Appendix O
Preliminary Hydrology Study

PRELIMINARY HYDROLOGY STUDY

Lucerne Solar Project

San Bernardino County, California

January 22, 2010

Prepared For:

Chevron Energy Solutions Company
A Division of Chevron U.S.A. Inc.
345 California Street, 18th Floor
San Francisco, CA 94104

Prepared By:

Westwood

PRELIMINARY HYDROLOGY STUDY
Lucerne Solar Project
San Bernardino County, California

January 22, 2010

Prepared for
Chevron Energy Solutions Company
345 California Street, 18th Floor
San Francisco, CA 94104

Prepared by
Westwood Professional Services, Inc.
Project No. 20081195

REPORT CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of California.

______________________	January 22, 2010
Christopher J. Carda License No. 75322	Date

CONTENTS

PROJECT OVERVIEW

This hydrology study summarizes the information and calculations developed by Westwood Professional Services on behalf of Chevron Energy Solutions Company to address the potential drainage and erosion impacts of the proposed Lucerne Solar Project in San Bernardino County, California. The study documents the existing conditions at the site, analyzes the hydrology and hydraulics of the project watershed, and reviews the impact of the proposed site development.

The Lucerne Solar Project site is located in the southwestern part of San Bernardino County in the Lucerne Valley at the foot of the San Bernardino National Forest on the western edge of the Mojave Desert. The site is situated on portions of an active alluvial fan. The 516-acre project is contained completely within public lands administered by the United States Department of Interior's Bureau of Land Management (BLM). Specifically, the site is located south of California Highway 247 at the intersection of Santa Fe Fire Road, approximately nine miles east of the community of Lucerne Valley. Refer to Figure 1: General Vicinity Map for details.

The project proposes to construct a solar generating facility of approximately 45 megawatts AC. The facility would use solar photovoltaic panels mounted on a framing system supported by driven steel piers. In addition to the arrays of solar panels, a 240 square-foot operations and maintenance building will be constructed to provide office space for maintenance staff and to house maintenance equipment. A grid of access roads will be constructed as shown on the 50% Construction Plans attached as Appendix B to provide access to the facility.

The facility design philosophy is to minimize impacts to the existing ground and vegetation during construction and thereby reduce erosive impacts associated with the development. The existing vegetation will remain in place where possible. Existing washes will remain in place to allow the larger flows to pass through the site. The piers of the solar arrays will be constructed through existing drainage paths to allow the existing flows to continue to fan out and flow through the site. These areas will remain undisturbed except for the installation of desert tortoise and security fencing at the site perimeter. This study will demonstrate that the existing storm water flow patterns will be maintained with construction and operation of the solar facility. This minimalistic approach will also ease the transition when the site returns to BLM control after the life of the project.

Bureau of Land Management (BLM)

As shown in Figure 2: Ownership Map, The site is contained within public lands administered by the BLM; therefore, the BLM is the regulatory agency responsible for permitting the project. A preliminary Plan of Development (POD) dated June 23, 2009 and hydrology calculations dated June 16, 2009 were previously provided to the BLM for review. The POD was reviewed by the BLM's consultant, Winzler and Kelley, and a summary of that review was provided to Chevron in October 2009. It is the intent of this study to address the comments provided during this review. The 50% Construction Plans are attached as Appendix B.

County of San Bernardino, California

The project is located on public lands within the County of San Bernardino. Although the BLM is responsible for the administration of these lands, the drainage analysis conforms to the procedures set forth by the revised County of San Bernardino Hydrology Manual (SBCHM) (1986).

According to the SBCHM, it is the goal of the County to provide 100-year return frequency flood protection for all habitable structures and other non-flood proof structures. Consequently, all drainage plans must demonstrate this 100-year flood protection criterion. This hydrology study models the effects of the 100-year rainfall event as well as the 10- and 25-year floods to meet the objectives of the County.

State of California

The project will require preparation of a StormWater Pollution Prevention Plan (SWPPP) to comply with the National Pollutant Discharge Elimination System (NPDES) program as authorized by the Clean Water Act and administered by the California Environmental Protection Agency. A draft SWPPP has been prepared to address detailed design for erosion control during construction activities and is attached as Appendix C. This hydrology study provides recommendations to be implemented as part of the SWPPP.

Mapping and Background Information

Aerial photography was captured specifically for the project site in November 2009 to produce an image with 3-inch pixels. Data from the flight was used to produce a detailed digital terrain model surface (DTM) with a vertical accuracy of ± one foot. This topographic data provides the basis for the cross-sectional models required to complete the hydraulic analysis. Refer to Figure 3: November 2009 Aerial Imagery for review. Additionally, the high-resolution photo and DTM provide details regarding water flow patterns, geology, and land cover.

A variety of aerial photo, DTM, and other GIS data sources were used to analyze the hydraulics and hydrology of the watershed. USGS quad maps and National Agriculture Imagery Program (NAIP) aerial imagery were used to analyze the mountainous portion of the watershed. Higher resolution aerial photos (Digital Globe) and DTMs (Intermap) were obtained to model the hydrology in areas near the actual project footprint.

Site Investigation

Westwood staff visited the site on January 19, 2010 to investigate the existing conditions and verify the desktop analysis. In addition to surveying the site geography, vegetation, and topography; site photos were taken and upstream and downstream drainage routing was confirmed. The photo inventory taken during this site investigation is attached as Appendix D.

Unit-Hydrograph Modeling

Runoff volumes were calculated using the unit hydrograph modeling procedure outlined in the SBCHM. The CivilDesign v7.0 Hydrology/Hydraulics (Bonadimin) computer software package was used to model the hydrology based on the SBCHM procedures. The unit hydrograph method utilizes watershed area, slope, and shape factors to determine total runoff volumes from a watershed. San Bernardino County requires the unit hydrograph method for all watersheds in excess of one square mile in area.

HEC-RAS Analysis

Hydrologic Engineering Center's River Analysis System (HEC-RAS) is an industry-standard software package that performs one-dimensional steady flow, unsteady flow, and sediment transport modeling of water flow though natural rivers and other channels. HEC-RAS is supported by the US Army Corps of Engineers and excels at modeling water flowing through open channels to compute water surface profiles.

The hydraulics of an alluvial fan are typically difficult to model due to unstable and braided channels. The Lucerne project, however, has evidence of defined channels flowing through the site such as: channels shown on the USGS mapping, defined "washes" on the geology mapping, and elevation and photo evidence that corresponds to the geology mapping. This report uses a modified hydraulic analysis method (HEC-RAS) that analyzes each channel individually and then merges the individual results to determine a combined "worst-case" for design purposes.

Sheetflow Analysis

According to FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping, a composite method combining a HEC-RAS analysis along with a sheetflow analysis is an acceptable way to model the flood depth and extents. FEMA states:

> *"Some parts of alluvial fans are characterized by sheetflow, which is the flow of water as broad sheets that are completely unconfined by any channel boundaries. Sheetflow might occur where flow departs from a confined channel and no new channel is formed. It might also occur where several shallow, distributary channels join together near the toe of a fan and the gradient of the fan is so low that the flows merge into a broad sheet. Because such sheetflows can carry high concentrations of sediment in shallow water and follow unpredictable flow paths, they are classified as active alluvial fan flooding.*

The portions of the site that have active alluvial fans can be approximated with sheet flow because the active channels overtop and allow shallow flooding as runoff flows down the relatively uniform slope to the north. In some areas of the site, the channels are shallow and numerous, therefore, the flood levels can be determined by modeling sheet flow using manning's equation based on the specific site constraints.

By using a combination of HEC-RAS and sheetflow analysis, the varied flood levels across the site may be modeled to determine the potential impacts to development. The marriage of two types of analyses provides a worst-case scenario for each model that can be compared to the other to provide a better overall estimate of actual drainage conditions.

Pier Scour

The solar array will be constructed on thousands of individual piers throughout the alluvial floodplain. Since flooding is planned to continue throughout the site, each of the piers may be subject to pier scour, which is the removal of sediment at the base of the column due to instabilities in flow patterns caused by the column. The anticipated depth of the scour has been approximated using Colorado State University's Pier

Scour equation, which is recommended by the Federal Highway Administration's Hydraulic Circular No. 18 (HEC-18).

GEOMORPHIC ASSESSMENT

Aerial Photography

The aerial photography shows a number of braided channels on site with the most significant located on the east side of Santa Fe Fire Road. This type of channel pattern is indicative of an active alluvial fan. A similar braided channel configuration is evident over the first quarter-mile of site area located west of Santa Fe Fire Road. Better-defined channels are evident over the western half of the project area.

USGS

The Lucerne Valley area geology was mapped by the US Geological Survey in 1998. Figure 4: Drainage Study Area Geology provides a map of the geologic formations for the entire contributing watershed area and Figure 5: Local Geology provides a detailed geological map of the site.

According to the USGS, the channels through the site (which can also be seen in the aerial photography) are classified as active wash deposits consisting of unconsolidated medium to coarse grained sand and sandy gravel with subordinate fine sand and silt. The channels are not vegetated and are characterized by active and recently active sediment accumulation with little or no soil-profile development.

The most-densely vegetated potions of the site are located east of Santa Fe Fire Road and the area and within a quarter of a mile to the west of Santa Fe Fire Road. These areas are designated as young alluvial fan deposits by the USGS and contain approximately thirty percent vegetation cover consisting of desert creosote bush. These areas contain braided fans that transition from few-to-many channels and then from many-to-few channels downstream. The surface exhibits prominent bar and swale morphology and the soils consist of unconsolidated to slightly consolidated sand and gravel, poorly to moderately sorted. The braided pattern indicates that flow patterns are unstable and this area is active. Based on the field survey of the site, the flow channels in this area are clearly active and their paths are ever-changing.

According to the USGS, areas of young slope wash and alluvial deposits can be found for the next quarter of a mile to the west of the young alluvial fan deposits. These areas contain somewhat less vegetation cover and consist of oxidized slope wash and alluvium deposited on a substrate of moderately old fan deposits. The particle size is smaller than the soils to the east and this area transitions from the young and active fan deposits to the east to the older fan deposits to the west.

The western portion of the site is farther away from the steep mountain slopes located upstream. The channels are less discernable because the vegetation is not washed out along their basins and the side slopes tend to be more gradual than the more active channels to the east. The USGS designates this area as very old debris flow fan deposits with angular, matrix-supported pebble to cobble-sized clasts in sand matrix that is very well cemented.

FEMA

Although the site is not mapped in FEMA Flood Insurance Rate Maps (FIRMs), is it designated as Zone D. According to FEMA, Zone D is defined as:

> *Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.*

FEMA maps are used to determine flood risks for development adjacent to active river, stream, and lake systems. Since the site is located in the desert with minimal development, it is not surprising that the flood risk for the area is undetermined.

Soils

The prevailing hydrologic soil group throughout the Mojave and this site is Group A. This classification is provided by the National Resource Conservation Service (NRCS) based on the soil's runoff potential. Group A generally consists of sandy soils with low runoff potential and high infiltration rates even when thoroughly wetted. The upstream watershed from the site includes some type D soils with higher runoff potential and lower infiltration rates. The NRCS does not have soil mapping for the project watershed, therefore the soil group mapping identified in the SBCHM was used for the hydrology calculations. Refer to Figure 6: SBCHM Hydrologic Soil Group for details. The hydrologic analysis incorporates the different soil types in the CivilDesign calculations.

The geomorphic assessment is collaborated by the soil borings taken by Earth Systems Southwest in late 2009. According to the geotechnical assessment by Earth Systems Southwest, the site generally consists of a three to five foot layer of silty sand over a layer of hardened caliche. Refer to the geotechnical report in Appendix E for additional information.

DRAINAGE CALCULATIONS

Regional Drainage

The project is located where the Mojave Desert meets the base of the San Bernardino National Forest. Figure 7: Drainage Study Area on 2005 Aerial Imagery shows the highlands to the south that are comprised of the northern edge of the forest and Blackhawk Mountain, which peaks at an elevation of approximately 6,750 feet above sea level. These highlands slope downward toward the north with an average slope exceeding ten-percent for a distance of approximately five miles towards the site. The site is at an elevation of approximately 3,200 feet above sea level and maintains the drainage to the north with markedly less slopes that are relatively consistent at two and one-half percent.

Downstream from the site, the alluvial fans and washes continue to drain to the north and west for approximately a mile and half to the Lucerne Valley Wash. This is a wide channel that receives all residual runoff from the site. The Lucerne Valley Wash drains northwest for a distance of approximately eight miles to the dry lakebed referred as Lucerne Lake as shown in Figure 8: Regional Drainage Map. Due to the high amount of evaporation, the low antecedent moisture conditions, and high permeability of the desert sands, the stormwater runoff that is generated in the region rarely reaches the dry lakebed of Lucerne Lake.

A visual comparison of washes located upstream and downstream from the site was completed by Westwood site investigation. It is evident that the washes decrease in size and frequency of use the farther the north they travel. This is evidence that the type A soils prevalent throughout the area do infiltrate a significant portion of the stormwater runoff. Some channels simply seem to vanish with no discernable outlet. The native soils, vegetation, and topography act as a natural deterrent to runoff and downstream flooding.

Rainfall

According to current (as of December 2009) precipitation frequency estimates prepared by the National Weather Service, the contributing watershed that affects the site experiences a broad range of rainfall amounts. For example, the higher regions at the southern end of the watershed that are part of the San Bernardino National Forest experience an annual rainfall of 10 inches with a 100-year, 24-hour rainfall event of 6.5 inches. Conversely, the site, which is located completely within the Mojave Desert, receives an annual rainfall of 6 inches with a 100-year rainfall, 24-hour rainfall event of 3.0 inches. The mountainous slopes from the forest to the desert span the difference in rainfall amounts between these two extremes. In order to accurately model the rainfall for the entire watershed, an area weighted average of the varied isohyetal lines was calculated for each drainage area. Figure 9: Drainage Area Isohyetal Map 100-Year, 24-hour Event shows the isohyetals for each watershed. The hydrologic analysis uses several different storm events and durations to build the hydrographs for each drainage area. CivilDesign automatically calculates the weighted average rainfall for each drainage area.

Watershed Hydrology

The watersheds that contribute to runoff that flows across the site begin in the San Bernardino National Forest at the Peak of Blackhawk Mountain. The contributing drainage area to each watershed is determined by delineating the drainage divides between each wash. The vast majority of the runoff going through the site originates from six distinct washes to the north. The drainage areas are illustrated in Figure 10: Drainage Study Area on USGS Quad Map. Drainage area DA-E1 covers a small drainage area (87 acres) that flows through an old alluvial fan over the western portion of the site. Drainage areas DA-E3 through DA-E7 are fairly uniform in area (600-1300 acres each) and topography. They generally start in the Blackhawk Mountains and flow northerly through the site. Drainage Area DA-E8 is a large, 3900 acre watershed that discharges to a single point near the eastern portion of the site. As shown in Figure 11: Existing Site Watersheds, the site is divided into drainage areas DA-E9 and DA-E10.

Hydrologic calculations were performed according to the Unit Hydrograph methodology and procedures outlined in the SBCHM. The computer software program CivilDesign (Bonadimin) was used to automate the hydrologic calculations. Table 1 –Runoff Calculation Summary summarizes the calculated peak runoff volumes for each of the described watersheds including the on-site areas for the 100- 25- and 10-year rainfall events. CivilDesign printouts for the 100-year event are included in Appendix F

Table 1 –Runoff Calculation Summary

					Average Rainfall Isohyetals			Peak Runoff		
Drainage Area	Total Drainage Area (Ac)	Type A Soils Area (Ac)	Type D Soils Area (Ac)	Time of Conc. (Hours)	100-Year, 1 Hour (in)	100-Year, 6 Hour (in)	100-Year, 24 Hour (in)	100-Year Event (cfs)	25-Year Event (cfs)	10-Year Event (cfs)
E1	87	87	0	0.242	1.5	2.4	3.0	221	147	99
E3	997	241	756	0.840	1.7	3.0	4.4	1281	881	622
E4	758	556	202	0.595	1.5	2.5	3.5	1075	705	472
E5	637	261	376	0.625	1.6	2.8	3.9	972	662	463
E6	1120	525	595	0.624	1.6	2.8	4.1	1679	1134	784
E7	1313	537	776	0.874	1.7	3.2	4.8	1713	1174	827
E8	3954	2919	1035	1.018	1.6	2.8	3.9	3267	2213	1425
E9	301	301	0	0.251	1.5	2.4	3.0	730	484	327
E10	203	203	0	0.344	1.5	2.4	3.0	410	270	182

Watershed Hydraulics

The drainage channels are relatively well-defined over the steeper mountain slopes of each watershed. As the terrain levels and the slopes decrease, it is apparent from the aerial mapping that the washes are less defined and multiple washes develop that can be traced to the same origin with convergent downstream channels. This braided pattern is the essence of an active alluvial fan. Despite the fact that much of the site is on an alluvial fan, several factors indicate the existence of defined channels through the site. For example, the water courses defined on the USGS mapping, along with the aerial mapping and DTM elevations generally correspond with the washes in the geologic mapping. For the purpose of this analysis, we have selected the six mapped washes and their contributing watersheds to determine flow volumes to the site. Refer to Appendix G for detailed HEC-RAS calculations and printouts.

Drainage Area DA-E1 contributes to an old alluvial fan with a fairly well-defined channel. Drainage from watersheds DA-E3 through DA-E6 flows through relatively narrow washes that are less defined at the northern portion of the site (DA-E9), but become well defined as the channels flow south. DA-E7 and DA-E8 combine at a location east of the site to form a fairly wide wash along the east edge of DA-E10. The HEC-RAS analysis models each of these channels following the assumption that the majority of the water flows though the channel. This tends to hold true for the smaller storm events (10-year and 25-year). For the larger 100-year event, the water tends to spill over the banks creating sheet flow through the site.

A second HEC-RAS analysis focused on the middle portion of the site. The flows from watersheds DA-E3 through DA-E6 were combined for this analysis. Only the 100-year event was modeled since this is the event that causes a sheet flow pattern, especially in the southern portion of the site. The water tends to follow the channels as the flow goes southerly. Cross-sections were cut to generally follow 5-foot contour intervals to ensure that water doesn't favor one channel over another.

A certain amount of meandering through fanned channels within each watershed is evident, especially for the larger storm events, and is modeled by the combined HEC-RAS analysis described above. Another way to look at the site is to assume the channels' capacity is relatively minimal and the flow spreads out, like water on a table top. A sheet flow approximation was made to compare against the channel modeling. Table 2 - Sheet Flow Approximation utilizes Manning's equation for sheet flow to approximate the average depth and velocity of the runoff flows for each drainage area entering the site. By adding the contributing site runoff, the total flows through the site are approximated. The HEC-RAS model provides a more rigorous analysis, however; the sheet flow analysis provides an indication of the water depth in the flatter portions of the site where there are shallow channels. Refer to Appendix G for detailed sheet flow calculations.

Table 2 – Sheet Flow Approximation

		100 Year Event		25 Year Event		10 Year Event	
Drainage Area	Approx. Width at northern project boundary (ft)	Flow depth (ft)	Flow Velocity (fps)	Flow depth (ft)	Flow Velocity (fps)	Flow depth (ft)	Flow Velocity (fps)
E1	830	0.16	1.7	0.12	1.4	0.10	1.2
E3	1020	0.40	3.2	0.32	2.7	0.26	2.4
E4	1660	0.27	2.4	0.21	2.1	0.16	1.8
E5	1230	0.30	2.6	0.24	2.3	0.19	2.0
E6	450	0.76	4.9	0.60	4.2	0.48	3.6
E7	1340	0.40	3.2	0.32	2.7	0.26	2.4
E8	880	0.76	4.9	0.60	4.2	0.46	3.5

PROPOSED DEVELOPMENT

Proposed Improvements

The proposed plan is to utilize a minimalistic approach and leave the exiting channels and washes in place and trim the existing vegetation. Grading will be limited to constructing a grid of access roads engineered from compacted native soils. The access roads will be constructed so the finished grade will be flush with the existing ground on either side to maintain sheet flow to the north. Arizona crossings will be constructed at existing depressions to maintain existing flow channels; therefore, no storm piping is proposed for the project.

The existing site is comprised entirely of type A soils (desert sands) with approximately thirty percent vegetation consisting of desert creosote bush. The proposed improvements consist of solar panels mounted on piers, access roads, small concrete inverter pads, and a small O&M building. As described previously, the field survey indicated that the native soils, vegetation, and topography act as a natural deterrent to stormwater runoff and downstream flooding. The proposed development will take advantage of this characteristic by minimizing the impacts to the native ground.

The total amount of proposed road surface is approximately 32 acres, which is only 6% of the total project area. The curve number for the 32 acres engineered roads is 89, as compared to 62 for the existing desert sands with thirty percent vegetation cover. In summary, the overall site curve number changes from 62 to 64, and the additional amount of runoff produced as a result of the project is negligible. For example the 100-year peak runoff from the western area increases from 730 to 739 cfs (an increase of 1.2%) and the 100-year peak runoff from the eastern site area increases from 410 to 414 cfs (an increase of less than one percent). Since these increased peak flows are negligible and there no infrastructure in place directly downstream that would be impacted by off-site flows, no permanent stormwater treatment strategies are proposed.

The solar panels will be mounted on piers that are driven into the ground. The majority of the site area will remain undisturbed beneath the panels. As shown in Figure 12: Typical Panel Layout, the piers will be spaced approximately 19 feet apart, of which the panels occupy 8 feet. This means that only 44% of the existing desert floor will actually be covered by panels. On a micro-scale, each panel is tilted and will shed rainfall to a concentrated area beneath. These concentrated flows will create a small trough at the base of each panel. During rainfall events, the concentrated runoff will create miniature storage basins (troughs) that overspill and sheet flow through areas that are sheltered by adjacent panels. The pervious surface area of the desert floor remains beneath the panels; therefore, the runoff coefficient of the underlying soils is unchanged.

The hydrologic modeling produces an approximation of the flood levels based on the existing topography across the site. For a given location, the modeling reveals if the area is prone to flooding, and the associated depth of a 100-year flood. The 100-year high water elevation from HEC-RAS was imported into AutoCAD and incorporated into the engineering profile drawings. A "worst-case" high water level from each HEC-RAS analysis was determined and plotted on the profile. Since the roads aren't exactly perpendicular to the channels, the water elevation may appears to "slope" in several locations because the channels have steeper slopes (2.5%) that contribute to the water surface elevation.

The solar panels are generally designed to have 18" to 24" minimum clearance above the existing ground. Based on the modeling, the panels have been designed to maintain a minimum clearance of 18" above the 100-year flood elevation. By designing the piers and panels to operate when the site is inundated by the 100-year flood, the existing drainage is maintained with minimal disturbance to the site.

Pier Scour

The solar panels will be mounted on six-inch H-piles that will be driven directly into the desert sands to a depth of approximately four feet where they will be anchored into the hardened caliche layer beneath. The stability of each pile is provided by penetration into the caliche layer, and scouring at the surface has little effect on the hardpan beneath. The scour depth has been calculated using the CSU Pier Scour Equation as shown in Figure 13: Pier Scour Calculations. These calculations assume worst-case angles of approach, flow velocity, and flow depth at the base of each pier. The maximum scour depth of about 25 inches will be incorporated into the structural design of the piers to ensure their stability over the life of the project.

Best Management Practices

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in storm water runoff. Erosion control Best Management Practices

(BMPs) protects the soil surface by covering and/or binding soil particles. The project will incorporate erosion control measures required as described in detail in the draft SWPPP attached as Appendix C. The following practices for effective temporary and final erosion control during construction will be implemented:

1) Preserve existing vegetation where required and when feasible.
2) Apply temporary erosion control to remaining active and non-active areas as required by the California Storm Water BMPs Handbook – Construction, and the contract documents. Reapply as necessary to maintain effectiveness.
3) Implement temporary erosion control measures at regular intervals throughout the defined rainy season to achieve and maintain the contract's disturbed soil area requirements. Implement erosion control prior to the defined rainy season.
4) Stabilize non-active areas as soon as feasible after the cessation of construction activities.
5) Control erosion in concentrated flow paths by applying erosion control blankets, erosion control seeding, and lining swales as required in the contract documents.
6) Apply seed to areas deemed substantially complete by the Owner during the defined rainy season.
7) At completion of construction, apply permanent erosion control to all remaining disturbed soil areas.

Long-Term Maintenance

There will be full-time staff on-site responsible for daily upkeep, monitoring, metering, cleaning, and repairs. The greatest enemy of a solar array in the desert is dust and sand that accumulates on the panels and reduces their efficiency. Dust control during construction and during the long-term operation of the project is critical. By minimizing the disturbed areas during construction, and trimming and not clearing the existing cover, the long-term dust production will be reduced. Synthetic dust suppressant products such as EnviroKleen® will be applied to the proposed access roads periodically

It is the intent to avoid washing the PV panels on a regular basis, and Chevron understands that this may result in a lower efficiency for the project. However, if efficiency falls too far and washing the panels is deemed necessary, Chevron may choose to wash the panels. Washing will be by hand with sponge and squeegee to keep the overall water consumption low and the wash runoff will easily be evaporated or infiltrated in the on-site sands.

The proposed service roads will include Arizona crossings at each channel crossing. Each of these crossings will experience flows that could potentially wash the road surface downstream. The maintenance staff will be responsible to monitor the road conditions and repair washouts when they occur.

As previously discussed, a certain amount of pier scour is anticipated. Although the design allows for pier scour to occur, maintenance staff will routinely inspect scouring at pier foundations and will be required to repair the scoured areas when they exceed 12-inches in depth.

An eight-foot-high, chain-link security fence will be constructed around the entire perimeter of the project. The base of this fence will include a 24-inch-high, wire-mesh fence imbedded 12-inches into the ground to keep the desert turtles outside of the project. This fence will be constructed through a number of existing washes. It is likely that debris and sediments will be carried through the washes as the result of a significant rainfall event. These fences will capture debris and accumulation will likely occur at the base of the fence. Since this is an active alluvial fan area and the channels that experience flows for a given storm are constantly changing, the potential diversion caused by accumulation of debris at the base of these fences cannot be avoided. The fences will be designed with a seam at the base of each wash. The seam will be tied with aluminum hog rings that will break away under the force caused by debris-laden flows. The maintenance team will be responsible for inspection and repair of fence areas on a periodic basis and after every significant rainfall event.

CONCLUSION

As demonstrated by this study, the Lucerne Solar Project proposes to use a minimalistic approach to reduce impacts associated with development. The attached calculations follow the guidelines and criteria of the County of San Bernardino and indicate negligible downstream impacts resulting from site development.

Because the site is located on an alluvial fan, the solar array will be designed with components that operate normally even when inundated by flows from the 100-year flood. Through careful design, implementation of BMP’s during construction, and long term maintenance; a solar array can successfully function on this site and still provide a smooth transition to BLM control when the project is decommissioned.

APPENDIX

A: Figures Referenced in Study

B: 50% Construction Plans

C: StormWater Pollution Prevention Plan

D: Photo Inventory

E: Geotechnical Analysis / Boring Logs

F: Hydrologic Calculations

G: Hydraulic (HEC-RAS) Calculations