Hydrology and Water Quality Analysis
of the
Proposed 3M Moody Flats Quarry
Use Permit and Reclamation Plan
Shasta County, California

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1.0 Introduction

This report has been prepared to evaluate hydrology and water quality conditions for the proposed 3M Moody Flats Quarry Use Permit and Reclamation Plan application prepared by Resource Design Technology, Inc. on behalf of 3M (the "Project"). This report has been prepared in coordination with the *Field Investigation Report, Hydrology Analysis Report, 3M Redding Hard Rock Aggregate Quarry, Shasta County, California*, prepared by Brown & Caldwell (the "Field Investigation Report"), which is included as Attachment A to this report. The Project is located in Shasta County east of Interstate 5 and north of the town of Shasta Lake (Figure 1).

The Project involves the quarrying of bedrock for the production of construction aggregate. The Project will occur within a metamorphosed basaltic-andesitic lava flow unit mapped as the Bass Mountain Diabase, as discussed in more detail in the Field Investigation Report. Additional details regarding the Project are provided in the Project Description within the application package.

This report describes the aquifer conditions at the site, assesses surface-water and groundwater quality, evaluates the hydrologic conditions within the quarry pits before and after mining, and presents conclusions regarding the potential impacts the Project may have on hydrology and water quality, consistent with California Environmental Quality Act (CEQA) guidelines. This evaluation of hydrology and water-quality issues is based on site-specific data collected specifically for this application, publicly available maps and reports from the California Department of Water Resources and other sources, and data provided by 3M. Data tables, figures, and appendices referenced in the text are found at the end of this report.

2.0 Site Setting

The Project is located in undeveloped land that consists primarily of meadows and forest land. In the Project vicinity, elevations range from approximately 900 feet above mean sea level (ft msl) to over 2000 ft msl (see Figure 1). The Union Pacific right-of-way crosses the southeast part of the Project area.

The most significant surface-water feature in the area is Shasta Lake, located approximately one to two miles northwest of the Project area. Shasta Dam has a crest elevation of 1077.5 ft msl. Water levels fluctuate seasonally within the lake. The recent peak water elevation occurred in June 2006 at 1064 ft msl. The recent low water elevation in the lake occurred in October 2008 at 909 ft msl. (www.cdec.water.ca.gov)

There are several surface-water drainages located within the Project area, as shown on Figure 1. Most of the Project area is within the Moody Creek watershed. The western side of the Project area is within the Salt Creek watershed. Salt Creek and Moody Creek are part of the Sacramento River watershed downstream of Shasta Dam.

General meteorological data for the Project area are presented in Table 1. The average high temperature ranges from 53 degrees F in January and December to 95 degrees F in July. The average low temperature ranges from 39 degrees F in January to 68 degrees F in July. The seasonal temperature variations, however, can be much larger. For example, the record high temperature is 115 degrees F (in 1981), whereas the record low temperature is 7 degrees F (in 1985). The average annual precipitation in the project vicinity is approximately 64 inches per year (www.weather.com, WRCC, 2007).

Evaporative loss of water is estimated through several parameters. The pan evaporation rate is the rate at which water will evaporate from a standard (Class A) pan used for making such a measurement. The measured pan evaporation rate is used to approximate other water-loss terms such as the lake evaporation rate and the evapotranspiration rate. The lake evaporation rate is the rate at which water evaporates from surface-water bodies, such as lakes or ponds, and is typically less than the pan evaporation rate. In the project area, the lake evaporation rate is assumed to be approximately 0.7 times the pan evaporation rate (Department of Water Resources, 1975, 1986). The evapotranspiration rate is the amount of rainfall and applied water (e.g. for irrigation or dust control) that is lost to both surface evaporation and transpiration from plant surfaces. In the project area, the evapotranspiration rate is assumed to be approximately 0.8 times the pan evaporation rate (Department of Water Resources, 1975, 1986). The average pan evaporation rate for the Project area is approximately 64 inches.

3.0 Aquifer Conditions

To assist in evaluation of the aggregate resource at the site, 3M drilled numerous boreholes in 1980 within the Project area. Logs for 13 of these boreholes were provided by 3M and are included in Appendix A of the Field Investigation Report. To further assess groundwater conditions at the Project site, Brown & Caldwell drilled four boreholes in the area of the South Pit during the first week of May 2009 (see Figure 2 for borehole locations). Three of these boreholes were located near the perimeter of the proposed South Pit and were drilled to a depth of 50 ft below ground surface (bgs). The fourth borehole was drilled to a depth of 100 ft bgs and was located within the proposed South Pit footprint. The boreholes were drilled using an air rotary rig. To comply with Shasta County Environmental Health Department permit requirements, a six-inch diameter steel conductor casing was installed in each borehole. After drilling to total depth, two-inch diameter PVC was installed in each borehole. The boreholes were open below the conductor casing, with a 20-foot screened section at the base of each borehole.

During drilling, groundwater was observed only in borehole B-1. Water production was estimated to average one to two gallons per minute during drilling. Borehole B-1 is located near the southeast edge of the proposed South Pit, adjacent to a small drainage that is tributary to Moody Creek. Water was not observed during drilling in any of the other boreholes. After completion, water was observed in all four boreholes. In B-1, almost 32 feet of water accumulated within the well casing. At MW-1, located within the quarry footprint, almost 77 feet of water accumulated within the well casing. At B-2 and

B-3, located near the north and west edges of the proposed quarry, less than two feet of water accumulated in the well casings. It is uncertain whether the small volume of water present in B-2 and B-3 represents actual groundwater conditions or was the result of condensation that accumulated within the borehole and casing after drilling.

The depth to groundwater in the boreholes ranged from approximately 18 feet to 49 feet bgs. In general, the groundwater surface tends to mimic the topography, as indicated in Table 2. The highest water-surface elevations are at B-3 and MW-1, located along the west side and central parts of the proposed South Pit. The lowest water-surface elevation was recorded at B-1, near the southeastern edge of the proposed South Pit and adjacent to a tributary of Moody Creek.

As shown on Figure 1, the proposed South Pit is located on a small peak that sits along a northwest-southeast trending ridge. Therefore, the groundwater identified in the boreholes must be sourced by local recharge within the project boundary, since there is no other upslope watershed area adjacent to the proposed quarry site. The water production information from drilling, and purge rates (discussed below) indicate that the fractured greenstone bedrock contains very limited quantities of groundwater.

4.0 Surface-Water and Groundwater Quality

Water samples were collected from several surface-water features and the boreholes to evaluate the baseline water quality. The samples were analyzed for general mineral parameters and for metals. Surface-water samples were collected on March 30, 2009. Groundwater samples were collected from the four boreholes on May 27, 2009. The laboratory analytical reports for the surface-water and groundwater samples are included in Appendix C of the Field Investigation Report.

Surface-water samples were collected from three locations within the Project area, as shown on Figure 2. Sample locations include:

- SW-1, collected from the unnamed tributary to Salt Creek located on the west side of the South Pit;
- SW-2, collected from the unnamed tributary to Moody Creek that drains the north and northeast sides of the South Pit and the southeast side of the North Pit; and
- SW-3, collected from Moody Creek upstream of the confluence with the unnamed tributary from which sample SW-2 was collected.

A duplicate sample was also collected at the SW-1 location for quality assurance/quality control (QA/QC) purposes. The water samples were collected from actively flowing surface streams.

The surface-water chemistry data are presented in Table 3. The only metal reported above its analytical detection limit in the surface-water samples was barium. Barium was reported at a concentration of 22 micrograms per liter (ug/L) in sample SW-3, collected from Moody Creek.

The surface-water samples had relatively low dissolved solids levels, with total dissolved solids (TDS) levels ranging from 65 milligrams per liter (mg/L) in the sample from the tributary to Moody Creek (SW-2), to 75 mg/L in the sample from the tributary to Salt Creek (SW-3), to 130 mg/L in the sample from Moody Creek (SW-1 and its duplicate). The pH levels were neutral, ranging from 6.99 to 7.65. Figures 3 and 5 present a Stiff Plot and Piper Diagram, respectively, of the water chemistry from the surface-water samples. The Stiff Plots indicate that the surface water is a calcium-bicarbonate water type at all three sample locations. The Piper Diagram indicates that all three surface water samples are very similar, with only minor differences in the ratios of bicarbonate, chloride, and sulfate. Stiff plots and Piper diagrams are graphical tools used to present the general mineral chemistry of water samples, based on the variations in the anions (negatively-charged atoms) and cations (positively-charged atoms) that make up the total dissolved solids in the water. Stiff plots and Piper diagrams are standard methods for interpretation of the chemical characteristics of water (Hem, 1989).

Groundwater samples were collected from all four boreholes drilled at the South Pit area. A duplicate sample was also collected from B-1 for QA/QC purposes. The groundwater chemistry data are presented in Table 3. Several metals were detected in the groundwater samples. Antimony, arsenic, molybdenum, and vanadium were detected at relatively low concentrations in the sample from B-3. Barium and iron were detected at relatively low concentrations in the sample from B-2. Manganese was detected in the samples collected from all four boreholes. Table 3 also shows the water-quality limits for metals identified in the Water Quality Control Plan for the Sacramento River Basin (the “Basin Plan”), prepared by the Regional Water Quality Control Board. The detected metals concentrations were below the Basin Plan limits except for the manganese levels in the samples from B-2 and MW-1.

The groundwater samples had moderate dissolved solids levels, with total dissolved solids (TDS) levels ranging from 140 mg/L in the samples from B-1, to 210 mg/L in the sample from MW-1, to 440 mg/L in the sample from B-2, to 700 mg/L in the sample from B-3. The pH levels ranged from slightly acidic in MW-1 (pH of 6.19), to neutral in B-2 (pH of 7.74), to slightly alkaline in B-1 and B-3 (pH of 8.14 and 8.29, respectively). Figures 4 and 5 present a Stiff Plot and Piper Diagram, respectively, of the water chemistry from the groundwater samples. The Stiff Plots and Piper Diagram indicate that the groundwater type varies somewhat in the Project area. The groundwater at B-1, B-2, and MW-1 is a calcium-bicarbonate water type. At B-3, the groundwater is a sodium-bicarbonate water type.

5.0 Hydrologic Conditions Within the Quarry Pits Before and After Mining

The proposed Project will include two separate pits. Details regarding the pit dimensions and mining sequence are presented in the Project Description for the Application. Specific details or assumptions used to evaluate the hydrologic conditions within the pits are summarized below.

The South Pit will have a surface area of approximately 64 acres. The current maximum elevation in the South Pit boundary is about 1400 ft msl. The final floor of the South Pit will have a surface elevation of 950 ft msl. As mining progresses, the pit will drain internally. Side slopes will average approximately 1:1 (horizontal:vertical). The quarry floor will have an area of approximately 25 acres. Once mining is completed, the southern pit will have a watershed area of about 64 acres, which is equivalent to the entire mined area. The reclaimed pit will consist of high-walls on the north, west, and south, but will be open on the east side, with the quarry floor matching the elevation of the natural topography. Thus, rainfall and groundwater that enter the pit after reclamation will drain to the east, into Moody Creek.

The North Pit will have a surface area of approximately 238 acres. The current maximum elevation within the North Pit area is about 2000 ft msl. The final floor of the North Pit will have a surface elevation of 1200 ft msl. As mining progresses, the pit will drain internally. Side slopes will average approximately 1:1 (horizontal:vertical). The quarry floor will have an area of approximately 137 acres. Once mining is completed, the southern pit will have a watershed area of about 238 acres, which is equivalent to the entire mined area. The reclaimed pit will consist of high-walls on the north, west, and south, but will be open on the southeast side, with the quarry floor matching the elevation of the natural topography. Thus, rainfall and groundwater that enter the pit will drain to a tributary of Moody Creek.

During mining, rainfall, groundwater seepage, and dust-control water that accumulates in the pits will be retained and used for process or dust-control water. Thus, there will be no drainage from the mine pits during operation. After mining is completed, the pits will be reclaimed and revegetated. As part of the reclamation activities, the floor of the pits will be sloped so that they drain into the natural drainages so that water will not accumulate in the pits.

Most of the area of the south pit is currently within the Moody Creek watershed. During mining, there will be a slight reduction in the runoff to Moody Creek since rain that falls on the pit area will be retained in the pit. Once mining is completed, however, the volume of runoff in the Moody Creek watershed will return to pre-mining levels. The mining activities will not result in a substantial increase in runoff into the Moody Creek watershed.

Most of the area of the north pit is currently within the Moody Creek watershed. During mining, there will be a slight reduction in the runoff to Moody Creek since rain that falls on the pit area will be retained in the pit. Once mining is completed, however, the volume of runoff in the Moody Creek watershed will return to pre-mining levels. The mining activities will not result in an increase in runoff into the Moody Creek watershed.

6.0 Project Water Demand

A comparison of the consumptive water use for hard-rock aggregate quarries in northern California that have recently been permitted or are in the process of being permitted was prepared to estimate the water needs for the proposed 3M quarry. Table 4 shows this comparison. Based on this assessment, the average net water use of hard-rock quarries in northern California for processing, dust control, and other project needs averages 130 acre-feet per year (AF/yr) per million tons of production. Therefore, at an initial production rate of 500,000 tons per year, the Project will require approximately 65 acre feet of water per year (AF/yr). At a production rate of 2,000,000 tons per year, the consumptive water use will be approximately 260 AF/yr. In terms of pumping rates, this represents a range of approximately 60 gallons per minute (gpm), 24-hours per day for 250 operating days per year to produce 65 AF, to pumping at 235 gpm, 24-hours per day for 250 operating days per year to produce 260 AF/yr.

The nearest groundwater production of any significance occurs in the Spring Branch Creek watershed, located just north of the Moody Creek watershed and the Project area. Most wells in the area produce only a few gpm, sufficient for domestic use, but the Mountain Gate Community Services District has two wells in the Spring Branch Creek watershed that combined produce approximately 350 AF/yr of groundwater (220 gpm average) (Lawrence & Associates, 1992). The wells are located in a highly folded, faulted, and fractured area within the Kennett Formation. The Kennett Formation consists of shale, chert, and sandstone within the Spring Branch Creek watershed and is much more fractured than the Bass Mountain Diabase in most areas. The Mountain Gate CSD water production information, however, suggests that identification of comparable areas of folding and faulting within the Project area may yield appreciable quantities of groundwater.

An alternative source for Project water supply is retention of local runoff within the quarry pits. The most likely scenario for water supply would include a combination of groundwater wells, with seasonal storage in the quarry basins and/or tailings ponds.

7.0 Evaluation of Potential Impacts

This section presents an evaluation of the potential impacts of the Project on hydrology and water quality based on the CEQA standards of significance. Appendix G of the Guidelines for Implementation of the California Environmental Quality Act provides guidance for assessing the significance of potential environmental impacts. Relative to hydrology and water quality, a Project will normally have a significant effect on the environment if it will:

- Violate any water quality standards or waste discharge requirements;
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a

lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted);

- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner, which would result in substantial erosion or siltation on- or off-site;
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site;
- Create or contribute runoff water, which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff;
- Otherwise substantially degrade water quality;
- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map;
- Place within a 100-year flood hazard area structures which would impede or redirect flood flows;
- Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam; or
- Inundation by seiche, tsunami, or mudflow.

Each of these significance criteria are discussed below.

Will the Project violate any water quality standards or waste discharge requirements?

Prior to commencing operations, the applicant will need to submit a Report of Waste Discharge (RoWD) to the Regional Water Quality Control Board to determine whether Waste Discharge Requirements (WDRs) will be required for the Project. Typical operations that may require a WDR include discharge of process water and the use of settling ponds. As discussed above, process water will be retained onsite. Settling ponds will be used to reclaim and recycle process wash water. Any tailings that accumulate in the settling ponds will have the same geologic composition as the bedrock that will be mined to produce aggregate. Therefore, the process water will have a water chemistry similar to that of the surface runoff and groundwater at the site. As discussed above, except for the concentrations of manganese in two groundwater samples, the water samples collected for this evaluation meet the Regional Water Quality Control Board Basin Plan limits, which are typically used for WDR water-quality standards.

The applicant will also need to submit a Notice of Intent (NOI) to discharge stormwater to the State Water Resources Control Board, and prepare Construction and Industrial Stormwater Pollution Prevention Plans (SWPPP), as appropriate. Best management practices will be used to control stormwater runoff from the process area, overburden storage site, plant site, and stockpile and loadout area, and prevent the discharge of pollutants, including sediment, from the Project facilities.

Compliance with the WDRs and SWPPP will maintain water quality at the Project site and prevent any violations of water quality standards.

Will the Project substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?

There are no known groundwater supply wells completed within the Bass Mountian Diabase bedrock formation that will be mined within the vicinity of the proposed Project. Groundwater production for domestic and municipal supply use occurs in adjacent watersheds and from different geologic formations. The Project will not affect these watersheds and will not involve the mining of these other geologic formations.

As discussed above, the groundwater surface tends to mimic the topography, but is located approximately 18 ft bgs to 49 ft bgs. The fractured bedrock contains very little groundwater, with maximum production rates of only one to two gallons per minute (1 to 2 gpm) observed in the area of the South Pit. Since the mine pit locations are on small peaks located along a topographic ridge, the pits form their own watersheds and will not intercept groundwater that has percolated into the subsurface from outside the pit boundaries. Therefore, the quarry pits will not affect groundwater supplies outside of the pit boundaries or at depths below the pit floors.

The mine pits will not interfere with or reduce recharge. During mining, all rain that falls within the pit will be retained within the pit. Part of the water retained within the pit will recharge groundwater through fractures in the bedrock. After mining is completed, reclamation will re-establish the natural surface drainage patterns in the area. The flat quarry floors, however, will enhance recharge locally.

The final elevation of the South Pit will be below the high water levels in Shasta Lake. The lake, however, is nearly two miles from the South Pit. In addition, another dense, massive geologic unit, the Copley Greenstone, is located between the South Pit and Shasta Lake. The Copley Greenstone is not highly fractured and does not transmit large quantities of groundwater. Therefore, there is no indication that the proposed Project could cause water to flow from Shasta Lake to the South Pit.

Based on the available data and the above discussion, the Project will not deplete groundwater supplies, interfere with recharge, or affect the production rate of pre-existing wells.

Will the Project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner, which would result in substantial erosion or siltation on- or off-site?

The Project will alter the drainage patterns at the two quarry locations, the plant site, and the overburden storage area. During mining, rain that falls on the disturbed quarry areas will be retained within the quarry pits for use as process water or dust control water. There will be no discharge of water from the quarry pits, and thus no potential for erosion or siltation, from the quarries. After the quarries have been reclaimed, surface runoff will occur within the same watersheds and natural drainage courses as it did prior to mining. The drainage pattern will not be altered substantially, and no streams or rivers will be altered by the quarry pits.

The processing area and overburden storage area will involve the filling of small drainages with waste rock and overburden. Major stream courses or rivers will not be altered. Drainage controls and stormwater best management practices will be constructed in these areas to prevent erosion or siltation.

Will the Project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?

During mining, the amount of surface runoff will be reduced since rain that falls within the quarry pits will be retained onsite. After the pits are reclaimed and revegetated, the rate and amount of runoff should be the same as that which occurred prior to mining. Therefore, the Project will not increase surface runoff and will not result in any flooding.

Will the Project create or contribute runoff water, which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?

As discussed above, any rain that falls within the quarry pits will be retained within the pits during mining. Runoff from the process area, overburden storage site, plant site, and stockpiling and loadout area will be controlled in accordance with best management practices, as defined in the SWPPP. After reclamation, runoff will occur through existing drainage channels and stream courses. Runoff will not exceed that which currently occurs through the same drainage courses.

Will the Project otherwise substantially degrade water quality?

Mining of the bedrock will require blasting. Blasting agents may include ammonia, nitrate, or other chemicals that may degrade water quality if not managed properly. Blasting agents will be managed in accordance with the Blasting Best Practices of the Institute of Makers of Explosives (Attachment B) to prevent degradation of water quality from blasting agents.

Will the Project place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?

The Project will not involve the construction of any housing.

Will the Project place within a 100-year flood hazard area structures which would impede or redirect flood flows?

The Project will not involve the placement of any structures within a 100-year flood hazard area that could impede or redirect flood flows.

Will the Project expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?

As discussed above, the Project will not cause an increase in runoff. The Project water supply, however, may include the in-stream or off-stream storage of surface water. Storage of surface water will require a water-rights determination from the Department of Water Resources (DWR) Division of Water Rights, along with other approvals and/or permits from US Army Corps of Engineers, California Department of Fish and Game, and DWR Division of Safety of Dams (DSoD). The DSoD requirements will ensure that any levee or dam meets current engineering and safety standards, and that annual inspections and maintenance are conducted. Compliance with these standards will minimize, to the extent feasible, the risk of flooding as a result of the failure of a levee or dam.

Is the Project subject to inundation by seiche, tsunami, or mudflow?

The Project site is not immediately adjacent to any large surface water bodies. Therefore, the Project is not subject to inundation by seiche or tsunami. The Project area is underlain by bedrock with minimal soil cover. Therefore, the Project is not subject to inundation by a mudflow.

8.0 Summary and Conclusions

To conduct this evaluation, both publicly-available and site-specific data were obtained to provide an adequate understanding of current, or baseline, conditions at the site and to estimate the conditions that will exist when the proposed project is completed. The site-specific data collection included field reconnaissance, collection and laboratory analysis of surface-water samples, drilling of four boreholes and subsequent monitoring well completions, measurement of groundwater levels, and the collection and laboratory analysis of groundwater samples. Readily available public information regarding meteorological and geological conditions was also obtained to assist in the evaluation of the project.

The proposed Moody Flats Quarry will be located west of Interstate Highway 5 and north of the town of Shasta Lake. Mining will occur from two quarry pits in the metamorphosed volcanic rocks of the Bass Mountain Diabase to produce crushed aggregate. The proposed quarry pits will cover an area of approximately 64 acres for the South Pit and 238 acres for the North Pit, and will be excavated to an elevation of 950 ft msl and 1200 ft msl, respectively. The current peak surface elevation ranges from 1400 ft msl at the South Pit to 2000 ft msl at the North Pit.

Water samples were collected from three surface-water drainages and four boorehoels at the Project site. The samples were analyzed for general mineral parameters and for metals. With two minor exceptions for manganese, the surface-water and groundwater quality meets Regional Water Quality Control Board Basin Plan limits.

Stiff plots and Piper diagrams were prepared to present the general mineral chemistry of water samples, based on the variations in the anions and cations that make up the total dissolved solids in the water. The Stiff plots and Piper diagrams indicate that the surface-water and groundwater samples are very similar in terms of their dissolved solids content, with the exception of one surface water sample collected on the west side of the Project area. The water types are interpreted to be indicative of the natural mineral variations in the geologic units across the area.

This hydrologic evaluation includes an assessment of the current, or baseline, conditions for the Project area, as well as the anticipated conditions when mining is completed. The quarry pits will be mined such that the eastern side of both the North and South Pits match the natural surface slopes. High walls will be present along the north, west, and south sides of the pits. During mining, rainfall and dust control water will be retained within the pits and there will be no discharge from the quarries. Any water that accumulates in the pits during active mining operations is anticipated to be used at the site for process water or dust control. Once mining is completed and the pits are reclaimed and revegetated, runoff from the high walls and pits will follow the natural drainage courses within the Moody Creek and Salt Creek watersheds. There will not be any increase in the amount of water flowing in these creeks as a result of the Project.

It is anticipated that the Project will have a net consumptive use of water ranging from 65 AF/yr at an initial production rate of 500,000 tpy up to 260 AF/yr for a production rate of 2,000,000 tpy. The bedrock in the area typically does not produce sufficient quantities of water to meet this demand, due to the limited amount of fracturing in the massive greenstone units. In an adjacent watershed, however, up to 350 AF/yr of groundwater is produced from wells within a highly fractured and faulted bedrock formation. Project water demand is anticipated to be met by a combination of groundwater, rainfall runoff collected within the quarry pits, and, if necessary, storage of surface water.

The CEQA Appendix G Guidelines provide significance criteria for evaluation of potential impacts related to hydrology and water quality. The Project will include the use of best management practices to protect water quality. The Project will not deplete the groundwater supplies of users in adjacent watersheds, and will not affect Shasta Lake.

Appropriate drainage controls and other stormwater protections will be taken to prevent erosion, siltation, and flooding impacts from occurring. By maintaining compliance with conditions in the WDRs, SWPPP, and other standard practices as part of the Project operations, the Project is not anticipated to have any significant impacts with respect to hydrology and water quality.

9.0 References Cited

Central Valley Regional Water Quality Control Board (CVRWQCB), The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region, Fourth Edition – 1998, The Sacramento River Basin and The San Joaquin River Basin, 1998.

Department of Water Resources, Vegetative Water Use in California, 1974, Bulletin 113-3, 1975.

Department of Water Resources, Evaporation from Water Surfaces in California, Bulletin 73-79, 1979.

Department of Water Resources, Crop Water Use in California, Bulletin 113-4, 1986.

Hem, J.D., Study and Interpretation of the of the Chemical Characteristics of Natural Water, 3rd ed., U.S. Geological Survey Water-Supply Paper 2254, 1989.

Lawrence & Associates, Hydrogeologic Conditions and Ground-Water Potential within the Mt. Gate CWSD Boundary, March 19, 1992.

www.cdec.water.ca.gov

www.weather.com

TABLE 1
TEMPERATURE AND METEOROLOGICAL DATA

Parameter	January	July
Average High Temperature	53	95
Average Low Temperature	39	68
Mean Temperature	46	81
Record High Temperature	75(1968)	115(1981)
Record Low Temperature	7(1985)	50(1997)
Average Annual Precipitation	64	
Pan Evaporation	64	
Lake Evaporation	45	

Notes:
Temperature in Degrees Fahrenheit
Rainfall and Evaporation Rates in Inches

Sources:
Weather.com
WRCC (2007)
Department of Water Resources (1975, 1979)

Table 2. Well Completion and Water Level Data
Proposed Moody Flats Quarry, Shasta County, California

Location Name	Sample Date	Total Depth (ft)	Conductor Interval (ft. msl)	Open Interval (ft. msl)	Screen Length (ft)	Depth To Water (ft)	Height of water in Well (ft)	Estimated Surface Elevation (ft. msl)	Estimated Water Surface Elevation (ft. msl)	Notes
B-1	5/27/2009	49.80	1115 - 1095	1095-1065	20	17.95	31.85	1115	1097.05	~1 gpm reacharge rate
B-2	5/27/2009	49.95	1150 - 1130	1130-1100	20	48.03	1.92	1150	1101.97	Water likely condensate
B-3	5/27/2009	49.90	1200 - 1180	1180-1150	20	48.82	1.08	1200	1151.18	Water likely condensate
MW-1	5/26/2009	99.70	1200 - 1180	1180-1100	20	22.86	76.84	1200	1177.14	<1 gpm recharge rate

Note:
ft = Feet
ft. msl = Feet above mean sea level
gpm = gallons per minute

TABLE 3

Water-Quality Data

			Surface Water				***Groundwater***					Basin Plan Limits
	Location		SW-1	SW-1 Dup	SW-2	SW-3	B-1	B-1 Dup	B-2	B-3	MW-1	
	Sample Date		3/30/2009	3/30/2009	3/30/2009	3/30/2009	5/27/2009	5/27/2009	5/27/2009	5/27/2009	5/27/2009	
Field Parameters	*Temperature*	*(°C)*	14.24	NA	14.62	12.9	17.8	NA	18.7	22.5	18.6	
	Conductivity	*(uS/cm)*	149	NA	200	145	210	NA	650	573.8	351	
	pH	*(pH units)*	7.65	NA	7	6.99	8.14	NA	7.74	8.29	6.19	
	Oxidation Reduction Potential	*(mV)*	69	NA	95	100	-42	NA	4	-30	40	
General Minerals	*Alkalinity, Bicarbonate as CACO3*	*(mg/L)*	96	97	38	38	120	110	350	420	190	
	Alkalinity, Carbonate as CACO3	*(mg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Alkalinity, Hydroxide as CACO3	*(mg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Alkalinity, Total as CACO3	*(mg/L)*	96	97	38	38	120	110	350	420	190	
	Ammonia as Nitrogen, Total	*(mg/L)*	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	<0.10	
	Bromide	*(mg/L)*	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
	Chloride	*(mg/L)*	1.0	1.0	0.82	0.83	1.1	1.1	3.4	5.4	1.2	
	Electrical Conductivity	*(µmhos/cm)*	200	200	100	110	230	230	710	910	370	230
	Flouride	*(mg/L)*	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.18	<0.10	
	Hardness as CACO3	*(mg/L)*	88	87	40	42	100	100	310	43	180	
	Nitrate as N	*(mg/L)*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
	Nitrite as N	*(mg/L)*	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
	Sulfate	*(mg/L)*	7.6	7.6	13	15	4.1	4.1	29	73	3.3	
	Total Dissolved Solids	*(mg/L)*	130	130	65	75	140	140	440	700	210	
	Calcium	*(µg/L)*	21000	21000	9000	9900	28000	30000	77000	15000	48000	
	Magnesium	*(µg/L)*	8300	8500	4100	4100	8800	9100	30000	7700	15000	
	Sodium	*(µg/L)*	3900	3900	2800	2900	5700	5800	34000	190000	8500	
	Potassium	*(µg/L)*	<1000	<1000	<1000	<1000	<1000	<1000	<1000	1900	<1000	
Metals	*Aluminum*	*(µg/L)*	<50	<50	<50	<50	<50	<50	<50	<50	<50	
	Antimony	*(µg/L)*	<6.0	<6.0	<6.0	<6.0	<5.0	<5.0	<5.0	8.1	<5.0	
	Arsenic	*(µg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.2	<5.0	10
	Barium	*(µg/L)*	<20	<20	<20	22	<20	<20	38	<20	<20	100
	Beryllium	*(µg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Cadmium	*(µg/L)*	<10	<10	<10	<10	<10	<10	<10	<10	<10	0.14
	Chromium	*(µg/L)*	<10	<10	<10	<10	<10	<10	<10	<10	<10	
	Chromium, Hex.	*(µg/L)*										
	Cobalt	*(µg/L)*	<20	<20	<20	<20	<20	<20	<20	<20	<20	
	Copper	*(µg/L)*	<10	<10	<10	<10	<10	<10	<10	<10	<10	24
	Iron	*(µg/L)*	<100	<100	<100	<100	<100	<100	150	<100	<100	300
	Lead	*(µg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Manganese	*(µg/L)*	<20	<20	<20	<20	31	26	150	25	81	50
	Mercury	*(µg/L)*	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	
	Molybdenum	*(µg/L)*	<20	<20	<20	<20	<20	<20	<20	35	<20	
	Nickel	*(µg/L)*	<20	<20	<20	<20	<20	<20	<20	<20	<20	
	Selenium	*(µg/L)*	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Silver	*(µg/L)*	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
	Thallium	*(µg/L)*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
	Vanadium	*(µg/L)*	<20	<20	<20	<20	<5.0	<5.0	<5.0	7.0	<5.0	
	Zinc	*(µg/L)*	<20	<20	<20	<20	<20	<20	<20	<20	<20	61

Notes:

°C = Degrees Celcius

uS/cm = Microseimens per centimeter

mV = millivolts

µg/L = micrograms per liter

mg/L = milligrams per liter

µmhos/cm = micromhos per centimeter

TABLE 4

Consumptive Water Use for Hard-Rock Quarries

In Northern California

Site Name	County	AF/yr	MM tons/yr	AF/MM t/yr
Handley Ranch	Monterey	300	2	150
Madera Ranch	Madera	55	0.9	61
DeSilva Gates	Sacramento	365	3	122
Teichert	Sacramento	1055	7	151
Walltown	Sacramento	1200	6	200
Jesse Morrow	Fresno	194.4	2	97
AVERAGE:				130

ATTACHMENT A.
Field Investigation Report, Hydrology Analysis, 3M Redding Hard Rock Aggregate Quarry, Shasta County, California, Brown & Caldwell, June 2009

ATTACHMENT B.
BLASTING BEST PRACTICES
INSTITUTE OF MAKERS OF EXPLOSIVES

INSTITUTE OF MAKERS OF EXPLOSIVES

Blasting; Best Practices

The potential to impact surface or groundwater with the substances used in commercial explosives can be controlled through the implementation of certain measures. Implementing such measures as part of a standard operating procedure will eliminate or minimize the potential for these substances to dissolve in or become associated with water. The specific measures included can be grouped into the following four (4) basic categories:

1. Education/Training of Explosive Users
2. Selection of Appropriate Explosives for the Job and Conditions
3. Explosives Loading and Handling
4. Attention to Technical Matters

1. Education/Training of Explosive Users

Both the owners/operators of the location where explosives are being used and the personnel working with commercial explosives should be well informed of all applicable regulations as well as any potential consequences associated with the products' exposure to water. The federal Clean Water Act, or the equivalent state statute, regulates the release of substances, in particular those that can cause an undue risk to human health or the environment. In addition, the Resource Conservation and Recovery Act, governs the disposal of hazardous wastes.

2. Selection of Appropriate Explosive for the Job and Conditions

Selecting the proper explosive for the particular job is critical to the prevention of surface or groundwater impact.

- ANFO (ammonium nitrate - fuel oil) is not water-resistant and should be avoided if contact with water is likely.

- Various types of commercial explosives are available to withstand exposure to water. Water-resistant explosives include the cartridge forms of gelatinous nitroglycerin, watergels and emulsions and the bulk forms of emulsions which are: 1) Site Mixed Emulsion (ammonium nitrate - fuel oil - emulsifier) is a water-resistant explosive, semi-solid. This is manufactured on site and detonated while still warm assuring complete detonation. 2) Repump Emulsion (ammonium nitrate - fuel oil - emulsifier) is a water-resistant explosive, semi solid, manufactured off site, transported and pumped into the borehole as needed.

3. Explosives Loading and Handling

- All excess product in augers or hoses is to be recovered and used either in the next blasthole or recycled in the mixer/holding tank.

- Explosive spillage around the blasthole collar is to be controlled and any such spillage should be placed into the blasthole before stemming

- Water contacting explosives during cleanup is to be contained and managed in accordance with applicable regulations

- Minimize the amount of time that explosives are exposed to wet conditions within the blasthole. The blast should be initiated as near the time the loading is completed as safety and operational procedures allow.

- Avoid having explosives exposed to precipitation.

- To assure complete detonation of explosives placed into the ground, a sufficient number of boosters must be used.

4. Attention to Technical Matters

- The actual physical conditions into which explosives are being placed must be taken into account.

- Personnel responsible for loading explosives into the boreholes should be in continuous communication with the drillers of those boreholes or supplied with adequate drill logs, so that any knowledge regarding fractures, crevices or cavities is obtained.

- Where Bulk ANFO or Emulsion is used in fractured, creviced or cavitied boreholes, plastic borehole sleeves and/or positioned inert stemming decks will be used to ensure total detonation of the explosives and avoidance of excessive charges.

- Choosing and placing the correct drilling patterns that results in the optimal use of explosives with all the explosives undergoing complete detonation.

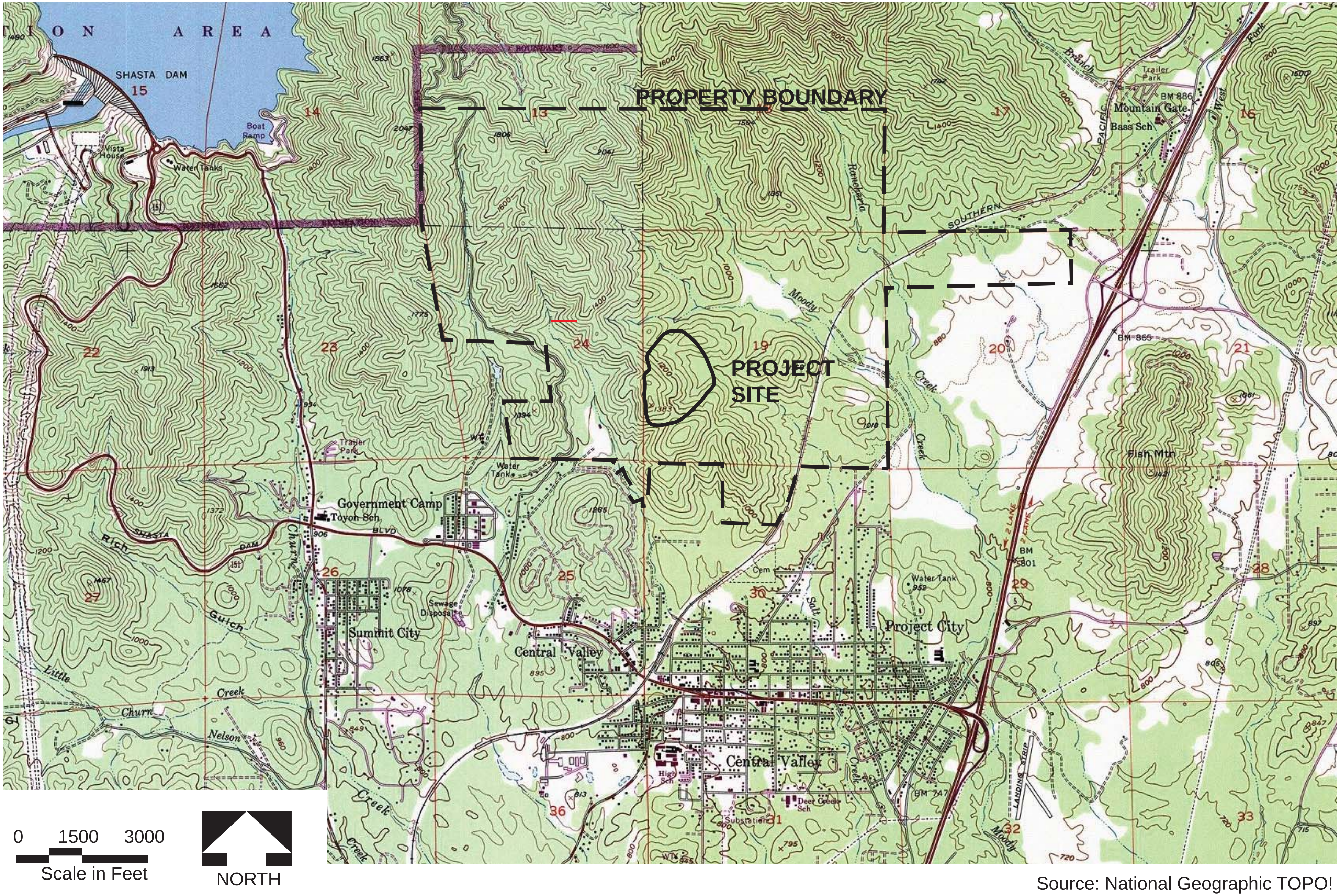
- Quality assurance/quality control measures to maintain drilling accuracy that prevents the detonation in one blasthole from impacting the proper detonation in a nearby blasthole.

- Selecting the appropriate drilling equipment so that adequate borehole quality is maintained.

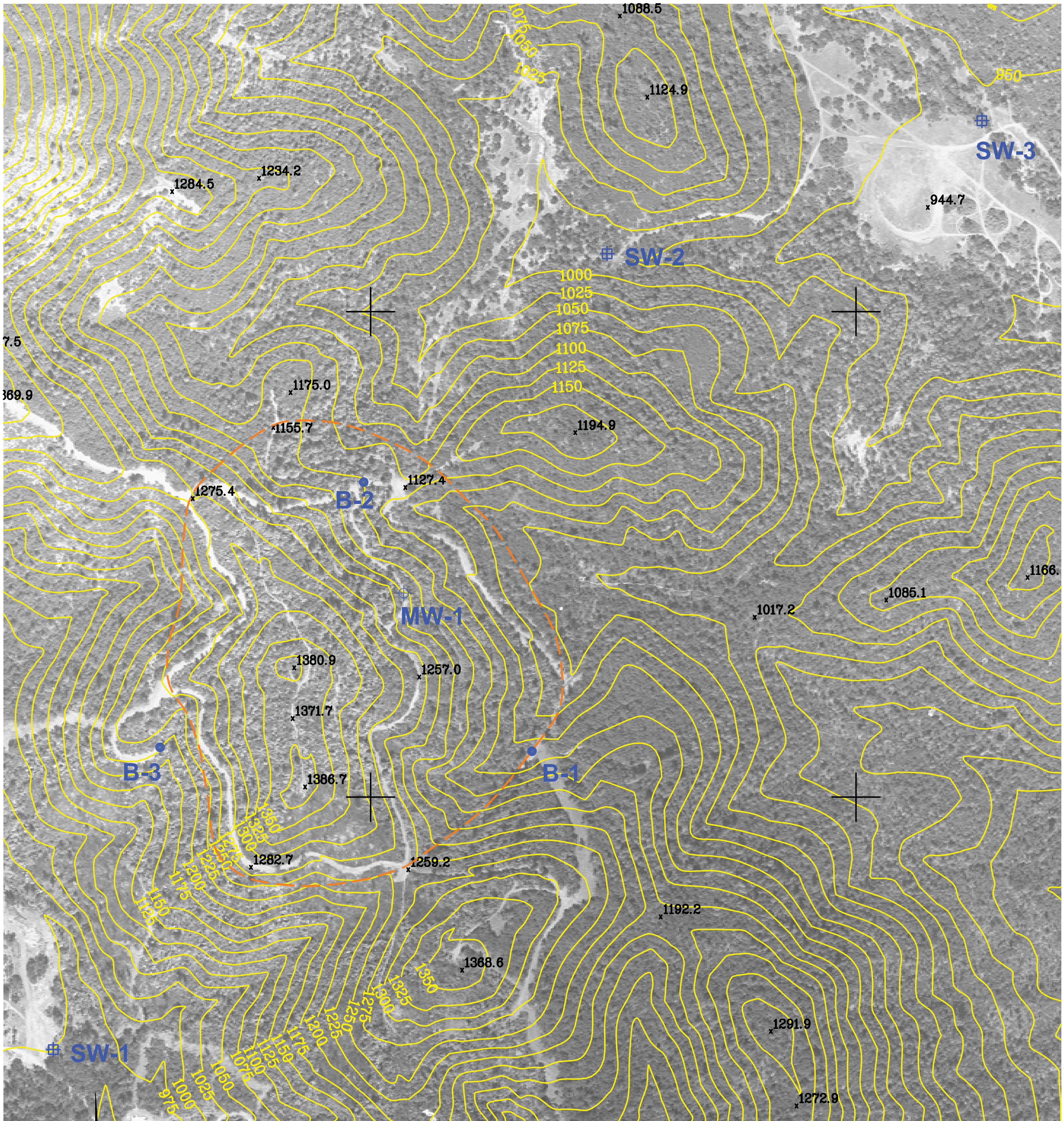
- Where appropriate to ensure complete detonation, two (2) primers will be used in each blasthole; one near the top and one near the bottom of the explosive column.

- Correct selection of delay timing for each blasthole to ensure detonation of the entire pattern, and the prevention of cut-off blastholes.

P:\37000\137108 - 3M Redding Hard Rock Quarry\Assessment Report\Figures



BROWN AND CALDWELL	DATE 6-30-09 PROJECT 137108-003	3M Quarry, Shasta, California Site Location Map	FIGURE 1



0 300 600
SCALE IN FEET

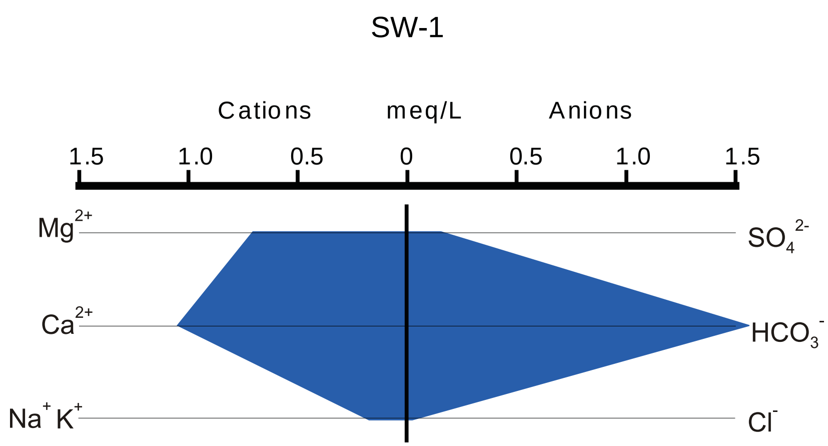
Surface Water Sampling Location

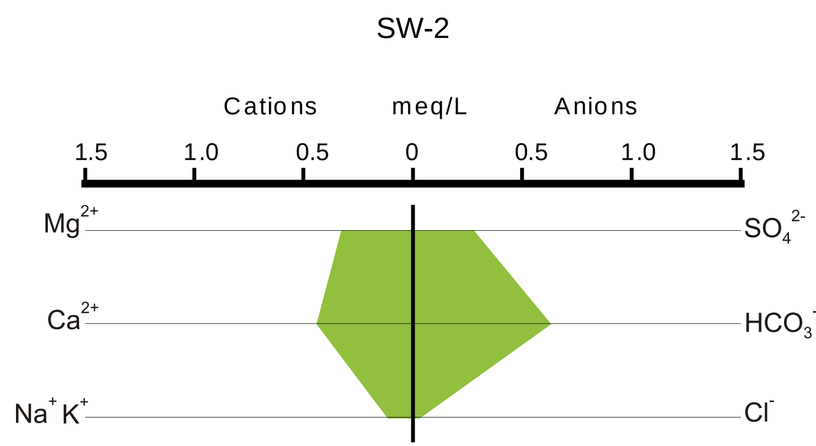
Monitoring well Location

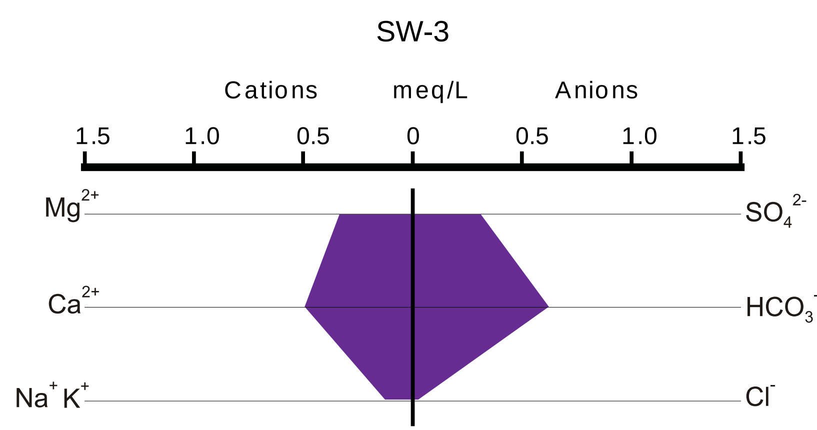
Boring Location

Proposed Quarry Boundary

BROWN AND CALDWELL	DATE 6-30-09 PROJECT 137108-003	3M Quarry, Shasta, California Sampling Locations	FIGURE 2







Legend

Ca^{2+} Calcium
Mg^{2+} Magnesium
Na^{+} Sodium
K^{+} Potassium
Cl^{-} Chloride
SO_4^{2-} Sulfate
HCO_3^{-} Bicarbonate
NO_3^{-} Nitrate
meq/L milliequivalents per liter

BROWN AND CALDWELL

DATE 6-30-09

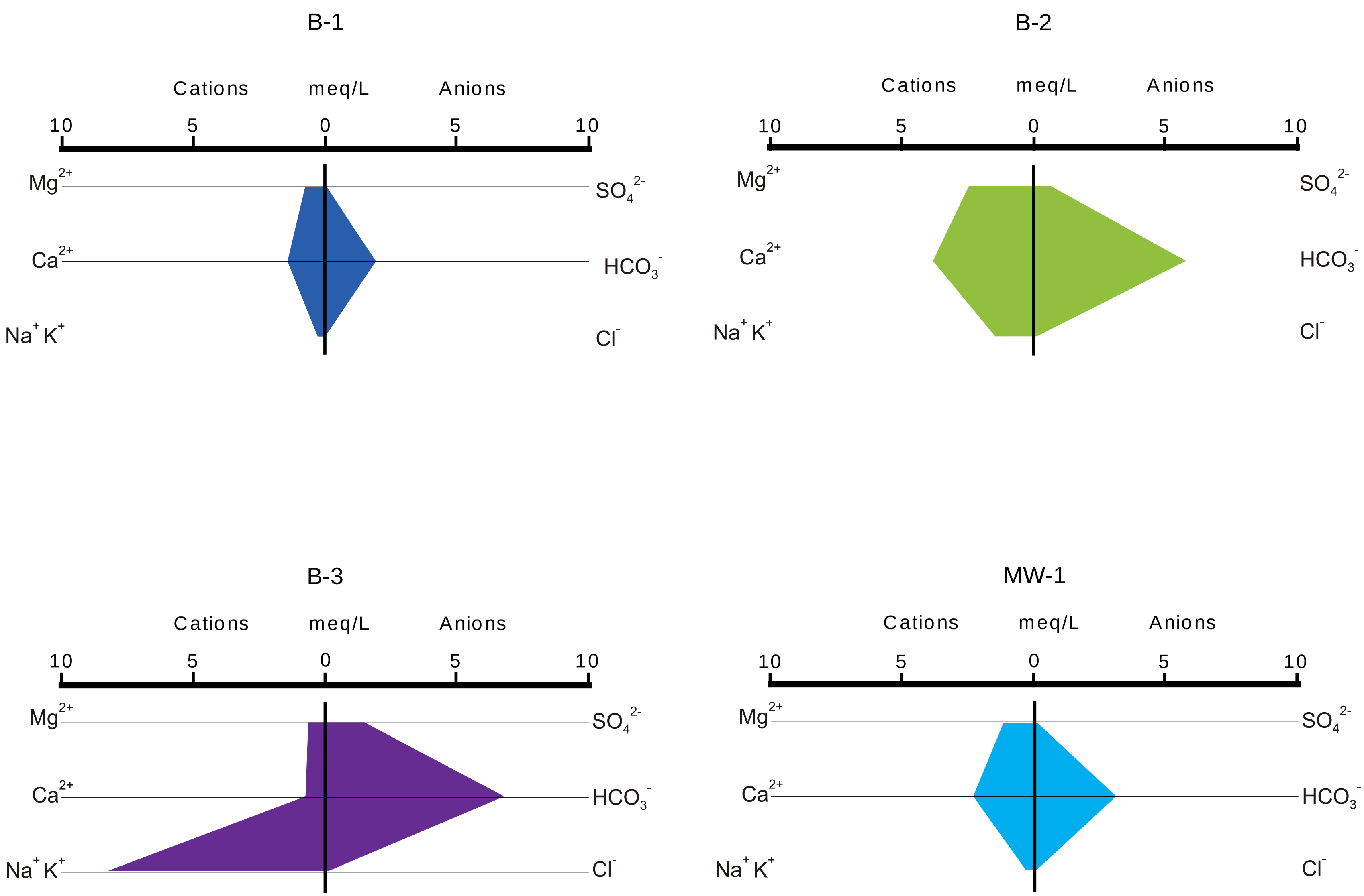
PROJECT 137108-003

3M Quarry, Shasta, California

Stiff Diagrams for Surface Water Samples - March 30, 2009

FIGURE 3

P:\37000\137108 - 3M Redding Hard Rock Quarry\Assessment Report\Figures



Legend

Ca^{2+}	Calcium
Mg^{2+}	Magnesium
Na^+	Sodium
K^+	Potassium
Cl^-	Chloride
SO_4^{2-}	Sulfate
HCO_3^-	Bicarbonate
NO_3^-	Nitrate
meq/L	milliequivalents per liter

BROWN AND CALDWELL

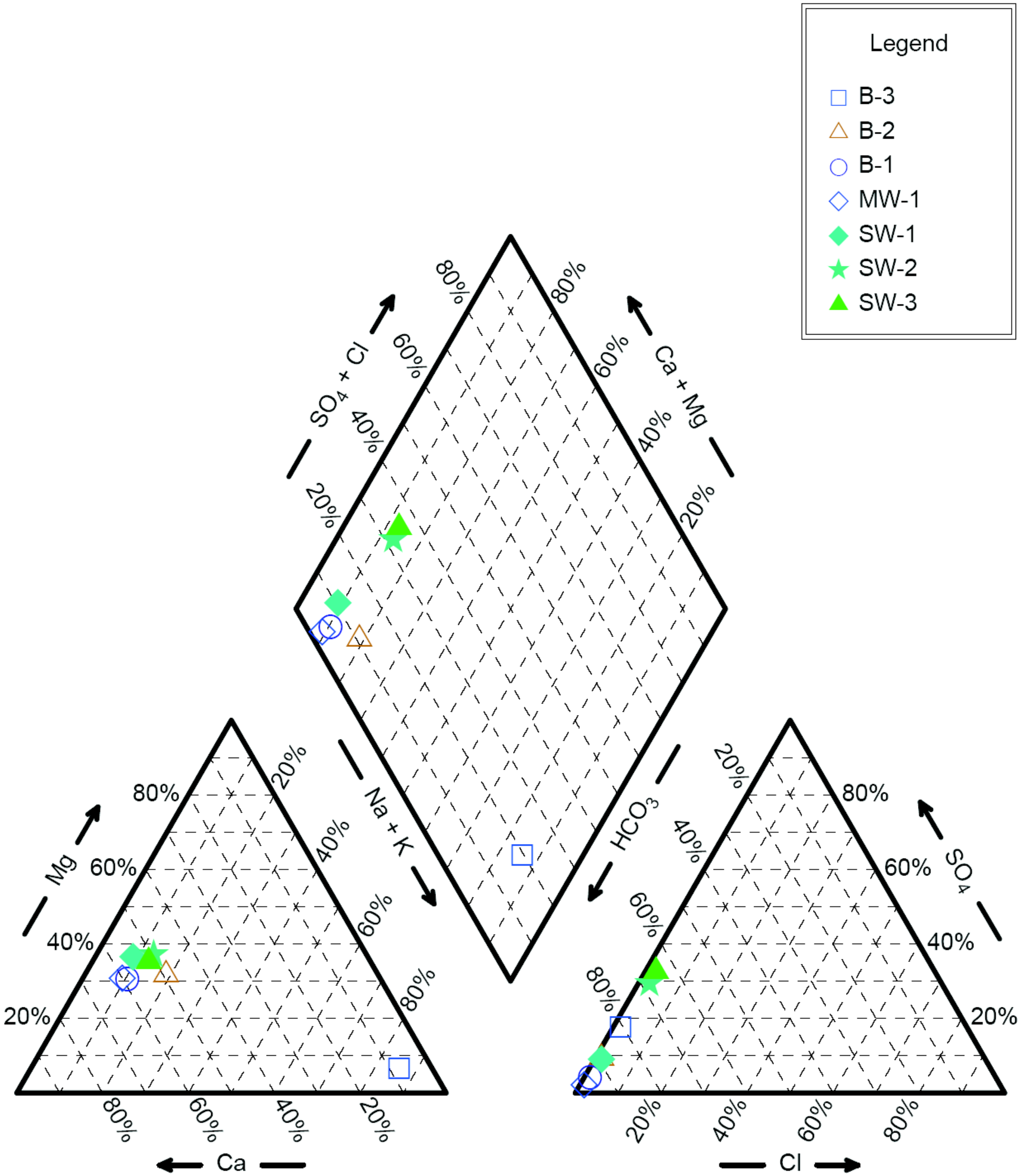
DATE 6-30-09

PROJECT 137108-003

3M Quarry, Shasta, California

Stiff Diagrams for Groundwater Samples - May 27, 2009

FIGURE 4



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BROWN AND CALDWELL

DATE 6-30-09

PROJECT 137108-003

3M Quarry, Shasta, California

Piper Diagram for Water Samples from Proposed Moody Creek Quarry Vicinity

FIGURE 5