (MDL) and below the RL/ML (Reporting Limit/Minimum Level). The 'J' flag is equivalent to the DNQ Estimated Concentration flag.

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LAB ORDER No.: D120046

LABORATORY CONTROL SAMPLE ANALYTICAL RESULTS

ANALYTE	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: I030049ALK							
ALKALINITY						12.05.03	
Bicarbonate as CaCO3	100.	96.\	96\	75-125\20			
Hydroxide as CaCO3		ND\		75-125\20			
Carbonate as CaCO3		ND\		75-125\20			
Total Alkalinity as CaCO3	100.	96.\	96\	75-125\20			
QC BATCH: I030056CON							
Electrical Conductance	1412.	1370.\	97\	75-125\20		12.09.03	
QC BATCH: I030207IC							
Chloride [1950]	10.0	11.2\	112\	75-125\20		12.16.03	
Fluoride [4825]	2.50	2.82\	113\	75-125\20		12.16.03	
Nitrate as N [5895]	6.25	7.00\	112\	75-125\20		12.16.03	
Sulfate [8025]	20.0	22.6\	113\	75-125\20		12.16.03	

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LAB ORDER No.: 0120046

DUPLICATE SAMPLES ANALYTICAL RESULTS

ANALYTE	R.L.	ORIGINAL RESULT	DUPLICATE RESULT	REL% DIFF	ACCEPT LIMIT	ANALYZED	NOTES
QC BATCH: B030340PH QC SAMPLE LAB NUMBER: D110001-30							
pH		9.95	9.95	0.0	20	12.01.03	
QC BATCH: I030049ALK QC SAMPLE LAB NUMBER: D110722-3							
ALKALINITY						12.05.03	
Bicarbonate as CaCO3	20.	300.	298.	0.7	20		
Hydroxide as CaCO3	20.	ND	ND	NC	20		
Carbonate as CaCO3	20.	ND	ND	NC	20		
Total Alkalinity as CaCO3	20.	300.	298.	0.7	20		
QC BATCH: I030056CON QC SAMPLE LAB NUMBER: D110786-3							
Electrical Conductance	10.	28.2	28.3	0.4	20	12.09.03	

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MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031290MER QC SAMPLE LAB NUMBER: D110821-1								
Mercury	ND	1.00	1.02\1.01	102\101	80-120\20	1	12.05.03	
QC BATCH: A031292UND QC SAMPLE LAB NUMBER: D120046-1								
Barium	ND	200.	192.\196.	96\98	80-120\20	2.1	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Beryllium	ND	200.	164.\165.	82\82	80-120\20	0.6	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Boron	J0.0694	0.200	0.244\0.249	88\90	80-120\20	2.0	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Cadmium	ND	200.	164.\164.	82\82	80-120\20	0.0	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Calcium	17.0	20.0	33.7\37.2	84\101	80-120\20	9.9	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Chromium	ND	200.	165.\166.	82\83	80-120\20	0.6	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Copper	ND	0.200	0.168\0.170	84\85	80-120\20	1.2	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Iron	ND	2.00	1.69\1.69	84\84	80-120\20	0.0	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Lead	ND	200.	162.\159.	81\80	80-120\20	1.9	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Magnesium	11.8	20.0	28.8\35.5	85\118	80-120\20	21.	12.05.03	1

1) MS/MSD RPD above control limits. LCS and MS/MSD recoveries are in control.

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MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031292UND (continued)								
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Manganese	ND	0.200	0.164\0.165	82\82	80-120\20	0.6	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Nickel	ND	200.	163.\162.	82\81	80-120\20	0.6	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Potassium	2.27	22.0	24.8\25.5	102\105	80-120\20	2.8	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Silica, total	41.9	45.0	79.4\89.4	83\106	80-120\20	12.	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Silver	ND	100.	83.0\83.0	83\83	80-120\20	0.0	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Sodium	39.1	20.0	58.1\63.0	95\120	80-120\20	8.1	12.05.03	
QC BATCH: A031292UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Zinc	ND	0.200	0.170\0.170	85\85	80-120\20	0.0	12.05.03	
QC BATCH: A031293UND QC SAMPLE LAB NUMBER: D120046-1								
Aluminum	ND	80.0	85.5\84.0	107\105	80-120\20	1.8	12.08.03	
QC BATCH: A031293UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Antimony	ND	20.0	21.6\20.5	108\102	75-125\20	5.2	12.05.03	
QC BATCH: A031293UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Arsenic	J0.536	20.0	24.2\22.5	118\110	75-125\20	7.3	12.05.03	

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MATRIX SPIKE ANALYTICAL RESULTS

ANALYTE	ORIGINAL RESULT	SPIKE AMOUNT	SPIKE\DUP RESULT	SPK\DUP %REC	ACCEPTANCE %REC \RPD	REL% DIFF	ANALYZED	NOTES
QC BATCH: A031293UND (continued)								
QC BATCH: A031293UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Selenium	J1.84	20.0	25.2\23.3	117\108	80-120\20	7.8	12.05.03	
QC BATCH: A031293UND (continued) QC SAMPLE LAB NUMBER: D120046-1								
Thallium	ND	20.0	20.3\19.5	102\98	75-125\20	4.0	12.05.03	
QC BATCH: I030207IC QC SAMPLE LAB NUMBER: D120567-1								
Chloride [1950]	217.	80.0	282.\298.	81\101	75-125\20	5.5	12.16.03	
QC BATCH: I030207IC (continued) QC SAMPLE LAB NUMBER: D120567-1								
Fluoride [4825]	0.51	20.0	22.3\23.4	109\114	75-125\20	4.8	12.16.03	
QC BATCH: I030207IC (continued) QC SAMPLE LAB NUMBER: D120567-1								
Nitrate as N [5895]	ND	50.0	61.8\62.4	124\125	75-125\20	1	12.16.03	
QC BATCH: I030207IC (continued) QC SAMPLE LAB NUMBER: D120567-1								
Sulfate [8025]	101.	160.	270.\284.	106\114	75-125\20	5.1	12.16.03	

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SAMPLE SUMMARY

Lab Order: H020233

Project ID: MARK WEST QUARRY

Lab ID	Sample ID	Matrix	Date Collected	Date Received
H020233001	**MARK WEST QUARRY**	Drinking Water	2/6/2007 14:00	2/6/2007 16:00

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NARRATIVE

Lab Order: H020233

Project ID: MARK WEST QUARRY

General Qualifiers and Notes

CALTEST authorizes this report to be reproduced only in its entirety. Results are specific to the sample(s) as submitted and only to the parameter(s) reported.

Caltest certifies that test results meet all applicable NELAC requirements unless stated otherwise.

All analyses performed by EPA Methods or Standard Methods (SM) 18th Ed. except where noted.

Caltest collects samples in compliance with 40 CFR, EPA Methods, Cal. Title 22, and Standard Methods.

Dilution Factors (DF) reported greater than '1' have been used to adjust the result, Reporting Limit (R.L.), and Method Detection Limit (MDL).

All Solid, sludge, and/or biosolids data is reported in Wet Weight, unless otherwise specified.

Results Qualifiers: Report fields may contain codes and non-numeric data correlating to one or more of the following definitions:

ND - Non Detect - indicates analytical result has not been detected.

RL - Reporting Limit is the quantitation limit at which the laboratory is able to detect an analyte with a certain level of confidence. Generally, this represents the laboratory's lowest calibration point.

J - reflects estimated analytical result value detected below the Reporting Limit (R.L.) and above the Method Detection Limit (MDL). The 'J' flag is equivalent to the DNQ Estimated Concentration flag.

E - indicates an estimated analytical result value.

B - indicates the analyte has been detected in the blank associated with the sample.

NC - means not able to be calculated for RPD or Spike Recoveries.

SS - compound is a Surrogate Spike used per laboratory quality assurance manual.

NOTE: This document represents a complete Analytical Report for the samples referenced herein and should be retained as a permanent record thereof.

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ANALYTICAL RESULTS

Lab Order: H020233

Project ID MARK WEST QUARRY

Lab ID:	**H020233001**	Date Collected:	2/6/2007 14:00	Matrix:	Drinking Water
Sample ID:	**MARK WEST QUARRY**	Date Received:	2/6/2007 16:00		

Parameters	Result	Units	R. L.	DF	Prepared	Batch	Analyzed	Batch	Qual
pH, Electrometric Analysis	**Analytical Method:**	EPA 150.1					**Analyzed by:** KMC		
pH	8.0	pH Units		1			02/07/07 00:00	BIO 3943	
Calculations	**Analytical Method:**	Calculation					**Analyzed by:** LM		
Hardness Calculation	98	mg/L		1			02/09/07 00:00	CALC	
Total Anions	4.6	meq/L		1			02/08/07 20:49	CALC	
Total Cations	4.2	meq/L		1			02/09/07 00:00	CALC	
Metals Analysis by ICP, Undigested	**Analytical Method:**	EPA 200.7					**Analyzed by:** LM		
Boron	ND	mg/L	0.10	1			02/09/07 00:00	MIC 2037	
Calcium	24	mg/L	0.50	1			02/09/07 00:00	MIC 2037	
Iron	ND	mg/L	0.10	1			02/09/07 00:00	MIC 2037	
Magnesium	9.4	mg/L	0.50	1			02/09/07 00:00	MIC 2037	
Manganese	0.032	mg/L	0.020	1			02/09/07 00:00	MIC 2037	
Potassium	2.3	mg/L	1.0	1			02/13/07 00:00	MIC 2037	
Silica (as SiO2)	58	mg/L	1.0	1			02/09/07 00:00	MIC 2037	
Sodium	52	mg/L	1.0	1			02/09/07 00:00	MIC 2037	
Zinc	0.17	mg/L	0.050	1			02/09/07 00:00	MIC 2037	
Metals Analysis by ICPMS, Undigested	**Analytical Method:**	EPA 200.8					**Analyzed by:** SMD		
Arsenic	ND	mg/L	0.002	1			02/09/07 15:36	MMS 3023	
Electrical Conductance Analysis	**Analytical Method:**	EPA 120.1					**Analyzed by:** AL		
Conductivity	430	umhos/cm	10	1			02/08/07 00:00	WET 3077	
Anions by Ion Chromatography	**Analytical Method:**	EPA 300.0					**Analyzed by:** MYS		
Chloride	15	mg/L	10	10			02/08/07 21:06	WIC 1597	
Fluoride	ND	mg/L	0.1	1			02/08/07 20:49	WIC 1597	
Nitrate, as NO3	ND	mg/L	2	1			02/08/07 20:49	WIC 1597	
Sulfate (as SO4)	56	mg/L	5	10			02/08/07 21:06	WIC 1597	
Alkalinity, Total by Standard Methods	**Analytical Method:**	SM20-2320 B					**Analyzed by:** EJP		
Alkalinity, Total (as CACO3)	150	mg/L	10	1			02/16/07 00:00	WTI 1331	
Bicarbonate (as HCO3)	180	mg/L	12	1			02/16/07 00:00	WTI 1331	
Carbonate (as CO3)	ND	mg/L	6.0	1			02/16/07 00:00	WTI 1331	
Hydroxide (as OH)	ND	mg/L	1.7	1			02/16/07 00:00	WTI 1331	

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QUALITY CONTROL DATA

Lab Order: H020233

Project ID: MARK WEST QUARRY

Analysis Description:	pH, Electrometric Analysis	**QC Batch:**	BIO/3943
Analysis Method:	EPA 150.1	**QC Batch Method:**	EPA 150.1

SAMPLE DUPLICATE: 139376

Parameter	Units	H020001006 Result	DUP Result	RPD	Max RPD	Qualifiers
pH	pH Units	6.8	6.82	0.3		

Analysis Description:		**QC Batch:**	CALC/
Analysis Method:	Calculation	**QC Batch Method:**	Calculation

Analysis Description:	Metals Analysis by ICP, Undigested	**QC Batch:**	MIC/2037
Analysis Method:	EPA 200.7	**QC Batch Method:**	EPA 200.7

METHOD BLANK: 138192

Parameter	Blank Result	Reporting Limit	Units	Qualifiers
Iron	ND	0.10	mg/L	
Magnesium	ND	0.50	mg/L	
Manganese	ND	0.020	mg/L	
Potassium	ND	1.0	mg/L	
Sodium	ND	1.0	mg/L	
Boron	ND	0.10	mg/L	
Zinc	ND	0.050	mg/L	
Calcium	ND	0.50	mg/L	
Silica (as SiO2)	ND	1.0	mg/L	

LABORATORY CONTROL SAMPLE: 138193

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Iron	mg/L	2	2.21236	111	80-120	
Magnesium	mg/L	20	19.82588	99	80-120	
Manganese	mg/L	0.2	0.20658	103	80-120	
Potassium	mg/L	22	21.05163	96	80-120	

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QUALITY CONTROL DATA

Lab Order: H020233

Project ID: MARK WEST QUARRY

Analysis Description:	Metals Analysis by ICP, Undigested	**QC Batch:**	MIC/2037
Analysis Method:	EPA 200.7	**QC Batch Method:**	EPA 200.7

LABORATORY CONTROL SAMPLE: 138193

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Sodium	mg/L	20	21.69351	108	80-120	
Boron	mg/L	0.2	0.20057	100	80-120	
Zinc	mg/L	0.2	0.20025	100	80-120	
Calcium	mg/L	20	20.24983	101	80-120	
Silica (as SiO2)	mg/L	43	45.45927	106	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 138194 138195

Parameter	Units	H020233001 Result	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Iron	mg/L	0	2	2.07404	2.07432	104	104	80-120	0	20	
Magnesium	mg/L	9.4	20	29.16655	29.13254	99	99	80-120	0.1	20	
Manganese	mg/L	0.032	0.2	0.22895	0.23045	99	99	80-120	0.7	20	
Potassium	mg/L	2.3	22	28.36944	27.81962	119	116	80-120	2	20	
Sodium	mg/L	52	20	73.98603	73.50517	110	108	80-120	0.7	20	
Boron	mg/L	0.1	0.2	0.30614	0.30892	103	105	80-120	0.9	20	
Zinc	mg/L	0.17	0.2	0.35527	0.35934	93	95	80-120	1.1	20	
Calcium	mg/L	24	20	43.03736	43.26961	97	98	80-120	0.5	20	
Silica (as SiO2)	mg/L	58	42.8	103.2931	102.9695	105	104	80-120	0.3	20	

Analysis Description:	Metals Analysis by ICPMS, Undigested	**QC Batch:**	MMS/3023
Analysis Method:	EPA 200.8	**QC Batch Method:**	EPA 200.8

METHOD BLANK: 138111

Parameter	Blank Result	Reporting Limit	Units	Qualifiers
Arsenic	ND	0.002	mg/L	

LABORATORY CONTROL SAMPLE: 138112

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Arsenic	ug/L	0.02	18.61	93	85-115	

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QUALITY CONTROL DATA

Lab Order: H020233

Project ID: MARK WEST QUARRY

Analysis Description:	Metals Analysis by ICPMS, Undigested	**QC Batch:**	MMS/3023
Analysis Method:	EPA 200.8	**QC Batch Method:**	EPA 200.8

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 138113 138114

Parameter	Units	H010984001 Result	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Arsenic	ug/L	0.008	20	26.793	24.542	95	84	85-115	8.8	20	2

Analysis Description:	Electrical Conductance Analysis	**QC Batch:**	WET/3077
Analysis Method:	EPA 120.1	**QC Batch Method:**	EPA 120.1

METHOD BLANK: 138041

Parameter	Blank Result	Reporting Limit	Units	Qualifiers
Conductivity	ND	10	umhos/c	

LABORATORY CONTROL SAMPLE: 138042

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Conductivity	umhos/c	1000	981.2	98	80-120	

SAMPLE DUPLICATE: 138043

Parameter	Units	H010984001 Result	DUP Result	RPD	Max RPD	Qualifiers
Conductivity	umhos/c	374.3	377.6	0.9		

Analysis Description:	Anions by Ion Chromatography	**QC Batch:**	WIC/1597
Analysis Method:	EPA 300.0	**QC Batch Method:**	EPA 300.0

METHOD BLANK: 139887

Parameter	Blank Result	Reporting Limit	Units	Qualifiers
Chloride	ND	1	mg/L	
Fluoride	ND	0.1	mg/L	
Nitrate, as NO3	ND	2	mg/L	
Sulfate (as SO4)	ND	0.5	mg/L	

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QUALITY CONTROL DATA

Lab Order: H020233

Project ID: MARK WEST QUARRY

Analysis Description:	Anions by Ion Chromatography	**QC Batch:**	WIC/1597
Analysis Method:	EPA 300.0	**QC Batch Method:**	EPA 300.0

LABORATORY CONTROL SAMPLE: 139888

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	10	9.823	98	90-110	
Fluoride	mg/L	2.5	2.462	98	90-110	
Nitrate, as NO3	mg/L	28	27.06287	98	90-110	
Sulfate (as SO4)	mg/L	20	19.699	98	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 139890 139891

Parameter	Units	H020214001 Result	Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limit	RPD	Max RPD	Qualifiers
Chloride	mg/L	110	8	165.556	166.204	661	669	90-110	0.4	20	3
Fluoride	mg/L	0.52	2	2.623	2.757	105	112	90-110	5	20	3
Nitrate, as NO3	mg/L	84	22.2	137.3477	137.8261	241	243	90-110	0.3	20	3
Sulfate (as SO4)	mg/L	89	16	134.337	134.498	286	287	90-110	0.1	20	3

Analysis Description:	Alkalinity, Total by Standard Methods	**QC Batch:**	WTI/1331
Analysis Method:	SM20-2320 B	**QC Batch Method:**	SM20-2320 B

METHOD BLANK: 140125

Parameter	Blank Result	Reporting Limit	Units	Qualifiers
Alkalinity, Total (as CACO3)	ND	10	mg/L	
Carbonate (as CO3)	ND	6.0	mg/L	
Bicarbonate (as HCO3)	ND	12	mg/L	
Hydroxide (as OH)	ND	1.7	mg/L	

LABORATORY CONTROL SAMPLE: 140126

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Alkalinity, Total (as CACO3)	mg/L	100	97	97	80-120	
Carbonate (as CO3)			0			
Bicarbonate (as HCO3)	mg/L	120	118.34	97	80-120	
Hydroxide (as OH)			0			

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QUALITY CONTROL DATA

Lab Order: H020233

Project ID: MARK WEST QUARRY

Analysis Description:	Alkalinity, Total by Standard Methods	**QC Batch:**	WTI/1331
Analysis Method:	SM20-2320 B	**QC Batch Method:**	SM20-2320 B

SAMPLE DUPLICATE: 140127

Parameter	Units	H020220001 Result	DUP Result	RPD	Max RPD	Qualifiers
Alkalinity, Total (as CACO3)	mg/L	78	78	0		
Carbonate (as CO3)	mg/L	0	0	0		
Bicarbonate (as HCO3)	mg/L	95.16	95.16	0		
Hydroxide (as OH)	mg/L	0	0	0		

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QUALITY CONTROL DATA QUALIFIERS

Lab Order: H020233

Project ID: MARK WEST QUARRY

QUALITY CONTROL PARAMETER QUALIFIERS

Results Qualifiers: Report fields may contain codes and non-numeric data correlating to one or more of the following definitions:

NS - means not spiked and will not have recoveries reported for Analyte Spike Amounts

NC - means not able to be calculated for RPD or Spike Recoveries.

QC Codes Keys: These descriptors are used to help identify the specific QC samples and clarify the report.

MB - Method Blank

LCS/LCSD - Laboratory Control Spike / Laboratory Control Spike Duplicate

DUP - Duplicate of Original Sample Matrix

MS/MSD - Matrix Spike / Matrix Spike Duplicate

RPD - Relative Percent Difference

%Recovery - Spike Recovery stated as a percentage

1 Sample reanalyzed/confirmed out of holdtime.

2 Low Matrix Spike recovery(ies) due to possible matrix interferences in the QC sample. QC batch accepted based on LCS and RPD results.

3 High Matrix Spike recovery(ies) due to possible matrix interferences in the QC sample. QC batch accepted based on LCS and RPD results.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Lab Order: H020233

Project ID: MARK WEST QUARRY

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
H020233001	**MARK WEST QUARRY**	EPA 150.1	BIO/3943		
H020233001	**MARK WEST QUARRY**	Calculation	CALC/	Calculation	CALC/
H020233001	**MARK WEST QUARRY**	EPA 200.7	MIC/2037		
H020233001	**MARK WEST QUARRY**	EPA 200.8	MMS/3023		
H020233001	**MARK WEST QUARRY**	EPA 120.1	WET/3077		
H020233001	**MARK WEST QUARRY**	EPA 300.0	WIC/1597		
H020233001	**MARK WEST QUARRY**	SM20-2320 B	WTI/1331		

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Caltest ANALYTICAL LABORATORY

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SAMPLE CHAIN OF CUSTODY

PAGE ______ OF ______

LAB ORDER #: H020233

PROJECT # / PROJECT NAME: Mark West Quarry

P.O. #:

CLIENT: Balance Hydrologics

REPORT TO:

ADDRESS: 841 Folger Ave CITY: Berkeley STATE: CA ZIP: 94710

BILLING ADDRESS: same

PHONE #: 510-704-1000 FAX PHONE: 510-704-1001 SAMPLER (PRINT & SIGN NAME): Mark Woyshner

ANALYSES REQUESTED: Homeowner #2; Potassium

TURN-AROUND TIME: ☐ STANDARD ☐ RUSH

DUE DATE: ______

REV. 11/03

CALTEST #	DATE SAMPLED	TIME SAMPLED	MATRIX	CONTAINER AMOUNT/TYPE	PRESERVATIVE	SAMPLE IDENTIFICATION SITE	CLIENT LAB #	COMP. or GRAB	Homeowner #2	Potassium					REMARKS
	2/6/07	14:00	H_2O	500 mL	HNO_3	Mark West Quarry			✓	✓					
	2/6/07	14:00	H_2O	1 L	no	Mark West Quarry			✓	✓					

By submittal of sample(s), client agrees to abide by the Terms and Conditions set forth on the reverse of this document.

RELINQUISHED BY	DATE/TIME	RECEIVED BY	RELINQUISHED BY	DATE/TIME	RECEIVED BY
Mark Woyshner (signature)	2/6/07 1600	(signature)			

FOR LAB USE ONLY

Samples: WC_____ MICRO_____ BIO_____ AA_____ SV_____ VOA_____ TEMP:_____ SEALED: Y___ / N___ INTACT: Y___ / N___

BD: BIO_____ WC_____ AA_____

CC: AA_____ SV_____ VOA_____

SIL: HP_____ PT_____ QT_____ VOA_____

W/HNO_3_____ H_2SO_4_____ NaOH_____

PIL: HNO_3_____ H_2SO_4_____ NaOH_____ HCL_____

COMMENTS

MATRIX: AQ = Aqueous Nondrinking Water, Digested Metals; FE = Low R.L.s, Aqueous Nondrinking Water, Digested Metals; DW = Drinking Water; SL = Soil, Sludge, Solid; FP = Free Product

CONTAINER TYPES: AL = Amber Liter; AHL = 500 ml Amber; PT = Pint (Plastic); QT=Quart (Plastic); HG = Half Gallon (Plastic); SJ = Soil Jar; B4 = 4 oz. BACT; BT = Brass Tube; VOA = 40 mL.VOA; OTC = Other Type Container

R_____ PR_____ M_____ F_____

WHITE - LABORATORY YELLOW - CLIENT COPY TO ACCOMPANY FINAL REPORT PINK - CLIENT COPY AS RECEIPT

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
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SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227
Attn: Mark Woyshner

Work Order #: 1070611
Reporting Date: July 29, 2011

Date Received:	July 22, 2011
Project # / Name:	211046 / Mark West Quarry
Water System #:	NA
Sample Identification:	Well Below Sub-Drain A, sampled 7/21/2011 10:15:00AM
Sampler Name / Co.:	Mark Woyshner / Balance Hydrologics
Matrix:	Water
Laboratory #:	1070611-01

	Results	Units	RL	State Drinking Water Limits 1	Analysis Method	Date Analyzed	Flags
General Mineral							
pH	7.6	pH Units	0.1	-	EPA 150.1	07/22/11	
Specific Conductance (EC)	380	uS/cm	1.0	1600	SM2510B	07/22/11	
Hydroxide as OH	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Carbonate as CO3	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Bicarbonate as HCO3	250	mg/L	2.0	-	SM 2320B	07/22/11	
Total Alkalinity as CaCO3	200	mg/L	2.0	-	SM 2320B	07/22/11	
Hardness	120	mg/L	5.0	-	SM 2340 B	07/26/11	
Total Dissolved Solids	240	mg/L	10	1000	SM2540C	07/27/11	
Nitrate as NO3	ND	mg/L	1.0	45	EPA 300.0	07/22/11	
Chloride	4.8	mg/L	1.0	500	EPA 300.0	07/22/11	
Sulfate as SO4	6.2	mg/L	1.0	500	EPA 300.0	07/22/11	
Fluoride	0.11	mg/L	0.10	2	EPA 300.0	07/22/11	
Calcium	31	mg/L	0.50	-	EPA 200.7	07/26/11	
Magnesium	9.1	mg/L	0.50	-	EPA 200.7	07/26/11	
Potassium	0.94	mg/L	0.50	-	EPA 200.7	07/26/11	
Sodium	34	mg/L	0.50	-	EPA 200.7	07/26/11	
Iron	ND	ug/L	50	300	EPA 200.7	07/26/11	
* Manganese	56	ug/L	20	50	EPA 200.7	07/26/11	
Copper	ND	ug/L	50	1000	EPA 200.7	07/26/11	
Zinc	ND	ug/L	50	5000	EPA 200.7	07/26/11	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.
State Drinking Water Limits1 - as listed by California Administrative Code, Title 22.
* - a * in the left hand margin of the report means that particular constituent is above the California Drinking Water Limits.

Mike Galloway

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

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FAX: 831-724-3188

Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227
Attn: Mark Woyshner

Work Order #: 1070611
Reporting Date: July 29, 2011

Date Received: July 22, 2011
Project # / Name: 211046 / Mark West Quarry
Water System #: NA
Sample Identification: 4500 Porter Creek Rd. Well, sampled 7/21/2011 11:00:00AM
Sampler Name / Co.: Mark Woyshner / Balance Hydrologics
Matrix: Water
Laboratory #: 1070611-02

	Results	Units	RL	State Drinking Water Limits [1]	Analysis Method	Date Analyzed	Flags
General Mineral							
pH	7.5	pH Units	0.1	-	EPA 150.1	07/22/11	
Specific Conductance (EC)	500	uS/cm	1.0	1600	SM2510B	07/22/11	
Hydroxide as OH	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Carbonate as CO3	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Bicarbonate as HCO3	310	mg/L	2.0	-	SM 2320B	07/22/11	
Total Alkalinity as CaCO3	250	mg/L	2.0	-	SM 2320B	07/22/11	
Hardness	200	mg/L	5.0	-	SM 2340 B	07/26/11	
Total Dissolved Solids	300	mg/L	10	1000	SM2540C	07/27/11	
Nitrate as NO3	ND	mg/L	1.0	45	EPA 300.0	07/22/11	
Chloride	4.7	mg/L	1.0	500	EPA 300.0	07/22/11	
Sulfate as SO4	21	mg/L	1.0	500	EPA 300.0	07/22/11	
Fluoride	0.14	mg/L	0.10	2	EPA 300.0	07/22/11	
Calcium	45	mg/L	0.50	-	EPA 200.7	07/26/11	
Magnesium	22	mg/L	0.50	-	EPA 200.7	07/26/11	
Potassium	1.2	mg/L	0.50	-	EPA 200.7	07/26/11	
Sodium	26	mg/L	0.50	-	EPA 200.7	07/26/11	
Iron	ND	ug/L	50	300	EPA 200.7	07/26/11	
Manganese	ND	ug/L	20	50	EPA 200.7	07/26/11	
Copper	ND	ug/L	50	1000	EPA 200.7	07/26/11	
Zinc	ND	ug/L	50	5000	EPA 200.7	07/26/11	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.
State Drinking Water Limits[1] - as listed by California Administrative Code, Title 22.
* - a * in the left hand margin of the report means that particular constituent is above the California Drinking Water Limits.

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Balance Hydrologics Inc.
800 Bancroft Way, Suite 101
Berkeley, CA 94710-2227
Attn: Mark Woyshner

Work Order #: 1070611
Reporting Date: July 29, 2011

Date Received: July 22, 2011
Project # / Name: 211046 / Mark West Quarry
Water System #: NA
Sample Identification: 4512 Porter Creek Rd. Well, sampled 7/21/2011 11:15:00AM
Sampler Name / Co.: Mark Woyshner / Balance Hydrologics
Matrix: Water
Laboratory #: 1070611-03

	Results	Units	RL	State Drinking Water Limits 1	Analysis Method	Date Analyzed	Flags
General Mineral							
pH	7.8	pH Units	0.1	-	EPA 150.1	07/22/11	
Specific Conductance (EC)	480	uS/cm	1.0	1600	SM2510B	07/22/11	
Hydroxide as OH	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Carbonate as CO3	ND	mg/L	2.0	-	SM 2320B	07/22/11	
Bicarbonate as HCO3	310	mg/L	2.0	-	SM 2320B	07/22/11	
Total Alkalinity as CaCO3	250	mg/L	2.0	-	SM 2320B	07/22/11	
Hardness	180	mg/L	5.0	-	SM 2340 B	07/26/11	
Total Dissolved Solids	300	mg/L	10	1000	SM2540C	07/27/11	
Nitrate as NO3	ND	mg/L	1.0	45	EPA 300.0	07/22/11	
Chloride	5.6	mg/L	1.0	500	EPA 300.0	07/22/11	
Sulfate as SO4	10	mg/L	1.0	500	EPA 300.0	07/22/11	
Fluoride	0.16	mg/L	0.10	2	EPA 300.0	07/22/11	
Calcium	36	mg/L	0.50	-	EPA 200.7	07/26/11	
Magnesium	22	mg/L	0.50	-	EPA 200.7	07/26/11	
Potassium	0.65	mg/L	0.50	-	EPA 200.7	07/26/11	
Sodium	30	mg/L	0.50	-	EPA 200.7	07/26/11	
Iron	ND	ug/L	50	300	EPA 200.7	07/26/11	
Manganese	46	ug/L	20	50	EPA 200.7	07/26/11	
Copper	ND	ug/L	50	1000	EPA 200.7	07/26/11	
Zinc	95	ug/L	50	5000	EPA 200.7	07/26/11	

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State Drinking Water Limits1 - as listed by California Administrative Code, Title 22.
* - a * in the left hand margin of the report means that particular constituent is above the California Drinking Water Limits.

Mike Galloway

1070611

SOIL CONTROL LAB CHAIN-OF-CUSTODY

COMPANY NAME: Balance Hydrologics
ATTN: Mark Woyshner
ADDRESS: 800 Bancroft Way Suite 101
Berkeley, CA 94710
PHONE: 510-704-1000 x 209
FAX: 510-704-1001
PROJECT NAME: Mark West Quarry
PROJECT NUMBER: 211046

COMMENTS / SPECIAL INSTRUCTIONS:

SEND INVOICE TO: Rachel Boitano
P.O. / CONTRACT NO: 211046

ANALYSIS(ES) REQUESTED: GENERAL MINERAL

Soil Control Lab
42 Hangar Way
Watsonville, CA 95076
PHONE: 831/724-5422
FAX: 831/724-3188

LAB USE ONLY:
STORAGE LOCATION
FREEZER #:
REFRIGERATOR #:

Lab Use Only: ID Number	Client Sample Identification	Sampling Date	Sampling Time	Sample Type	Sample Preservative	Bottle Type:	Bottle Size:	No. of Bottles:	GENERAL MINERAL
	~~Well below Subdrain~~						~~1~~		
01	Well below	20110721	10:15	Water	none	PVC	1L	1	✓
	Subdrain A	"	"	"	HNO3	"	16oz	1	✓
02	4500 Porter	20110721	11:00	Water	none	PVC	1L	1	✓
	Creek Rd Well	"	"	"	HNO3	"	16oz	1	✓
03	4512 Porter	20110721	11:15	Water	none	PVC	1L	1	✓
	Creek Rd Well	"	"	"	HNO3	"	16oz	1	✓

CHECK THE APPROPRIATE BOX

Balance Hydrologics, Inc.
Mark Woyshner
Principal / Hydrologist / Hydrogeologist
101 Lucas Valley Road • Suite 229 • San Rafael, CA 94901
(510) 704-1000 Ext. 209 • (tel) (415) 472-7584 • (fax) (415) 472-7594
email: mwoyshner@balancehydro.com • balancehydro.com

SAMPLER'S SIGNATURE AND PRINTED NAME:

RELINQUISHED BY (SIGNATURE AND PRINTED NAME):	RECEIVED BY (SIGNATURE AND PRINTED NAME):	DATE:	TIME:
[signature] Mark Woyshner	[signature] Susan Ussler	07/22/11	09:40

fed ex
8°C

APPENDIX C

Water-quality data from prior investigations

Table 3

General Mineral Analyses of Selected Wells, Springs, and Surface Sources West-Central Marin County[a]

Source	Location	Date	Analyst	EC	pH	Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3-N	F	Fe	Mn	TDS
Nicasio Valley Groundwaters																	
Spring	Rawnsley "Main Spring"	8/9/79	LFE	240	7.4	26	5.3	10	-	78	9.2	10	2.6	0.12	1.0	0.046	120
Spring	Rawnsley "Home Spring"	5/1/78	NMCWD	220	7.5	34	16	16	-	129	10	8	1.25	-	0.14	0.02	-
Well	150 Road to Ranches	5/25/78	NMCWD	175	7.4	21	7	7	-	76	-	6	0.51	-	0.14	0.02	-
Well	800 Old Rancheria Rd.	8/21/78	NMCWD	-	6.54	15	18	19	-	98	11	25	0.11	-	4.48	0.20	287
Well	do		NMCWD	-	7.67	28	13	34	-	168	15	28	0.17	-	0.68	0.15	274
Other Waters Emanating From Meta-Volcanic Sources																	
Spring	Deadmans Springs[b] (Samuel P. Taylor State Park)	5/14/65	USGS	282	7.9	29	13	11	0.4	142	9.0	11	1.5	0.3	0.031	0.009	175
Spring	Crystal Spring[c] (Samuel P. Taylor State Park)	5/13/65	USGS	293	7.4	25	16	11	0.3	151	7.0	16	0.4	0.1	0.007	-	175

[a]All constituents expressed in mg/l, with the exception of EC (µmhos/cm) and pH (units).

[b]Other trace elements analyzed: As=0.00, Sr=0.0, Li=0.03, B=0.1, Al=0.030, Ni-0.001, Ti=0.001, V=0.014 mg/l. Mo not detected.

[c]Other tract elements analyzed: As=0.00, Sr=0.0, Li-0.03, B=0.0, Al-0.006, Ni-0.0004, V-0.006 mg/l. Mo not detected.

Source table: Hecht 1979

APPENDIX D

Regional rainfall record (Santa Rosa)

Monthly rainfall (inches) at Santa Rosa, CA.

Latitude N38:26:42, Longitude W122:45:11, Elevation 109 ft.

Sonoma County Station SRO

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% MEAN
1905	--	--	--	5.53	4.26	5.59	1.45	2.93	0.00	0.00	0.00	0.00	--	
1906	0.00	1.97	1.81	10.95	5.24	7.95	0.72	3.31	1.23	0.00	0.00	0.16	33.34	110%
1907	0.00	1.88	6.79	7.57	5.17	11.21	0.34	0.32	1.00	0.00	0.00	0.46	34.74	115%
1908	0.87	0.13	6.30	5.61	4.88	1.45	0.30	0.85	0.08	0.02	0.00	0.00	20.49	68%
1909	1.37	2.12	4.00	18.45	8.74	3.98	0.00	0.00	0.07	0.00	0.00	1.29	40.02	133%
1910	1.73	4.53	7.61	4.94	3.75	4.17	0.85	0.08	0.05	0.00	0.00	0.01	27.72	92%
1911	0.68	1.76	1.68	14.20	2.75	4.96	3.04	0.44	0.02	0.00	0.00	0.00	29.53	98%
1912	0.58	0.72	2.41	3.39	1.09	4.69	1.54	2.88	1.14	0.00	0.00	2.99	21.43	71%
1913	1.47	5.11	1.78	6.11	0.58	2.73	1.91	1.28	0.05	0.07	0.00	0.00	21.09	70%
1914	0.00	7.50	11.15	14.00	5.60	1.49	1.66	0.95	0.41	0.00	0.00	0.07	42.83	142%
1915	1.91	1.30	7.23	9.08	13.52	3.98	0.65	4.82	0.00	0.00	0.00	0.00	42.49	141%
1916	0.20	1.71	8.34	15.20	3.53	1.89	0.00	0.65	0.06	0.61	0.32	0.32	32.83	109%
1917	1.17	2.68	5.92	2.37	5.15	1.22	2.52	0.14	0.02	0.00	0.00	0.33	21.52	71%
1918	0.00	1.49	2.25	1.43	7.06	4.73	0.86	0.03	0.00	0.00	0.03	2.52	20.40	68%
1919	1.04	3.96	2.55	5.59	8.52	2.30	0.50	0.20	0.00	0.00	0.00	0.58	25.24	84%
1920	0.25	0.30	4.35	0.40	1.35	3.06	2.46	0.00	0.50	0.06	0.00	0.10	12.83	43%
1921	3.00	7.78	8.65	9.60	1.83	2.74	0.75	1.19	0.00	0.00	0.00	0.15	35.69	118%
1922	0.63	2.03	8.78	1.10	6.81	3.66	0.25	0.52	0.06	0.00	0.00	0.00	23.84	79%
1923	2.79	4.92	10.84	2.27	1.14	0.05	5.24	0.22	0.44	0.00	0.22	1.78	29.91	99%
1924	0.50	0.48	1.25	4.50	5.58	0.83	0.43	0.33	0.01	0.01	0.01	0.01	13.94	46%
1925	4.34	2.35	7.33	1.88	14.42	3.93	1.77	5.11	0.01	0.07	0.01	1.17	42.39	140%
1926	0.19	3.53	1.53	8.84	6.88	0.25	9.58	0.40	0.00	0.02	0.03	0.02	31.27	104%
1927	1.37	12.64	2.91	6.82	10.93	3.68	3.47	0.43	0.40	0.01	0.01	0.01	42.68	141%
1928	1.98	7.48	3.71	3.10	3.52	6.96	1.97	0.18	0.00	0.00	0.00	0.00	28.90	96%
1929	0.34	4.28	5.02	1.48	2.10	2.10	1.30	0.13	2.48	0.00	0.00	0.00	19.23	64%
1930	0.04	0.00	12.47	5.40	3.91	2.53	1.53	0.62	0.00	0.00	0.00	0.44	26.94	89%
1931	0.87	1.40	0.62	6.52	1.87	2.94	0.49	0.90	0.67	0.00	0.00	0.00	16.28	54%
1932	1.40	2.27	11.29	3.45	1.49	1.21	1.43	1.65	0.00	0.00	0.00	0.00	24.19	80%
1933	0.08	1.69	4.06	6.40	1.51	4.64	0.12	2.23	0.00	0.02	0.00	0.17	20.92	69%
1934	2.02	0.00	8.14	1.75	4.69	1.13	0.73	1.39	1.00	0.00	0.00	0.03	20.88	69%
1935	2.28	5.19	3.45	7.36	3.50	6.31	6.87	0.00	0.00	0.00	0.12	0.23	35.31	117%
1936	1.02	1.47	3.09	7.77	11.81	1.58	1.86	0.61	0.80	0.00	0.03	0.00	30.04	100%
1937	0.22	0.02	2.90	4.92	8.59	6.31	1.87	0.19	1.28	0.05	0.00	0.00	26.35	87%
1938	1.03	7.47	5.40	4.77	9.66	8.03	2.45	0.06	0.00	0.02	0.00	0.38	39.27	130%
1939	2.18	2.22	2.14	3.36	1.61	2.41	0.14	1.12	0.00	0.00	0.00	0.08	15.26	51%
1940	0.52	0.46	2.88	10.87	12.31	7.14	1.84	1.96	0.07	0.00	0.00	0.50	38.55	128%
1941	1.82	2.59	13.56	11.02	8.22	5.59	6.71	1.84	0.30	0.00	0.00	0.13	51.78	172%
1942	1.53	2.98	9.12	6.50	8.65	3.78	5.58	1.67	0.00	0.02	0.00	0.15	39.98	132%
1943	1.23	5.75	5.80	9.28	2.73	4.85	2.67	0.05	0.00	0.03	0.00	0.00	32.39	107%
1944	0.68	1.16	2.38	5.07	7.66	2.25	2.15	1.58	0.28	0.00	0.00	0.02	23.23	77%
1945	2.45	5.90	4.22	3.13	4.92	5.82	0.33	1.39	0.00	0.00	0.00	0.00	28.16	93%
1946	2.91	4.23	10.37	2.32	2.98	2.20	0.10	0.47	0.00	0.20	0.00	0.06	25.84	86%
1947	0.28	4.08	3.66	0.76	3.82	4.94	0.65	0.40	1.63	0.00	0.00	0.00	20.22	67%
1948	5.28	1.55	1.22	4.18	1.51	5.57	7.61	1.03	0.25	0.06	0.00	0.13	28.39	94%
1949	0.85	1.87	4.67	1.39	3.32	6.83	0.08	0.74	0.00	0.05	0.04	0.02	19.86	66%
1950	0.02	2.12	2.79	10.12	5.15	3.29	1.31	0.56	0.06	0.00	0.00	0.00	25.42	84%
1951	3.46	7.19	9.38	5.14	2.84	1.25	1.27	1.48	0.00	0.00	0.01	0.04	32.06	106%
1952	2.68	6.26	8.01	10.19	2.88	4.62	0.84	0.57	1.38	0.04	0.00	0.05	37.52	124%
1953	0.08	2.73	14.72	6.74	0.08	3.17	3.91	0.57	0.97	0.00	0.17	0.00	33.14	110%
1954	1.31	4.64	0.96	7.80	3.19	5.74	3.23	0.37	0.26	0.00	1.35	0.00	28.85	96%
1955	0.90	5.64	4.43	3.63	1.22	0.60	3.68	0.01	0.00	0.00	0.00	0.45	20.56	68%
1956	0.51	3.28	17.89	11.78	6.15	0.31	2.48	1.28	0.10	0.00	0.00	0.17	43.95	146%
1957	2.28	0.23	0.38	3.85	5.57	2.49	2.32	3.93	0.08	0.00	0.00	2.16	23.29	77%
1958	6.16	0.93	3.99	7.18	11.94	6.87	5.43	0.45	0.44	0.01	0.01	0.03	43.44	144%
1959	0.15	0.29	1.96	7.75	6.24	1.60	0.25	0.16	0.00	0.00	0.00	3.16	21.56	71%
1960	0.14	0.08	1.80	5.65	8.46	6.05	1.38	0.80	0.00	0.00	0.00	0.01	24.37	81%
1961	0.74	3.81	4.50	5.22	3.29	4.60	1.07	0.77	0.16	0.00	0.03	0.57	24.76	82%
1962	0.17	2.88	3.93	2.02	8.79	4.34	0.51	0.06	0.00	0.00	0.08	0.36	23.14	77%
1963	9.47	0.95	4.64	3.75	4.22	4.94	6.57	0.66	0.00	0.00	0.01	0.09	35.30	117%
1964	2.61	7.53	0.81	5.19	0.33	1.97	0.33	0.40	1.10	0.00	0.02	0.00	20.29	67%
1965	2.31	6.12	8.64	6.63	1.24	0.97	5.04	0.00	0.00	0.01	0.50	0.00	31.46	104%
1966	0.23	6.11	3.74	8.62	3.30	0.97	1.31	0.21	0.13	0.00	0.12	0.35	25.09	83%

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% MEAN
1967	0.01	7.61	6.55	12.42	0.58	5.86	6.72	0.17	1.94	0.00	0.00	0.07	41.93	139%
1968	0.86	2.68	4.01	7.63	4.82	4.20	0.48	0.26	0.00	0.00	1.68	0.02	26.64	88%
1969	2.07	7.16	9.00	13.25	8.23	1.79	3.23	0.03	0.04	0.00	0.00	0.03	44.83	149%
1970	2.42	1.19	11.79	15.89	2.89	3.44	0.07	0.00	0.44	0.00	0.00	0.00	38.13	126%
1971	2.24	8.97	10.78	3.13	0.19	4.05	1.22	0.24	0.05	0.00	0.03	0.34	31.24	103%
1972	0.49	2.39	5.49	1.89	3.49	1.02	1.79	0.09	0.13	0.05	0.11	0.66	17.60	58%
1973	3.47	6.87	5.12	15.38	7.17	3.48	0.65	0.03	0.00	0.00	0.00	0.74	42.91	142%
1974	2.37	13.23	5.33	6.48	3.54	6.67	2.87	0.09	0.00	1.61	0.00	0.00	42.19	140%
1975	1.27	1.20	3.80	1.98	9.88	7.84	1.71	0.02	0.10	0.00	0.21	0.02	28.03	93%
1976	6.44	1.58	0.89	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	16.92	56%
1977	0.46	1.76	1.15	2.01	1.93	2.65	0.23	1.43	0.00	0.00	0.00	1.16	12.78	42%
1978	0.65	0.03	5.22	9.81	7.60	5.30	2.29	0.08	0.00	0.00	0.00	1.38	32.36	107%
1979	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1980	4.14	5.99	7.71	7.09	8.82	1.52	2.00	0.19	0.27	0.00	0.00	0.00	37.73	125%
1981	*0.38*	*0.50*	*6.60*	*7.81*	*2.60*	*3.58*	*0.20*	*0.63*	*0.00*	*0.02*	*0.00*	*0.24*	22.56	75%
1982	*2.76*	*8.91*	*11.29*	*8.72*	*5.23*	*6.50*	*4.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.97*	48.41	160%
1983	4.30	8.44	3.61	8.39	9.83	*15.74*	3.46	0.92	0.00	0.00	0.75	0.24	55.68	184%
1984	1.20	11.21	11.33	0.65	2.45	2.25	1.18	0.11	0.13	0.00	0.17	0.09	30.77	102%
1985	2.36	10.92	2.60	1.87	3.01	4.61	0.20	0.04	0.02	0.03	0.00	1.04	26.70	88%
1986	1.06	4.57	3.24	6.45	14.14	5.90	0.83	0.82	0.00	0.00	0.00	2.75	39.76	132%
1987	0.55	0.20	2.65	4.83	5.45	4.83	0.15	0.01	0.00	0.00	0.00	0.00	18.67	62%
1988	1.37	4.45	6.11	6.99	0.40	0.02	1.53	0.73	0.49	0.00	0.00	0.00	22.09	73%
1989	0.11	4.89	4.07	1.47	1.53	10.22	1.22	0.13	0.22	0.00	0.04	2.72	26.62	88%
1990	2.65	1.71	0.00	5.74	3.27	2.03	0.24	5.46	0.01	0.00	0.00	0.27	21.38	71%
1991	0.62	0.44	1.16	0.75	4.72	13.74	0.33	0.13	0.72	0.00	0.05	0.01	22.67	75%
1992	1.74	1.15	2.91	2.03	9.34	4.69	1.64	0.00	0.79	0.00	0.00	0.00	24.29	80%
1993	3.65	0.31	8.73	11.48	5.58	3.44	1.60	1.43	1.06	0.00	0.00	0.00	37.28	124%
1994	3.28	3.39	4.12	3.55	5.27	0.32	1.57	0.84	0.00	0.00	0.00	0.04	22.38	74%
1995	1.02	7.21	4.56	19.99	1.14	13.40	3.43	0.86	0.63	0.00	0.00	0.00	52.24	173%
1996	0.23	0.14	9.38	9.93	9.52	2.75	3.59	3.75	0.00	0.00	0.00	0.00	39.29	130%
1997	0.71	3.88	12.40	11.66	0.41	1.20	1.12	1.11	0.42	0.00	0.98	0.40	34.29	114%
1998	1.58	8.93	3.65	11.17	19.76	3.56	2.25	2.90	0.00	0.00	0.00	0.03	53.83	178%
1999	1.20	7.00	1.06	4.75	12.34	4.31	2.20	0.08	0.13	0.00	0.00	0.03	33.10	110%
2000	0.98	4.39	0.43	5.09	12.74	2.68	2.15	1.21	0.22	0.00	0.00	0.41	30.30	100%
2001	2.32	1.65	1.00	5.64	6.62	1.94	1.04	0.00	0.33	0.00	0.00	0.09	20.63	68%
2002	1.18	12.09	12.29	6.42	1.66	2.08	0.61	1.13	0.00	0.00	0.00	0.00	37.46	124%
2003	0.00	3.48	16.18	3.63	2.18	2.24	4.78	1.48	0.05	0.03	0.01	0.07	34.13	113%
2004	0.04	3.19	11.42	3.44	9.29	1.14	0.68	*0.03*	*0.00*	*0.02*	*0.01*	*0.11*	29.37	97%
2005	3.27	1.81	10.46	4.12	4.29	5.74	1.61	5.55	0.95	0.00	0.02	0.00	37.82	125%
2006	1.00	2.47	17.65	5.36	3.63	10.03	5.05	0.49	0.02	0.02	0.00	0.00	45.72	151%
2007	0.57	3.58	5.46	0.49	7.07	0.28	2.58	*0.36*	*0.00*	0.17	0.00	0.05	20.61	68%
2008	3.26	0.81	5.06	10.21	3.09	0.32	0.30	0.03	0.00	0.00	0.00	0.03	23.11	77%
2009	0.80	1.94	3.26	0.63	7.97	2.77	0.49	3.10	0.06	0.00	0.00	0.16	21.18	70%
2010	3.34	1.05	3.34	8.88	3.84	3.70	4.29	2.68	0.11	0.01	0.01	0.10	31.35	104%
2011	5.14	3.13	8.38	1.68	5.71	10.44	0.66	2.41	*1.51*				39.06	129%
Mean	1.60	3.66	5.71	6.26	5.28	4.01	1.99	0.95	0.28	0.03	0.08	0.35	30.18	
Cumulative	1.60	5.26	10.97	17.22	22.50	26.51	28.50	29.45	29.73	29.76	29.84	30.19	--	
Maximum	9.47	13.23	17.89	19.99	19.76	15.74	9.58	5.55	2.48	1.61	1.68	3.16	55.68	
Minimum	0.00	0.00	0.00	0.39	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	12.78	
Sta. Dev.	1.599	3.102	4.041	4.160	3.761	2.983	1.903	1.234	0.477	0.169	0.254	0.680	9.591	
Skew	1.933	1.064	0.933	0.885	1.058	1.455	1.584	2.055	2.223	8.432	4.554	2.753	0.494	
Kurtosis	5.535	0.669	0.386	0.687	1.242	2.896	2.571	4.168	5.194	76.376	22.225	7.253	-0.327	
Sample Size	105	105	105	106	106	106	106	106	106	105	105	105	105	

Notes: 1. *Italicized* font indicates data from NCDC Station 7965 substituting missing data.

2. Red font indicates multiple drought years and blue font indicates multiple wet years or an isolated extreme year.

APPENDIX E

Water consumption estimates

Appendix E1. Water Consumption Estimates for **Existing** Production,
Mark West Quarry, Sonoma County, California.

MWQ Production

457,500	Total Annual Tons (all plants)
85%	Non-Washed
15%	All Washed

Washed Product

80%	Washed Sand
20%	Washed Course Aggregate

Additional Water Use

1,000,000	Yard & Road Dust Control (gal/yr)
0	Solar Panels (gallons per wash)
0	Solar Panels (washes per year)

Washed Product Production

56,000	Sand (tons per year)
14,000	Course Aggregate (tons per year)
58	Peak Production Rate (tons/hour)
10	Peak Production (hours per day)
60	Peak Production (days per year)
145	Total Production (days per year)
11%	Moisture Content in Sand
10%	Moisture Content in Filter Cake
3%	Moisture in Course Aggregate
2%	Additional Moisture Loss Factor

WASH PLANT CALCULATIONS

Peak Production and Makeup Water Consumption Rate

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
58 tons/hour	8 tons/hour	66 tons/hour	
580 tons/day	81 tons/day	661 tons/day	
34,800 tons/year	4,872 tons/year	39,672 tons/year	
1,529 gallons/hour	195 gallons	1,724 gallons	0.0053 acre-feet
15,291 gallons/day	1,946 gallons	17,237 gallons	0.053 acre-feet
917,436 gallons/year	116,765 gallons	1,034,200 gallons	3.17 acre-feet

Non-Peak Production and Makeup Water Consumption Rate

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
55 tons/hour	7.7 tons/hour	63 tons/hour	
414 tons/day	58 tons/day	472 tons/day	
35,200 tons/year	4,928 tons/year	40,128 tons/year	
7.53 hours/day			
87 days			
1,450 gallons/hour	185 gallons	1,635 gallons	0.0050 acre-feet
10,917 gallons/day	1,389 gallons	12,307 gallons	0.038 acre-feet
927,981 gallons/year	118,107 gallons	1,046,087 gallons	3.21 acre-feet

Annual Production and Makeup Water Consumption Rate (Peak + Non-Peak)

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
56 tons/hour	7.8 tons/hour	64 tons/hour	
483 tons/day	68 tons/day	550 tons/day	
70,000 tons/year	9,800 tons/year	79,800 tons/year	
1,255 hours/year			
145 days/year			
1,470 gallons/hour	187 gallons	1,658 gallons	0.0051 acre-feet
12,727 gallons/day	1,620 gallons	14,347 gallons	0.044 acre-feet
1,845,416 gallons/year	234,871 gallons	**2,080,288** gallons	**6.38** acre-feet

SUMMARY OF ANNUAL WATER CONSUMPTION

Secondary Plant[2] =	3,660,000	gallons/year	11.23	acre-feet/year
Wash Plant =	2,080,288	gallons/year	6.38	acre-feet/year
Yard & Road Dust Control =	1,045,750	gallons/year	3.21	acre-feet/year
Solar Wash System =	0	gallons/year	0.00	acre-feet/year
Total =	**6,786,038**	gallons/year	**20.83**	acre-feet/year
Equivalent households[3] =	53.27			

Notes:
1. Filter Cake production is approximately 14 percent of the washed product production.
2. The Secondary Plant consumes approximately 8 gallons per ton of aggregate produced.
3. According to the American Water Works Association, the average American household consumes 127,400 gallons of water per year.

Appendix E2. Water Consumption Estimates for **Proposed** Production,
Mark West Quarry, Sonoma County, California.

MWQ Production	
750,000	Total Annual Tons (all plants)
87%	Non-Washed
13%	All Washed
Washed Product	
74%	Washed Sand
26%	Washed Course Aggregate
Additional Water Use	
1,000,000	Yard & Road Dust Control (gal/yr)
500	Solar Panels (gallons per wash)
52	Solar Panels (washes per year)

Washed Product Production	
70,000	Sand (tons per year)
25,000	Course Aggregate (tons per year)
58	Peak Production Rate (tons/hour)
10	Peak Production (hours per day)
60	Peak Production (days per year)
200	Total Production (days per year)
11%	Moisture Content in Sand
10%	Moisture Content in Filter Cake
3%	Moisture in Course Aggregate
2%	Additional Moisture Loss Factor

WASH PLANT CALCULATIONS

Peak Production and Makeup Water Consumption Rate

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
58 tons/hour	8 tons/hour	66 tons/hour	
580 tons/day	81 tons/day	661 tons/day	
34,800 tons/year	4,872 tons/year	39,672 tons/year	
1,441 gallons/hour	195 gallons	1,636 gallons	0.0050 acre-feet
14,413 gallons/day	1,946 gallons	16,359 gallons	0.050 acre-feet
864,760 gallons/year	116,765 gallons	981,524 gallons	3.01 acre-feet

Non-Peak Production and Makeup Water Consumption Rate

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
55 tons/hour	7.7 tons/hour	63 tons/hour	
430 tons/day	60 tons/day	490 tons/day	
60,200 tons/year	8,428 tons/year	68,628 tons/year	
7.82 hours/day			
142 days			
1,367 gallons/hour	185 gallons	1,551 gallons	0.0048 acre-feet
10,685 gallons/day	1,443 gallons	12,128 gallons	0.037 acre-feet
1,495,935 gallons/year	201,989 gallons	1,697,924 gallons	5.21 acre-feet

Annual Production and Makeup Water Consumption Rate (Peak + Non-Peak)

Washed Product	Filter Cake[1]	Total Washed Product + Filter Cake	
56 tons/hour	7.8 tons/hour	63 tons/hour	
475 tons/day	67 tons/day	542 tons/day	
95,000 tons/year	13,300 tons/year	108,300 tons/year	
1,710 hours/year			
200 days/year			
1,380 gallons/hour	186 gallons	1,567 gallons	0.0048 acre-feet
11,803 gallons/day	1,594 gallons	13,397 gallons	0.041 acre-feet
2,360,695 gallons/year	318,754 gallons	**2,679,449** gallons	**8.22** acre-feet

SUMMARY OF ANNUAL WATER CONSUMPTION

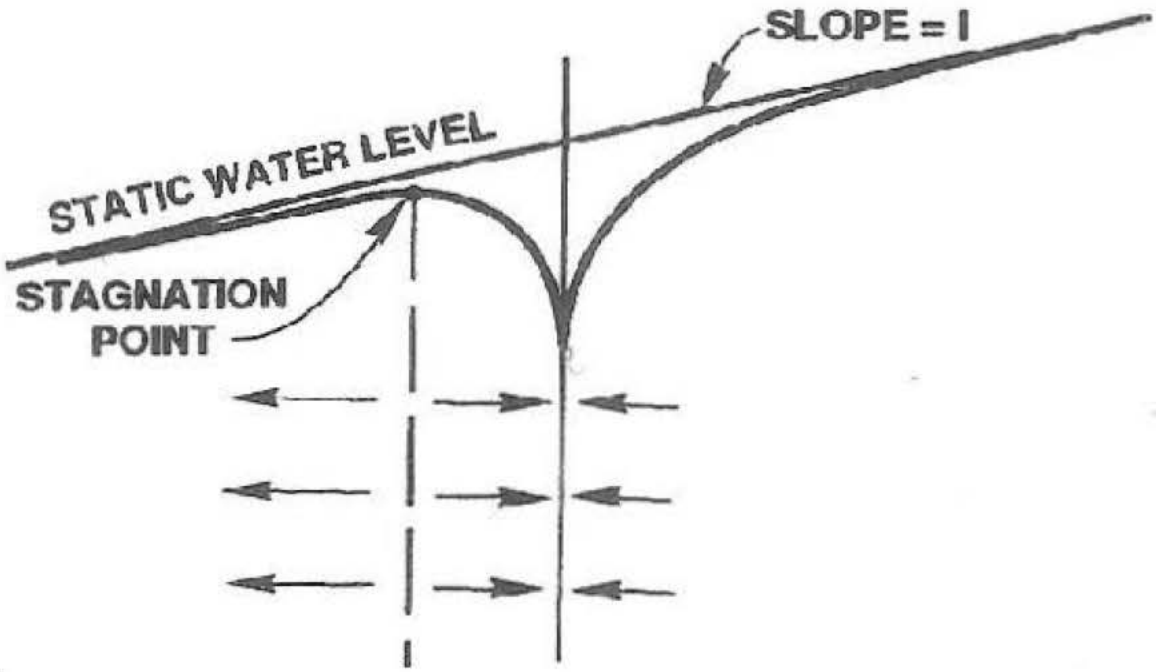
Secondary Plant[2] =	6,000,000	gallons/year	18.41	acre-feet/year
Wash Plant =	2,679,449	gallons/year	8.22	acre-feet/year
Yard & Road Dust Control =	1,075,000	gallons/year	3.30	acre-feet/year
Solar Wash System =	33,500	gallons/year	0.10	acre-feet/year
Total =	**9,787,949**	gallons/year	**30.04**	acre-feet/year
Equivalent households[3] =	76.83			

Notes:
1. Filter Cake production is approximately 14 percent of the washed product production.
2. The Secondary Plant consumes approximately 8 gallons per ton of aggregate produced.
3. According to the American Water Works Association, the average American household consumes 127,400 gallons of water per year.

APPENDIX F

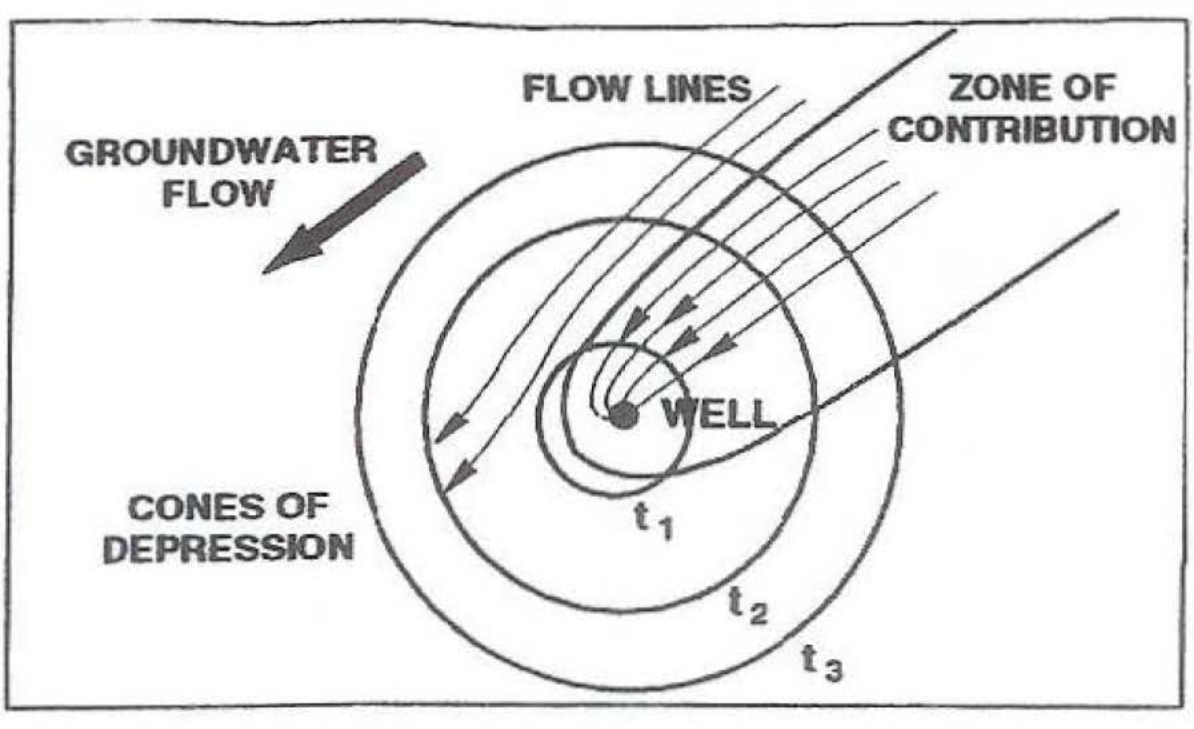
Diagrams of theoretical capture-zone models

WELL IN UNIFORM FLOW

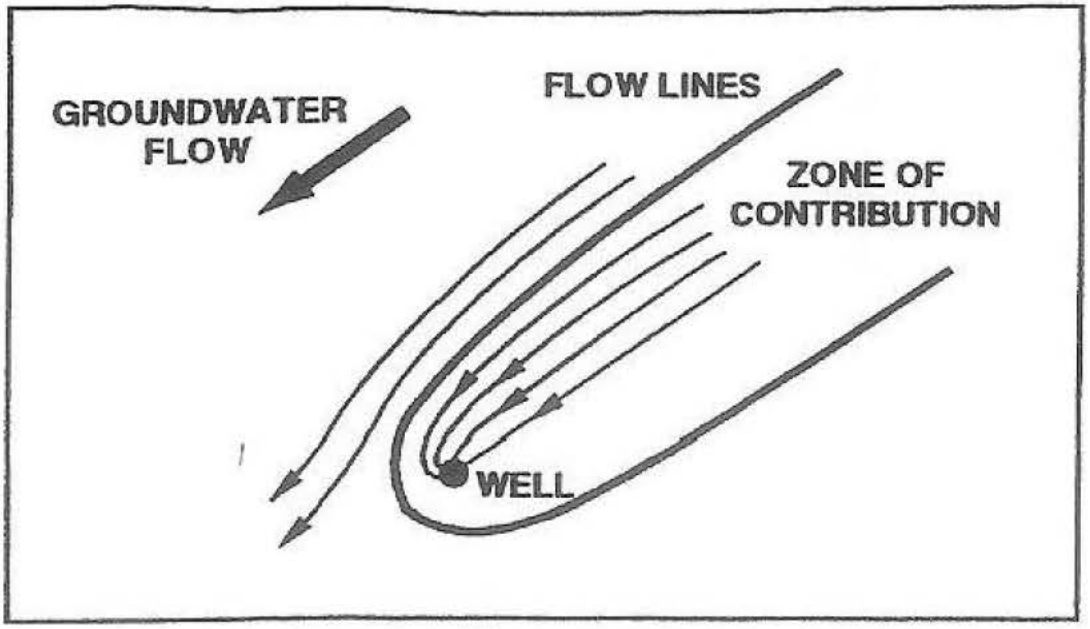


1.6

ZONE OF CONTRIBUTION VS. CONE OF DEPRESSION



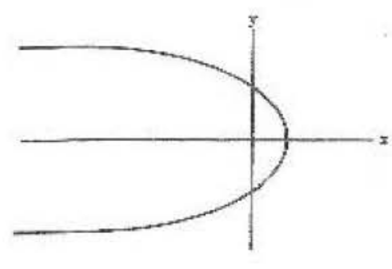
RECOVERY WELL CAPTURE ZONE



EQUATION FOR CAPTURE ZONE BOUNDARY

$$y = \frac{Q}{2\pi TI} \arctan \frac{y}{x}$$

Q - DISCHARGE RATE
T - TRANSMISSIVITY
I - GRADIENT

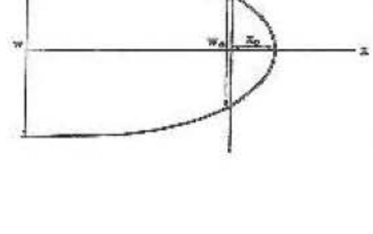


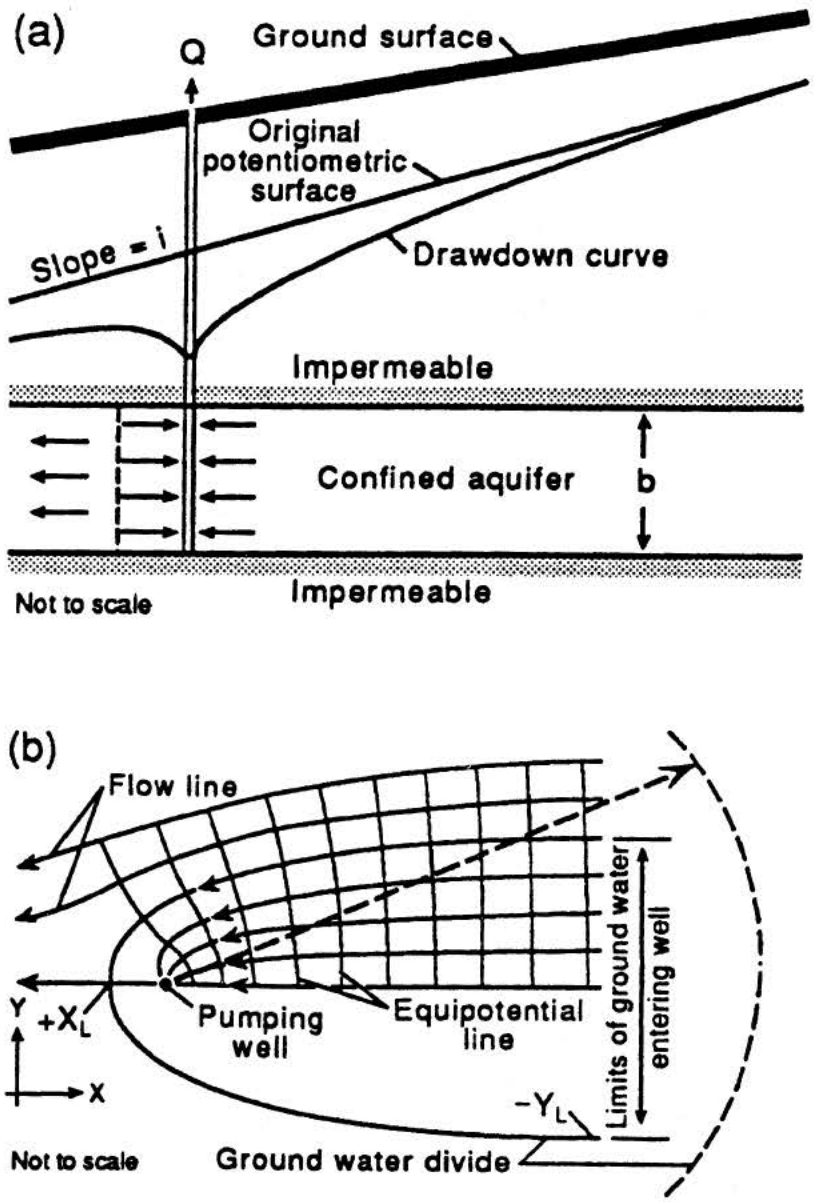
EQUATIONS FOR CAPTURE ZONE DIMENSIONS

STAGNATION POINT $x_0 = \frac{Q}{2\pi TI}$

WIDTH AT WELL $w_0 = \frac{Q}{2TI}$

UPGRADIENT WIDTH $w = \frac{Q}{TI}$





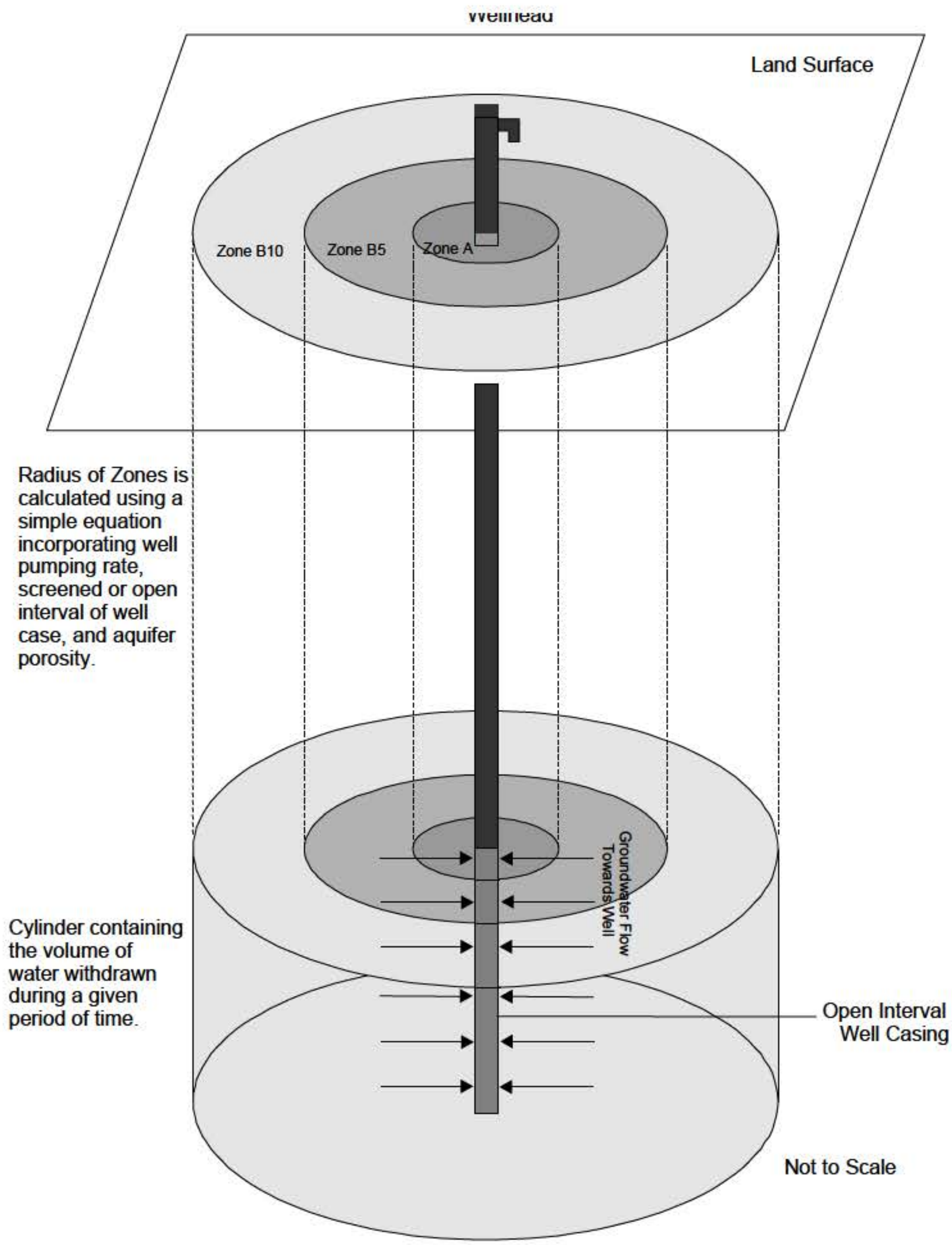
Uniform flow equation: $-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q} Y\right)$

Distance to down-gradient null point: $X_L = -\frac{Q}{2\pi Kbi}$

Boundary limit: $Y_L = \pm\frac{Q}{2Kbi}$

Where: Q = Well pumping rate
K = Hydraulic conductivity
b = saturated thickness

Figure 6-7. Uniform flow equations for determining area of contribution to a pumping well (adapted from Todd, 1980)



$$r = \sqrt{\frac{Q\,t}{\pi\, n\, H}}$$

Where
Q = Pumping Rate of Well
n = Effective Porosity (0.2)
H = Open Interval or Length of Screen
t = Travel Time to Well (2, 5, 10 years)

Figure 6-4. Calculated fixed radius delineation method (Adapted from Washington State, "Wellhead Protection Program Guidance Document," 1995)

APPENDIX G

Photographs of site and vicinity

Balance Hydrologics, Inc.

Appendix G1. Existing landscape, Mark West Quarry, Sonoma County. Upper image shows ravines in Sonoma Volcanics on the northern portion of the property, draining to Franz Creek. Lower image shows greenstone slope west of the quarry, draining to Porter Creek.

Balance Hydrologics, Inc.

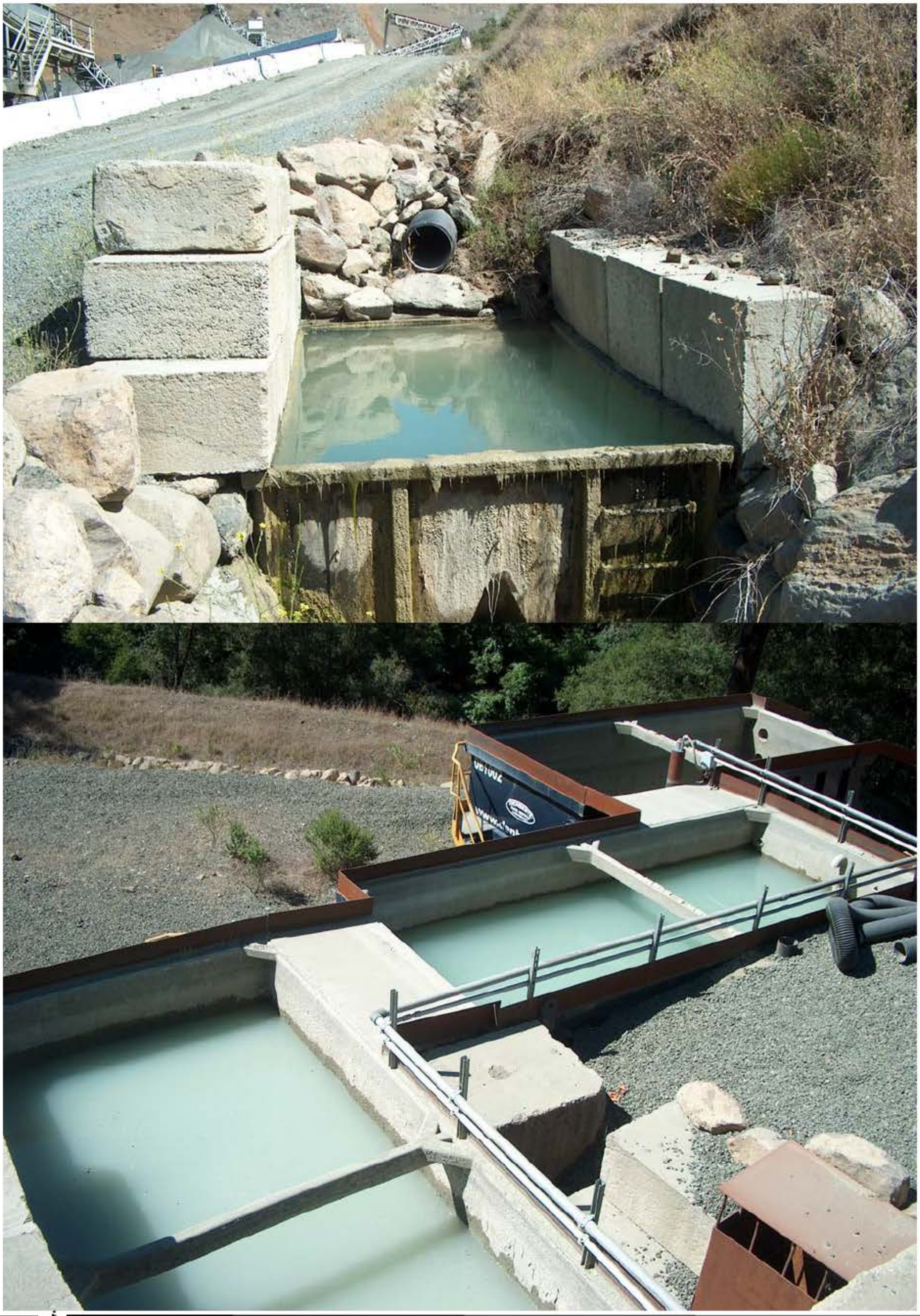
Appendix G2. Exposed greenstone slopes in upper portion of Mark Wes Quarry, Sonoma County.

Balance Hydrologics, Inc.

Appendix G3. Reclaimed fill slopes east of active quarry, Mark West Quarry, Sonoma County. Upper image shows condition of a 4-year old slope. Lower image shows a slope actively being reclaimed.

Balance Hydrologics, Inc.

Appendix G4. Typical on-site sediment detention features, Mark West Quarry, Sonoma County.



Appendix G5. Drainage E1 sediment detention features, Mark West Quarry, Sonoma County.

Balance Hydrologics, Inc.

Balance Hydrologics, Inc.

Appendix G6. Wash plan recycled water treatment, Mark West Quarry, Sonoma County.

Balance Hydrologics, Inc.

Appendix G7. Typical regional agricultural landscape, Mark West Quarry, Sonoma County.

APPENDIX D-2

Water Supply Assessment

Water Supply Assessment, Mark West Quarry Proposed Expansion and Reclamation, Sonoma County, California

Prepared for:

BoDean Company

Prepared by:

Balance Hydrologics, Inc.

Mark Woyshner

Barry Hecht

March 2012

A report prepared for:

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Water Supply Assessment, Mark West Quarry Proposed Expansion and Reclamation, Sonoma County, California

Balance Project Assignment 211046

by

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March 26, 2011

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1. SUMMARY OF FINDINGS

The objective of this Water Supply Assessment (WSA) was to assess whether existing water supplies meet the projected water demand of the proposed Mark West Quarry expansion. The assessment documents project water supplies and demands for a typical year, a single extreme dry year, and multiple dry years during a 20-year projection.

Water is supplied to the quarry from four (4) on-site wells. The wells draw water from fractured rock that is recharged each year by infiltrating rainfall. Given that the volume of water stored in the fractures, the rate of recharge, and flow of groundwater flow directions are difficult to quantify in a fractured rock aquifer, we quantified water supply to the quarry by estimating recharge to groundwater with a soil-moisture budget model (Table 6). Regional data and conservative assumptions were used in the model. The recharge estimates are considered conservative because they do not include groundwater stored in the fractures from recharge during previous year(s) and infiltration from on-site ponds, nor do they likely include deep up-flowing groundwater source(s).

The quarry is currently operating at a level less than its historic maximum production level, but expects to again produce at this higher level, given the market demand. Water demand by the quarry is assessed for the existing production rate and for the maximum production rate (proposed usage). Existing and maximum groundwater usage by off-site domestic wells was also assessed.

Based on the estimates of groundwater recharge versus groundwater demand, there are sufficient groundwater resources to serve the project, except for possibly during a severely dry year when the quarry may need to reduce water use (Table 9). The small deficit indicated by the soil-moisture budget model would be reasonably by pond infiltration and the use of additional pond storage as proposed in the expansion plan.

Uncertainty in the recharge estimates are largely affected by spatial variability of precipitation, and somewhat less by runoff estimates, as described in the sensitivity analysis of the soil-moisture budget model. During a typical year and during multiple dry years a 10 percent uncertainty in the data (Table 7) was less than the projected recharge surplus (recharge minus demand) (Table 9). These results indicate that these recharge estimates are a reasonable predictor of the suitability of groundwater supplies during normal and dry years.

2. INTRODUCTION

2.1 Background

Effective January 1, 2002, Senate Bills 610 and 221 (SB 610 and SB 221) amended state law to improve the link between information on water supply availability and certain land use decisions made by cities and counties. SB 610 and SB 221 are companion measures which seek to promote more collaborative planning between local water suppliers and cities and counties. Both statutes require detailed information regarding water availability to be provided to the city and county decision-makers prior to approval of specified large development projects. Both statutes also require this detailed information be included in the administrative record that serves as the evidentiary basis for an approval action by the city or county on such projects. Under SB 610, water assessments must be furnished to local governments for inclusion in any environmental documentation for certain projects (as defined in Water Code 10912 [a]) subject to the California Environmental Quality Act. Under SB 221, approval by a city or county of certain residential subdivisions requires an affirmative written verification of sufficient water supply. [For further details refer to the guidebook for implementation of SB 610 and SB 221, California Department of Water Resources, October 8, 2003]

This report describes the SB 610 Water Supply Assessment (WSA) for the Mark West Quarry proposed expansion and reclamation, located at 4611 Porter Creek Road on Sonoma County near its boundary with Napa County (Figure 1). The objective of this WSA is to evaluate whether water supply to the quarry meets the projected water demand of the proposed project, in addition to existing and planned future uses. The WSA is required to document project water supplies and demands for 1) a typical (normal rainfall) year, 2) a single extreme dry year, and 3) multiple drought years during a 20-year projection.

2.2 Project Description

BoDean Company intends to expand Mark West Quarry to include a larger area to the west. The expansion area includes permitted lands within the existing BoDean holdings, and a leased area of similar size immediately to the west. The mined area is proposed to expand from the current 58 acres to 100 acres (approximate), during the proposed 20-year mining period. The total property and leased area is approximately 154 acres (shown as the Project site on Figure 1).

The vested right[1] limit for production purposes, determined in 1981, is "subject to fluctuations in local demand." While operating under this vested right, the Mark West Quarry has from

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[1] "Vested right" means the quarry was operating prior to the State's passage of SMARA. Quarries and mines operating under vested right means the quarry or mine can continue operation without the need to

time-to-time produced at a level of 750,000 tons per year, which shall serve as the maximum permitted limit. The quarry expects to again produce at this level, given the market demand, but for purposes of this study, the existing production level of 457,500 tons per year shall serve as a baseline for comparison to a proposed production level of 750,000 tons per year. Water usage for the quarry operations is proposed to increase from an existing 21.6 acre-feet per year to approximately 30 acre-feet per year at the maximum production limit.

2.3 Prior Work

Project details and a hydrologic assessment are provided in "Surface-Water and Groundwater Evaluation for CEQA, Mark West Quarry Proposed Expansion and Reclamation, Sonoma County, California" (Woyshner and Hecht, 2011). The existing reclamation plan was developed by Sandine & Associates (1988) and approved by Sonoma County. The existing Storm Water Pollution Prevention Plan (SWPPP), Storm Water Monitoring Program (SWMP), and Spill Prevention Control and Countermeasure (SPCC) plan for above-ground fuel storage were developed by EnviroNet Consulting (2001). Geologic interpretation was provided by engineering geologist Mike Dwyer and a slope stability investigation by Miller Pacific Engineering Group (2011).

2.4 SB 610 Applicability

Section 10910 of the California Water Code (as revised by Senate Bill 610, or SB610) requires the preparation of a Water Supply Assessment (WSA) for a project subject to the California Environmental Quality Act (CEQA) to address the increased water use over existing conditions.

2.4.1 Is the project subject to CEQA?

California Public Resources Code Section 21065 defines "Project" as an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, and which is any of the following:

(a) An activity directly undertaken by any public agency.

(b) An activity undertaken by a person which is supported, in whole or in part, through contracts, grants, subsidies, loans, or other forms of assistance from one or more public agencies.

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obtain new permits if it was legally and diligently commenced prior to January 1, 1976, and no substantial changes in operation are made.

(c) An activity that involves the issuance to a person of a lease, permit, license, certificate, or other entitlement for use by one or more public agencies.

The application is a "Project" and is subject to CEQA because it requests discretionary approvals that may result in a direct physical change in the environment.

2.4.2 Is it a "Project" as defined by Water Code 10912?

Per Section 10912(a) of the California Water Code, projects required to prepare a WSA are those that propose any one or a combination of the following:

1. A proposed residential development of more than 500 dwelling units;
2. A proposed shopping center or other business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space;
3. A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space;
4. A proposed hotel or motel, or both, having more than 500 rooms;
5. A proposed industrial, manufacturing, or processing plant or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area;
6. A mixed-use project that includes one or more of the projects specified in this subdivision; and
7. A project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project.

A WSA is required for the Mark West Quarry expansion project because it is an industrial and processing site occupying more than 40 acres and subject to the CEQA review process.

2.4.3 Is there a public water system ("Water Supplier")?

There are no urban or public water suppliers in the area. Water is supplied entirely by local groundwater from four (4) on-site wells and by capture of reclamation sub-drain seepage. The wash plant also recycles nearly all of its water for reuse.

The closest water service district is the Town of Calistoga, roughly 3 miles east of Mark West Quarry. Cal-American Water Company is the purveyor of water to the Larkfield/Wikiup area, roughly 6 miles to the west from Mark West Quarry, and the water service district for the Town of Windsor, Shiloh areas and Sonoma County Airport area is roughly 8 miles west of Mark West Quarry. Appendix E lists the water suppliers for Sonoma County.

Transient non-community water systems[2] are operated at The Petrified Forest (~1 mile to the east), at Mountain Home Ranch and Mayacamas Ranch (~1 mile to the north), at Pepperwood Preserve (~2 miles to the northwest), and at Safari West (~2 miles to the west).

2.4.4 Is there an adopted Urban Water Management Plan ("UWMP")?

A primary document for compliance with both SB 610 and SB 221 is the Urban Water Management Plan (UWMP), prepared by water suppliers to support their long-term resource planning over a 20-year planning horizon. An UWMP assesses water supplies and demands for a normal rainfall year, an extreme dry year, and a multi-year drought. There are no urban water suppliers or public water systems responsible for supplying water in the vicinity of Mark West Quarry, and therefore there is no UWMP that applies to the quarry project. The Local Agency Formation Commission (LAFCO) of Sonoma County and Napa County does not identify plans for public water supply in the vicinity of Mark West Quarry site.

2.4.5 Information included in the Water Supply Assessment ("WSA")

Based on an analysis of a normal, single dry, and multiple dry years, the WSA must address whether the projected supply for the next 20 years will meet the demand projected for the project plus existing and planned future use, including agricultural and manufacturing uses. The WSA is required to include an identification of existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project.

2.4.6 Is the proposed project supplied by groundwater?

Water for Mark West Quarry is supplied by local groundwater from four (4) water wells on site and by capture of reclamation sub-drain seepage. As defined in California Water Code section 10910, subdivision (f), if a water supply for a proposed project includes groundwater, the following additional information shall be included in the water assessment:

[2] Transient Non-Community Water System (TNCWS) is a Non-Community Water System that does not regularly serve at least 25 of the same persons over 6 months per year. It is a public water system that provides water to facilities such as a gas station or campground where the public does not remain for long periods of time.

1. A review of any information contained in urban water management plan relevant to the identified water supply for proposed project (not applicable to the Mark West Quarry expansion and reclamation project).

2. A description of any groundwater basin or basins from which the proposed project will be supplied. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), has the legal right to pump under the order or decree. For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current bulletin of the department that characterizes the condition of the groundwater basin, and a detailed description by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), of the efforts being undertaken in the basin or basins to eliminate the long-term overdraft condition.

3. A detailed description and analysis of the amount and location of groundwater pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), for the past five years from any groundwater basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

4. A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), from any basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

5. An analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project. A water assessment shall not be required to include the information required by this paragraph if the public water system determines, as part of the review required by paragraph (1), that the sufficiency of groundwater necessary to

meet the initial and projected water demand associated with the project was addressed in the description and analysis required by paragraph (4) of subdivision (b) of Section 10631.

3. WATER SUPPLY

3.1 Water use

Water is used on site for increasing aggregate saturation, the aggregate wash plant, dust control, equipment rinse and office use. As described in Section 2.4.3, water is supplied by local groundwater from four (4) on-site wells and by capture of reclamation sub-drain seepage. Well specifications are summarized in Table 1. The wash plant also recycles nearly all of its water for reuse.

Existing and proposed water usage was obtained from the project hydrology report (Woyshner and Hecht, 2011) and is summarized in Table 2. Existing (5-year) water usage has been 7.04 million gallons per year (or 21.6 acre-feet per year) and the proposed water usage is 9.79 million gallons per year (or 30 acre-feet per year). 83 percent of the water supplied to the quarry is pumped from the on-site wells, 14 percent is captured from reclamation sub-drains, and 3 percent is reused in the wash plant.

The average rate of use was estimated (in Table 3 of Woyshner and Hecht, 2011) for the months June through October, when water use is seasonally highest.

- For existing production rates, the average water consumption rate is estimated at 26 gallons per minute (if continuous from June through October).
- For proposed increased production rates, the average water consumption rate is estimated at 35 gallons per minute (if continuous from June through October).

The highest water usage has been during the month of August with an average pumping rate of 34 gallons per minute for existing production rates and an estimated 47 gallons per minute for proposed production rates.

3.2 Water rights

Groundwater usage by Mark West Quarry operations is categorized as an "overlying" right. Overlying rights, which are appurtenant to real property overlying a source of "percolating groundwater"[3], allow a landowner to extract percolating groundwater from beneath the property for use on the overlying parcel. Overlying rights arise solely from property ownership, and thus are generally not limited by the history or frequency of water use.

[3] Percolating groundwater occurs broadly in alluvial groundwater basins and upland, fractured-rock groundwater systems. It is distinct from groundwater flowing in known and definite channels that are typically closely associated with streams.

Overlying rights are correlative rights (i.e., they are of equal priority to one another), but are superior in priority to appropriative rights (i.e., the use of groundwater off the parcel) (Bachman and others, 2005). All water rights in California are further subject to the restriction that the use of water be reasonable and beneficial. Use of groundwater for processing aggregate and incidental dust control meets that standard.

3.3 Description of aquifer supplying water to quarry

The quarry site has evolved geologically as part of the regional Maacama fault zone, east of the Rodgers Creek-Healdsburg fault zones. While the entire region is underlain by Franciscan basement rocks and overlain by Pliocene Sonoma Volcanics and Quaternary sediments, Franciscan mélange terrain is generally mapped along much of the Maacama fault (Wagner and Bortugno, 1982). In the vicinity of the quarry, the Maacama fault thrusts north-northeast and has apparently uplifted and exposed a massive block of Franciscan greenstone (Fox and others, 1973; Graymer and others, 2007) (Figure 2). Greenstone outcrops across most of the south and center portions of the site, and overlying Sonoma Volcanics tuff across the northern portion of the site. Ravines formed by the headwaters of Franz Creek have eroded southward into the watershed divide crossing the site, exposing 50 to 75 feet of tuff just north of the greenstone contact on site. The Franz Creek headwaters have not yet exposed the underlying greenstone. Drillers logs for all wells in the quarry processing area, extending to a maximum depth of 720 feet, indicate fractured greenstone throughout the column with interbeds of chert at depth.

Groundwater occurs throughout the portions of the site underlain by greenstone and the wells all draw groundwater from the fractured greenstone aquifer. Groundwater is generally at substantial depths during the dry months; static groundwater levels ranged from 22 to 70 feet below ground surface during the dry season when the wells were drilled (Table 1). The static groundwater flow gradient is 0.09, generally southward from the Franz Creek watershed divide to Porter Creek (Figure 6). Groundwater local to the quarry flows toward the quarry floor (Figure 7). Both the vegetation and static water levels in the wells suggest that the water table is only slightly elevated above the levels of the nearby streams during the summer. Drawdown in the wells can range 50 to 100 feet when pumped a couple of hours, and rebounds considerably when not pumped. Water levels reportedly rise considerably during the winter months with artesian conditions in the deeper wells. Well pumping and water-quality test results (Woyshner and Hecht, 2011) indicate that the on-site wells draw on a deeper groundwater source uniquely different from Porter Creek and the groundwater supplying the off-site domestic wells in the vicinity, perhaps partially drawing on groundwater beneath the bottom of the wells. Specific capacity of the wells ranged from 0.1 to 0.3 gallons per minute per foot of drawdown, and the estimated hydraulic conductivity of the aquifer was about $1x10^{-5}$ centimeters per second (Woyshner and Hecht, 2011).

3.4 Groundwater Recharge

Rainfall infiltrating the soil surface is stored as moisture in the soil, consumed by plants and evaporation, and recharges the groundwater. Wells in the quarry area (and off-site wells in the vicinity of the quarry) draw from groundwater in bedrock fractures. The locally fractured bedrock aquifer generally allows recharge to rapidly infiltrate but the volume of water storage available within the fracture network is assumed to be relatively small. Therefore, the annual recharge to the aquifer from rainfall is the primary source of water to the quarry wells, and 'carryover' from the previous year(s) recharge is assumed to be minor.

The capture area of the quarry wells for the 153-day pumping period from June through October was estimated in the project hydrology report (Woyshner and Hecht, 2011) and shown in Figure 3. However, as described in Section 3.3, the quarry water supply wells also draw on a deeper groundwater source with some wells exhibiting artesian conditions, suggesting a larger aquifer. We, therefore, evaluated recharge for a larger area consisting of a ½ mile radius around the wells (502 acres) that includes the Mark West Quarry property/lease area (the Project area) and other off-site wells. We also evaluated recharge for the 154-acre Project area, a relatively conservative estimate of recharge that is potentially available to the quarry wells and allowable for CEQA purposes.

Recharge to groundwater was estimated utilizing a monthly soil-moisture budget (water balance) approach, adapted after Thornthwaite and Mather (1955). Groundwater recharge was calculated each month by subtracting evapotranspiration (AET), runoff (RO), and change is soil moisture (ST) from precipitation (P). A monthly soil moisture budget was calculated for each soil type within the ½ mile radius of the quarry wells and groundwater recharge was calculated for three conditions:

a) for mean precipitation to represent a typical year (Appendix B);

b) for precipitation during 1976, the driest year on record[4] (Appendix C); and,

[4] Water years 1976 and 1977 were two extremely dry years, respectively 56 percent and 42 percent of mean (see Appendix A). Calendar year 1976 was the driest year on record at 38 percent of mean (Table 3). Although data are typically expressed on a 'water year' basis in hydrologic reports (October through September), expressing soil-moisture budgets on a calendar year is often preferred, particularly for

c) for precipitation during the years 1987 through 1991, to represent a multiple year drought (Appendix D).

Results are summarized in Table 6.

3.4.1 Soils

Surficial soils at the quarry site (Figure 4) reflect the geologic parent material from which they have developed. Soils in the northern portion of the site – derived from geologically recent deposits of Sonoma Volcanic tuffs – are mapped as Forward (FoG) and Forward-Kidd (FrG) series by the agency that is now the USDA Natural Resources Conservation Service (Miller, 1972). Forward soils average 21 inches deep and are typically well-drained gravelly loams with a gravelly, sandy clay loam subsoil. Available water capacity of the soils is commonly about 2.3 inches (Table 3). The moderately high permeability and moderately low water-holding capacity generally promote recharge to groundwater. At depth, bedrock is typically weathered rhyolitic tuff of the Sonoma Volcanics with a substantially lower permeability, distributed mainly within the fractures. Runoff and erosion hazard may be high to very high, particularly on steeper slopes with shallower soils, as commonly associated with the Forward-Kidd soil complex.

Soils on the greenstone ridge in the center portion of the site are older and mapped as Spreckles loam (SkE). Ranging from 22 to 60 inches in depth, the soils are deeper than the Forward soils and have a developed clay subsoil with moderately low permeability, approaching that of the fractured bedrock. The available water capacity is moderate, typically about 6.3 inches. Runoff and erosion potential of Spreckles soil are moderate to high.

Goulding soils (GgF, GiF) are mapped on the greenstone slopes, and are mainly found in the south portion of the site. These loam soils are similar in depth and permeability as Forward soils, but are characterized by having less gravel and more clay at depth. Therefore, water holding capacity is higher, and recharge less. As with Forward soils, infiltrating water may temporarily perch during storms, increasing runoff and erosion hazard from moderate to high.

Due to their limited infiltration rates, mainly from the clay layers impeding percolation, soils on the site are either classed in hydrologic group C or D (Table 3). Artificial fill on reclaimed fill slopes of the east portion of the site is assumed to also have low range of permeabilities. In addition, about twenty-five percent of the site, including the expansion area, is mapped as either steep-sloped rock land or actively mined area, which is estimated to have very low

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Mediterranean climates, where rainfall is low when evapotranspiration is high and an extended soil-moisture deficit develops.

permeability and high runoff. Overall, recharge on the site is moderately low, and runoff and erosion potential moderately high.

3.4.2 Precipitation

The nearest, most-complete long-term record of precipitation is available for Santa Rosa at the California Data Exchange Center (CDEC) station SRO, from January 1905 to present (Appendix A), where mean annual rainfall is 30.09 inches. Monthly precipitation at SRO is shown in Table 4 for a typical (mean) year, a single extreme year (1976), and a multiple year drought (1987-91). Being at a higher elevation, though, the quarry site has higher rainfall. Mean annual precipitation at the quarry site is 47 inches on the Sonoma County Water Agency isoheytal map (1983). This annual total was proportioned to calculate mean monthly precipitation at the quarry site using mean monthly precipitation at SRO (Appendices B, C, and D).

3.4.3 Evapotranspiration

Evapotranspiration is the combined loss of moisture from the terrain by direct evaporation and transpiration from vegetation. There are several ways of calculating evapotranspiration from meteorological data (such as air temperature, relative humidity, wind speed, and solar radiation), and different ways of expressing it. Reference evapotranspiration (ETo) is a standard method and commonly published form of evapotranspiration, and data are readily available from the California Irrigation Management Information System (CIMIS) website[5]. Table 5 lists the mean monthly ETo data for regional CIMIS stations. Data from the Windsor station (103) is closest in proximity and best represents ETo at the quarry site.

Reference evapotranspiration (ETo) represents water use by well-irrigated mowed turf grass, and is used to calculate the potential evapotranspiration (PET) by applying a plant-specific coefficient (Kc), where PET = ETo * Kc. Kc also varies with growth stage.[6] For conservative estimate of groundwater recharge, we used a Kc of 1.0 in the soil-moisture budgets (hence, PET = ETo). In California, actual evapotranspiration (AET) is generally less than PET (except in wetland terrain, for example). AET was calculated in the monthly soil-moisture budgets based on the soil properties and soil moisture available for evapotranspiration (Appendices B, C, and

[5] http://wwwcimis.water.ca.gov/cimis/welcome.jsp

[6] For example, Kc for grapes is generally about 0.8 but much less prior to leaf-out and after leaf-fall (~0.25), and about ¾ into the season, Kc declines from 0.8 as seasonal growth drops off.

D).[7] AET estimates (Appendix B) concur with published values of a California woodland-grass, interior Douglas-fir, and mixed conifer vegetation types (Van der Leeden and others, 1990).

3.4.4 Runoff

Mean annual runoff at in the vicinity of Mark West Quarry was estimated at 18 inches (Rantz, 1974). This value was used in the in the soil-moisture budget on all soil types except for the quarried area (Rck) and rock land (RoG) rainfall (see Figure 4), where runoff was set higher at 86 percent of mean annual precipitation to minimize recharge from these areas.[8] Mean annual runoff from the 154-acre quarry property/lease are totaled 23.35 inches or 50 percent of mean annual precipitation (Appendix B). Monthly runoff was calculated in the soil-moisture budgets (Appendices B, C, and D) by proportioning the mean annual runoff relative to the amount of surplus water available after actual evapotranspiration (AET) and the change in soil moisture was subtracted from precipitation for the month. The soil-moisture budget first allocates precipitation to evapotranspiration and soil moisture and then the remaining 'water surplus' is available for runoff and groundwater recharge. The monthly runoff is then subtracted from the 'water surplus' to estimate recharge.

3.4.5 Parameter sensitivity

As described above, groundwater recharge was calculated each month in the soil-moisture budgets by subtracting evapotranspiration (AET), runoff (RO), and change is soil moisture (ST) from precipitation (P). Basic data used in the soil-moisture budgets included:

- Long-term precipitation at Santa Rosa (CDEC station SRO) proportioned higher based on the mean annual precipitation at the quarry site on the Sonoma County Water Agency isoheytal map (1983);

- Reference evaporation (ETo) at Windsor (CIMIS station 103), to which a plant-specific coefficient (Kc) of 1.0 was applied to estimate potential evapotranspiration (PET) at the site (the selected Kc is considered conservative, resulting in a lower recharge estimate) ;

- Mean annual runoff (Rantz, 1974); and,

- Soil water holding capacity (NRCS soil survey, 1972).

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[7] If the precipitation (P) during the month is greater than PET, then AET = PET, otherwise if P < PET then AET = P - change in soil moisture from the previous month.

[8] Annual runoff during drought years was proportioned lower based on the ratio of drought-year 'water surplus' to mean annual 'water surplus'.

We varied each of these data by 10 percent to evaluate their sensitivity on the calculation of groundwater recharge (as a measure of uncertainty). Precipitation was most sensitive, varying 40 percent for mean conditions at the project site. Runoff varied 17 percent, evapotranspiration varied 10 percent, and soil-water holding capacity varied 3 percent. Dry years showed higher uncertainty. Detailed results are shown in Table 7.

4. WATER DEMAND

As described above in Section 3.1, water supply to the Mark West Quarry site is drawn from four (4) on-site wells, and a minor amount captured from reclamation sub-drain seepage and wash plant water reuse (Table 2). The quarry is currently operating at a level less than their historic maximum production level. The quarry expects to again produce at this level, given the market demand, but for purposes of comparison in this WSA it is described as the proposed usage. Water usage for the quarry operations is correspondingly proposed to increase from an existing 21.6 acre-feet per year to approximately 30 acre-feet per year at the maximum production limit. The demand on groundwater is proposed to increase from 17.9 acre-feet per year to 24.9 acre-feet per year.

Within a ½ mile radius of the quarry wells, there are 6 off-site domestic wells. A typical demand rate for a single family dwelling in the area is 0.5 acre-feet per year. To account of additional use or dwelling additions during a 20-year projection, a maximum demand of 50% more was used (or 0.75 acre-feet per year per dwelling).

Groundwater demand estimates are listed in Table 8 for the Mark West Quarry property/lease area and for the area within a ½ mile radius around the quarry wells.

5. WATER SUPPLY AND DEMAND COMPARISON

The objective of this WSA was to assess whether existing water supplies meet the projected water demand of the proposed Mark West Quarry expansion. The assessment is required to document project water supplies and demands for a typical year, a single extreme dry year, and multiple dry years during a 20-year projection. Annual recharge to groundwater was assumed as the available water supply, and estimated utilizing a soil-moisture budget model (Appendices B, C, and D). This approach was based on a reasonable assumption that the proposed water source (the 4 on-site quarry wells) draws water from a fractured bedrock aquifer with limited groundwater storage, requiring recharge each year from rainfall. This assumption eliminates potential water supply contributions from any groundwater storage 'carry-over' from the previous year(s), a conservative assumption minimizing initial water availability. In addition, the project hydrology report (Woyshner and Hecht, 2011) identified a deep groundwater source (possibly fault related) supplying some of the wells, some of which may not have been accounted for in the recharge estimates.

The following periods represent the three year types:

- Typical year – average rainfall for the period 1905 through 2011, average evapotranspiration for the period 1991 through 2011, and mean annual runoff.
- Single extreme dry year – rainfall for calendar year 1976 (the driest of a 106-year record), average evapotranspiration for the period 1991 through 2011, and runoff calibrated to 1976 streamflow data from USGS Maacama Creek station near Kellogg.
- Multiple dry years – average rainfall for calendar years 1987 through 1991; average evapotranspiration for the period 1991 through 2011, mean annual runoff proportioned to lower rainfall.

Recharge to groundwater was evaluated for the 154-acre Project area, which is a relatively conservative estimate of recharge that is potentially available to the quarry wells and allowable for CEQA purposes. We also evaluated recharge for a larger area consisting of a ½ mile radius around the wells (502 acres) that includes the Mark West Quarry property/lease area (the Project area) and other off-site wells (Figure 3).

Table 9 summarizes estimated water supply, represented by simulated groundwater recharge, and proposed demand for normal, single dry, and multiple dry years. The results indicated that groundwater supply estimates are adequate to meet existing and proposed future demand, except possibly during an extremely dry year, when demand exceeds supply. The small deficit shown in Table 9 for the (more conservative) property/lease boundary area would be reasonably by pond infiltration and the use of additional pond storage as proposed in the expansion plan. Nevertheless, for worst-case panning purposes, it seems reasonable to anticipate quarry operations to potentially reduce groundwater demand during extremely dry years. The project hydrology report recommends limiting pumping during drought years from the well closest to Porter Creek (Well #2), the shallowest well that draws on shallow groundwater.

6. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing for CEQA evaluation of projects of comparable size and complexity in Northern California at the time the investigation was performed. No other warranties, expressed or implied, are made. It should be recognized that interpretation and evaluation of subsurface conditions is a difficult and inexact art. Judgment leading to conclusions and recommendations presented above were based on existing information and personnel communications which in total represent an incomplete picture of the site. More extensive studies, including those recommended above, can reduce some of the uncertainties associated with this study.

Balance Hydrologics has prepared this report for the client's exclusive use on this particular CEQA level evaluation. Analyses and information included in this report are intended for use at the watershed scale and for the planning purposes described above. Analyses of groundwater conditions have been purposely simplified for this analysis, which explores effects at the regional scale. Groundwater availability and movement is also influenced by conditions which precede a specific year, whereas the conventional WSA analysis calls for considering a specific period in isolation. Both the simplification and temporal isolation have been conducted in a manner which we believe to underestimate actual recharge or to overestimate the effects of this project. during a specific period. Information and interpretations presented in this report should not be applied to specific projects or parcels other than the Mark West Quarry site without the expressed written permission of the authors, nor should they be used beyond the particular area to which we have applied them.

This study was conducted partly to help interpret work done by others, portions of which have not been independently verified. Our conclusions and any implied or inferred recommendations are based on a limited range of surface water and groundwater data in a region of relatively complex geology. They are limited to planning purposes and should not be used for design or site-specific work. If readers are aware of additional data, observations, conditions, or forthcoming changes to the bases of our decisions, please let us know at the first opportunity, such that this report may be promptly revised.

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TABLES

Table 1. Specifications of wells located at Mark West Quarry, Sonoma County, California.

	Units	Well #4	Well #3	Well #2	Well #1
Site locators:					
Assessors parcel number		120-210-048	120-210-048	120-210-048	120-210-02
DWR well report number		1078646	548113	433700	212074
Latitude (NAD27)	degrees	N38.55528	N38.55545	N38.55386	N38.55472
Longitude (NAD27)	degrees	W122.65511	W122.65449	W122.65454	W122.65460
Elevation (approx.)	feet	995	1028	970	992
Drilling and well construction descriptors [1] :					
Well driller		Peterson	Fisch Bros.	Fisch Bros.	Fisch Bros.
Depth of boring		645	720	400	190
Depth of well	feet	640	420	400	190
Depth of surface seal	feet	50	22	20	20
Depth of perforations	feet	80-100, 160-640	80 to 420	25 to 400	140 to 190
Well diameter	inches	5	8	4.5	5
Date of well completion		7/5/2005	10/5/1994	8/23/1991	9/16/1982
Depth of static water level	feet	30	70	70	22
Estimated yield (air-lift test), q	gpm	60	70	20	20
Length of air-lift test	hours	2	2	4	--
Total drawdown, s	feet	620	400	360	--
Specific capacity, Cs=q/s	gpm/ft	0.10	0.21	0.069	--
Estimated transmissivity[2], T=1860*Cs	gpd/ft	189	395	128	--
Primary rock types		greenstone with sandstone and quartz	greenstone 0-680 feet, chert 680-720 feet	greenstone with quartz; chert 300-315 feet	greenstone
Yield testing [3] :					
Date of test		not tested	11/30/1003	not tested	11/29/1003
Pumping duration	hours	--	2	--	4
Pumping rate, q	gpm	--	6	--	9
Total drawdown, s	feet	--	48	--	100
Specific capacity, Cs=q/s	gpm/ft	--	0.13	--	0.090
Transmissivity, T	gpd/ft	--	58.7	--	47.5
Hydraulic conductivity, K	gpd/ft^2	--	0.21	--	0.29
Hydraulic conductivity, K	cm/s	--	9.70E-06	--	1.40E-05
Recovery	%	--	75% after 2 hours 100% after 6 hours	--	87% after 4 hours 96% after 20 hours
5-year usage:					
Installed flow meter	--	Summer 2006	Summer 2006	none	none
Mean monthly water production	gallons	162,738	182,133	94,444	47,222
Annual water production [4]	gallons	1,952,856	2,185,596	1,133,333	566,667
Annual water production	acre-feet	6.0	6.7	3.5	1.7
Average pumping rate (if continuous)	gpm	3.7	4.2	2.2	1.1

Notes:

1. Drilling and well descriptors were transcribed from driller's well comple ion reports filed at the Department of Water Resources.
2. Estimated transmissivity, T = 1860 Cs (gpd/ft) after DWR Bulletin No. 118-2, June 1974.
3. Constant-rate pumping tests were conducted by Balance Hydrologics' staff.
4. An additional 1,000,000 gallons per year (gpy) is collected from the sub drains underneath the existing reclamation, and 200,000 gpy from a sump pump that retrieves all the processed water from the wash plant.

Table 2. Summary of water sources and usage,
Mark West Quarry, Sonoma County, California.

Source	Existing Usage (gallons)	Existing Usage (acre-feet)	Proposed Usage (gallons)	Proposed Usage (acre-feet)
Groundwater (on-site wells)	5,838,452	17.9	8,119,181	24.9
Reclamation sub-drains	1,000,000	3.07	1,390,639	4.27
Reuse (wash plant)	200,000	0.61	278,128	0.85
Local surface water	0	0	0	0
Wholesale	0	0	0	0
Transfers	0	0	0	0
Exchanges	0	0	0	0
TOTAL	7,038,452	21.6	9,787,949	30.0

Data source: Table 2 of Woyshner and Hecht, 2011.

Table 3. Recharge and water-holding properties of surficial soils, Mark West Quarry, Sonoma County, California

Map Symbol	Soil Series[1]	Parent Material	Taxonomy	Hydrologic Soil Group	Project Area Coverage	Depth Zone	USCS[2]	Attenberg Limits		Permeability	Available Water Capacity[3]		Reaction	Remarks
					(% estimated)	(inches)		Liquid	Plastic	(inches/hour)	Per Inch *(in /in. of soil)*	Profile *(total, in)*	(pH) *(pH)*	
Fo, Fr	Forward, Forward-Kidd	Rhyolite rock and soft rhyolitic tuff	Inceptisols	C	40	0 to 21	SM, SC	15-25	10-20	0.63 to 2.0	0.10 to 0.12	2.3	4.5-7.3	Soil type at site on the northern portion of the site
			Typic Vitrandepts								*Total*	***2.3***		
			Ashy, mesic											
Gg, Gl	Goulding	Metamorphosed basic igneous and weathered andesitic basalt of old volcanic	Inceptisols	D	10	0 to 11	CL	30-40	15-30	0.63 to 2.0	0.19 to 0.21	2.2	5.6-6.5	Main soil type on the southern portion of the site; located on mountainous uplands over fracture rock
			Lithic Xerochrepts			11 to 22	GC	30-40	15-30	0.63 to 2.0	0.09 to 0.11	1.1	6.1-6.5	
			Loamy-skeletal, mixed, mesic								*Total*	***3.3***		
Sk	Spreckles	Volcanic tuffs and weathered basic igneous rock.	Alfisols	C	10	0 to 18	CL/ML	30-40	10-25	0.2 to 0.63	0.17-0.21	3.4	6.1-6.5	Located on ridge in center portion of property
			Ultic Palexeralfs			18 to 37	CL	40-50	20-30	0.06-0.2	0.14-0.16	2.9	5.1-5.5	
			Fine, mixed, thermic								*Total*	***6.3***		
Qaf	Artificial fill	Site overburden engineered on reclaimed slopes		C	15	36				0.63 to 2.0	0.16 to 0.20	6.5		Mainly located on the east and north slopes of existing quarry
											Total	***6.5***		
RoG, Rck	Rock land	Stony steep slopes and ridges, and actively mined areas			25	0				0.01	0	0		Mainly located in the central portion of existing quarry
											Total	***0***		

Notes

1) Information taken from the most-recent USDA soil survey for the area (1972), and/or Soil Survey Laboratory Data for Some Soils of California (Soil Survey Investigations Report No. 24), 1973. This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 acres will not be mapped.

2) USCS = Unified Soils Classification System, commonly used in geotechnical or soil-foundation investigations, and in routine engineering geologic logging.

3) Avaiable Water Capacity = Held water available for use by most plants, usually defined as the difference between the amount of soil water at field capacity (one day of drainage after a rain or recharge event) and the amount at the wilting point.

Table 4. Precipitation for Santa Rosa, Sonoma County, California.

CALENDAR YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	% Mean
Typical year														
Mean (Jan 1905 - Feb 2012)	**6.26**	**5.25**	**4.01**	**1.99**	**0.95**	**0.28**	**0.03**	**0.08**	**0.35**	**1.60**	**3.64**	**5.66**	**30.09**	**100%**
Single extreme dry year														
1976	**0.39**	**2.61**	**0.92**	**2.62**	**0.00**	**0.03**	**0.00**	**0.78**	**0.66**	**0.46**	**1.76**	**1.15**	**11.38**	**38%**
Multiple drought years														
1987	4.83	5.45	4.83	0.15	0.01	0.00	0.00	0.00	0.00	1.37	4.45	6.11	27.20	90%
1988	6.99	0.40	0.02	1.53	0.73	0.49	0.00	0.00	0.00	0.11	4.89	4.07	19.23	64%
1989	1.47	1.53	10.22	1.22	0.13	0.22	0.00	0.04	2.72	2.65	1.71	0.00	21.91	73%
1990	5.74	3.27	2.03	0.24	5.46	0.01	0.00	0.00	0.27	0.62	0.44	1.16	19.24	64%
1991	0.75	4.72	13.74	0.33	0.13	0.72	0.00	0.05	0.01	1.74	1.15	2.91	26.25	87%
Average 1987-91	**3.96**	**3.07**	**6.17**	**0.69**	**1.29**	**0.29**	**0.00**	**0.02**	**0.60**	**1.30**	**2.53**	**2.85**	**22.77**	**76%**

Data source: California Data Exchange Center (CDEC) station SRO, operated by Sonoma County.

Table 5. Regional mean monthly reference evapotranspiration, Sonoma and Napa Counties, California.

ID	Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Period of record
Sonoma County															
51	Healdsburg	1.27	1.85	3.26	4.70	5.94	6.99	7.77	6.80	5.21	3.53	1.97	1.22	50.51	Aug 1986 - Mar 1994
83	Santa Rosa	0.82	1.44	2.87	4.31	5.26	6.14	6.30	5.76	4.25	3.10	1.38	0.86	42.49	Jan 1990 - present
103	Windsor	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	Dec 1990 - present
144	Petaluma East	0.98	1.65	2.81	4.25	5.61	6.26	6.47	5.86	4.49	3.05	1.54	0.98	43.95	Aug 1999 - present
158	Bennett Valley	0.82	1.44	2.87	4.31	5.26	6.14	6.30	5.76	4.25	3.10	1.38	0.86	42.49	Oct 2000 - present
164	Valley of the Moon	0.97	1.59	3.02	4.52	5.62	6.60	7.06	6.31	4.69	3.28	1.49	0.98	46.13	Apr 2000 - Dec 2001
Napa County															
77	Oakville	1.03	1.53	2.93	4.71	5.82	6.85	7.21	6.44	4.87	3.53	1.64	1.17	47.73	Mar 1989 - present
79	Angwin	1.81	1.90	3.23	4.68	5.80	7.33	8.07	7.07	5.54	4.47	2.90	2.06	54.86	May 1989 - Dec 1996
109	Carneros	0.82	1.49	3.09	4.57	5.46	6.61	6.89	6.18	4.71	3.52	1.41	1.02	45.77	Mar 1993 - present

Data source: California Irrigation Management Information System (CIMIS).

Table 6. Groundwater recharge estimates, Mark West Quarry, Sonoma County, California.[1]

	Property/lease boundary (154 acres)			1/2 mile radius around wells (502 acres)		
	inches	acre-feet	million gallons	inches	acre-feet	million gallons
Typical year						
Precipitation, P (Mean)	47.00	604	197	47.00	1967	641
Evapotranspiration, AET	16.42	211	68.8	18.08	757	247
Runoff, RO	22.68	291	95.0	19.66	823	268
Groundwater recharge	**7.90**	**102**	**33.1**	**9.27**	**388**	**126**
Single extreme dry year						
Precipitation, P (1976)	17.78	228	74.4	17.78	744	242
Evapotranspiration, AET	14.10	181	59.0	15.34	642	209
Runoff, RO	3.60	46.3	15.1	2.11	88	28.8
Groundwater recharge	**1.12**	**14.3**	**4.67**	**1.19**	**49.7**	**16.2**
Multiple drought years						
Precipitation, P (Mean 1987-91)	35.56	457	149	35.56	1488	485
Evapotranspiration, AET	15.18	195	63.6	16.54	692	226
Runoff, RO	15.27	196	63.9	12.99	544	177
Groundwater recharge	**5.18**	**66.6**	**21.7**	**6.06**	**254**	**83**

Notes:

1. Calculated with monthly soil-moisture budgets located in appendices.

Table 7. Sensitivity analysis of groundwater recharge estimates, Mark West Quarry, Sonoma County, California.[1]

	Results of soil-moisture budget model results	Precipitation		Evapotranspiration		Runoff		Soil-water holding capacity	
		Increased 10%	Decreased 10%	Increased 10%	Decreased 10%	Increased 10%	Decreased 10%	Increased 10%	Decreased 10%
Property/lease boundary (154 acres)									
Typical year (Mean)									
inches	7.90	11.05	4.76	7.19	8.61	6.53	9.27	7.63	8.17
% of modeled results		40%	-40%	-9%	9%	-17%	17%	-3%	3%
Single extreme dry year (1976)									
inches	1.12	1.56	0.77	1.00	1.27	1.01	1.22	1.10	1.16
% of modeled results		40%	-31%	-11%	14%	-9%	9%	-1%	4%
Multiple drought years (1987-91)									
inches	5.18	7.33	3.09	4.66	5.72	4.30	6.07	5.01	5.37
% of modeled results		41%	-40%	-10%	10%	-17%	17%	-3%	4%
1/2 mile radius around wells (502 acres)									
Typical year (Mean)									
inches	9.27	12.88	5.65	8.51	10.02	7.62	10.91	8.98	9.56
% of modeled results		39%	-39%	-8%	8%	-18%	18%	-3%	3%
Single extreme dry year (1976)									
inches	1.19	1.65	0.82	1.07	1.34	1.07	1.31	1.17	1.23
% of modeled results		39%	-31%	-10%	12%	-10%	10%	-1%	4%
Multiple drought years (1987-91)									
inches	6.06	8.56	3.63	5.49	6.64	4.99	7.13	5.86	6.27
% of modeled results		41%	-40%	-9%	10%	-18%	18%	-3%	4%

Notes:

1. Calculated with monthly soil-moisture budgets located in appendices.

Table 8. Groundwater demand estimates, Mark West Quarry, Sonoma County, California.

Source	Property/lease boundary (154 acres)				1/2 mile radius around wells (502 acres)			
	Existing Usage		Proposed Usage		Existing Usage		Proposed Usage	
	acre-feet	*million gallons*	*acre-feet*	*million gallons*	*acre-feet*	*million gallons*	*acre-feet*	*million gallons*
Mark West Quarry wells (Table 2)	17.9	5.84	24.9	8.12	17.9	5.84	24.9	8.12
Off-site domestic wells[1]	0.00	0.00	0.00	0.00	9.21	3.00	13.8	4.50
TOTAL	17.9	5.84	24.9	8.12	27.1	8.84	38.7	12.6

Notes:

1. There are 6 off-site domestic wells within 1/2 mile radius of the Mark West Quarry water supply wells. A typical demand rate for a single family dwelling is 0.5 acre-feet per year. The maximum demand used was 50% more, or 0.75 acre-feet per year per dwelling.

Table 9. Water supply and demand comparison, Mark West Quarry, Sonoma County, California.

Source	Property/lease boundary (154 acres)				1/2 mile radius around wells (502 acres)			
	Existing Usage		Proposed Usage		Existing Usage		Proposed Usage	
	acre-feet	*million gallons*	*acre-feet*	*million gallons*	*acre-feet*	*million gallons*	*acre-feet*	*million gallons*
Typical year (Mean)								
Groundwater recharge (Table 5)	102	33.1	102	33.1	388	126	388	126
Groundwater demand (Table 6)	17.9	5.84	24.9	8.12	27.1	8.84	38.7	12.6
Surplus or deficit	83.6	27.2	76.6	25.0	361	118	349	114
Single extreme dry year (1976)								
Groundwater recharge (Table 5)	14.3	4.67	14.3	4.67	49.7	16.2	49.7	16.2
Groundwater demand (Table 6)	17.9	5.84	24.9	8.12	27.1	8.84	38.7	12.6
Surplus or deficit	-3.57	-1.16	-10.6	-3.45	22.6	7.36	11.0	3.58
Multiple drought years (1987-91)								
Groundwater recharge (Table 5)	66.6	21.7	66.6	21.7	254	83	254	83
Groundwater demand (Table 6)	17.9	5.84	24.9	8.12	27.1	8.84	38.7	12.6
Surplus or deficit	48.7	15.9	41.7	13.6	227	73.8	215	70.0

Notes:

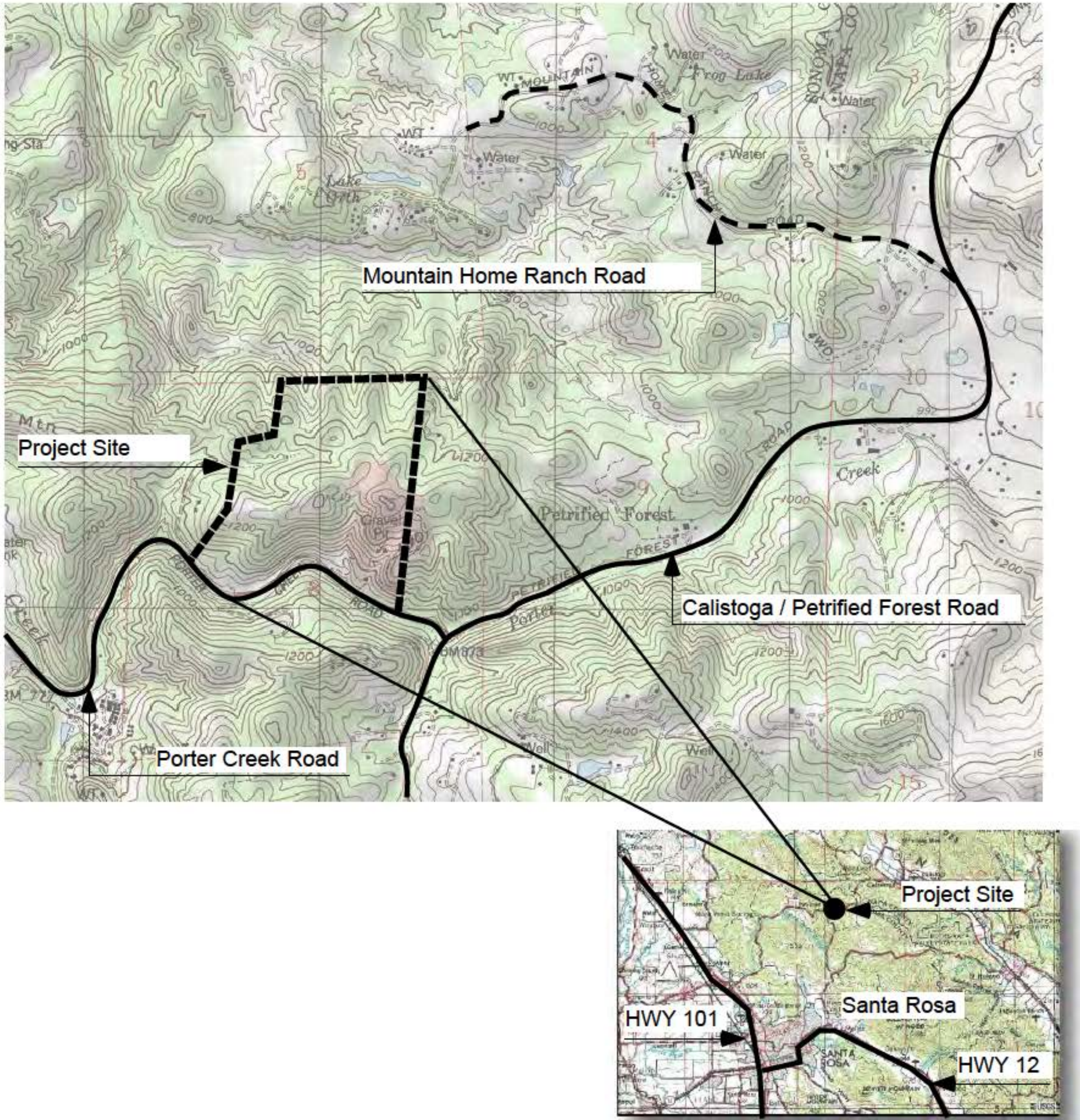
1. There are 6 off-site domestic wells within 1/2 mile radius of the Mark West Quarry water supply wells. A typical demand rate for a single family dwelling is 0.5 acre-feet per year. The maximum demand used was 50% more, or 0.75 acre-feet per year per dwelling.

FIGURES

Mark West Quarry Expansion

BoDean Company, Inc
1060 North Dutton Avenue
Santa Rosa, CA 95401

Figure 1
Regional Location

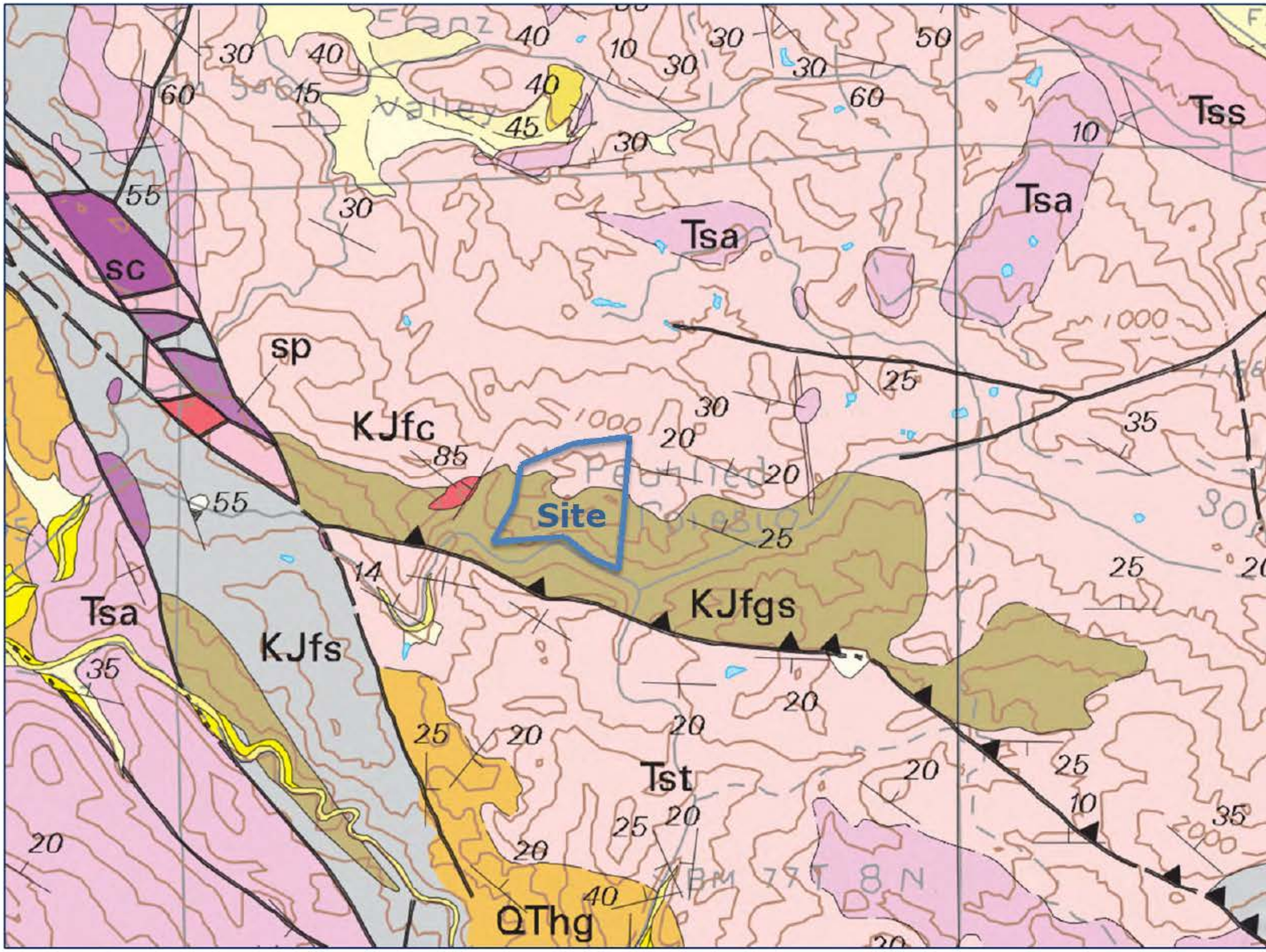


Date: 1/12/09

North

Not to Scale

This drawing is conceptual and for planning and permit-processing purposes only. Program information, scale, location of areas, and other information shown are subject to field evaluation and modification.



QThg Huichica and Glen Ellen Formations, undivided (early Pleistocene? and Pliocene)

Tsa Andesite to basalt lava flows (Pliocene And late Miocene)

Tss Volcanic sand and gravel (Pliocene And late Miocene)

Tst Pumiceous ash-flow tuff (Pliocene And late Miocene)

KJfc Chert (Cretaceous to Jurassic)

KJfs Graywacke and mélange (Early Cretaceous and Late Jurassic)

KJfgs Greenstone (Cretaceous to Jurassic)

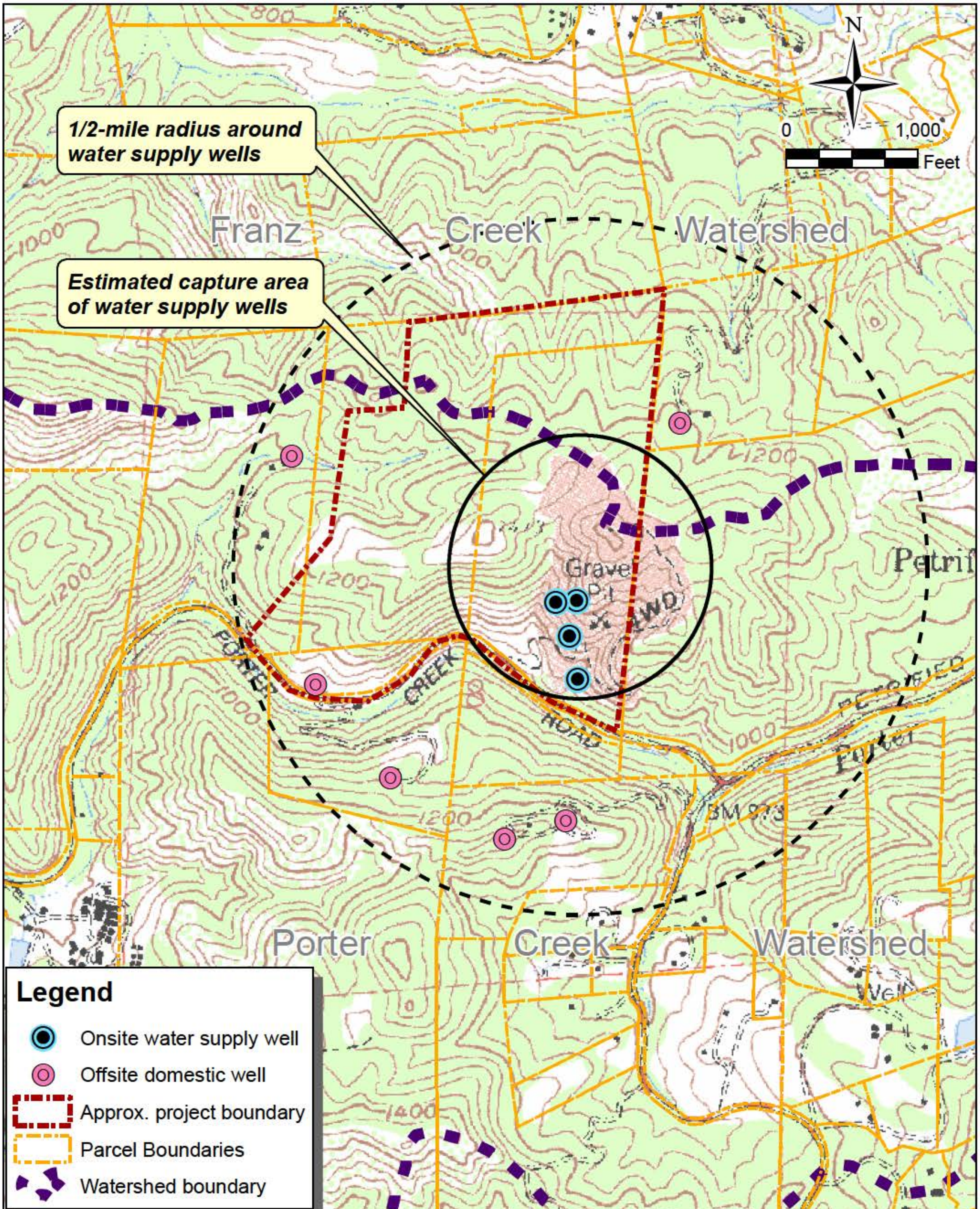
sp Serpentinite

sc Silica-carbonate rock

NORTH

Balance Hydrologics, Inc.®

Figure 2. Regional GeologyMark West Quarry, Sonoma County, California.
Source: Graymer and others, 2007, Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California: USGS Scientific Investigations Map 2956

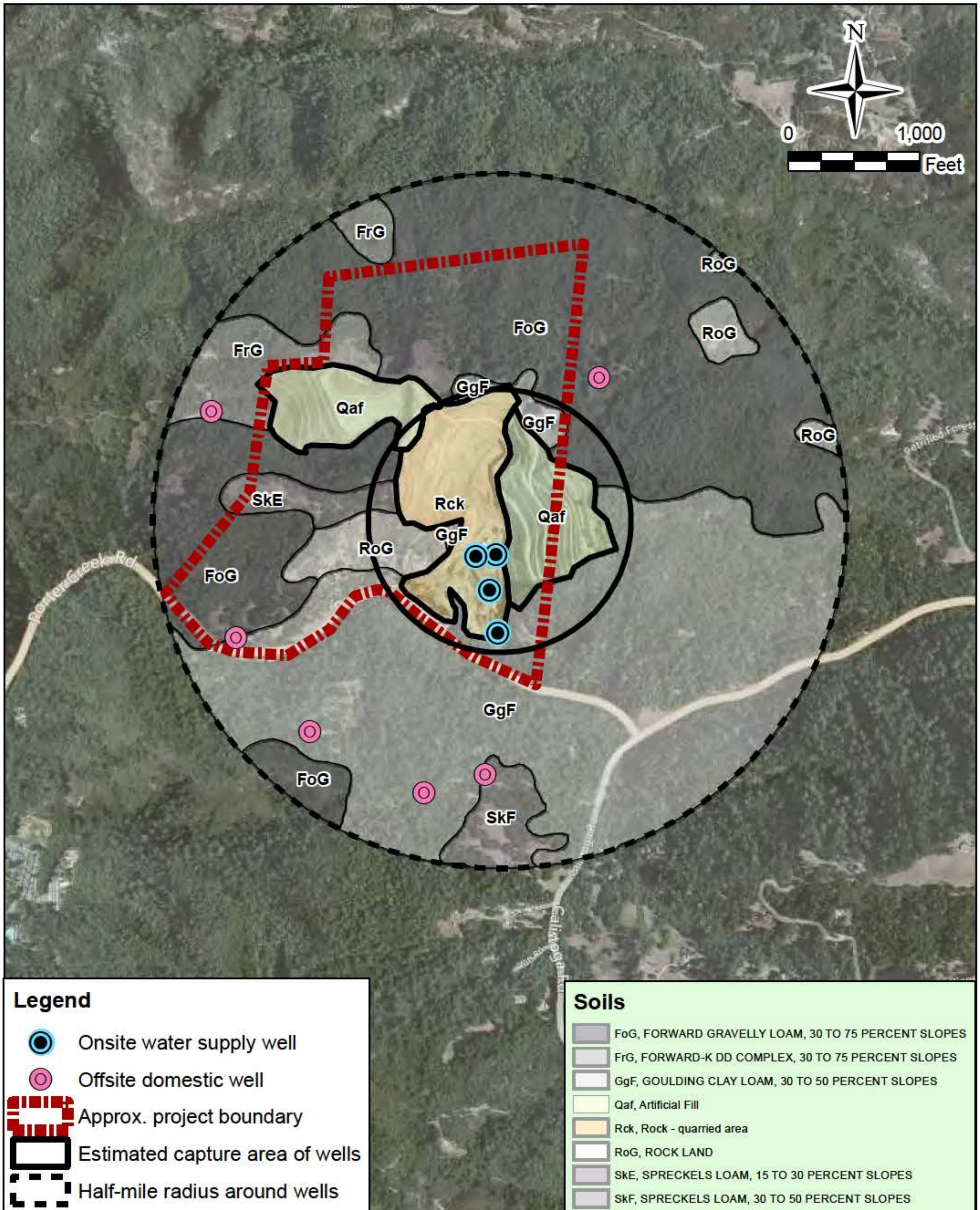


Balance Hydrologics, Inc.

Figure 3. Watershed boundaries and water wells in the vicinity of Mark West Quarry, Sonoma County, California.

Sources: USGS, Sonoma County.

211046 wells location.mxd



Balance Hydrologics, Inc.

Figure 4. Local soils, Mark West Quarry, Sonoma County, California.

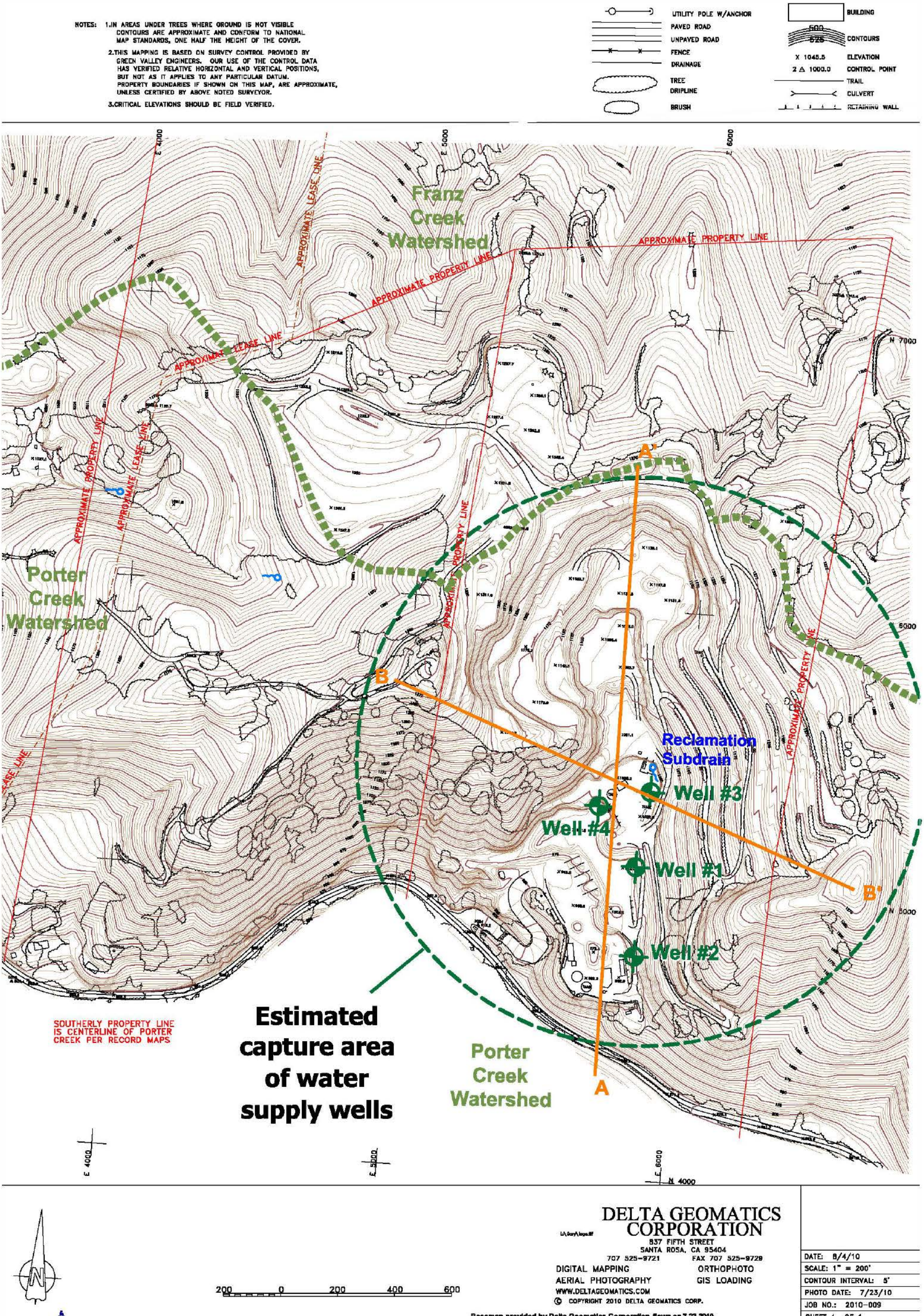
Sources: USGS, NRCS, Sonoma County.

211046 soils.mxd

NOTES: 1. IN AREAS UNDER TREES WHERE GROUND IS NOT VISIBLE CONTOURS ARE APPROXIMATE AND CONFORM TO NATIONAL MAP STANDARDS, ONE HALF THE HEIGHT OF THE COVER.

2. THIS MAPPING IS BASED ON SURVEY CONTROL PROVIDED BY GREEN VALLEY ENGINEERS. OUR USE OF THE CONTROL DATA HAS VERIFIED RELATIVE HORIZONTAL AND VERTICAL POSITIONS, BUT NOT AS IT APPLIES TO ANY PARTICULAR DATUM. PROPERTY BOUNDARIES IF SHOWN ON THIS MAP, ARE APPROXIMATE, UNLESS CERTIFIED BY ABOVE NOTED SURVEYOR.

3. CRITICAL ELEVATIONS SHOULD BE FIELD VERIFIED.



DELTA GEOMATICS CORPORATION
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AERIAL PHOTOGRAPHY GIS LOADING
WWW.DELTAGEOMATICS.COM

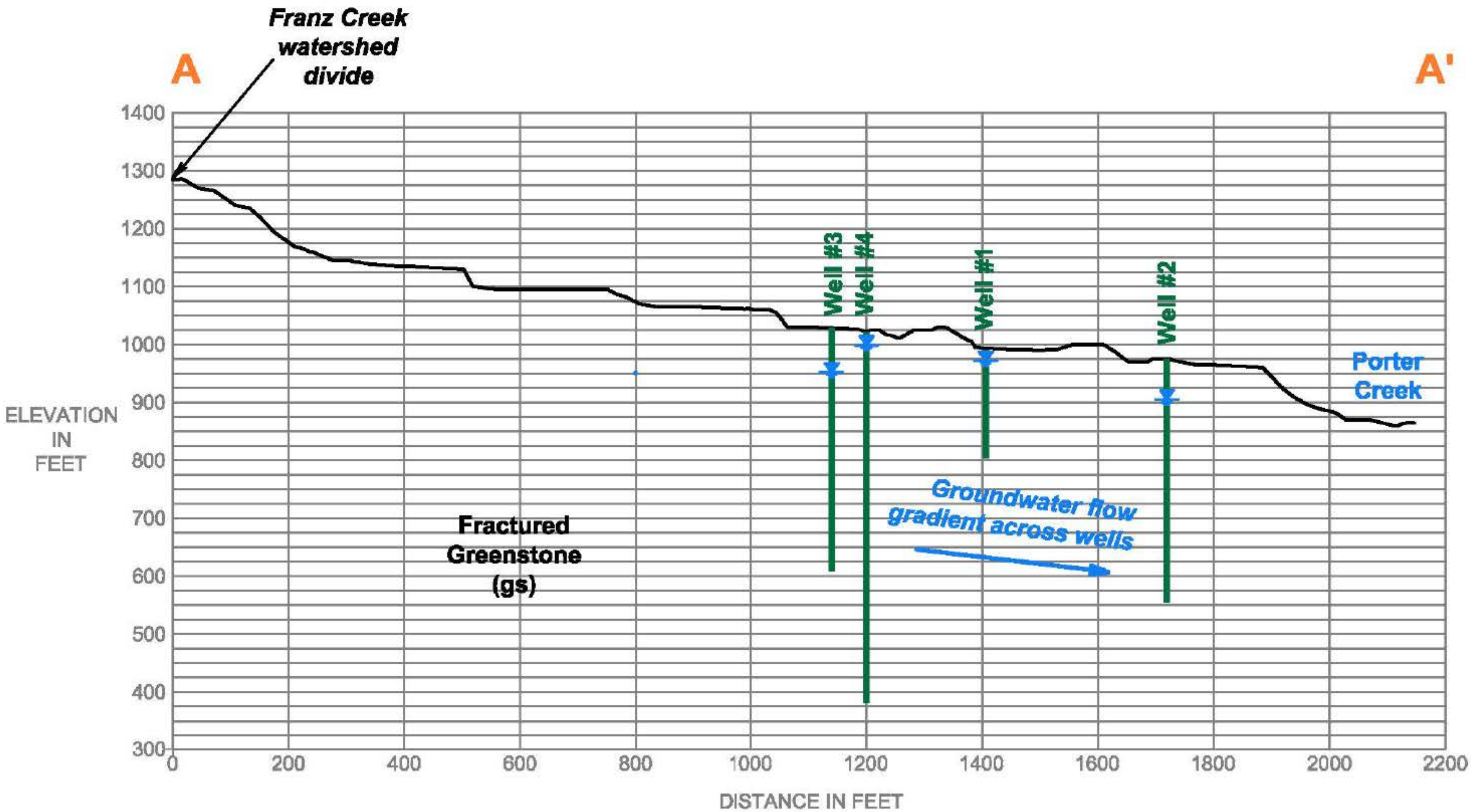
DATE:	8/4/10
SCALE:	1" = 200'
CONTOUR INTERVAL:	5'
PHOTO DATE:	7/23/10
JOB NO.:	2010-009
SHEET 1	OF 1

Basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

Balance Hydrologics, Inc.

Figure 5. On-site water wells, Mark West Quarry, Sonoma County, California.

211046 drainage.dwg



See Figure 9 for cross-section locations.

Elevations from basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

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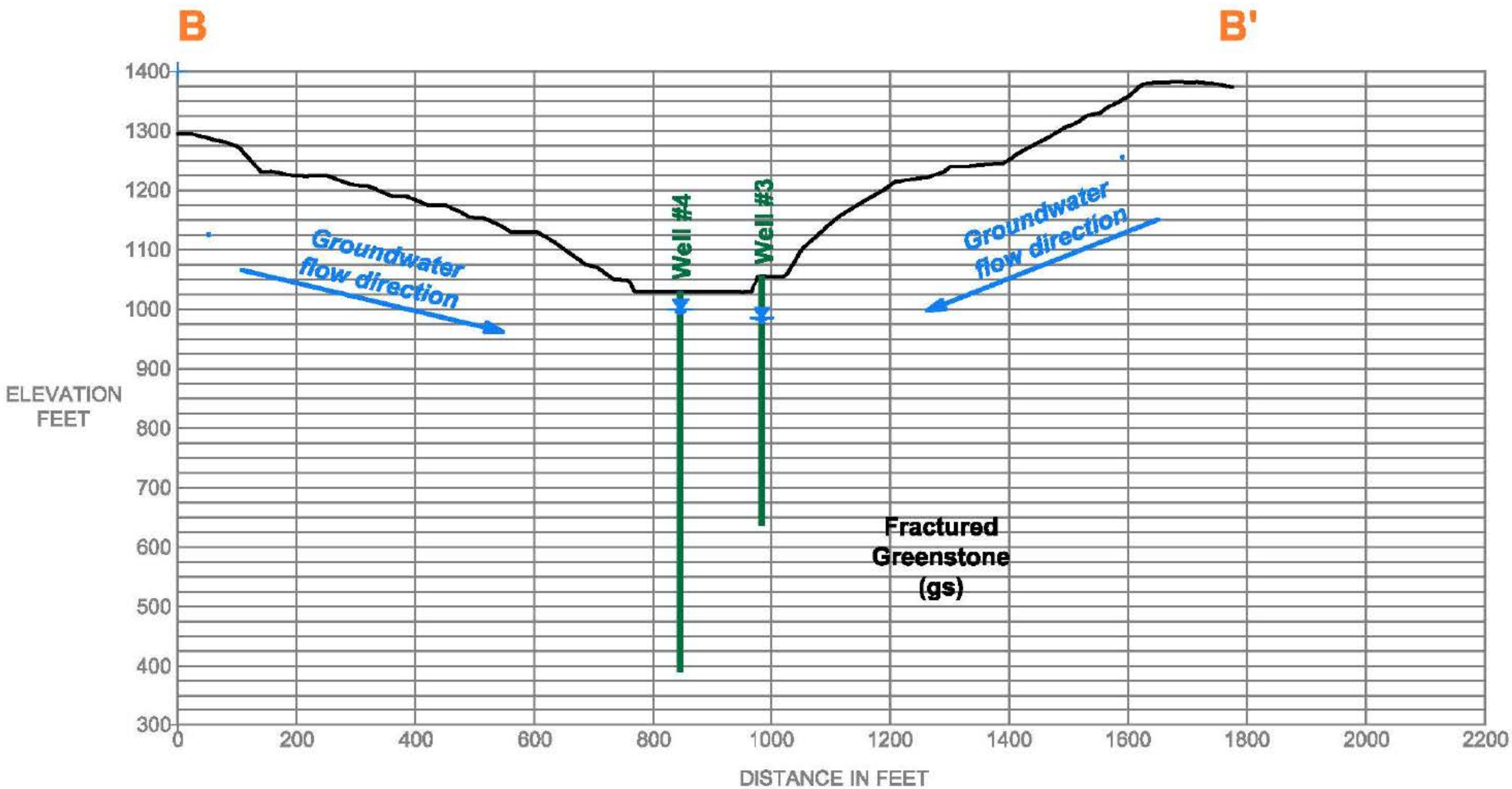
Figure 6. Cross Section A - A', Mark West Quarry, Sonoma County, California

211046 drainage.dwg



See Figure 9 for cross-section locations.

Elevations from basemap provided by Delta Geomatics Corporation, flown on 7-23-2010.

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Figure 7. Cross Section B - B', Mark West Quarry, Sonoma County, California

211046 drainage.dwg

APPENDICES

APPENDIX A

Monthly rainfall record for Santa Rosa, California

Appendix A: Monthly rainfall record (inches) at Santa Rosa, CA.

Latitude N38:26:42, Longitude W122:45:11, Elevation 109 ft.

Sonoma County Station SRO

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% MEAN
1905	--	--	--	5.53	4.26	5.59	1.45	2.93	0.00	0.00	0.00	0.00	--	
1906	0.00	1.97	1.81	10.95	5.24	7.95	0.72	3.31	1.23	0.00	0.00	0.16	33.34	111%
1907	0.00	1.88	6.79	7.57	5.17	11.21	0.34	0.32	1.00	0.00	0.00	0.46	34.74	115%
1908	0.87	0.13	6.30	5.61	4.88	1.45	0.30	0.85	0.08	0.02	0.00	0.00	20.49	68%
1909	1.37	2.12	4.00	18.45	8.74	3.98	0.00	0.00	0.07	0.00	0.00	1.29	40.02	133%
1910	1.73	4.53	7.61	4.94	3.75	4.17	0.85	0.08	0.05	0.00	0.00	0.01	27.72	92%
1911	0.68	1.76	1.68	14.20	2.75	4.96	3.04	0.44	0.02	0.00	0.00	0.00	29.53	98%
1912	0.58	0.72	2.41	3.39	1.09	4.69	1.54	2.88	1.14	0.00	0.00	2.99	21.43	71%
1913	1.47	5.11	1.78	6.11	0.58	2.73	1.91	1.28	0.05	0.07	0.00	0.00	21.09	70%
1914	0.00	7.50	11.15	14.00	5.60	1.49	1.66	0.95	0.41	0.00	0.00	0.07	42.83	142%
1915	1.91	1.30	7.23	9.08	13.52	3.98	0.65	4.82	0.00	0.00	0.00	0.00	42.49	141%
1916	0.20	1.71	8.34	15.20	3.53	1.89	0.00	0.65	0.06	0.61	0.32	0.32	32.83	109%
1917	1.17	2.68	5.92	2.37	5.15	1.22	2.52	0.14	0.02	0.00	0.00	0.33	21.52	72%
1918	0.00	1.49	2.25	1.43	7.06	4.73	0.86	0.03	0.00	0.00	0.03	2.52	20.40	68%
1919	1.04	3.96	2.55	5.59	8.52	2.30	0.50	0.20	0.00	0.00	0.00	0.58	25.24	84%
1920	0.25	0.30	4.35	0.40	1.35	3.06	2.46	0.00	0.50	0.06	0.00	0.10	12.83	43%
1921	3.00	7.78	8.65	9.60	1.83	2.74	0.75	1.19	0.00	0.00	0.00	0.15	35.69	119%
1922	0.63	2.03	8.78	1.10	6.81	3.66	0.25	0.52	0.06	0.00	0.00	0.00	23.84	79%
1923	2.79	4.92	10.84	2.27	1.14	0.05	5.24	0.22	0.44	0.00	0.22	1.78	29.91	99%
1924	0.50	0.48	1.25	4.50	5.58	0.83	0.43	0.33	0.01	0.01	0.01	0.01	13.94	46%
1925	4.34	2.35	7.33	1.88	14.42	3.93	1.77	5.11	0.01	0.07	0.01	1.17	42.39	141%
1926	0.19	3.53	1.53	8.84	6.88	0.25	9.58	0.40	0.00	0.02	0.03	0.02	31.27	104%
1927	1.37	12.64	2.91	6.82	10.93	3.68	3.47	0.43	0.40	0.01	0.01	0.01	42.68	142%
1928	1.98	7.48	3.71	3.10	3.52	6.96	1.97	0.18	0.00	0.00	0.00	0.00	28.90	96%
1929	0.34	4.28	5.02	1.48	2.10	2.10	1.30	0.13	2.48	0.00	0.00	0.00	19.23	64%
1930	0.04	0.00	12.47	5.40	3.91	2.53	1.53	0.62	0.00	0.00	0.00	0.44	26.94	90%
1931	0.87	1.40	0.62	6.52	1.87	2.94	0.49	0.90	0.67	0.00	0.00	0.00	16.28	54%
1932	1.40	2.27	11.29	3.45	1.49	1.21	1.43	1.65	0.00	0.00	0.00	0.00	24.19	80%
1933	0.08	1.69	4.06	6.40	1.51	4.64	0.12	2.23	0.00	0.02	0.00	0.17	20.92	70%
1934	2.02	0.00	8.14	1.75	4.69	1.13	0.73	1.39	1.00	0.00	0.00	0.03	20.88	69%
1935	2.28	5.19	3.45	7.36	3.50	6.31	6.87	0.00	0.00	0.00	0.12	0.23	35.31	117%
1936	1.02	1.47	3.09	7.77	11.81	1.58	1.86	0.61	0.80	0.00	0.03	0.00	30.04	100%
1937	0.22	0.02	2.90	4.92	8.59	6.31	1.87	0.19	1.28	0.05	0.00	0.00	26.35	88%
1938	1.03	7.47	5.40	4.77	9.66	8.03	2.45	0.06	0.00	0.02	0.00	0.38	39.27	131%
1939	2.18	2.22	2.14	3.36	1.61	2.41	0.14	1.12	0.00	0.00	0.00	0.08	15.26	51%
1940	0.52	0.46	2.88	10.87	12.31	7.14	1.84	1.96	0.07	0.00	0.00	0.50	38.55	128%
1941	1.82	2.59	13.56	11.02	8.22	5.59	6.71	1.84	0.30	0.00	0.00	0.13	51.78	172%
1942	1.53	2.98	9.12	6.50	8.65	3.78	5.58	1.67	0.00	0.02	0.00	0.15	39.98	133%
1943	1.23	5.75	5.80	9.28	2.73	4.85	2.67	0.05	0.00	0.03	0.00	0.00	32.39	108%
1944	0.68	1.16	2.38	5.07	7.66	2.25	2.15	1.58	0.28	0.00	0.00	0.02	23.23	77%
1945	2.45	5.90	4.22	3.13	4.92	5.82	0.33	1.39	0.00	0.00	0.00	0.00	28.16	94%
1946	2.91	4.23	10.37	2.32	2.98	2.20	0.10	0.47	0.00	0.20	0.00	0.06	25.84	86%
1947	0.28	4.08	3.66	0.76	3.82	4.94	0.65	0.40	1.63	0.00	0.00	0.00	20.22	67%
1948	5.28	1.55	1.22	4.18	1.51	5.57	7.61	1.03	0.25	0.06	0.00	0.13	28.39	94%
1949	0.85	1.87	4.67	1.39	3.32	6.83	0.08	0.74	0.00	0.05	0.04	0.02	19.86	66%
1950	0.02	2.12	2.79	10.12	5.15	3.29	1.31	0.56	0.06	0.00	0.00	0.00	25.42	84%
1951	3.46	7.19	9.38	5.14	2.84	1.25	1.27	1.48	0.00	0.00	0.01	0.04	32.06	107%
1952	2.68	6.26	8.01	10.19	2.88	4.62	0.84	0.57	1.38	0.04	0.00	0.05	37.52	125%
1953	0.08	2.73	14.72	6.74	0.08	3.17	3.91	0.57	0.97	0.00	0.17	0.00	33.14	110%
1954	1.31	4.64	0.96	7.80	3.19	5.74	3.23	0.37	0.26	0.00	1.35	0.00	28.85	96%
1955	0.90	5.64	4.43	3.63	1.22	0.60	3.68	0.01	0.00	0.00	0.00	0.45	20.56	68%
1956	0.51	3.28	17.89	11.78	6.15	0.31	2.48	1.28	0.10	0.00	0.00	0.17	43.95	146%
1957	2.28	0.23	0.38	3.85	5.57	2.49	2.32	3.93	0.08	0.00	0.00	2.16	23.29	77%
1958	6.16	0.93	3.99	7.18	11.94	6.87	5.43	0.45	0.44	0.01	0.01	0.03	43.44	144%
1959	0.15	0.29	1.96	7.75	6.24	1.60	0.25	0.16	0.00	0.00	0.00	3.16	21.56	72%
1960	0.14	0.08	1.80	5.65	8.46	6.05	1.38	0.80	0.00	0.00	0.00	0.01	24.37	81%
1961	0.74	3.81	4.50	5.22	3.29	4.60	1.07	0.77	0.16	0.00	0.03	0.57	24.76	82%
1962	0.17	2.88	3.93	2.02	8.79	4.34	0.51	0.06	0.00	0.00	0.08	0.36	23.14	77%
1963	9.47	0.95	4.64	3.75	4.22	4.94	6.57	0.66	0.00	0.00	0.01	0.09	35.30	117%
1964	2.61	7.53	0.81	5.19	0.33	1.97	0.33	0.40	1.10	0.00	0.02	0.00	20.29	67%
1965	2.31	6.12	8.64	6.63	1.24	0.97	5.04	0.00	0.00	0.01	0.50	0.00	31.46	105%
1966	0.23	6.11	3.74	8.62	3.30	0.97	1.31	0.21	0.13	0.00	0.12	0.35	25.09	83%

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% MEAN
1967	0.01	7.61	6.55	12.42	0.58	5.86	6.72	0.17	1.94	0.00	0.00	0.07	41.93	139%
1968	0.86	2.68	4.01	7.63	4.82	4.20	0.48	0.26	0.00	0.00	1.68	0.02	26.64	89%
1969	2.07	7.16	9.00	13.25	8.23	1.79	3.23	0.03	0.04	0.00	0.00	0.03	44.83	149%
1970	2.42	1.19	11.79	15.89	2.89	3.44	0.07	0.00	0.44	0.00	0.00	0.00	38.13	127%
1971	2.24	8.97	10.78	3.13	0.19	4.05	1.22	0.24	0.05	0.00	0.03	0.34	31.24	104%
1972	0.49	2.39	5.49	1.89	3.49	1.02	1.79	0.09	0.13	0.05	0.11	0.66	17.60	58%
1973	3.47	6.87	5.12	15.38	7.17	3.48	0.65	0.03	0.00	0.00	0.00	0.74	42.91	143%
1974	2.37	13.23	5.33	6.48	3.54	6.67	2.87	0.09	0.00	1.61	0.00	0.00	42.19	140%
1975	1.27	1.20	3.80	1.98	9.88	7.84	1.71	0.02	0.10	0.00	0.21	0.02	28.03	93%
1976	6.44	1.58	0.89	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	16.92	56%
1977	0.46	1.76	1.15	2.01	1.93	2.65	0.23	1.43	0.00	0.00	0.00	1.16	12.78	42%
1978	0.65	0.03	5.22	9.81	7.60	5.30	2.29	0.08	0.00	0.00	0.00	1.38	32.36	108%
1979	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1980	4.14	5.99	7.71	7.09	8.82	1.52	2.00	0.19	0.27	0.00	0.00	0.00	37.73	125%
1981	*0.38*	*0.50*	*6.60*	*7.81*	*2.60*	*3.58*	*0.20*	*0.63*	*0.00*	*0.02*	*0.00*	*0.24*	22.56	75%
1982	*2.76*	*8.91*	*11.29*	*8.72*	*5.23*	*6.50*	*4.00*	*0.00*	*0.03*	*0.00*	*0.00*	*0.97*	48.41	161%
1983	4.30	8.44	3.61	8.39	9.83	*15.74*	3.46	0.92	0.00	0.00	0.75	0.24	55.68	185%
1984	1.20	11.21	11.33	0.65	2.45	2.25	1.18	0.11	0.13	0.00	0.17	0.09	30.77	102%
1985	2.36	10.92	2.60	1.87	3.01	4.61	0.20	0.04	0.02	0.03	0.00	1.04	26.70	89%
1986	1.06	4.57	3.24	6.45	14.14	5.90	0.83	0.82	0.00	0.00	0.00	2.75	39.76	132%
1987	0.55	0.20	2.65	4.83	5.45	4.83	0.15	0.01	0.00	0.00	0.00	0.00	18.67	62%
1988	1.37	4.45	6.11	6.99	0.40	0.02	1.53	0.73	0.49	0.00	0.00	0.00	22.09	73%
1989	0.11	4.89	4.07	1.47	1.53	10.22	1.22	0.13	0.22	0.00	0.04	2.72	26.62	88%
1990	2.65	1.71	0.00	5.74	3.27	2.03	0.24	5.46	0.01	0.00	0.00	0.27	21.38	71%
1991	0.62	0.44	1.16	0.75	4.72	13.74	0.33	0.13	0.72	0.00	0.05	0.01	22.67	75%
1992	1.74	1.15	2.91	2.03	9.34	4.69	1.64	0.00	0.79	0.00	0.00	0.00	24.29	81%
1993	3.65	0.31	8.73	11.48	5.58	3.44	1.60	1.43	1.06	0.00	0.00	0.00	37.28	124%
1994	3.28	3.39	4.12	3.55	5.27	0.32	1.57	0.84	0.00	0.00	0.00	0.04	22.38	74%
1995	1.02	7.21	4.56	19.99	1.14	13.40	3.43	0.86	0.63	0.00	0.00	0.00	52.24	174%
1996	0.23	0.14	9.38	9.93	9.52	2.75	3.59	3.75	0.00	0.00	0.00	0.00	39.29	131%
1997	0.71	3.88	12.40	11.66	0.41	1.20	1.12	1.11	0.42	0.00	0.98	0.40	34.29	114%
1998	1.58	8.93	3.65	11.17	19.76	3.56	2.25	2.90	0.00	0.00	0.00	0.03	53.83	179%
1999	1.20	7.00	1.06	4.75	12.34	4.31	2.20	0.08	0.13	0.00	0.00	0.03	33.10	110%
2000	0.98	4.39	0.43	5.09	12.74	2.68	2.15	1.21	0.22	0.00	0.00	0.41	30.30	101%
2001	2.32	1.65	1.00	5.64	6.62	1.94	1.04	0.00	0.33	0.00	0.00	0.09	20.63	69%
2002	1.18	12.09	12.29	6.42	1.66	2.08	0.61	1.13	0.00	0.00	0.00	0.00	37.46	124%
2003	0.00	3.48	16.18	3.63	2.18	2.24	4.78	1.48	0.05	0.03	0.01	0.07	34.13	113%
2004	0.04	3.19	11.42	3.44	9.29	1.14	0.68	*0.03*	*0.00*	*0.02*	*0.01*	*0.11*	29.37	98%
2005	3.27	1.81	10.46	4.12	4.29	5.74	1.61	5.55	0.95	0.00	0.02	0.00	37.82	126%
2006	1.00	2.47	17.65	5.36	3.63	10.03	5.05	0.49	0.02	0.02	0.00	0.00	45.72	152%
2007	0.57	3.58	5.46	0.49	7.07	0.28	2.58	*0.36*	*0.00*	0.17	0.00	0.05	20.61	68%
2008	3.26	0.81	5.06	10.21	3.09	0.32	0.30	0.03	0.00	0.00	0.00	0.03	23.11	77%
2009	0.80	1.94	3.26	0.63	7.97	2.77	0.49	3.10	0.06	0.00	0.00	0.16	21.18	70%
2010	3.34	1.05	3.34	8.88	3.84	3.70	4.29	2.68	0.11	0.01	0.01	0.10	31.35	104%
2011	5.14	3.13	8.38	1.68	5.71	10.44	0.66	2.41	1.62	0.00	0.00	0.01	39.18	130%
2012	2.07	2.07	0.09	6.31	2.16									
Mean	1.60	3.64	5.66	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	30.18	
Cumulative	1.60	5.25	10.90	17.16	22.41	26.42	28.40	29.35	29.64	29.67	29.74	30.09	--	
Maximum	9.47	13.23	17.89	19.99	19.76	15.74	9.58	5.55	2.48	1.61	1.68	3.16	55.68	
Minimum	0.00	0.00	0.00	0.39	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	12.78	
Sta. Dev.	1.592	3.091	4.059	4.141	3.756	2.983	1.903	1.234	0.480	0.168	0.253	0.677	9.592	
Skew	1.931	1.078	0.926	0.888	1.071	1.455	1.584	2.055	2.226	8.472	4.578	2.769	0.494	
Kurtosis	5.577	0.707	0.379	0.721	1.265	2.896	2.571	4.168	5.159	77.106	22.466	7.353	-0.329	
Sample Size	106	106	106	107	107	106	106	106	106	106	106	106	105	

Notes: 1. *Italicized* font indicates data from NCDC Station 7965 substituting missing data.
2. Red font indicates multiple drought years and blue font indicates multiple wet years or an isolated extreme year.

APPENDIX B

Mean annual water balance and groundwater recharge estimates

Appendix B. Mean annual water balance and groundwater recharge estimates, Mark West Quarry existing conditions, Sonoma County, California

Map Symbol	Soil Series[1]	Property/lease boundary			1/2 mile radius around wells		
		acres	*acre-feet*	*inches*	*acres*	*acre-feet*	*inches*
Rainfall:	All soils	154	604	47.00	502	1967	47.00
Actual evapotranspiration:							
Fo, Fr	Forward, Forward-Kidd	67.1	102	18.30	217	330	18.30
Gg, Gl	Goulding	18.8	30.3	19.29	194	312	19.29
Sk	Spreckles	6.52	12.1	22.29	17.8	33.1	22.29
Qaf	Artificial fill	24.9	46.7	22.47	31.2	58.3	22.47
RoG, Rck	Rock land	36.8	19.6	6.39	42.5	22.6	6.39
	TOTAL	154	211	**16.42**	502	757	**18.08**
Runoff:							
Fo, Fr	Forward, Forward-Kidd	67.1	101	18.00	217	325	18.00
Gg, Gl	Goulding	18.8	28.3	18.00	194	291	18.00
Sk	Spreckles	6.52	9.78	18.00	17.8	26.7	18.00
Qaf	Artificial fill	24.9	37.4	18.00	31.2	46.7	18.00
RoG, Rck	Rock land	36.8	115.4	37.60	42.5	133.1	37.60
	TOTAL	154	291	**22.68**	502	823	**19.66**
Groundwater recharge:							
Fo, Fr	Forward, Forward-Kidd	67.1	59.8	10.70	217	193	10.70
Gg, Gl	Goulding	18.8	15.2	9.71	194	157	9.71
Sk	Spreckles	6.52	3.64	6.71	17.8	9.96	6.71
Qaf	Artificial fill	24.9	13.6	6.53	31.2	17.0	6.53
RoG, Rck	Rock land	36.8	9.2	3.01	42.5	10.6	3.01
	TOTAL	154	101.5	**7.90**	502	388	**9.27**

Notes:

1) Information taken from the most-recent USDA soil survey for the area (1972), and/or Soil Survey Laboratory Data for Some Soils of California (Soil Survey Investigations Report No. 24), 1973. This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 acres will not be mapped.

Appendix B. Estimated groundwater recharge from **Forward** soil areas during a typical (mean) year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	2.31	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	67.1	acres	
Annual actual evapotranspiration	102	acre-feet	
Annual runoff	101	acre-feet	
Annual groundwater recharge	59.8	acre-feet	
Soil area within 1/2 mile radius of wells	217	acres	
Annual actual evapotranspiration	330	acre-feet	
Annual runoff	325	acre-feet	
Annual groundwater recharge	193	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean)	inches	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.64	5.66	30.09	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	9.77	8.20	6.26	3.10	1.48	0.44	0.05	0.12	0.54	2.50	5.69	8.83	47.00	Mean annual rainfall (SCWA, April 1983) proportioned to mean monthly rainfall at CDEC station SRO
P - PET	inches	8.89	6.65	3.27	-1.43	-3.98	-6.03	-6.48	-5.75	-3.82	-0.74	4.32	7.87	2.79	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	2.31	2.31	2.31	0.88	0.00	0.00	0.00	0.00	0.00	0.00	2.31	2.31	--	If P>PET, then ST=AWC unless previous ST<AWC, then ST=P-PET + previous ST. If P<PET, then ST = previous ST - (PET - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-1.43	-0.88	0.00	0.00	0.00	0.00	0.00	2.31	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	2.37	0.44	0.05	0.12	0.54	2.50	1.37	0.96	18.30	If P>PET, then PET else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	-3.09	-6.03	-6.48	-5.75	-3.82	-0.74	0.00	0.00	-25.91	AET - PET
Water surplus (available for runoff and recharge)	inches	8.89	6.65	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	7.87	28.70	P - AET - change in ST
Runoff, RO	inches	5.58	4.17	2.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	4.94	18.00	Mean annual runoff (Rantz, 1974) proportioned to monthly water surplus
Groundwater recharge	inches	3.32	2.48	1.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	2.94	**10.70**	Water surplus - runoff

Appendix B. Estimated groundwater recharge from **Goulding** soil areas during a typical (mean) year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	3.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	18.8	acres	
Annual actual evapotranspiration	30.3	acre-feet	
Annual runoff	28.3	acre-feet	
Annual groundwater recharge	15.2	acre-feet	
Soil area within 1/2 mile radius of wells	194	acres	
Annual actual evapotranspiration	312	acre-feet	
Annual runoff	291	acre-feet	
Annual groundwater recharge	157	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean)	inches	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.64	5.66	30.09	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	9.77	8.20	6.26	3.10	1.48	0.44	0.05	0.12	0.54	2.50	5.69	8.83	47.00	Mean annual rainfall (SCWA, April 1983) proportioned to mean monthly rainfall at CDEC station SRO
P - ETo	inches	8.89	6.65	3.27	-1.43	-3.98	-6.03	-6.48	-5.75	-3.82	-0.74	4.32	7.87	2.79	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	3.30	3.30	3.30	1.87	0.00	0.00	0.00	0.00	0.00	0.00	3.30	3.30	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-1.43	-1.87	0.00	0.00	0.00	0.00	0.00	3.30	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	3.36	0.44	0.05	0.12	0.54	2.50	1.37	0.96	19.29	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	-2.10	-6.03	-6.48	-5.75	-3.82	-0.74	0.00	0.00	-24.92	AET - ETo
Water surplus (available for runoff and recharge)	inches	8.89	6.65	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	7.87	27.71	P - AET - change in ST
Runoff, RO	inches	5.78	4.32	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	5.12	18.00	Mean annual runoff (Rantz, 1974) proportioned to monthly water surplus
Groundwater recharge	inches	3.12	2.33	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	2.76	**9.71**	Water surplus - runoff

Appendix B. Estimated groundwater recharge from **Sprekles** soil areas during a typical (mean) year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	6.52	acres	
Annual actual evapotranspiration	12.1	acre-feet	
Annual runoff	9.78	acre-feet	
Annual groundwater recharge	3.64	acre-feet	
Soil area within 1/2 mile radius of wells	17.8	acres	
Annual actual evapotranspiration	33.1	acre-feet	
Annual runoff	26.7	acre-feet	
Annual groundwater recharge	9.96	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean)	inches	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.64	5.66	30.09	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	9.77	8.20	6.26	3.10	1.48	0.44	0.05	0.12	0.54	2.50	5.69	8.83	47.00	Mean annual rainfall (SCWA, April 1983) proportioned to mean monthly rainfall at CDEC station SRO
P - ETo	inches	8.89	6.65	3.27	-1.43	-3.98	-6.03	-6.48	-5.75	-3.82	-0.74	4.32	7.87	2.79	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.30	6.30	6.30	4.87	0.90	0.00	0.00	0.00	0.00	0.00	4.32	6.30	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-1.43	-3.98	-0.90	0.00	0.00	0.00	0.00	4.32	1.98	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	5.46	1.34	0.05	0.12	0.54	2.50	1.37	0.96	22.29	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	0.00	-5.13	-6.48	-5.75	-3.82	-0.74	0.00	0.00	-21.92	AET - ETo
Water surplus (available for runoff and recharge)	inches	8.89	6.65	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.90	24.71	P - AET - change in ST
Runoff, RO	inches	6.48	4.85	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.30	18.00	Mean annual runoff (Rantz, 1974) proportioned to monthly water surplus
Groundwater recharge	inches	2.41	1.81	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	**6.71**	Water surplus - runoff

Appendix B. Estimated groundwater recharge from **artificial fill** areas during a typical (mean) year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.5	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	24.9	acres	
Annual actual evapotranspiration	46.7	acre-feet	
Annual runoff	37.4	acre-feet	
Annual groundwater recharge	13.6	acre-feet	
Soil area within 1/2 mile radius of wells	31.2	acres	
Annual actual evapotranspiration	58.3	acre-feet	
Annual runoff	46.7	acre-feet	
Annual groundwater recharge	17.0	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean)	inches	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.64	5.66	30.09	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	9.77	8.20	6.26	3.10	1.48	0.44	0.05	0.12	0.54	2.50	5.69	8.83	47.00	Mean annual rainfall (SCWA, April 1983) proportioned to mean monthly rainfall at CDEC station SRO
P - ETo	inches	8.89	6.65	3.27	-1.43	-3.98	-6.03	-6.48	-5.75	-3.82	-0.74	4.32	7.87	2.79	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.48	6.48	6.48	5.05	1.08	0.00	0.00	0.00	0.00	0.00	4.32	6.48	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-1.43	-3.98	-1.08	0.00	0.00	0.00	0.00	4.32	2.16	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	5.46	1.52	0.05	0.12	0.54	2.50	1.37	0.96	22.47	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	0.00	-4.95	-6.48	-5.75	-3.82	-0.74	0.00	0.00	-21.74	AET - ETo
Water surplus (available for runoff and recharge)	inches	8.89	6.65	3.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.72	24.53	P - AET - change in ST
Runoff, RO	inches	6.52	4.88	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.20	18.00	Mean annual runoff (Rantz, 1974) proportioned to monthly water surplus
Groundwater recharge	inches	2.37	1.77	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52	**6.53**	Water surplus - runoff

Appendix B. Estimated groundwater recharge from **rock** soil areas during a typical (mean) year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	0.0	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	0.25	inches	evaporation from bare soil
Soil area on Mark West Quarry	36.8	acres	
Annual actual evapotranspiration	19.6	acre-feet	
Annual runoff	115	acre-feet	
Annual groundwater recharge	9.23	acre-feet	
Soil area within 1/2 mile radius of wells	42.5	acres	
Annual actual evapotranspiration	22.6	acre-feet	
Annual runoff	133	acre-feet	
Annual groundwater recharge	10.64	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.22	0.388	0.748	1.133	1.365	1.618	1.633	1.468	1.09	0.81	0.343	0.24	11.05	ETo * Kc
Precipitation at Santa Rosa (Mean)	inches	6.26	5.25	4.01	1.99	0.95	0.28	0.03	0.08	0.35	1.60	3.64	5.66	30.09	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	9.77	8.20	6.26	3.10	1.48	0.44	0.05	0.12	0.54	2.50	5.69	8.83	47.00	Mean annual rainfall (SCWA, April 1983) proportioned to mean monthly rainfall at CDEC station SRO
P - ETo	inches	9.55	7.82	5.51	1.97	0.12	-1.18	-1.58	-1.35	-0.55	1.69	5.35	8.59	35.95	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.22	0.39	0.75	1.13	1.37	0.44	0.05	0.12	0.54	0.81	0.34	0.24	6.39	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	0.00	-1.18	-1.58	-1.35	-0.55	0.00	0.00	0.00	-4.66	AET - ETo
Water surplus (available for runoff and recharge)	inches	9.55	7.82	5.51	1.97	0.12	0.00	0.00	0.00	0.00	1.69	5.35	8.59	40.61	P - AET - change in ST
Runoff, RO	inches	8.84	7.24	5.10	1.82	0.11	0.00	0.00	0.00	0.00	1.57	4.95	7.96	37.60	80% of P proportioned to monthly water surplus
Groundwater recharge	inches	0.71	0.58	0.41	0.15	0.01	0.00	0.00	0.00	0.00	0.13	0.40	0.64	**3.01**	Water surplus - runoff

APPENDIX C

1976 annual water balance and groundwater recharge estimates

Appendix C. 1976 water balance and groundwater recharge estimates, Mark West Quarry existing conditions, Sonoma County, California

Map Symbol	Soil Series[1]	Property/lease boundary			1/2 mile radius around wells		
		acres	*acre-feet*	*inches*	*acres*	*acre-feet*	*inches*
Rainfall:	All soils	154	228	17.78	502	744	17.78
Actual evapotranspiration:							
Fo, Fr	Forward, Forward-Kidd	67.1	86	15.34	217	277	15.34
Gg, Gl	Goulding	18.8	25.6	16.33	194	264	16.33
Sk	Spreckles	6.52	10.5	19.33	17.8	28.7	19.33
Qaf	Artificial fill	24.9	40.5	19.51	31.2	50.7	19.51
RoG, Rck	Rock land	36.8	18.7	6.08	42.5	21.5	6.08
	TOTAL	154	181	**14.10**	502	642	**15.34**
Runoff:							
Fo, Fr	Forward, Forward-Kidd	67.1	7	1.27	217	23	1.27
Gg, Gl	Goulding	18.8	2.1	1.31	194	21	1.31
Sk	Spreckles	6.52	0.80	1.47	17.8	2.2	1.47
Qaf	Artificial fill	24.9	3.1	1.48	31.2	3.9	1.48
RoG, Rck	Rock land	36.8	33.2	10.83	42.5	38.3	10.83
	TOTAL	154	46	**3.60**	502	88	**2.11**
Groundwater recharge:							
Fo, Fr	Forward, Forward-Kidd	67.1	7.0	1.26	217	23	1.26
Gg, Gl	Goulding	18.8	1.9	1.21	194	20	1.21
Sk	Spreckles	6.52	0.57	1.05	17.8	1.56	1.05
Qaf	Artificial fill	24.9	2.2	1.04	31.2	2.7	1.04
RoG, Rck	Rock land	36.8	2.7	0.87	42.5	3.1	0.87
	TOTAL	154	14	**1.12**	502	50	**1.19**

Notes:

1) Information taken from the most-recent USDA soil survey for the area (1972), and/or Soil Survey Laboratory Data for Some Soils of California (Soil Survey Investigations Report No. 24), 1973. This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 acres will not be mapped.

Appendix C. Estimated groundwater recharge from **Forward** soil areas during a single extreme dry year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	2.31	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	67.1	acres	
Annual actual evapotranspiration	86	acre-feet	
Annual runoff	7	acre-feet	
Annual groundwater recharge	7.0	acre-feet	
Soil area within 1/2 mile radius of wells	217	acres	
Annual actual evapotranspiration	277	acre-feet	
Annual runoff	23	acre-feet	
Annual groundwater recharge	23	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (1976)	inches	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	0.46	1.76	1.15	11.38	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	0.61	4.08	1.44	4.09	0.00	0.05	0.00	1.22	1.03	0.72	2.75	1.80	17.78	1976 annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1976 monthly rainfall at SRO
P - PET	inches	-0.27	2.53	-1.55	-0.44	-5.46	-6.42	-6.53	-4.65	-3.33	-2.52	1.38	0.84	-26.43	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	2.31	2.31	0.76	0.32	0.00	0.00	0.00	0.00	0.00	0.00	1.38	2.22	--	If P>PET, then ST=AWC unless previous ST<AWC, then ST=P-PET + previous ST. If P<PET, then ST = previous ST - (PET - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	-1.55	-0.44	-0.32	0.00	0.00	0.00	0.00	0.00	1.38	0.84	-0.09	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.61	1.55	2.99	4.53	0.32	0.05	0.00	1.22	1.03	0.72	1.37	0.96	15.34	If P>PET, then PET else P - change in ST
Water deficiency	inches	-0.27	0.00	0.00	0.00	-5.14	-6.42	-6.53	-4.65	-3.33	-2.52	0.00	0.00	-28.87	AET - PET
Water surplus (available for runoff and recharge)	inches	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	P - AET - change in ST
Runoff, RO	inches	0.00	1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	1976 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1976 monthly water surplus
Groundwater recharge	inches	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.26**	Water surplus - runoff

Appendix C. Estimated groundwater recharge from **Goulding** soil areas during a single extreme dry year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	3.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	18.8	acres	
Annual actual evapotranspiration	25.6	acre-feet	
Annual runoff	2.1	acre-feet	
Annual groundwater recharge	1.9	acre-feet	
Soil area within 1/2 mile radius of wells	194	acres	
Annual actual evapotranspiration	264	acre-feet	
Annual runoff	21	acre-feet	
Annual groundwater recharge	20	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (1976)	inches	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	0.46	1.76	1.15	11.38	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	0.61	4.08	1.44	4.09	0.00	0.05	0.00	1.22	1.03	0.72	2.75	1.80	17.78	1976 annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1976 monthly rainfall at SRO
P - ETo	inches	-0.27	2.53	-1.55	-0.44	-5.46	-6.42	-6.53	-4.65	-3.33	-2.52	1.38	0.84	-26.43	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	3.30	3.30	1.75	1.31	0.00	0.00	0.00	0.00	0.00	0.00	1.38	2.22	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	-1.55	-0.44	-1.31	0.00	0.00	0.00	0.00	0.00	1.38	0.84	-1.08	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.61	1.55	2.99	4.53	1.31	0.05	0.00	1.22	1.03	0.72	1.37	0.96	16.33	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	-0.27	0.00	0.00	0.00	-4.15	-6.42	-6.53	-4.65	-3.33	-2.52	0.00	0.00	-27.88	AET - ETo
Water surplus (available for runoff and recharge)	inches	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	P - AET - change in ST
Runoff, RO	inches	0.00	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	1976 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1976 monthly water surplus
Groundwater recharge	inches	0.00	1.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.21**	Water surplus - runoff

Appendix C. Estimated groundwater recharge from **Sprekles** soil areas during a single extreme dry year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	6.52	acres	
Annual actual evapotranspiration	10.5	acre-feet	
Annual runoff	0.80	acre-feet	
Annual groundwater recharge	0.57	acre-feet	
Soil area within 1/2 mile radius of wells	17.8	acres	
Annual actual evapotranspiration	28.7	acre-feet	
Annual runoff	2.2	acre-feet	
Annual groundwater recharge	1.56	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (1976)	inches	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	0.46	1.76	1.15	11.38	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	0.61	4.08	1.44	4.09	0.00	0.05	0.00	1.22	1.03	0.72	2.75	1.80	17.78	1976 annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1976 monthly rainfall at SRO
P - ETo	inches	-0.27	2.53	-1.55	-0.44	-5.46	-6.42	-6.53	-4.65	-3.33	-2.52	1.38	0.84	-26.43	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.30	6.30	4.75	4.31	0.00	0.00	0.00	0.00	0.00	0.00	1.38	2.22	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	-1.55	-0.44	-4.31	0.00	0.00	0.00	0.00	0.00	1.38	0.84	-4.08	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.61	1.55	2.99	4.53	4.31	0.05	0.00	1.22	1.03	0.72	1.37	0.96	19.33	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	-0.27	0.00	0.00	0.00	-1.15	-6.42	-6.53	-4.65	-3.33	-2.52	0.00	0.00	-24.88	AET - ETo
Water surplus (available for runoff and recharge)	inches	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	P - AET - change in ST
Runoff, RO	inches	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	1976 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1976 monthly water surplus
Groundwater recharge	inches	0.00	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.05**	Water surplus - runoff

Appendix C. Estimated groundwater recharge from **artificial fill** areas during a single extreme dry year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.5	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	24.9	acres	
Annual actual evapotranspiration	40.5	acre-feet	
Annual runoff	3.1	acre-feet	
Annual groundwater recharge	2.2	acre-feet	
Soil area within 1/2 mile radius of wells	31.2	acres	
Annual actual evapotranspiration	50.7	acre-feet	
Annual runoff	3.9	acre-feet	
Annual groundwater recharge	2.7	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (1976)	inches	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	0.46	1.76	1.15	11.38	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	0.61	4.08	1.44	4.09	0.00	0.05	0.00	1.22	1.03	0.72	2.75	1.80	17.78	1976 annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1976 monthly rainfall at SRO
P - ETo	inches	-0.27	2.53	-1.55	-0.44	-5.46	-6.42	-6.53	-4.65	-3.33	-2.52	1.38	0.84	-26.43	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.48	6.48	4.93	4.49	0.00	0.00	0.00	0.00	0.00	0.00	1.38	2.22	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	-1.55	-0.44	-4.49	0.00	0.00	0.00	0.00	0.00	1.38	0.84	-4.26	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.61	1.55	2.99	4.53	4.49	0.05	0.00	1.22	1.03	0.72	1.37	0.96	19.51	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	-0.27	0.00	0.00	0.00	-0.97	-6.42	-6.53	-4.65	-3.33	-2.52	0.00	0.00	-24.70	AET - ETo
Water surplus (available for runoff and recharge)	inches	0.00	2.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.53	P - AET - change in ST
Runoff, RO	inches	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.48	1976 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1976 monthly water surplus
Groundwater recharge	inches	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.04**	Water surplus - runoff

Appendix C. Estimated groundwater recharge from **rock** soil areas during a single extreme dry year, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	0.0	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	0.25	inches	evaporation from bare soil
Soil area on Mark West Quarry	36.8	acres	
Annual actual evapotranspiration	18.7	acre-feet	
Annual runoff	33	acre-feet	
Annual groundwater recharge	2.66	acre-feet	
Soil area within 1/2 mile radius of wells	42.5	acres	
Annual actual evapotranspiration	21.5	acre-feet	
Annual runoff	38	acre-feet	
Annual groundwater recharge	3.06	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.22	0.388	0.748	1.133	1.365	1.618	1.633	1.468	1.09	0.81	0.343	0.24	11.05	ETo * Kc
Precipitation at Santa Rosa (1976)	inches	0.39	2.61	0.92	2.62	0.00	0.03	0.00	0.78	0.66	0.46	1.76	1.15	11.38	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	0.61	4.08	1.44	4.09	0.00	0.05	0.00	1.22	1.03	0.72	2.75	1.80	17.78	1976 annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1976 monthly rainfall at SRO
P - ETo	inches	0.39	3.69	0.69	2.96	-1.37	-1.57	-1.63	-0.25	-0.06	-0.09	2.41	1.56	6.72	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.22	0.39	0.75	1.13	0.00	0.05	0.00	1.22	1.03	0.72	0.34	0.24	6.08	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	-1.37	-1.57	-1.63	-0.25	-0.06	-0.09	0.00	0.00	-4.97	AET - ETo
Water surplus (available for runoff and recharge)	inches	0.39	3.69	0.69	2.96	0.00	0.00	0.00	0.00	0.00	0.00	2.41	1.56	11.69	P - AET - change in ST
Runoff, RO	inches	0.36	3.42	0.64	2.74	0.00	0.00	0.00	0.00	0.00	0.00	2.23	1.44	10.83	1976 annual water surplus proportioned to mean annual runoff and water surplus and then to 1976 monthly water surplus
Groundwater recharge	inches	0.03	0.27	0.05	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.12	**0.87**	Water surplus - runoff

APPENDIX D

1987-91 annual water balance and groundwater recharge estimates

Appendix D. 1987-91 water balance and groundwater recharge estimates,
Mark West Quarry existing conditions, Sonoma County, California

Map Symbol	Soil Series[1]	Property/lease boundary			1/2 mile radius around wells		
		acres	*acre-feet*	*inches*	*acres*	*acre-feet*	*inches*
Rainfall:	All soils	154	457	35.56	502	1488	35.56
Actual evapotranspiration:							
Fo, Fr	Forward, Forward-Kidd	67.1	92.9	16.60	217	300	16.60
Gg, Gl	Goulding	18.8	27.6	17.59	194	285	17.59
Sk	Spreckles	6.52	11.2	20.59	17.8	30.6	20.59
Qaf	Artificial fill	24.9	43.2	20.77	31.2	53.9	20.77
RoG, Rck	Rock land	36.8	20.3	6.61	42.5	23.4	6.61
	TOTAL	154	195	**15.18**	502	692	**16.54**
Runoff:							
Fo, Fr	Forward, Forward-Kidd	67.1	56.5	10.11	217	182	10.11
Gg, Gl	Goulding	18.8	15.6	9.92	194	161	9.92
Sk	Spreckles	6.52	5.11	9.41	17.8	14.0	9.41
Qaf	Artificial fill	24.9	19.7	9.48	31.2	24.6	9.48
RoG, Rck	Rock land	36.8	82.3	26.81	42.5	95	26.81
	TOTAL	154	179	**13.94**	502	476	**11.38**
Groundwater recharge:							
Fo, Fr	Forward, Forward-Kidd	67.1	49.5	8.85	217	160	8.85
Gg, Gl	Goulding	18.8	12.63	8.05	194	130	8.05
Sk	Spreckles	6.52	3.14	5.79	17.8	8.58	5.79
Qaf	Artificial fill	24.9	11.88	5.72	31.2	14.8	5.72
RoG, Rck	Rock land	36.8	6.58	2.14	42.5	7.59	2.14
	TOTAL	154	83.7	**6.51**	502	321	**7.67**

Notes:

1) Information taken from the most-recent USDA soil survey for the area (1972), and/or Soil Survey Laboratory Data for Some Soils of California (Soil Survey Investigations Report No. 24), 1973. This soil survey generally does not distinguish areas smaller than about 20 to 40 acres, so that wetlands, alluvium, or swale fills smaller than 10 to 20 acres will not be mapped.

Appendix D. Estimated groundwater recharge from **Forward** soil areas during multiple drought years, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	2.31	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	67.1	acres	
Annual actual evapotranspiration	93	acre-feet	
Annual runoff	66	acre-feet	
Annual groundwater recharge	39.5	acre-feet	
Soil area within 1/2 mile radius of wells	217	acres	
Annual actual evapotranspiration	300	acre-feet	
Annual runoff	215	acre-feet	
Annual groundwater recharge	128	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean 1987-91)	inches	3.96	3.07	6.17	0.69	1.29	0.29	0.00	0.02	0.60	1.30	2.53	2.85	22.77	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	6.18	4.80	9.63	1.08	2.02	0.45	0.00	0.03	0.94	2.03	3.95	4.45	35.56	1987-91 mean annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1987-91 monthly rainfall at SRO
P - PET	inches	5.30	3.25	6.64	-3.45	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	2.58	3.49	-8.65	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	2.31	2.31	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.31	2.31	--	If P>PET, then ST=AWC unless previous ST<AWC, then ST=P-PET + previous ST. If P<PET, then ST = previous ST - (PET - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-2.31	0.00	0.00	0.00	0.00	0.00	0.00	2.31	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	3.39	2.02	0.45	0.00	0.03	0.94	2.03	1.37	0.96	16.60	If P>PET, then PET else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	-1.14	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	0.00	0.00	-27.61	AET - PET
Water surplus (available for runoff and recharge)	inches	5.30	3.25	6.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	3.49	18.96	P - AET - change in ST
Runoff, RO	inches	3.32	2.04	4.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	2.19	11.89	1987-91 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1987-91 monthly water surplus
Groundwater recharge	inches	1.98	1.21	2.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	1.30	**7.07**	Water surplus - runoff

Appendix D. Estimated groundwater recharge from **Goulding** soil areas during multiple drought years, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	3.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	18.8	acres	
Annual actual evapotranspiration	27.6	acre-feet	
Annual runoff	18.3	acre-feet	
Annual groundwater recharge	9.9	acre-feet	
Soil area within 1/2 mile radius of wells	194	acres	
Annual actual evapotranspiration	285	acre-feet	
Annual runoff	189	acre-feet	
Annual groundwater recharge	102	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean 1987-91)	inches	3.96	3.07	6.17	0.69	1.29	0.29	0.00	0.02	0.60	1.30	2.53	2.85	22.77	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	6.18	4.80	9.63	1.08	2.02	0.45	0.00	0.03	0.94	2.03	3.95	4.45	35.56	1987-91 mean annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1987-91 monthly rainfall at SRO
P - ETo	inches	5.30	3.25	6.64	-3.45	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	2.58	3.49	-8.65	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	3.30	3.30	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.58	3.30	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-3.30	0.00	0.00	0.00	0.00	0.00	0.00	2.58	0.72	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.38	2.02	0.45	0.00	0.03	0.94	2.03	1.37	0.96	17.59	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	-0.15	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	0.00	0.00	-26.62	AET - ETo
Water surplus (available for runoff and recharge)	inches	5.30	3.25	6.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.77	17.97	P - AET - change in ST
Runoff, RO	inches	3.44	2.11	4.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.80	11.67	1987-91 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1987-91 monthly water surplus
Groundwater recharge	inches	1.86	1.14	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	**6.30**	Water surplus - runoff

Appendix D. Estimated groundwater recharge from **Sprekles** soil areas during multiple drought years, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.3	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	6.52	acres	
Annual actual evapotranspiration	11.2	acre-feet	
Annual runoff	6.01	acre-feet	
Annual groundwater recharge	2.24	acre-feet	
Soil area within 1/2 mile radius of wells	17.8	acres	
Annual actual evapotranspiration	30.6	acre-feet	
Annual runoff	16.4	acre-feet	
Annual groundwater recharge	6.12	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean 1987-91)	inches	3.96	3.07	6.17	0.69	1.29	0.29	0.00	0.02	0.60	1.30	2.53	2.85	22.77	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	6.18	4.80	9.63	1.08	2.02	0.45	0.00	0.03	0.94	2.03	3.95	4.45	35.56	1987-91 mean annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1987-91 monthly rainfall at SRO
P - ETo	inches	5.30	3.25	6.64	-3.45	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	2.58	3.49	-8.65	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.30	6.30	6.30	2.85	0.00	0.00	0.00	0.00	0.00	0.00	2.58	6.07	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-3.45	-2.85	0.00	0.00	0.00	0.00	0.00	2.58	3.49	-0.23	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	4.87	0.45	0.00	0.03	0.94	2.03	1.37	0.96	20.59	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	-0.59	-6.02	-6.53	-5.84	-3.42	-1.21	0.00	0.00	-23.62	AET - ETo
Water surplus (available for runoff and recharge)	inches	5.30	3.25	6.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.20	P - AET - change in ST
Runoff, RO	inches	3.86	2.37	4.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.07	1987-91 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1987-91 monthly water surplus
Groundwater recharge	inches	1.44	0.88	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.13**	Water surplus - runoff

Appendix D. Estimated groundwater recharge from **artificial fill** areas during multiple drought years, Mark West Quarry, Sonoma County, California

Available water capacity, AWC	6.5	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	1	inches	grass/woodland land cover
Soil area on Mark West Quarry	24.9	acres	
Annual actual evapotranspiration	43.2	acre-feet	
Annual runoff	23.2	acre-feet	
Annual groundwater recharge	8.4	acre-feet	
Soil area within 1/2 mile radius of wells	31.2	acres	
Annual actual evapotranspiration	53.9	acre-feet	
Annual runoff	28.9	acre-feet	
Annual groundwater recharge	10.5	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	ETo * Kc
Precipitation at Santa Rosa (Mean 1987-91)	inches	3.96	3.07	6.17	0.69	1.29	0.29	0.00	0.02	0.60	1.30	2.53	2.85	22.77	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	6.18	4.80	9.63	1.08	2.02	0.45	0.00	0.03	0.94	2.03	3.95	4.45	35.56	1987-91 mean annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1987-91 monthly rainfall at SRO
P - ETo	inches	5.30	3.25	6.64	-3.45	-3.44	-6.02	-6.53	-5.84	-3.42	-1.21	2.58	3.49	-8.65	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	6.48	6.48	6.48	3.03	0.00	0.00	0.00	0.00	0.00	0.00	2.58	6.07	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	-3.45	-3.03	0.00	0.00	0.00	0.00	0.00	2.58	3.49	-0.41	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.88	1.55	2.99	4.53	5.05	0.45	0.00	0.03	0.94	2.03	1.37	0.96	20.77	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	0.00	-0.41	-6.02	-6.53	-5.84	-3.42	-1.21	0.00	0.00	-23.44	AET - ETo
Water surplus (available for runoff and recharge)	inches	5.30	3.25	6.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.20	P - AET - change in ST
Runoff, RO	inches	3.89	2.39	4.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.15	1987-91 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1987-91 monthly water surplus
Groundwater recharge	inches	1.41	0.87	1.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.05**	Water surplus - runoff

Appendix D. Estimated groundwater recharge from **rock** soil areas, Mark West Quarry during multiple drought years, Sonoma County, California

Available water capacity, AWC	0.0	inches	Soil Survey (Miller, 1972), summarized in Table 3 of Woyshner and Hecht, 2011
Plant-specific coefficient, Kc	0.25	inches	evaporation from bare soil
Soil area on Mark West Quarry	36.8	acres	
Annual actual evapotranspiration	20.3	acre-feet	
Annual runoff	82	acre-feet	
Annual groundwater recharge	6.58	acre-feet	
Soil area within 1/2 mile radius of wells	42.5	acres	
Annual actual evapotranspiration	23.4	acre-feet	
Annual runoff	95	acre-feet	
Annual groundwater recharge	7.59	acre-feet	

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	Remarks
Reference evapotranspiration, ETo	inches	0.88	1.55	2.99	4.53	5.46	6.47	6.53	5.87	4.36	3.24	1.37	0.96	44.21	CIMIS station 103
Potential evapotranspiration, PET	inches	0.22	0.388	0.748	1.133	1.365	1.618	1.633	1.468	1.09	0.81	0.343	0.24	11.05	ETo * Kc
Precipitation at Santa Rosa (Mean 1987-91)	inches	3.96	3.07	6.17	0.69	1.29	0.29	0.00	0.02	0.60	1.30	2.53	2.85	22.77	CDEC station SRO
Precipitation at Mark West Quarry, P	inches	6.18	4.80	9.63	1.08	2.02	0.45	0.00	0.03	0.94	2.03	3.95	4.45	35.56	1987-91 mean annual rainfall at CDEC station SRO proportioned to mean annual rainfall and then to 1987-91 monthly rainfall at SRO
P - ETo	inches	5.96	4.41	8.89	-0.05	0.65	-1.17	-1.63	-1.44	-0.15	1.22	3.61	4.21	24.51	surplus water available for runoff, soil moisture replenishment, and groundwater recharge
Soil moisture storage, ST	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--	If P>ETo, then ST=AWC unless previous ST<AWC, then ST=P-ETo + previous ST. If P<ETo, then ST = previous ST - (ETo - P), and not to drop below 0.
Change in ST from previous month	inches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Soil moisture utilization and replenishment
Actual evapotranspiration, AET	inches	0.22	0.39	0.75	1.08	1.37	0.45	0.00	0.03	0.94	0.81	0.34	0.24	6.61	If P>ETo, then ETo else P - change in ST
Water deficiency	inches	0.00	0.00	0.00	-0.05	0.00	-1.17	-1.63	-1.44	-0.15	0.00	0.00	0.00	-4.44	AET - ETo
Water surplus (available for runoff and recharge)	inches	5.96	4.41	8.89	0.00	0.65	0.00	0.00	0.00	0.00	1.22	3.61	4.21	28.95	P - AET - change in ST
Runoff, RO	inches	5.52	4.09	8.23	0.00	0.60	0.00	0.00	0.00	0.00	1.13	3.34	3.90	26.81	1987-91 annual water surplus proportioned to mean annual runoff (Rantz, 1974) and water surplus and then to 1987-91 monthly water surplus
Groundwater recharge	inches	0.44	0.33	0.66	0.00	0.05	0.00	0.00	0.00	0.00	0.09	0.27	0.31	**2.14**	Water surplus - runoff

APPENDIX E

Water suppliers in Sonoma County, California

Water & Sewer Referral List

SAN-006

This is a referral list of agencies and companies in Sonoma County that provide water and/or sewer services. Properties not served by these entities may be on a small well or served by a septic system. The California State Department of Health Services, Drinking Water Field Operations, monitors the small water systems. The telephone number for their Santa Rosa office is 707-576-2145.

Bodega Bay Public Utilities District
265 Doran Park Road, Bodega Bay, CA 94923
707-875-3332

Bodega Water Company
Service area: City of Bodega
P O Box 87, Bodega, CA 94922
707-876-1919

Cal-American Water Company
(formerly Citizens Utilities)
Service area: Larkfield/Wikiup area
640 Larkfield Center, Santa Rosa, CA 95403
707-542-1717
888-237-1333

California Water District
(Armstrong Valley Water)
14034 Armstrong Woods Road,
Guerneville, CA 95446
707-869-0050

Cloverdale, City Of
Mailing: P.O. Box 217, Cloverdale, CA 95425
124 North Cloverdale Boulevard
Cloverdale, CA 95425
707-894-1700

Cotati, City of
Public Utilities
201 West Sierra Avenue, Cotati, CA 94931
707-792-4600 ext 631
Web site: www.ci.cotati.ca.us

Sonoma County Environmental Health
475 Aviation Blvd. Ste.,220
Santa Rosa, CA 95403
707-565-6565

Forestville Water District
Mail: P.O. Box 261, Forestville, CA 95436
6530 Mirabel Road, Forestville, CA 95436
707-887-1551

Geyserville Water System
Mail: P.O. Box 65, Geyserville, CA 95441
21060 Geyserville Avenue, Geyserville, CA 95441
707-857-3163 or General store (857-3463)

Healdsburg, City of
401 Grove Street, Healdsburg, CA 95448
707-431-3307
Web site: www.ci.healdsburg.ca.us

Kenwood/Penngrove Water Company
Service area: Kenwood/Penngrove
4984 Sonoma Hwy, Santa Rosa, CA 95409-4247
707-539-6397
800-244-9489 (Emergency only)

Occidental Water Co.
Mailing: P.O. Box337 or 525
Occidental, CA 95465
3799 Bohemian Highway
Occidental, CA 95465
707-874-3441

Petaluma, City of
Public Facilities
555 N. McDowell Blvd, Petaluma, CA 94954
707-778-4303
City Hall
11 English Street, Petaluma, CA 94952
707-778-4304
Sewer and Water
202 N. McDowell Blvd, Petaluma, CA 94952
707-778-4393
Web site: www.cityofpetaluma.net

Rohnert Park, City of
Public Works - Water & Sewer
6800 Hunter Dr., Suite B, Rohnert Park, CA 94928
707-585-6750 for Residential & Commercial Customer Service
707-588-6755 for Billing Utilities
707-588-3300 Public Works
Web site: www.ci.rohnert-park.ca.us

Russian River Utility- Water
Service area: Camp Meeker, Freestone, Hacienda, Jenner, and Occidental
7131 Mirabel Road, Forestville, CA 95436
707-887 - 7735
Web site : www.rruwater.com

Santa Rosa, City of
Public Utilities
90 Santa Rosa Ave, Santa Rosa, CA 95404
707-543-3150 (Billing Utilities)
69 Stony Circle, Santa Rosa, CA 95401
707-543-4200 (Water & Sewer Problems)
707-543-3800 (Encroachment & Transportation)
707-543-3222 (Community Development)
Web site: ci.santa-rosa.ca.us

Sea Ranch Water Company
Mailing: P.O. Box 16, Sea Ranch, CA 95497
975 Annapolis Road, Sea Ranch, CA 95497
On-site wastewater
35600 Verdent View
707-785-2411

Sebastopol, City of
Service area: City limits only
Public Works-service/repairs
714 Johnson Street, Sebastopol, CA 95473
707-823-7863 (Utilities Billing)
707-823-5331 (Problems)
707-823-5381(Public Works)

Sonoma, City of
Public Works - Water
Corporation Yard
19678 8th Street East, Sonoma, CA 95476
City Hall
No. 1 The Plaza, Sonoma, CA 95476
707-938-3681 (except west and unincorporated Sonoma - See Valley of the Moon)
Web site: www.sonomacity.org

Sonoma County Transportation and Public Works
Service area: Fitch Mtn, Freestone, Jenner, and Salmon Creek
County of Sonoma Auditor-Controller
2300 County Center Dr., Suite B100,
Santa Rosa, CA 95403
707-565-3440

Sonoma County Water Agency
404 Aviation Blvd , Santa Rosa, CA 95403
707-526-5370 (Information/Operator)
Web site: www.scwa.ca.gov

State Mobile Home Ombudsman
P.O. Box 31
Sacramento, CA 95812-0031
800-952-5275
Web site: www.hcd.ca.gov

Sweetwater Springs Water District
Service area: Guerneville, Monte Rio, Rio Nido, and Ville Grande
17081 Hwy 116, Suite B, Guerneville, CA 95446
707-869-4000
FAX 707-869-4005
Web site: www.sweetwatersprings.com

USA Underground Service Alert
Call Center
800-227-2600
Main Office
4090 Nelson Avenue, Suite A, Concord, CA 94520
925-798-9504 Ext. 0

Valley of the Moon Water District
Service Area: Boyes Hot Springs, El Verano, and Glen Ellen
Mailing: P.O. Box 280, El Verano, CA 95433
19039 Bay Street, Sonoma, CA 95476
707-996-1037

Water Quality Control Board
5550 Skylane Blvd #A, Santa Rosa, CA 95403
707-576-2220

Windsor, Town of
Service area: Windsor, Shiloh areas, and Sonoma County Airport area
Mailing: P.O. Box 100, Windsor, CA 95492
9291 Old Redwood Highway, Building 300A
Windsor, CA 95492
707-838-1004
Web site: www.townofwindsor.com

LOCAL WATER SUPPLIERS

If these companies do not supply water to your area, water source could be from a well or small water system. The California State Department of Health Services, Drinking Water Field Operations, monitors water systems. The telephone number for their Santa Rosa office is 707-576-2145.

Bodega Bay Public Utility District
265 Doran Park Road, Bodega Bay, CA 94923
Payments mailed to: P.O. Box 70, Bodega Bay, CA 94923
707-875-3332

Bodega Water Company
Service area: City of Bodega
P.O. Box 87, Bodega, CA 94922
707-876-3257

Cal-American Water Company
Service area: Larkfield/Wikiup area
640 Larkfield Center, Santa Rosa, CA 95403
707-542-1717
Website: www.amwater.com

Cloverdale, City of
Water Department
124 North Cloverdale Boulevard, Cloverdale, CA 95425
Payments mailed to: P.O. Box 217, Cloverdale, CA 95425
707-894-1700

Cotati, City of
Public Utilities
201 West Sierra Avenue, Cotati, CA 94931
707-792-4600 ext. 631
Website: www.ci.cotati.ca.us

Forestville Water District
Service area: west to Giovanetti Road, north to Mirabel Heights, south to Kay Lane, east to Wohler Road
6530 Mirabel Road, Forestville, CA 95436
Payments mailed to: P.O. Box 261, Forestville, CA 95436
707-887-1551

Geyserville Water System
21060 Geyserville Avenue, Geyserville, CA 95441
Payments mailed to: P.O. Box 65, Geyserville, CA 95441
707-857-3163

Healdsburg, City of
401 Grove Street, Healdsburg, CA 95448
707-431-3307
Website: www.ci.healdsburg.ca.us

Kenwood/Penngrove Water Company
Service area: Kenwood, Penngrove
4984 Sonoma Highway, Santa Rosa, CA 95409-4247
707-539-6397

Marin Municipal Water District
220 Nellen Avenue, Corte Madera, CA 94925
Payments mailed to: P.O. Box 994, Corte Madera, CA 94976-0994
415-945-1455
Website: www.marinwater.org

North Marin County Water District
999 Rush Creek Place, Novato, CA 94945
415-897-4133
Website: www.nmwd.com

Penngrove/Kenwood Water Company
Service area: Kenwood, Penngrove
4984 Sonoma Highway, Santa Rosa, CA 95409-4247
707-539-6397

Petaluma, City of
Public Utilities
11 English Street, Petaluma, CA 94952
Payments mailed to: P.O. Box 6011, Petaluma, CA 94953
707-778-4350
Website: www.ci.petaluma.ca.us

Rohnert Park, City of
Public Works
6800 Hunter Drive, Suite B, Rohnert Park, CA 94928
Payments mailed to: P.O. Box 1489, Rohnert Park, CA 94927-1489
707-585-6750 or 585-6755
Website: www.ci.rohnert-park.ca.us

Russian River Utility
Service area: Camp Meeker, Freestone, Hacienda, Jenner, Occidental
7131 Mirabel Road, Forestville, CA 95436
Payments mailed to: P.O. Box 730, Forestville, CA 95436
707-887-7735
Website:	www.rruwater.com

Santa Rosa, City of
Public Utilities
90 Santa Rosa Avenue, Santa Rosa, CA 95404
69 Stony Circle, Santa Rosa, CA 95401
Payments mailed to: P.O. Box 1658, Santa Rosa, CA 95402
707-543-3150
Website:	www.ci.santa-rosa.ca.us

Sea Ranch Water Company
975 Annapolis Road, Sea Ranch, CA 95497
Payments mailed to: P.O. Box 16, Sea Ranch, CA 95497
707-785-2411

Sebastopol, City of
Service area: City limits only
Public Works – service/repairs
Finance – billing questions
7120 Bodega Avenue, Sebastopol, CA 95472
Payments mailed to: P.O. Box 1776, Sebastopol, CA 95473
707-823-7863

Sonoma, City of
Public Works
No. 1 The Plaza, Sonoma, CA 95476
707-938-3681
Website:	www.sonomacity.org

Sonoma County Transportation and Public Works
Service area: Fitch Mtn, Freestone, Jenner, Salmon Creek
County of Sonoma Auditor-Controller, 585 Fiscal Drive, Santa Rosa, CA 95403
Payments mailed to: CSA 41 Water District, P.O. Box 5859, Santa Rosa, CA 95402
707-565-3440

Sweetwater Springs Water District
Service area: Guerneville, Monte Rio, Rio Nido, Ville Grande
17081 Hwy 116, Suite B, Guerneville, CA 95446
Payments mailed to: P.O. Box 48, Guerneville, CA 95446
707-869-4000
Website: www.sweetwatersprings.com

Valley of the Moon Water District
Service area: Boyes Hot Springs, El Verano, Glen Ellen
19039 Bay Street, Sonoma, CA 95476
Payments mailed to: P.O. Box 280, El Verano, CA 95433
707-996-1037
Website: www.vomwd.com

Windsor, Town of
Service area: Windsor, Shiloh areas, Sonoma County Airport area
9291 Old Redwood Highway, Building 300A **(No mail delivery to street address.)**
Mailing address: P.O. Box 100, Windsor, CA 95492
707-838-1004
Website: www.townofwindsor.com

APPENDIX F

Streamflow at USGS station 11463900, Maacama Creek near Kellogg, Sonoma County, California

Appendix F. Streamflow at USGS station 11463900, Maacama Creek near Kellogg, Sonoma County, California

YEAR	JAN (cfs)	FEB (cfs)	MAR (cfs)	APR (cfs)	MAY (cfs)	JUN (cfs)	JUL (cfs)	AUG (cfs)	SEP (cfs)	OCT (cfs)	NOV (cfs)	DEC (cfs)
1961	106.4	181.6	128.7	39.5	18	6.55	1.43	0.584	0.73	0.794	15.5	60.9
1962	35	445.9	224.2	25.8	10.8	2.89	0.858	0.342	0.4	153.9	19.9	146.5
1963	205.6	184.4	122.5	314.6	65.9	18.5	7.13	3.15	1.95	3.75	140.6	25.6
1964	135	37	24.7	12.1	7.36	3.29	0.519	0.103	0.04	0.681	65.9	598.6
1965	458.5	64.4	24.8	140.9	26.5	10.3	4.24	1.37	0.967	0.997	69.8	105
1966	352	184.2	69.1	39.8	12.8	5.01	1.9	0.629	0.937	0.794	132.2	297.6
1967	454.3	115.3	211	215.5	44.5	24.8	6.24	1.78	1.07	3.16	5.2	48
1968	231.3	222.5	141.2	26.9	11.4	3.26	0.703	0.821	0.395	2.44	5.48	200.3
1969	664.2	505.4	136.7	64.9	20.6	8.61	2.84	1.07	0.829	1.88	2.71	346.7
1970	932.9	194	100.2	20.8	9.52	4.47	1.76	0.635	0.558	1.83	138	406.1
1971	196.7	34.8	134.4	48.2	17.2	6.83	3.14	0.881	0.688	1.01	2.66	43.4
1972	62.1	83.1	52.2	40.6	11.3	3.88	1.36	0.485	0.549	2.99	85.2	98.2
1973	530	325.2	133.1	32.8	11.2	3.42	1.01	0.44	1.23	7.03	475.5	277
1974	391.8	153.1	502.2	165.7	22.2	7.83	4.56	1.29	1.13	1.47	2.62	25.2
1975	30.8	387	323.2	60.2	19.5	5.7	2.21	1.31	0.915	8.97	12.8	17.7
1976	6.6	25	31.2	31.7	6.35	1.5	0.189	0.232	0.11	0.31	1.42	1.31
1977	5.29	4.87	8.36	2.82	2.55	0.323	0.001	0	0.113	0.655	81.1	162.3
1978	613.6	340.5	259.5	95.9	23.1	6.27	2.17	0.757	1.57	0.738	1.88	2.65
1979	177.5	294.5	109.3	38.3	21.9	4.58	0.985	0.133	0.23	14.1	50.2	183.6
1980	355.5	380.1	139.3	37	12.8	6.15	2.1	0.894	0.904	0.769	1.12	93.4
1981	205.2	101.3	131.2	30.5	10.1	2.85	0.85	0.218	0.188	--	--	--
Mean	293	203	143	71	18	6.5	2.2	0.8	0.7	10	65	157

Notes:

Hydrologic Unit Code 18010110

Latitude 38°38'25", Longitude 122°45'45" NAD27

Drainage area 43.4 square miles

Gage datum 188.91 feet above NGVD29

Appendix F. Streamflow at USGS gaging station 11463900, Maacama Creek near Kellogg, Sonoma County, California

YEAR	JAN (acre-feet)	FEB (acre-feet)	MAR (acre-feet)	APR (acre-feet)	MAY (acre-feet)	JUN (acre-feet)	JUL (acre-feet)	AUG (acre-feet)	SEP (acre-feet)	OCT (acre-feet)	NOV (acre-feet)	DEC (acre-feet)	TOTAL (acre-feet)	TOTAL (inches)	% of MEAN
1961	6,542	10,086	7,913	2,350	1,107	390	88	36	43	49	922	3,745	33,271	14.37	57%
1962	2,152	24,764	13,786	1,535	664	172	53	21	24	9,463	1,184	9,008	62,825	27.14	108%
1963	12,642	10,241	7,532	18,720	4,052	1,101	438	194	116	231	8,366	1,574	65,207	28.17	112%
1964	8,301	2,128	1,519	720	453	196	32	6	2	42	3,921	36,806	54,126	23.38	93%
1965	28,192	3,577	1,525	8,384	1,629	613	261	84	58	61	4,153	6,456	54,993	23.76	94%
1966	21,644	10,230	4,249	2,368	787	298	117	39	56	49	7,866	18,299	66,001	28.51	113%
1967	27,934	6,403	12,974	12,823	2,736	1,476	384	109	64	194	309	2,951	68,358	29.53	117%
1968	14,222	12,798	8,682	1,601	701	194	43	50	24	150	326	12,316	51,107	22.08	88%
1969	40,840	28,068	8,405	3,862	1,267	512	175	66	49	116	161	21,318	104,839	45.29	180%
1970	57,362	10,774	6,161	1,238	585	266	108	39	33	113	8,212	24,970	109,861	47.46	188%
1971	12,095	1,933	8,264	2,868	1,058	406	193	54	41	62	158	2,669	29,800	12.87	51%
1972	3,818	4,780	3,210	2,416	695	231	84	30	33	184	5,070	6,038	26,587	11.49	46%
1973	32,588	18,061	8,184	1,952	689	204	62	27	73	432	28,294	17,032	107,598	46.49	185%
1974	24,091	8,503	30,879	9,860	1,365	466	280	79	67	90	156	1,549	77,386	33.43	133%
1975	1,894	21,493	19,873	3,582	1,199	339	136	81	54	552	762	1,088	51,052	22.06	88%
1976	406	1,438	1,918	1,886	390	89	12	14	7	19	84	81	6,345	2.74	10.9%
1977	325	270	514	168	157	19	0	0	7	40	4,826	9,979	16,306	7.04	28%
1978	37,729	18,910	15,956	5,706	1,420	373	133	47	93	45	112	163	80,689	34.86	138%
1979	10,914	16,356	6,721	2,279	1,347	273	61	8	14	867	2,987	11,289	53,114	22.95	91%
1980	21,859	21,864	8,565	2,202	787	366	129	55	54	47	67	5,743	61,737	26.67	106%
1981	12,617	5,626	8,067	1,815	621	170	52	13	11	--	--	--	--	--	--
Mean	18,008	11,348	8,805	4,206	1,129	388	135	50	44	640	3,897	9,654	59,060	25.52	--
Cumulative	18,008	29,356	38,160	42,367	43,496	43,884	44,019	44,069	44,113	44,754	48,650	58,304	--	25.19	--

Notes:
Hydrologic Unit Code 18010110
Latitude 38°38'25", Longitude 122°45'45" NAD27
Drainage area 43.4 square miles
Gage datum 188.91 feet above NGVD29

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APPENDIX E

Background Biological Data

Table 1. Special-status plant species with potential to occur within the Mark West Quarry 2011 study area.

Common name *Scientific name*[1]	Listing Status[2] Federal	State	CNPS	Flowering Period	Habitat Preferences	Estimated Potential to Occur at the Project Site[3]
Franciscan onion *Allium peninsulare* var. *franciscanum*	-	-	1B.2	May-June	Cismontane woodland, valley and foothill grassland; clay soil. 100-300 m	**Moderate**. Nearest known occurrence < 3 miles from project site (Best et al. 1996, CNDDB 2010).
Napa false indigo *Amorpha californica* var. *napensis*	-	-	1B.2	Apr-July	Shaded, moist, mixed evergreen forest and oak woodlands. 150-2000m	**High**. Mapped at project site during surveys for Biological Constraints Analysis (Macmillan and Buck 2003). One study area location destroyed in 2006 when area cleared during emergency operations. Other known occurrences within 1 mile of project site (CNDDB 2010).
Bent-flowered fiddleneck *Amsinckia lunaris*	-	-	1B.2	Mar-June	Coastal bluff scrub, cismontane woodland, valley and foothill grassland. 3-500m	**Low**. A wide-ranging species. Nearest known occurrence is > 10 miles from project site (Best et al. 1996, CNDDB 2010).
Sonoma canescent manzanita *Arctostaphylos canescens* ssp. *sonomensis*	-	-	1B.2	Jan-Apr	Chaparral, lower montane coniferous forest; sometimes on serpentine. 180-1675m	**Moderate**. Nearest location > 10 miles from project site (Best et al. 1996, CNDDB 2010).
Konocti manzanita *Arctostaphylos manzanita* ssp. *elegans*	-	-	1B.3	Mar-May	Chaparral, cismontane woodland, lower montane coniferous forest; volcanic substrates. 395-1615m	**Moderate**. Nearest known location > 10 miles from project site (Best et al. 1996, CalFlora 2006, CNDDB 2006).
Rincon Ridge manzanita *Arctostaphylos stanfordiana* ssp. *decumbens*	-	-	1B.1	Feb-Apr	Chaparral, cismontane woodland. 75-370m	**Moderate**. Nearest known location about 5 miles from project site (CalFlora 2006, CNDDB 2006).
Clara Hunt milk-vetch *Astragalus claranus*	FE	ST	1B.1	Mar-May	Cismontane woodland, valley and foothill grassland, chaparral; thin volcanic clay soil. 75-275m	**Low**. Nearest location about 4 miles south of project site (Best et al. 1996, CNDDB 2010).

Table 1. Special-status plant species with potential to occur within the Mark West Quarry 2011 study area.						
Common name *Scientific name*[1]	**Listing Status**[2] **Federal**	**State**	**CNPS**	**Flowering Period**	**Habitat Preferences**	**Estimated Potential to Occur at the Project Site**[3]
Narrow-anthered California brodiaea *Brodiaea californica var. leptandra*	-	-	1B.2	May-July	Broadleaved upland forest, chaparral, lower montane coniferous forest. 110-915	**High**. Nearest known location within 3 miles of project site (CalFlora 2006, CNDDB 2006).
Rincon Ridge ceanothus *Ceanothus confusus*	-	-	1B.1	Feb-June	Closed-cone coniferous forest, chaparral, cismontane woodland; volcanic or serpentine soils; dry shrubby slopes. 75-1065m	**High**. Nearest known location 4 miles south of project site (CNDDB 2010).
Calistoga ceanothus *Ceanothus divergens*	-	-	1B.2	Feb-April	Chaparral; rocky serpentine or volcanic substrates. 170-950m	**High**. Several known locations < 5 miles from project site; nearest is 2 miles northwest of project site (Best et al. 1996, CNDDB 2010).
Holly-leaved ceanothus *Ceanothus purpureus*	-	-	1B.2	Feb-June	Chaparral, cismontane woodland; rocky volcanic substrates. 120-640m	**Moderate.** Nearest known location about 5 miles southeast of project site (CNDDB 2010).
Sonoma ceanothus *Ceanothus sonomensis*	-	-	1B.2	Feb-Apr	Chaparral; rocky or sandy, serpentine or volcanic substrates. 215-800m	**Moderate**. Nearest known location > 10 miles from project site (CNDDB 2006).
Pappose tarplant *Centromadia parryi* ssp. *parryi*	-	-	1B.2	May-Nov	Chaparral, valley and foothill woodland, and other habitats; vernally mesic, often alkaline, often disturbed sites. 2-420m	**Very Low.** Suitable habitat unlikely to occur within study area. Nearest known location < 1 mile east of the project site (CNDDB 2010).
Streamside daisy *Erigeron biolettii*	-	-	3.?	Jun-Oct	Broadleaved upland forest, cismontane woodland, North Coast coniferous forest; rocky, mesic sites. 30-1100m	**Very Low**. A wide-ranging species. Nearest known location > 10 miles from project site (Best et al. 1996, Jepson Online Interchange 2010).
Colusa layia *Layia septentrionalis*	-	-	1B.2	Apr-May	Chaparral, cismontane woodland, valley and foothill grassland; sometimes serpentine. 100-1095m	**Very Low.** Suitable habitat unlikely to occur within study area. Nearest known location > 5 miles from project site (Best et al. 1996, CNDDB 2010).

Table 1. Special-status plant species with potential to occur within the Mark West Quarry 2011 study area.						
Common name *Scientific name*[1]	**Listing Status**[2]			**Flowering Period**	**Habitat Preferences**	**Estimated Potential to Occur at the Project Site**[3]
	Federal	**State**	**CNPS**			
Jepson's linanthus *Leptosiphon jepsonii (=Linanthus jepsonii)*	-	-	1B.2	Apr-May	Chaparral, cismontane woodland; open to partly shaded grassy slopes; volcanic or edge of serpentine areas. 100-500m	**High**. Nearest known location within 2 miles of project site (CNDDB 2010). One location found within project site during 2006 surveys.
Woolly-headed lessingia *Lessingia hololeuca*	-	-	3.?	Jun-Oct	Broadleaved upland forest, coastal scrub, lower montane coniferous forest, valley and foothill grassland; sometimes serpentine. 15-305m	**Low.** Nearest known location > 5 miles from project site (Best et al. 1996, CNDDB 2010).
Cobb Mountain lupine *Lupinus sericatus*	-	-	1B.2	Mar-June	Broadleaved upland forest, chaparral, cismontane woodland, lower montane coniferous forest. 275-1525	**High**. Nearest known location within 3 miles of project site (Best et al. 1996, CNDDB 2006).
Mt. Diablo cottonweed *Micropus amphibolus*	-	-	3.2	Mar-May	Broadleaved upland forest, chaparral, cismontane woodland, valley and foothill grassland; rocky. 45-825m	**Moderate.** Nearest known location is > 5 miles from project site (Best et al. 1996, Jepson Online Interchange 2010).
Robust monardella *Monardella villosa* ssp. *globosa*	-	-	1B.2	June-July (Aug)	Chaparral (openings), cismontane woodland, coastal scrub. 185-600m	**Low**. A wide-ranging species. Nearest known location > 10 mi from project site (CNDDB 2010).
Green monardella *Monardella viridis* (= *M. v.* var. *viridis*)	-	-	4.3	June-Sept	Broadleaved upland forest, chaparral, cismontane woodland. 100-1010m	**High.** Nearest known location within 2 miles of project site (Best et al. 1996, Jepson Online Interchange 2010). One location found within project site during surveys conducted in 2006.
Cotula navarretia *Navarretia cotulifolia*	-	-	4.2	May-June	Chaparral, cismontane woodland, valley and foothill grassland. 4-1830m	**Very Low.** A wide-ranging species; rare in Sonoma Co. Nearest known location > 10 miles from project site (Best et al. 1996, Jepson Online Interchange 2010).
Gairdner's yampah *Perideridia gairdneri* ssp. *gairdneri*	-	-	4.2	June-Oct	Broadleaved upland forest, chaparral, coastal prairie, valley and foothill grassland, vernal pools. 0-365m	**Very Low.** A wide-ranging species. Nearest known location > 10 mi from proect site (Best et al. 1996, Jepson Online Interchange 2010).

Table 1. Special-status plant species with potential to occur within the Mark West Quarry 2011 study area.						
Common name *Scientific name*[1]	**Listing Status**[2]			**Flowering Period**	**Habitat Preferences**	**Estimated Potential to Occur at the Project Site**[3]
	Federal	**State**	**CNPS**			
Lobb's aquatic buttercup *Ranunculus lobbii*	-	-	4.2	Feb-April	Vernal pools and shallow ponds.	**Very Low.** Suitable habitat unlikely to occur within study area. A wide-ranging species known from small ponds within 5 mi of the study area (DeNevers 2005).
Napa checkerbloom *Sidalcea hickmanii* ssp. *napensis*	-	-	1B.1	Apr-June	Chaparral; rhyolitic. 415-620m	**Moderate.** Nearest known location is near Calistoga, about 5 mi E of the project site (CNDDB 2011).
Napa bluecurls *Trichostemma ruygtii*	-	-	1B.2	June-Oct	Chaparral, cismontane woodland, lower montane conferous forest, valley and foothill woodland, vernal pools. 30-680m	**Low.** Nearest known location > 10 miles east of the project site (Lewis 2006).
Oval-leaved viburnum *Viburnum ellipticum*	-	-	2.3	May-June	Chaparral, cismontane woodland, lower montane coniferous forest. 215-1400m	**High**. Nearest known location about 3 miles from project site (CNDDB 2010).

Sources:

California Native Plant Society. 2011.
California Natural Diversity Database. 2010.
Hickman, James. 1993. *The Jepson Manual*. University of California, Berkeley.
Jepson Online Interchange, 2010.

Notes:

1. Scientific and common names from *The Jepson Manual* (Hickman 1993), Jepson Online Interchange (2010), *A Flora of Sonoma County* (Best et al. 1996), and other sources.

2. Status designations

Federal Status:

FE Listed as Endangered under the federal Endangered Species Act
FT Listed as Threatened under the federal Endangered Species Act

State of California Status:

SE Listed as Endangered under the California Endangered Species Act
ST Listed as Threatened under the California Endangered Species Act

California Native Plant Society (CNPS) Status:

List 1B Plants rare, threatened, or endangered in California and elsewhere.
List 2 Plants rare, threatened, or endangered in California, but more common elsewhere.
List 3 Plants for which more information is needed.
List 4 Plants of limited distribution.

CNPS threat code extensions:

.1 Seriously endangered in California.
.2 Fairly endangered in California.
.3 Not very endangered in California.
? Not determined.

3. A plant species was determined to have potential to occur at the project site if its known or expected geographic range includes the vicinity of the project site (Mark West Quarry), and if its known or expected habitat is represented within or near the project site.

u.s. Fish &. Wildlife Service
Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in
or may be Affected by Projects in the Counties and/or
U.S.G.S.7 1/2 Minute Quads you requested

Document Number: 110311012918
Database Last Updated : April 29, 2010

Quad Lists

Listed Species
Invertebrates
Syncarls pacifica
California freshwater shrimp (E)
Fish
Hypomesus transpacificus
delta smelt (T)
Oncorhynchus kisutch
coho salmon - central CA coast (E) (NMFS)
Critical habitat, cOho salmon - central CA coast (X) (NMFS)
Oncorhynchus myklss
Central California Coastal steelhead en (NMFS)
Central Valley steel head (T) (NMFS)
Critical habitat, Central California coastal steel head (X) (NMFS)
Oncorhynchus tshawytscha
California coastal chinook salmon (T) (NMFS)
Central Valley spring-run chinook salmon (T) (NMFS)
Critical habitat, California coastal chinook salmon (X) (NMFS)
winter-run chinook salmon, Sacramento River (E) (NMFS)
Amphibians
Ambystoma californiense
California tiger salamander, central population (T)
California tiger salamander, Sonoma Co. pop (E)
Rana draytonii
California red-legged frog (T)
Critical habitat, California red-legged frog (X)
Birds
Strix occidentalis caurina
northern spotted owl (T)
Plants
Alopecurus aequalis var. sonomensis
Sonoma alopecurus (E)
Astragalus clarianus
Clara Hunt's milk-vetch (E)
Blennosperma bakeri
Baker's stickyseed [=Sonoma Sunshine] (E)
Garex albida
white sedge (1:)
Clarkia imbricata
Vine Hill clarkia eE)
Eryngium constancei
Loch Lomond coyote-thistle (=button-celery) (E)
Lasthenia burkei
Burke's goldfields (E)
Lilium pardalinum ssp. pitkinense
Pitkin Marsh lily (E)

Limmmthes vinculans
Sebastopol meadowfoam (E)
Navarretia leucocephala ssp. Plleantha
many-flowered navarretla (E)
Plagiobothrys strictus
Calistoga allocarya (popcorn-flower) (E)
Poa napensis
Napa bluegrass (E)
Sidalcea oregana ssp. valida
Kenwood Marsh checkermallow (=:checkerbloom) (E)

Proposed Species
Amphibians
Rana draytonii
Critical habitat, Callfomia red-legged frog (PX)

Quads Containing Usted, Proposed or Candidate Species;
KENWOOD (SOIA)
SANTA ROSA (5016)
SEBASTOPOL (S02A)
DETERT RESERVOIR (S17A)
MARK WEST SPRINGS (SI7e)
CAUSTOGA (5170)
JIMTOWN (S1SA)
HEALDSBURG (5180)

Key:
(E) *Endangered* - Listed as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed In the Federal Register for listing iiS endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(V) Vacated by a court order. Not currently In effect. Being reviewed by the Service.
(X) *Critical Habitat* designated for this species

APPENDIX F-1

Level of Service Methodology

APPENDIX F-1
LEVEL OF SERVICE

The description and procedures for calculating capacity and level of service (LOS) are found in Transportation Research Board, *Highway Capacity Manual 2000*. *Highway Capacity Manual 2000* represents the latest research on capacity and quality of service for transportation facilities.

Quality of service requires quantitative measures to characterize operational conditions within a traffic stream. LOS is a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience.

Six levels of service are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each LOS represents a range of operating conditions and the driver's perception of these conditions. Safety is not included in the measures that establish service levels.

A general description of service levels for various types of facilities is shown in Table F-1-I.

Table F-1-I: Level of Service Description

Facility Type	***Uninterrupted Flow***	***Interrupted Flow***
	Freeways Multi-lane Highways Two-lane Highways Urban Streets	Signalized Intersections Unsignalized Intersections Two-way Stop Control All-way Stop Control
LOS		
A	Free-flow	Very low delay.
B	Stable flow. Presence of other users noticeable.	Low delay.
C	Stable flow. Comfort and convenience starts to decline.	Acceptable delay.
D	High-density stable flow.	Tolerable delay.
E	Unstable flow.	Limit of acceptable delay.
F	Forced or breakdown flow.	Unacceptable delay

Source: *Highway Capacity Manual 2000*

Urban Streets
The term "urban streets" refers to urban arterials and collectors, including those in downtown areas.

Arterial streets are roads that primarily serve longer through trips. However, providing access to abutting commercial and residential land uses is also an important function of arterials.
Collector streets provide both land access and traffic circulation within residential, commercial and industrial areas. Their access function is more important than that of arterials, and unlike arterials their operation is not always dominated by traffic signals.

Downtown streets are signalized facilities that often resemble arterials. They not only move through traffic but also provide access to local businesses for passenger cars, transit buses, and trucks.

Pedestrian conflicts and lane obstructions created by stopping or standing buses, trucks and parking vehicles that cause turbulence in the traffic flow are typical of downtown streets.

The speed of vehicles on urban streets is influenced by three main factors, street environment, interaction among vehicles and traffic control. As a result, these factors also affect quality of service.

The street environment includes the geometric characteristics of the facility, the character of roadside activity and adjacent land uses. Thus, the environment reflects the number and width of lanes, type of median, driveway density, spacing between signalized intersections, existence of parking, level of pedestrian activity and speed limit.

The interaction among vehicles is determined by traffic density, the proportion of trucks and buses, and turning movements. This interaction affects the operation of vehicles at intersections and, to a lesser extent, between signals.

Traffic control (including signals and signs) forces a portion of all vehicles to slow or stop. The delays and speed changes caused by traffic control devices reduce vehicle speeds, however, such controls are needed to establish right-of-way.

The average travel speed for through vehicles along an urban street is the determinant of the operating LOS. The travel speed along a segment, section or entire length of an urban street is dependent on the running speed between signalized intersections and the amount of control delay incurred at signalized intersections.

LOS A describes primarily free-flow operations. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Control delay at signalized intersections is minimal.

LOS B describes reasonably unimpeded operations. The ability to maneuver within the traffic stream is only slightly restricted, and control delays at signalized intersections are not significant.

LOS C describes stable operations, however, ability to maneuver and change lanes in midblock location may be more restricted than at LOS B. Longer queues, adverse signal coordination, or both may contribute to lower travel speeds.

LOS D borders on a range in which in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or a combination of these factors.

LOS E is characterized by significant delays and lower travel speeds. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.

LOS F is characterized by urban street flow at extremely low speeds. Intersection congestion is likely at critical signalized locations, with high delays, high volumes, and extensive queuing.

The methodology to determine LOS stratifies urban streets into four classifications. The classifications are complex, and are related to functional and design categories. Table F-1-II describes the functional and design categories, while Table F-1-III relates these to the urban street classification.

Once classified, the urban street is divided into segments for analysis. An urban street segment is a one-way section of street encompassing a series of blocks or links terminating at a signalized intersection. Adjacent segments of urban streets may be combined to form larger street sections, provided that the segments have similar demand flows and characteristics.

Levels of service are related to the average travel speed of vehicles along the urban street segment or section.

Travel times for existing conditions are obtained by field measurements. The maximum-car technique is used. The vehicle is driven at the posted speed limit unless impeded by actual traffic conditions. In the maximum-car technique, a safe level of vehicular operation is maintained by observing proper following distances and by changing speeds at reasonable rates of acceleration and deceleration. The maximum-car technique provides the best base for measuring traffic performance.

An observer records the travel time and locations and duration of delay. The beginning and ending points are the centers of intersections. Delays include times waiting in queues at signalized intersections. The travel speed is determined by dividing the length of the segment by the travel time. Once the travel speed on the arterial is determined, the LOS is found by comparing the speed to the criteria in Table F-1-IV. LOS criteria vary for the different classifications of urban street, reflecting differences in driver expectations.

Table F-1-II: Functional and Design Categories for Urban Streets

Criterion	***Functional Category***			
	Principal Arterial		***Minor Arterial***	
Mobility function	Very important		Important	
Access function	Very minor		Substantial	
Points connected	Freeways, important activity centers, major traffic generators		Principal arterials	
Predominant trips served	Relatively long trips between major points and through trips entering, leaving, and passing through city		Trips of moderate length within relatively small geographical areas	
Criterion	***Design Category***			
	High-Speed	***Suburban***	***Intermediate***	***Urban***
Driveway access density	Very low density	Low density	Moderate density	High density
Arterial type	Multilane divided; undivided or two-lane with shoulders	Multilane divided: undivided or two-lane with shoulders	Multilane divided or undivided; one way, two lane	Undivided one way; two way, two or more lanes
Parking	No	No	Some	Usually
Separate left-turn lanes	Yes	Yes	Usually	Some
Signals per mile	0.5 to 2	1 to 5	4 to 10	6 to 12
Speed limits	45 to 55 mph	40 to 45 mph	30 to 40 mph	25 to 35 mph
Pedestrian activity	Very little	Little	Some	Usually
Roadside development	Low density	Low to medium density	Medium to moderate density	High density

Source: *Highway Capacity Manual 2000*

Table F-1-III: Urban Street Class based on Function and Design Categories

Design Category	*Functional Category*	
	Principal Arterial	*Minor Arterial*
High-Speed	I	Not applicable
Suburban	II	II
Intermediate	II	III or IV
Urban	III or IV	IV

Source: *Highway Capacity Manual 2000*

Table F-1-IV: Urban Street Levels of Service by Class

Urban Street Class	*I*	*II*	*III*	*IV*
Range of Free Flow Speeds (mph)	45 to 55	35 to 45	30 to 35	25 to 35
Typical Free Flow Speed (mph)	50	40	33	30
LOS	*Average Travel Speed (mph)*			
A	>42	>35	>30	>25
B	>34	>28	>24	>19
C	>27	>22	>18	>13
D	>21	>17	>14	>9
E	>16	>13	>10	>7
F	≤16	≤13	≤10	≤7

Source: *Highway Capacity Manual 2000*

Interrupted Flow

One of the more important elements limiting, and often interrupting the flow of traffic on a highway is the intersection. Flow on an interrupted facility is usually dominated by points of fixed operation such as traffic signals, stop and yield signs. These all operate quite differently and have differing impacts on overall flow.

Signalized Intersections

The capacity of a highway is related primarily to the geometric characteristics of the facility, as well as to the composition of the traffic stream on the facility. Geometrics are a fixed, or non-varying, characteristic of a facility.

At the signalized intersection, an additional element is introduced into the concept of capacity: time allocation. A traffic signal essentially allocates time among conflicting traffic movements seeking use of the same physical space. The way in which time is allocated has a significant impact on the operation of the intersection and on the capacity of the intersection and its approaches.

LOS for signalized intersections is defined in terms of control delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, traffic and incidents. Total delay is the difference between the travel time actually experienced and the reference travel time that would result during base conditions, *i. e.,* in the absence of traffic control, geometric delay, any incidents, and any other vehicles. Specifically, LOS criteria for traffic signals are stated in terms of average control delay per vehicle, typically for a 15-minute analysis period. Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the ratio of green time to cycle length and the volume to capacity ratio for the lane group.

For each intersection analyzed the average control delay per vehicle per approach is determined for the peak hour. A weighted average of control delay per vehicle is then determined for the intersection. A LOS designation is given to the control delay to better describe the level of operation. A description of levels of service for signalized intersections can be found in Table F-1-V.

Table F-1-V: Description of Level of Service for Signalized Intersections

LOS	*Description*
A	Very low control delay, up to 10 seconds per vehicle. Progression is extremely favorable, and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.
B	Control delay greater than 10 and up to 20 seconds per vehicle. There is good progression or short cycle lengths or both. More vehicles stop causing higher levels of delay.
C	Control delay greater than 20 and up to 35 seconds per vehicle. Higher delays are caused by fair progression or longer cycle lengths or both. Individual cycle failures may begin to appear. Cycle failure occurs when a given green phase doe not serve queued vehicles, and overflow occurs. The number of vehicles stopping is significant, though many still pass through the intersection without stopping.
D	Control delay greater than 35 and up to 55 seconds per vehicle. The influence of congestions becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high volumes. Many vehicles stop, the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	Control delay greater than 55 and up to 80 seconds per vehicle. The limit of acceptable delay. High delays usually indicate poor progression, long cycle lengths, and high volumes. Individual cycle failures are frequent.
F	Control delay in excess of 80 seconds per vehicle. Unacceptable to most drivers. Oversaturation, arrival flow rates exceed the capacity of the intersection. Many individual cycle failures. Poor progression and long cycle lengths may also be contributing factors to higher delay.

Source: *Highway Capacity Manual 2000*

The use of control delay, which may also be referred to as signal delay, was introduced in the 1997 update to the *Highway Capacity Manual*, and represents a departure from previous updates. In the third edition, published in 1985 and the 1994 update to the third edition, delay only included stopped delay. Thus, the LOS criteria listed in Table F-1-V differs from earlier criteria.

Unsignalized Intersections

The current procedures on unsignalized intersections were first introduced in the 1997 update to the *Highway Capacity Manual* and represent a revision of the methodology published in the 1994 update to the 1985 *Highway Capacity Manual*. The revised procedures use control delay as a measure of effectiveness to determine LOS. Delay is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. The delay experienced by a motorist is made up of a number of factors that relate to control, traffic and incidents. Total delay is the difference between the travel time actually experienced and the reference travel time that would result during base conditions, *i. e.,* in the absence of traffic control, geometric delay, any incidents, and any other vehicles. Control delay is the increased time of travel for a vehicle approaching and passing through an unsignalized intersection, compared with a free-flow vehicle if it were not required to slow or stop at the intersection.

Two-Way Stop Controlled Intersections
Two-way stop controlled intersections in which stop signs are used to assign the right-of-way, are the most prevalent type of intersection in the United States. At two-way stop-controlled intersections the stop-controlled approaches are referred as the minor street approaches and can be either public streets or private driveways. The approaches that are not controlled by stop signs are referred to as the major street approaches.

The capacity of movements subject to delay are determined using the "critical gap" method of capacity analysis. Expected average control delay based on movement volume and movement capacity is calculated. A LOS designation is given to the expected control delay for each minor movement. LOS is not defined for the intersection as a whole. Control delay is the increased time of travel for a vehicle approaching and passing through a stop-controlled intersection, compared with a free-flow vehicle if it were not required to slow or stop at the intersection. A description of levels of service for two-way stop-controlled intersections is found in Table F-1-VI.

Table F-1-VI: Description of Level of Service for Two-Way Stop Controlled Intersections

LOS	*Description*
A	Very low control delay less than 10 seconds per vehicle for each movement subject to delay.
B	Low control delay greater than 10 and up to 15 seconds per vehicle for each movement subject to delay.
C	Acceptable control delay greater than 15 and up to 25 seconds per vehicle for each movement subject to delay.
D	Tolerable control delay greater than 25 and up to 35 seconds per vehicle for each movement subject to delay.
E	Limit of tolerable control delay greater than 35 and up to 50 seconds per vehicle for each movement subject to delay.
F	Unacceptable control delay in excess of 50 seconds per vehicle for each movement subject to delay.

Source: *Highway Capacity Manual 2000*

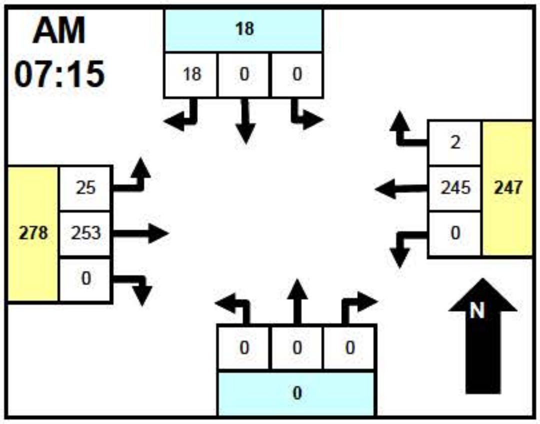
APPENDIX F-2

Existing Traffic Counts

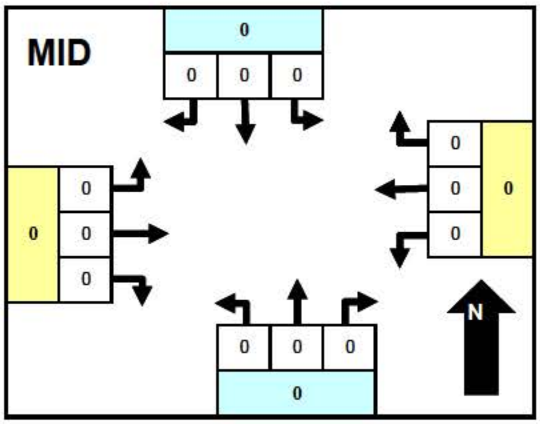
TRAFFIC RESEARCH & ANALYSIS, INC.
Specializing in Traffic Data Collection

Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

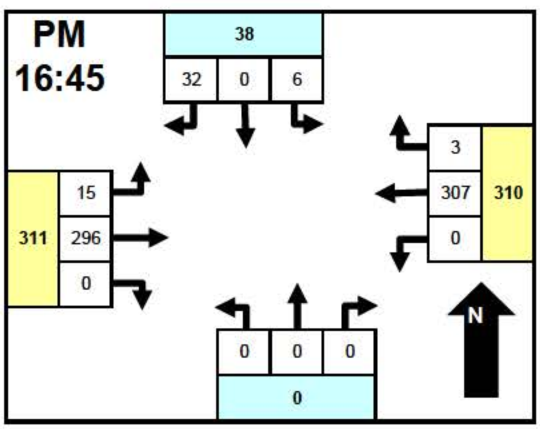
Intersection TMC: CA10050
Count Date: 5/26/2010



	From North				From East				From South				From West				INTSEC
	FRANZ VALLEY RD				PORTER CREEK RD				NONE				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	2	0	0	45	0	0	0	0	0	0	3	41	0	0	91
7:15	0	0	1	0	0	56	0	0	0	0	0	0	5	64	0	0	126
7:30	0	0	7	0	0	62	0	0	0	0	0	0	8	72	0	0	149
7:45	0	0	5	0	0	68	0	0	0	0	0	0	3	61	0	0	137
8:00	0	0	5	0	0	59	2	0	0	0	0	0	9	56	0	0	131
8:15	0	0	4	0	0	35	2	0	0	0	0	0	2	47	0	0	90
8:30	0	0	5	0	0	73	4	0	0	0	0	0	4	51	0	0	137
8:45	0	0	5	0	0	54	0	0	0	0	0	0	7	46	0	0	112
Total	0	0	34	0	0	452	8	0	0	0	0	0	41	438	0	0	973
Peak	0	0	18	0	0	245	2	0	0	0	0	0	25	253	0	0	543



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	1	0	9	0	0	54	1	0	0	0	0	0	7	59	0	0	131
16:15	3	0	8	0	0	61	1	0	0	0	0	0	5	72	0	0	150
16:30	2	0	10	0	0	55	0	0	0	0	0	0	5	63	0	0	135
16:45	0	0	12	0	0	78	1	0	0	0	0	0	4	75	0	0	170
17:00	3	0	10	0	0	82	0	0	0	0	0	0	4	72	0	0	171
17:15	2	0	6	0	0	69	1	0	0	0	0	0	3	97	0	0	178
17:30	1	0	4	0	0	78	1	0	0	0	0	0	4	52	0	0	140
17:45	0	0	4	0	0	69	0	0	0	0	0	0	3	77	0	0	153
18:00	1	0	3	0	0	55	0	0	0	0	0	0	2	52	0	0	113
18:15	1	0	4	0	0	41	0	0	0	0	0	0	3	54	0	0	103
Total	14	0	70	0	0	642	5	0	0	0	0	0	40	673	0	0	1444
Peak	6	0	32	0	0	307	3	0	0	0	0	0	15	296	0	0	659

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	543	7:30 AM	149
MID				
PM	4:45 PM	659	5:15 PM	178

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:30 AM	21	7:15 AM	247			7:15 AM	278
MID								
PM	4:15 PM	48	4:45 PM	310			4:30 PM	323

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	34	49	460	438	0	0	479	486
MID	0	0	0	0	0	0	0	0
PM	84	45	647	687	0	0	713	712

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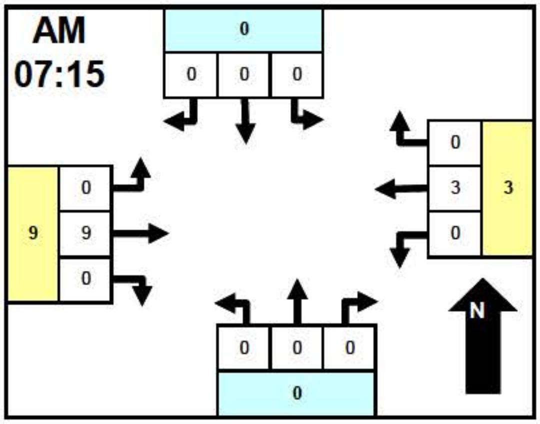
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

Intersection TMC: CA10051
Count Date: 5/26/2010

	From North				From East				From South				From West				INTSEC
	FRANZ VALLEY RD				PORTER CREEK RD				NONE				MARK WEST SPRINGS R				



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
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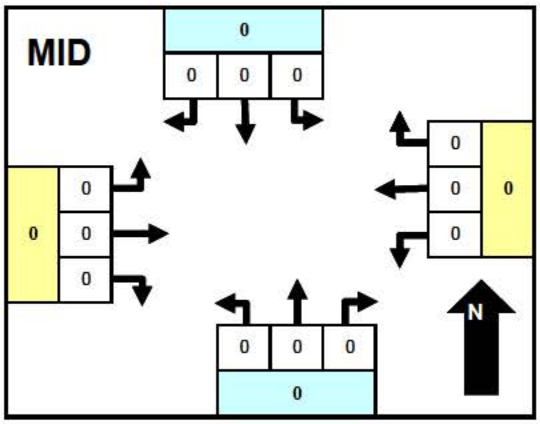
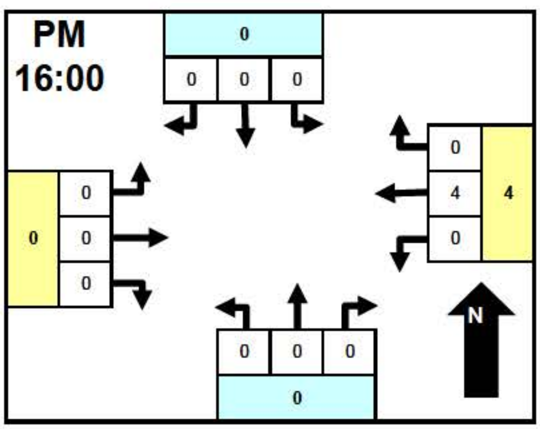
7:15	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
7:30	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
7:45	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	3
8:00	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	3
8:15	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
8:30	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8:45	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	5	0	0	0	0	0	0	0	12	0	0	17
Peak	0	0	0	0	0	3	0	0	0	0	0	0	0	9	0	0	12



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
16:45	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:30	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	8
Peak	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	12	7:15 AM	4
MID				
PM	4 00 PM	4	4:00 PM	2

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			7:45 AM	4			7:15 AM	9
MID								
PM			4 00 PM	4				

Comments

Approach & Departure Volumes (No Peds)

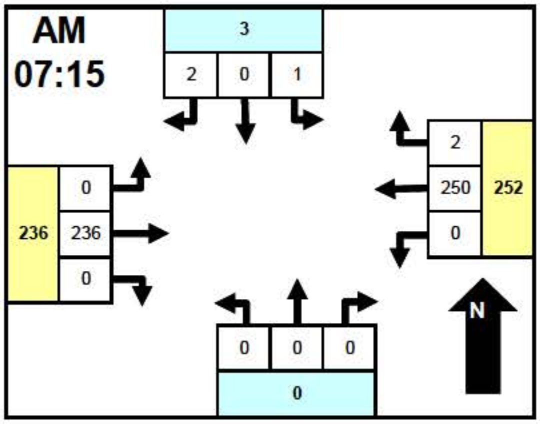
Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	0	5	12	0	0	12	5
MID	0	0	0	0	0	0	0	0
PM	0	0	8	0	0	0	0	8

TRAFFIC RESEARCH & ANALYSIS, INC.
Specializing in Traffic Data Collection

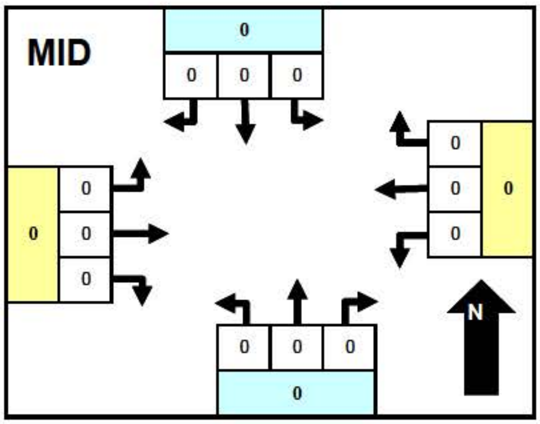
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

Intersection TMC: CA10052
Count Date: 5/26/2010

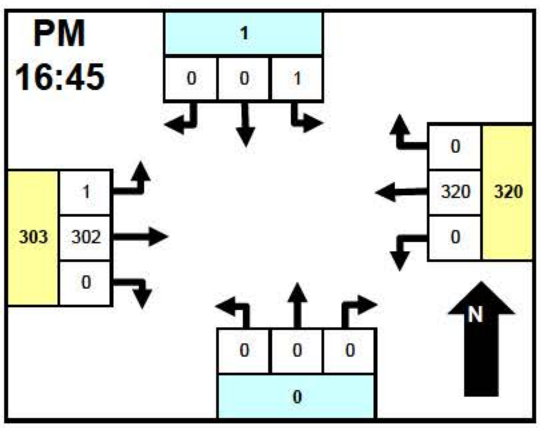
	From North				From East				From South				From West				INTSEC
	QUARRY DRWY				PORTER CREEK RD				NONE				PORTER CREEK RD				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	0	48	1	0	0	0	0	0	0	41	0	0	90
7:15	0	0	0	0	0	65	0	0	0	0	0	0	0	46	0	0	111
7:30	0	0	2	0	0	66	1	0	0	0	0	0	0	69	0	0	138
7:45	1	0	0	0	0	51	1	0	0	0	0	0	0	66	0	0	119
8:00	0	0	0	0	0	68	0	0	0	0	0	0	0	55	0	0	123
8:15	0	0	0	0	0	47	0	0	0	0	0	0	0	48	0	0	95
8:30	0	0	0	0	0	64	0	0	0	0	0	0	0	42	0	0	106
8:45	0	0	0	0	0	53	0	0	0	0	0	0	0	51	0	0	104
Total	1	0	2	0	0	462	3	0	0	0	0	0	0	418	0	0	886
Peak	1	0	2	0	0	250	2	0	0	0	0	0	0	236	0	0	491



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	67	0	0	0	0	0	0	0	51	0	0	118
16:15	0	0	0	0	0	50	0	0	0	0	0	0	0	74	0	0	124
16:30	1	0	1	0	0	69	0	0	0	0	0	0	0	61	0	0	132
16:45	0	0	0	0	0	87	0	0	0	0	0	0	0	69	0	0	156
17:00	0	0	0	0	0	68	0	0	0	0	0	0	0	71	0	0	139
17:15	0	0	0	0	0	82	0	0	0	0	0	0	1	92	0	0	175
17:30	1	0	0	0	0	83	0	0	0	0	0	0	0	70	0	0	154
17:45	0	0	0	0	0	63	0	0	0	0	0	0	0	67	0	0	130
18:00	0	0	1	0	0	42	0	0	0	0	0	0	0	54	0	0	97
18:15	0	0	0	0	0	48	0	0	0	0	0	0	0	53	0	0	101
Total	2	0	2	0	0	659	0	0	0	0	0	0	1	662	0	0	1326
Peak	1	0	0	0	0	320	0	0	0	0	0	0	1	302	0	0	624



Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	491	7:30 AM	138
MID				
PM	4:45 PM	624	5:15 PM	175

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:00 AM	3	7:15 AM	252			7:30 AM	238
MID								
PM	4:00 PM	2	4:45 PM	320			4:45 PM	303

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	3	3	465	419	0	0	418	464
MID	0	0	0	0	0	0	0	0
PM	4	1	659	664	0	0	663	661

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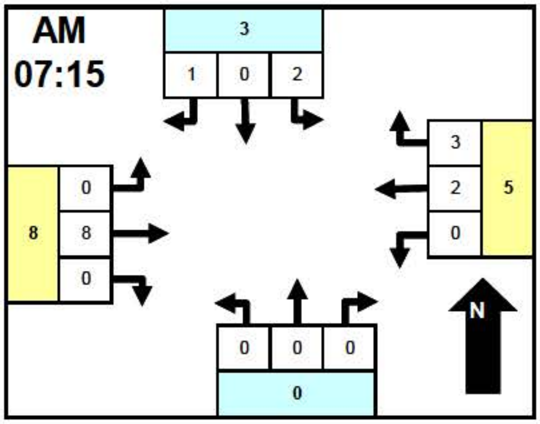
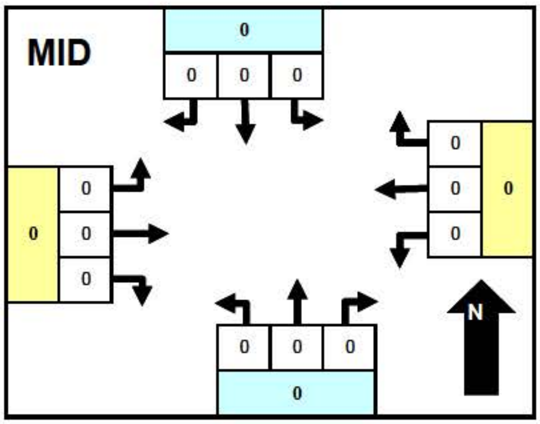
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

Intersection TMC: CA10053
Count Date: 5/26/2010

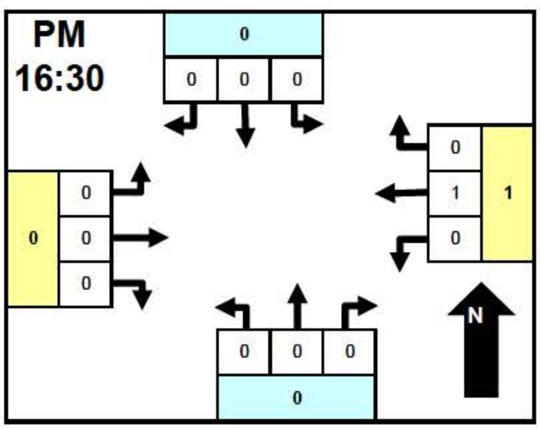
	From North				From East				From South				From West				INTSEC
	QUARRY DRWY				PORTER CREEK RD				NONE				PORTER CREEK RD				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15	1	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	4
7:30	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
7:45	0	0	0	0	0	2	1	0	0	0	0	0	0	1	0	0	4
8:00	1	0	1	0	0	0	1	0	0	0	0	0	0	2	0	0	5
8:15	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	3
8:30	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	3
8:45	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Total	2	0	2	0	0	4	4	0	0	0	0	0	0	12	0	0	24
Peak	2	0	1	0	0	2	3	0	0	0	0	0	0	8	0	0	16



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Peak	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1



Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	16	8:00 AM	5
MID				
PM	4:30 PM	1	5:15 PM	1

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:15 AM	3	7:45 AM	6			7:15 AM	8
MID								
PM			4:30 PM	1				

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	4	4	8	14	0	0	12	6
MID	0	0	0	0	0	0	0	2
PM	0	0	2	0	0	0	0	2

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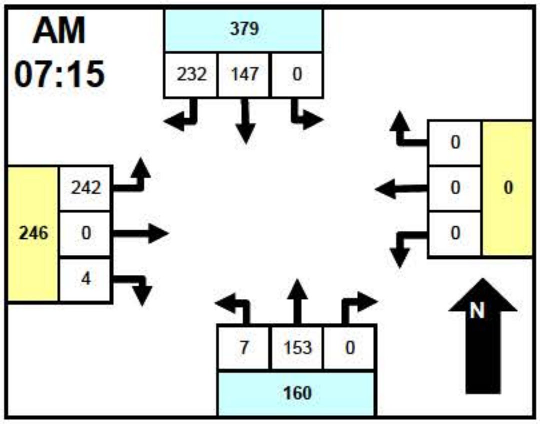
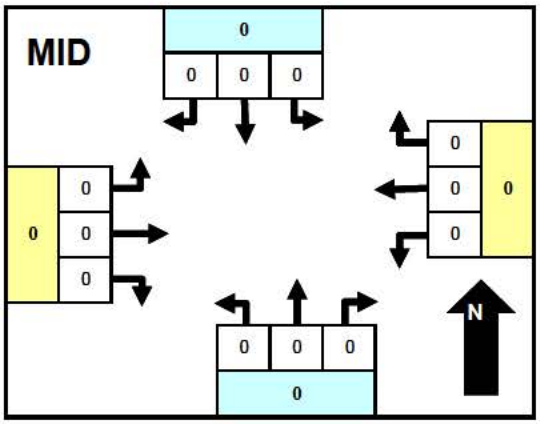
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

Intersection TMC: CA10054
Count Date: 5/26/2010

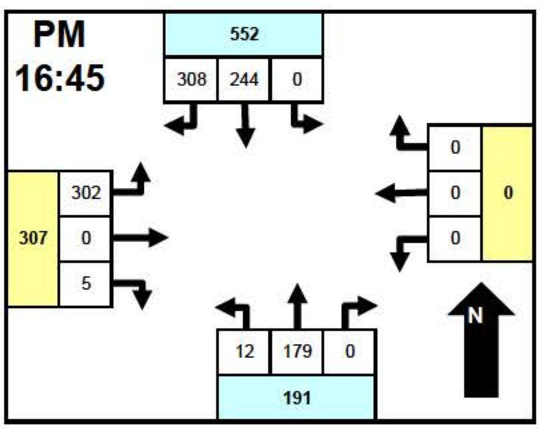
	From North				From East				From South				From West				INTSEC
	PETRIFIED FOREST RD				NONE				CALISTOGA RD				PORTER CREEK RD				



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	27	53	0	0	0	0	0	0	32	0	0	40	0	0	0	152
7:15	0	40	55	0	0	0	0	0	1	38	0	0	56	0	1	0	191
7:30	0	43	66	0	0	0	0	0	0	26	0	0	65	0	3	0	203
7:45	0	28	46	0	0	0	0	0	3	44	0	0	66	0	0	0	187
8:00	0	36	65	0	0	0	0	0	3	45	0	0	55	0	0	0	204
8:15	0	31	49	0	0	0	0	0	1	38	0	0	47	0	0	0	166
8:30	0	39	63	0	0	0	0	0	2	44	0	0	44	0	0	0	192
8:45	0	24	49	0	0	0	0	0	1	24	0	0	50	0	0	0	148
Total	0	268	446	0	0	0	0	0	11	291	0	0	423	0	4	0	1443
Peak	0	147	232	0	0	0	0	0	7	153	0	0	242	0	4	0	785



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	50	70	0	0	0	0	0	0	49	0	0	51	0	0	0	220
16:15	0	54	47	0	0	0	0	0	1	49	0	0	69	0	3	0	223
16:30	0	42	60	0	0	0	0	0	4	43	0	0	62	0	2	0	213
16:45	0	48	82	0	0	0	0	0	6	41	0	0	69	0	0	0	246
17:00	0	73	68	0	0	0	0	0	2	48	0	0	64	0	1	0	256
17:15	0	63	87	0	0	0	0	0	2	42	0	0	93	0	1	0	288
17:30	0	60	71	0	0	0	0	0	2	48	0	0	76	0	3	0	260
17:45	0	38	63	0	0	0	0	0	2	48	0	0	63	0	3	0	217
18:00	0	28	32	0	0	0	0	0	2	26	0	0	56	0	0	0	144
18:15	0	49	52	0	0	0	0	0	0	33	0	0	50	0	3	0	187
Total	0	505	632	0	0	0	0	0	21	427	0	0	653	0	16	0	2254
Peak	0	244	308	0	0	0	0	0	12	179	0	0	302	0	5	0	1050

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	785	8:00 AM	204
MID				
PM	4:45 PM	1050	5:15 PM	288

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:15 AM	379			7:45 AM	180	7:15 AM	246
MID								
PM	4:45 PM	552			4:15 PM	194	4:45 PM	307

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	714	714	0	0	302	272	427	457
MID	0	0	0	0	0	0	0	0
PM	1137	1080	0	0	448	521	669	653

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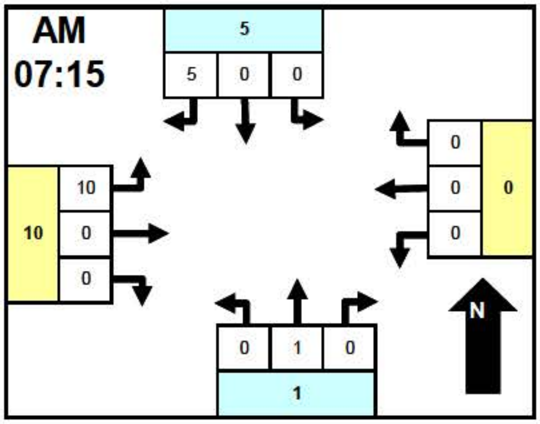
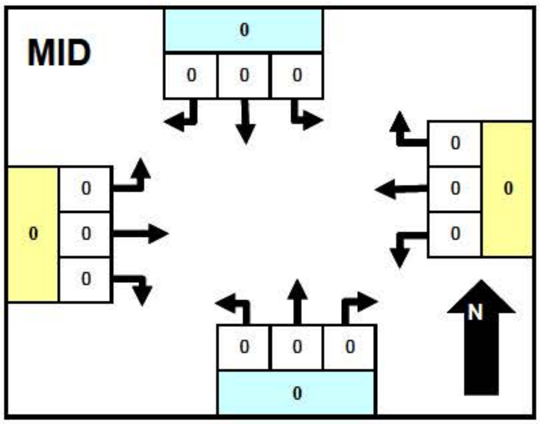
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

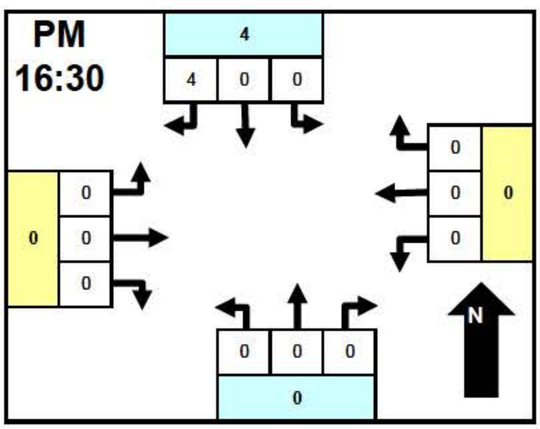
Intersection TMC: CA10055
Count Date: 5/26/2010



	From North				From East				From South				From West				INTSEC
	PETRIFIED FOREST RD				NONE				CALISTOGA RD				PORTER CREEK RD				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7:15	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	3
7:30	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
7:45	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	5
8:00	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	4
8:15	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	3
8:30	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	3
8:45	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Total	0	1	8	0	0	0	0	0	0	2	0	0	14	0	0	0	25
Peak	0	0	5	0	0	0	0	0	0	1	0	0	10	0	0	0	16



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16:45	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
17:30	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Peak	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	16	7:45 AM	5
MID				
PM	4:30 PM	4	5:15 PM	2

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:45 AM	6			7:00 AM	1	7:15 AM	10
MID								
PM	4:30 PM	4						

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	9	16	0	0	2	1	14	8
MID	0	0	0	0	0	0	0	0
PM	7	0	0	0	0	0	0	7

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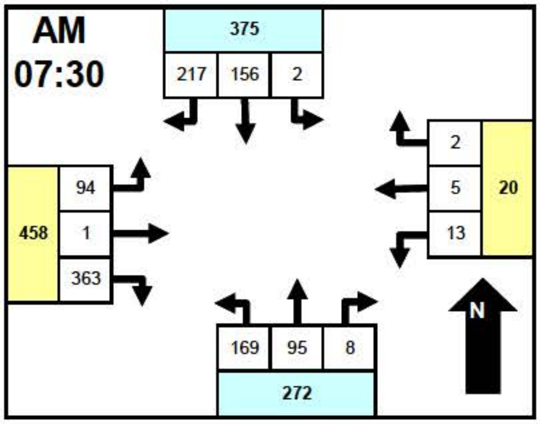
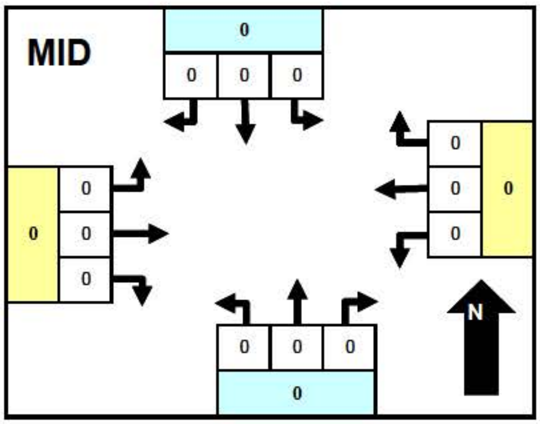
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

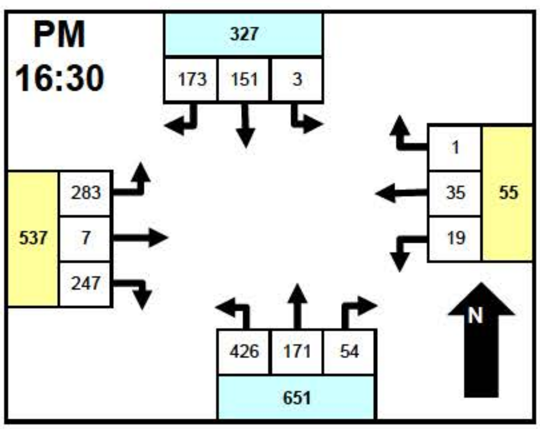
Intersection TMC: CA10056
Count Date: 5/26/2010



	From North				From East				From South				From West				INTSEC
	SR 128				PETRIFIED FOREST RD				SR 128				PETRIFIED FOREST RD				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	29	54	0	7	1	0	0	42	14	0	0	18	2	65	0	232
7:15	1	39	67	0	4	1	1	0	60	17	0	0	18	1	78	0	287
7:30	1	29	51	0	4	0	0	0	32	19	2	0	16	0	97	0	251
7:45	0	47	58	0	3	3	0	0	50	27	1	0	23	0	98	0	310
8:00	1	40	35	0	2	1	0	0	36	23	2	0	30	0	88	0	258
8:15	0	40	73	0	4	1	2	0	51	26	3	0	25	1	80	0	306
8:30	0	24	49	0	7	0	0	0	37	27	1	0	21	1	72	0	239
8:45	0	28	40	0	4	0	0	0	57	31	6	0	27	0	63	0	256
Total	3	276	427	0	35	7	3	0	365	184	15	0	178	5	641	0	2139
Peak	2	156	217	0	13	5	2	0	169	95	8	0	94	1	363	0	1125



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	47	34	0	4	0	1	0	99	43	9	0	48	1	67	0	353
16:15	1	28	27	0	4	1	0	0	79	39	4	0	60	3	60	0	306
16:30	0	51	33	0	4	4	0	0	109	37	9	0	67	1	62	0	377
16:45	2	30	53	0	4	9	0	0	112	36	21	0	64	4	58	0	393
17:00	0	34	41	0	4	13	0	0	103	55	11	0	77	1	63	0	402
17:15	1	36	46	0	7	9	1	0	102	43	13	0	75	1	64	0	398
17:30	1	29	32	0	1	1	0	0	94	44	5	0	77	0	58	0	342
17:45	1	15	18	0	5	0	1	0	67	29	7	0	77	1	53	0	274
18:00	0	15	31	0	1	2	0	0	77	33	3	0	58	0	54	0	274
18:15	0	19	29	0	4	4	2	0	52	30	8	0	50	1	33	0	232
Total	6	304	344	0	38	43	5	0	894	389	90	0	653	13	572	0	3351
Peak	3	151	173	0	19	35	1	0	426	171	54	0	283	7	247	0	1570

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	1125	7:45 AM	310
MID				
PM	4:30 PM	1570	5:00 PM	402

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:00 AM	376	7 00 AM	24	8:00 AM	300	7:30 AM	458
MID								
PM	4:30 PM	327	4:30 PM	55	4:30 PM	651	5:00 PM	547

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	706	365	45	23	564	952	824	799
MID	0	0	0	0	0	0	0	0
PM	654	1047	86	109	1373	914	1238	1281

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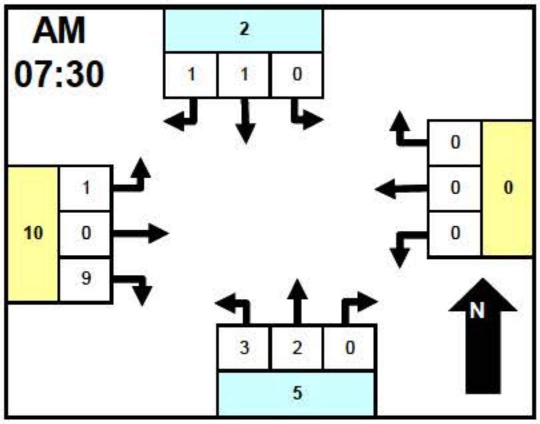
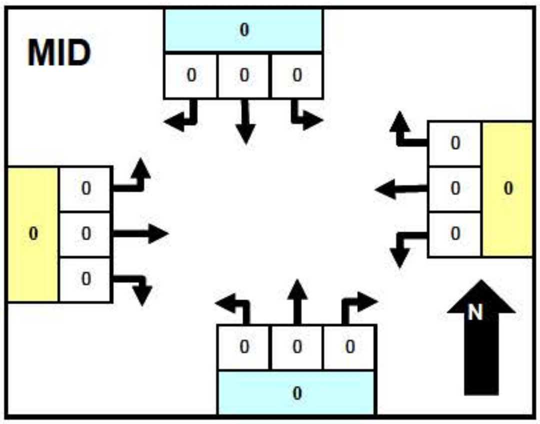
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

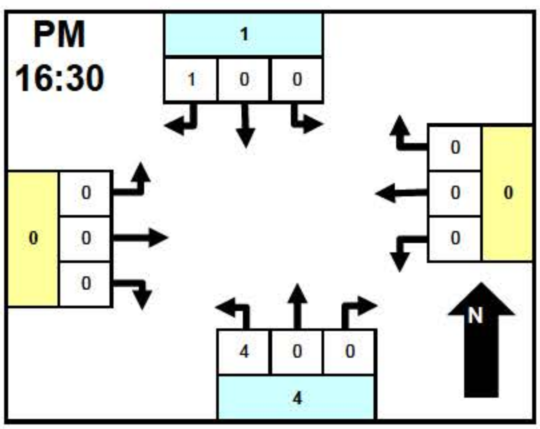
Intersection TMC: CA10057
Count Date: 5/26/2010



Time	From North SR 128 LT	Thru	RT	Ped	From East PETRIFIED FOREST RD LT	Thru	RT	Ped	From South SR 128 LT	Thru	RT	Ped	From West PETRIFIED FOREST RD LT	Thru	RT	Ped	INTSEC TOTAL
7:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
7:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30	0	0	1	0	0	0	0	0	1	0	0	0	0	0	4	0	6
7:45	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0	4
8:00	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2
8:15	0	1	0	0	0	0	0	0	1	0	0	0	0	0	3	0	5
8:30	0	0	0	0	0	0	0	0	1	0	0	0	2	0	2	0	5
8:45	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	3
Total	0	1	2	0	0	0	0	0	6	2	0	0	4	0	11	0	26
Peak	0	1	1	0	0	0	0	0	3	2	0	0	1	0	9	0	17



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
16:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
17:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
17:15	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	0	0	0	0	0	6	0	0	0	0	0	1	0	8
Peak	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	5

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	17	7:30 AM	6
MID				
PM	4:30 PM	5	4:45 PM	2

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:30 AM	2			7:30 AM	5	7:30 AM	10
MID								
PM	4:00 PM	1			4:30 PM	4	4:00 PM	1

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	3	6	0	0	8	12	15	8
MID	0	0	0	0	0	0	0	0
PM	1	0	0	0	6	1	1	7

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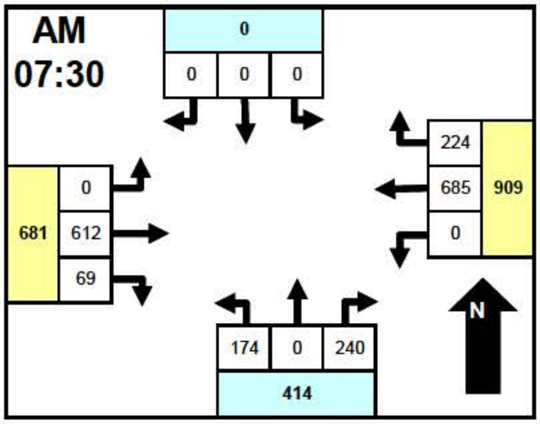
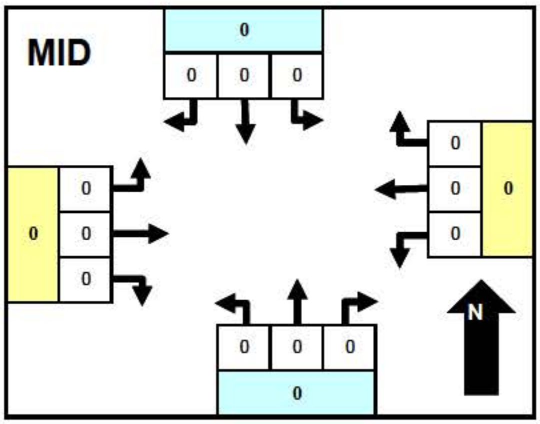
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

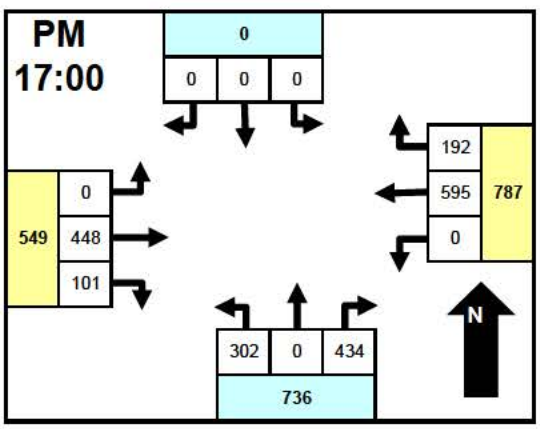
Intersection TMC: CA10058
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	SR 101 NB				RIVER RD				SR 101 NB				RIVER RD				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	0	106	30	0	21	0	30	0	0	78	9	0	274
7:15	0	0	0	0	0	140	40	0	45	0	37	0	0	107	9	0	378
7:30	0	0	0	0	0	156	47	0	47	0	47	0	0	144	13	0	454
7:45	0	0	0	0	0	200	76	0	50	0	62	0	0	155	22	0	565
8:00	0	0	0	0	0	158	50	0	40	0	60	0	0	140	20	0	468
8:15	0	0	0	0	0	171	51	0	37	0	71	0	0	173	14	0	517
8:30	0	0	0	0	0	167	39	0	25	0	58	0	0	91	22	0	402
8:45	0	0	0	0	0	137	35	0	33	0	78	0	0	81	20	0	384
Total	0	0	0	0	0	1235	368	0	298	0	443	0	0	969	129	0	3442
Peak	0	0	0	0	0	685	224	0	174	0	240	0	0	612	69	0	2004



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	169	57	0	70	0	98	0	0	92	18	0	504
16:15	0	0	0	0	0	169	39	0	91	0	82	0	0	91	19	0	491
16:30	0	0	0	0	0	118	48	0	72	0	99	0	0	105	24	0	466
16:45	0	0	0	0	0	127	50	0	63	0	123	0	0	90	23	0	476
17:00	0	0	0	0	0	166	45	0	79	0	116	0	0	121	40	0	567
17:15	0	0	0	0	0	128	53	0	79	0	104	0	0	123	29	0	516
17:30	0	0	0	0	0	148	46	0	64	0	116	0	0	100	23	0	497
17:45	0	0	0	0	0	153	48	0	80	0	98	0	0	104	9	0	492
18:00	0	0	0	0	0	142	27	0	61	0	87	0	0	78	15	0	410
18:15	0	0	0	0	0	121	44	0	67	0	93	0	0	66	9	0	400
Total	0	0	0	0	0	1441	457	0	726	0	1016	0	0	970	209	0	4819
Peak	0	0	0	0	0	595	192	0	302	0	434	0	0	448	101	0	2072

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	2004	7:45 AM	565
MID				
PM	5 00 PM	2072	5:00 PM	567

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			7:45 AM	912	7:30 AM	414	7:30 AM	681
MID								
PM			5 00 PM	787	4:45 PM	744	4:30 PM	555

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	368	1603	1412	741	129	1098	1533
MID	0	0	0	0	0	0	0	0
PM	0	457	1898	1986	1742	209	1179	2167

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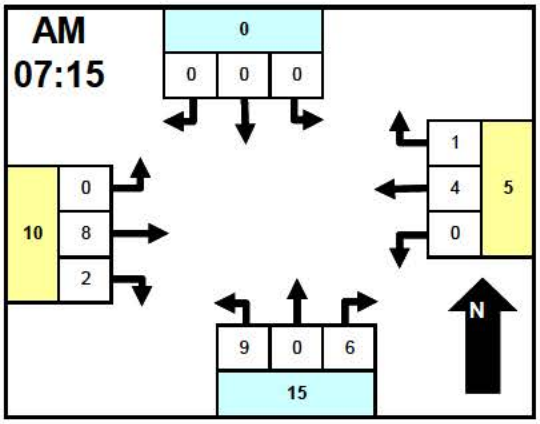
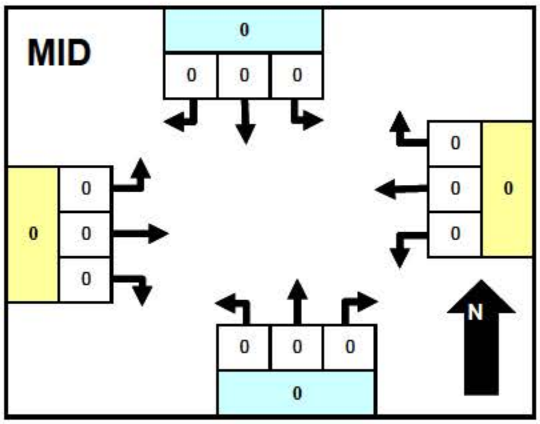
Phoenix, AZ 85018
(602) 840-1500

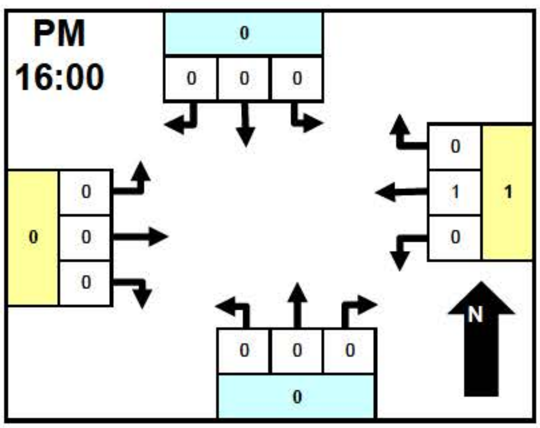
Intersection TMC: CA10059
Count Date: 5/27/2010



Time	From North SR 101 NB LT	Thru	RT	Ped	From East RIVER RD LT	Thru	RT	Ped	From South SR 101 NB LT	Thru	RT	Ped	From West RIVER RD LT	Thru	RT	Ped	INTSEC TOTAL
7:00	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
7:15	0	0	0	0	0	1	1	0	1	0	1	0	0	1	1	0	6
7:30	0	0	0	0	0	0	0	0	3	0	4	0	0	4	0	0	11
7:45	0	0	0	0	0	1	0	0	3	0	1	0	0	2	1	0	8
8:00	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	0	5
8:15	0	0	0	0	0	1	1	0	2	0	1	0	0	0	0	0	5
8:30	0	0	0	0	0	0	0	0	2	0	1	0	0	1	0	0	4
8:45	0	0	0	0	0	3	1	0	1	0	0	0	0	2	1	0	8
Total	0	0	0	0	0	8	3	0	15	0	8	0	0	12	3	0	49
Peak	0	0	0	0	0	4	1	0	9	0	6	0	0	8	2	0	30



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Peak	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	30	7:30 AM	11
MID				
PM	4 00 PM	1	4:15 PM	1

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			8 00 AM	8	7:30 AM	16	7:00 AM	10
MID								
PM			4 00 PM	1				

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	3	11	20	23	3	15	23
MID	0	0	0	0	0	0	0	0
PM	0	0	2	0	0	0	0	2

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3844 East Indian School Road
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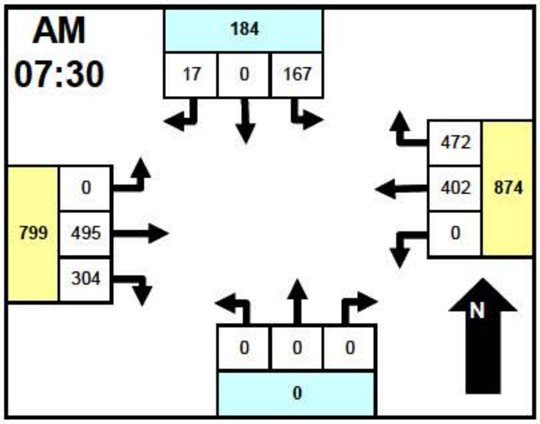
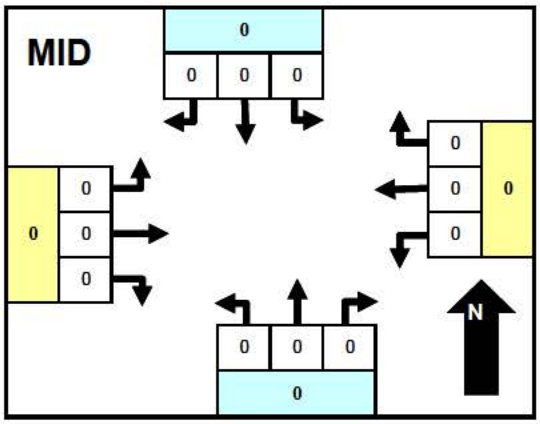
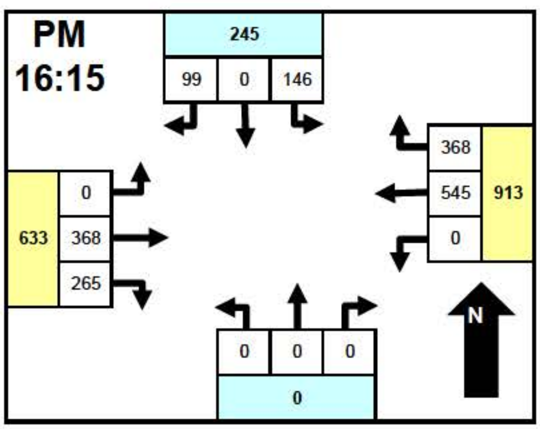
Intersection TMC: CA10060
Count Date: 5/27/2010



	From North SR 101 SB				From East RIVER RD				From South SR 101 SB				From West RIVER RD				INTSEC
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	27	0	2	0	0	47	84	0	0	0	0	0	0	53	52	0	265
7:15	42	0	2	0	0	81	104	0	0	0	0	0	0	79	73	0	381
7:30	51	0	5	0	0	98	109	0	0	0	0	0	0	111	90	0	464
7:45	39	0	5	0	0	120	139	0	0	0	0	0	0	131	77	0	511
8:00	35	0	5	0	0	97	107	0	0	0	0	0	0	118	69	0	431
8:15	42	0	2	0	0	87	117	0	0	0	0	0	0	135	68	0	451
8:30	32	0	1	0	0	71	115	0	0	0	0	0	0	68	95	0	382
8:45	25	0	5	0	0	69	102	0	0	0	0	0	0	78	61	0	340
Total	293	0	27	0	0	670	877	0	0	0	0	0	0	773	585	0	3225
Peak	167	0	17	0	0	402	472	0	0	0	0	0	0	495	304	0	1857



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	35	0	12	0	0	134	113	0	0	0	0	0	0	78	76	0	448
16:15	36	0	15	0	0	154	105	0	0	0	0	0	0	77	64	0	451
16:30	38	0	22	0	0	114	87	0	0	0	0	0	0	86	75	0	422
16:45	30	0	29	0	0	123	85	0	0	0	0	0	0	91	58	0	416
17:00	42	0	33	0	0	154	91	0	0	0	0	0	0	114	68	0	502
17:15	40	0	8	0	0	134	78	0	0	0	0	0	0	104	65	0	429
17:30	40	0	14	0	0	130	92	0	0	0	0	0	0	85	56	0	417
17:45	31	0	16	0	0	144	89	0	0	0	0	0	0	76	52	0	408
18:00	33	0	13	0	0	111	86	0	0	0	0	0	0	52	46	0	341
18:15	28	0	12	0	0	125	70	0	0	0	0	0	0	49	40	0	324
Total	353	0	174	0	0	1323	896	0	0	0	0	0	0	812	600	0	4158
Peak	146	0	99	0	0	545	368	0	0	0	0	0	0	368	265	0	1791

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	1857	7:45 AM	511
MID				
PM	4:15 PM	1791	5:00 PM	502

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:15 AM	184	7:30 AM	874			7:30 AM	799
MID								
PM	4:15 PM	245	4 00 PM	915			4:30 PM	661

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	320	877	1547	1066	0	585	1358	697
MID	0	0	0	0	0	0	0	0
PM	527	896	2219	1165	0	600	1412	1497

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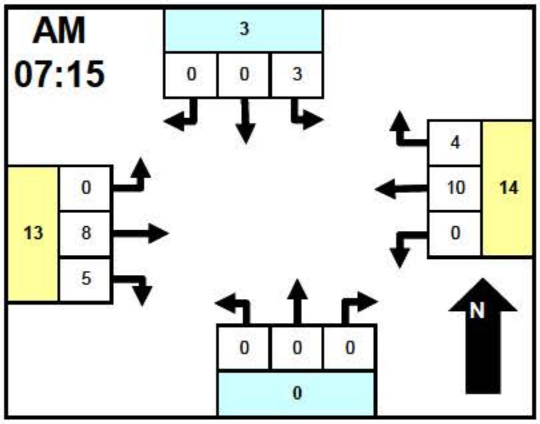
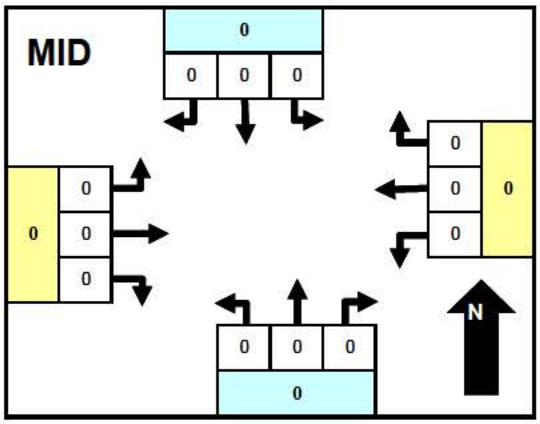
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

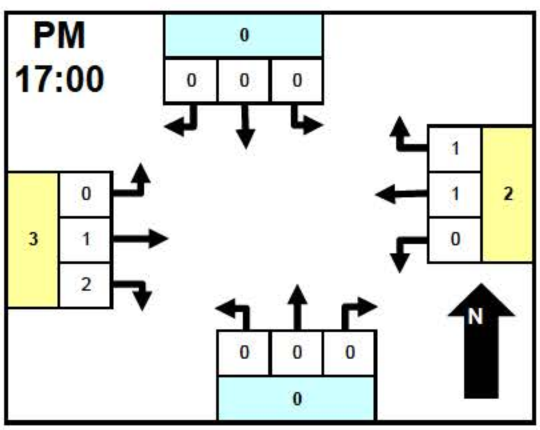
Intersection TMC: CA10061
Count Date: 5/27/2010



Time	From North SR 101 SB LT	Thru	RT	Ped	From East RVIER RD LT	Thru	RT	Ped	From South SR 101 SB LT	Thru	RT	Ped	From West RVIER RD LT	Thru	RT	Ped	INTSEC TOTAL
7:00	0	0	0	0	0	2	1	0	0	0	0	0	0	2	0	0	5
7:15	1	0	0	0	0	2	0	0	0	0	0	0	0	2	1	0	6
7:30	2	0	0	0	0	3	0	0	0	0	0	0	0	2	2	0	9
7:45	0	0	0	0	0	3	1	0	0	0	0	0	0	3	1	0	8
8:00	0	0	0	0	0	2	3	0	0	0	0	0	0	1	1	0	7
8:15	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	4
8:30	0	0	1	0	0	2	1	0	0	0	0	0	0	1	2	0	7
8:45	0	0	0	0	0	1	2	0	0	0	0	0	0	3	1	0	7
Total	3	0	1	0	0	18	8	0	0	0	0	0	0	14	9	0	53
Peak	3	0	0	0	0	10	4	0	0	0	0	0	0	8	5	0	30



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	3
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
17:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	0	0	2	1	0	0	0	0	0	0	1	3	0	8
Peak	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2	0	5

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	30	7:30 AM	9
MID				
PM	5 00 PM	5	4:00 PM	3

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:00 AM	3	7:30 AM	15			7:00 AM	13
MID								
PM	4:00 PM	1	4:30 PM	2			5:00 PM	3

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	4	8	26	17	0	9	23	19
MID	0	0	0	0	0	0	0	0
PM	1	1	3	1	0	3	4	3

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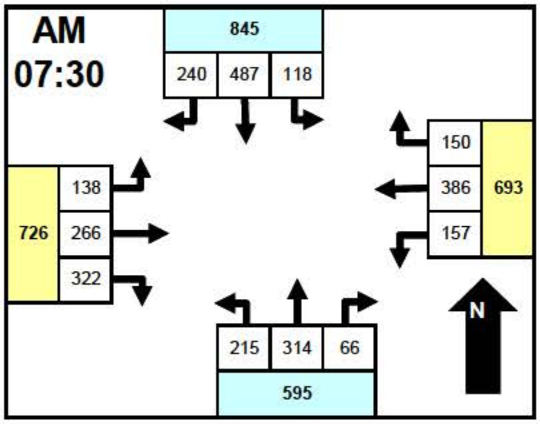
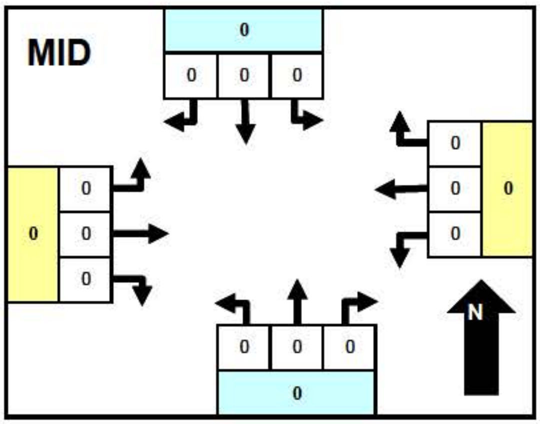
Traffic Research & Analysis, Inc.
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

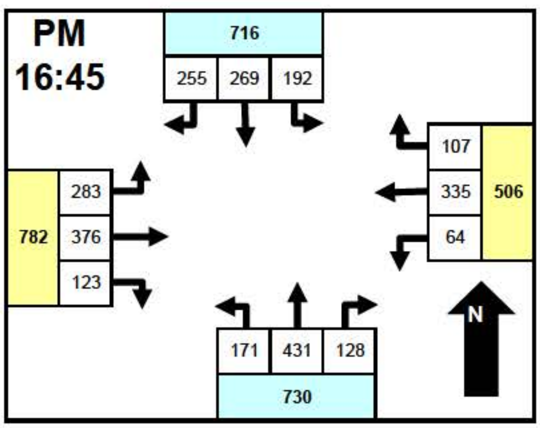
Intersection TMC: CA10062
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	OLD RDWD HWY				MARK WEST SPRINGS R				OLD RDWD HWY				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	10	55	49	0	12	68	19	0	9	21	3	0	29	57	28	0	360
7:15	26	75	58	0	18	94	18	0	18	40	13	0	17	65	25	0	467
7:30	43	124	56	0	34	80	27	0	47	56	12	0	19	56	53	0	607
7:45	22	155	82	0	50	121	42	0	65	86	23	0	27	73	114	0	860
8:00	31	99	59	0	37	102	54	0	41	80	18	0	39	73	69	0	702
8:15	22	109	43	0	36	83	27	0	62	92	13	0	53	64	86	0	690
8:30	29	89	50	0	19	90	19	0	32	47	9	0	58	66	60	0	568
8:45	24	78	58	0	10	84	25	0	17	64	9	0	48	46	31	0	494
Total	207	784	455	0	216	722	231	0	291	486	100	0	290	500	466	0	4748
Peak	118	487	240	0	157	386	150	0	215	314	66	0	138	266	322	0	2859



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	44	75	80	0	24	78	16	0	43	98	21	0	48	93	22	0	642
16:15	42	75	69	0	22	91	28	0	47	101	30	0	68	80	21	0	674
16:30	46	63	53	0	19	77	37	0	32	108	20	0	65	102	23	0	645
16:45	45	67	56	0	13	94	32	0	44	101	25	0	64	89	33	0	663
17:00	45	76	66	0	14	87	16	0	52	109	19	0	62	108	41	0	695
17:15	58	68	60	0	25	74	28	0	40	111	45	0	78	86	25	0	698
17:30	44	58	73	0	12	80	31	0	35	110	39	0	79	93	24	0	678
17:45	45	58	56	0	17	109	22	0	34	86	39	0	58	77	20	0	621
18:00	44	67	56	0	10	65	26	0	30	81	22	0	69	75	29	0	574
18:15	29	47	49	0	9	76	19	0	37	64	18	0	53	70	27	0	498
Total	442	654	618	0	165	831	255	0	394	969	278	0	644	873	265	0	6388
Peak	192	269	255	0	64	335	107	0	171	431	128	0	283	376	123	0	2734

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	2859	7:45 AM	860
MID				
PM	4:45 PM	2734	5:15 PM	698

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:30 AM	845	7:30 AM	693	7:30 AM	595	7:45 AM	782
MID								
PM	4:45 PM	716	4 00 PM	531	4:45 PM	730	4:45 PM	782

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	1446	1007	1169	807	877	1466	1256	1468
MID	0	0	0	0	0	0	0	0
PM	1714	1868	1251	1593	1641	1084	1782	1843

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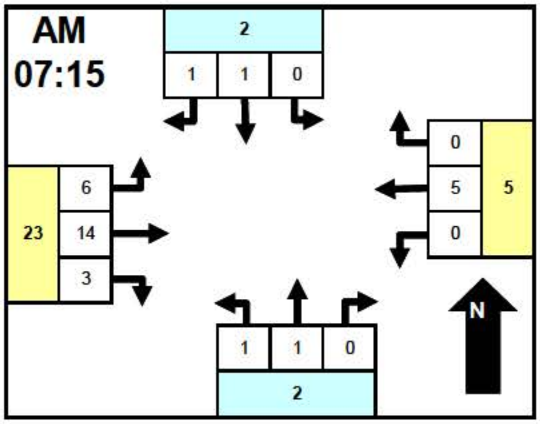
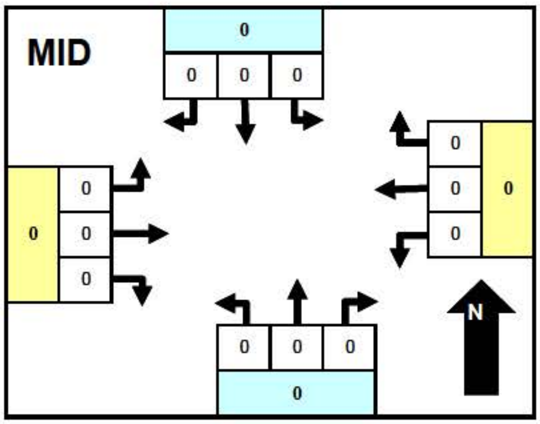
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

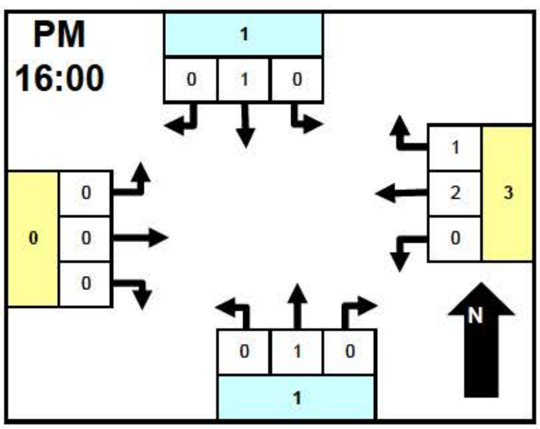
Intersection TMC: CA10063
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	OLD RDWD HWY				MARK WEST SPRINGS R				OLD RDWD HWY				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	4
7:15	0	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	6
7:30	0	0	0	0	0	0	0	0	0	0	0	0	5	7	1	0	13
7:45	0	0	1	0	0	1	0	0	0	0	0	0	1	2	1	0	6
8:00	0	0	0	0	0	4	0	0	1	1	0	0	0	1	0	0	7
8:15	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3
8:30	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	3
8:45	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	5
Total	1	2	3	0	0	9	0	0	1	1	0	0	8	19	3	0	47
Peak	0	1	1	0	0	5	0	0	1	1	0	0	6	14	3	0	32



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	3
16:15	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	1	0	0	3	1	0	0	1	0	0	1	0	0	0	8
Peak	0	1	0	0	0	2	1	0	0	1	0	0	0	0	0	0	5

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	32	7:30 AM	13
MID				
PM	4 00 PM	5	4:00 PM	3

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:00 AM	4	8 00 AM	8	7:15 AM	2	7:00 AM	24
MID								
PM	4:00 PM	1	4 00 PM	3	4:00 PM	1	5:15 PM	1

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	6	9	9	20	2	5	30	13
MID	0	0	0	0	0	0	0	0
PM	2	3	4	0	1	1	1	4

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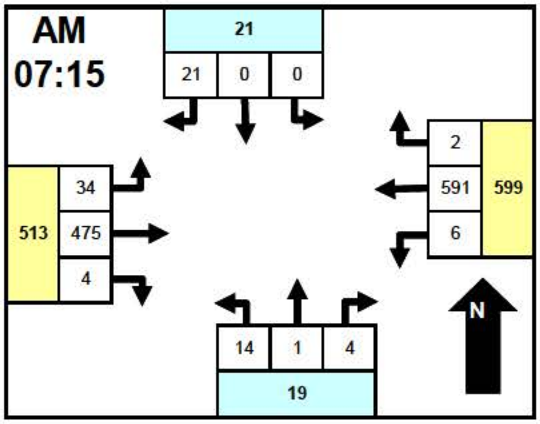
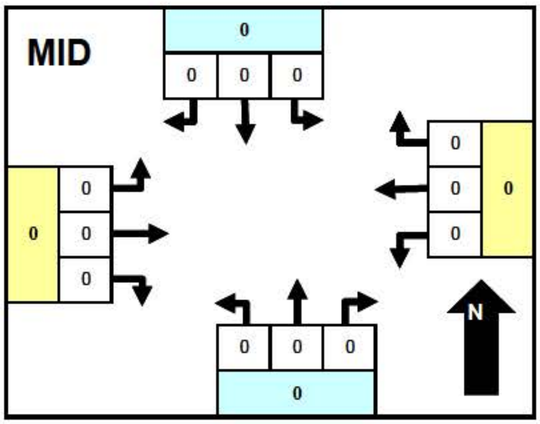
(602) 840-1500

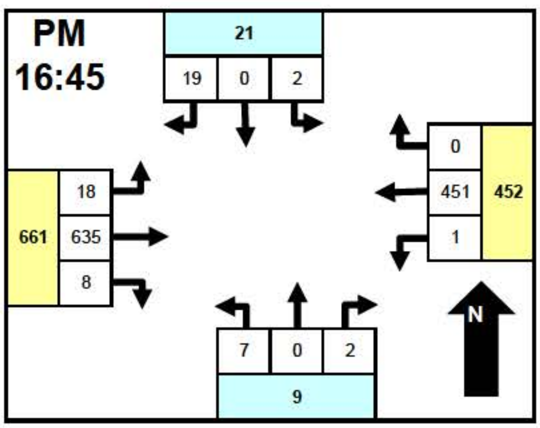
Intersection TMC: CA10064
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	URSULINE RD				MARK WEST SPRINGS R				URSULINE RD				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	0	86	0	0	1	0	1	0	2	80	1	0	171
7:15	0	0	1	0	1	113	0	0	1	0	1	0	6	113	1	0	237
7:30	0	0	5	0	1	120	0	0	8	0	3	0	5	120	2	0	264
7:45	0	0	5	0	3	197	0	0	2	0	0	0	7	125	0	0	339
8:00	0	0	10	0	1	161	2	0	3	1	0	0	16	117	1	0	312
8:15	1	0	6	0	1	121	0	0	3	0	0	0	10	89	1	0	232
8:30	0	0	4	0	0	109	0	0	0	0	0	0	8	90	0	0	211
8:45	0	0	5	0	0	103	0	0	1	0	1	0	5	75	6	0	196
Total	1	0	36	0	7	1010	2	0	19	1	6	0	59	809	12	0	1962
Peak	0	0	21	0	6	591	2	0	14	1	4	0	34	475	4	0	1152



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	5	0	0	118	0	0	1	0	1	0	5	139	1	0	270
16:15	0	1	2	0	0	126	0	0	1	1	1	0	5	140	2	0	279
16:30	1	0	11	0	0	112	0	0	1	0	0	0	5	159	0	0	289
16:45	1	0	4	0	0	118	0	0	1	0	0	0	2	164	1	0	291
17:00	0	0	8	0	0	103	0	0	1	0	0	0	3	154	1	0	270
17:15	0	0	3	0	1	107	0	0	4	0	1	0	5	163	5	0	289
17:30	1	0	4	0	0	123	0	0	1	0	1	0	8	154	1	0	293
17:45	1	0	7	0	0	128	0	0	0	0	0	0	2	148	4	0	290
18:00	0	2	3	0	2	91	0	0	2	0	1	0	3	125	1	0	230
18:15	0	0	1	0	0	91	0	0	0	0	0	0	0	106	4	0	202
Total	4	3	48	0	3	1117	0	0	12	1	5	0	38	1452	20	0	2703
Peak	2	0	19	0	1	451	0	0	7	0	2	0	18	635	8	0	1143

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	1152	7:45 AM	339
MID				
PM	4:45 PM	1143	5:30 PM	293

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:30 AM	27	7:30 AM	607	7:30 AM	20	7:15 AM	513
MID								
PM	4:15 PM	28	4 00 PM	474	5:15 PM	10	4:30 PM	662

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	37	62	1019	816	26	19	880	1065
MID	0	0	0	0	0	0	0	0
PM	55	39	1120	1461	18	26	1510	1177

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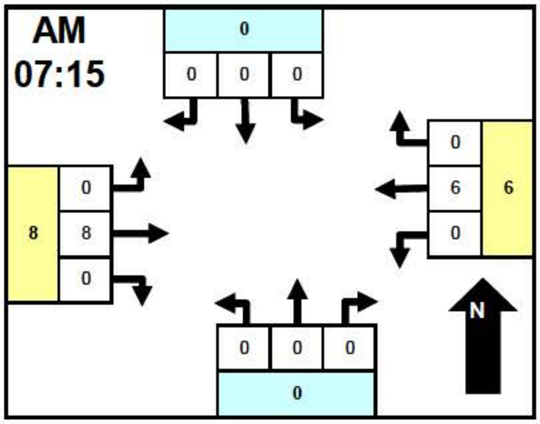
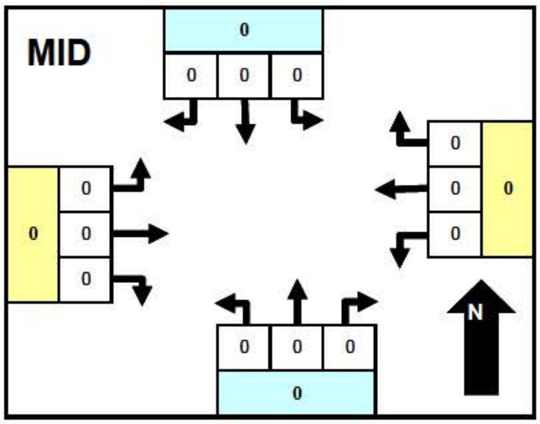
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

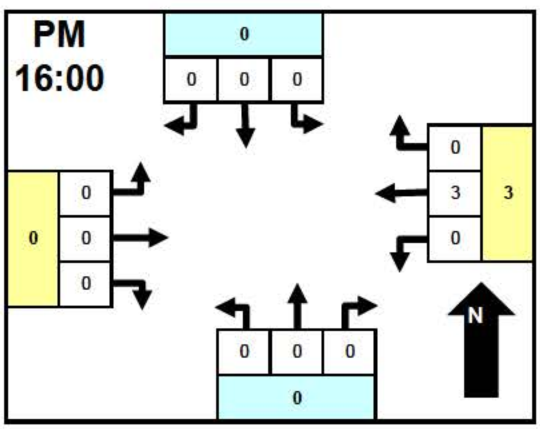
Intersection TMC: CA10065
Count Date: 5/27/2010



Time	From North URSULINE RD LT	Thru	RT	Ped	From East MARK WEST SPRINGS R LT	Thru	RT	Ped	From South URSULINE RD LT	Thru	RT	Ped	From West MARK WEST SPRINGS R LT	Thru	RT	Ped	INTSEC TOTAL
7:00	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	4
7:15	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
7:30	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
7:45	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
8:00	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	6
8:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	5
Total	0	0	0	0	0	10	0	0	0	0	0	0	0	13	0	0	23
Peak	0	0	0	0	0	6	0	0	0	0	0	0	0	8	0	0	14



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
16:15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4
Peak	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	14	8:00 AM	6
MID				
PM	4 00 PM	3	4:00 PM	2

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			8 00 AM	8			7:00 AM	10
MID								
PM			4 00 PM	3				

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	0	10	13	0	0	13	10
MID	0	0	0	0	0	0	0	0
PM	0	0	4	0	0	0	0	4

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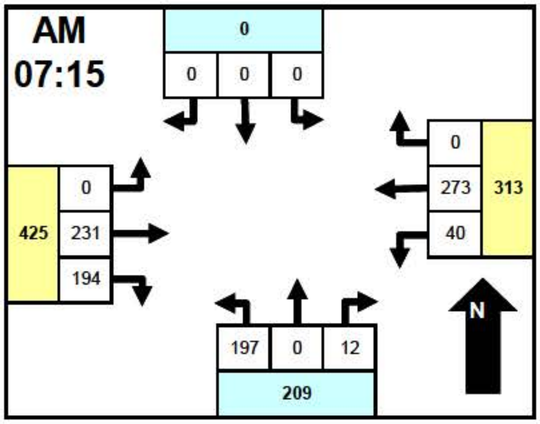
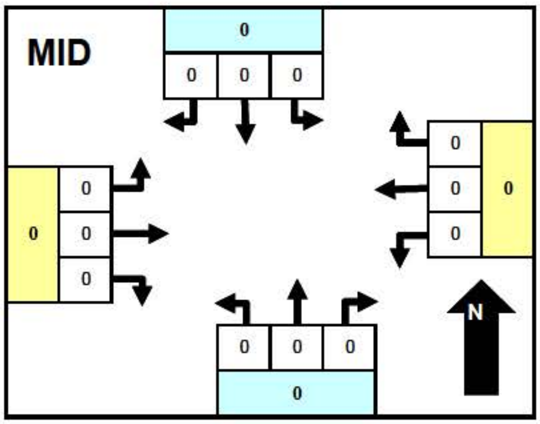
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

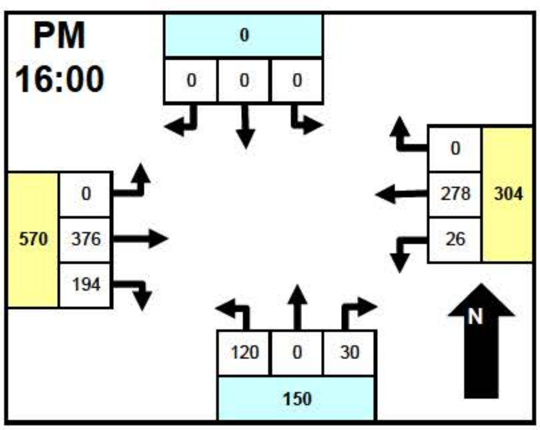
Intersection TMC: CA10066
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	NONE				MARK WEST SPRINGS R				RIEBLI RD				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	4	45	0	0	28	0	4	0	0	63	19	0	163
7:15	0	0	0	0	7	48	0	0	51	0	1	0	0	66	49	0	222
7:30	0	0	0	0	17	73	0	0	36	0	4	0	0	55	65	0	250
7:45	0	0	0	0	7	77	0	0	63	0	2	0	0	57	36	0	242
8:00	0	0	0	0	9	75	0	0	47	0	5	0	0	53	44	0	233
8:15	0	0	0	0	2	53	0	0	25	0	4	0	0	56	27	0	167
8:30	0	0	0	0	9	66	0	0	36	0	2	0	0	64	27	0	204
8:45	0	0	0	0	8	60	0	0	30	0	6	0	0	51	28	0	183
Total	0	0	0	0	63	497	0	0	316	0	28	0	0	465	295	0	1664
Peak	0	0	0	0	40	273	0	0	197	0	12	0	0	231	194	0	947



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	7	82	0	0	25	0	10	0	0	81	48	0	253
16:15	0	0	0	0	8	68	0	0	31	0	7	0	0	97	43	0	254
16:30	0	0	0	0	7	66	0	0	23	0	5	0	0	95	53	0	249
16:45	0	0	0	0	4	62	0	0	41	0	8	0	0	103	50	0	268
17:00	0	0	0	0	3	65	0	0	16	0	4	0	0	89	48	0	225
17:15	0	0	0	0	4	56	0	0	37	0	6	0	0	99	64	0	266
17:30	0	0	0	0	8	69	0	0	30	0	3	0	0	91	58	0	259
17:45	0	0	0	0	8	64	0	0	30	0	5	0	0	93	60	0	260
18:00	0	0	0	0	3	60	0	0	34	0	6	0	0	77	38	0	218
18:15	0	0	0	0	3	39	0	0	21	0	5	0	0	64	44	0	176
Total	0	0	0	0	55	631	0	0	288	0	59	0	0	889	506	0	2428
Peak	0	0	0	0	26	278	0	0	120	0	30	0	0	376	194	0	1024

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:15 AM	947	7:30 AM	250
MID				
PM	4 00 PM	1024	4:45 PM	268

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			7:15 AM	313	7:15 AM	209	7:15 AM	425
MID								
PM			4 00 PM	304	5:15 PM	151	4:45 PM	602

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	0	560	493	344	358	760	813
MID	0	0	0	0	0	0	0	0
PM	0	0	686	948	347	561	1395	919

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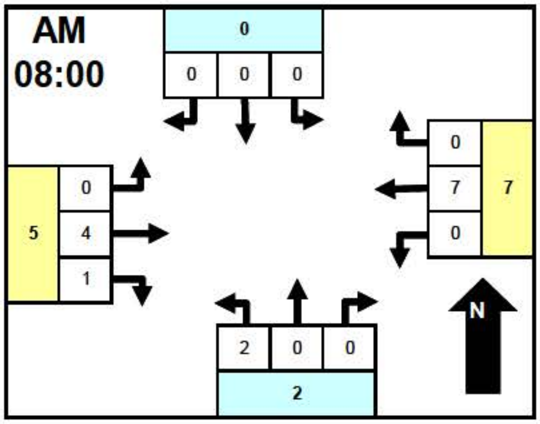
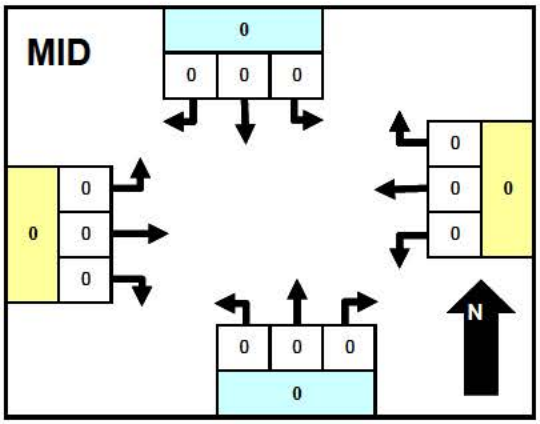
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

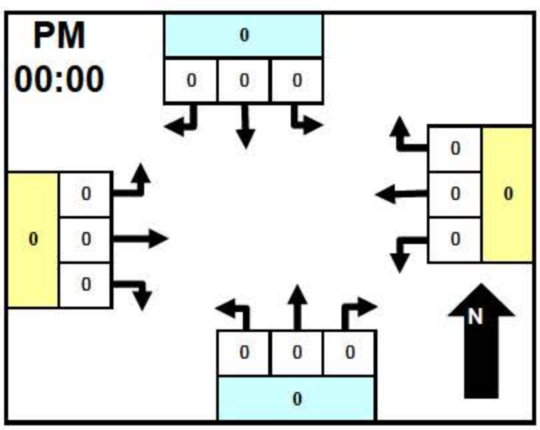
Intersection TMC: CA10067
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	NONE				MARK WEST SPRINGS R				RIEBLI RD				MARK WEST SPRINGS R				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
7:15	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	3
7:30	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
7:45	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	3
8:00	0	0	0	0	0	3	0	0	1	0	0	0	0	0	1	0	5
8:15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
8:30	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
8:45	0	0	0	0	0	2	0	0	1	0	0	0	0	3	0	0	6
Total	0	0	0	0	0	9	0	0	2	0	0	0	0	11	2	0	24
Peak	0	0	0	0	0	7	0	0	2	0	0	0	0	4	1	0	14



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	8 00 AM	14	8:45 AM	6
MID				
PM	12:00 AM	0	12 00 AM	0

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM			7:45 AM	7	8:00 AM	2	7:00 AM	8
MID								
PM								

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	0	0	9	11	2	2	13	11
MID	0	0	0	0	0	0	0	0
PM	0	0	0	0	0	0	0	0

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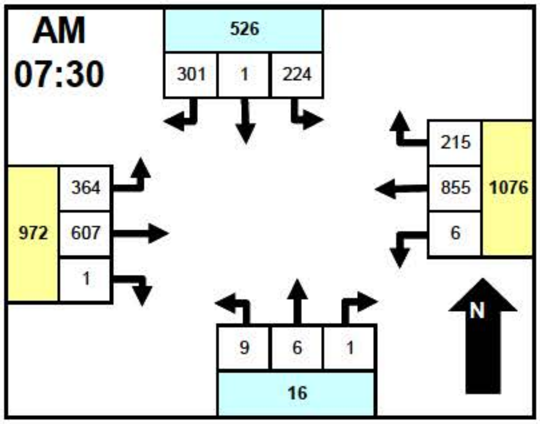
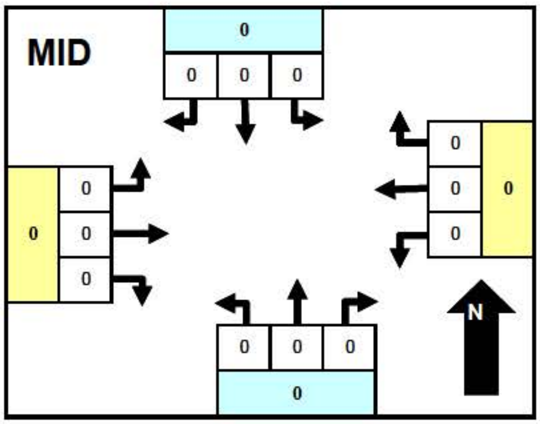
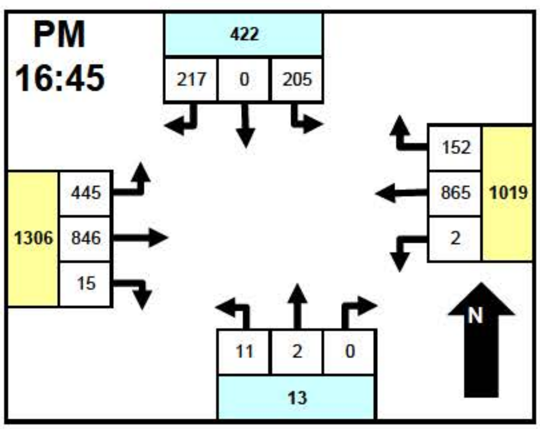
Intersection TMC: CA10068
Count Date: 5/27/2010



	From North				From East				From South				From West				INTSEC
	CALISTOGA RD				SR 12				CALISTOGA RD				SR 12				
Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
7:00	33	0	42	0	2	124	16	0	1	2	0	0	35	108	0	0	363
7:15	21	0	49	0	0	199	15	0	2	2	0	0	39	114	1	0	442
7:30	60	0	92	0	3	238	93	0	1	2	0	0	73	143	0	0	705
7:45	58	0	76	0	1	202	66	0	2	3	1	0	85	159	0	0	653
8:00	66	1	79	0	2	190	34	0	6	1	0	0	102	136	0	0	617
8:15	40	0	54	0	0	225	22	0	0	0	0	0	104	169	1	0	615
8:30	46	0	99	0	0	200	27	0	4	1	0	0	48	138	6	0	569
8:45	43	0	57	0	1	216	23	0	4	0	0	0	55	131	0	0	530
Total	367	1	548	0	9	1594	296	0	20	11	1	0	541	1098	8	0	4494
Peak	224	1	301	0	6	855	215	0	9	6	1	0	364	607	1	0	2590



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	47	1	45	0	1	200	41	0	2	1	0	0	95	188	1	0	622
16:15	47	1	46	0	0	204	49	0	1	1	0	0	88	199	2	0	638
16:30	39	1	47	0	0	230	30	1	5	0	0	0	119	189	3	0	664
16:45	51	0	59	0	2	221	46	0	1	0	0	0	116	201	1	0	698
17:00	48	0	61	0	0	212	42	0	3	1	0	0	109	181	7	0	664
17:15	55	0	39	0	0	216	45	0	3	0	0	0	127	221	2	0	708
17:30	51	0	58	0	0	216	19	0	4	1	0	0	93	243	5	0	690
17:45	58	0	59	0	0	216	47	0	0	0	0	0	127	187	1	0	695
18:00	48	1	58	0	0	148	36	0	0	0	0	0	104	181	6	0	582
18:15	42	1	52	0	1	143	25	0	1	0	0	0	84	174	5	0	528
Total	486	5	524	0	4	2006	380	1	20	4	0	0	1062	1964	33	0	6489
Peak	205	0	217	0	2	865	152	0	11	2	0	0	445	846	15	0	2760

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7:30 AM	2590	7:30 AM	705
MID				
PM	4:45 PM	2760	5:15 PM	708

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:30 AM	526	7:30 AM	1076	7:15 AM	20	7:30 AM	972
MID								
PM	5:00 PM	429	4:30 PM	1045	4:30 PM	13	4:45 PM	1306

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	916	848	1899	1466	32	18	1647	2162
MID	0	0	0	0	0	0	0	0
PM	1015	1446	2390	2450	24	42	3059	2550

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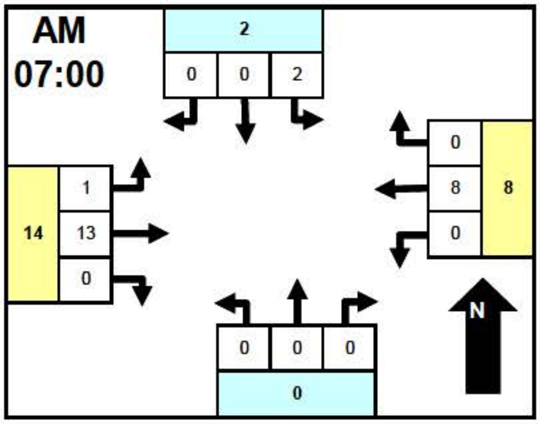
3844 East Indian School Road
Phoenix, AZ 85018
(602) 840-1500

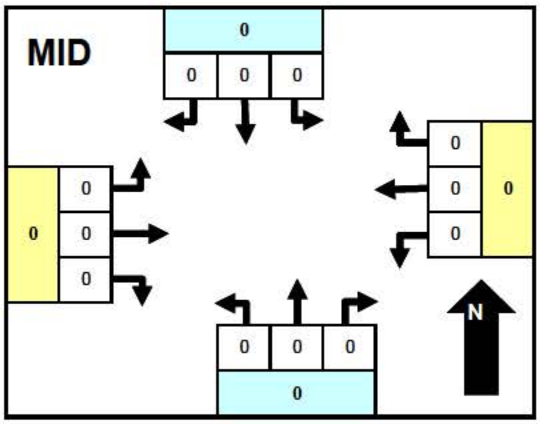
Intersection TMC: CA10069
Count Date: 5/27/2010

AM 07:00



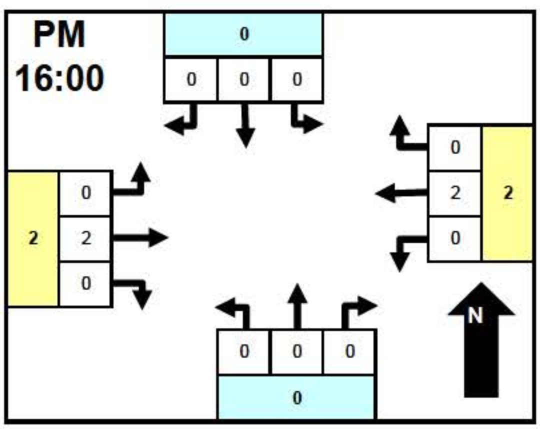
Time	From North CALISTOGA RD LT	Thru	RT	Ped	From East SR 12 LT	Thru	RT	Ped	From South CALISTOGA RD LT	Thru	RT	Ped	From West SR 12 LT	Thru	RT	Ped	INTSEC TOTAL
7:00	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	6
7:15	0	0	0	0	0	2	0	0	0	0	0	0	1	2	0	0	5
7:30	1	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	7
7:45	1	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	6
8:00	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
8:15	0	0	0	0	0	1	1	0	0	0	0	0	0	3	0	0	5
8:30	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	3
8:45	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	3
Total	2	0	1	0	0	11	3	0	0	0	0	0	1	19	0	0	37
Peak	2	0	0	0	0	8	0	0	0	0	0	0	1	13	0	0	24

MID



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak																	0

PM 16:00



Time	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	LT	Thru	RT	Ped	TOTAL
16:00	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
16:15	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:15	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
18:15	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	1	0	0	5	0	0	0	0	0	0	1	3	0	0	10
Peak	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	4

Intersection Statistics

Per	Peak Hour	Pk Hr Vol	Peak Intvl	Pk Intv Vol
AM	7 00 AM	24	7:30 AM	7
MID				
PM	4 00 PM	4	4:00 PM	2

Approach Statistics

Per	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol	Peak Hour	Pk Hr Vol
AM	7:00 AM	2	7 00 AM	8			7:00 AM	14
MID								
PM	5:30 PM	1	5 00 PM	3			4:00 PM	2

Comments

Approach & Departure Volumes (No Peds)

Per	Approach	Depart	Approach	Depart	Approach	Depart	Approach	Depart
AM	3	4	14	21	0	0	20	12
MID	0	0	0	0	0	0	0	0
PM	1	1	5	3	0	0	4	6

Location: 12-7006-001 Sonoma County

Date:	Saturday 1/7/2012			Sunday 1/8/2012			Monday 1/9/2012			Tuesday 1/10/2012			Wednesday 1/11/2012			Thursday 1/12/2012			Friday 1/13/2012		
	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**
7:00 AM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**
7:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**
7:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**
8:15 AM	0	1	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:45 AM	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**
9:30 AM	0	1	**1**	0	1	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	10	**10**
10:00 AM	0	2	**2**	0	0	**0**	0	0	**0**	0	0	**0**	2	0	**2**	0	0	**0**	0	8	**8**
10:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:30 AM	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:45 AM	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**
11:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	4	**4**	0	0	**0**
11:15 AM	0	2	**2**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:30 AM	0	0	**0**	2	0	**2**	0	1	**1**	0	0	**0**	0	2	**2**	0	0	**0**	12	1	**13**
11:45 AM	0	1	**1**	0	0	**0**	1	0	**1**	0	1	**1**	3	0	**3**	1	0	**1**	1	0	**1**
12:00 PM	0	1	**1**	0	0	**0**	0	0	**0**	1	0	**1**	1	1	**2**	0	0	**0**	2	0	**2**
12:15 PM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	2	0	**2**	0	0	**0**
12:30 PM	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**	0	1	**1**	0	0	**0**
12:45 PM	0	0	**0**	1	3	**4**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**
1:00 PM	0	1	**1**	1	0	**1**	0	0	**0**	0	0	**0**	0	2	**2**	3	0	**3**	0	2	**2**
1:15 PM	0	0	**0**	1	1	**2**	0	1	**1**	2	1	**3**	1	1	**2**	0	1	**1**	0	0	**0**
1:30 PM	1	0	**1**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**
1:45 PM	0	0	**0**	0	2	**2**	0	0	**0**	0	0	**0**	1	0	**1**	1	1	**2**	1	0	**1**
2:00 PM	1	0	**1**	0	0	**0**	0	0	**0**	1	1	**2**	0	0	**0**	0	2	**2**	0	0	**0**
2:15 PM	2	1	**3**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	1	**2**
2:30 PM	1	0	**1**	0	2	**2**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**
2:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:00 PM	0	0	**0**	3	0	**3**	0	0	**0**	0	0	**0**	1	0	**1**	2	0	**2**	0	0	**0**
3:15 PM	4	0	**4**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:30 PM	3	0	**3**	0	0	**0**	0	1	**1**	1	0	**1**	1	2	**3**	0	0	**0**	0	0	**0**
3:45 PM	0	0	**0**	1	0	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**
4:00 PM	0	0	**0**	2	0	**2**	1	0	**1**	1	1	**2**	0	0	**0**	0	1	**1**	0	0	**0**
4:15 PM	0	0	**0**	0	0	**0**	1	0	**1**	1	0	**1**	0	0	**0**	0	1	**1**	0	1	**1**
4:30 PM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	2	0	**2**	0	0	**0**
4:45 PM	0	0	**0**	0	0	**0**	2	0	**2**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	1	0	**1**
5:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	1	0	**1**	0	0	**0**	0	0	**0**
5:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**
5:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Total:	13	10	**23**	12	11	**23**	10	6	**16**	9	6	**15**	12	10	**22**	12	13	**25**	19	25	**44**

Location: 12-7006-002 Sonoma County

Date:	Saturday 1/7/2012			**Sunday 1/15/2012**			Monday 1/9/2012			Tuesday 1/10/2012			Wednesday 1/11/2012			Thursday 1/12/2012			Friday 1/13/2012		
	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**
7:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:45 AM	0	0	**0**	0	6	**6**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10 00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**
11:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**
11:45 AM	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:15 PM	0	0	**0**	3	0	**3**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:00 PM	0	0	**0**	0	4	**4**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**
1:30 PM	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**
2:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:15 PM	0	1	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**
4:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:00 PM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:15 PM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Total:	0	3	**3**	3	11	**14**	2	0	**2**	0	0	**0**	1	0	**1**	1	2	**3**	1	0	**1**

Location: 12-7006-003 Sonoma County

Date:	Saturday 1/7/2012			Sunday 1/8/2012			Monday 1/9/2012			Tuesday 1/10/2012			Wednesday 1/11/2012			Thursday 1/12/2012			Friday 1/13/2012		
	East bound	West bound	**Total**	East bound	West bound	**Total**	East bound	West bound	**Total**	East bound	West bound	**Total**	East bound	West bound	**Total**	East bound	West bound	**Total**	East bound	West bound	**Total**
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:00 PM	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Location: 12-7006-004 Sonoma County

Date:	Saturday 1/7/2012			Sunday 1/8/2012			Monday 1/9/2012			Tuesday 1/10/2012			Wednesday 1/11/2012			Thursday 1/12/2012			Friday 1/13/2012		
	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**
7:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**
8:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:30 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
12:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
1:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:00 PM	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
4:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Total:	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	1	**1**

Location: 12-7006-005 Sonoma County

Date:	Saturday 1/7/2012			Sunday 1/8/2012			Monday 1/9/2012			Tuesday 1/10/2012			Wednesday 1/11/2012			Thursday 1/12/2012			Friday 1/13/2012		
	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**	North bound	South bound	**Total**
7:00 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
7:15 AM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**
7:30 AM	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	1	**1**	1	0	**1**	2	0	**2**
7:45 AM	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	1	**1**
8:00 AM	0	0	**0**	0	1	**1**	0	1	**1**	0	6	**6**	0	0	**0**	0	1	**1**	1	4	**5**
8:15 AM	0	0	**0**	1	0	**1**	0	1	**1**	0	0	**0**	0	2	**2**	3	0	**3**	0	2	**2**
8:30 AM	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
8:45 AM	0	3	**3**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
9:00 AM	0	2	**2**	0	1	**1**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**
9:15 AM	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	1	**1**	0	2	**2**
9:30 AM	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**
9:45 AM	0	0	**0**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	1	**1**
10 00 AM	0	0	**0**	0	0	**0**	0	2	**2**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**
10:15 AM	0	0	**0**	0	0	**0**	0	1	**1**	0	0	**0**	1	0	**1**	0	0	**0**	0	0	**0**
10:30 AM	0	1	**1**	0	2	**2**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
10:45 AM	0	1	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
11:00 AM	0	1	**1**	0	2	**2**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	1	1	**2**
11:15 AM	2	1	**3**	1	0	**1**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**
11:30 AM	3	1	**4**	0	0	**0**	1	0	**1**	1	0	**1**	1	0	**1**	0	1	**1**	1	0	**1**
11:45 AM	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	3	**4**	0	0	**0**
12:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	1	**1**	1	0	**1**	0	1	**1**
12:15 PM	2	3	**5**	1	2	**3**	0	0	**0**	0	0	**0**	1	0	**1**	0	0	**0**	0	1	**1**
12:30 PM	0	0	**0**	2	4	**6**	1	0	**1**	0	0	**0**	0	0	**0**	1	1	**2**	1	0	**1**
12:45 PM	2	2	**4**	3	0	**3**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**
1:00 PM	1	2	**3**	0	2	**2**	0	0	**0**	0	0	**0**	0	6	**6**	0	0	**0**	0	0	**0**
1:15 PM	2	1	**3**	2	3	**5**	1	0	**1**	0	1	**1**	0	0	**0**	0	0	**0**	0	2	**2**
1:30 PM	3	0	**3**	2	0	**2**	0	2	**2**	0	1	**1**	0	0	**0**	0	0	**0**	0	0	**0**
1:45 PM	1	1	**2**	2	0	**2**	0	2	**2**	0	1	**1**	3	1	**4**	0	1	**1**	0	0	**0**
2:00 PM	1	3	**4**	1	2	**3**	0	0	**0**	2	1	**3**	3	1	**4**	0	0	**0**	0	0	**0**
2:15 PM	1	0	**1**	0	0	**0**	0	0	**0**	1	0	**1**	0	2	**2**	0	2	**2**	1	2	**3**
2:30 PM	1	0	**1**	0	2	**2**	0	0	**0**	2	0	**2**	1	1	**2**	1	0	**1**	3	1	**4**
2:45 PM	0	1	**1**	0	1	**1**	0	0	**0**	0	1	**1**	0	1	**1**	1	1	**2**	0	1	**1**
3:00 PM	0	2	**2**	2	1	**3**	5	1	**6**	2	1	**3**	1	0	**1**	0	1	**1**	1	1	**2**
3:15 PM	0	0	**0**	0	1	**1**	1	0	**1**	0	0	**0**	0	2	**2**	0	4	**4**	3	2	**5**
3:30 PM	0	2	**2**	0	3	**3**	0	2	**2**	1	1	**2**	0	0	**0**	1	0	**1**	0	0	**0**
3:45 PM	0	1	**1**	1	0	**1**	1	0	**1**	0	1	**1**	2	1	**3**	0	0	**0**	0	1	**1**
4:00 PM	0	1	**1**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	1	1	**2**
4:15 PM	0	2	**2**	1	1	**2**	0	1	**1**	1	1	**2**	0	1	**1**	1	0	**1**	0	0	**0**
4:30 PM	0	2	**2**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	2	2	**4**
4:45 PM	0	1	**1**	0	0	**0**	1	0	**1**	0	0	**0**	0	2	**2**	0	0	**0**	0	0	**0**
5:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	1	0	**1**	0	1	**1**	1	0	**1**
5:15 PM	0	1	**1**	1	0	**1**	0	0	**0**	0	0	**0**	0	1	**1**	2	1	**3**	0	1	**1**
5:30 PM	1	0	**1**	0	1	**1**	1	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
5:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:00 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:15 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:30 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
6:45 PM	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
Total:	21	35	**56**	22	32	**54**	15	15	**30**	13	15	**28**	15	25	**40**	15	18	**33**	21	27	**48**

APPENDIX F-3

Collision Data

Mark West Springs Road / Porter Creek Road Corridor

2001 Collision Summary

32 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	2	2	2	2	0	0	0	8		0	0	0
Segment 2	0	1	1	2	0	5	0	0	0	9		1	0	1
Segment 3	0	2	1	5	0	6	1	0	0	15		0	0	0
Subtotal	0	3	4	9	2	13	1	0	0			1	0	
Total										32				1

2002 Collision Summary

28 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	2	2	1	2	1	0	0	8		0	0	0
Segment 2	0	1	3	3	2	2	0	0	0	11		1	1	2
Segment 3	0	0	1	2	0	4	1	0	1	9		0	0	0
Subtotal	0	1	6	7	3	8	2	0	1			1	1	
Total										28				2

2003 Collision Summary

28 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	1	5	1	0	0	0	0	7		0	0	0
Segment 2	0	1	0	4	1	5	0	0	0	11		2	0	2
Segment 3	0	0	0	2	3	4	1	0	0	10		0	0	0
Subtotal	0	1	1	11	5	9	1	0	0			2	0	
Total										28				2

Mark West Springs Road / Porter Creek Road Corridor

2004 Collision Summary

29 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	1	2	5	0	0	0	0	8		0	0	0
Segment 2	1	0	2	3	1	6	0	0	0	13		0	1	1
Segment 3	1	1	0	2	1	3	0	0	0	8		0	0	0
Subtotal	2	1	3	7	7	9	0	0	0			0	1	
Total										29				1

2005 Collision Summary

36 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	1	3	0	1	0	0	0	5		0	0	0
Segment 2	0	0	2	3	1	12	1	0	0	19		0	2	2
Segment 3	0	0	1	2	3	5	1	0	0	12		1	0	1
Subtotal	0	0	4	8	4	18	2	0	0			1	2	
Total										36				3

2006 Collision Summary

27 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	0	3	2	0	0	0	0	5		0	0	0
Segment 2	0	3	3	2	1	7	0	0	0	16		2	4	5*
Segment 3	0	0	1	0	2	3	0	0	0	6		0	0	0
Subtotal	0	3	4	5	5	10	0	0	0			2	4	
Total										27				5*

*Note that one accident involved a "Truck and a "Truck with trailer". This accident was tallied as one accident.

Mark West Springs Road / Porter Creek Road Corridor

<u>2007 Collision Summary</u>

24 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	0	2	3	1	0	0	0	6		0	0	0
Segment 2	0	0	0	3	2	7	0	0	0	12		0	1	1
Segment 3	0	0	1	0	1	4	0	0	0	6		0	0	0
Subtotal	0	0	1	5	6	12	0	0	0			0	1	
Total										24				1

<u>2008 Collision Summary</u>

23 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	2	1	3	1	0	0	0	7		0	0	0
Segment 2	0	0	1	1	1	2	1	0	0	6		0	1	1
Segment 3	0	0	1	0	3	4	2	0	0	10		0	1	1
Subtotal	0	0	4	2	7	7	3	0	0			0	2	
Total										23				2

<u>2009 Collision Summary</u>

28 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	0	4	2	0	0	0	0	6		1	0	1
Segment 2	0	1	1	3	0	7	1	0	0	13		0	0	0
Segment 3	0	1	1	1	3	2	1	0	0	9		1	0	1
Subtotal	0	2	2	8	5	9	2	0	0			2	0	
Total										28				2

Mark West Springs Road / Porter Creek Road Corridor

2005-2009 Collision Summary

138 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 1	0	0	3	13	10	3	0	0	0	29		1	0	1
Segment 2	0	4	7	12	5	35	3	0	0	66		2	8	9*
Segment 3	0	1	5	3	12	18	4	0	0	43		2	1	3
Subtotal	0	5	15	28	27	56	7	0	0			5	9	
Total										138				13*

*Note that one accident involved a "Truck and a "Truck with trailer". This accident was tallied as one accident.

Notes:

Segment 1 = Old Redwood Highway to Riebli Road – segment serving primarily residential, commercial, and school land uses

Segment 2 = Riebli Road to Franz Valley Road – primarily rural segment serving fewer residences and Mark West Lodge

Segment 3 = Franz Valley Road to Calistoga Road / Petrified Forest Road – primarily rural segment with lowest density of residential use on the entire corridor

Petrified Forest Road Corridor

2001 Collision Summary

12 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	1	0	3	0	7	1	0	0	12		0	0	0
Subtotal	0	1	0	3	0	7	1	0	0			0	0	
Total										12				0

2002 Collision Summary

12 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	0	2	3	0	6	0	0	1	12		0	0	0
Subtotal	0	0	2	3	0	6	0	0	1			0	0	
Total										12				0

2003 Collision Summary

12 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	0	0	3	3	4	1	0	1	12		0	0	0
Subtotal	0	0	0	3	3	4	1	0	1			0	0	
Total										12				0

Petrified Forest Road Corridor

2004 Collision Summary

7 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	1	1	1	1	3	0	0	0	7		0	0	0
Subtotal	0	1	1	1	1	3	0	0	0			0	0	
Total										7				0

2005 Collision Summary

11 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	1	1	1	3	4	1	0	0	11		1	0	1
Subtotal	0	1	1	1	3	4	1	0	0			1	0	
Total										11				1

2006 Collision Summary

9 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	0	1	1	2	5	0	0	0	9		0	0	0
Subtotal	0	0	1	1	2	5	0	0	0			0	0	
Total										9				0

Petrified Forest Road Corridor

2007 Collision Summary

8 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	0	1	2	2	3	0	0	0	8		0	0	0
Subtotal	0	0	1	2	2	3	0	0	0			0	0	
Total										8				0

2008 Collision Summary

11 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	0	1	0	3	5	2	0	0	11		0	0	0
Subtotal	0	0	1	0	3	5	2	0	0			0	0	
Total										11				0

2009 Collision Summary

7 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	1	1	1	2	1	1	0	0	7		0	0	0
Subtotal	0	1	1	1	2	1	1	0	0			0	0	
Total										7				0

Petrified Forest Road Corridor

2005-2009 Collision Summary

46 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 4	0	2	5	5	12	18	4	0	0	46		1	0	1
Subtotal	0	2	5	5	12	18	4	0	0			1	0	
Total										46				1

Notes:

Segment 4 = Petrified Forest Road from Porter Creek/Calistoga intersection to SR 128 – primarily rural segment serving fewer residences

Calistoga Road Corridor

2001 Collision Summary

51 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	3	9	9	7	16	4	1	2	51		1	0	1
Subtotal	0	3	9	9	7	16	4	1	2			1	0	
Total										51				1

2002 Collision Summary

29 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	3	4	10	6	5	1	0	0	29		0	0	0
Subtotal	0	3	4	10	6	5	1	0	0			0	0	
Total										29				0

2003 Collision Summary

38 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	0	4	15	9	10	0	0	0	38		0	0	0
Subtotal	0	0	4	15	9	10	0	0	0			0	0	
Total										38				0

Calistoga Road Corridor

2004 Collision Summary

30 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	2	7	6	4	8	1	1	1	30		0	3	3
Subtotal	0	2	7	6	4	8	1	1	1			0	3	
Total										30				3

2005 Collision Summary

27 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	4	1	3	10	8	1	0	0	27		1	0	1
Subtotal	0	4	1	3	10	8	1	0	0			1	0	
Total										27				1

2006 Collision Summary

27 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	2	3	8	5	5	4	0	0	27		0	0	0
Subtotal	0	2	3	8	5	5	4	0	0			0	0	
Total										27				0

Calistoga Road Corridor

2007 Collision Summary

33 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	1	4	8	3	14	2	1	0	33		0	1	1
Subtotal	0	1	4	8	3	14	2	1	0			0	1	
Total										33				1

2008 Collision Summary

26 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	5	3	3	3	7	2	0	3	26		1	0	1
Subtotal	0	5	3	3	3	7	2	0	3			1	0	
Total										26				1

2009 Collision Summary

19 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	1	2	5	3	7	0	0	1	19		0	0	0
Subtotal	0	1	2	5	3	7	0	0	1			0	0	
Total										19				0

Calistoga Road Corridor

2005-2009 Collision Summary

132 Total Collisions

	Not stated	Head on	Side Swipe	Rear end	Broadside	Hit object	Over-turned	Auto-ped	Other CollType	Total Collisions		Involving Truck	Involving Truck w/ trailer	Total Collisions Involving Trucks
Segment 5	0	13	13	27	24	41	9	1	4	132		2	1	3
Subtotal	0	13	13	27	24	41	9	1	4			2	1	
Total										132				3

Notes:

Segment 5 =Calistoga Road from Porter Creek Road to SR 12 – segment serving primarily residential and commercial uses

APPENDIX F-4

Intersection Analysis Results (All Scenarios)

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	503	412	0	184	17
Peak Hour Factor	0.96	0.96	0.84	0.85	0.81	0.85
Hourly flow rate (vph)	0	524	490	0	227	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	490				1014	490
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	490				1014	490
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				14	97
cM capacity (veh/h)	1073				264	582

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	524	490	227	20
Volume Left	0	0	227	0
Volume Right	0	0	0	20
cSH	1700	1700	264	582
Volume to Capacity	0.31	0.29	0.86	0.03
Queue Length 95th (ft)	0	0	180	3
Control Delay (s)	0.0	0.0	66.2	11.4
Lane LOS			F	B
Approach Delay (s)	0.0	0.0	61.8	
Approach LOS			F	

Intersection Summary			
Average Delay	12.1		
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	634	0	0	700	183	257
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	689	0	0	814	199	279
RTOR Reduction (vph)	0	0	0	0	0	171
Lane Group Flow (vph)	689	0	0	814	199	108
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	34.6			34.6	26.8	26.8
Effective Green, g (s)	34.6			34.6	26.8	26.8
Actuated g/C Ratio	0.50			0.50	0.39	0.39
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	938			938	664	611
v/s Ratio Prot	0.37			c0.43	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.73			0.87	0.30	0.18
Uniform Delay, d1	13.8			15.4	14.8	14.0
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	3.0			8.5	1.2	0.6
Delay (s)	16.8			23.9	15.9	14.7
Level of Service	B			C	B	B
Approach Delay (s)	16.8			23.9	15.2	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	69.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3441		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3441		1805	3516		1736	3438	1599
Volume (vph)	144	305	325	157	416	150	216	315	66	118	488	241
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	167	328	378	191	507	183	251	366	77	146	602	298
RTOR Reduction (vph)	0	0	286	0	36	0	0	17	0	0	0	102
Lane Group Flow (vph)	167	328	92	191	654	0	251	426	0	146	602	196
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		Perm	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			2									8
Actuated Green, G (s)	8.6	24.2	24.2	14.5	30.1		21.0	32.1		12.9	24.0	24.0
Effective Green, g (s)	8.6	24.2	24.2	14.5	30.1		21.0	32.1		12.9	24.0	24.0
Actuated g/C Ratio	0.09	0.24	0.24	0.15	0.30		0.21	0.32		0.13	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	302	876	392	263	1039		380	1132		225	828	385
v/s Ratio Prot	0.05	0.09		c0.11	0.20		c0.14	0.13		0.08	0.18	
v/s Ratio Perm			0.23									0.19
v/c Ratio	0.55	0.37	0.23	0.73	0.63		0.66	0.38		0.65	0.73	0.51
Uniform Delay, d1	43.7	31.4	30.3	40.7	30.0		36.1	26.1		41.2	34.8	32.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.2	1.2	1.4	9.6	2.9		8.7	0.2		6.3	5.5	4.8
Delay (s)	45.9	32.7	31.7	50.3	32.9		44.8	26.3		47.6	40.4	37.5
Level of Service	D	C	C	D	C		D	C		D	D	D
Approach Delay (s)		34.8			36.7			33.0			40.6	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	36.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	99.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	59.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1781				1615
Flt Permitted	0.12	1.00		0.33	1.00	1.00		0.86				1.00
Satd. Flow (perm)	222	1861		631	1881	1615		1591				1615
Volume (vph)	34	508	4	6	622	2	14	1	4	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.75	0.75	0.75	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	35	529	4	8	829	3	33	2	9	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	1	0	6	0	0	0	25
Lane Group Flow (vph)	35	533	0	8	829	2	0	38	0	0	0	15
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	34.2	34.2		34.2	34.2	34.2		24.8				24.8
Effective Green, g (s)	34.2	34.2		34.2	34.2	34.2		24.8				24.8
Actuated g/C Ratio	0.51	0.51		0.51	0.51	0.51		0.37				0.37
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	113	950		322	960	824		589				598
v/s Ratio Prot		0.29			c0.44							
v/s Ratio Perm	0.16			0.01		0.00		c0.03				0.02
v/c Ratio	0.31	0.56		0.02	0.86	0.00		0.07				0.02
Uniform Delay, d1	9.5	11.2		8.1	14.4	8.0		13.6				13.4
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	1.6	0.8		0.0	8.1	0.0		0.2				0.1
Delay (s)	11.1	12.0		8.2	22.5	8.0		13.8				13.5
Level of Service	B	B		A	C	A		B				B
Approach Delay (s)		12.0			22.3			13.8			13.5	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	67.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	260	195	40	305	199	12
Peak Hour Factor	0.88	0.88	0.89	0.89	0.81	0.81
Hourly flow rate (vph)	295	222	45	343	246	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			295		728	295
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			295		728	295
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		35	98
cM capacity (veh/h)			1278		378	749

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	295	222	45	343	246	15
Volume Left	0	0	45	0	246	0
Volume Right	0	222	0	0	0	15
cSH	1700	1700	1278	1700	378	749
Volume to Capacity	0.17	0.13	0.04	0.20	0.65	0.02
Queue Length 95th (ft)	0	0	3	0	110	2
Control Delay (s)	0.0	0.0	7.9	0.0	30.6	9.9
Lane LOS			A		D	A
Approach Delay (s)	0.0		0.9		29.4	
Approach LOS					D	

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	38.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	287	273	2	0	18
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	28	326	300	2	0	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	302				684	301
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	302				684	301
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	96
cM capacity (veh/h)	1270				408	743

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	355	302	28
Volume Left	28	0	0
Volume Right	0	2	28
cSH	1270	1700	557
Volume to Capacity	0.02	0.18	0.05
Queue Length 95th (ft)	2	0	4
Control Delay (s)	0.8	0.0	11.8
Lane LOS	A		B
Approach Delay (s)	0.8	0.0	11.8
Approach LOS			B

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	37.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	244	252	22	20	28
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	29	287	271	24	27	37
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	295				629	283
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	295				629	283
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	98				92	95
cM capacity (veh/h)	1278				349	688

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	316	295	64
Volume Left	29	0	27
Volume Right	0	24	37
cSH	1278	1700	490
Volume to Capacity	0.02	0.17	0.13
Queue Length 95th (ft)	2	0	11
Control Delay (s)	0.9	0.0	13.4
Lane LOS	A		B
Approach Delay (s)	0.9	0.0	13.4
Approach LOS			B

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	42.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	252	7	10	154	147	251
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	283	8	12	183	167	285

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	291	195	452
Volume Left (vph)	283	12	0
Volume Right (vph)	8	0	285
Hadj (s)	0.24	0.03	-0.36
Departure Headway (s)	5.7	5.4	4.7
Degree Utilization, x	0.46	0.30	0.60
Capacity (veh/h)	587	621	730
Control Delay (s)	13.6	10.7	14.5
Approach Delay (s)	13.6	10.7	14.5
Approach LOS	B	B	B

Intersection Summary			
Delay	13.4		
HCM Level of Service	B		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	98	1	383	13	5	2	183	97	8	2	157	221
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	104	1	407	18	7	3	215	114	9	2	189	266

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	105	407	28	215	124	2	455
Volume Left (vph)	104	0	18	215	0	2	0
Volume Right (vph)	0	407	3	0	9	0	266
Hadj (s)	0.51	-0.67	0.07	0.53	-0.02	0.50	-0.40
Departure Headway (s)	7.4	6.2	8.0	7.5	7.0	7.3	6.4
Degree Utilization, x	0.22	0.70	0.06	0.45	0.24	0.00	0.81
Capacity (veh/h)	465	555	397	451	490	467	547
Control Delay (s)	11.2	21.5	11.6	15.4	10.9	9.2	30.0
Approach Delay (s)	19.4		11.6	13.7		29.9	
Approach LOS	C		B	B		D	

Intersection Summary			
Delay	21.4		
HCM Level of Service	C		
Intersection Capacity Utilization	58.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3466			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3466			1832			1792	1615
Volume (vph)	368	620	1	6	863	215	9	6	1	226	1	304
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	413	697	1	7	959	265	16	11	2	263	1	353
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	285
Lane Group Flow (vph)	413	697	1	7	1203	0	0	27	0	0	264	68
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	17.0	61.0	61.0	4.0	48.0			16.0			23.0	23.0
Effective Green, g (s)	17.0	61.0	61.0	4.0	48.0			16.0			23.0	23.0
Actuated g/C Ratio	0.14	0.51	0.51	0.03	0.40			0.13			0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	496	1799	821	60	1386			244			343	310
v/s Ratio Prot	c0.12	0.20		0.00	c0.35			c0.02			0.15	
v/s Ratio Perm			0.00									0.22
v/c Ratio	0.83	0.39	0.00	0.12	0.87			0.11			0.77	0.22
Uniform Delay, d1	50.1	18.1	14.5	56.3	33.1			45.7			46.0	40.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	15.0	0.6	0.0	3.9	7.6			0.9			15.3	1.6
Delay (s)	65.2	18.7	14.5	60.2	40.7			46.7			61.3	42.5
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		36.0			40.8			46.7			50.5	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	41.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	369	546	0	154	99
Peak Hour Factor	0.89	0.87	0.89	0.88	0.87	0.82
Hourly flow rate (vph)	0	424	613	0	177	121
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	613				1038	613
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	613				1038	613
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				31	76
cM capacity (veh/h)	976				258	496

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	424	613	177	121
Volume Left	0	0	177	0
Volume Right	0	0	0	121
cSH	1700	1700	258	496
Volume to Capacity	0.25	0.36	0.69	0.24
Queue Length 95th (ft)	0	0	113	24
Control Delay (s)	0.0	0.0	44.7	14.6
Lane LOS			E	B
Approach Delay (s)	0.0	0.0	32.5	
Approach LOS			D	

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	456	0	0	604	302	440
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	501	0	0	649	321	468
RTOR Reduction (vph)	0	0	0	0	0	165
Lane Group Flow (vph)	501	0	0	649	321	303
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	31.3			31.3	38.6	38.6
Effective Green, g (s)	31.3			31.3	38.6	38.6
Actuated g/C Ratio	0.40			0.40	0.50	0.50
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	763			763	894	800
v/s Ratio Prot	0.26			c0.34	0.18	
v/s Ratio Perm						0.29
v/c Ratio	0.66			0.85	0.36	0.38
Uniform Delay, d1	18.9			21.2	12.1	12.2
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.0			9.0	1.1	1.4
Delay (s)	21.0			30.2	13.2	13.6
Level of Service	C			C	B	B
Approach Delay (s)	21.0			30.2	13.4	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	77.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	98.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3449		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3449		1805	3486		1805	3610	1615
Volume (vph)	283	390	123	64	353	108	171	432	128	192	270	255
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	304	419	132	70	384	117	184	465	138	200	281	266
RTOR Reduction (vph)	0	0	93	0	28	0	0	26	0	0	0	193
Lane Group Flow (vph)	304	419	39	70	473	0	184	577	0	200	281	73
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	13.1	30.8	29.6	7.3	25.0		19.0	29.6		15.5	26.1	26.1
Effective Green, g (s)	13.1	30.8	29.6	7.3	25.0		19.0	29.6		15.5	26.1	26.1
Actuated g/C Ratio	0.13	0.31	0.30	0.07	0.25		0.19	0.30		0.16	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	462	1121	482	133	869		346	1040		282	950	425
v/s Ratio Prot	c0.09	0.12		0.04	c0.15		0.10	c0.17		c0.11	0.08	
v/s Ratio Perm			0.08									0.16
v/c Ratio	0.66	0.37	0.08	0.53	0.54		0.53	0.55		0.71	0.30	0.17
Uniform Delay, d1	40.9	26.7	25.0	44.3	32.2		36.1	29.3		39.7	29.2	28.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.4	1.0	0.1	3.7	2.4		5.8	0.6		7.9	0.8	0.9
Delay (s)	44.3	27.6	25.1	48.0	34.6		41.8	29.9		47.6	30.0	29.1
Level of Service	D	C	C	D	C		D	C		D	C	C
Approach Delay (s)		33.2			36.2			32.7			34.4	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	33.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	99.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	61.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.97			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1778			1805	1615
Flt Permitted	0.30	1.00		0.14	1.00			0.89			0.74	1.00
Satd. Flow (perm)	562	1897		273	1881			1649			1414	1615
Volume (vph)	18	649	8	1	470	0	7	0	2	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	19	676	8	1	511	0	16	0	4	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	2	0	0	0	16
Lane Group Flow (vph)	19	683	0	1	511	0	0	18	0	0	3	13
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	27.8	27.8		27.8	27.8			28.6			28.6	28.6
Effective Green, g (s)	27.8	27.8		27.8	27.8			28.6			28.6	28.6
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.44			0.44	0.44
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	243	819		118	812			732			628	717
v/s Ratio Prot		c0.36			0.27							
v/s Ratio Perm	0.03			0.00				0.01			0.00	0.02
v/c Ratio	0.08	0.83		0.01	0.63			0.02			0.00	0.02
Uniform Delay, d1	10.8	16.3		10.4	14.3			10.1			10.0	10.0
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	7.3		0.0	1.5			0.1			0.0	0.0
Delay (s)	10.9	23.6		10.5	15.8			10.1			10.0	10.1
Level of Service	B	C		B	B			B			A	B
Approach Delay (s)		23.3			15.8			10.1			10.1	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	19.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	64.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	390	194	26	294	120	30
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	419	209	31	346	156	39
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			419		826	419
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			419		826	419
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		54	94
cM capacity (veh/h)			1151		335	638

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	419	209	31	346	156	39
Volume Left	0	0	31	0	156	0
Volume Right	0	209	0	0	0	39
cSH	1700	1700	1151	1700	335	638
Volume to Capacity	0.25	0.12	0.03	0.20	0.46	0.06
Queue Length 95th (ft)	0	0	2	0	59	5
Control Delay (s)	0.0	0.0	8.2	0.0	24.7	11.0
Lane LOS			A		C	B
Approach Delay (s)	0.0		0.7		22.0	
Approach LOS					C	

Intersection Summary			
Average Delay	3.8		
Intersection Capacity Utilization	34.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	15	310	327	3	6	32
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	19	397	341	3	8	44
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	344				778	342
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	344				778	342
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				98	94
cM capacity (veh/h)	1227				362	705

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	417	344	52
Volume Left	19	0	8
Volume Right	0	3	44
cSH	1227	1700	837
Volume to Capacity	0.02	0.20	0.06
Queue Length 95th (ft)	1	0	5
Control Delay (s)	0.5	0.0	9.6
Lane LOS	A		A
Approach Delay (s)	0.5	0.0	9.6
Approach LOS			A

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	15	302	321	9	12	16
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	19	373	349	10	48	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	359				764	354
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	359				764	354
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				87	91
cM capacity (veh/h)	1211				369	695

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	391	359	112
Volume Left	19	0	48
Volume Right	0	10	64
cSH	1211	1700	504
Volume to Capacity	0.02	0.21	0.22
Queue Length 95th (ft)	1	0	21
Control Delay (s)	0.5	0.0	14.2
Lane LOS	A		B
Approach Delay (s)	0.5	0.0	14.2
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	38.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	302	7	14	179	244	320
Peak Hour Factor	0.82	0.82	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	368	9	15	186	268	352

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	377	201	620
Volume Left (vph)	368	15	0
Volume Right (vph)	9	0	352
Hadj (s)	0.18	0.01	-0.33
Departure Headway (s)	6.3	6.2	5.2
Degree Utilization, x	0.65	0.35	0.90
Capacity (veh/h)	556	555	681
Control Delay (s)	20.3	12.4	36.6
Approach Delay (s)	20.3	12.4	36.6
Approach LOS	C	B	E

Intersection Summary			
Delay	27.4		
HCM Level of Service	D		
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	285	7	255	19	35	1	436	171	54	3	151	176
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Hourly flow rate (vph)	300	7	268	23	43	1	454	178	56	3	159	185

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	307	268	68	454	234	3	344
Volume Left (vph)	300	0	23	454	0	3	0
Volume Right (vph)	0	268	1	0	56	0	185
Hadj (s)	0.49	-0.70	0.06	0.52	-0.17	0.50	-0.37
Departure Headway (s)	8.2	7.0	8.9	7.9	7.2	8.5	7.6
Degree Utilization, x	0.70	0.52	0.17	1.00	0.47	0.01	0.72
Capacity (veh/h)	432	511	385	454	490	415	467
Control Delay (s)	26.8	16.1	13.6	68.8	15.2	10.3	26.9
Approach Delay (s)	21.8		13.6	50.5		26.7	
Approach LOS	C		B	F		D	

Intersection Summary			
Delay	34.3		
HCM Level of Service	D		
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3529			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3529			1823			1805	1615
Volume (vph)	447	848	15	2	867	152	11	2	0	205	0	219
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	481	912	16	2	913	160	17	3	0	214	0	228
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	188
Lane Group Flow (vph)	481	912	8	2	1061	0	0	20	0	0	214	40
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1323			243			316	283
v/s Ratio Prot	c0.14	0.25		0.00	c0.30			c0.01			0.12	
v/s Ratio Perm			0.01									0.14
v/c Ratio	0.75	0.48	0.01	0.03	0.80			0.08			0.68	0.14
Uniform Delay, d1	46.4	18.1	13.6	56.1	33.5			45.6			46.3	41.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	7.8	0.9	0.0	1.0	5.2			0.7			11.1	1.0
Delay (s)	54.2	19.0	13.6	57.2	38.7			46.2			57.4	42.9
Level of Service	D	B	B	E	D			D			E	D
Approach Delay (s)		31.0			38.8			46.2			49.9	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	36.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	503	412	0	193	17
Peak Hour Factor	0.96	0.96	0.86	0.86	0.81	0.85
Hourly flow rate (vph)	0	524	479	0	238	20
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	479				1003	479
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	479				1003	479
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				11	97
cM capacity (veh/h)	1083				268	591

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	524	479	238	20
Volume Left	0	0	238	0
Volume Right	0	0	0	20
cSH	1700	1700	268	591
Volume to Capacity	0.31	0.28	0.89	0.03
Queue Length 95th (ft)	0	0	194	3
Control Delay (s)	0.0	0.0	70.6	11.3
Lane LOS			F	B
Approach Delay (s)	0.0	0.0	66.0	
Approach LOS			F	

Intersection Summary			
Average Delay	13.5		
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	643	0	0	707	183	264
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	699	0	0	822	199	287
RTOR Reduction (vph)	0	0	0	0	0	170
Lane Group Flow (vph)	699	0	0	822	199	117
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	35.1			35.1	26.8	26.8
Effective Green, g (s)	35.1			35.1	26.8	26.8
Actuated g/C Ratio	0.50			0.50	0.38	0.38
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	945			945	659	607
v/s Ratio Prot	0.37			c0.44	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.74			0.87	0.30	0.19
Uniform Delay, d1	13.8			15.4	15.0	14.4
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	3.1			8.6	1.2	0.7
Delay (s)	16.9			24.0	16.2	15.1
Level of Service	B			C	B	B
Approach Delay (s)	16.9			24.0	15.5	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	69.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3445		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3445		1805	3516		1736	3438	1599
Volume (vph)	144	321	325	157	432	150	216	315	66	118	488	241
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	167	345	378	191	527	183	251	366	77	146	602	298
RTOR Reduction (vph)	0	0	286	0	34	0	0	17	0	0	0	102
Lane Group Flow (vph)	167	345	92	191	676	0	251	426	0	146	602	196
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		Perm	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			2									8
Actuated Green, G (s)	8.6	24.2	24.2	14.5	30.1		21.0	32.1		12.9	24.0	24.0
Effective Green, g (s)	8.6	24.2	24.2	14.5	30.1		21.0	32.1		12.9	24.0	24.0
Actuated g/C Ratio	0.09	0.24	0.24	0.15	0.30		0.21	0.32		0.13	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	302	876	392	263	1040		380	1132		225	828	385
v/s Ratio Prot	0.05	0.10		c0.11	0.21		c0.14	0.13		0.08	0.18	
v/s Ratio Perm			0.23									0.19
v/c Ratio	0.55	0.39	0.23	0.73	0.65		0.66	0.38		0.65	0.73	0.51
Uniform Delay, d1	43.7	31.6	30.3	40.7	30.2		36.1	26.1		41.2	34.8	32.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.2	1.3	1.4	9.6	3.1		8.7	0.2		6.3	5.5	4.8
Delay (s)	45.9	32.9	31.7	50.3	33.4		44.8	26.3		47.6	40.4	37.5
Level of Service	D	C	C	D	C		D	C		D	D	D
Approach Delay (s)		34.8			37.0			33.0			40.6	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	99.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	59.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1781				1615
Flt Permitted	0.12	1.00		0.33	1.00	1.00		0.86				1.00
Satd. Flow (perm)	219	1861		620	1881	1615		1589				1615
Volume (vph)	34	524	4	6	638	2	14	1	4	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.75	0.75	0.75	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	35	546	4	8	851	3	33	2	9	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	1	0	6	0	0	0	26
Lane Group Flow (vph)	35	550	0	8	851	2	0	38	0	0	0	14
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	34.7	34.7		34.7	34.7	34.7		23.8				23.8
Effective Green, g (s)	34.7	34.7		34.7	34.7	34.7		23.8				23.8
Actuated g/C Ratio	0.52	0.52		0.52	0.52	0.52		0.36				0.36
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	114	971		324	982	843		569				578
v/s Ratio Prot		0.30			c0.45							
v/s Ratio Perm	0.16			0.01		0.00		c0.03				0.02
v/c Ratio	0.31	0.57		0.02	0.87	0.00		0.07				0.02
Uniform Delay, d1	9.1	10.8		7.7	13.9	7.6		14.0				13.8
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	1.5	0.8		0.0	8.1	0.0		0.2				0.1
Delay (s)	10.6	11.6		7.7	22.0	7.6		14.3				13.9
Level of Service	B	B		A	C	A		B				B
Approach Delay (s)		11.5			21.8			14.3			13.9	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	66.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	276	195	40	321	199	12
Peak Hour Factor	0.88	0.88	0.89	0.89	0.81	0.81
Hourly flow rate (vph)	314	222	45	361	246	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			314		764	314
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			314		764	314
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		32	98
cM capacity (veh/h)			1258		360	731

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	314	222	45	361	246	15
Volume Left	0	0	45	0	246	0
Volume Right	0	222	0	0	0	15
cSH	1700	1700	1258	1700	360	731
Volume to Capacity	0.18	0.13	0.04	0.21	0.68	0.02
Queue Length 95th (ft)	0	0	3	0	121	2
Control Delay (s)	0.0	0.0	8.0	0.0	34.0	10.0
Lane LOS			A		D	B
Approach Delay (s)	0.0		0.9		32.6	
Approach LOS					D	

Intersection Summary			
Average Delay	7.4		
Intersection Capacity Utilization	38.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	303	289	2	0	18
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	28	344	318	2	0	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	320				720	319
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	320				720	319
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	96
cM capacity (veh/h)	1252				389	727

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	373	320	28
Volume Left	28	0	0
Volume Right	0	2	28
cSH	1252	1700	545
Volume to Capacity	0.02	0.19	0.05
Queue Length 95th (ft)	2	0	4
Control Delay (s)	0.8	0.0	12.0
Lane LOS	A		B
Approach Delay (s)	0.8	0.0	12.0
Approach LOS			B

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	41	244	252	33	31	44
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	48	287	271	35	41	59
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	306				672	289
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	306				672	289
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	96				87	91
cM capacity (veh/h)	1266				323	682

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	335	306	100
Volume Left	48	0	41
Volume Right	0	35	59
cSH	1266	1700	467
Volume to Capacity	0.04	0.18	0.21
Queue Length 95th (ft)	3	0	20
Control Delay (s)	1.5	0.0	14.8
Lane LOS	A		B
Approach Delay (s)	1.5	0.0	14.8
Approach LOS			B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	252	9	12	154	147	260
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	283	10	14	183	167	295

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	293	198	463
Volume Left (vph)	283	14	0
Volume Right (vph)	10	0	295
Hadj (s)	0.24	0.03	-0.36
Departure Headway (s)	5.8	5.5	4.8
Degree Utilization, x	0.47	0.30	0.61
Capacity (veh/h)	584	606	729
Control Delay (s)	13.8	10.8	15.0
Approach Delay (s)	13.8	10.8	15.0
Approach LOS	B	B	B

Intersection Summary			
Delay	13.7		
HCM Level of Service	B		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	100	1	390	13	5	2	190	97	8	2	157	223
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	106	1	415	18	7	3	224	114	9	2	189	269

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	107	415	28	224	124	2	458
Volume Left (vph)	106	0	18	224	0	2	0
Volume Right (vph)	0	415	3	0	9	0	269
Hadj (s)	0.51	-0.67	0.07	0.53	-0.02	0.50	-0.40
Departure Headway (s)	7.4	6.3	8.1	7.6	7.0	7.4	6.5
Degree Utilization, x	0.22	0.72	0.06	0.47	0.24	0.00	0.82
Capacity (veh/h)	463	553	394	449	487	464	543
Control Delay (s)	11.4	22.6	11.7	16.0	11.0	9.2	31.4
Approach Delay (s)	20.3		11.7	14.2		31.3	
Approach LOS	C		B	B		D	

Intersection Summary			
Delay	22.3		
HCM Level of Service	C		
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		0.99		1.00	0.99		1.00	0.91	
Flt Protected		0.95	1.00		0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583		1814		1770	1845		1805	1725	
Flt Permitted		0.95	1.00		0.97		0.23	1.00		0.68	1.00	
Satd. Flow (perm)		1793	1583		1814		434	1845		1288	1725	
Volume (vph)	100	1	390	13	5	2	190	97	8	2	157	223
Peak-hour factor, PHF	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Adj. Flow (vph)	106	1	415	18	7	3	224	114	9	2	189	269
RTOR Reduction (vph)	0	0	339	0	3	0	0	3	0	0	52	0
Lane Group Flow (vph)	0	107	76	0	25	0	224	120	0	2	406	0
Heavy Vehicles (%)	1%	0%	2%	0%	0%	0%	2%	2%	0%	0%	1%	0%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		10.4	10.4		2.1		32.2	32.2		19.7	19.7	
Effective Green, g (s)		10.4	10.4		2.1		32.2	32.2		19.7	19.7	
Actuated g/C Ratio		0.18	0.18		0.04		0.57	0.57		0.35	0.35	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		329	290		67		447	1048		448	599	
v/s Ratio Prot		0.06			c0.02		c0.08	0.07			c0.27	
v/s Ratio Perm			0.26				0.21			0.00		
v/c Ratio		0.33	0.26		0.37		0.50	0.11		0.00	0.68	
Uniform Delay, d1		20.1	19.9		26.7		7.9	5.7		12.1	15.8	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6	0.5		3.5		0.9	0.0		0.0	3.0	
Delay (s)		20.7	20.3		30.2		8.8	5.7		12.1	18.8	
Level of Service		C	C		C		A	A		B	B	
Approach Delay (s)		20.4			30.2			7.7			18.8	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	56.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	59.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3466			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3466			1832			1792	1615
Volume (vph)	370	620	1	6	863	215	9	6	1	226	1	306
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	416	697	1	7	959	265	16	11	2	263	1	356
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	288
Lane Group Flow (vph)	416	697	1	7	1203	0	0	27	0	0	264	68
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	17.0	61.0	61.0	4.0	48.0			16.0			23.0	23.0
Effective Green, g (s)	17.0	61.0	61.0	4.0	48.0			16.0			23.0	23.0
Actuated g/C Ratio	0.14	0.51	0.51	0.03	0.40			0.13			0.19	0.19
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	496	1799	821	60	1386			244			343	310
v/s Ratio Prot	c0.12	0.20		0.00	c0.35			c0.02			0.15	
v/s Ratio Perm			0.00									0.22
v/c Ratio	0.84	0.39	0.00	0.12	0.87			0.11			0.77	0.22
Uniform Delay, d1	50.2	18.1	14.5	56.3	33.1			45.7			46.0	40.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	15.5	0.6	0.0	3.9	7.6			0.9			15.3	1.6
Delay (s)	65.7	18.7	14.5	60.2	40.7			46.7			61.3	42.6
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		36.2			40.8			46.7			50.5	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	41.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	0	369	546	0	162	99
Peak Hour Factor	0.89	0.87	0.89	0.88	0.87	0.82
Hourly flow rate (vph)	0	424	613	0	186	121
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	613				1038	613
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	613				1038	613
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				28	76
cM capacity (veh/h)	976				258	496

Direction, Lane #	EB 1	WB 1	SB 1	SB 2
Volume Total	424	613	186	121
Volume Left	0	0	186	0
Volume Right	0	0	0	121
cSH	1700	1700	258	496
Volume to Capacity	0.25	0.36	0.72	0.24
Queue Length 95th (ft)	0	0	125	24
Control Delay (s)	0.0	0.0	48.2	14.6
Lane LOS			E	B
Approach Delay (s)	0.0	0.0	35.0	
Approach LOS			D	

Intersection Summary			
Average Delay	8.0		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	464	0	0	612	302	446
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	510	0	0	658	321	474
RTOR Reduction (vph)	0	0	0	0	0	167
Lane Group Flow (vph)	510	0	0	658	321	307
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	31.2			31.2	37.6	37.6
Effective Green, g (s)	31.2			31.2	37.6	37.6
Actuated g/C Ratio	0.41			0.41	0.49	0.49
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	772			772	884	791
v/s Ratio Prot	0.27			c0.35	0.18	
v/s Ratio Perm						0.29
v/c Ratio	0.66			0.85	0.36	0.39
Uniform Delay, d1	18.5			20.7	12.2	12.3
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.1			9.0	1.2	1.4
Delay (s)	20.6			29.7	13.3	13.8
Level of Service	C			C	B	B
Approach Delay (s)	20.6			29.7	13.6	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	20.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	76.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	99.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3453		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3453		1805	3486		1805	3610	1615
Volume (vph)	283	404	123	64	368	108	171	432	128	192	270	255
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	304	434	132	70	400	117	184	465	138	200	281	266
RTOR Reduction (vph)	0	0	93	0	27	0	0	26	0	0	0	193
Lane Group Flow (vph)	304	434	39	70	490	0	184	577	0	200	281	73
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	13.1	30.8	29.6	7.3	25.0		19.0	29.6		15.5	26.1	26.1
Effective Green, g (s)	13.1	30.8	29.6	7.3	25.0		19.0	29.6		15.5	26.1	26.1
Actuated g/C Ratio	0.13	0.31	0.30	0.07	0.25		0.19	0.30		0.16	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	462	1121	482	133	870		346	1040		282	950	425
v/s Ratio Prot	c0.09	0.12		0.04	c0.15		0.10	c0.17		c0.11	0.08	
v/s Ratio Perm			0.08									0.16
v/c Ratio	0.66	0.39	0.08	0.53	0.56		0.53	0.55		0.71	0.30	0.17
Uniform Delay, d1	40.9	26.8	25.0	44.3	32.3		36.1	29.3		39.7	29.2	28.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.4	1.0	0.1	3.7	2.6		5.8	0.6		7.9	0.8	0.9
Delay (s)	44.3	27.8	25.1	48.0	35.0		41.8	29.9		47.6	30.0	29.1
Level of Service	D	C	C	D	C		D	C		D	C	C
Approach Delay (s)		33.2			36.5			32.7			34.4	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	34.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	99.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	61.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.97			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1778			1805	1615
Flt Permitted	0.29	1.00		0.14	1.00			0.89			0.74	1.00
Satd. Flow (perm)	545	1897		264	1881			1648			1414	1615
Volume (vph)	18	663	8	1	485	0	7	0	2	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	19	691	8	1	527	0	16	0	4	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	2	0	0	0	16
Lane Group Flow (vph)	19	698	0	1	527	0	0	18	0	0	3	13
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	28.8	28.8		28.8	28.8			28.6			28.6	28.6
Effective Green, g (s)	28.8	28.8		28.8	28.8			28.6			28.6	28.6
Actuated g/C Ratio	0.44	0.44		0.44	0.44			0.44			0.44	0.44
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	240	835		116	828			721			618	706
v/s Ratio Prot		c0.37			0.28							
v/s Ratio Perm	0.03			0.00				0.01			0.00	0.02
v/c Ratio	0.08	0.84		0.01	0.64			0.02			0.00	0.02
Uniform Delay, d1	10.6	16.2		10.3	14.2			10.5			10.4	10.4
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	7.3		0.0	1.6			0.1			0.0	0.0
Delay (s)	10.8	23.5		10.3	15.8			10.5			10.4	10.5
Level of Service	B	C		B	B			B			B	B
Approach Delay (s)		23.2			15.8			10.5			10.5	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	19.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	65.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	404	194	26	309	120	30
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	434	209	31	364	156	39
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			434		859	434
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			434		859	434
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		51	94
cM capacity (veh/h)			1136		321	626

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	434	209	31	364	156	39
Volume Left	0	0	31	0	156	0
Volume Right	0	209	0	0	0	39
cSH	1700	1700	1136	1700	321	626
Volume to Capacity	0.26	0.12	0.03	0.21	0.49	0.06
Queue Length 95th (ft)	0	0	2	0	63	5
Control Delay (s)	0.0	0.0	8.3	0.0	26.4	11.1
Lane LOS			A		D	B
Approach Delay (s)	0.0		0.6		23.4	
Approach LOS					C	

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	34.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	15	324	342	3	6	32
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	19	415	356	3	8	44
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	359				812	358
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	359				812	358
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				98	94
cM capacity (veh/h)	1210				346	691

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	435	359	52
Volume Left	19	0	8
Volume Right	0	3	44
cSH	1210	1700	820
Volume to Capacity	0.02	0.21	0.06
Queue Length 95th (ft)	1	0	5
Control Delay (s)	0.5	0.0	9.7
Lane LOS	A		A
Approach Delay (s)	0.5	0.0	9.7
Approach LOS			A

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	29	302	321	19	23	31
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	36	373	349	21	92	124
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	370				804	359
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	370				804	359
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				73	82
cM capacity (veh/h)	1200				345	690

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	409	370	216
Volume Left	36	0	92
Volume Right	0	21	124
cSH	1200	1700	483
Volume to Capacity	0.03	0.22	0.45
Queue Length 95th (ft)	2	0	57
Control Delay (s)	1.0	0.0	18.3
Lane LOS	A		C
Approach Delay (s)	1.0	0.0	18.3
Approach LOS			C

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	302	8	15	179	244	328
Peak Hour Factor	0.84	0.84	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	360	10	16	186	268	360

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	369	202	629
Volume Left (vph)	360	16	0
Volume Right (vph)	10	0	360
Hadj (s)	0.18	0.02	-0.33
Departure Headway (s)	6.3	6.2	5.2
Degree Utilization, x	0.64	0.35	0.91
Capacity (veh/h)	548	558	685
Control Delay (s)	19.8	12.4	37.6
Approach Delay (s)	19.8	12.4	37.6
Approach LOS	C	B	E

Intersection Summary			
Delay	27.9		
HCM Level of Service	D		
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	286	7	263	19	35	1	442	171	54	3	151	177
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.97	0.97	0.97	0.95	0.95	0.95
Hourly flow rate (vph)	301	7	277	23	43	1	456	176	56	3	159	186

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	308	277	68	456	232	3	345
Volume Left (vph)	301	0	23	456	0	3	0
Volume Right (vph)	0	277	1	0	56	0	186
Hadj (s)	0.49	-0.70	0.06	0.52	-0.17	0.50	-0.37
Departure Headway (s)	8.2	7.0	8.9	7.9	7.2	8.5	7.6
Degree Utilization, x	0.70	0.54	0.17	1.00	0.47	0.01	0.73
Capacity (veh/h)	432	512	385	456	488	414	466
Control Delay (s)	27.1	16.6	13.7	70.6	15.2	10.4	27.3
Approach Delay (s)	22.1		13.7	51.9		27.1	
Approach LOS	C		B	F		D	

Intersection Summary			
Delay	34.9		
HCM Level of Service	D		
Intersection Capacity Utilization	76.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		1.00		1.00	0.96		1.00	0.92	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1811	1615		1864		1787	1832		1805	1737	
Flt Permitted		0.95	1.00		0.98		0.19	1.00		0.61	1.00	
Satd. Flow (perm)		1811	1615		1864		357	1832		1165	1737	
Volume (vph)	286	7	263	19	35	1	442	171	54	3	151	177
Peak-hour factor, PHF	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Adj. Flow (vph)	301	7	277	23	43	1	460	178	56	3	159	186
RTOR Reduction (vph)	0	0	158	0	1	0	0	11	0	0	42	0
Lane Group Flow (vph)	0	308	119	0	66	0	460	223	0	3	303	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		17.4	17.4		6.6		44.5	44.5		18.4	18.4	
Effective Green, g (s)		17.4	17.4		6.6		44.5	44.5		18.4	18.4	
Actuated g/C Ratio		0.22	0.22		0.08		0.55	0.55		0.23	0.23	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		391	349		153		590	1013		266	397	
v/s Ratio Prot		0.17			c0.04		c0.21	0.13			0.20	
v/s Ratio Perm			0.17				c0.22			0.00		
v/c Ratio		0.79	0.34		0.43		0.78	0.22		0.01	0.76	
Uniform Delay, d1		29.8	26.7		35.2		16.2	9.2		24.0	29.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		10.1	0.6		2.0		6.5	0.1		0.0	8.4	
Delay (s)		39.9	27.3		37.1		22.7	9.3		24.0	37.4	
Level of Service		D	C		D		C	A		C	D	
Approach Delay (s)		33.9			37.1			18.2			37.3	
Approach LOS		C			D			B			D	

Intersection Summary			
HCM Average Control Delay	28.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3529			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3529			1823			1805	1615
Volume (vph)	448	848	15	2	867	152	11	2	0	205	0	220
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	482	912	16	2	913	160	17	3	0	214	0	229
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	189
Lane Group Flow (vph)	482	912	8	2	1061	0	0	20	0	0	214	40
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1323			243			316	283
v/s Ratio Prot	c0.14	0.25		0.00	c0.30			c0.01			0.12	
v/s Ratio Perm			0.01									0.14
v/c Ratio	0.75	0.48	0.01	0.03	0.80			0.08			0.68	0.14
Uniform Delay, d1	46.4	18.1	13.6	56.1	33.5			45.6			46.3	41.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	7.9	0.9	0.0	1.0	5.2			0.7			11.1	1.0
Delay (s)	54.3	19.0	13.6	57.2	38.7			46.2			57.4	42.9
Level of Service	D	B	B	E	D			D			E	D
Approach Delay (s)		31.0			38.8			46.2			49.9	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	36.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1863	1863		1770	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1863	1863		1770	1615
Volume (vph)	0	509	415	0	195	18
Peak-hour factor, PHF	0.96	0.96	0.84	0.85	0.81	0.85
Adj. Flow (vph)	0	530	494	0	241	21
RTOR Reduction (vph)	0	0	0	0	0	15
Lane Group Flow (vph)	0	530	494	0	241	6
Heavy Vehicles (%)	2%	2%	2%	1%	2%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		14.8	14.8		10.1	10.1
Effective Green, g (s)		14.8	14.8		10.1	10.1
Actuated g/C Ratio		0.45	0.45		0.31	0.31
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		838	838		543	496
v/s Ratio Prot		c0.28	0.27		c0.14	
v/s Ratio Perm						0.01
v/c Ratio		0.63	0.59		0.44	0.01
Uniform Delay, d1		7.0	6.8		9.1	7.9
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		1.6	1.1		0.6	0.0
Delay (s)		8.5	7.8		9.7	7.9
Level of Service		A	A		A	A
Approach Delay (s)		8.5	7.8		9.6	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	8.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	32.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	652	0	0	739	183	257
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	709	0	0	859	199	279
RTOR Reduction (vph)	0	0	0	0	0	175
Lane Group Flow (vph)	709	0	0	859	199	104
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	36.9			36.9	25.9	25.9
Effective Green, g (s)	36.9			36.9	25.9	25.9
Actuated g/C Ratio	0.52			0.52	0.37	0.37
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	980			980	629	579
v/s Ratio Prot	0.38			c0.46	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.72			0.88	0.32	0.18
Uniform Delay, d1	13.0			14.9	16.1	15.2
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.7			8.9	1.3	0.7
Delay (s)	15.7			23.8	17.4	15.9
Level of Service	B			C	B	B
Approach Delay (s)	15.7			23.8	16.5	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3441		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3441		1805	3516		1736	3438	1599
Volume (vph)	147	311	332	174	458	166	216	315	66	125	517	255
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	171	334	386	212	559	202	251	366	77	154	638	315
RTOR Reduction (vph)	0	0	255	0	36	0	0	17	0	0	0	101
Lane Group Flow (vph)	171	334	131	212	725	0	251	426	0	154	638	214
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	7.9	17.0	33.8	19.9	29.0		22.0	33.8		13.2	25.0	25.0
Effective Green, g (s)	7.9	17.0	33.8	19.9	29.0		22.0	33.8		13.2	25.0	25.0
Actuated g/C Ratio	0.08	0.17	0.34	0.20	0.29		0.22	0.34		0.13	0.25	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	277	614	546	360	999		397	1190		229	860	400
v/s Ratio Prot	0.05	c0.09		0.12	c0.22		0.14	0.13		0.09	0.19	
v/s Ratio Perm			0.24									0.20
v/c Ratio	0.62	0.54	0.24	0.59	0.73		0.63	0.36		0.67	0.74	0.53
Uniform Delay, d1	44.5	37.9	23.8	36.3	31.9		35.3	24.9		41.3	34.5	32.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	3.4	0.2	2.5	4.6		7.5	0.2		7.6	5.7	5.0
Delay (s)	48.6	41.3	24.0	38.7	36.5		42.7	25.1		48.8	40.2	37.5
Level of Service	D	D	C	D	D		D	C		D	D	D
Approach Delay (s)		35.2			37.0			31.5			40.6	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	36.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	99.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1775				1615
Flt Permitted	0.11	1.00		0.35	1.00	1.00		0.85				1.00
Satd. Flow (perm)	202	1861		658	1881	1615		1572				1615
Volume (vph)	35	525	4	7	691	2	16	1	5	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.75	0.75	0.75	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	36	547	4	9	921	3	37	2	12	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	1	0	8	0	0	0	27
Lane Group Flow (vph)	36	551	0	9	921	2	0	43	0	0	0	13
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	37.7	37.7		37.7	37.7	37.7		21.9				21.9
Effective Green, g (s)	37.7	37.7		37.7	37.7	37.7		21.9				21.9
Actuated g/C Ratio	0.56	0.56		0.56	0.56	0.56		0.32				0.32
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	113	1038		367	1049	901		509				523
v/s Ratio Prot		0.30			c0.49							
v/s Ratio Perm	0.18			0.01		0.00		c0.03				0.02
v/c Ratio	0.32	0.53		0.02	0.88	0.00		0.08				0.02
Uniform Delay, d1	8.0	9.4		6.7	13.0	6.6		15.9				15.6
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	1.6	0.5		0.0	8.5	0.0		0.3				0.1
Delay (s)	9.7	9.9		6.7	21.4	6.6		16.2				15.7
Level of Service	A	A		A	C	A		B				B
Approach Delay (s)		9.9			21.2			16.2			15.7	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	67.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	271	204	44	332	199	12
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	301	227	49	369	221	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			301		768	301
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			301		768	301
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		38	98
cM capacity (veh/h)			1271		357	743

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	301	227	49	369	221	13
Volume Left	0	0	49	0	221	0
Volume Right	0	227	0	0	0	13
cSH	1700	1700	1271	1700	357	743
Volume to Capacity	0.18	0.13	0.04	0.22	0.62	0.02
Queue Length 95th (ft)	0	0	3	0	99	1
Control Delay (s)	0.0	0.0	7.9	0.0	30.1	9.9
Lane LOS			A		D	A
Approach Delay (s)	0.0		0.9		29.0	
Approach LOS					D	

Intersection Summary			
Average Delay	6.1		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	288	299	2	0	18
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	28	327	329	2	0	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	331				714	330
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	331				714	330
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	96
cM capacity (veh/h)	1240				392	716

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	28	327	331	28
Volume Left	28	0	0	0
Volume Right	0	0	2	28
cSH	1240	1700	1700	537
Volume to Capacity	0.02	0.19	0.19	0.05
Queue Length 95th (ft)	2	0	0	4
Control Delay (s)	8.0	0.0	0.0	12.1
Lane LOS	A			B
Approach Delay (s)	0.6		0.0	12.1
Approach LOS				B

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	246	278	23	20	28
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	29	289	299	25	27	37
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	324				660	311
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	324				660	311
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	98				92	94
cM capacity (veh/h)	1247				334	662

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	319	324	64
Volume Left	29	0	27
Volume Right	0	25	37
cSH	1247	1700	470
Volume to Capacity	0.02	0.19	0.14
Queue Length 95th (ft)	2	0	12
Control Delay (s)	0.9	0.0	13.9
Lane LOS	A		B
Approach Delay (s)	0.9	0.0	13.9
Approach LOS			B

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	43.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	254	7	10	154	160	272
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	285	8	12	183	182	309

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	293	195	491
Volume Left (vph)	285	12	0
Volume Right (vph)	8	0	309
Hadj (s)	0.24	0.03	-0.36
Departure Headway (s)	5.8	5.5	4.8
Degree Utilization, x	0.48	0.30	0.65
Capacity (veh/h)	576	600	729
Control Delay (s)	14.0	10.9	16.3
Approach Delay (s)	14.0	10.9	16.3
Approach LOS	B	B	C

Intersection Summary			
Delay	14.5		
HCM Level of Service	B		
Intersection Capacity Utilization	46.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	98	1	383	15	5	2	183	110	9	2	177	221
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	104	1	407	21	7	3	215	129	11	2	213	266

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	105	407	31	215	140	2	480
Volume Left (vph)	104	0	21	215	0	2	0
Volume Right (vph)	0	407	3	0	11	0	266
Hadj (s)	0.51	-0.67	0.08	0.53	-0.02	0.50	-0.38
Departure Headway (s)	7.5	6.4	8.2	7.6	7.1	7.4	6.5
Degree Utilization, x	0.22	0.72	0.07	0.46	0.28	0.00	0.87
Capacity (veh/h)	457	544	395	445	484	463	542
Control Delay (s)	11.5	22.7	11.8	15.7	11.5	9.2	36.9
Approach Delay (s)	20.4		11.8	14.1		36.8	
Approach LOS	C		B	B		E	

Intersection Summary			
Delay	24.3		
HCM Level of Service	C		
Intersection Capacity Utilization	59.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		0.99		1.00	0.99		1.00	0.92	
Flt Protected		0.95	1.00		0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583		1814		1770	1844		1805	1734	
Flt Permitted		0.95	1.00		0.97		0.22	1.00		0.67	1.00	
Satd. Flow (perm)		1793	1583		1814		419	1844		1269	1734	
Volume (vph)	98	1	383	15	5	2	183	110	9	2	177	221
Peak-hour factor, PHF	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Adj. Flow (vph)	104	1	407	21	7	3	215	129	11	2	213	266
RTOR Reduction (vph)	0	0	334	0	3	0	0	3	0	0	45	0
Lane Group Flow (vph)	0	105	73	0	28	0	215	137	0	2	434	0
Heavy Vehicles (%)	1%	0%	2%	0%	0%	0%	2%	2%	0%	0%	1%	0%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		10.3	10.3		2.2		32.8	32.8		20.6	20.6	
Effective Green, g (s)		10.3	10.3		2.2		32.8	32.8		20.6	20.6	
Actuated g/C Ratio		0.18	0.18		0.04		0.57	0.57		0.36	0.36	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		322	285		70		433	1056		456	623	
v/s Ratio Prot		0.06			c0.02		c0.07	0.08			c0.28	
v/s Ratio Perm			0.26				0.21			0.00		
v/c Ratio		0.33	0.26		0.40		0.50	0.13		0.00	0.70	
Uniform Delay, d1		20.5	20.2		26.9		8.0	5.7		11.8	15.7	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6	0.5		3.7		0.9	0.1		0.0	3.4	
Delay (s)		21.1	20.7		30.7		8.9	5.7		11.8	19.1	
Level of Service		C	C		C		A	A		B	B	
Approach Delay (s)		20.8			30.7			7.6			19.0	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	57.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	59.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3466			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3466			1832			1792	1615
Volume (vph)	379	639	1	6	893	222	9	6	1	233	1	313
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	426	718	1	7	992	274	16	11	2	271	1	364
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	297
Lane Group Flow (vph)	426	718	1	7	1245	0	0	27	0	0	272	67
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	17.0	62.0	62.0	4.0	49.0			16.0			22.0	22.0
Effective Green, g (s)	17.0	62.0	62.0	4.0	49.0			16.0			22.0	22.0
Actuated g/C Ratio	0.14	0.52	0.52	0.03	0.41			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	496	1828	834	60	1415			244			329	296
v/s Ratio Prot	c0.12	0.20		0.00	c0.37			c0.02			0.15	
v/s Ratio Perm			0.00									0.23
v/c Ratio	0.86	0.39	0.00	0.12	0.88			0.11			0.83	0.23
Uniform Delay, d1	50.3	17.6	14.0	56.3	32.8			45.7			47.2	41.7
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	17.3	0.6	0.0	3.9	8.1			0.9			20.6	1.8
Delay (s)	67.7	18.2	14.0	60.2	40.9			46.7			67.8	43.5
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		36.6			41.0			46.7			53.9	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	42.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1900	1900		1805	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1900	1900		1805	1615
Volume (vph)	0	385	552	0	171	111
Peak-hour factor, PHF	0.89	0.87	0.89	0.88	0.87	0.82
Adj. Flow (vph)	0	443	620	0	197	135
RTOR Reduction (vph)	0	0	0	0	0	98
Lane Group Flow (vph)	0	443	620	0	197	37
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		16.7	16.7		9.4	9.4
Effective Green, g (s)		16.7	16.7		9.4	9.4
Actuated g/C Ratio		0.49	0.49		0.28	0.28
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		930	930		498	445
v/s Ratio Prot		0.23	c0.33		c0.11	
v/s Ratio Perm						0.08
v/c Ratio		0.48	0.67		0.40	0.08
Uniform Delay, d1		5.8	6.6		10.0	9.2
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		0.4	1.8		0.5	0.1
Delay (s)		6.2	8.4		10.6	9.2
Level of Service		A	A		B	A
Approach Delay (s)		6.2	8.4		10.0	
Approach LOS		A	A		B	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	34.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	499	0	0	630	307	448
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	548	0	0	677	327	477
RTOR Reduction (vph)	0	0	0	0	0	150
Lane Group Flow (vph)	548	0	0	677	327	327
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	32.9			32.9	38.6	38.6
Effective Green, g (s)	32.9			32.9	38.6	38.6
Actuated g/C Ratio	0.41			0.41	0.49	0.49
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	786			786	876	784
v/s Ratio Prot	0.29			c0.36	0.18	
v/s Ratio Perm						0.30
v/c Ratio	0.70			0.86	0.37	0.42
Uniform Delay, d1	19.2			21.2	12.8	13.2
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.7			9.6	1.2	1.6
Delay (s)	21.9			30.8	14.1	14.8
Level of Service	C			C	B	B
Approach Delay (s)	21.9			30.8	14.5	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	21.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	79.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	103.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3448		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3448		1805	3486		1805	3610	1615
Volume (vph)	302	415	131	69	381	117	175	443	131	197	277	262
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	325	446	141	75	414	127	188	476	141	205	289	273
RTOR Reduction (vph)	0	0	101	0	29	0	0	26	0	0	0	194
Lane Group Flow (vph)	325	446	40	75	512	0	188	591	0	205	289	79
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	13.5	32.7	28.4	6.9	26.1		18.0	28.4		15.6	26.0	26.0
Effective Green, g (s)	13.5	32.7	28.4	6.9	26.1		18.0	28.4		15.6	26.0	26.0
Actuated g/C Ratio	0.14	0.33	0.29	0.07	0.26		0.18	0.29		0.16	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	475	1185	461	125	904		326	994		283	942	422
v/s Ratio Prot	c0.09	0.12		0.04	c0.16		0.10	c0.18		c0.11	0.08	
v/s Ratio Perm			0.09									0.17
v/c Ratio	0.68	0.38	0.09	0.60	0.57		0.58	0.59		0.72	0.31	0.19
Uniform Delay, d1	41.0	25.6	26.1	45.0	31.8		37.3	30.6		40.0	29.6	28.6
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	0.9	0.1	7.5	2.6		7.2	1.0		8.9	0.8	1.0
Delay (s)	45.1	26.5	26.2	52.6	34.4		44.6	31.6		48.8	30.4	29.6
Level of Service	D	C	C	D	C		D	C		D	C	C
Approach Delay (s)		33.1			36.6			34.6			35.0	
Approach LOS		C			D			C			D	

Intersection Summary			
HCM Average Control Delay	34.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	99.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1781			1805	1615
Flt Permitted	0.29	1.00		0.13	1.00			0.88			0.74	1.00
Satd. Flow (perm)	547	1897		244	1881			1635			1412	1615
Volume (vph)	20	720	9	1	511	0	8	0	2	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	21	750	9	1	555	0	18	0	4	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	2	0	0	0	17
Lane Group Flow (vph)	21	758	0	1	555	0	0	20	0	0	3	12
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	31.1	31.1		31.1	31.1			26.7			26.7	26.7
Effective Green, g (s)	31.1	31.1		31.1	31.1			26.7			26.7	26.7
Actuated g/C Ratio	0.47	0.47		0.47	0.47			0.41			0.41	0.41
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	259	897		115	889			663			573	655
v/s Ratio Prot		c0.40			0.30							
v/s Ratio Perm	0.04			0.00				0.01			0.00	0.02
v/c Ratio	0.08	0.85		0.01	0.62			0.03			0.01	0.02
Uniform Delay, d1	9.5	15.2		9.2	13.0			11.8			11.6	11.7
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	7.4		0.0	1.4			0.1			0.0	0.1
Delay (s)	9.6	22.6		9.2	14.4			11.8			11.7	11.8
Level of Service	A	C		A	B			B			B	B
Approach Delay (s)		22.3			14.3			11.8			11.7	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	18.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	437	218	27	304	140	35
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	470	234	32	358	182	45
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			470		891	470
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			470		891	470
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		41	92
cM capacity (veh/h)			1102		306	598

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	470	234	32	358	182	45
Volume Left	0	0	32	0	182	0
Volume Right	0	234	0	0	0	45
cSH	1700	1700	1102	1700	306	598
Volume to Capacity	0.28	0.14	0.03	0.21	0.59	0.08
Queue Length 95th (ft)	0	0	2	0	89	6
Control Delay (s)	0.0	0.0	8.4	0.0	32.5	11.5
Lane LOS			A		D	B
Approach Delay (s)	0.0		0.7		28.3	
Approach LOS					D	

Intersection Summary			
Average Delay	5.1		
Intersection Capacity Utilization	37.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	16	335	334	3	6	32
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	21	429	348	3	8	44
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	351				820	349
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	351				820	349
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				98	94
cM capacity (veh/h)	1219				342	698

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	21	429	351	52
Volume Left	21	0	0	8
Volume Right	0	0	3	44
cSH	1219	1700	1700	829
Volume to Capacity	0.02	0.25	0.21	0.06
Queue Length 95th (ft)	1	0	0	5
Control Delay (s)	8.0	0.0	0.0	9.6
Lane LOS	A			A
Approach Delay (s)	0.4		0.0	9.6
Approach LOS				A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	27.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	15	328	328	9	12	16
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	19	405	357	10	48	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	366				803	361
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	366				803	361
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				86	91
cM capacity (veh/h)	1203				350	688

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	423	366	112
Volume Left	19	0	48
Volume Right	0	10	64
cSH	1203	1700	486
Volume to Capacity	0.02	0.22	0.23
Queue Length 95th (ft)	1	0	22
Control Delay (s)	0.5	0.0	14.6
Lane LOS	A		B
Approach Delay (s)	0.5	0.0	14.6
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	39.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	327	7	14	182	245	321
Peak Hour Factor	0.82	0.82	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	399	9	15	190	269	353

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	407	204	622
Volume Left (vph)	399	15	0
Volume Right (vph)	9	0	353
Hadj (s)	0.18	0.01	-0.33
Departure Headway (s)	6.3	6.4	5.4
Degree Utilization, x	0.72	0.36	0.93
Capacity (veh/h)	549	543	663
Control Delay (s)	23.9	13.0	42.6
Approach Delay (s)	23.9	13.0	42.6
Approach LOS	C	B	E

Intersection Summary			
Delay	31.5		
HCM Level of Service	D		
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	285	7	255	21	35	1	438	193	61	3	171	176
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Hourly flow rate (vph)	300	7	268	26	43	1	456	201	64	3	180	185

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	307	268	70	456	265	3	365
Volume Left (vph)	300	0	26	456	0	3	0
Volume Right (vph)	0	268	1	0	64	0	185
Hadj (s)	0.49	-0.70	0.06	0.52	-0.17	0.50	-0.35
Departure Headway (s)	8.2	7.0	8.9	8.0	7.3	8.4	7.6
Degree Utilization, x	0.70	0.52	0.17	1.01	0.54	0.01	0.77
Capacity (veh/h)	428	505	380	456	476	412	464
Control Delay (s)	26.9	16.3	13.8	73.7	17.3	10.3	30.5
Approach Delay (s)	21.9		13.8	53.0		30.3	
Approach LOS	C		B	F		D	

Intersection Summary			
Delay	36.3		
HCM Level of Service	E		
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		1.00		1.00	0.96		1.00	0.92	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1811	1615		1862		1787	1831		1805	1747	
Flt Permitted		0.95	1.00		0.98		0.17	1.00		0.60	1.00	
Satd. Flow (perm)		1811	1615		1862		328	1831		1132	1747	
Volume (vph)	285	7	255	21	35	1	438	193	61	3	171	176
Peak-hour factor, PHF	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Adj. Flow (vph)	300	7	268	26	43	1	456	201	64	3	180	185
RTOR Reduction (vph)	0	0	154	0	1	0	0	11	0	0	37	0
Lane Group Flow (vph)	0	307	114	0	69	0	456	254	0	3	328	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		17.5	17.5		6.8		46.0	46.0		19.5	19.5	
Effective Green, g (s)		17.5	17.5		6.8		46.0	46.0		19.5	19.5	
Actuated g/C Ratio		0.21	0.21		0.08		0.56	0.56		0.24	0.24	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		385	343		154		582	1023		268	414	
v/s Ratio Prot		c0.17			c0.04		c0.21	0.14			0.21	
v/s Ratio Perm			0.17				c0.22			0.00		
v/c Ratio		0.80	0.33		0.45		0.78	0.25		0.01	0.79	
Uniform Delay, d1		30.7	27.4		36.0		17.3	9.3		24.0	29.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		10.9	0.6		2.1		6.8	0.1		0.0	10.0	
Delay (s)		41.7	28.0		38.0		24.2	9.4		24.0	39.5	
Level of Service		D	C		D		C	A		C	D	
Approach Delay (s)		35.3			38.0			18.7			39.4	
Approach LOS		D			D			B			D	

Intersection Summary			
HCM Average Control Delay	29.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	82.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3529			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3529			1823			1805	1615
Volume (vph)	455	862	15	2	874	153	11	2	0	210	0	224
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	489	927	16	2	920	161	17	3	0	219	0	233
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	192
Lane Group Flow (vph)	489	927	8	2	1069	0	0	20	0	0	219	41
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1323			243			316	283
v/s Ratio Prot	c0.14	0.26		0.00	c0.31			c0.01			0.12	
v/s Ratio Perm			0.01									0.14
v/c Ratio	0.76	0.49	0.01	0.03	0.81			0.08			0.69	0.14
Uniform Delay, d1	46.5	18.2	13.6	56.1	33.6			45.6			46.5	41.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	8.3	0.9	0.0	1.0	5.4			0.7			11.8	1.1
Delay (s)	54.8	19.1	13.6	57.2	39.0			46.2			58.3	43.0
Level of Service	D	B	B	E	D			D			E	D
Approach Delay (s)		31.3			39.1			46.2			50.4	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	37.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1863	1863		1770	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1863	1863		1770	1615
Volume (vph)	0	509	415	0	209	18
Peak-hour factor, PHF	0.96	0.96	0.84	0.85	0.81	0.85
Adj. Flow (vph)	0	530	494	0	258	21
RTOR Reduction (vph)	0	0	0	0	0	14
Lane Group Flow (vph)	0	530	494	0	258	7
Heavy Vehicles (%)	2%	2%	2%	1%	2%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		15.1	15.1		10.5	10.5
Effective Green, g (s)		15.1	15.1		10.5	10.5
Actuated g/C Ratio		0.45	0.45		0.31	0.31
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		837	837		553	505
v/s Ratio Prot		c0.28	0.27		c0.15	
v/s Ratio Perm						0.01
v/c Ratio		0.63	0.59		0.47	0.01
Uniform Delay, d1		7.1	6.9		9.3	8.0
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		1.6	1.1		0.6	0.0
Delay (s)		8.7	8.1		9.9	8.0
Level of Service		A	A		A	A
Approach Delay (s)		8.7	8.1		9.8	
Approach LOS		A	A		A	

Intersection Summary			
HCM Average Control Delay	8.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	33.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	666	0	0	750	183	268
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	724	0	0	872	199	291
RTOR Reduction (vph)	0	0	0	0	0	176
Lane Group Flow (vph)	724	0	0	872	199	115
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	36.9			36.9	24.9	24.9
Effective Green, g (s)	36.9			36.9	24.9	24.9
Actuated g/C Ratio	0.53			0.53	0.36	0.36
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	994			994	613	565
v/s Ratio Prot	0.38			c0.46	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.73			0.88	0.32	0.20
Uniform Delay, d1	12.6			14.5	16.3	15.6
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.7			8.8	1.4	0.8
Delay (s)	15.3			23.3	17.7	16.4
Level of Service	B			C	B	B
Approach Delay (s)	15.3			23.3	16.9	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	69.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3446		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3446		1805	3516		1736	3438	1599
Volume (vph)	147	336	332	174	483	166	216	315	66	125	517	255
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	171	361	386	212	589	202	251	366	77	154	638	315
RTOR Reduction (vph)	0	0	263	0	34	0	0	17	0	0	0	101
Lane Group Flow (vph)	171	361	123	212	757	0	251	426	0	154	638	214
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	7.9	19.0	31.8	19.9	31.0		21.0	31.8		13.2	24.0	24.0
Effective Green, g (s)	7.9	19.0	31.8	19.9	31.0		21.0	31.8		13.2	24.0	24.0
Actuated g/C Ratio	0.08	0.19	0.32	0.20	0.31		0.21	0.32		0.13	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	277	687	514	360	1069		379	1119		229	826	384
v/s Ratio Prot	0.05	0.10		c0.12	c0.23		0.14	0.13		0.09	0.19	
v/s Ratio Perm			0.24									0.20
v/c Ratio	0.62	0.53	0.24	0.59	0.71		0.66	0.38		0.67	0.77	0.56
Uniform Delay, d1	44.5	36.4	25.1	36.3	30.5		36.2	26.4		41.3	35.4	33.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	2.9	0.2	2.5	4.0		8.8	0.2		7.6	6.9	5.7
Delay (s)	48.6	39.3	25.4	38.7	34.4		45.0	26.6		48.8	42.3	39.0
Level of Service	D	D	C	D	C		D	C		D	D	D
Approach Delay (s)		35.2			35.3			33.3			42.3	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	37.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	99.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1775				1615
Flt Permitted	0.10	1.00		0.34	1.00	1.00		0.85				1.00
Satd. Flow (perm)	193	1861		641	1881	1615		1568				1615
Volume (vph)	35	550	4	7	716	2	16	1	5	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.75	0.75	0.75	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	36	573	4	9	955	3	37	2	12	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	1	0	8	0	0	0	28
Lane Group Flow (vph)	36	577	0	9	955	2	0	43	0	0	0	12
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	39.3	39.3		39.3	39.3	39.3		20.9				20.9
Effective Green, g (s)	39.3	39.3		39.3	39.3	39.3		20.9				20.9
Actuated g/C Ratio	0.58	0.58		0.58	0.58	0.58		0.31				0.31
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	111	1072		369	1084	931		481				495
v/s Ratio Prot		0.31			c0.51							
v/s Ratio Perm	0.19			0.01		0.00		c0.03				0.02
v/c Ratio	0.32	0.54		0.02	0.88	0.00		0.09				0.02
Uniform Delay, d1	7.5	8.9		6.2	12.4	6.1		16.9				16.5
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	1.7	0.5		0.0	8.6	0.0		0.4				0.1
Delay (s)	9.2	9.4		6.2	21.0	6.1		17.2				16.6
Level of Service	A	A		A	C	A		B				B
Approach Delay (s)		9.4			20.8			17.2			16.6	
Approach LOS		A			C			B			B	

Intersection Summary			
HCM Average Control Delay	16.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	68.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	296	204	44	357	199	12
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	329	227	49	397	221	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			329		823	329
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			329		823	329
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		33	98
cM capacity (veh/h)			1242		331	717

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	329	227	49	397	221	13
Volume Left	0	0	49	0	221	0
Volume Right	0	227	0	0	0	13
cSH	1700	1700	1242	1700	331	717
Volume to Capacity	0.19	0.13	0.04	0.23	0.67	0.02
Queue Length 95th (ft)	0	0	3	0	114	1
Control Delay (s)	0.0	0.0	8.0	0.0	35.3	10.1
Lane LOS			A		E	B
Approach Delay (s)	0.0		0.9		33.8	
Approach LOS					D	

Intersection Summary			
Average Delay	6.7		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	313	324	2	0	18
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	28	356	356	2	0	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	358				770	357
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	358				770	357
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				100	96
cM capacity (veh/h)	1212				363	692

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	28	356	358	28
Volume Left	28	0	0	0
Volume Right	0	0	2	28
cSH	1212	1700	1700	519
Volume to Capacity	0.02	0.21	0.21	0.05
Queue Length 95th (ft)	2	0	0	4
Control Delay (s)	8.0	0.0	0.0	12.3
Lane LOS	A			B
Approach Delay (s)	0.6		0.0	12.3
Approach LOS				B

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	50	246	278	40	37	53
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	59	289	299	43	49	71
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	342				727	320
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	342				727	320
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	95				83	89
cM capacity (veh/h)	1228				294	654

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	348	342	120
Volume Left	59	0	49
Volume Right	0	43	71
cSH	1228	1700	435
Volume to Capacity	0.05	0.20	0.28
Queue Length 95th (ft)	4	0	28
Control Delay (s)	1.8	0.0	16.4
Lane LOS	A		C
Approach Delay (s)	1.8	0.0	16.4
Approach LOS			C

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	254	10	13	154	160	286
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	285	11	15	183	182	325

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	297	199	507
Volume Left (vph)	285	15	0
Volume Right (vph)	11	0	325
Hadj (s)	0.24	0.03	-0.36
Departure Headway (s)	5.9	5.6	4.8
Degree Utilization, x	0.48	0.31	0.68
Capacity (veh/h)	572	595	727
Control Delay (s)	14.3	11.0	17.2
Approach Delay (s)	14.3	11.0	17.2
Approach LOS	B	B	C

Intersection Summary			
Delay	15.1		
HCM Level of Service	C		
Intersection Capacity Utilization	47.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	101	1	394	15	5	2	194	110	9	2	177	224
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	107	1	419	21	7	3	228	129	11	2	213	270

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	109	419	31	228	140	2	483
Volume Left (vph)	107	0	21	228	0	2	0
Volume Right (vph)	0	419	3	0	11	0	270
Hadj (s)	0.51	-0.67	0.08	0.53	-0.02	0.50	-0.38
Departure Headway (s)	7.6	6.4	8.3	7.7	7.2	7.5	6.6
Degree Utilization, x	0.23	0.75	0.07	0.49	0.28	0.01	0.89
Capacity (veh/h)	454	541	391	441	479	458	536
Control Delay (s)	11.7	24.8	12.0	16.7	11.7	9.3	40.0
Approach Delay (s)	22.1		12.0	14.8		39.8	
Approach LOS	C		B	B		E	

Intersection Summary			
Delay	26.1		
HCM Level of Service	D		
Intersection Capacity Utilization	60.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		0.99		1.00	0.99		1.00	0.92	
Flt Protected		0.95	1.00		0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583		1814		1770	1844		1805	1733	
Flt Permitted		0.95	1.00		0.97		0.22	1.00		0.67	1.00	
Satd. Flow (perm)		1793	1583		1814		403	1844		1269	1733	
Volume (vph)	101	1	394	15	5	2	194	110	9	2	177	224
Peak-hour factor, PHF	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Adj. Flow (vph)	107	1	419	21	7	3	228	129	11	2	213	270
RTOR Reduction (vph)	0	0	343	0	3	0	0	3	0	0	46	0
Lane Group Flow (vph)	0	108	76	0	28	0	228	137	0	2	437	0
Heavy Vehicles (%)	1%	0%	2%	0%	0%	0%	2%	2%	0%	0%	1%	0%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		10.5	10.5		2.2		33.2	33.2		20.6	20.6	
Effective Green, g (s)		10.5	10.5		2.2		33.2	33.2		20.6	20.6	
Actuated g/C Ratio		0.18	0.18		0.04		0.57	0.57		0.36	0.36	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		325	287		69		434	1057		451	617	
v/s Ratio Prot		0.06			c0.02		c0.08	0.08			c0.28	
v/s Ratio Perm			0.26				0.22			0.00		
v/c Ratio		0.33	0.26		0.41		0.53	0.13		0.00	0.71	
Uniform Delay, d1		20.6	20.4		27.2		8.2	5.7		12.0	16.1	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6	0.5		3.9		1.2	0.1		0.0	3.7	
Delay (s)		21.3	20.9		31.1		9.4	5.7		12.0	19.8	
Level of Service		C	C		C		A	A		B	B	
Approach Delay (s)		21.0			31.1			8.0			19.8	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	57.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	60.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3466			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3466			1832			1792	1615
Volume (vph)	382	639	1	6	893	222	9	6	1	233	1	316
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	429	718	1	7	992	274	16	11	2	271	1	367
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	300
Lane Group Flow (vph)	429	718	1	7	1245	0	0	27	0	0	272	67
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	18.0	62.0	62.0	4.0	48.0			16.0			22.0	22.0
Effective Green, g (s)	18.0	62.0	62.0	4.0	48.0			16.0			22.0	22.0
Actuated g/C Ratio	0.15	0.52	0.52	0.03	0.40			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	525	1828	834	60	1386			244			329	296
v/s Ratio Prot	c0.12	0.20		0.00	c0.37			c0.02			0.15	
v/s Ratio Perm			0.00									0.23
v/c Ratio	0.82	0.39	0.00	0.12	0.90			0.11			0.83	0.23
Uniform Delay, d1	49.4	17.6	14.0	56.3	33.7			45.7			47.2	41.8
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	13.2	0.6	0.0	3.9	9.5			0.9			20.6	1.8
Delay (s)	62.6	18.2	14.0	60.2	43.2			46.7			67.8	43.5
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		34.8			43.3			46.7			53.9	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	42.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1900	1900		1805	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1900	1900		1805	1615
Volume (vph)	0	385	552	0	179	111
Peak-hour factor, PHF	0.89	0.87	0.89	0.88	0.87	0.82
Adj. Flow (vph)	0	443	620	0	206	135
RTOR Reduction (vph)	0	0	0	0	0	97
Lane Group Flow (vph)	0	443	620	0	206	38
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		16.8	16.8		9.8	9.8
Effective Green, g (s)		16.8	16.8		9.8	9.8
Actuated g/C Ratio		0.49	0.49		0.28	0.28
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		923	923		511	457
v/s Ratio Prot		0.23	c0.33		c0.11	
v/s Ratio Perm						0.08
v/c Ratio		0.48	0.67		0.40	0.08
Uniform Delay, d1		6.0	6.8		10.0	9.1
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		0.4	1.9		0.5	0.1
Delay (s)		6.4	8.7		10.6	9.2
Level of Service		A	A		B	A
Approach Delay (s)		6.4	8.7		10.0	
Approach LOS		A	A		B	

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	34.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	507	0	0	638	307	454
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	557	0	0	686	327	483
RTOR Reduction (vph)	0	0	0	0	0	153
Lane Group Flow (vph)	557	0	0	686	327	330
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	32.9			32.9	37.6	37.6
Effective Green, g (s)	32.9			32.9	37.6	37.6
Actuated g/C Ratio	0.42			0.42	0.48	0.48
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	796			796	865	774
v/s Ratio Prot	0.29			c0.36	0.18	
v/s Ratio Perm						0.30
v/c Ratio	0.70			0.86	0.38	0.43
Uniform Delay, d1	18.7			20.7	13.0	13.4
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	2.7			9.5	1.3	1.7
Delay (s)	21.4			30.2	14.3	15.1
Level of Service	C			C	B	B
Approach Delay (s)	21.4			30.2	14.8	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	21.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	78.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3452		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3452		1805	3486		1805	3610	1615
Volume (vph)	302	429	131	69	396	117	175	443	131	197	277	262
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	325	461	141	75	430	127	188	476	141	205	289	273
RTOR Reduction (vph)	0	0	111	0	27	0	0	28	0	0	0	194
Lane Group Flow (vph)	325	461	30	75	530	0	188	589	0	205	289	79
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	13.5	32.7	21.1	6.9	26.1		18.0	21.1		22.9	26.0	26.0
Effective Green, g (s)	13.5	32.7	21.1	6.9	26.1		18.0	21.1		22.9	26.0	26.0
Actuated g/C Ratio	0.14	0.33	0.21	0.07	0.26		0.18	0.21		0.23	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	475	1185	342	125	905		326	739		415	942	422
v/s Ratio Prot	c0.09	0.13		0.04	c0.16		c0.10	c0.18		0.11	0.08	
v/s Ratio Perm			0.09									0.17
v/c Ratio	0.68	0.39	0.09	0.60	0.59		0.58	0.80		0.49	0.31	0.19
Uniform Delay, d1	41.0	25.8	31.5	45.0	32.0		37.3	37.2		33.3	29.6	28.6
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	1.0	0.1	7.5	2.8		7.2	6.0		0.9	0.8	1.0
Delay (s)	45.1	26.7	31.6	52.6	34.8		44.6	43.2		34.2	30.4	29.6
Level of Service	D	C	C	D	C		D	D		C	C	C
Approach Delay (s)		33.9			36.9			43.5			31.1	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	36.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	99.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1781			1805	1615
Flt Permitted	0.28	1.00		0.13	1.00			0.88			0.74	1.00
Satd. Flow (perm)	528	1897		238	1881			1634			1412	1615
Volume (vph)	20	734	9	1	526	0	8	0	2	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	21	765	9	1	572	0	18	0	4	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	2	0	0	0	17
Lane Group Flow (vph)	21	773	0	1	572	0	0	20	0	0	3	12
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	31.9	31.9		31.9	31.9			26.7			26.7	26.7
Effective Green, g (s)	31.9	31.9		31.9	31.9			26.7			26.7	26.7
Actuated g/C Ratio	0.48	0.48		0.48	0.48			0.40			0.40	0.40
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	253	909		114	901			655			566	647
v/s Ratio Prot		c0.41			0.30							
v/s Ratio Perm	0.04			0.00				0.01			0.00	0.02
v/c Ratio	0.08	0.85		0.01	0.63			0.03			0.01	0.02
Uniform Delay, d1	9.4	15.3		9.1	13.0			12.1			12.0	12.0
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	7.7		0.0	1.5			0.1			0.0	0.1
Delay (s)	9.6	23.0		9.1	14.5			12.2			12.0	12.1
Level of Service	A	C		A	B			B			B	B
Approach Delay (s)		22.6			14.5			12.2			12.1	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	66.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	451	218	27	319	140	35
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	485	234	32	375	182	45
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			485		924	485
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			485		924	485
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		38	92
cM capacity (veh/h)			1088		293	586

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	485	234	32	375	182	45
Volume Left	0	0	32	0	182	0
Volume Right	0	234	0	0	0	45
cSH	1700	1700	1088	1700	293	586
Volume to Capacity	0.29	0.14	0.03	0.22	0.62	0.08
Queue Length 95th (ft)	0	0	2	0	96	6
Control Delay (s)	0.0	0.0	8.4	0.0	35.5	11.7
Lane LOS			A		E	B
Approach Delay (s)	0.0		0.7		30.7	
Approach LOS					D	

Intersection Summary			
Average Delay	5.4		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	16	349	349	3	6	32
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	21	447	364	3	8	44
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	367				854	365
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	367				854	365
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	94
cM capacity (veh/h)	1203				326	684

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	21	447	367	52
Volume Left	21	0	0	8
Volume Right	0	0	3	44
cSH	1203	1700	1700	813
Volume to Capacity	0.02	0.26	0.22	0.06
Queue Length 95th (ft)	1	0	0	5
Control Delay (s)	8.0	0.0	0.0	9.7
Lane LOS	A			A
Approach Delay (s)	0.4		0.0	9.7
Approach LOS				A

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	28.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	29	328	328	19	23	31
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	36	405	357	21	92	124
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	377				843	367
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	377				843	367
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				72	82
cM capacity (veh/h)	1192				326	683

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	441	377	216
Volume Left	36	0	92
Volume Right	0	21	124
cSH	1192	1700	466
Volume to Capacity	0.03	0.22	0.46
Queue Length 95th (ft)	2	0	60
Control Delay (s)	1.0	0.0	19.2
Lane LOS	A		C
Approach Delay (s)	1.0	0.0	19.2
Approach LOS			C

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	50.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	327	8	15	182	245	329
Peak Hour Factor	0.82	0.82	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	399	10	16	190	269	362

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	409	205	631
Volume Left (vph)	399	16	0
Volume Right (vph)	10	0	362
Hadj (s)	0.18	0.02	-0.33
Departure Headway (s)	6.4	6.4	5.4
Degree Utilization, x	0.72	0.37	0.94
Capacity (veh/h)	550	543	653
Control Delay (s)	24.3	13.1	45.4
Approach Delay (s)	24.3	13.1	45.4
Approach LOS	C	B	E

Intersection Summary			
Delay	33.1		
HCM Level of Service	D		
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	286	7	263	21	35	1	444	193	61	3	171	177
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Hourly flow rate (vph)	301	7	277	26	43	1	462	201	64	3	180	186

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	308	277	70	463	265	3	366
Volume Left (vph)	301	0	26	463	0	3	0
Volume Right (vph)	0	277	1	0	64	0	186
Hadj (s)	0.49	-0.70	0.06	0.52	-0.17	0.50	-0.35
Departure Headway (s)	8.2	7.0	8.9	8.0	7.3	8.4	7.6
Degree Utilization, x	0.70	0.54	0.17	1.03	0.54	0.01	0.77
Capacity (veh/h)	428	505	379	463	476	411	462
Control Delay (s)	27.0	16.7	13.8	77.4	17.3	10.3	30.8
Approach Delay (s)	22.1		13.8	55.5		30.6	
Approach LOS	C		B	F		D	

Intersection Summary			
Delay	37.4		
HCM Level of Service	E		
Intersection Capacity Utilization	77.3%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		1.00		1.00	0.96		1.00	0.92	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1811	1615		1862		1787	1831		1805	1746	
Flt Permitted		0.95	1.00		0.98		0.17	1.00		0.60	1.00	
Satd. Flow (perm)		1811	1615		1862		323	1831		1132	1746	
Volume (vph)	286	7	263	21	35	1	444	193	61	3	171	177
Peak-hour factor, PHF	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Adj. Flow (vph)	301	7	277	26	43	1	462	201	64	3	180	186
RTOR Reduction (vph)	0	0	159	0	1	0	0	11	0	0	37	0
Lane Group Flow (vph)	0	308	118	0	69	0	462	254	0	3	329	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		17.6	17.6		6.8		46.1	46.1		19.5	19.5	
Effective Green, g (s)		17.6	17.6		6.8		46.1	46.1		19.5	19.5	
Actuated g/C Ratio		0.21	0.21		0.08		0.56	0.56		0.24	0.24	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		386	345		153		582	1023		268	413	
v/s Ratio Prot		0.17			c0.04		c0.22	0.14			0.21	
v/s Ratio Perm			0.17				c0.23			0.00		
v/c Ratio		0.80	0.34		0.45		0.79	0.25		0.01	0.80	
Uniform Delay, d1		30.8	27.5		36.1		17.8	9.3		24.1	29.6	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		10.9	0.6		2.1		7.3	0.1		0.0	10.3	
Delay (s)		41.7	28.1		38.2		25.1	9.5		24.1	39.9	
Level of Service		D	C		D		C	A		C	D	
Approach Delay (s)		35.3			38.2			19.4			39.8	
Approach LOS		D			D			B			D	

Intersection Summary			
HCM Average Control Delay	29.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	82.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	77.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3529			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3529			1823			1805	1615
Volume (vph)	456	862	15	2	874	153	11	2	0	210	0	225
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	490	927	16	2	920	161	17	3	0	219	0	234
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	193
Lane Group Flow (vph)	490	927	8	2	1069	0	0	20	0	0	219	41
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1323			243			316	283
v/s Ratio Prot	c0.14	0.26		0.00	c0.31			c0.01			0.12	
v/s Ratio Perm			0.01									0.14
v/c Ratio	0.76	0.49	0.01	0.03	0.81			0.08			0.69	0.14
Uniform Delay, d1	46.5	18.2	13.6	56.1	33.6			45.6			46.5	41.9
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	8.4	0.9	0.0	1.0	5.4			0.7			11.8	1.1
Delay (s)	54.9	19.1	13.6	57.2	39.0			46.2			58.3	43.0
Level of Service	D	B	B	E	D			D			E	D
Approach Delay (s)		31.3			39.1			46.2			50.4	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	37.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1863	1863		1770	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1863	1863		1770	1615
Volume (vph)	0	535	428	0	239	23
Peak-hour factor, PHF	0.96	0.96	0.84	0.85	0.81	0.85
Adj. Flow (vph)	0	557	510	0	295	27
RTOR Reduction (vph)	0	0	0	0	0	18
Lane Group Flow (vph)	0	557	510	0	295	9
Heavy Vehicles (%)	2%	2%	2%	1%	2%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		16.1	16.1		11.6	11.6
Effective Green, g (s)		16.1	16.1		11.6	11.6
Actuated g/C Ratio		0.45	0.45		0.32	0.32
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		840	840		575	525
v/s Ratio Prot		c0.30	0.27		c0.17	
v/s Ratio Perm						0.02
v/c Ratio		0.66	0.61		0.51	0.02
Uniform Delay, d1		7.7	7.4		9.8	8.2
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		2.0	1.2		0.8	0.0
Delay (s)		9.7	8.7		10.5	8.2
Level of Service		A	A		B	A
Approach Delay (s)		9.7	8.7		10.3	
Approach LOS		A	A		B	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	35.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	724	0	0	897	183	257
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	787	0	0	1043	199	279
RTOR Reduction (vph)	0	0	0	0	0	189
Lane Group Flow (vph)	787	0	0	1043	199	90
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	45.9			45.9	21.0	21.0
Effective Green, g (s)	45.9			45.9	21.0	21.0
Actuated g/C Ratio	0.61			0.61	0.28	0.28
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	1153			1153	482	444
v/s Ratio Prot	0.42			c0.55	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.68			0.90	0.41	0.20
Uniform Delay, d1	9.7			12.6	21.9	20.6
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	1.7			10.1	2.6	1.0
Delay (s)	11.3			22.7	24.5	21.6
Level of Service	B			C	C	C
Approach Delay (s)	11.3			22.7	22.8	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	18.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3439		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3439		1805	3516		1736	3438	1599
Volume (vph)	160	336	361	242	628	231	216	315	66	153	633	312
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	186	361	420	295	766	282	251	366	77	189	781	385
RTOR Reduction (vph)	0	0	299	0	38	0	0	17	0	0	0	101
Lane Group Flow (vph)	186	361	121	295	1010	0	251	426	0	189	781	284
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	7.0	20.0	28.9	20.0	33.0		18.0	28.9		15.1	26.0	26.0
Effective Green, g (s)	7.0	20.0	28.9	20.0	33.0		18.0	28.9		15.1	26.0	26.0
Actuated g/C Ratio	0.07	0.20	0.29	0.20	0.33		0.18	0.29		0.15	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	245	722	467	361	1135		325	1016		262	894	416
v/s Ratio Prot	0.05	0.10		c0.16	c0.30		0.14	0.13		0.11	0.23	
v/s Ratio Perm			0.26									0.24
v/c Ratio	0.76	0.50	0.26	0.82	0.89		0.77	0.42		0.72	0.87	0.68
Uniform Delay, d1	45.7	35.6	27.3	38.3	31.8		39.0	28.8		40.4	35.4	33.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	12.7	2.5	0.3	13.3	10.6		16.2	0.3		9.4	11.6	8.7
Delay (s)	58.3	38.0	27.6	51.6	42.4		55.3	29.0		49.8	47.0	42.0
Level of Service	E	D	C	D	D		E	C		D	D	D
Approach Delay (s)		37.4			44.4			38.5			46.0	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	42.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1781				1615
Flt Permitted	0.06	1.00		0.32	1.00	1.00		0.83				1.00
Satd. Flow (perm)	121	1861		614	1881	1615		1530				1615
Volume (vph)	40	592	5	9	969	3	23	2	7	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.76	0.76	0.76	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	42	617	5	12	1275	4	53	5	16	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	1	0	10	0	0	0	28
Lane Group Flow (vph)	42	622	0	12	1275	3	0	64	0	0	0	12
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	63.0	63.0		63.0	63.0	63.0		29.0				29.0
Effective Green, g (s)	63.0	63.0		63.0	63.0	63.0		29.0				29.0
Actuated g/C Ratio	0.63	0.63		0.63	0.63	0.63		0.29				0.29
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	76	1172		387	1185	1017		444				468
v/s Ratio Prot		0.33			c0.68							
v/s Ratio Perm	0.35			0.02		0.00		c0.04				0.01
v/c Ratio	0.55	0.53		0.03	1.08	0.00		0.14				0.02
Uniform Delay, d1	10.5	10.3		7.0	18.5	6.9		26.3				25.4
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	8.4	0.5		0.0	49.1	0.0		0.7				0.1
Delay (s)	18.9	10.7		7.0	67.6	6.9		27.0				25.5
Level of Service	B	B		A	E	A		C				C
Approach Delay (s)		11.3			66.9			27.0			25.5	
Approach LOS		B			E			C			C	

Intersection Summary			
HCM Average Control Delay	46.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	67.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	314	240	59	438	199	12
Peak Hour Factor	0.88	0.88	0.89	0.89	0.81	0.81
Hourly flow rate (vph)	357	273	66	492	246	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			357		982	357
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			357		982	357
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		6	98
cM capacity (veh/h)			1213		262	692

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	357	273	66	492	246	15
Volume Left	0	0	66	0	246	0
Volume Right	0	273	0	0	0	15
cSH	1700	1700	1213	1700	262	692
Volume to Capacity	0.21	0.16	0.05	0.29	0.94	0.02
Queue Length 95th (ft)	0	0	4	0	215	2
Control Delay (s)	0.0	0.0	8.1	0.0	81.7	10.3
Lane LOS			A		F	B
Approach Delay (s)	0.0		1.0		77.7	
Approach LOS					F	

Intersection Summary			
Average Delay	14.3		
Intersection Capacity Utilization	40.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	26	294	404	3	0	26
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	30	334	444	3	0	41
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	447				839	446
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	447				839	446
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				100	93
cM capacity (veh/h)	1124				330	617

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	30	334	447	41
Volume Left	30	0	0	0
Volume Right	0	0	3	41
cSH	1124	1700	1700	463
Volume to Capacity	0.03	0.20	0.26	0.09
Queue Length 95th (ft)	2	0	0	7
Control Delay (s)	8.3	0.0	0.0	13.5
Lane LOS	A			B
Approach Delay (s)	0.7		0.0	13.5
Approach LOS				B

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	31.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	25	252	381	25	20	28
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	29	296	410	27	27	37
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	437				778	423
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	437				778	423
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	97				90	93
cM capacity (veh/h)	1134				279	570

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	326	437	64
Volume Left	29	0	27
Volume Right	0	27	37
cSH	1134	1700	398
Volume to Capacity	0.03	0.26	0.16
Queue Length 95th (ft)	2	0	14
Control Delay (s)	1.0	0.0	15.8
Lane LOS	A		C
Approach Delay (s)	1.0	0.0	15.8
Approach LOS			C

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	44.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	260	7	10	154	212	355
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	292	8	12	183	241	403

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	300	195	644
Volume Left (vph)	292	12	0
Volume Right (vph)	8	0	403
Hadj (s)	0.25	0.03	-0.35
Departure Headway (s)	6.2	5.9	4.9
Degree Utilization, x	0.52	0.32	0.87
Capacity (veh/h)	552	584	726
Control Delay (s)	15.8	11.6	31.9
Approach Delay (s)	15.8	11.6	31.9
Approach LOS	C	B	D

Intersection Summary			
Delay	24.2		
HCM Level of Service	C		
Intersection Capacity Utilization	54.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	98	1	383	24	5	4	183	179	15	4	290	221
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	104	1	407	34	7	6	215	211	18	5	349	266

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	105	407	46	215	228	5	616
Volume Left (vph)	104	0	34	215	0	5	0
Volume Right (vph)	0	407	6	0	18	0	266
Hadj (s)	0.51	-0.67	0.07	0.53	-0.02	0.50	-0.29
Departure Headway (s)	7.9	6.7	8.7	7.9	7.3	7.7	6.9
Degree Utilization, x	0.23	0.76	0.11	0.47	0.46	0.01	1.18
Capacity (veh/h)	447	523	386	439	481	448	523
Control Delay (s)	12.1	27.0	12.8	16.5	15.3	9.6	123.4
Approach Delay (s)	23.9		12.8	15.8		122.5	
Approach LOS	C		B	C		F	

Intersection Summary			
Delay	59.1		
HCM Level of Service	F		
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		0.98		1.00	0.99		1.00	0.94	
Flt Protected		0.95	1.00		0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583		1802		1770	1844		1805	1767	
Flt Permitted		0.95	1.00		0.97		0.17	1.00		0.62	1.00	
Satd. Flow (perm)		1793	1583		1802		314	1844		1170	1767	
Volume (vph)	98	1	383	24	5	4	183	179	15	4	290	221
Peak-hour factor, PHF	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Adj. Flow (vph)	104	1	407	34	7	6	215	211	18	5	349	266
RTOR Reduction (vph)	0	0	343	0	6	0	0	3	0	0	27	0
Lane Group Flow (vph)	0	105	64	0	41	0	215	226	0	5	588	0
Heavy Vehicles (%)	1%	0%	2%	0%	0%	0%	2%	2%	0%	0%	1%	0%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		10.5	10.5		4.0		40.4	40.4		28.6	28.6	
Effective Green, g (s)		10.5	10.5		4.0		40.4	40.4		28.6	28.6	
Actuated g/C Ratio		0.16	0.16		0.06		0.60	0.60		0.43	0.43	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		281	248		108		359	1114		500	755	
v/s Ratio Prot		0.06			c0.03		c0.07	0.12			c0.35	
v/s Ratio Perm			0.26				0.29			0.00		
v/c Ratio		0.37	0.26		0.38		0.60	0.20		0.01	0.78	
Uniform Delay, d1		25.3	24.8		30.3		10.0	6.0		11.0	16.4	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8	0.6		2.3		2.7	0.1		0.0	5.1	
Delay (s)		26.1	25.3		32.5		12.7	6.1		11.0	21.5	
Level of Service		C	C		C		B	A		B	C	
Approach Delay (s)		25.5			32.5			9.3			21.4	
Approach LOS		C			C			A			C	

Intersection Summary			
HCM Average Control Delay	19.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	66.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3465			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3465			1832			1792	1615
Volume (vph)	424	714	1	7	1011	252	9	6	1	259	1	348
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	476	802	1	9	1123	311	16	11	2	301	1	405
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	319
Lane Group Flow (vph)	476	802	1	9	1413	0	0	27	0	0	302	86
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	17.0	63.0	63.0	4.0	50.0			16.0			21.0	21.0
Effective Green, g (s)	17.0	63.0	63.0	4.0	50.0			16.0			21.0	21.0
Actuated g/C Ratio	0.14	0.52	0.52	0.03	0.42			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	496	1858	848	60	1444			244			314	283
v/s Ratio Prot	c0.14	0.23		0.00	c0.41			c0.02			0.17	
v/s Ratio Perm			0.00									0.25
v/c Ratio	0.96	0.43	0.00	0.15	0.98			0.11			0.96	0.30
Uniform Delay, d1	51.2	17.5	13.5	56.3	34.5			45.7			49.1	43.1
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	31.5	0.7	0.0	5.2	19.1			0.9			41.9	2.7
Delay (s)	82.7	18.2	13.5	61.6	53.6			46.7			91.0	45.9
Level of Service	F	B	B	E	D			D			F	D
Approach Delay (s)		42.2			53.6			46.7			65.2	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	51.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1900	1900		1805	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1900	1900		1805	1615
Volume (vph)	0	448	575	0	240	157
Peak-hour factor, PHF	0.89	0.87	0.89	0.88	0.87	0.82
Adj. Flow (vph)	0	515	646	0	276	191
RTOR Reduction (vph)	0	0	0	0	0	132
Lane Group Flow (vph)	0	515	646	0	276	59
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		18.8	18.8		11.9	11.9
Effective Green, g (s)		18.8	18.8		11.9	11.9
Actuated g/C Ratio		0.49	0.49		0.31	0.31
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		923	923		555	497
v/s Ratio Prot		0.27	c0.34		c0.15	
v/s Ratio Perm						0.12
v/c Ratio		0.56	0.70		0.50	0.12
Uniform Delay, d1		7.0	7.8		11.0	9.6
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		0.7	2.3		0.7	0.1
Delay (s)		7.8	10.1		11.7	9.7
Level of Service		A	B		B	A
Approach Delay (s)		7.8	10.1		10.9	
Approach LOS		A	B		B	

Intersection Summary			
HCM Average Control Delay	9.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	38.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.3%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	670	0	0	734	329	478
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	736	0	0	789	350	509
RTOR Reduction (vph)	0	0	0	0	0	105
Lane Group Flow (vph)	736	0	0	789	350	404
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	39.4			39.4	37.6	37.6
Effective Green, g (s)	39.4			39.4	37.6	37.6
Actuated g/C Ratio	0.46			0.46	0.44	0.44
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	881			881	798	714
v/s Ratio Prot	0.39			c0.42	0.19	
v/s Ratio Perm						0.32
v/c Ratio	0.84			0.90	0.44	0.57
Uniform Delay, d1	20.0			20.9	16.4	17.6
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	6.9			11.6	1.8	3.2
Delay (s)	26.9			32.5	18.1	20.8
Level of Service	C			C	B	C
Approach Delay (s)	26.9			32.5	19.7	
Approach LOS	C			C	B	

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	85.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	132.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3448		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3448		1805	3486		1805	3610	1615
Volume (vph)	376	514	164	91	494	153	192	485	144	217	305	288
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	404	553	176	99	537	166	206	522	155	226	318	300
RTOR Reduction (vph)	0	0	130	0	29	0	0	27	0	0	0	194
Lane Group Flow (vph)	404	553	46	99	674	0	206	650	0	226	318	106
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	14.9	33.5	26.0	8.3	26.9		20.0	26.0		16.0	22.0	22.0
Effective Green, g (s)	14.9	33.5	26.0	8.3	26.9		20.0	26.0		16.0	22.0	22.0
Actuated g/C Ratio	0.15	0.34	0.26	0.08	0.27		0.20	0.26		0.16	0.22	0.22
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	523	1212	421	150	929		362	908		289	796	356
v/s Ratio Prot	c0.12	0.15		0.05	c0.20		0.11	c0.19		c0.13	0.09	
v/s Ratio Perm			0.11									0.19
v/c Ratio	0.77	0.46	0.11	0.66	0.73		0.57	0.72		0.78	0.40	0.30
Uniform Delay, d1	40.8	26.0	28.1	44.4	33.1		36.0	33.5		40.2	33.3	32.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	7.0	1.2	0.1	10.4	4.9		6.4	2.7		12.9	1.5	2.1
Delay (s)	47.8	27.2	28.2	54.8	38.0		42.4	36.2		53.1	34.7	34.6
Level of Service	D	C	C	D	D		D	D		D	C	C
Approach Delay (s)		34.7			40.1			37.7			39.6	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	37.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	99.8	Sum of lost time (s)	20.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.97			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1772			1805	1615
Flt Permitted	0.26	1.00		0.09	1.00			0.85			0.73	1.00
Satd. Flow (perm)	500	1897		174	1881			1562			1391	1615
Volume (vph)	28	1006	12	1	675	0	13	0	4	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	29	1048	12	1	734	0	29	0	9	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	7	0	0	0	21
Lane Group Flow (vph)	29	1059	0	1	734	0	0	31	0	0	3	8
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	43.7	43.7		43.7	43.7			18.1			18.1	18.1
Effective Green, g (s)	43.7	43.7		43.7	43.7			18.1			18.1	18.1
Actuated g/C Ratio	0.63	0.63		0.63	0.63			0.26			0.26	0.26
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	313	1188		109	1178			405			361	419
v/s Ratio Prot		c0.56			0.39							
v/s Ratio Perm	0.06			0.01				c0.02			0.00	0.02
v/c Ratio	0.09	0.89		0.01	0.62			0.08			0.01	0.02
Uniform Delay, d1	5.2	11.0		4.9	8.0			19.5			19.2	19.2
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	8.7		0.0	1.0			0.4			0.0	0.1
Delay (s)	5.3	19.8		4.9	9.0			19.9			19.2	19.3
Level of Service	A	B		A	A			B			B	B
Approach Delay (s)		19.4			9.0			19.9			19.3	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	69.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	626	316	30	342	218	55
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	673	340	35	402	283	71
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			673		1146	673
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			673		1146	673
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		0	84
cM capacity (veh/h)			927		214	459

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	673	340	35	402	283	71
Volume Left	0	0	35	0	283	0
Volume Right	0	340	0	0	0	71
cSH	1700	1700	927	1700	214	459
Volume to Capacity	0.40	0.20	0.04	0.24	1.32	0.16
Queue Length 95th (ft)	0	0	3	0	387	14
Control Delay (s)	0.0	0.0	9.0	0.0	218.4	14.3
Lane LOS			A		F	B
Approach Delay (s)	0.0		0.7		177.3	
Approach LOS					F	

Intersection Summary			
Average Delay	35.0		
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	21	434	360	3	6	33
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	27	556	375	3	8	45
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	378				987	377
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	378				987	377
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	93
cM capacity (veh/h)	1191				271	674

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	27	556	378	53
Volume Left	27	0	0	8
Volume Right	0	0	3	45
cSH	1191	1700	1700	797
Volume to Capacity	0.02	0.33	0.22	0.07
Queue Length 95th (ft)	2	0	0	5
Control Delay (s)	8.1	0.0	0.0	9.8
Lane LOS	A			A
Approach Delay (s)	0.4		0.0	9.8
Approach LOS				A

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	32.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	15	432	354	9	12	16
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	19	533	385	10	48	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	395				960	390
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	395				960	390
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				83	90
cM capacity (veh/h)	1175				283	663

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	552	395	112
Volume Left	19	0	48
Volume Right	0	10	64
cSH	1175	1700	420
Volume to Capacity	0.02	0.23	0.27
Queue Length 95th (ft)	1	0	27
Control Delay (s)	0.5	0.0	16.6
Lane LOS	A		C
Approach Delay (s)	0.5	0.0	16.6
Approach LOS			C

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	427	9	15	193	249	326
Peak Hour Factor	0.82	0.82	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	521	11	16	201	274	358

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	532	217	632
Volume Left (vph)	521	16	0
Volume Right (vph)	11	0	358
Hadj (s)	0.18	0.01	-0.33
Departure Headway (s)	6.5	6.9	6.0
Degree Utilization, x	0.95	0.42	1.05
Capacity (veh/h)	547	510	597
Control Delay (s)	52.9	14.8	73.3
Approach Delay (s)	52.9	14.8	73.3
Approach LOS	F	B	F

Intersection Summary			
Delay	56.3		
HCM Level of Service	F		
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	285	7	255	35	35	2	436	315	100	6	279	176
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Hourly flow rate (vph)	300	7	268	43	43	2	454	328	104	6	294	185

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	307	268	89	454	432	6	479
Volume Left (vph)	300	0	43	454	0	6	0
Volume Right (vph)	0	268	2	0	104	0	185
Hadj (s)	0.49	-0.70	0.08	0.52	-0.17	0.50	-0.26
Departure Headway (s)	8.6	7.5	9.6	8.3	7.6	8.8	8.1
Degree Utilization, x	0.74	0.56	0.24	1.05	0.92	0.02	1.08
Capacity (veh/h)	409	468	358	438	461	390	442
Control Delay (s)	31.2	18.3	15.5	85.3	50.2	10.8	91.6
Approach Delay (s)	25.2		15.5	68.2		90.6	
Approach LOS	D		C	F		F	

Intersection Summary			
Delay	59.1		
HCM Level of Service	F		
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		1.00		1.00	0.96		1.00	0.94	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1811	1615		1849		1787	1831		1805	1783	
Flt Permitted		0.95	1.00		0.98		0.14	1.00		0.51	1.00	
Satd. Flow (perm)		1811	1615		1849		254	1831		971	1783	
Volume (vph)	285	7	255	35	35	2	436	315	100	6	279	176
Peak-hour factor, PHF	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Adj. Flow (vph)	300	7	268	43	43	2	454	328	104	6	294	185
RTOR Reduction (vph)	0	0	155	0	1	0	0	10	0	0	22	0
Lane Group Flow (vph)	0	307	113	0	87	0	454	422	0	6	457	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		17.3	17.3		7.9		51.6	51.6		25.6	25.6	
Effective Green, g (s)		17.3	17.3		7.9		51.6	51.6		25.6	25.6	
Actuated g/C Ratio		0.19	0.19		0.09		0.58	0.58		0.29	0.29	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		353	315		164		527	1064		280	514	
v/s Ratio Prot		c0.17			c0.05		c0.21	0.24			0.27	
v/s Ratio Perm			0.17				c0.29			0.01		
v/c Ratio		0.87	0.36		0.53		0.86	0.40		0.02	0.89	
Uniform Delay, d1		34.7	31.0		38.7		22.4	10.1		22.6	30.2	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		19.8	0.7		3.3		13.5	0.2		0.0	16.9	
Delay (s)		54.4	31.7		42.0		35.9	10.4		22.7	47.2	
Level of Service		D	C		D		D	B		C	D	
Approach Delay (s)		43.8			42.0			23.5			46.9	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	35.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	88.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3530			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3530			1823			1805	1615
Volume (vph)	485	920	16	2	904	158	11	2	0	228	0	243
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	522	989	17	2	952	166	17	3	0	238	0	253
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	209
Lane Group Flow (vph)	522	989	9	2	1106	0	0	20	0	0	238	44
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1324			243			316	283
v/s Ratio Prot	c0.15	0.27		0.00	c0.32			c0.01			0.13	
v/s Ratio Perm			0.01									0.16
v/c Ratio	0.81	0.52	0.01	0.03	0.84			0.08			0.75	0.16
Uniform Delay, d1	47.0	18.6	13.6	56.1	34.1			45.6			47.0	42.0
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	10.8	1.0	0.0	1.0	6.4			0.7			15.3	1.2
Delay (s)	57.8	19.7	13.6	57.2	40.5			46.2			62.3	43.2
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		32.6			40.5			46.2			52.4	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1863	1863		1770	1615
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1863	1863		1770	1615
Volume (vph)	0	535	428	0	253	23
Peak-hour factor, PHF	0.96	0.96	0.84	0.85	0.81	0.85
Adj. Flow (vph)	0	557	510	0	312	27
RTOR Reduction (vph)	0	0	0	0	0	18
Lane Group Flow (vph)	0	557	510	0	312	9
Heavy Vehicles (%)	2%	2%	2%	1%	2%	0%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		16.4	16.4		12.0	12.0
Effective Green, g (s)		16.4	16.4		12.0	12.0
Actuated g/C Ratio		0.45	0.45		0.33	0.33
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		839	839		584	532
v/s Ratio Prot		c0.30	0.27		c0.18	
v/s Ratio Perm						0.02
v/c Ratio		0.66	0.61		0.53	0.02
Uniform Delay, d1		7.8	7.6		9.9	8.2
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		2.0	1.3		0.9	0.0
Delay (s)		9.8	8.8		10.9	8.2
Level of Service		A	A		B	A
Approach Delay (s)		9.8	8.8		10.7	
Approach LOS		A	A		B	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	36.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	106.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑			↑	↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1881			1881	1719	1583
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1881			1881	1719	1583
Volume (vph)	738	0	0	908	183	268
Peak-hour factor, PHF	0.92	0.92	0.82	0.86	0.92	0.92
Adj. Flow (vph)	802	0	0	1056	199	291
RTOR Reduction (vph)	0	0	0	0	0	185
Lane Group Flow (vph)	802	0	0	1056	199	106
Heavy Vehicles (%)	1%	3%	0%	1%	5%	2%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	46.7			46.7	21.0	21.0
Effective Green, g (s)	46.7			46.7	21.0	21.0
Actuated g/C Ratio	0.62			0.62	0.28	0.28
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	1160			1160	477	439
v/s Ratio Prot	0.43			c0.56	0.12	
v/s Ratio Perm						0.18
v/c Ratio	0.69			0.91	0.42	0.24
Uniform Delay, d1	9.7			12.7	22.3	21.2
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	1.8			10.7	2.7	1.3
Delay (s)	11.5			23.3	25.0	22.5
Level of Service	B			C	C	C
Approach Delay (s)	11.5			23.3	23.5	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	75.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	64.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3443		1805	3516		1736	3438	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3443		1805	3516		1736	3438	1599
Volume (vph)	160	361	361	242	653	231	216	315	66	153	633	312
Peak-hour factor, PHF	0.86	0.93	0.86	0.82	0.82	0.82	0.86	0.86	0.86	0.81	0.81	0.81
Adj. Flow (vph)	186	388	420	295	796	282	251	366	77	189	781	385
RTOR Reduction (vph)	0	0	299	0	36	0	0	18	0	0	0	101
Lane Group Flow (vph)	186	388	121	295	1042	0	251	425	0	189	781	284
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	4%	5%	1%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	6.0	22.0	28.7	20.0	36.0		17.0	28.7		13.3	25.0	25.0
Effective Green, g (s)	6.0	22.0	28.7	20.0	36.0		17.0	28.7		13.3	25.0	25.0
Actuated g/C Ratio	0.06	0.22	0.29	0.20	0.36		0.17	0.29		0.13	0.25	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	210	794	464	361	1239		307	1009		231	860	400
v/s Ratio Prot	0.05	0.11		c0.16	c0.31		0.14	0.13		0.11	0.23	
v/s Ratio Perm			0.26									0.24
v/c Ratio	0.89	0.49	0.26	0.82	0.84		0.82	0.42		0.82	0.91	0.71
Uniform Delay, d1	46.7	34.1	27.5	38.3	29.4		40.0	28.9		42.2	36.4	34.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	32.8	2.1	0.3	13.3	7.0		20.9	0.3		19.7	15.1	10.2
Delay (s)	79.4	36.2	27.8	51.6	36.4		60.9	29.2		61.8	51.5	44.4
Level of Service	E	D	C	D	D		E	C		E	D	D
Approach Delay (s)		40.7			39.6			40.7			50.9	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	43.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Frt	1.00	1.00		1.00	1.00	0.85		0.97				0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97				1.00
Satd. Flow (prot)	1805	1861		1805	1881	1615		1781				1615
Flt Permitted	0.06	1.00		0.31	1.00	1.00		0.83				1.00
Satd. Flow (perm)	121	1861		583	1881	1615		1530				1615
Volume (vph)	40	617	5	9	994	3	23	2	7	0	0	21
Peak-hour factor, PHF	0.96	0.96	0.96	0.76	0.76	0.76	0.43	0.43	0.43	0.53	0.53	0.53
Adj. Flow (vph)	42	643	5	12	1308	4	53	5	16	0	0	40
RTOR Reduction (vph)	0	0	0	0	0	0	0	10	0	0	0	28
Lane Group Flow (vph)	42	648	0	12	1308	4	0	64	0	0	0	12
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	63.0	63.0		63.0	63.0	63.0		29.0				29.0
Effective Green, g (s)	63.0	63.0		63.0	63.0	63.0		29.0				29.0
Actuated g/C Ratio	0.63	0.63		0.63	0.63	0.63		0.29				0.29
Clearance Time (s)	4.0	4.0		4.0	4.0	4.0		4.0				4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0		3.0				3.0
Lane Grp Cap (vph)	76	1172		367	1185	1017		444				468
v/s Ratio Prot		0.35			c0.70							
v/s Ratio Perm	0.35			0.02		0.00		c0.04				0.01
v/c Ratio	0.55	0.55		0.03	1.10	0.00		0.14				0.02
Uniform Delay, d1	10.5	10.5		7.0	18.5	6.9		26.3				25.4
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00				1.00
Incremental Delay, d2	8.4	0.6		0.0	59.4	0.0		0.7				0.1
Delay (s)	18.9	11.1		7.0	77.9	6.9		27.0				25.5
Level of Service	B	B		A	E	A		C				C
Approach Delay (s)		11.5			77.1			27.0			25.5	
Approach LOS		B			E			C			C	

Intersection Summary			
HCM Average Control Delay	53.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	339	240	59	463	199	12
Peak Hour Factor	0.88	0.88	0.89	0.89	0.81	0.81
Hourly flow rate (vph)	385	273	66	520	246	15
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			385		1038	385
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			385		1038	385
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		0	98
cM capacity (veh/h)			1184		243	667

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	385	273	66	520	246	15
Volume Left	0	0	66	0	246	0
Volume Right	0	273	0	0	0	15
cSH	1700	1700	1184	1700	243	667
Volume to Capacity	0.23	0.16	0.06	0.31	1.01	0.02
Queue Length 95th (ft)	0	0	4	0	245	2
Control Delay (s)	0.0	0.0	8.2	0.0	105.1	10.5
Lane LOS			A		F	B
Approach Delay (s)	0.0		0.9		99.7	
Approach LOS					F	

Intersection Summary			
Average Delay	17.6		
Intersection Capacity Utilization	42.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1863	1599	1805	1845	1787	1615
Flt Permitted	1.00	1.00	0.50	1.00	0.95	1.00
Satd. Flow (perm)	1863	1599	949	1845	1787	1615
Volume (vph)	339	240	59	463	199	12
Peak-hour factor, PHF	0.88	0.88	0.89	0.89	0.81	0.81
Adj. Flow (vph)	385	273	66	520	246	15
RTOR Reduction (vph)	0	151	0	0	0	10
Lane Group Flow (vph)	385	122	66	520	246	5
Heavy Vehicles (%)	2%	1%	0%	3%	1%	0%
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	14.8	14.8	14.8	14.8	10.2	10.2
Effective Green, g (s)	14.8	14.8	14.8	14.8	10.2	10.2
Actuated g/C Ratio	0.45	0.45	0.45	0.45	0.31	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	836	717	426	827	552	499
v/s Ratio Prot	0.21			c0.28	c0.14	
v/s Ratio Perm		0.17	0.07			0.01
v/c Ratio	0.46	0.17	0.15	0.63	0.45	0.01
Uniform Delay, d1	6.3	5.4	5.4	7.0	9.1	7.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.1	0.2	1.5	0.6	0.0
Delay (s)	6.7	5.5	5.6	8.5	9.7	7.9
Level of Service	A	A	A	A	A	A
Approach Delay (s)	6.2			8.2	9.6	
Approach LOS	A			A	A	

Intersection Summary			
HCM Average Control Delay	7.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	33.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	42.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	26	319	429	3	0	26
Peak Hour Factor	0.88	0.88	0.91	0.91	0.64	0.64
Hourly flow rate (vph)	30	362	471	3	0	41
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	475				895	473
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	475				895	473
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				100	93
cM capacity (veh/h)	1098				305	595

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	30	362	475	41
Volume Left	30	0	0	0
Volume Right	0	0	3	41
cSH	1098	1700	1700	446
Volume to Capacity	0.03	0.21	0.28	0.09
Queue Length 95th (ft)	2	0	0	7
Control Delay (s)	8.4	0.0	0.0	13.9
Lane LOS	A			B
Approach Delay (s)	0.6		0.0	13.9
Approach LOS				B

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	32.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	50	252	381	42	37	53
Peak Hour Factor	0.85	0.85	0.93	0.93	0.75	0.75
Hourly flow rate (vph)	59	296	410	45	49	71
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	455				846	432
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	455				846	432
tC, single (s)	4.1				7.1	6.5
tC, 2 stage (s)						
tF (s)	2.2				4.1	3.6
p0 queue free %	95				80	87
cM capacity (veh/h)	1117				246	563

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	355	455	120
Volume Left	59	0	49
Volume Right	0	45	71
cSH	1117	1700	368
Volume to Capacity	0.05	0.27	0.33
Queue Length 95th (ft)	4	0	35
Control Delay (s)	1.8	0.0	19.5
Lane LOS	A		C
Approach Delay (s)	1.8	0.0	19.5
Approach LOS			C

Intersection Summary			
Average Delay	3.2		
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	260	10	13	154	212	369
Peak Hour Factor	0.89	0.89	0.84	0.84	0.88	0.88
Hourly flow rate (vph)	292	11	15	183	241	419

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	303	199	660
Volume Left (vph)	292	15	0
Volume Right (vph)	11	0	419
Hadj (s)	0.24	0.03	-0.36
Departure Headway (s)	6.3	5.9	4.9
Degree Utilization, x	0.53	0.33	0.90
Capacity (veh/h)	552	583	724
Control Delay (s)	16.2	11.8	35.5
Approach Delay (s)	16.2	11.8	35.5
Approach LOS	C	B	E

Intersection Summary			
Delay	26.4		
HCM Level of Service	D		
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	101	1	394	24	5	4	194	179	15	4	290	224
Peak Hour Factor	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Hourly flow rate (vph)	107	1	419	34	7	6	228	211	18	5	349	270

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	109	419	46	228	228	5	619
Volume Left (vph)	107	0	34	228	0	5	0
Volume Right (vph)	0	419	6	0	18	0	270
Hadj (s)	0.51	-0.67	0.07	0.53	-0.02	0.50	-0.30
Departure Headway (s)	7.9	6.8	8.8	7.9	7.4	7.8	7.0
Degree Utilization, x	0.24	0.79	0.11	0.50	0.47	0.01	1.20
Capacity (veh/h)	446	522	382	437	478	443	517
Control Delay (s)	12.2	29.2	12.9	17.5	15.5	9.7	131.6
Approach Delay (s)	25.7		12.9	16.5		130.7	
Approach LOS	D		B	C		F	

Intersection Summary			
Delay	62.4		
HCM Level of Service	F		
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		0.98		1.00	0.99		1.00	0.93	
Flt Protected		0.95	1.00		0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583		1802		1770	1844		1805	1766	
Flt Permitted		0.95	1.00		0.97		0.16	1.00		0.62	1.00	
Satd. Flow (perm)		1793	1583		1802		302	1844		1170	1766	
Volume (vph)	101	1	394	24	5	4	194	179	15	4	290	224
Peak-hour factor, PHF	0.94	0.94	0.94	0.71	0.71	0.71	0.85	0.85	0.85	0.83	0.83	0.83
Adj. Flow (vph)	107	1	419	34	7	6	228	211	18	5	349	270
RTOR Reduction (vph)	0	0	353	0	6	0	0	3	0	0	26	0
Lane Group Flow (vph)	0	108	66	0	41	0	228	226	0	5	593	0
Heavy Vehicles (%)	1%	0%	2%	0%	0%	0%	2%	2%	0%	0%	1%	0%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		10.8	10.8		4.0		41.4	41.4		29.0	29.0	
Effective Green, g (s)		10.8	10.8		4.0		41.4	41.4		29.0	29.0	
Actuated g/C Ratio		0.16	0.16		0.06		0.61	0.61		0.43	0.43	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		284	251		106		364	1119		498	751	
v/s Ratio Prot		0.06			c0.03		c0.08	0.12			c0.35	
v/s Ratio Perm			0.26				0.30			0.00		
v/c Ratio		0.38	0.26		0.39		0.63	0.20		0.01	0.79	
Uniform Delay, d1		25.7	25.2		30.9		10.4	6.0		11.3	17.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.9	0.6		2.4		3.3	0.1		0.0	5.5	
Delay (s)		26.6	25.8		33.3		13.7	6.1		11.3	22.5	
Level of Service		C	C		C		B	A		B	C	
Approach Delay (s)		25.9			33.3			9.9			22.4	
Approach LOS		C			C			A			C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	68.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97			0.99			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (prot)	3502	3539	1615	1805	3465			1832			1792	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.97			0.95	1.00
Satd. Flow (perm)	3502	3539	1615	1805	3465			1832			1792	1615
Volume (vph)	427	714	1	7	1011	252	9	6	1	259	1	351
Peak-hour factor, PHF	0.89	0.89	0.89	0.81	0.90	0.81	0.57	0.57	0.57	0.86	0.86	0.86
Adj. Flow (vph)	480	802	1	9	1123	311	16	11	2	301	1	408
RTOR Reduction (vph)	0	0	0	0	21	0	0	2	0	0	0	319
Lane Group Flow (vph)	480	802	1	9	1413	0	0	27	0	0	302	89
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	17.0	63.0	63.0	4.0	50.0			16.0			21.0	21.0
Effective Green, g (s)	17.0	63.0	63.0	4.0	50.0			16.0			21.0	21.0
Actuated g/C Ratio	0.14	0.52	0.52	0.03	0.42			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	496	1858	848	60	1444			244			314	283
v/s Ratio Prot	c0.14	0.23		0.00	c0.41			c0.02			0.17	
v/s Ratio Perm			0.00									0.25
v/c Ratio	0.97	0.43	0.00	0.15	0.98			0.11			0.96	0.31
Uniform Delay, d1	51.2	17.5	13.5	56.3	34.5			45.7			49.1	43.2
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	33.2	0.7	0.0	5.2	19.1			0.9			41.9	2.9
Delay (s)	84.4	18.2	13.5	61.6	53.6			46.7			91.0	46.1
Level of Service	F	B	B	E	D			D			F	D
Approach Delay (s)		43.0			53.6			46.7			65.2	
Approach LOS		D			D			D			E	

Intersection Summary			
HCM Average Control Delay	52.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations		↑	↑		↰	↱
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0
Lane Util. Factor		1.00	1.00		1.00	1.00
Frt		1.00	1.00		1.00	0.85
Flt Protected		1.00	1.00		0.95	1.00
Satd. Flow (prot)		1900	1900		1805	1583
Flt Permitted		1.00	1.00		0.95	1.00
Satd. Flow (perm)		1900	1900		1805	1583
Volume (vph)	0	448	575	0	248	157
Peak-hour factor, PHF	0.89	0.87	0.89	0.88	0.87	0.82
Adj. Flow (vph)	0	515	646	0	285	191
RTOR Reduction (vph)	0	0	0	0	0	132
Lane Group Flow (vph)	0	515	646	0	285	59
Heavy Vehicles (%)	0%	0%	0%	0%	0%	2%
Turn Type						Perm
Protected Phases		4	8		6	
Permitted Phases						6
Actuated Green, G (s)		19.1	19.1		12.2	12.2
Effective Green, g (s)		19.1	19.1		12.2	12.2
Actuated g/C Ratio		0.49	0.49		0.31	0.31
Clearance Time (s)		4.0	4.0		4.0	4.0
Vehicle Extension (s)		3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		923	923		560	491
v/s Ratio Prot		0.27	c0.34		c0.16	
v/s Ratio Perm						0.12
v/c Ratio		0.56	0.70		0.51	0.12
Uniform Delay, d1		7.1	7.9		11.1	9.7
Progression Factor		1.00	1.00		1.00	1.00
Incremental Delay, d2		0.7	2.3		0.7	0.1
Delay (s)		7.9	10.2		11.8	9.8
Level of Service		A	B		B	A
Approach Delay (s)		7.9	10.2		11.0	
Approach LOS		A	B		B	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	39.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	102.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0			4.0	4.0	4.0
Lane Util. Factor	1.00			1.00	1.00	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	1.00			1.00	0.95	1.00
Satd. Flow (prot)	1900			1900	1805	1615
Flt Permitted	1.00			1.00	0.95	1.00
Satd. Flow (perm)	1900			1900	1805	1615
Volume (vph)	678	0	0	742	329	484
Peak-hour factor, PHF	0.91	0.85	0.93	0.93	0.94	0.94
Adj. Flow (vph)	745	0	0	798	350	515
RTOR Reduction (vph)	0	0	0	0	0	104
Lane Group Flow (vph)	745	0	0	798	350	411
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type						Perm
Protected Phases	4			8	2	
Permitted Phases						2
Actuated Green, G (s)	39.9			39.9	37.6	37.6
Effective Green, g (s)	39.9			39.9	37.6	37.6
Actuated g/C Ratio	0.47			0.47	0.44	0.44
Clearance Time (s)	4.0			4.0	4.0	4.0
Vehicle Extension (s)	3.0			3.0	3.0	3.0
Lane Grp Cap (vph)	887			887	794	710
v/s Ratio Prot	0.39			c0.42	0.19	
v/s Ratio Perm						0.32
v/c Ratio	0.84			0.90	0.44	0.58
Uniform Delay, d1	20.0			21.0	16.6	18.0
Progression Factor	1.00			1.00	1.00	1.00
Incremental Delay, d2	7.1			11.9	1.8	3.4
Delay (s)	27.1			32.8	18.4	21.4
Level of Service	C			C	B	C
Approach Delay (s)	27.1			32.8	20.2	
Approach LOS	C			C	C	

Intersection Summary			
HCM Average Control Delay	26.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	85.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	133.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3450		1805	3486		1805	3610	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3450		1805	3486		1805	3610	1615
Volume (vph)	376	528	164	91	509	153	192	485	144	217	305	288
Peak-hour factor, PHF	0.93	0.93	0.93	0.92	0.92	0.92	0.93	0.93	0.93	0.96	0.96	0.96
Adj. Flow (vph)	404	568	176	99	553	166	206	522	155	226	318	300
RTOR Reduction (vph)	0	0	132	0	28	0	0	27	0	0	0	194
Lane Group Flow (vph)	404	568	44	99	691	0	206	650	0	226	318	106
Heavy Vehicles (%)	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		custom	Prot			Prot			Prot		Perm
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases			4									8
Actuated Green, G (s)	14.5	35.0	25.0	8.3	28.8		20.0	25.0		16.0	21.0	21.0
Effective Green, g (s)	14.5	35.0	25.0	8.3	28.8		20.0	25.0		16.0	21.0	21.0
Actuated g/C Ratio	0.14	0.35	0.25	0.08	0.29		0.20	0.25		0.16	0.21	0.21
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	506	1260	403	149	991		360	869		288	756	338
v/s Ratio Prot	c0.12	0.16		0.05	c0.21		0.11	c0.19		c0.13	0.09	
v/s Ratio Perm			0.11									0.19
v/c Ratio	0.80	0.45	0.11	0.66	0.70		0.57	0.75		0.78	0.42	0.31
Uniform Delay, d1	41.5	25.2	29.1	44.6	31.9		36.3	34.7		40.5	34.4	33.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	8.6	1.2	0.1	10.6	4.1		6.5	3.6		13.1	1.7	2.4
Delay (s)	50.1	26.4	29.2	55.3	35.9		42.8	38.3		53.6	36.1	35.9
Level of Service	D	C	C	E	D		D	D		D	D	D
Approach Delay (s)		35.1			38.3			39.3			40.7	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	38.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	100.3	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Frt	1.00	1.00		1.00	1.00			0.97			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	1805	1897		1805	1881			1772			1805	1615
Flt Permitted	0.26	1.00		0.09	1.00			0.85			0.73	1.00
Satd. Flow (perm)	486	1897		170	1881			1561			1391	1615
Volume (vph)	28	1020	12	1	690	0	13	0	4	2	0	19
Peak-hour factor, PHF	0.96	0.96	0.96	0.92	0.92	0.92	0.45	0.45	0.45	0.66	0.66	0.66
Adj. Flow (vph)	29	1062	12	1	750	0	29	0	9	3	0	29
RTOR Reduction (vph)	0	1	0	0	0	0	0	7	0	0	0	22
Lane Group Flow (vph)	29	1073	0	1	750	0	0	31	0	0	3	7
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm			Perm		Perm	Perm			Perm		Perm
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		6
Actuated Green, G (s)	44.7	44.7		44.7	44.7			18.1			18.1	18.1
Effective Green, g (s)	44.7	44.7		44.7	44.7			18.1			18.1	18.1
Actuated g/C Ratio	0.63	0.63		0.63	0.63			0.26			0.26	0.26
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0			3.0	3.0
Lane Grp Cap (vph)	307	1198		107	1188			399			356	413
v/s Ratio Prot		c0.57			0.40							
v/s Ratio Perm	0.06			0.01				c0.02			0.00	0.02
v/c Ratio	0.09	0.90		0.01	0.63			0.08			0.01	0.02
Uniform Delay, d1	5.1	11.1		4.8	8.0			20.0			19.7	19.7
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	0.1	8.9		0.0	1.1			0.4			0.0	0.1
Delay (s)	5.3	20.0		4.9	9.1			20.4			19.7	19.8
Level of Service	A	C		A	A			C			B	B
Approach Delay (s)		19.6			9.1			20.4			19.8	
Approach LOS		B			A			C			B	

Intersection Summary			
HCM Average Control Delay	15.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Volume (veh/h)	640	316	30	357	218	55
Peak Hour Factor	0.93	0.93	0.85	0.85	0.77	0.77
Hourly flow rate (vph)	688	340	35	420	283	71
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			688		1179	688
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			688		1179	688
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		0	84
cM capacity (veh/h)			915		204	450

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NW 1	NW 2
Volume Total	688	340	35	420	283	71
Volume Left	0	0	35	0	283	0
Volume Right	0	340	0	0	0	71
cSH	1700	1700	915	1700	204	450
Volume to Capacity	0.40	0.20	0.04	0.25	1.39	0.16
Queue Length 95th (ft)	0	0	3	0	409	14
Control Delay (s)	0.0	0.0	9.1	0.0	245.3	14.5
Lane LOS			A		F	B
Approach Delay (s)	0.0		0.7		198.8	
Approach LOS					F	

Intersection Summary			
Average Delay	38.5		
Intersection Capacity Utilization	52.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NWL	NWR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1900	1615	1805	1900	1805	1615
Flt Permitted	1.00	1.00	0.24	1.00	0.95	1.00
Satd. Flow (perm)	1900	1615	464	1900	1805	1615
Volume (vph)	640	316	30	357	218	55
Peak-hour factor, PHF	0.93	0.93	0.85	0.85	0.77	0.77
Adj. Flow (vph)	688	340	35	420	283	71
RTOR Reduction (vph)	0	164	0	0	0	50
Lane Group Flow (vph)	688	176	35	420	283	21
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	22.0	22.0	22.0	22.0	12.5	12.5
Effective Green, g (s)	22.0	22.0	22.0	22.0	12.5	12.5
Actuated g/C Ratio	0.52	0.52	0.52	0.52	0.29	0.29
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	984	836	240	984	531	475
v/s Ratio Prot	c0.36			0.22	c0.16	
v/s Ratio Perm		0.21	0.08			0.04
v/c Ratio	0.70	0.21	0.15	0.43	0.53	0.04
Uniform Delay, d1	7.7	5.5	5.3	6.3	12.6	10.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.2	0.1	0.3	0.3	1.0	0.0
Delay (s)	9.9	5.7	5.6	6.6	13.6	10.8
Level of Service	A	A	A	A	B	B
Approach Delay (s)	8.5			6.6	13.0	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	42.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	21	448	375	3	6	33
Peak Hour Factor	0.78	0.78	0.96	0.96	0.73	0.73
Hourly flow rate (vph)	27	574	391	3	8	45
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	394				1020	392
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	394				1020	392
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				97	93
cM capacity (veh/h)	1176				258	661

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	27	574	394	53
Volume Left	27	0	0	8
Volume Right	0	0	3	45
cSH	1176	1700	1700	781
Volume to Capacity	0.02	0.34	0.23	0.07
Queue Length 95th (ft)	2	0	0	5
Control Delay (s)	8.1	0.0	0.0	9.9
Lane LOS	A			A
Approach Delay (s)	0.4		0.0	9.9
Approach LOS				A

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	33.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Volume (veh/h)	29	432	354	19	23	31
Peak Hour Factor	0.81	0.81	0.92	0.92	0.25	0.25
Hourly flow rate (vph)	36	533	385	21	92	124
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type					None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	405				1000	395
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	405				1000	395
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				65	81
cM capacity (veh/h)	1164				263	658

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	569	405	216
Volume Left	36	0	92
Volume Right	0	21	124
cSH	1164	1700	402
Volume to Capacity	0.03	0.24	0.54
Queue Length 95th (ft)	2	0	77
Control Delay (s)	0.9	0.0	23.9
Lane LOS	A		C
Approach Delay (s)	0.9	0.0	23.9
Approach LOS			C

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	427	10	16	193	249	334
Peak Hour Factor	0.82	0.82	0.96	0.96	0.91	0.91
Hourly flow rate (vph)	521	12	17	201	274	367

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total (vph)	533	218	641
Volume Left (vph)	521	17	0
Volume Right (vph)	12	0	367
Hadj (s)	0.18	0.02	-0.33
Departure Headway (s)	6.5	6.9	6.0
Degree Utilization, x	0.96	0.42	1.06
Capacity (veh/h)	547	510	597
Control Delay (s)	53.5	14.8	78.0
Approach Delay (s)	53.5	14.8	78.0
Approach LOS	F	B	F

Intersection Summary			
Delay	58.7		
HCM Level of Service	F		
Intersection Capacity Utilization	64.5%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	286	7	263	35	35	2	442	315	100	6	279	177
Peak Hour Factor	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Hourly flow rate (vph)	301	7	277	43	43	2	460	328	104	6	294	186

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total (vph)	308	277	89	460	432	6	480
Volume Left (vph)	301	0	43	460	0	6	0
Volume Right (vph)	0	277	2	0	104	0	186
Hadj (s)	0.49	-0.70	0.08	0.52	-0.17	0.50	-0.27
Departure Headway (s)	8.6	7.5	9.6	8.3	7.7	8.9	8.1
Degree Utilization, x	0.74	0.57	0.24	1.07	0.92	0.02	1.08
Capacity (veh/h)	410	468	358	439	460	389	442
Control Delay (s)	31.4	18.9	15.5	90.4	50.6	10.8	93.5
Approach Delay (s)	25.5		15.5	71.2		92.4	
Approach LOS	D		C	F		F	

Intersection Summary			
Delay	60.8		
HCM Level of Service	F		
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Frt		1.00	0.85		1.00		1.00	0.96		1.00	0.94	
Flt Protected		0.95	1.00		0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1811	1615		1849		1787	1831		1805	1783	
Flt Permitted		0.95	1.00		0.98		0.13	1.00		0.51	1.00	
Satd. Flow (perm)		1811	1615		1849		253	1831		971	1783	
Volume (vph)	286	7	263	35	35	2	442	315	100	6	279	177
Peak-hour factor, PHF	0.95	0.95	0.95	0.81	0.81	0.81	0.96	0.96	0.96	0.95	0.95	0.95
Adj. Flow (vph)	301	7	277	43	43	2	460	328	104	6	294	186
RTOR Reduction (vph)	0	0	159	0	1	0	0	10	0	0	23	0
Lane Group Flow (vph)	0	308	118	0	87	0	460	422	0	6	457	0
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Turn Type	Split		Perm	Split			pm+pt			Perm		
Protected Phases	4	4		8	8		5	2			6	
Permitted Phases			4				2			6		
Actuated Green, G (s)		17.3	17.3		8.0		52.2	52.2		25.7	25.7	
Effective Green, g (s)		17.3	17.3		8.0		52.2	52.2		25.7	25.7	
Actuated g/C Ratio		0.19	0.19		0.09		0.58	0.58		0.29	0.29	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0	3.0		3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		350	312		165		533	1068		279	512	
v/s Ratio Prot		0.17			c0.05		c0.22	0.24			0.27	
v/s Ratio Perm			0.17				c0.29			0.01		
v/c Ratio		0.88	0.38		0.53		0.86	0.39		0.02	0.89	
Uniform Delay, d1		35.1	31.4		38.9		22.6	10.1		22.9	30.6	
Progression Factor		1.00	1.00		1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		21.7	0.8		3.0		13.5	0.2		0.0	17.7	
Delay (s)		56.8	32.2		42.0		36.2	10.3		22.9	48.3	
Level of Service		E	C		D		D	B		C	D	
Approach Delay (s)		45.2			42.0			23.7			47.9	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	36.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	89.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95			1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98			1.00			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (prot)	3502	3610	1615	1805	3530			1823			1805	1615
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.96			0.95	1.00
Satd. Flow (perm)	3502	3610	1615	1805	3530			1823			1805	1615
Volume (vph)	486	920	16	2	904	158	11	2	0	228	0	244
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.65	0.65	0.65	0.96	0.96	0.96
Adj. Flow (vph)	523	989	17	2	952	166	17	3	0	238	0	254
RTOR Reduction (vph)	0	0	8	0	12	0	0	0	0	0	0	210
Lane Group Flow (vph)	523	989	9	2	1106	0	0	20	0	0	238	44
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Split			Split		Perm
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases			2									8
Actuated Green, G (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Effective Green, g (s)	22.0	63.0	63.0	4.0	45.0			16.0			21.0	21.0
Actuated g/C Ratio	0.18	0.52	0.52	0.03	0.38			0.13			0.18	0.18
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0			4.0			4.0	4.0
Lane Grp Cap (vph)	642	1895	848	60	1324			243			316	283
v/s Ratio Prot	c0.15	0.27		0.00	c0.32			c0.01			0.13	
v/s Ratio Perm			0.01									0.16
v/c Ratio	0.81	0.52	0.01	0.03	0.84			0.08			0.75	0.16
Uniform Delay, d1	47.0	18.6	13.6	56.1	34.1			45.6			47.0	42.0
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	1.00
Incremental Delay, d2	10.9	1.0	0.0	1.0	6.4			0.7			15.3	1.2
Delay (s)	57.9	19.7	13.6	57.2	40.5			46.2			62.3	43.2
Level of Service	E	B	B	E	D			D			E	D
Approach Delay (s)		32.7			40.5			46.2			52.4	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

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APPENDIX G

2013 Air Quality GHG

Mark West Quarry Off-Road Equipment & On-Site Vehicle Exhaust Emissions
Quarry Operation at Baseline Production Rate - 2013

Analysis Year = 2013 **250 = Annual Days of Operation**

	Equipment Type	No. Units	Engine Age (years)	Engine Model Year	Daily Hours In Use	Days Per Year	Unit Annual Hours Use	Use Factor	Load Factor	Cumulative Hours Operation Per Unit	Engine (hp)	Fuel Type	Level of VDECS Used
Off-Road Equipment													
	Drill Rig	1	11	2002	3.0	50	150	1.00	0.50	1,650	240	ULSD	0
	Loader - Cat 988G	1	10	2003	7.0	180	1260	1.00	0.36	12,600	475	ULSD	0
	Loader - Cat 972G	1	10	2003	4.0	150	600	1.00	0.36	6,000	280	ULSD	0
	Loader - Cat 972H	1	6	2007	7.0	245	1715	1.00	0.36	10,290	287	ULSD	0
	Loader - Cat 972H	1	4	2009	7.0	43	301	1.00	0.36	1,204	287	ULSD	0
	Loader - Cat 988H	1	5	2008	6.0	120	720	1.00	0.36	3,600	500	ULSD	0
	Skid Steer loader - Cat 279	1	4	2009	3.0	114	342	1.00	0.37	1,368	82	ULSD	0
	Excavator - Cat 325CL	1	11	2002	4.0	120	480	1.00	0.38	5,280	188	ULSD	0
	Backhoe - Cat 416C	1	16	1997	2.0	115	230	1.00	0.37	3,680	81	ULSD	0
	Bulldozer - Cat D10T	1	8	2005	4.0	78	312	1.00	0.43	2,496	579	ULSD	0
	Compactor - Cat 825	1	17	1996	6.5	120	780	1.00	0.43	13,260	315	ULSD	0
	Man lift - Simpson MP60	1	18	1995	1.0	50	50	1.00	0.31	900	60	ULSD	0
	Portable Screen - John De	1	6	2007	4.0	90	360	1.00	0.40	2,160	125	ULSD	0
	Street Sweeper - Tymco 43	1	2	2009	2.0	150	300	1.00	0.46	1,200	56	ULSD	0
	Subtotal												
On-Road Vehicles		**No. Trucks**			**Hours/ Day**	**Days/ Year**	**Annual Hours per Truck**		**Speed (mph)**	**Travel Miles per Day**			
14	Water Truck	1	-	-	1.25	150	187.5	-	10	13	-	ULSD	-
15	Haul Truck - Cat 740 EJ	1	-	-	4	120	480	-	10	40	-	ULSD	-
16	Service Trucks	4	-	-	0.5	250	125	-	15	8	-	ULSD	-
	Subtotal	6											
	TOTAL	-			-	-	-	-	-	-	-	-	

Equipment Type	NOx	CO	ROG	PM10	PM2.5	SO2	CO2
Emission Factor (g/hp-hr)							
Drill Rig	6.15	0.96	0.34	0.13	0.12	0.006	562.6
Loader - Cat 988G	4.73	1.14	0.40	0.14	0.14	0.006	562.6
Loader - Cat 972G	4.40	1.03	0.26	0.12	0.11	0.006	562.6
Loader - Cat 972H	2.63	1.11	0.36	0.13	0.13	0.006	562.6
Loader - Cat 972H	2.36	0.94	0.13	0.09	0.09	0.006	562.6
Loader - Cat 988H	2.43	0.99	0.19	0.10	0.10	0.006	562.6
Skid Steer loader - Cat 279	2.79	3.16	0.13	0.17	0.16	0.007	562.6
Excavator - Cat 325CL	6.65	1.05	0.40	0.15	0.14	0.006	562.6
Backhoe - Cat 416C	8.83	3.83	1.16	0.63	0.59	0.007	562.6
Bulldozer - Cat D10T	4.20	0.97	0.18	0.10	0.09	0.006	562.6
Compactor - Cat 825	7.11	1.14	0.45	0.20	0.19	0.006	562.6
Man lift - Simpson MP60	8.31	3.57	1.03	0.53	0.49	0.007	562.6
Portable Screen - John De	2.39	3.22	0.15	0.17	0.16	0.007	562.6
Street Sweeper - Tymco 43	2.78	3.15	0.13	0.17	0.16	0.007	562.6
Subtotal							
Emission Factors (g/mi)	**NOx**	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**
Water Truck	22.92	6.877	3.323	0.644	0.592	0.017	3293.0
Haul Truck - Cat 740 EJ	22.92	6.877	3.323	0.644	0.592	0.017	3293.0
Service Trucks	5.060	1.821	0.332	0.078	0.072	0.005	518.9
Subtotal							
TOTAL	-	-	-	-			

Equipment Type	NOx	CO	ROG	PM10	PM2.5	SO2	CO2
Average Daily Emissions (lb/day)							
Drill Rig	1.0	0.2	0.1	0.02	0.02	0.001	89
Loader - Cat 988G	9.0	2.2	0.8	0.27	0.26	0.011	1069
Loader - Cat 972G	2.3	0.5	0.1	0.06	0.06	0.003	300
Loader - Cat 972H	4.1	1.7	0.6	0.21	0.20	0.009	879
Loader - Cat 972H	0.6	0.3	0.0	0.03	0.02	0.002	154
Loader - Cat 988H	2.8	1.1	0.2	0.12	0.11	0.006	643
Skid Steer loader - Cat 279	0.3	0.3	0.0	0.02	0.01	0.001	51
Excavator - Cat 325CL	2.0	0.3	0.1	0.05	0.04	0.002	170
Backhoe - Cat 416C	0.5	0.2	0.1	0.04	0.04	0.000	34
Bulldozer - Cat D10T	2.9	0.7	0.1	0.07	0.06	0.004	385
Compactor - Cat 825	6.6	1.1	0.4	0.18	0.17	0.005	524
Man lift - Simpson MP60	0.1	0.0	0.0	0.00	0.00	0.000	5
Portable Screen - John De	0.4	0.5	0.0	0.03	0.03	0.001	89
Street Sweeper - Tymco 43	0.2	0.2	0.0	0.01	0.01	0.000	38
Subtotal	***32.8***	***9.3***	***2.6***	***1.1***	***1.0***	***0.0***	***4432***
	NOx	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**
Water Truck	0.38	0.11	0.05	0.01	0.01	0.000	54
Haul Truck - Cat 740 EJ	0.97	0.29	0.14	0.03	0.03	0.001	139
Service Trucks	0.33	0.12	0.02	0.01	0.00	0.000	34
Subtotal	***1.68***	***0.53***	***0.22***	***0.04***	***0.04***	***0.001***	***228***
TOTAL	**34.5**	**9.8**	**2.8**	**1.1**	**1.08**	**0.05**	**4,661**

Equipment Type	NOx	CO	ROG	PM10	PM2.5	SO2	CO2
Annual Emissions (ton/yr)							
Drill Rig	0.12	0.019	0.007	0.003	0.002	0.000	11
Loader - Cat 988G	1.12	0.270	0.096	0.034	0.032	0.001	134
Loader - Cat 972G	0.29	0.069	0.017	0.008	0.007	0.000	38
Loader - Cat 972H	0.51	0.216	0.070	0.026	0.025	0.001	110
Loader - Cat 972H	0.08	0.032	0.004	0.003	0.003	0.000	19
Loader - Cat 988H	0.35	0.141	0.027	0.015	0.014	0.001	80
Skid Steer loader - Cat 279	0.03	0.036	0.002	0.002	0.002	0.000	6
Excavator - Cat 325CL	0.25	0.040	0.015	0.006	0.005	0.000	21
Backhoe - Cat 416C	0.07	0.029	0.009	0.005	0.004	0.000	4
Bulldozer - Cat D10T	0.36	0.083	0.015	0.009	0.008	0.000	48
Compactor - Cat 825	0.83	0.133	0.053	0.023	0.022	0.001	66
Man lift - Simpson MP60	0.01	0.004	0.001	0.001	0.001	0.000	1
Portable Screen - John De	0.05	0.064	0.003	0.003	0.003	0.000	11
Street Sweeper - Tymco 43	0.02	0.027	0.001	0.001	0.001	0.000	5
Subtotal	***4.1***	***1.2***	***0.3***	***0.14***	***0.13***	***0.006***	***554***
	NOx	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**
Water Truck	0.05	0.01	0.01	0.00	0.001	0.000	7
Haul Truck - Cat 740 EJ	0.12	0.04	0.02	0.00	0.003	0.000	17
Service Trucks	0.04	0.02	0.00	0.00	0.001	0.000	4
Subtotal	***0.21***	***0.07***	***0.027***	***0.005***	***0.005***	***0.000***	***29***
TOTAL	**4.3**	**1.2**	**0.3**	**0.14**	**0.14**	**0.01**	**583**

Notes On-Road vehicle emission factors from EMFAC2011 for Sonoma Co.

Emission Factors - Off-Road Compression Ignited Engines

	NOx			CO			ROG			PM10			PM2.5			CO2			SO2
EF ID	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**ZH EF (g/hp-hr)**	**DR (g/hp-hr^2)**	**Fuel CF**	**(g/hp-hr)**
ULSD2502002	6.25	1.45E-04	0.95	0.92	2.43E-05	1.00	0.32	1.48E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002003	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002003	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002007	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002009	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002008	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD1202009	2.89	3.80E-05	0.95	3.05	8.10E-05	1.00	0.10	2.50E-05	1.00	0.20	8.58E-06	0.80	0.18	8.58E-06	0.80	568.30	0.00E+00	0.99	0.007
ULSD2502002	6.25	1.45E-04	0.95	0.92	2.43E-05	1.00	0.32	1.48E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD1201997	8.75	2.02E-04	0.93	3.49	9.23E-05	1.00	0.99	4.58E-05	1.00	0.69	5.02E-05	0.72	0.63	5.02E-05	0.72	568.30	0.00E+00	0.99	0.007
ULSD7502005	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5001996	6.25	1.04E-04	0.95	0.92	1.82E-05	1.00	0.32	1.12E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD1201995	8.75	2.02E-04	0.93	3.49	9.23E-05	1.00	0.99	4.58E-05	1.00	0.69	5.02E-05	0.72	0.63	5.02E-05	0.72	568.30	0.00E+00	0.99	0.007
ULSD1752007	2.45	3.20E-05	0.95	2.70	7.14E-05	1.00	0.10	2.50E-05	1.00	0.14	1.00E-05	0.80	0.13	1.00E-05	0.80	568.30	0.00E+00	0.99	0.006
ULSD1202009	2.89	3.80E-05	0.95	3.05	8.10E-05	1.00	0.10	2.50E-05	1.00	0.20	8.58E-06	0.80	0.18	8.58E-06	0.80	568.30	0.00E+00	0.99	0.007

Notes: ZH EF Zero hour emission factor
DR Deterioration rate
ULSD Ultra low sulfur diesel (15 ppmw su fur, 0.0015% sulfur)

Refs: CARB OFFFROAD2007 model (http //www.arb.ca.gov/msei/offroad/offroad.htm), December, 2006.
Stationary/Off-road engines ARB, "California's Emissions Inventory for Off-Road Large Compression-Ignited (CI) Engines (> 25 HP)" MAC#99-32

Mark West Quarry Off-Road Equipment & On-Site Vehicle Exhaust Emissions
Quarry Operation at Baseline Production Rate - 2013
Greenhouse Gases

	N2O	CH4
EF (kg/gal)	0.00026	0.00058
GWP	296	23

		N2O	CH4	MT CO2e/year			
(gal/hr)	(gal/yr)	(kg/yr)	(kg/yr)	CO2	N2O	CH4	Total
8.1	1,209	0.3	0.7	10.1	0.09	0.02	10
10.0	12,620	3.3	7.3	121.2	0.97	0.17	122
5.9	3,542	0.9	2.1	34.0	0.27	0.05	34
6.1	10,378	2.7	6.0	99.7	0.80	0.14	101
6.1	1,822	0.5	1.1	17.5	0.14	0.02	18
10.5	7,591	2.0	4.4	72.9	0.58	0.10	74
2.1	726	0.2	0.4	5.8	0.06	0.01	6
4.8	2,302	0.6	1.3	19.3	0.18	0.03	20
2.1	483	0.1	0.3	3.9	0.04	0.01	4
14.9	4,661	1.2	2.7	43.7	0.36	0.06	44
7.9	6,188	1.6	3.6	59.4	0.48	0.08	60
1.3	65	0.0	0.0	0.5	0.01	0.00	1
3.4	1,209	0.3	0.7	10.1	0.09	0.02	10
1.8	541	0.1	0.3	4.3	0.04	0.01	4
85.0	53,336	13.9	30.9	**502.6**	**4.1**	**0.7**	**507**
		negligible	negligible	6.2	-	-	6
		negligible	negligible	15.8	-	-	16
		negligible	negligible	3.9	-	-	4
				25.9			***26***
			Total	**528.5**	**4.1**	**0.7**	**533**

Table 1
Mark West Quarry
PM10 and PM2.5 Emissions From Quarry Processing Operations
Baseline Production

Quarry Production Rate Information

Annual Process Rate (yd^3/yr) =	305,000	
Annual Process Rate (ton/yr) =	457,500	
Max Hourly process rate (ton/hr) =	450	
Average Hourly process rate (ton/hr) =	416	
Max Daily Process Rate (ton/day)	2,700	
Average Daily Process Rate (ton/day)	1,872	
Days to Process Annual Amount =	244	(at average daily production level)
Days to Process Annual Amount =	169	(at max daily production level)
Average Hours per day Processing (hrs) =	4 5	(at average daily production level)
Maximum Hours per day Processing (hrs) =	6	(at max daily production level)

Quarry Processing Equipment Emissions - Baseline Conditions												
		Process	**Number**	**Daily**	**Emission**	**PM10 Emissions**			**Emission**	**PM2.5 Emissions**		
	Percent	**Rate**	**of**	**Operation**	**Factor**	**Hourly**	**Daily**	**Annual**	**Factor**	**Hourly**	**Daily**	**Annual**
Equipment Type	**of Input**	**(ton/hr)**	**Transfers**	**(hours)**	**(lb/ton)**	**(lb/hr)**	**(lb/day)**	**(ton/yr)**	**(lb/ton)**	**(lb/hr)**	**(lb/day)**	**(ton/yr)**
Processing Plant												
Feed Hopper	100%	416	1	4 5	0 000016	0 007	0 03	0 004	0 000003	0 001	0 006	0 0007
Primary Jaw Crusher (CR1)	60%	250	1	4 5	0 00054	0 135	0 61	0 074	0 00010	0 025	0 112	0 0095
Conveyor to Stacking Conveyor	100%	416	1	4 5	0 00110	0 458	2 06	0 252	0 000311	0 129	0 582	0 0493
Stacking Conveyor /Loadout - Surge Pile	100%	416	2	4 5	0 00061	0 5065	2 28	0 278	0 000164	0 137	0 615	0 0521
Belt Feeder (2) - Surge Pile Reclaim	100%	416	2	4 5	0 000046	0 038	0 17	0 021	0 000013	0 011	0 049	0 0041
Conveyor - Surge Pile to Screen 1	100%	416	1	4 5	0 00110	0 458	2 06	0 252	0 000311	0 129	0 582	0 0493
Screen 1 - Primary Screen	100%	416	1	4 5	0 00074	0 308	1 39	0 169	0 00005	0 021	0 094	0 0079
Conveyor 1 to Base/Subbase Radial Stacker	15%	62	1	4 5	0 00110	0 069	0 31	0 038	0 000311	0 019	0 087	0 0074
Conveyor 2 to Base/Subbase Radial Stacker	35%	146	1	4 5	0 00110	0 160	0 72	0 088	0 000311	0 045	0 204	0 0173
Radial Stacker/Loadout - Base/Subbase Pile	50%	208	2	4 5	0 00061	0 2532	1 14	0 139	0 000164	0 068	0 308	0 0261
Conveyor to Drain Rock Stacker	2%	8	1	4 5	0 00110	0 009	0 04	0 005	0 000311	0 003	0 012	0 0010
Stacking Conveyor /Loadout - Drain Rock Pile	2%	8	2	4 5	0 00061	0 0101	0 05	0 006	0 000164	0 003	0 012	0 0010
Conveyor to Cone Crusher	40%	166	1	4 5	0 00110	0 183	0 82	0 101	0 000311	0 052	0 233	0 0197
Cone Crusher (CR2)	40%	166	1	4 5	0 00054	0 090	0 40	0 049	0 00010	0 017	0 075	0 0063
Conveyor to Vertical Impact Crusher	29%	121	1	4 5	0 00110	0 133	0 60	0 073	0 000311	0 038	0 169	0 0143
Vertical Impact Crusher (CR3)	29%	121	1	4 5	0 00120	0 145	0 65	0 080	0 00007	0 008	0 038	0 0032
Conveyor - From Crushers to Screen 2	69%	287	1	4 5	0 00110	0 316	1 42	0 174	0 000311	0 089	0 402	0 0340
Screen 2	69%	287	1	4 5	0 00074	0 212	0 96	0 117	0 00005	0 014	0 065	0 0055
Conveyor to 3/4" Drain Rock Stacker	3 5%	15	1	4 5	0 00110	0 016	0 07	0 009	0 000311	0 005	0 020	0 0017
Stacking Conveyor /Loadout - 3/4" Drain Rock Pile	3 5%	15	2	4 5	0 00061	0 0177	0 08	0 010	0 000164	0 005	0 022	0 0018
Screen 3	60%	250	1	4 5	0 00074	0 185	0 83	0 102	0 00005	0 012	0 056	0 0048
Radial Stacker/Loadout - Fines/Sand Plant	31%	129	2	4 5	0 00061	0 1570	0 71	0 086	0 000164	0 042	0 191	0 0162
Screen 4 (dry) - Wash Plant	12%	59	1	4 5	0 00220	0 130	0 59	0 072	0 000050	0 003	0 013	0 0011
Conveyor to 5/8" Chips Stacker	11 5%	48	1	4 5	0 00110	0 053	0 24	0 029	0 000311	0 015	0 067	0 0057
Stacking Conveyor /Loadout - 5/8" Chips Pile	11 5%	48	2	4 5	0 00061	0 0582	0 26	0 032	0 000164	0 016	0 071	0 0060
Conveyor to 3/8" Chips Stacker	13%	54	1	4 5	0 00110	0 059	0 27	0 033	0 000311	0 017	0 076	0 0064
Stacking Conveyor /Loadout - 3/8" Chips Pile	13%	54	2	4 5	0 00061	0 0658	0 30	0 036	0 000164	0 018	0 080	0 0068
Other Internal System Conveyors (11)	15%	62	11	4 5	0 00110	0 755	3 40	0 415	0 000311	0 213	0 960	0 0814
Total Quarry Processing Equipment						***5.0***	***22.44***	***2.74***		***1.16***	***5.20***	***0.44***

Table 2
Mark West Quarry
PM10 and PM2.5 From Quarry Fugitive Emission Sources
Baseline Production

Quarry Excavation/Processing Fugitive Emission Sources - Proposed Operations	**Operation**						**Emission Factors**			**PM10 Emissions**			**PM2.5 Emissions**		
	Process Rate	**Process Rate Units**	**No. of Equip.**	**Total Daily Hours (hours/day)**	**Days per Year**	**Total Annual Hours (hours/yr)**	**PM10 Emission Factor**	**PM2.5 Emission Factor**	**Emission Factor Units**	**Ave Hourly (lb/hr)**	**Ave Daily (lb/day)**	**Annual Average (ton/yr)**	**Ave Hourly (lb/hr)**	**Ave Daily (lb/day)**	**Annual Average (ton/yr)**
Loader Travel - Cat 988s															
Quarry Area	7 4	mile/day	1	6	120	720	0 50	0 05	lb/VMT	0 61	3 68	0 22	0 06	0 37	0 02
Feed Hopper Area	8 9	mile/day	1	6 5	180	1170	0 50	0 05	lb/VMT	0 68	4 42	0 40	0 07	0 44	0 04
Loader Travel - Cat 972s															
Quarry Area	9 8	mile/day	2	6	150	900	0 38	0 04	lb/VMT	0 62	3 72	0 28	0 06	0 37	0 03
Truck Loading Areas/Pile Maintenance	3 9	mile/day	1	7	245	1715	0 38	0 04	lb/VMT	0 21	1 49	0 18	0 02	0 15	0 02
Bulldozing	-	-	1	4	78	312	0 56	0 37	lb/hr	0 56	2 24	0 09	0 37	1 48	0 06
Excavator	208	ton/hr	1	4	120	480	0 0004	0 00006	lb/ton	0 08	0 33	0 02	0 01	0 05	0 003
Backhoe	130	ton/hr	1	2	115	230	0 0004	0 00006	lb/ton	0 05	0 10	0 01	0 01	0 02	0 001
Truck Loading (via loader)	416	ton/hr	1	5	244	1100	0 0004	0 00006	lb/ton	0 16	0 73	0 09	0 02	0 11	0 014
Off Road Haul Truck Unpaved Travel - Quarry	13 13	mile/day	1	3	120	360	0 483	0 048	lb/VMT	2 12	6 35	0 38	0 21	0 63	0 04
Service Truck Unpaved Travel - Daily	15	mile/day	3	0 5	200	300	0 36	0 036	lb/VMT	10 71	5 36	-	1 07	0 54	-
Service Truck Unpaved Travel - Annual	3,000	mile/yr	3	0 5	200	300	0 29	0 029	lb/VMT	-	-	0 43	-	-	0 04
Haul Trucks On-site Paved Road Travel - Daily	27 4	mile/day	83	9 5	-	-	0 078	0 096	lb/VMT	0 22	2 13	-	0 28	2 62	-
Haul Trucks On-site Paved Road Travel - Annual	7,221	mile/yr	21,786	-	-	-	0 074	0 091	lb/VMT	-	-	0 27	-	-	0 33
Total Excavation/Processing Fugitives										***16.0***	***30.5***	***2.36***	***2.2***	***6.77***	***0.59***
Total Processing and Fugitives										**21.0**	**53.0**	**5.1**	**3.3**	**12.0**	**1.0**

Mark West Quarry

Emissions Factors Used For Quarry Processing and Fugitive PM10 & PM2.5 Emissions

	PM10 Emission Factors			PM2.5 Emission Factors				
Emission Source	**Uncontrolled**	**% Control**	**Controlled**	**Uncontrolled**	**Fraction of PM10**	**Controlled**	**Units**	**Reference**
Feed Hopper	0 000016	0%	0 000016	0 00000	0 20	0 000003	lb/ton	8/04AP-42 Section 11 19 2 (Crushed Stone Processing) - uncontrolled
Primary Crushing	-	-	0 00054	-	-	0 00010	lb/ton	8/04 AP-42 Section 11 19 2 (Crushed Stone Processing) - tertiary crushing (estimate for primary crusher)
Secondary Crushing	-	-	0 00054	-	-	0 00010	lb/ton	8/04 AP-42 Section 11 19 2 (Crushed Stone Processing) - tertiary crushing (estimate for secondary crusher)
Fines Crushing	0 015	-	0 0012	-	-	0 00007	lb/ton	8/04AP-42 Section 11 19 2 (Crushed Stone Processing) - Fines Crushing
Screening	0 0087	-	0 00074	-	-	0 00005	lb/ton	8/04AP-42 Section 11 19 2 (Crushed Stone Processing) - Screening
Fines Screening	0 072	-	0 0022	-	-	0 00005	lb/ton	8/04AP-42 Section 11 19 2 (Crushed Stone Processing) - Fines screening
Conveyor Transfer Points	0 0011	-	0 000046	0 00031	-	0 000013	lb/ton	8/04 AP-42 Section 11 19 2 (Crushed Stone Processing) - Conveyor transfer point
Loading/stockpiling*	0 0004	70%	0 00012	0 00006	0 15	0 000018	lb/ton	11/06 AP-42 Section 13 2 4 (Aggregate handling and Storage Piles) - Material drop operations
Avg of Conveyor Transfer + Stockpiling	-		0 00061	-	-	0 000164	lb/ton	uncontrolled drop to conveyor & controlled loadout
Haul Truck Quarry Unpaved Travel (daily)*	2 77	70%	0 831	0 277	-	0 083	lb/VMT	AP-42 Unpaved Roads
Haul Truck Quarry Unpaved Travel (Annual)*	2 22	70%	0 665	0 222	-	0 066	lb/VMT	AP-42 Unpaved Roads
Service Trucks Quarry Unpaved Travel (daily)*	1 19	70%	0 357	0 119		0 036	lb/VMT	AP-42 Unpaved Roads
Service Trucks Quarry Unpaved Travel (annual)*	0 95	70%	0 286	0 095		0 029	lb/VMT	AP-42 Unpaved Roads
Haul Truck Quarry Paved Travel (daily)**	0 39	80%	0 078	0 096	-	0 096		AP-42 Paved Roads, Section 13 2 1, 1/2001
Haul Truck Quarry Paved Travel (Annual)**	0 37	80%	0 074	0 091	-	0 091		AP-42 Paved Roads, Section 13 2 1, 1/2001
Bulldozing (lb/hr)	0 56	0%	0 56	0 37	-	0 37		AP-42 Western Surface Coal mining (overburden dozing)

Note: * Controlled emission factor assumes 70% control effectiveness for watering and reduced speed

** Controlled emission factor assumes 80% control effectiveness for use of SCAQMD PM10 street sweeper

On-Site Equipment Unpavved Road Emission Factors

Equipment Type	Average Weight (tons)	Silt Content (%)	PM10 Uncontrolled Factor (lb/VMT)	PM10 Controlled Factor (lb/VMT)	PM2.5 Uncontrolled Factor (lb/VMT)	PM2.5 Controlled Factor (lb/VMT)
Cat 972 Loaders	32 5	3	1 26	0 38	0 13	0 04
Cat 988 Loaders	60 3	3	1 66	0 50	0 17	0 05
Off Road Haul Truck- Cat 740EJ	56 3	3	1 61	0 48	0 16	0 05

Note: * Controlled emission factor assumes 70% control effectiveness for watering and reduced speed

Vehicle/Process/Emission Factor Information		
Loader Capacity - 972 Loaders	6	cubic yards
Loader Capacity - 988 Loaders	8	cubic yards
On-site truck haul distance (access road) =	1,750	feet
Service Trucks Average Weight =	3 8	tons
Haul Truck Capacity (tons) =	21	per truck
Average Haul Truck Wt (load & no load)	25	tons
Ave No Trucks per day (baseline) =	83	trucks/day
Annual No Trucks (baseline) =	21,786	trucks/year
Ave No Trucks per day (proposed) =	135	trucks/day
Annual No Trucks - aggregate (proposed) =	35,714	trucks/year
Average wind speed (mph)	4 7	NWS Station, Santa Rosa, Ca
No days with precip > 0 01 inch	73	NWS Station, Santa Rosa, Ca
Material Moisture content (%) =	4	Applicant
Access Road Silt Loading (g/m2) =	8 2	AP-42 sL value for paved quarry road
Unpaved Road Silt Content (%)	8 3	AP-42
Material Silt Content (%) =	3	Assumed

Mark West Quarry Baseline Production - 2013
Daily and Annual Emissions From Off-Site Vehicle Travel - Criteria Pollutants

Trip Type	Average Daily Trips	Trip Length (mi)	Daily Emissions (lb/day)								
						PM10			PM2.5		
			NOx	CO	ROG	Exhaust	Road Dust	Total	Exhaust	Road Dust	Total
Off-Site Travel											
Trucks - Aggregate Haul*	166	15	56.19	11.37	2.22	1.32	0.80	2.11	1.21	0.20	1.41
Worker Vehicles - Commute	22	20	0.39	3.84	0.13	0.00	0 14	0.15	0.00	0.04	0.04
Total			**56.6**	**15.2**	**2.4**	**1.3**	**0 9**	**2.3**	**1.2**	**0.2**	**1.4**

* Based on 21,762 trucks per year, 22 working days per month, and an average 21 tons per load

Annual Average Emissions (tons/year)

Trip Type	Annual Trips	Trip Length (mi)	Annual Emissions (tons/year)								
						PM10			PM2.5		
			NOx	CO	ROG	Exhaust	Road Dust	Total	Exhaust	Road Dust	Total
Off-Site Travel											
Trucks - Aggregate Haul	43571	15	7.4	1.5	0.3	0.17	0 10	0.28	0.16	0.03	0.18
Worker Vehicles - Commute	5808	20	0.05	0.51	0.018	0.001	0.02	0.02	0.001	0.00	0.01
Total			**7.4**	**2.0**	**0.3**	**0.2**	**0 1**	**0.3**	**0.2**	**0.0**	**0.2**

* Based on annual production of 457,500 tons, 22 days per month, and an average 21 tons per load

Emission Factors

Vehicle Type	Travel Speed (mph)	Emission Factor Units	NOx	CO	ROG	PM10 (Exhaust)	PM10 (Road Dust)	PM10 (Total)	PM2.5 (Exhaust)	PM2.5 (Road Dust)	PM2.5 (Total)
Heavy-Duty Diesel Trucks	40	gram/VMT	9.79	1.86	0.36	0.236	0.145	0.38	0.217	0.036	0.25
Heavy-Duty Diesel Trucks	Idle	gram/hour	80.14	37.83	7.28	0.603	-	-	0.554	-	-
Worker Vehicles	40	gram/VMT	0.40	3.96	0.14	0.005	0.145	0.15	0.004	0.036	0.04

Emission factors from EMFAC2011 for 2011

Truck idle time (min) = 5
Paved road Dust Emissions Data
Mean vehicle Weight (tons) = 3
Silt Loading (g/m2) = 0.035

Mark West Quarry Baseline Production - 2013
Daily and Annual Emissions From Off-Site Vehicle Travel - GHG Emissions

Trip Type	Average Daily Trips	Trip Length (mi)	Daily Emissions (lb/day) CO2	N2O	CH4
Off-Site Travel					
Trucks - Aggregate Haul*	166	15	9468	0.03	0.03
Worker Vehicles - Commute	22	20	306	0.02	0.03
Total			**9773**	**0.05**	**0.06**

* Based on 21,786 trucks per year, 22 working days per month, and an average 21 tons per load

Annual Average Emissions

	Annual	Trip Length	(tons/year)			GHGs (MT CO2e/year)			
Trip Type	Trips	(mi)	CO2	N2O	CH4	CO2	N2O	CH4	Total
Off-Site Travel									
Trucks - Aggregate Haul	43571	15	1243	0.003	0.004	1127.2	0.9	0.1	1128
Worker Vehicles - Commute	5808	20	40	0.003	0.004	36.6	0.7	0.1	37
Total			**1283**	**0.006**	**0.008**	**1163.8**	**1.6**	**0.2**	**1166**

* Based on annual production of 457,500 tons, 22 days per month, and an average 21 tons per load

Emission Factors

Vehicle Type	Travel Speed (mph)	Emission Factor Units	CO2	N2O	CH4
Heavy-Duty Diesel Trucks	40	gram/VMT	1686 2	0.0048	0.0051
Heavy-Duty Diesel Trucks	Idle	gram/hour	6925.6	-	-
Worker Vehicles	40	gram/VMT	315.0	0.02	0.03

CO2 emission factors from EMFAC2011
N2O and CH4 emission factors from Californai Climate Action Registry (CCAR, 2009)
Global Warming Potential of N2O = 296
Global Warming Potential of CH4 = 23

Mark West Quarry
Drilling and Blasting Emissions
Existing and Proposed Operations

Blasting Activity

Holes per Blast =	36	(25 - 40 holes typical)
Area per Blast (sq ft) =	5184	(holes on 12 ft centers)
Blast Depth (ft) =	35	
Tons ANFO per Blast =	2.0	
Blasts per Year =	129	

Blasting Emissions

Pollutant	Emission Factor	Emission Factor Units	Emissions per Blast (lbs)	Average Daily Emissions (lb/day)	Annual Emissions (tons/year)
PM10	$(0.52) \times 0.000014 (A)^{1.5}$	lb/blast	2.7	1.3	0.18
PM2.5	$(0.03) \times 0.000014 (A)^{1.5}$	lb/blast	0.2	0.1	0.01
CO	67	lb/ton	135.1	67.0	8.71
NOx	17	lb/ton	34.3	17.0	2.21
SO_2	2	lb/ton	4.0	2.0	0.26

Notes: PM emission factors from AP-42, Section 11.9 (Western Surface Coal Mining)
Other emission factors from AP-42, Section 13.3 (Explosives Detonation)
A = area of blast (sq ft)
Average daily emissions based on 260 days per year operation

Mark West Quarry Off-Road Equipment & On-Site Vehicle Exhaust Emissions
Quarry Operation at Proposed Production Rate - 2013

Analysis Year = 2013 **260 = Annual Days of Operatior**

Off-Road Equipment / Equipment Type	No. Units	Engine Age (years)	Engine Model Year	Daily Hours In Use	Days Per Year	Unit Annual Hours Use	Use Factor	Load Factor	Cumulative Hours Operation Per Unit	Engine (hp)	Fuel Type	Level of VDECS Used	Emission Factor (g/hp-hr) NOx	CO	ROG	PM10	PM2.5	SO2	CO2	Average Daily Emissions (lb/day) NOx	CO	ROG	PM10	PM2.5	SO2	CO2	Annual Emissions (ton/yr) NOx	CO	ROG	PM10	PM2.5	SO2	CO2
Drill Rig	1	11	2002	4.0	75	300	1.00	0.50	1,800	240	ULSD	0	6.17	0.96	0.35	0.13	0.12	0.006	562.6	1.9	0.3	0.1	0.04	0.04	0.002	172	0.24	0.04	0.01	0.005	0.005	0.000	22
Loader - Cat 988G	1	10	2003	5.0	200	1000	1.00	0.36	12,600	475	ULSD	0	4.73	1.14	0.40	0.14	0.14	0.006	562.6	6.9	1.7	0.6	0.21	0.20	0.008	816	0.9	0.2	0.1	0.03	0.03	0.001	106
Loader - Cat 972G	1	10	2003	8.0	150	1200	1.00	0.36	6,600	280	ULSD	0	4.43	1.04	0.28	0.12	0.11	0.006	562.6	4.5	1.1	0.3	0.12	0.11	0.006	577	0.6	0.1	0.0	0.02	0.01	0.001	75
Loader - Cat 972H	1	6	2007	9.0	248	2232	1.00	0.36	10,807	287	ULSD	0	2.65	1.12	0.37	0.14	0.13	0.006	562.6	5.2	2.2	0.7	0.27	0.25	0.011	1100	0.7	0.3	0.1	0.03	0.03	0.001	143
Loader - Cat 972H	1	4	2009	9.0	248	2232	1.00	0.36	3,135	287	ULSD	0	2.42	0.98	0.18	0.10	0.09	0.006	562.6	4.7	1.9	0.3	0.20	0.19	0.011	1100	0.6	0.2	0.0	0.03	0.02	0.001	143
Loader - Cat 988H	1	5	2008	6.0	200	1200	1.00	0.36	4,080	500	ULSD	0	2.45	0.99	0.20	0.11	0.10	0.006	562.6	4.5	1.8	0.4	0.19	0.18	0.010	1030	0.6	0.2	0.0	0.03	0.02	0.001	134
Skid Steer loader - Cat 279	1	4	2009	4.0	150	600	1.00	0.37	1,626	82	ULSD	0	2.80	3.18	0.14	0.17	0.16	0.007	562.6	0.4	0.5	0.0	0.03	0.02	0.001	87	0.1	0.1	0.0	0.00	0.00	0.000	11
Excavator - Cat 325CL	1	11	2002	6.0	150	900	1.00	0.38	5,700	188	ULSD	0	6.71	1.06	0.40	0.16	0.15	0.006	562.6	3.7	0.6	0.2	0.09	0.08	0.003	307	0.5	0.1	0.0	0.01	0.01	0.000	40
Backhoe - Cat 416C	1	16	1997	2.0	150	300	1.00	0.37	3,750	81	ULSD	0	8.84	3.84	1.16	0.63	0.59	0.007	562.6	0.7	0.3	0.1	0.05	0.05	0.001	43	0.1	0.0	0.0	0.01	0.01	0.000	6
Bulldozer - Cat D10T	1	8	2005	6.0	125	750	1.00	0.43	2,934	579	ULSD	0	4.23	0.97	0.19	0.10	0.09	0.006	562.6	6.7	1.5	0.3	0.16	0.15	0.009	891	0.9	0.2	0.0	0.02	0.02	0.001	116
Compactor - Cat 825	1	17	1996	6.5	120	780	1.00	0.43	13,260	315	ULSD	0	7.11	1.14	0.45	0.20	0.19	0.006	562.6	6.4	1.0	0.4	0.18	0.17	0.005	504	0.8	0.1	0.1	0.02	0.02	0.001	66
Bulldozer - Cat[a]	1	2	2011	6.0	120	720	1.00	0.43	1,440	350	ULSD	0	1.31	0.95	0.10	0.01	0.01	0.006	562.6	1.2	0.9	0.1	0.01	0.01	0.005	517	0.2	0.1	0.0	0.00	0.00	0.001	67
Man lift - Simpson MP60	1	18	1995	1.0	55	55	1.00	0.31	905	60	ULSD	0	8.31	3.57	1.03	0.53	0.49	0.007	562.6	0.1	0.0	0.0	0.00	0.00	0.000	5	0.0	0.0	0.0	0.00	0.00	0.000	1
Portable Screen - John De	1	6	2007	6.0	90	540	1.00	0.40	2,340	125	ULSD	0	2.39	2.87	0.16	0.13	0.12	0.006	562.6	0.5	0.7	0.0	0.03	0.03	0.001	129	0.1	0.1	0.0	0.00	0.00	0.000	17
Street Sweeper - Tymco 43	1	2	2009	2.0	150	300	1.00	0.46	1,200	56	ULSD	0	2.78	3.15	0.13	0.17	0.16	0.007	562.6	0.2	0.2	0.0	0.01	0.01	0.000	37	0.0	0.0	0.0	0.00	0.00	0.000	5
Subtotal																				***47.5***	***14.6***	***3.6***	***1.6***	***1.5***	***0.1***	***7314***	***6.2***	***1.9***	***0.5***	***0.21***	***0.19***	***0.010***	***951***
On-Road Vehicles[b]	**No. Trucks**			**Hours/ Day**	**Days/ Year**	**Annual Hours per Truck**		**Speed (mph)**	**Travel Miles per Day**				**Emission Factors (g/mi) NOx**	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**	**NOx**	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**	**NOx**	**CO**	**ROG**	**PM10**	**PM2.5**	**SO2**	**CO2**
Water Truck	1	-	-	2	150	300	-	10	20	-	ULSD	-	22.92	6.88	3.323	0.644	0.592	0.017	3293.0	0.58	0.17	0.08	0.02	0.02	0.000	84	0.08	0.02	0.01	0.00	0.002	0.000	11
Haul Truck - Cat 740 EJ	1	-	-	4	180	720	-	10	40	-	ULSD	-	22.92	6.88	3.323	0.644	0.592	0.017	3293.0	1.40	0.42	0.20	0.04	0.04	0.001	201	0.18	0.05	0.03	0.01	0.005	0.000	26
Service Trucks	4	-	-	0.75	250	187.5	-	15	11	-	ULSD	-	5.06	1.821	0.332	0.078	0.072	0.005	518.9	0.48	0.17	0.03	0.01	0.01	0.000	49	0.06	0.02	0.00	0.00	0.001	0.000	6
Subtotal	6																			***2.46***	***0.77***	***0.32***	***0.06***	***0.06***	***0.002***	***334***	***0.32***	***0.10***	***0.041***	***0.008***	***0.008***	***0.000***	***43***
TOTAL	-			-	-	-	-	-	-	-	-		-	-	-	-				**50.0**	**15.4**	**3.9**	**1.6**	**1.54**	**0.08**	**7,648**	**6.5**	**2.0**	**0.5**	**0.21**	**0.20**	**0.01**	**994**

Notes a An add tional bulldozer may be added in 2014 or later, so t is included in the proposed project emissions.
b On-Road vehicle emission factors from EMFAC2011 for Sonoma Co.

Emission Factors - Off-Road Compression Ignited Engine: EF ID	NOx ZH EF (g/hp-hr)	NOx DR (g/hp-hr^2)	NOx Fuel CF	CO ZH EF (g/hp-hr)	CO DR (g/hp-hr^2)	CO Fuel CF	ROG ZH EF (g/hp-hr)	ROG DR (g/hp-hr^2)	ROG Fuel CF	PM10 ZH EF (g/hp-hr)	PM10 DR (g/hp-hr^2)	PM10 Fuel CF	PM2.5 ZH EF (g/hp-hr)	PM2.5 DR (g/hp-hr^2)	PM2.5 Fuel CF	CO2 ZH EF (g/hp-hr)	CO2 DR (g/hp-hr^2)	CO2 Fuel CF	SO2 (g/hp-hr)
ULSD2502002	6.25	1.45E-04	0.95	0.92	2.43E-05	1.00	0.32	1.48E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002003	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002003	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002007	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002009	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002008	2.45	3.18E-05	0.95	0.92	1.82E-05	1.00	0.10	2.50E-05	1.00	0.11	5.55E-06	0.80	0.10	5.55E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD1202009	2.89	3.80E-05	0.95	3.05	8.10E-05	1.00	0.10	2.50E-05	1.00	0.20	8.58E-06	0.80	0.18	8.58E-06	0.80	568.30	0.00E+00	0.99	0.007
ULSD2502002	6.25	1.45E-04	0.95	0.92	2.43E-05	1.00	0.32	1.48E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD1201997	8.75	2.02E-04	0.93	3.49	9.23E-05	1.00	0.99	4.58E-05	1.00	0.69	5.02E-05	0.72	0.63	5.02E-05	0.72	568.30	0.00E+00	0.99	0.007
ULSD7502005	4.29	5.81E-05	0.95	0.92	1.82E-05	1.00	0.12	2.36E-05	1.00	0.11	5.79E-06	0.80	0.10	5.79E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5001996	6.25	1.04E-04	0.95	0.92	1.82E-05	1.00	0.32	1.12E-05	1.00	0.15	7.96E-06	0.80	0.14	7.96E-06	0.80	568.30	0.00E+00	0.99	0.006
ULSD5002011	1.36	1.75E-05	0.95	0.92	1.82E-05	1.00	0.07	1.83E-05	1.00	0.01	3.75E-07	0.85	0.01	3.75E-07	0.85	568.30	0.00E+00	0.99	0.006
ULSD1201995	8.75	2.02E-04	0.93	3.49	9.23E-05	1.00	0.99	4.58E-05	1.00	0.69	5.02E-05	0.72	0.63	5.02E-05	0.72	568.30	0.00E+00	0.99	0.007
ULSD1752007	2.45	3.20E-05	0.95	2.70	7.14E-05	1.00	0.10	2.50E-05	1.00	0.14	1.00E-05	0.80	0.13	1.00E-05	0.80	568.30	0.00E+00	0.99	0.006
ULSD1202009	2.89	3.80E-05	0.95	3.05	8.10E-05	1.00	0.10	2.50E-05	1.00	0.20	8.58E-06	0.80	0.18	8.58E-06	0.80	568.30	0.00E+00	0.99	0.007

Notes ZH EF Zero hour emission factor
DR Deterioration rate
ULSD U tra low sulfur diesel (15 ppmw sulfur, 0.0015% sulfur)

Refs CARB OFFFROAD2007 model (http //www.arb.ca.gov/msei/offroad/offroad.htm), December, 2006.
Stationary/Off-road engines ARB, "California's Emissions Inventory for Off-Road Large Compression-Ignited (CI) Engines (> 25 HP)" MAC#99-32

Mark West Quarry Off-Road Equipment & On-Site Vehicle Exhaust Emissions
Quarry Operation at Proposed Production Rate - 2013
Greenhouse Gases

	N2O	CH4
EF (kg/gal)	0.00026	0.00058
GWP	296	23

		N2O	CH4	MT CO2e/year			
(gal/hr)	(gal/yr)	(kg/yr)	(kg/yr)	CO2	N2O	CH4	Total
8.1	2,417	0.6	1.4	20.3	0.19	0.03	20
11.5	11,481	3.0	6.7	96.2	0.88	0.15	97
6.8	8,122	2.1	4.7	68.1	0.63	0.11	69
6.9	15,484	4.0	9.0	129.7	1.19	0.21	131
6.9	15,484	4.0	9.0	129.7	1.19	0.21	131
12.1	14,503	3.8	8.4	121.5	1.12	0.19	123
2.1	1,274	0.3	0.7	10.2	0.10	0.02	10
4.8	4,317	1.1	2.5	36.2	0.33	0.06	37
2.1	629	0.2	0.4	5.1	0.05	0.01	5
16.7	12,537	3.3	7.3	105.1	0.96	0.17	106
9.1	7,094	1.8	4.1	59.4	0.55	0.09	60
10.1	7,276	1.9	4.2	61.0	0.56	0.10	62
1.3	72	0.0	0.0	0.6	0.01	0.00	1
3.4	1,813	0.5	1.1	15.2	0.14	0.02	15
1.8	541	0.1	0.3	4.3	0.04	0.01	4
103.7	**103044**	**27**	**60**	**862.6**	**7.9**	**1.4**	**872**
		negligible	negligible	9.9	-	-	10
		negligible	negligible	23.7	-	-	24
		negligible	negligible	5.8	-	-	6
				39.4			***39***
				902.0	**7.9**	**1.4**	**911**

Table 3
Mark West Quarry
PM10 and PM2.5 Emissions From Quarry Processing Operations
Proposed Operations

Quarry Production Rate Information

Annual Process Rate (yd^3/yr) =	500,000	
Annual Process Rate (ton/yr) =	750,000	
Max Hourly process rate (ton/hr) =	550	
Average Hourly process rate (ton/hr) =	523	
Max. Daily Process Rate (ton/day)	4,400	
Average Daily Process Rate (ton/day)	3,033	
Days to Process Annual Amount =	247	(at average daily production level)
Days to Process Annual Amount =	170	(at max. daily production level)
Average Hours per day Processing (hrs) =	5.8	(at average daily production level)
Maximum Hours per day Processing (hrs) =	8	(at max. daily production level)

Quarry Processing Equipment Emissions - Proposed Project

Equipment Type	Percent of Input	Process Rate (ton/hr)	Number of Transfers	Daily Operation (hours)	Emission Factor (lb/ton)	PM10 Emissions Hourly (lb/hr)	PM10 Emissions Daily (lb/day)	PM10 Emissions Annual (ton/yr)	Emission Factor (lb/ton)	PM2.5 Emissions Hourly (lb/hr)	PM2.5 Emissions Daily (lb/day)	PM2.5 Emissions Annual (ton/yr)
Processing Plant												
Feed Hopper	100%	523	1	5.8	0.000016	0.008	0.05	0.006	0.000003	0.002	0.010	0.0012
Primary Jaw Crusher (CR1)	60%	314	1	5.8	0.00054	0.169	0 98	0.122	0.00010	0.031	0.182	0.0155
Conveyor to Stacking Conveyor	100%	523	1	5.8	0.00110	0.575	3 34	0.413	0.000311	0.163	0.943	0.0804
Stacking Conveyor /Loadout - Surge Pile	100%	523	2	5.8	0.00061	0.6367	3.69	0.457	0.000164	0.172	0.997	0.0850
Belt Feeder (2) - Surge Pile Reclaim	100%	523	2	5.8	0.000046	0.048	0 28	0.035	0.000013	0.014	0.079	0.0067
Conveyor - Surge Pile to Screen 1	100%	523	1	5.8	0.00110	0.575	3 34	0.413	0.000311	0.163	0.943	0.0804
Screen 1 - Primary Screen	100%	523	1	5.8	0.00074	0.387	2 24	0.278	0.00005	0.026	0.152	0.0129
Conveyor 1 to Base/Subbase Radial Stacker	15%	78	1	5.8	0.00110	0.086	0 50	0.062	0.000311	0.024	0.141	0.0121
Conveyor 2 to Base/Subbase Radial Stacker	35%	183	1	5.8	0.00110	0.201	1 17	0.144	0.000311	0.057	0.330	0.0281
Radial Stacker/Loadout - Base/Subbase Pile	50%	262	2	5.8	0.00061	0.3184	1.85	0.228	0.000164	0.086	0.498	0.0425
Conveyor to Drain Rock Stacker	2%	10	1	5.8	0.00110	0.012	0.07	0.008	0.000311	0.003	0.019	0.0016
Stacking Conveyor /Loadout - Drain Rock Pile	2%	10	2	5.8	0.00061	0.0127	0.07	0.009	0.000164	0.003	0.020	0.0017
Conveyor to Cone Crusher	40%	209	1	5.8	0.00110	0.230	1 33	0.165	0.000311	0.065	0.377	0.0321
Cone Crusher (CR2)	40%	209	1	5.8	0.00054	0.113	0.66	0.081	0.00010	0.021	0.121	0.0103
Conveyor to Vertical Impact Crusher	29%	152	1	5.8	0.00110	0.167	0 97	0.120	0.000311	0.047	0.273	0.0233
Vertical Impact Crusher (CR3)	29%	152	1	5.8	0.00120	0.182	1.06	0.131	0.00007	0.011	0.062	0.0052
Conveyor - From Crushers to Screen 2	69%	361	1	5.8	0.00110	0.397	2 30	0.285	0.000311	0.112	0.651	0.0555
Screen 2	69%	361	1	5.8	0.00074	0.267	1 55	0.191	0.00005	0.018	0.105	0.0089
Conveyor to 3/4" Drain Rock Stacker	3.5%	18	1	5.8	0.00110	0.020	0 12	0.014	0.000311	0.006	0.033	0.0028
Stacking Conveyor /Loadout - 3/4" Drain Rock P	3.5%	18	2	5.8	0.00061	0.0223	0 13	0.016	0.000164	0.006	0.035	0.0030
Screen 3	60%	314	1	5.8	0.00074	0.232	1 35	0.167	0.00005	0.016	0.091	0.0078
Radial Stacker/Loadout - Fines/Sand Plant	31%	162	2	5.8	0.00061	0.1974	1 14	0.142	0.000164	0.053	0.309	0.0263
Screen 4 (dry) - Wash Plant	9%	59	1	5.8	0.00220	0.1300	0.75	0.093	0.000050	0.003	0.017	0.0015
Conveyor to 5/8" Chips Stacker	11.5%	60	1	5.8	0.00110	0.066	0 38	0.047	0.000311	0.019	0.108	0.0092
Stacking Conveyor /Loadout - 5/8" Chips Pile	11.5%	60	2	5.8	0.00061	0.0732	0.42	0.053	0.000164	0.020	0.115	0.0098
Conveyor to 3/8" Chips Stacker	13%	68	1	5.8	0.00110	0.075	0.43	0.054	0.000311	0.021	0.123	0.0104
Stacking Conveyor /Loadout - 3/8" Chips Pile	13%	68	2	5.8	0.00061	0.0828	0.48	0.059	0.000164	0.022	0.130	0.0110
Other Internal System Conveyors (13)	15%	78	13	5.8	0.00110	1.122	6 51	0.804	0.000311	0.317	1.839	0.1567
Total Quarry Processing Equipment						***6.4***	***37.16***	***4.59***		***1.50***	***8.70***	***0.74***

Table 4
Mark West Quarry
PM10 and PM2.5 From Quarry Fugitive Emission Sources
Proposed Operations

Quarry Excavation/Processing Fugitive Emission Sources - Proposed Operations															
	Operation						**Emission Factors**			**PM10 Emissions**			**PM2.5 Emissions**		
	Process Rate	**Process Rate Units**	**No. of Equip.**	**Total Daily Hours (hours/day)**	**Days per Year**	**Total Annual Hours (hours/yr)**	**PM10 Emission Factor**	**PM2.5 Emission Factor**	**Emission Factor Units**	**Ave Hourly (lb/hr)**	**Ave Daily (lb/day)**	**Annual Average (ton/yr)**	**Ave Hourly (lb/hr)**	**Ave Daily (lb/day)**	**Annual Average (ton/yr)**
Loader Travel - Cat 988s															
Quarry Area	12.0	mile/day	1	5	200	1000	0 50	0.05	lb/VMT	1.19	5.97	0.60	0 12	0.60	0.06
Quarry Area	14.4	mile/day	1	6	200	1200	0 50	0.05	lb/VMT	1.19	7.16	0.72	0 12	0.72	0.07
Loader Travel - Cat 972s															
Quarry Area	16.0	mile/day	1	8	150	1200	0 38	0.04	lb/VMT	0.75	6.03	0.45	0.08	0.60	0.05
Feed Hopper Area	19.2	mile/day	1	9	248	2232	0 38	0.04	lb/VMT	0.80	7.23	0.90	0.08	0.72	0.09
Truck Loading Areas/Pile Maintenance	6.4	mile/day	1	9	248	2232	0 38	0.04	lb/VMT	0.27	2.41	0.30	0.03	0.24	0.030
Bulldozing	-	-	1	6	125	750	0 56	0 37	lb/hr	0.56	3.36	0.21	0 37	2.21	0.14
Excavator	262	ton/hr	1	6	150	900	0.0004	0.00006	lb/ton	0.10	0.61	0.05	0.02	0.09	0.007
Backhoe	130	ton/hr	1	2	150	300	0.0004	0.00006	lb/ton	0.05	0.10	0.01	0.01	0.02	0.001
Truck Loading (via loader)	523	ton/hr	1	6	248	1438	0.0004	0.00006	lb/ton	0.20	1.19	0.15	0.03	0.18	0.022
Off Road Haul Truck Unpaved Travel - Quarry	21.28	mile/day	1	5	180	900	0.48	0.05	lb/VMT	2.06	10.28	0.93	0 21	1.03	0.09
Service Truck Unpaved Travel - Daily	15	mile/day	3	0 5	200	300	0 36	0.036	lb/VMT	10.71	5.36	-	1.07	0.54	-
Service Truck Unpaved Travel - Annual	3,000	mile/yr	3	0 5	200	300	0 29	0.029	lb/VMT	-	-	0.43	-	-	0.04
Haul Trucks On-site Paved Road Travel - Daily	44.8	mile/day	135	9 5	-	-	0.078	0.096	lb/VMT	0.37	3.50	-	0.45	4.29	-
Haul Trucks On-site Paved Road Travel - Annual	11,837	mile/yr	21,786	-	-	-	0.074	0.091	lb/VMT	-	-	0.44	-	-	0.54
Total Excavation/Processing Fugitives										***18.3***	***53.2***	***5.16***	***2.6***	***11.24***	***1.14***
Total Processing and Fugitives										**24.7**	**90.4**	**9.8**	**4.1**	**19.9**	**1.9**

Mark West Quarry Proposed Production - 2013
Daily and Annual Emissions From Off-Site Vehicle Travel - Criteria Pollutants

	Average	Trip	Daily Emissions (lb/day)								
	Daily	Length				PM10			PM2.5		
Trip Type	**Trips**	**(mi)**	**NOx**	**CO**	**ROG**	**Exhaust**	**Road Dust**	**Total**	**Exhaust**	**Road Dust**	**Total**
Off-Site Travel											
Trucks - Aggregate Haul*	270	15	91.39	18.50	3.60	2.14	1 30	3.43	1.97	0.32	2.29
Worker Vehicles - Commute	32	20	0.57	5.58	0.20	0.01	0 20	0.211	0.01	0.05	0.06
Total			**92.0**	**24.1**	**3.8**	**2.1**	**1 5**	**3.6**	**2.0**	**0.4**	**2.3**

* Based on 35,714 trucks per year, 22 working days per month, and an average 21 tons per load

Annual Average Emissions (tons/year)

		Trip	Annual Emissions (tons/year)								
	Annual	Length				PM10			PM2.5		
Trip Type	**Trips**	**(mi)**	**NOx**	**CO**	**ROG**	**Exhaust**	**Road Dust**	**Total**	**Exhaust**	**Road Dust**	**Total**
Off-Site Travel											
Trucks - Aggregate Haul	71,429	15	12 1	2.4	0.5	0.28	0 17	0.45	0.26	0.04	0.30
Worker Vehicles - Commute	8,448	20	0.08	0.74	0.026	0.001	0.03	0.03	0.001	0.01	0.01
Total			**12 2**	**3.18**	**0.5**	**0.3**	**0 2**	**0.5**	**0.3**	**0.0**	**0.3**

* Based on annual production of 457,500 tons, 22 days per month, and an average 21 tons per load

Emission Factors

Vehicle Type	Travel Speed (mph)	Emission Factor Units	NOx	CO	ROG	PM10 (Exhaust)	PM10 (Road Dust)	PM10 (Total)	PM2.5 (Exhaust)	PM2.5 (Road Dust)	PM2.5 (Total)
Heavy-Duty Diesel Trucks	40	gram/VMT	9.79	1.86	0.36	0.236	0.145	0.38	0.217	0.036	0.25
Heavy-Duty Diesel Trucks	Idle	gram/hour	80.14	37.83	7.28	0.603	-	-	0.554	-	-
Worker Vehicles	40	gram/VMT	0.40	3.96	0.14	0.005	0.145	0.15	0.004	0.036	0.04

Emission factors from EMFAC2011 for 2011

Truck idle time (min) = 5

Paved road Dust Emissions Data

Mean vehicle Weight (tons) = 3

Silt Loading (g/m2) = 0.035

Mark West Quarry Proposed Production - 2013
Daily and Annual Emissions From Off-Site Vehicle Travel - GHG Emissions

Trip Type	Average Daily Trips	Trip Length (mi)	Daily Emissions (lb/day) CO2	N2O	CH4
Off-Site Travel					
Trucks - Aggregate Haul*	270	15	15399	0.04	0.05
Worker Vehicles - Commute	32	20	444	0.03	0.04
Total			**15844**	**0.07**	**0.09**

* Based on 21,786 trucks per year, 22 working days per month, and an average 21 tons per load

Annual Average Emissions

Trip Type	Annual Trips	Trip Length (mi)	(tons/year) CO2	N2O	CH4	GHGs (MT CO2e/year) CO2	N2O	CH4	Total
Off-Site Travel									
Trucks - Aggregate Haul	71429	15	2037	0.006	0.006	1847.9	1.5	0.1	1850
Worker Vehicles - Commute	8448	20	59	0.004	0.006	53.2	1.0	0.1	54
Total			**2096**	**0.009**	**0.012**	**1901.1**	**2.5**	**0.2**	**1904**

* Based on annual production of 457,500 tons, 22 days per month, and an average 21 tons per load

Emission Factors

Vehicle Type	Travel Speed (mph)	Emission Factor Units	CO2	N2O	CH4
Heavy-Duty Diesel Trucks	40	gram/VMT	1686 2	0.0048	0.0051
Heavy-Duty Diesel Trucks	Idle	gram/hour	6925.6	-	-
Worker Vehicles	40	gram/VMT	315.0	0.02	0.03

CO2 emission factors from EMFAC2011
N2O and CH4 emission factors from Californai Climate Action Registry (CCAR, 2009)
Global Warming Potential of N2O = 296
Global Warming Potential of CH4 = 23

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20:28:55

*** SCREEN3 MODEL RUN ***
*** VERSION DATED 96043 ***

Mark West Quarry Expansion - DPM at Nearby Residences

SIMPLE TERRAIN INPUTS:
SOURCE TYPE = AREA
EMISSION RATE (G/(S-M**2)) = 0.571000E-07
SOURCE HEIGHT (M) = 21.0000
LENGTH OF LARGER SIDE (M) = 150.0000
LENGTH OF SMALLER SIDE (M) = 150.0000
RECEPTOR HEIGHT (M) = 1.5000
URBAN/RURAL OPTION = RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

MODEL ESTIMATES DIRECTION TO MAX CONCENTRATION

BUOY. FLUX = 0.000 M**4/S**3; MOM. FLUX = 0.000 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN AUTOMATED DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
150.	0.1613	1	1.0	1.1	320.0	21.00	44.
200.	0.1804	2	1.0	1.1	320.0	21.00	45.
300.	0.1880	3	1.0	1.1	320.0	21.00	45.
400.	0.1678	4	1.0	1.1	320.0	21.00	45.
500.	0.1769	4	1.0	1.1	320.0	21.00	45.
600.	0.1695	4	1.0	1.1	320.0	21.00	44.
700.	0.1560	4	1.0	1.1	320.0	21.00	45.
800.	0.1449	5	1.0	1.3	10000.0	21.00	45.
900.	0.1406	5	1.0	1.3	10000.0	21.00	45.
1000.	0.1340	5	1.0	1.3	10000.0	21.00	45.

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 150. M:

290.	0.1883	3	1.0	1.1	320.0	21.00	45.

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
165.	0.1654	1	1.0	1.1	320.0	21.00	45.
240.	0.1777	3	1.0	1.1	320.0	21.00	45.
255.	0.1835	3	1.0	1.1	320.0	21.00	45.

****
*** SUMMARY OF SCREEN MODEL RESULTS ***
****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	0.1883	290.	0.

****
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****

SCREEN3 Risk Modeling Parameters and Maximum Cancer Risk in Project Area
Mark West Quarry
Proposed Project Operation in 2013

Receptor Information

Number of Receptors	variable
Receptor Height =	1.5 m
Receptor distances =	165 m - 1,000 m

Meteorological Conditions

SCREEN3 screening meteorology	
Land Use Classification	rural
Wind speed =	variable
Wind direction =	variable

Cancer Risk Calculation Method

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air (μg/m^3)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Inhalation Dose Factors

	Value[1]							
Exposure Type	**DBR (L/kg BW-day)**	**A (-)**	**Exposure (hr/day)**	**Exposure (days/week)**	**Exposure (week/year)**	**EF (days/yr)**	**ED (Years)**	**AT (days)**
Residential (70-Year)	302	1	10	6	50	300	70	25,550

[1] Default values recommended by OEHHA& Bay Area Air Quality Management District

Cancer Risk (per million) = Inhalation Dose x CRAF x CPF x 10^6
= URF x Cair

Where: CPF = Cancer potency factor (mg/kg-day)[1]
CRAF = Cancer Risk Adjustment Factor
URF =Unit risk factor (cancer risk per μg/m^3)

Risk Factors for DPM

Exposure Type	**CPF (mg/kg-day)$^{-1}$**	**CRAF (-)**
Residential (70-Yr Exposure)	1.10E+00	1.7

Cancer Risk - Mark West Quarry Proposed Operations - 2013 Emissions

	DPM Concentration		**DPM**
Sensitive Receptor	**Max 1-Hr (μg/m^3)**	**Annual Ave (μg/m^3)**	**Cancer Risk (per million)**
Off-Site Resident 1	0.1835	0.018	**3.5**
Off-Site Resident 2	0.1777	0.018	**3.4**
On-Site Resident	0.1654	0.017	**3.2**

Notes:
Maximum DPM concentration at 255 meters from center of area source.

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

DATE : 1/23/13
TIME : 1:25: 9

The MODE flag has been set to P for calculating PM averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 10. CM
U = 1.0 M/S CLAS = 1 (A) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 ug/m**3

LINK VARIABLES

LINK DESCRIPTION	LINK COORDINATES (M) X1	Y1	X2	Y2	LENGTH (M)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (M)	W (M)	V/C	QUE (VE
1. Link_1	-1.83	-500.00	-1.83	500.00	1000.	360.	AG	5.	217.3	0.0	9.7		
2. Link_2	-5.49	500.00	-5.49	-500.00	1000.	180.	AG	5.	217.3	3.0	9.7		

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

DATE : 1/23/13
TIME : 1:25: 9

RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (M) X	Y	Z
1. R_1	15.20	-500.00	1.5
2. R_2	15.20	-250.00	1.5
3. R 3	15.20	0.00	1.5
4. R_4	15.20	250.00	1.5
5. R_5	15.20	500.00	1.5

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	22.	22.	21.	20.	0.
5.	20.	20.	20.	18.	0.
10.	18.	18.	17.	16.	0.
15.	16.	16.	15.	14.	0.
20.	13.	13.	13.	12.	0.
25.	11.	11.	10.	9.	0.
30.	9.	9.	8.	7.	0.
35.	7.	6.	6.	5.	0.
40.	4.	4.	4.	4.	0.
45.	3.	3.	2.	2.	0.
50.	2.	2.	2.	1.	0.
55.	1.	1.	1.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	1.	1.	1.
130.	0.	1.	2.	2.	2.
135.	0.	2.	2.	3.	3.
140.	0.	4.	4.	4.	4.
145.	0.	5.	6.	6.	7.
150.	0.	7.	8.	9.	9.
155.	0.	9.	10.	11.	11.
160.	0.	12.	13.	13.	13.
165.	0.	14.	15.	16.	16.
170.	0.	16.	17.	18.	18.
175.	0.	18.	20.	20.	20.
180.	0.	20.	21.	22.	22.
MAX	22.	22.	21.	22.	22.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 22. ug/m**3 OCCURRED AT RECEPTOR REC5 .

METEOROLOGICAL VARIABLES

U = 1.0 M/S CLAS = 2 (B) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 ug/m**3

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	30.	30.	28.	25.	0.
5.	26.	25.	24.	21.	0.
10.	21.	20.	19.	16.	0.
15.	16.	15.	14.	12.	0.
20.	11.	11.	10.	8.	0.
25.	7.	7.	7.	5.	0.
30.	4.	4.	4.	3.	0.
35.	2.	2.	2.	2.	0.
40.	1.	1.	1.	1.	0.
45.	0.	0.	0.	0.	0.
50.	0.	0.	0.	0.	0.
55.	0.	0.	0.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	0.	0.	0.
130.	0.	0.	0.	0.	0.
135.	0.	0.	0.	0.	0.
140.	0.	1.	1.	1.	1.
145.	0.	2.	2.	2.	2.
150.	0.	3.	4.	4.	4.
155.	0.	5.	7.	7.	7.
160.	0.	8.	10.	11.	11.
165.	0.	12.	14.	15.	16.
170.	0.	16.	19.	20.	21.
175.	0.	21.	24.	25.	26.
180.	0.	25.	28.	30.	30.
MAX	30.	30.	28.	30.	30.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 30. ug/m**3 OCCURRED AT RECEPTOR REC5 .

METEOROLOGICAL VARIABLES

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

MODEL RESULTS

REMARKS : In search of the angle corresponding to
the maximum concentration, only the first
angle, of the angles with same maximum
concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	40.	38.	35.	29.	0.
5.	29.	28.	25.	20.	0.
10.	18.	18.	16.	12.	0.
15.	10.	9.	8.	6.	0.
20.	5.	4.	4.	3.	0.
25.	2.	2.	2.	1.	0.
30.	0.	0.	0.	0.	0.
35.	0.	0.	0.	0.	0.
40.	0.	0.	0.	0.	0.
45.	0.	0.	0.	0.	0.
50.	0.	0.	0.	0.	0.
55.	0.	0.	0.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	0.	0.	0.
130.	0.	0.	0.	0.	0.
135.	0.	0.	0.	0.	0.
140.	0.	0.	0.	0.	0.
145.	0.	0.	0.	0.	0.
150.	0.	0.	0.	0.	0.
155.	0.	1.	2.	2.	2.
160.	0.	3.	4.	4.	5.
165.	0.	6.	8.	9.	10.
170.	0.	12.	16.	18.	18.
175.	0.	20.	25.	28.	29.
180.	0.	29.	35.	38.	40.
MAX	40.	38.	35.	38.	40.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 40. ug/m**3 OCCURRED AT RECEPTOR REC5 .

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

METEOROLOGICAL VARIABLES

U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 ug/m**3

MODEL RESULTS

REMARKS : In search of the angle corresponding to
the maximum concentration, only the first
angle, of the angles with same maximum
concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	54.	50.	44.	30.	0.
5.	28.	26.	22.	14.	0.
10.	10.	9.	7.	4.	0.
15.	2.	2.	2.	1.	0.
20.	0.	0.	0.	0.	0.
25.	0.	0.	0.	0.	0.
30.	0.	0.	0.	0.	0.
35.	0.	0.	0.	0.	0.
40.	0.	0.	0.	0.	0.
45.	0.	0.	0.	0.	0.
50.	0.	0.	0.	0.	0.
55.	0.	0.	0.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	0.	0.	0.
130.	0.	0.	0.	0.	0.
135.	0.	0.	0.	0.	0.
140.	0.	0.	0.	0.	0.
145.	0.	0.	0.	0.	0.
150.	0.	0.	0.	0.	0.
155.	0.	0.	0.	0.	0.
160.	0.	0.	0.	0.	0.
165.	0.	1.	2.	2.	2.
170.	0.	4.	7.	9.	10.
175.	0.	14.	22.	26.	28.
180.	0.	30.	44.	50.	54.
MAX	54.	50.	44.	50.	54.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 54. ug/m**3 OCCURRED AT RECEPTOR REC5 .

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

METEOROLOGICAL VARIABLES

U = 1.0 M/S CLAS = 5 (E) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 ug/m**3

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	75.	68.	57.	34.	0.
5.	29.	26.	20.	10.	0.
10.	6.	5.	4.	2.	0.
15.	0.	0.	0.	0.	0.
20.	0.	0.	0.	0.	0.
25.	0.	0.	0.	0.	0.
30.	0.	0.	0.	0.	0.
35.	0.	0.	0.	0.	0.
40.	0.	0.	0.	0.	0.
45.	0.	0.	0.	0.	0.
50.	0.	0.	0.	0.	0.
55.	0.	0.	0.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	0.	0.	0.
130.	0.	0.	0.	0.	0.
135.	0.	0.	0.	0.	0.
140.	0.	0.	0.	0.	0.
145.	0.	0.	0.	0.	0.
150.	0.	0.	0.	0.	0.
155.	0.	0.	0.	0.	0.
160.	0.	0.	0.	0.	0.
165.	0.	0.	0.	0.	0.
170.	0.	2.	4.	5.	6.
175.	0.	10.	20.	26.	29.
180.	0.	34.	57.	68.	75.
MAX	75.	68.	57.	68.	75.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 75. ug/m**3 OCCURRED AT RECEPTOR REC5 .

JOB: 2-Lane Road DPM Modeling - Emissions x 1,000 RUN: CAL3QHC RUN

METEOROLOGICAL VARIABLES

U = 1.0 M/S CLAS = 6 (F) ATIM = 60. MINUTES MIXH = 1000. M AMB = 0.0 ug/m**3

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-180.

WIND ANGLE (DEGR)	CONCENTRATION (ug/m**3) REC1	REC2	REC3	REC4	REC5
0.	120.	103.	77.	33.	0.
5.	18.	15.	10.	3.	0.
10.	0.	0.	0.	0.	0.
15.	0.	0.	0.	0.	0.
20.	0.	0.	0.	0.	0.
25.	0.	0.	0.	0.	0.
30.	0.	0.	0.	0.	0.
35.	0.	0.	0.	0.	0.
40.	0.	0.	0.	0.	0.
45.	0.	0.	0.	0.	0.
50.	0.	0.	0.	0.	0.
55.	0.	0.	0.	0.	0.
60.	0.	0.	0.	0.	0.
65.	0.	0.	0.	0.	0.
70.	0.	0.	0.	0.	0.
75.	0.	0.	0.	0.	0.
80.	0.	0.	0.	0.	0.
85.	0.	0.	0.	0.	0.
90.	0.	0.	0.	0.	0.
95.	0.	0.	0.	0.	0.
100.	0.	0.	0.	0.	0.
105.	0.	0.	0.	0.	0.
110.	0.	0.	0.	0.	0.
115.	0.	0.	0.	0.	0.
120.	0.	0.	0.	0.	0.
125.	0.	0.	0.	0.	0.
130.	0.	0.	0.	0.	0.
135.	0.	0.	0.	0.	0.
140.	0.	0.	0.	0.	0.
145.	0.	0.	0.	0.	0.
150.	0.	0.	0.	0.	0.
155.	0.	0.	0.	0.	0.
160.	0.	0.	0.	0.	0.
165.	0.	0.	0.	0.	0.
170.	0.	0.	0.	0.	0.
175.	0.	3.	10.	15.	18.
180.	0.	33.	77.	103.	121.
MAX	120.	103.	77.	103.	121.
DEGR.	0	0	0	180	180

THE HIGHEST CONCENTRATION OF 121. ug/m**3 OCCURRED AT RECEPTOR REC5 .

Mark West Quarry - Two Lane Road DPM Risk Modeling Using CAL3QHC
Proposed Project in 2013

Roadway Information

Number of Lanes =	2	
Lane Width =	12	feet

CAL3QHC Link/Source Information

Num of Links =	2	
Link Length =	1000 m	
Link Width =	32 ft	9.66 m
Release Height =	9.8 ft	3 m

DPM Emission Factors

Model	EMFAC2011
County	Sonoma
Year	2013

Receptor Information

Number of Receptors	5
Receptor distances =	at 50 ft perpendicular to the roadway, spaced every 250 m parallel to the highway

Meteorological Conditions

Land Use Classification	Rural
Stability class =	A,B,C,D, E, & F
Wind speed =	1 m/s
Wind direction =	Worst-case wind angle search (0 to 180 degrees in 5 degree increments)
Surface roughness =	10 cm

Cancer Risk Calculation Method

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air (μg/m^3)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Inhalation Dose Factors

	Value[1]							
Exposure Type	**DBR (L/kg BW-day)**	**A (-)**	**Exposure (hr/day)**	**Exposure (days/week)**	**Exposure (week/year**	**EF (days/yr)**	**ED (Years)**	**AT (days)**
Residential (70-Year)	302	1	10	6	50	300	70	25,550

[1] Default values recommended by OEHHA& Bay Area Air Quality Management District

Cancer Risk (per million) = Inhalation Dose x CRAF x CPF x 10^6
= URF x Cair

Where: CPF = Cancer potency factor (mg/kg-day)$^{-1}$
CRAF = Cancer Risk Adjustment Factor
URF =Unit risk factor (cancer risk per μg/m^3)

Diesel Particulate Matter Risk Factors

Exposure Type	**CPF (mg/kg-day)$^{-1}$**	**CRAF (-)**
Residential (70-Yr Exposure)	1.10E+00	1.7

DPM Concentrations and Maximum Cancer Risks

	Residetnial at 50 Feet	
Meteorological Conditions	**Concentration ((μg/m3)*** **1-Hour**	**Annual Ave.**
A at 1 m/s	0.022	0.0022
B at 1 m/s	0.030	0.003
C at 1 m/s	0.040	0.004
D at 1 m/s	0.054	0.0054
E at 1 m/s	0.075	0.008
F at 1 m/s	0.120	0.012
	Cancer Risk (per million) at 50 Feet	
A at 1 m/s	0.4	
B at 1 m/s	0.6	
C at 1 m/s	0.8	
D at 1 m/s	1.0	
E at 1 m/s	1 5	
F at 1 m/s	2 3	

Based on 2013 DPM emissions for entire exposure period
* Receptor distances are from edge of traveled roadway
** Conversion factor for 1-hr to annual average conc. of 0.1

01/22/13
17:52:13

*** SCREEN3 MODEL RUN ***
*** VERSION DATED 96043 ***

C:\Projects1\I&R\Mark West\Risk\Screen\2013\Silica-P.scr

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	AREA
EMISSION RATE (G/(S-M**2))	=	0.736000E-06
SOURCE HEIGHT (M)	=	3.0000
LENGTH OF LARGER SIDE (M)	=	144.6000
LENGTH OF SMALLER SIDE (M)	=	87.5000
RECEPTOR HEIGHT (M)	=	1.5000
URBAN/RURAL OPTION	=	RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

ANGLE RELATIVE TO LONG AXIS = 66.0000

BUOY. FLUX = 0.000 M**4/S**3; MOM. FLUX = 0.000 M**4/S**2.

*** FULL METEOROLOGY ***

****
*** SCREEN DISCRETE DISTANCES ***
****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	MAX DIR (DEG)
560.	5.730	6	1.0	1.0	10000.0	3.00	66.

****
*** SUMMARY OF SCREEN MODEL RESULTS ***
****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	5.730	560.	0.

****
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
****

APPENDIX H

Noise Background Data

Appendix H – Noise Background Data

Possible Future Mining Noise Impacts

The cumulative analysis assesses the impact of the project plus future mining of the area currently zoned MR or proposed to be zoned MR, and future mining below the 945-foot elevation. Future mining in the MR areas would be primarily in the northern areas of the site, and would occur after mining in the other areas of the quarry is completed. The processing equipment is proposed to be moved west and eventually back to the central area of the site to a location convenient for processing.

Future noise levels were modeled assuming mobile equipment operating on the north slope of the site in the area zoned MR including the existing overburden area. The modeling results are summarized in Table 1 below. Under this scenario, and assuming the equipment is operating on the slope with an unobstructed sound transmission path to the receptors, noise levels are calculated to exceed the adjusted County limit at the Mountain House Ranch Resort and the northwest residence.

At Mountain Home Ranch Resort and Mayacamas Ranch to the north, the future noise levels during quarry operations are calculated to be up to 48 dBA L_{dn} and 45 dBA L_{dn}, respectively, a 13 dBA and 10 dBA increase above the existing noise level, respectively.[1] There would be a substantial increase in noise at these receptors located north of the quarry.

Table 1
Possible Future Mining Noise (Worst Case) - Comparison to County Standards

Receptor Location*	Existing L50	Future L50	Impact Level (Adjusted County Limit Daytime)	Project Impact Yes/No
West Residence	42	48	50	No
Northwest Residence	53	57	53	Yes
LT-1/Southwest Residence	53	50	53	No
South Residence	54	45	54	No
LT-3/Mountain House Ranch/ Mayacamas Ranch	30-40	43/49/45	45	Yes
ST-1	45	42	50	No
ST-2	46	46	50	No
M-1**	73	73	N/A	N/A

** Reference locations are shown for comparison purposes only.

[1] These noise levels are worst case when the mining is occurring at the nearest point to the two receptors and there is a clear line of sight (I.e., the mining is not buffered by a hill or bank).

When mobile equipment operates at positions where drilling and excavating is expected to take place further north and at a lower elevation, this equipment would be acoustically shielded from the residences to the south. Similarly, mining below the 945-foot elevation would be acoustically shielded and result in noise levels equal to or lower than existing levels. At the southwest residence noise levels due to mining operations are projected to be 40 dBA, 10 dBA below the County's daytime noise limit. Daytime noise levels under these conditions were calculated to be 45 dBA L_{eq} at the south residence, 5 dB below the daytime limit. Once the processing area has been moved to the west and quarry operations have moved to a lower elevation, noise levels from quarry activities are calculated to be at least 5 dBA lower at the south and southwest residences.

Blasting would occur in the MR-zoned areas. Blasting in the overburden area could occur within several hundred feet of the northwest residence. Ground vibration levels are projected to exceed County thresholds if blasting occurs within 600 feet of a residence. The blasting would occur at a distance of at least 2,000 feet from the nearest sensitive receptors located to the north.

Traffic volumes for future baseline and future plus project scenarios were reviewed to calculate future traffic noise levels and the project's relative contribution to noise levels along Porter Creek Road/Mark West Springs Road. Future noise level increases of 2 dBA L_{dn} were calculated with the Caltrans traffic noise model. Future traffic noise increases with truck traffic from the project would be below the impact level of 3 dBA, would not a considerable contribution of at least 1 dBA to the calculated increase.

APPENDIX - NOISE AND VIBRATION

MEASURED BASELINE NOISE LEVELS

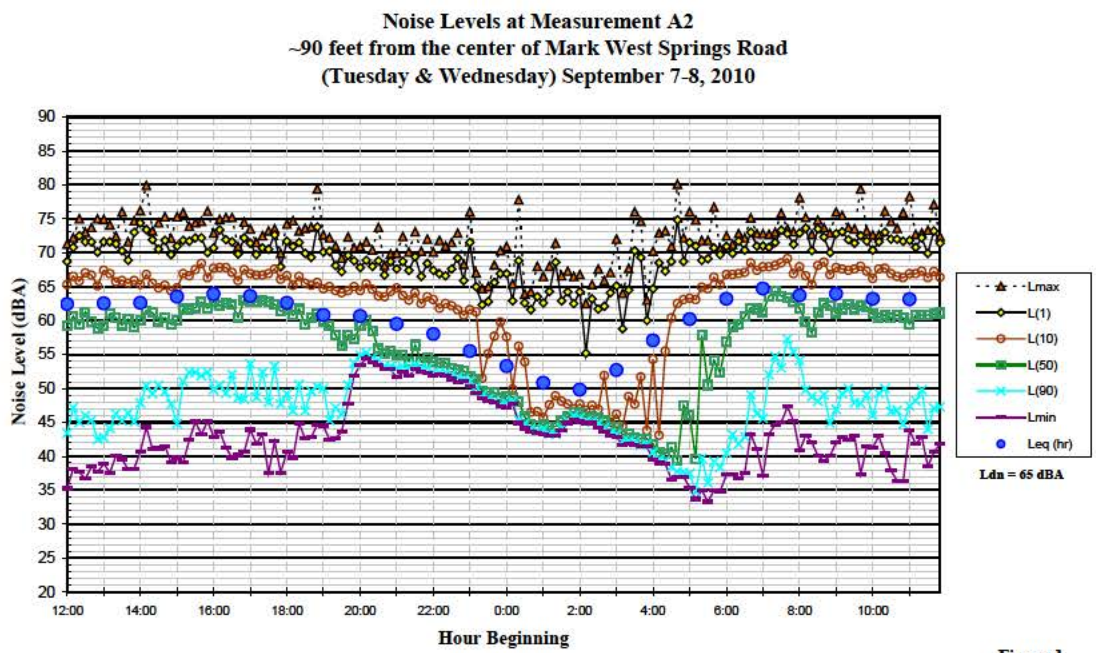


Figure 1

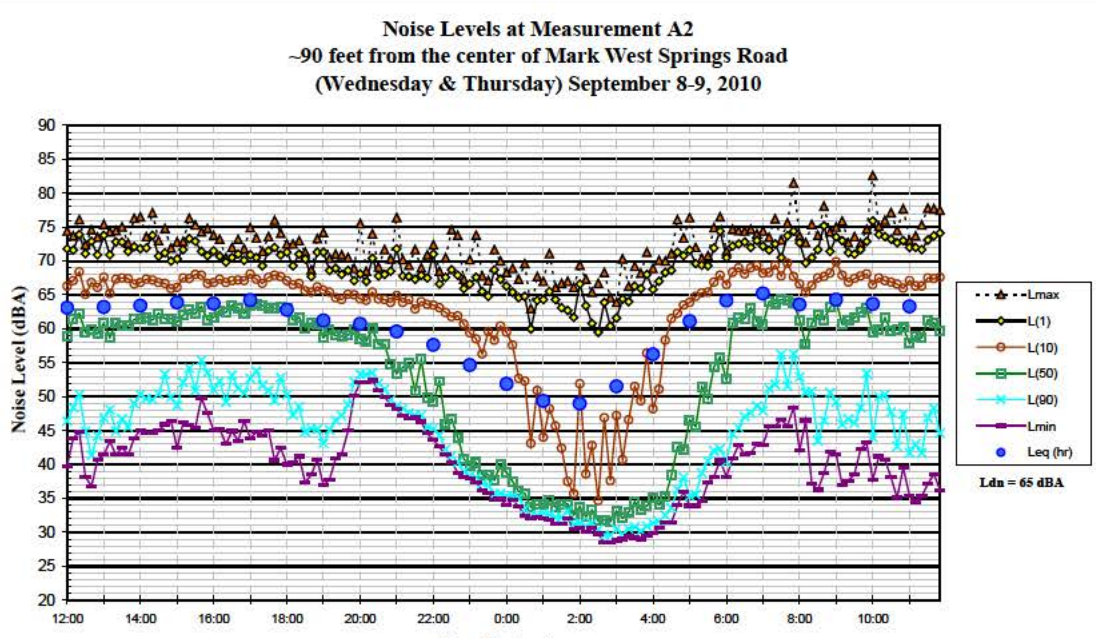


Figure 2

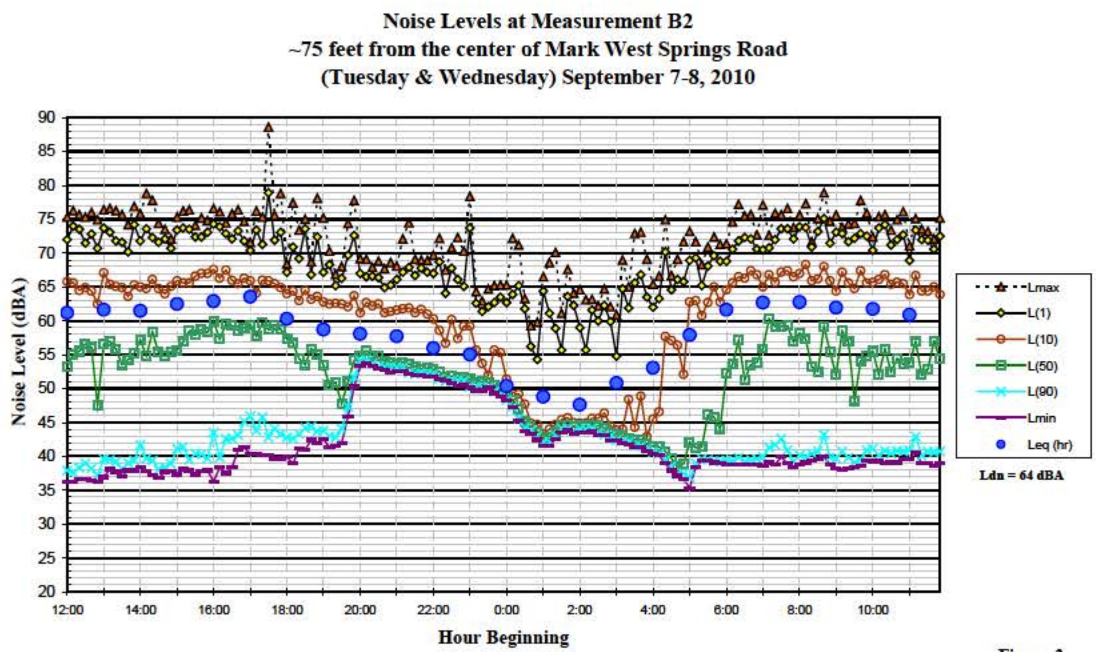


Figure 3

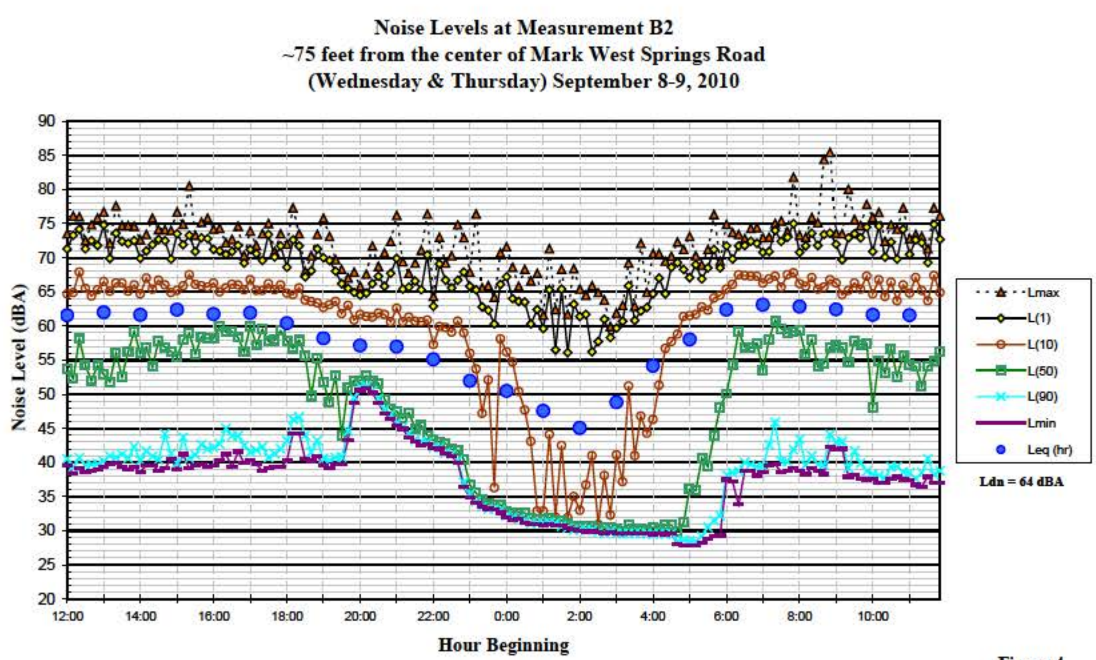


Figure 4

Noise Levels at LT-1
~Residential Land Use Adjacent to Quarry, 700 feet from entrance
(Thursday & Friday) September 9-10, 2010

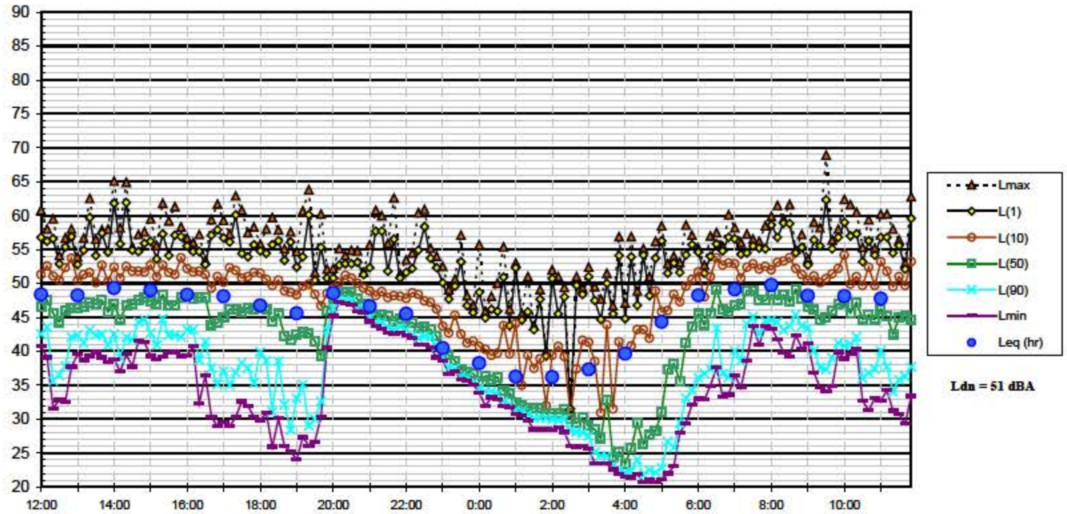


Figure 5

Noise Levels at LT-1
~Residential Land Use Adjacent to Quarry, 700 feet from entrance
(Friday & Saturday) September 10-11, 2010

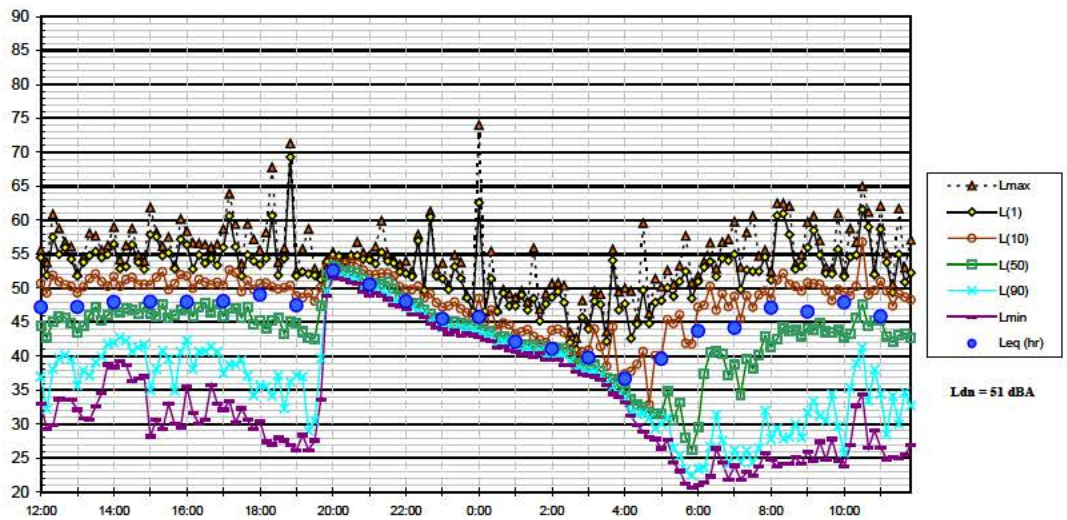


Figure 6

Noise Levels at LT-1
~Residential Land Use Adjacent to Quarry, 700 feet from entrance
(Saturday & Sunday) September 11-12, 2010

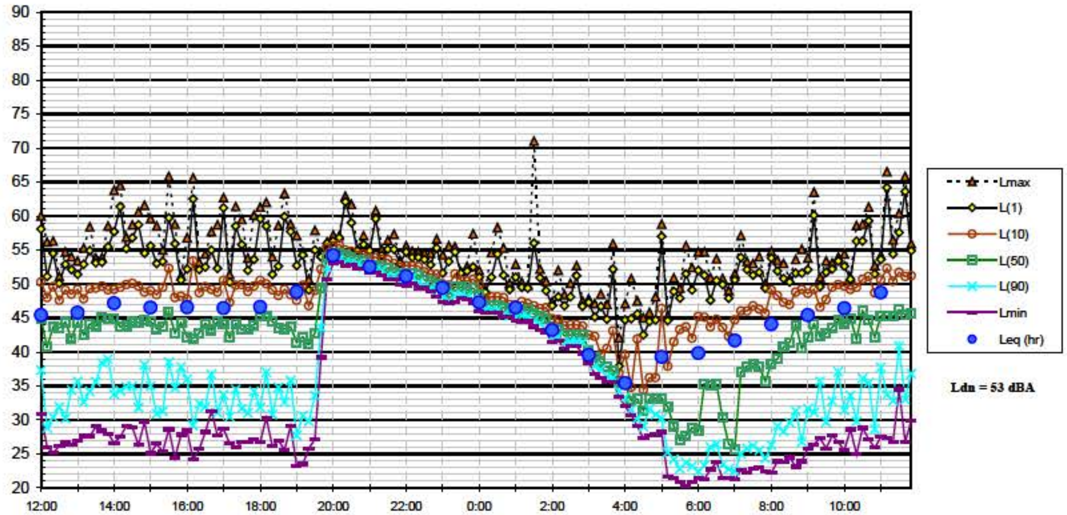


Figure 7

Noise Levels at LT-1
~Residential Land Use Adjacent to Quarry, 700 feet from entrance
(Sunday & Monday) September 12-13, 2010

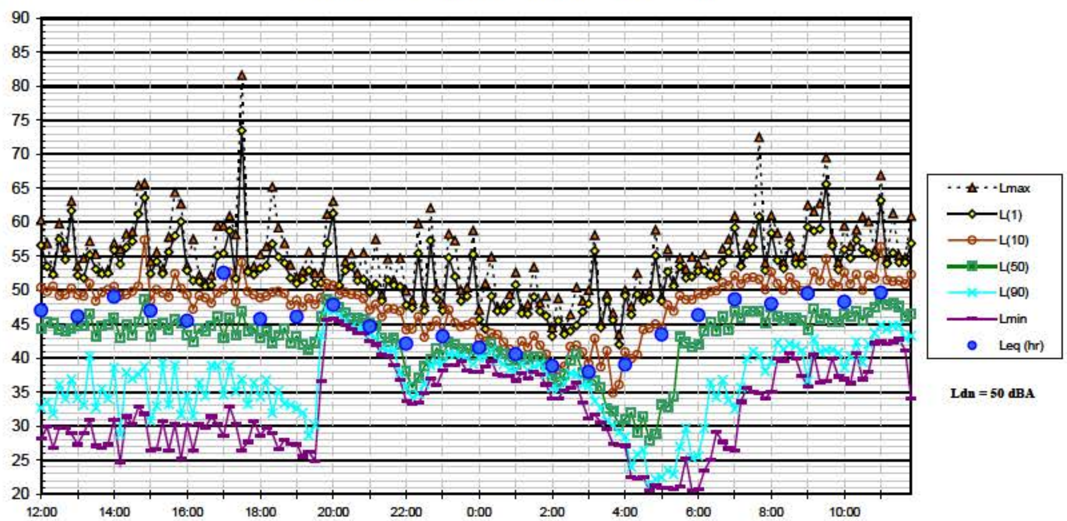


Figure 8

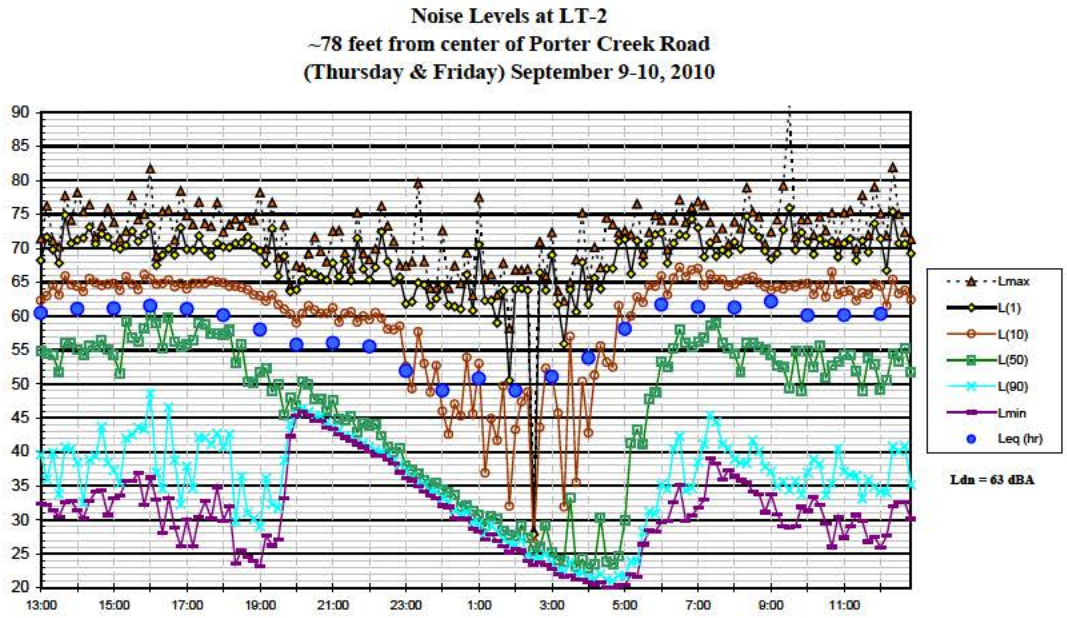


Figure 9

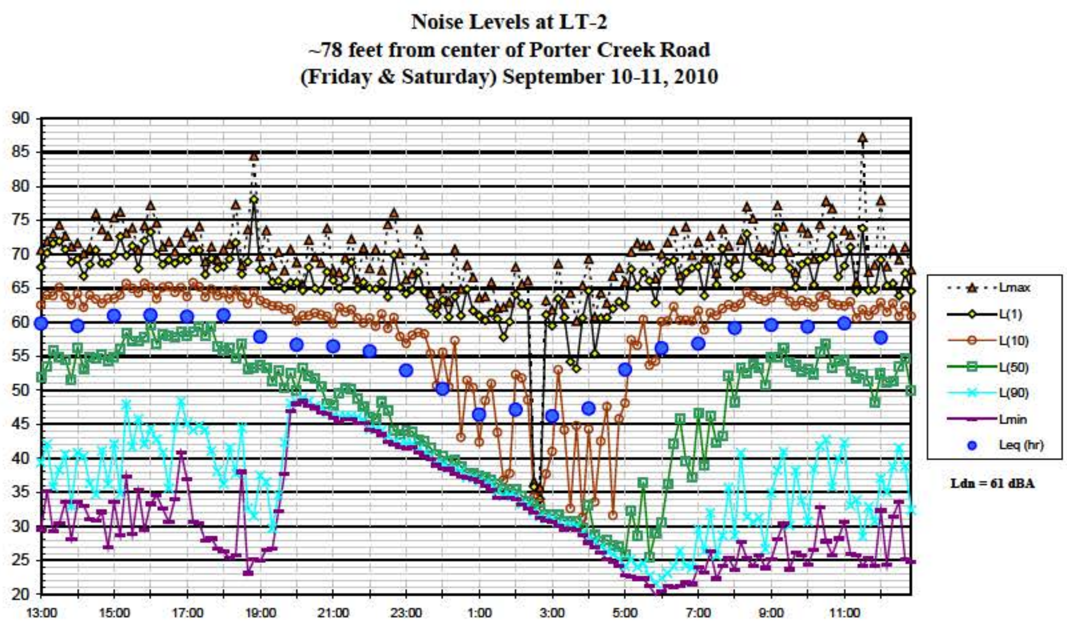


Figure 10

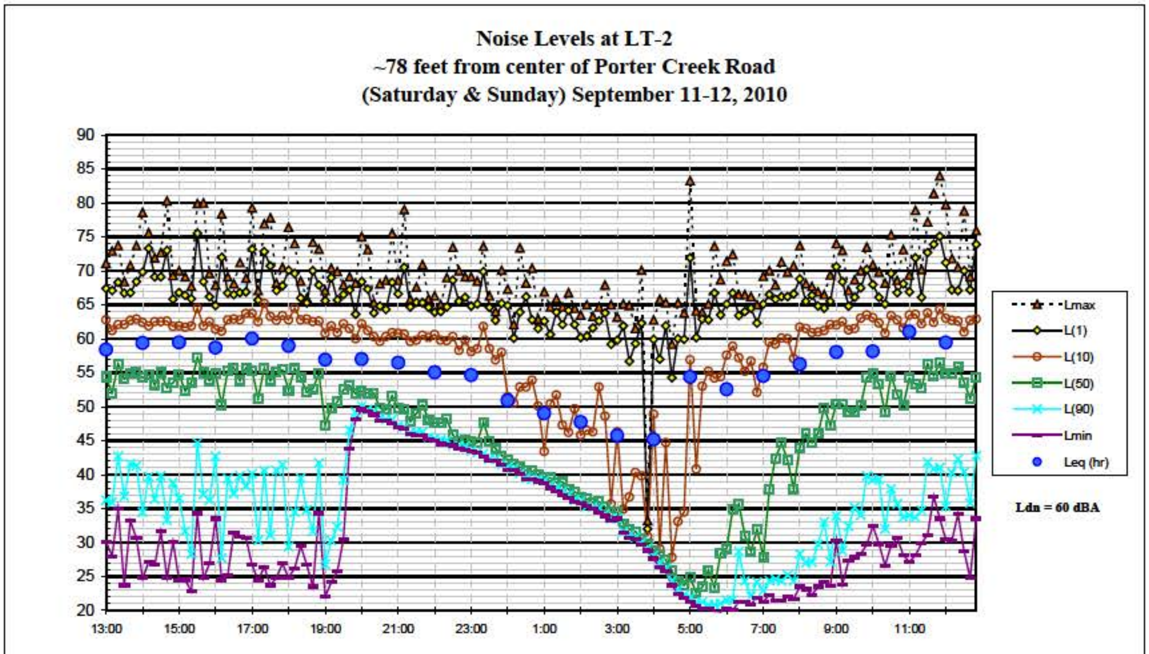


Figure 11

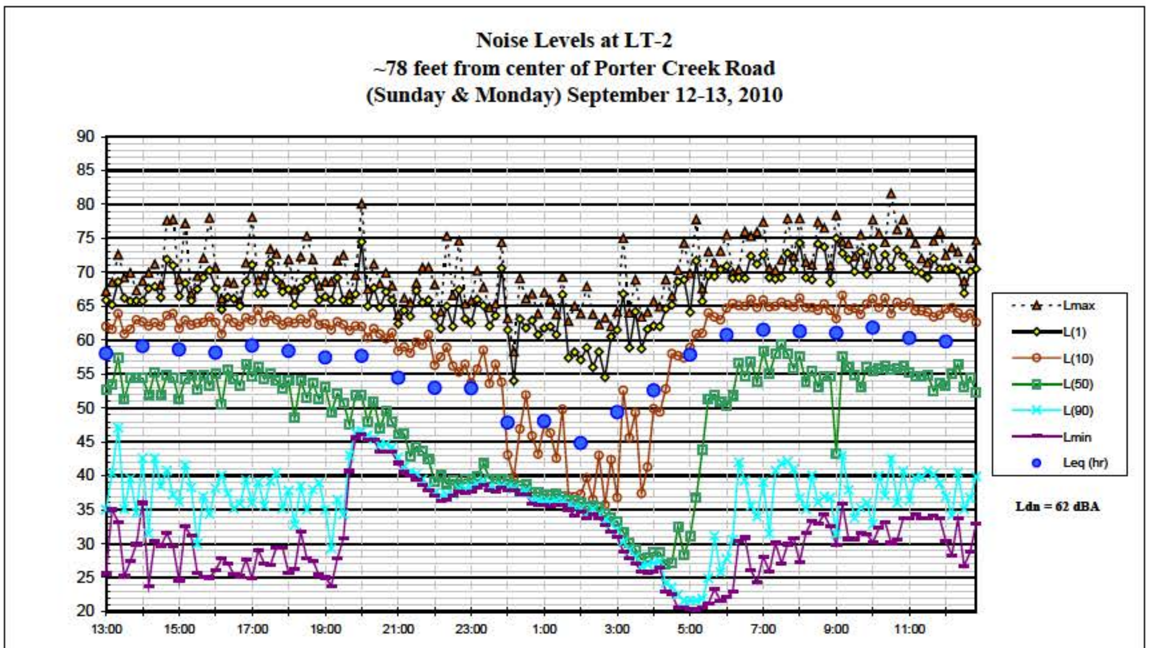


Figure 12

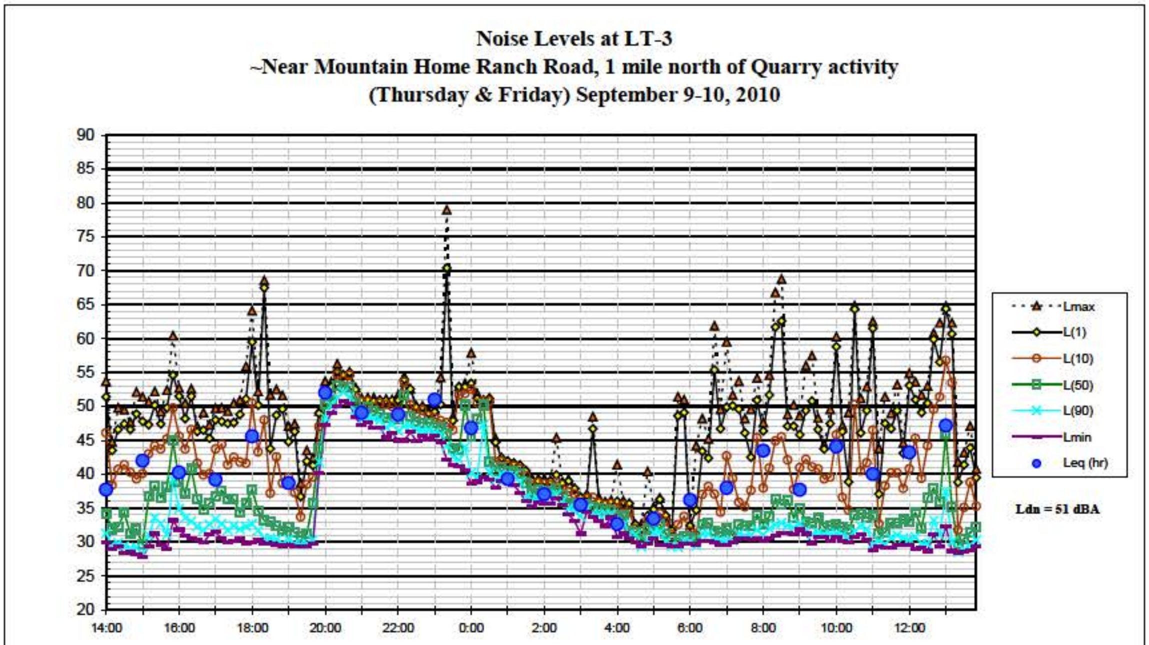


Figure 13

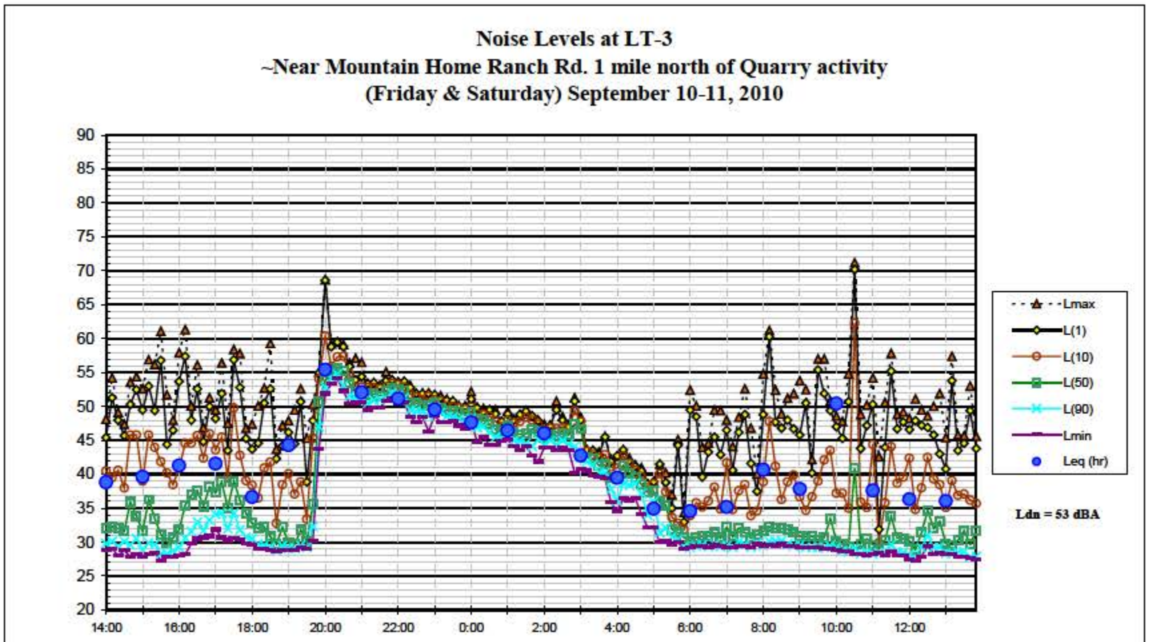
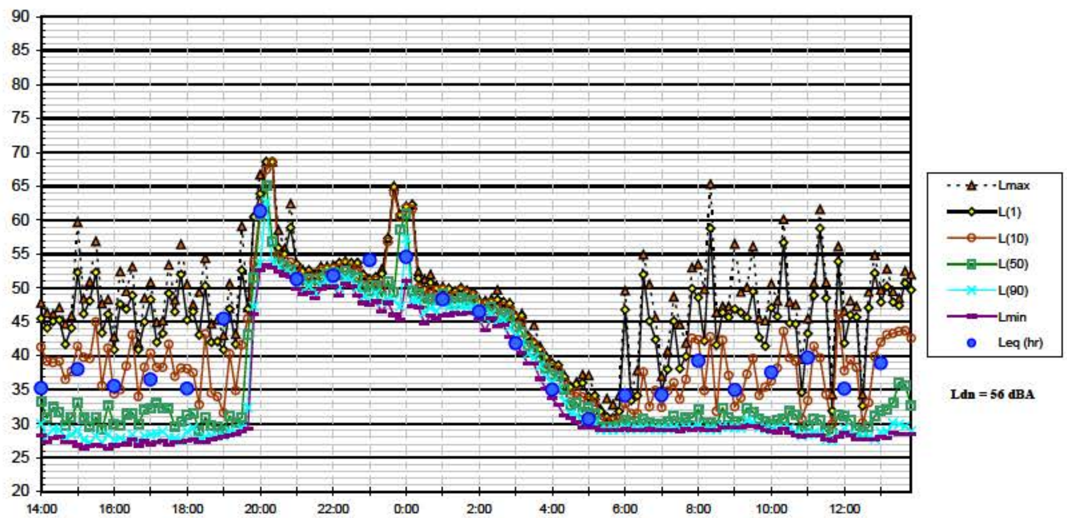


Figure 14

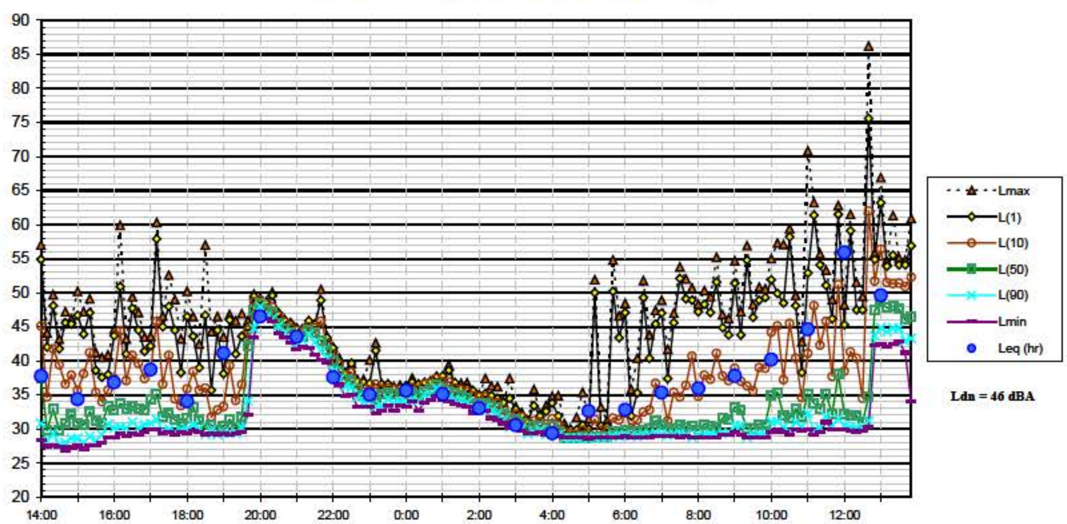
Noise Levels at LT-3
~Near Mountain Home Ranch Rd. 1 mile north of Quarry activity
(Saturday & Sunday) September 11-12, 2010



Ldn = 56 dBA

Figure 15

Noise Levels at LT-3
~Near Mountain Home Ranch Rd. 1 mile north of Quarry activity.
(Sunday & Monday) September 12-13, 2010



Ldn = 46 dBA

Figure 16

BLASTING GROUND VIBRATION LEVELS

Ground vibration levels are calculated with the following equation representing the upper range of levels established by the US Bureau of Mines for various soil conditions:

$PPV = 300 \times (D/W^{1/2})^{1.6}$

PPV = Peak Particle Velocity (in/sec)
D = Distance from explosive charge to receptor (ft.)
W = Weight of explosive charge per delay (lbs).

The calculations are summarized below:

	Location	Distance to Blast (ft)	lbs per delay	PPV
Existing	Rec 1	1920	100	0.066656
Existing	Rec 2	2260	100	0.051351
Existing	Rec 3	1620	100	0.087478
Existing	Rec 4	1690	100	0.081753
Project	Rec 1	1100	100	0.162515
Project	Rec 2	1640	100	0.085777
Project	Rec 3	600	100	0.428627
Project	Rec 4	515	100	0.547305

	Location	Distance to Blast (ft)	lbs per delay	PPV
Existing	Rec 1	1920	60	0.044296
Existing	Rec 2	2260	60	0.034125
Existing	Rec 3	1620	60	0.058132
Existing	Rec 4	1690	60	0.054328
Project	Rec 1	1100	60	0.107998
Project	Rec 2	1640	60	0.057002
Project	Rec 3	600	60	0.28484
Project	Rec 4	515	60	0.363706

TRUCK TRAFFIC NOISE CALCULATIONS

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise
Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road east of driveway - Existing

INPUT DATA (Feet & MPH)	ELEMENT NUMBER 1
1. Auto Volume	625
2. Medium Truck Volume	6
3. Heavy Truck Volume	13
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER   TOTAL LEQ = 61 DBA (APPROX. L10 63 DBA)

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise
Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road west of driveway - Existing

INPUT DATA (Feet & MPH)	ELEMENT NUMBER 1
1. Auto Volume	625
2. Medium Truck Volume	6
3. Heavy Truck Volume	20
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER   TOTAL LEQ = 62 DBA (APPROX. L10 63 DBA)

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road east of driveway - Existing + Project

INPUT DATA (Feet & MPH)	ELEMENT NUMBER 1
1. Auto Volume	625
2. Medium Truck Volume	6
3. Heavy Truck Volume	22
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER TOTAL LEQ = 62 DBA (APPROX. L10 63 DBA)

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise
Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road west of driveway - Existing + Project

INPUT DATA (Feet & MPH)	ELEMENT NUMBER 1
1. Auto Volume	625
2. Medium Truck Volume	6
3. Heavy Truck Volume	32
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER   TOTAL LEQ = 62 DBA (APPROX. L10 64 DBA)

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise
Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road east of driveway - 2035 + Project

INPUT DATA (Feet & MPH)	**ELEMENT NUMBER 1**
1. Auto Volume	770
2. Medium Truck Volume	8
3. Heavy Truck Volume	22
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER   TOTAL LEQ = 62 DBA (APPROX. L10 64 DBA)

*** * * * * * LEQV2 * * * * * ***

San Fransisco Highway Traffic Noise
Prediction Program
Model Version 2.5 February 1985
(Calif. Vehicle Emissions Added)

Based on FHWA-RD-77-108

Title: Porter Creek Road west of driveway - 2035 + Project

INPUT DATA (Feet & MPH)	ELEMENT NUMBER 1
1. Auto Volume	770
2. Medium Truck Volume	8
3. Heavy Truck Volume	32
4. Vehicle Speed	45
5. Dist. to CTR. Near Lane	100
6. Roadway Angle, Left	-90
7. Roadway Angle, Right	90
8. Drop-Off Rate	4.50
9. Number of lanes	2
10. Grade Correction	0
11. Dist. to Shoulder/Cut	0
12. Height of Shoulder/Cut	0
13. Distance to Barrier	0
14. Barrier Type	0
15. Height of Barrier	0
16. Barrier Angle, Left	0
17. Barrier Angle, Right	0
18. Height of Observer	0

OUTPUT DATA (Based on CALIFORNIA Ref. Energy Mean Emission Levels)

NO BARRIER   TOTAL LEQ = 63 DBA (APPROX. L10 65 DBA)