PARSONS

City of Los Angeles - Bureau of Sanitation
Task Order Solicitation 69

Feasibility Study for Solar Power Generation at Lopez Canyon Landfill

July 10, 2015

THIS PAGE INTENTIONALLY LEFT BLANK.

PARSONS

100 West Walnut Street • Pasadena, California 91124 • Phone: (626) 440-2000 • Fax: (626) 440-2630 • www.parsons.com

July 10, 2015

Mr. Timmie De Ramos, PE
Task Order Manager
City of Los Angeles Bureau of Sanitation
Solid Resources Processing & Construction Division
1149 South Broadway, Suite 500
Los Angeles, California 90015

Subject: Task Order Solicitation No. 69: Solar Power Feasibility Study at Lopez Canyon Landfill

Dear Mr. De Ramos:

Thank you for the opportunity to submit this Final Draft Feasibility Study to the City of Los Angeles Bureau of Sanitation (LASAN) per our awarded scope of work under Task Order Solicitation No. 69: Solar Power Feasibility Study at Lopez Canyon Landfill. The contents of this report are in accordance with the scope of work defined in the March 7, 2014; refined proposal letter; and Amendment 1, provided via email on June 12, 2014.

This feasibility study has been provided for your review and comment per your request. Please note that the study attached hereto is a final draft that has been revised from the previously submitted drafts to incorporate LASAN comments provided on March 24, 2015, and July 9, 2015, and per Parsons' in-person meetings with LASAN's executive management on May 6, 2015, and June 18th, 2015.

We thank LASAN for the opportunity to submit this Final Draft Feasibility Study and look forward to continuing to work with you on this interesting project. If you have any questions, would like additional information, or would like discuss any part of this project further, please call Surendra Thakral at (626) 440-6263 or Satish Kamath at (626) 440-3355.

Sincerely,

Surendra Thakral, PE, BCEE
Senior Vice President, Project Principal-in-Charge

Satish Kamath, PE, BCEE
Principal Project Manager

THIS PAGE INTENTIONALLY LEFT BLANK.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

THIS PAGE INTENTIONALLY LEFT BLANK.

.

EXECUTIVE SUMMARY

INTRODUCTION AND OBJECTIVE

The LASAN of Los Angeles Bureau of Sanitation (LASAN) is evaluating the feasibility of installing a solar power generation system at the Lopez Canyon Landfill in Los Angeles, California. The development of this new energy source may serve to offset on-site energy use, reduce/replace energy produced by fossil fuels, and increase renewable energy generation within the City of Los Angeles. This report presents the results of the feasibility study, conducted by Parsons on behalf of LASAN, to evaluate the potential installation of a solar power generation system at one of two available decks at the Lopez Canyon Landfill.

PROJECT BACKGROUND

The Lopez Canyon Landfill was in operation from October 1975 to July 1996 and completed final closure in February 2011. The landfill property is 399 acres, and the landfill is 166 acres. Today, it continues to produce landfill gas that is collected and converted into electricity at an on-site gas-to-energy plant. The Lopez Canyon Landfill Environmental Center, subsequently constructed on the deck of the upper canyon of the landfill, currently collects and grinds green waste into mulch for reuse by Los Angeles residents. The landfill site is currently zoned as “open space”; LASAN indicated that the landfill site would be developed for beneficial re-use after 30 years of closure.

The primary goal of this study is to assess the feasibility of installing a solar power generation system at Lopez Canyon Landfill. This study identifies and evaluates alternatives for developing the system design basis; selection of solar technology; interconnection requirements; site selection; project economics, incentives, financial options; potential environmental and community concerns; and the electrification of the composting facility. Parsons has obtained and reviewed available project drawings, data, planning documents, and other pertinent information related to the landfill, power generation facilities, and composting facility at Lopez Canyon Landfill to conduct this evaluation. Project background is further discussed in Section 2 of this report.

SOLAR TECHNOLOGIES

Existing solar power generation technologies include solar energy cells (photovoltaic [PV] cells), thin-film solar cells, and flexible PV solar. Depending on the system size and the site limitations, PV solar panels can be mounted at a fixed angle or mounted on a tracking device, which allows the solar modules to track and capture more sunlight, thus generating more energy output. Due to site conditions of expected settlement and limitation that landfill cap cannot be penetrated, PV cells on a fixed tilt racking system are the recommended technology for this project, as tracking systems would require ground-penetrated structural mounting. Additional discussion of solar technologies, case studies, and recommendations on technology are provided in Sections 3, 4, and 5, respectively.

SITE SELECTION AND SYSTEM CAPACITY

Based on the acreage, topography, and shading requirements for a ground-mounted system, one area has been identified as a suitable location for the PV system: C Deck (see Figure ES-1 below). Using this deck, approximately 22 acres of land would be available for the solar PV system. Given that a typical fixed tilt system requires roughly 4 to 6 acres per megawatt (MW), it is anticipated that a 4 MW system could be installed in the proposed area of C Deck; however, depending upon the system layout and the rated capacity of the panels, the C Deck site may allow for the installation of an up to 5 MW system.

Figure ES-1: Lopez Canyon Landfill Potential Installation Sites: C Deck

Additional civil, geotechnical, and electrical evaluations will need to be conducted as part of the preliminary engineering phase of project development to mitigate the challenges of site settlement, seismic loading, wind loading, and electrical interconnection.

Additional discussion of the site selection is provided in Section 6.

SYSTEM LAYOUT AND EQUIPMENT DESIGN

A typical solar PV system comprises the following components: PV modules, racking, inverter(s), electrical wiring, and the balance of system hardware. Typically, underground electrical conduit or overhead lines are installed to connect the solar PV arrays to the electrical equipment at the main electric utility meter. However, an alternative connection scheme may need to be developed for this particular system due the site loading and soil disruption restrictions.

The existing electrical infrastructure at the site was evaluated, and the electrical system modifications necessary to interconnect a new 4 MW solar power generation system were identified. Additional discussion of the system layout and equipment design is provided in Section 7.

SHADE STUDY

Parsons conducted a shade study to evaluate the impacts of the local topography on the amount of sunlight that the proposed area would receive. The study determined that shading from higher areas of the site onto lower areas would have an insignificant impact on exposure to sunlight and, subsequently, solar system production. Additional discussion of the site selection is provided in Section 8.

ENVIRONMENTAL CONSIDERATIONS

The proposed installation a solar facility at the Lopez Canyon Landfill could be subject to the preparation of both a Phase 1 Environmental Site Assessment (Phase I ESA) and/or a Mitigated Negative Declaration (MND). It is recommended that a Phase 1 ESA be conducted to identify existing site conditions of the property before construction, as it is a good method for documenting site conditions. To address the potential requirement for an MND, LASAN will be required to comply with applicable California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements pertinent to the construction and operation of a new solar facility. Other environmental clearances and permits also potentially required are discussed in Section 9 and include:

- California Regional Water Quality Control Board Order R4-2004-0176
- Zoning
- Federal Aviation Administration (FAA)
- U.S. Forest Service Special Use Authorization
- Certified Unified Public Agency (CUPA)
- Post-Closure Maintenance
- South Coast Air Quality Management District (SCAQMD) Air Sampling
- Pesticide Management
- Landfill Leachate Monitoring
- Surface Water Monitoring
- CalRecycle Permit for Lopez Canyon Landfill

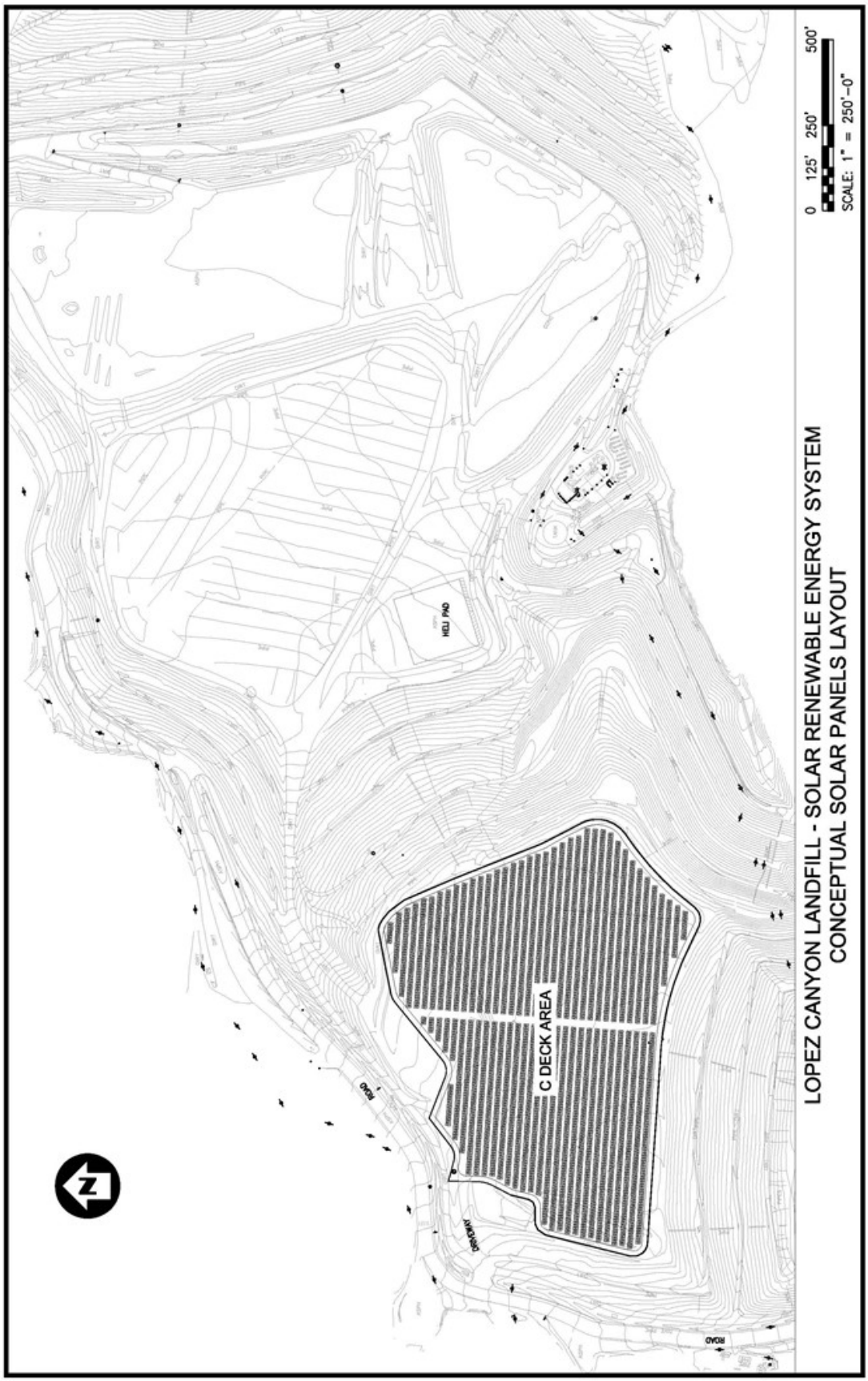

Figure ES-2: Lopez Canyon Landfill Solar Renewable Energy System – Conceptual Solar Panels Layout

MAINTENANCE IMPACTS AND RECOMMENDED MITIGATIONS

Over the life of a solar generation system, regular maintenance activities will be necessary to ensure the system is operable and producing energy to its optimal capacity. These activities primarily include cleaning of the solar panels and servicing of the electrical equipment and infrastructure. In parallel, the landfill staff will be conducting landfill maintenance activities to maintain the landfill cover in response to address differential settlement of the landfill surface and to respond to emissions of landfill gases, if necessary. Mitigation measures and potential compliance activities will need to be established and implemented as part of the operations and maintenance phase of the project lifecycle, as discussed in Section 9.

PROJECT ECONOMICS, INCENTIVES, AND FINANCING OPTIONS

Project economics often drive design and sizing decisions for solar renewable energy projects. Factors that affect project economics include initial upfront cost, financing rates, long-term operation costs, offset energy benefits, and incentives offered by the utility. The estimated overall return on investment (ROI) for a project compiles all of these factors and can be used as a basis for decision-making when evaluating multiple project options. Note that comprehensive economic analysis was not included in the scope of this feasibility study and will be conducted separately by LASAN.

ESTIMATED PROJECT COSTS AND ANNUAL PRODUCTION

For the selected solar technology (fixed tilt PV), the cost for a 4 MW alternating current (AC) system (estimated annual production of roughly 6,700,000 kWh/year) was estimated to be approximately $13,000,000. This cost is based on recently observed industry data in Southern California and includes labor and materials for design, construction, and operation and maintenance (O&M) for the first 10 years of operation. Site preparation, environmental mitigation, project management, construction management, and operations and maintenance costs after the first 10 years of operation are not included. Current market conditions, material availability, and siting limitations may impact project costs.

Table ES-1: Fixed Tilt System Estimated Annual Production

System Technology	System Capacity using C Deck (MW)	Estimated Annual Generation (kWh/year)
Fixed Tilt	4 MW	6,700,000 kWh

INCENTIVE OPTIONS

Currently available incentive programs for solar energy generation were evaluated, and the following programs were identified as being applicable in LADWP territory:

- Feed-in-Tariff (FIT)
- Net Energy Metering (NEM)
- Senate Bill 1 (SB1)

Upon evaluation of the potential incentives available, it was recommended that LASAN pursue incentives through the FIT program to optimize the total amount of incentives received.

FINANCING OPTIONS

Project financing options of cash purchase, power purchase agreement, and tax-exempt municipal lease were compared. Generally, the option of a cash purchase is recommended if feasible for LASAN. Further discussion of project economics, incentives, and financing is provided in Section 10.

DIESEL TO ELECTRIC CONVERSION

Some of the equipment used by the existing composting facility at the landfill could potentially be converted to electric power in order to more directly utilize electricity generated by a solar power generation system on-site. Based on the currently used diesel-powered equipment, a preliminary electrical power load was estimated to be approximately 2,500 kilowatts (kW). The electrical distribution system required to power the composting facility was also evaluated and is presented in Section 12.

PEER REVIEW

LASAN requested that Parsons solicit the services of an outside expert with specific experience with solar power facilities at landfill sites to conduct a peer review of this feasibility study. However, though Parsons conducted a search to identify an expert to conduct this peer review, all identified candidates indicated they were not interested in performing this peer review due to the low contract value and potential that providing this service would preclude them from bidding on the final design or installation work should the project move forward. As such, in lieu of a third-party peer review, Parsons utilized the services of its internal technical experts throughout the country to conduct an engineering peer review of this study. For additional discussion, please see Section 13.

CONCLUSIONS AND OVERALL RECOMMENDATIONS

Overall, this feasibility study concludes that installation of a solar power generation system at the Lopez Canyon Landfill is technically and financially feasible. The most feasible and financially viable option was determined to be the installation of a 4 MW fixed tilt photovoltaic or flexible solar photovoltaic system (estimated annual production of roughly 6,700,000 kWh/year) on C Deck. If desired, this energy could be utilized to power some of the equipment used by the composting facility, if that equipment is converted to use electric power.

Based on this evaluation, it is recommended that LASAN:

- Determine their preference for financing (cash purchase, or other)
- Install a fixed tilt photovoltaic on C Deck.
- Pursue financial incentives through the Feed-in-Tariff program
- As part of the design phase, further evaluate the identified engineering challenges, including:
  - Geotechnical conditions and site settlement
  - Electrical infrastructure requirements
  - System racking and wiring design to mitigate movement due to settlement
- Address public concerns regarding the project
- Comply with permitting and compliance requirements, as applicable

The complete discussion of this study's conclusions and recommendations is provided in Section 14.

I. INTRODUCTION

LASAN is evaluating the development of a new energy source, solar photovoltaic energy, to offset on-site energy use and reduce overall energy costs for Lopez Canyon Landfill. The Lopez Canyon Landfill was in operation from October 1975 to July 1996 and completed final closure in February 2011. The property is 399 acres, and the landfill is 166 acres. Today, it continues to produce landfill gas that is collected and converted into electricity at an on-site gas-to-energy plant. The Lopez Canyon Landfill Environmental Center, subsequently constructed on the deck of the upper canyon of the landfill, currently collects and grinds green waste into mulch for reuse by Los Angeles residents.

The LASAN has zoned the landfill site as "open space," and after 30 years of closure, LASAN would develop the landfill site for beneficial re-use. With the available electrical infrastructure and acreage, the LASAN is currently evaluating the feasibility of constructing and operating a photovoltaic (PV) solar power generation system on the C Deck of the Lopez Canyon Landfill site.

Parsons has obtained and reviewed available project drawings, data, planning documents, and other pertinent information related to the landfill, power generation facilities, and composting facility at Lopez Canyon Landfill. Parsons has reviewed as-built drawings, site evaluation reports, studies, permits, and other appropriate planning documents as provided by LASAN or in the public domain.

SCOPE AND OBJECTIVES

This feasibility study's primary goal is to assess the feasibility of installing a solar power generation system at the Lopez Canyon Landfill. This study identifies and evaluates alternatives for developing the system design basis; selection of solar technology; interconnection requirements; site selection; project economics, incentives, financial options; and the electrification of the composting facility. Parsons has obtained and reviewed available project drawings, data, planning documents and other pertinent information related to the landfill, power generation facilities, and composting facility at Lopez Canyon Landfill to conduct this evaluation.

The following project aspects will be reviewed and evaluated:

- Project Background
- Solar Technologies
- Site Selection
- System Layout and Equipment Design
- Environmental Considerations
- Maintenance Impacts and Recommended Mitigations
- Project Economics, Incentives, and Financing Options
- Diesel to Electric Conversion of the Composting Facility
- Feasibility Study Peer Review

Through this review and evaluation, proven, cost-effective, and state-of-the-art technologies and financial scenarios will be considered to provide an optimal return on investment over the life of the project. A conceptual design for a solar PV system will be evaluated, factoring in site conditions and existing electrical infrastructure.

THIS PAGE INTENTIONALLY LEFT BLANK.

II. PROJECT BACKGROUND

REVIEW OF PLANNING DOCUMENTS

The planning documents and project information shown on Table 1 were obtained and reviewed by Parsons. No information obtained from the review of documents suggested that a solar project would not be technically feasible. Additionally, review of these documents served to confirm background information concerning the management, operation, and environmental compliance aspects of the landfill site.

Table 1: Planning Documents Review

Date	Document Description (Filename)
1975 to 1989	Record of Inflow to LASAN from 1975 – 1989 (Scan_101228.pdf)
Oct. 1976	Sunland Annex (Ordinance No. 148902.pdf)
June 22, 1988	Solid Waste Water Quality Assessment Test (SWAT Report) Lopez Canyon Landfill. Ground surface/vadose zone monitoring. (SWAT Lopez Canyon Landfill.pdf)
Sept. 27, 1995	Summary of events and LASAN's plan to convert to park, cites specific documents which track the legal history of the land becoming Open Space (LASAN Plan Case No 95-0166 CU.pdf)
June 1996	Gas Purchase and Sale Agreement (Lopez Canyon Landfill Gas to Energy Contract.pdf, 3 files)
Sept 1996	CAD files of Landfill Final Closure Plans (4100-series.dwg, 74 total)
June 1997 and Sept 1998	CEQA Negative Declaration. CEQA evaluation of Lopez Canyon Landfill Restoration Final Closure Plan (Class III Municipal Solid Waste Landfill and restoration of site to Open Space). 30-day review period, no comments received. (do not have actual documents)
May 25, 2000	AQMD Compliance Plan (1- Rule 1150-1 Compliance Plan.pdf)
Sept. 19, 2002	Uniform Hazardous Waste Manifest (10 - Condensate-NAOH MSDS.pdf)
Oct. 8, 2002	Cross section of landfill but section cut is not provided. Indicates a 3' monolithic cover. May not be needed if Final Closure Plans determined to be "As-Built" (N_SD_1 and _2.dwg)
Feb. 4, 2003	Road alignment with elevations (E_B deck_2-04-03.dwg)
May 22, 2003	Boundary of Fuel Station and elevations. (Fuel Station_4-03.dwg)
Jan. 19, 2005	Details of sump but unclear and appears incomplete (Flare_SUMP.dwg)
Feb. 13, 2007	Gas lines. (Lopez Gas System.dwg)
Feb. 13, 2007	Site gas system drawing (Lopez Gas System_working.dwg)
Oct. 2007	Latest gas system layout in Area B (Lopez Gas System_working_monitor_pts.pdf)
Dec. 11, 2008	Record of accepted repair (hot spot maintenance) to comply with AQMD Rule1150.1 allowable emissions at Grids 117 and 121. Compliance approved 12/19/08. (Lopez AQMD Notice to Comply 12-11-08.pdf)
April 2010	Geotech Investigation Study on Existing Soil Cover Deck C dated April 2010. (Characterization of Existing Soil Cover Deck C.pdf)
July 5, 2012	Stormwater Prevention Pollution Plan (important for permit and compliance)Lopez_SWPPP_rev_July 2012 signed.pdf
2013 to 2014	2013 - 2014 Electric Bill (11950 Lopez Cyn 2013-2014 Electric.pdf)
Feb. 2013	Groundwater monitoring data (Lopez Sounding 2013_03.pdf)
Sept. 9, 2013	Single line diagrams for connection to microturbine. However, on site visit it was stated that microturbine not in use. (Lopez Canyon Landfill Electrical Diagrams.pdf)
May 6, 2014	topo file (LOPEZ2011ASBUILTTOPO.dwg)

Date	Document Description (Filename)
Aug. 2014	10/2013 to 2014 Engine Gas Composition and other data (Daily Gas Report.xlsx)
Aug. 29, 2014	Brief history of landfill from LA Clerk website (Fwd Lopez Canyon Landfill Zone-1.msg)
Aug. 29, 2014	Ordinance 169732 and Sunland Annex 1976 (Fwd Lopez Canyon Landfill Zone-2.msg)
Aug. 2014	2014 Well Gas Data Gas Well Readings.xlsx
Aug. 2014	Instantaneous Report for the LASAN, between 4/1/14 & 8/8/14 (Instantaneous 4.1.14 - 8.8.14.pdf)
Aug. 2014	(Lopez Probes 4.1.14 - 8.8.14.xlsx)
Oct. 18, 2014	Latest gas system layout dated 12/12/2011 (Lopez Gas System_working_08292011 Model (1).pdf)

REVIEW OF REGULATORY PERMITS

The regulatory permits and approvals shown on Table 2 were obtained and reviewed by Parsons.

Table 2: Regulatory Permits and Approvals Reviewed

Date Issued	Description
Apr. 30, 1995	U.S. Dept of Agriculture Forest Service Special Use Authorization - extending expiration date of SUA (11a - LAC DOA Permit Special Use Authorization exp 12-31-06.pdf)
Nov. 12, 1997	SCAQMD Equipment Permits containing equipment specifications (4 – Gas System & Flare Station Permits.pdf)
Dec. 13, 2000	Four LASAN of LA DPW BOS Industrial Waste Mgmt Division Industrial Wastewater Permits (no expiration dates) for truck wash, clarifier, condensate system and leachate storage and neutralization tanks (13 - Industrial Waste Water Permits (LAMC SEC.64.30).pdf)
Apr. 19, 2001	SCAQMD Conditions for operating microturbines (7 - Lopez Microturbines Permits.pdf)
May 30, 2001	SCAQMD Excavation Permit effective June 28, 1996 through July 1, 2001. Request for renewal on 5/30/2001. (2 - Rule 1150 Excavation Permit and Renewal A-N 317153.pdf)
Aug. 4, 2003	LA CUPA. LA Fire Dept: Hazardous Waste and Hazardous Material Management Program Consolidated Permit Conditions. Permits dated 7/01/2001 through 6/30/2004. (12 - Fire & Hazardous Material Permit.pdf)
Nov. 26, 2003	LA County Agriculture Restricted Material Permit Conditions for 2003 for pesticides – rodent control (11 - LA County - Dept of Agriculture Permit.pdf)
Aug. 5, 2004	SCAQMD Permit to construct and operate modified unleaded gasoline underground storage tank. Permit was issued for compliance with SB989 requirements. Additional conditions placed on when fueling. (6 - Lopez Fuel Station Permits.pdf)
Dec. 16, 2004	RWQCB Waste Discharge Requirements R4-2004-0176 (9 - Part 1 - Revised Waste Discharge Requirements.pdf four files, Parts 1 through 4 back to 1991 Order No. 91-122
Jan. 3, 2006	US Dept of Agriculture extending expiration date of Special Use Authorization and Secondary Containment Testing Results (14 - Other Lopez Permits & Regulatory Info.pdf)
May 19, 2009	Solid Waste Facility Permit (Lopez Closed SWFP-20090519.pdf)
May 19, 2009	CalRecycle Permit for Lopez Canyon Landfill (19-AA-0820). Solid Waste Facility Permit issued May 19, 2009. Currently permitted; permit was subject to review on May 19, 2014. Quarterly inspections of closed landfill; last inspected Oct 2014. Ceased operations on June 30, 1996. Financial assurance responsibilities. LEA is LASAN of LA Dept of Bldg and Safety. (Online file review)
Dec 6, 2011	Monitoring and Reporting Program (No. CI-5636) as revised November 30, 2011. (Lopez Canyon Landfill_Rev MRP,CI 5636_2011-12-06.pdf)

The Lopez Canyon Landfill site is no longer accepting municipal waste, but continues to operate a landfill gas control system whereby gas is either disposed of via combustion in a flare system or converted into electricity in a 6.0 MW electrical generating facility. In addition, a green waste recycling facility is located on the decks of Disposal Areas A and B. Based on a review of available planning documents and permits identified above, the Lopez Canyon Landfill site currently operates in accordance with the requirements of multiple permits and approvals. Ongoing activities at the landfill include:

- **Groundwater Monitoring.** To ensure that past landfill disposal activities are not impacting groundwater quality, five (5) groundwater monitoring wells are in operation in accordance with California Regional Water Quality Control Board Order No. R4-2004-0176 (revised in 2011).
- **Landfill Leachate Monitoring.** Landfill leachate is monitored at a well at Disposal Area C; leachate has not been extracted at a similar well at Disposal Area AB. Discharge limitations and monitoring are also required in accordance with LASAN Industrial Wastewater Permits for the truck wash, clarifier at the scale house, condensate system and leachate storage/neutralization tanks.
- **Surface Water Monitoring.** In accordance with the General Industrial Stormwater NPDES Permit.
- **Stormwater Management.** Stormwater generated at the site is monitored and managed in accordance with the Storm Water Pollution Prevention Plan (SWPPP) which also includes best management practices, preventive maintenance, and housekeeping, inspection, and recordkeeping requirements.
- **Air Sampling.** Landfill gas sampling and ambient air sampling in accordance with SCAQMD Rule 1150.1 Compliance Plan.
- **Closure and Post closure Maintenance Plan.** Quarterly status reports for self monitoring programs and requirements.
- **Consolidated Permit Compliance.** Hazardous material inventory and reporting is conducted on an on-going basis to comply with the Los Angeles Certified Unified Public Agency (CUPA; Los Angeles Fire Department) consolidated permit (effective through June 30, 2002) for Underground Storage Tanks (USTs), Hazardous Materials Business Plan (HMBP) and Inventory, hazardous waste generation programs and Spill Prevention, Control, and Countermeasure (SPCC) for aboveground storage tanks (AST).
- **Pesticide Management.** Use of pesticides (strychnine and aluminum phosphide) for rodent control in accordance with Los Angeles County Dept of Agriculture Restricted Material Permits.
- **Special Use Authorization.** Compliance with conditions of U.S. Department of Agriculture – Forest Service Special Use Authorization
- **Mitigation Measures.** Specific mitigation meas ures contained in the CEQA document (SCH#1997051017) for landfill closure (1997) would be made conditions of project approval for the Mitigated Negative Declaration (to be reviewed when obtained).

EXISTING ON-SITE GENERATION

The gas collection system at the Lopez Canyon Landfill includes 450 gas collection wells, several miles of gas collection header line, and 7 landfill gas flares. Fortistar Methane Group owns and operates the 6 MW landfill gas utilization plant. A Landfill Gas Purchase and Sale Agreement was executed in 1999 between LASAN and MM Lopez Energy, LLC (Buyer). As such, this electricity is not available to the landfill.

In addition to the internal combustion (I.C.) cogeneration engines owned and operated by Fortistar, LADWP also owns and operates 50 microturbines with a capacity of 1.5 MW of green energy; however, these microturbines are currently offline and produce no energy.

CURRENT ENERGY DEMAND

Currently, the Lopez Canyon Landfill has four LADWP meters, which meter the electricity usage of the on-site administrative buildings:

- APMV-419-6151
- APMYV-122-7388
- M-19-22070
- APMYV-119-7733

There is also a Southern California Edison (SCE) meter at the landfill, which is used to meter the electricity export of the on-site power plant.

Based on utility billing provided by LASAN for 2013 and 2014, the landfill has an annual usage of approximately 200,000 to 300,000 kWh per year, which costs LASAN approximately $40,000 to $55,000 annually. A typical fixed tilt system generates roughly 1,700,000 kWh/MW annually, so the anticipation is that the electricity usage of the landfill should be offset with a 100 to 200 kW solar PV system.

Figure 1: Lopez Canyon Landfill Potential Installation Sites: C Deck

THIS PAGE INTENTIONALLY LEFT BLANK.

III. SOLAR TECHNOLOGIES

PV SYSTEM DETERMINATION

Solar energy cells, also commonly called photovoltaic (PV) cells, are the most prevalent form of renewable energy generation powering businesses, homes, and municipalities. Traditional solar cells are made from silicon and are generally more efficient than thin-film solar cells. Thin-film solar cells are made from non-silicon materials and are found in building-integrated photovoltaic (BIPV) systems where solar cells are integrated within the architecture of the building, such as facades, glazing, and rooftop material.

Solar panels consist of modules containing 40 to 60 solar cells. A solar array comprises an interconnected set of solar panels. Solar array system sizes for a typical business range from 10 kilowatts (kW) to 1 megawatt (MW) in California, and have been frequently installed since the enactment of the California Solar Incentive (CSI) Program in 2007.

Solar energy may be used directly by a property owner to power energy-using devices. More commonly, however, it is fed into the grid to offset energy used in a net energy metering (NEM) program approved by the California Public Utilities Commission (CPUC). Financial incentive programs for solar system generation are further discussed in Section 10.

Depending on the PV system size and the site limitations, solar panels can be mounted at a fixed angle or mounted on a tracking device, which allows the solar modules to track and capture more sunlight, thus generating more energy output.

Another available PV technology is flexible photovoltaic solar, which has been utilized at landfills in the U.S.; however, due to other factors explained in this report, we do not recommend it for this project.

FIXED-TILT SOLAR ARRAY

In fixed-tilt solar arrays, solar modules are mounted at a fixed angle, which is calculated beforehand to provide optimum solar energy generation. Generally, the angle is determined by the array's geographical location and solar radiance. Installation designs can vary; some allow for seasonal adjustment to optimize generation during the summer and winter. Fixed-tilt solar arrays are the most common and lowest cost solar systems. This type of array typically requires 4 to 6 acres (ac) of open land per MW.

TRACKING SYSTEM SOLAR ARRAYS

In comparing identical solar arrays with only varied mounting systems (fixed versus tracking), the tracking solar array typically outperforms the fixed array. According to the National Renewable Energy Laboratory (NREL), the annual energy generation improvement for tracking systems can range from 29 to 42 percent depending on the geographic latitude and solar resource. Several types of tracking systems are commercially available. Tracking systems are generally more land intensive than fixed-tilt systems because additional physical space is required to provide clearance between the arcs of the moving panels and to prevent shading by one panel onto another.

As discussed below, there are two types of tracking systems: single and dual axis trackers.

SINGLE AXIS

In a single-axis tracking configuration, solar panels rotate along one axis in an effort to continually face the sun as directly as possible. The rotation occurs in concurrence with change in the sun's relative angle

throughout the day. Although multiple designs are available for single-axis trackers, all share the commonality of a single axis for rotation (horizontal or vertical). Single-axis trackers have been the most frequently installed configuration on undeveloped land within the last 5 years.

This type of array typically requires 6 to 8 ac of open land per MW. In 2008, the Rancho California Water District installed a 1.1 MW solar system using a single-axis tracking solution on 8 ac of land at the Santa Rosa Water Reclamation Facility (Figures 1a and 1b). This system used more than 4,800 panels, offsetting the facility's energy demand by approximately 30 percent.

Figure 1a: SunPower Single-axis Tracker – Santa Rosa Water Reclamation Facility Case Study (1.1 MW)

Source: sunpowercorp.com

Figure 1b: SunPower Single-axis Tracker – Santa Rosa Water Reclamation Facility Case Study

Source: sunpowercorp.com

DUAL AXIS

Similar to single-axis tracking systems, dual-axis trackers optimize solar energy capture using the ability to rotate the panels to follow the sun both vertically and horizontally. However, in dual-axis tracking systems, the angle of the solar panels can be adjusted in both axes of rotation rather than along just one axis of rotation. This type of array typically requires approximately 8 to 10 ac of open land per MW. Examples of dual-axis tracking systems are depicted in Figures 2a, 2b, and 2c, below.

In comparison to fixed-tilt or single-axis tracking systems, dual-axis trackers require more moving parts and calibration during operations and maintenance. Although studies from NREL and NREL's "PVWatts" calculator show that dual-axis tracking systems produce more energy than fixed-tilt or

single-axis trackers, solar installers have historically not installed as many dual-axis tracking systems because the added cost was not outweighed by the increased generation.

FLEXIBLE SOLAR PHOTOVOLTAIC

Flexible solar panels (thin-film photovoltaic) allow for greater freedom in designing solar PV system layouts that maximize solar collection while adapting to landfills' natural contours. They are often considered aesthetically pleasing and more versatile than traditional solar PV systems. However, these flexible strips tend to have a lower efficiency than standard PV panels, thereby reducing overall system production. Flexible solar panels would also require a geomembrane to bond the flexible panels to a liner to prevent movement. A summary of the main advantages and disadvantages of using flexible solar photovoltaic is provided below.

Advantages

- Significantly higher temperature resistance compared to traditional panels.
- Many thin-film modules are flexible, which greatly increases versatility for uneven surfaces.
- Limited to no inherent shading (i.e., panel on panel).
- Minimizes structural system requirements to overcome wind load.

Disadvantages

- Lower efficiency rates require a physically larger system for the same capacity.
- Increased installation cost due to larger number of panels required.
- Thin film solar panels tend to degrade faster.
- Less available industry data for evaluation.

SPECIAL NOTE

Flexible solar is not currently listed as an approved technology on the California Solar Initiative (CSI) list, which typically serves as a resource for incentive programs to screen technologies for industry acceptance and proven performance. As such, the viability of this technology for this project may depend primarily on its acceptance by the selected incentive program that will be pursued and will need to be verified with the utility.

IV. LANDFILL SOLAR CASE STUDIES

Several case studies are provided below which depict examples of the use of different technologies for varied applications.

MADERA WASTEWATER TREATMENT PLANS; MADERA, CA

In 2010, a 1.1-MW solar system was installed at Madera's Wastewater Treatment Plant (WWTP), generating approximately 2,500,000 kWh per year. This system consists of 94 dual-axis system trackers mounting over 5,200 solar panels spread across 9 acres. This application claims to improve energy output by 35 percent compared to a traditional fixed-tilt system.

Figure 2a: Dual Tracker in Operation

Figure 2b: REC Solar Madera WWTP – Dual Tracker Case Study

Figure 2c: Madera WWTP Facility with Solar (1.1 MW)

Source: www.recsolar.com

TEQUESQUITE SANITARY LANDFILL; RIVERSIDE, CA

Tequesquite Landfill will consist of a 6 MW to 10 MW PV generation system that will occupy approximately 40 acres. The Project site is located at the closed Tequesquite Landfill, generally located west of the westerly terminus of Tequesquite Avenue in Riverside, California. The landfill site covers approximately 120 acres. However, to limit visual impacts to residences southeast of the landfill, about 40 acres will occupy solar panels on a fixed tilt. No penetration of the capped landfill is allowed, as stipulated in the Project Final Initial Study & Mitigated Negative Declaration.[1]

Figure 3: Tequesquite Landfill (6 to 10 MW)

Source: http://riversidecountysolarprogram.org/

[1] http://www.riversidepublicutilities.com/pdf/2010/tequesquite/Tequesquite%20Landfill%20Photovoltaic%20System%20Mitigated%20Negative%20Declaration%20Part%201.pdf

BOX CANYON LANDFILL; CAMP PENDLETON, CA

The United States Marine Corps Base Camp Pendleton contains a ground-mounted fixed tilt 1.4 megawatt project. The renewable energy project will produce 2,400,000 kWh each year. An additional benefit of the project is its location by installing the panels on top of the Box Canyon Landfill; the project is able to produce a significant amount of power without impacting new land and ecosystems.

Figure 4: Box Canyon Landfill (1.4 MW)

Source: http://www.synergyelectric.com/box-canyon-landfill-photovoltaic-solar-system/

HICKORY RIDGE LANDFILL; CONLEY, GA

Republic Services Inc., a waste management company, has converted two of their landfills into solar farms. The Hickory Ridge Landfill is a municipal solid waste landfill located in Conley, Georgia. The landfill opened in 1993 and closed in 2006. With 48 acres in total, an integrated 1 megawatt flexible photovoltaic array was installed covering approximately 10 acres of the landfill. The 1 megawatt solar array contains over 7,000 flexible solar panels. Flexible solar panels are more accommodating to the landfill natural source for the following reasons: they minimize infiltration, maintain soil, and accommodate settling and subsidence.

Figure 5: Completed Hickory Ridge Landfill (1 MW)

Source: http://www.hdrinc.com/portfolio/hckory-ridge-landfill-solar-energy-cover

Figure 6: Flexible Solar Panels

TESSMAN ROAD LANDFILL; SAN ANTONIO, TX

Republic Services Inc.'s second flexible landfill conversion is Tessman Road Landfill located in San Antonio, Texas; it has about nine megawatts of power. Of the 680-acre landfill, 5.6 acres have been installed with flexible solar panels, attaching more than 1,000 flexible solar strips to the landfill.

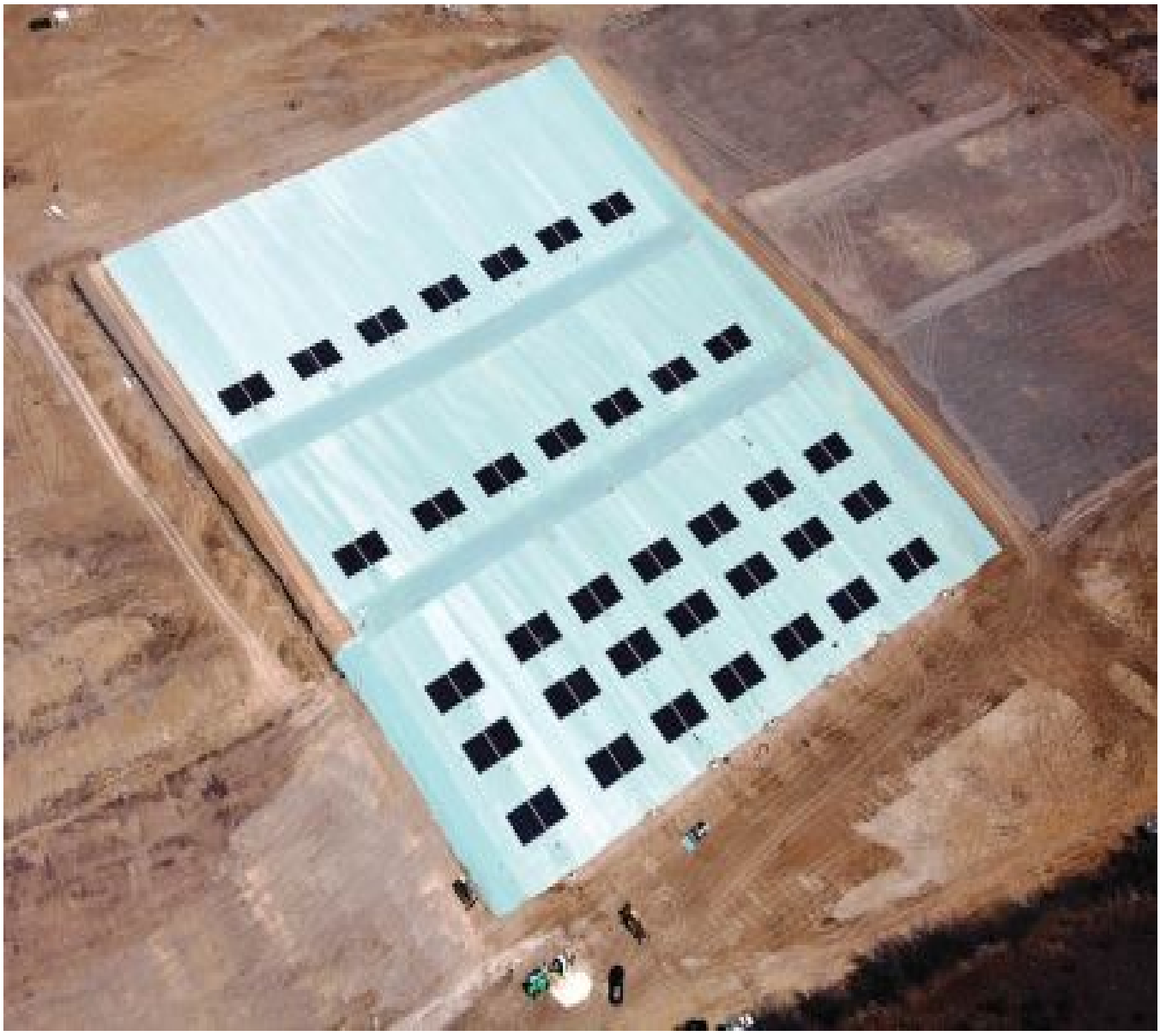

Figure 7: Tessman Road Landfill

Due to the limited public financial information on the pricing of thin-film solar installation for large ground-covered systems, an estimated price per watt is not available for this technology.

THIS PAGE INTENTIONALLY LEFT BLANK.

V. RECOMMENDED TECHNOLOGY

Due to the site limitations posed by the landfill cap and settlement, system efficiencies, and restrictions on incentives, only one of the identified technologies are recommended for further development during the design phase of this project: a fixed tilt system that is surface mounted and self ballasted. Tracking systems (single and dual axis) are eliminated from further consideration, since the mechanical tracker systems used would require a support structure that would either penetrate the ground (which would compromise the landfill cap) or would require a concrete foundation (which would create an excessive load and reduction in access to the cap). Given that definitive pricing and confirmation of incentive availability for flexible solar photovoltaic was not available, a summary analysis of fixed tilt only is provided below.

FIXED TILT SYSTEM ESTIMATED ANNUAL PRODUCTION

NREL's PVWatts calculator was used to evaluate the expected energy generation for the fixed tilt system.

Table 3: Fixed Tilt System Estimated Annual Production

System Technology	System Capacity using C Deck (MW)	Estimated Annual Generation (kWh/year)
Fixed Tilt	4 MW	6,700,000 kWh

The complete PVWatts output is provided in Exhibit 1 below (see also Appendix A). Note that solar photovoltaic systems only generate energy when sunlight is available (daytime only, with fewer daytime hours in winter). Therefore, even though a system is sized as a 4 MW system, it will not be generating 4 MW of energy continuously.

COST BENEFIT ANALYSIS OF TECHNOLOGIES

Preliminary cost/benefit analyses for the fixed tilt alternative described above was developed using the installed cost and the cumulative benefit are presented in Table 4 below. The cumulative benefit includes the direct value of offset energy costs at full retail rate. As discussed earlier, the installed cost includes the O&M cost for the first 10 years of operation.

PVWatts estimates were used to estimate production for the fixed tilt technology. No project financial incentives were assumed in this particular analysis.

Exhibit 1: PVWatts Estimated Production for a 4 MW Fixed Tilt System

PVWatts Calculator

NREL

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

RESULTS

6,682,825 kWh per Year *

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	3.45	373,332	48,645
February	4.44	436,696	56,901
March	5.18	561,871	73,212
April	6.02	628,049	81,835
May	6.64	711,379	92,693
June	6.79	700,850	91,321
July	7.04	745,234	97,104
August	6.82	718,086	93,567
September	5.49	559,158	72,858
October	4.67	497,130	64,776
November	3.81	394,849	51,449
December	3.34	356,190	46,412
Annual	5.31	6,682,824	$ 870,773

Location and Station Identification

Requested Location	11950 Lopez Canyon Road, Lakeview Terrace, California
Weather Data Source	(TMY2) LOS ANGELES, CA 24 mi
Latitude	33.93° N
Longitude	118.4° W

PV System Specifications *(Residential)*

DC System Size	4400 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	10°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

VI. SITE SELECTION

EXISTING SITE SETTING

The Lopez Canyon Landfill, located at 11950 Lopez Canyon Landfill Road in Los Angeles, has a main access road that leads to the gas utilization plant, associated offices, a helipad, and auxiliary paths that navigate the landfill site. The landfill generates about 5,000,000 cubic feet (ft3) of landfill gas per day, and the mulching and composting facilities contribute free mulch to the surrounding community[2].

In 1972, the Lopez Canyon Landfill area was designated a landfill site by the county and, in 1976, was annexed into the LASAN. Through the A.B. 283 Plan Consistency Program, the land was reclassified from "Public Owned 1 plan" classification to "open space" classification per the Sunland-Tujunga-Lake View Terrace –Shadow Hills – East LA Tuna Canyon Community plan.

In 1994, the City of Los Angeles zoned the landfill as "open space," and thereafter planned to provide the space for beneficial re-use after 30 years of closure.

PRELIMINARY GEOTECHNICAL EVALUATION

The geotechnical evaluation will evaluate the potential to install a PV solar generation system at Lopez Canyon Landfill and determine the optimal locations within the landfill to place the system. Based on the acreage required, one location has been identified as a favorable location for the PV system: C Deck (see Figure 8 below). This section will further evaluate the site suitability at these two locations.

It was indicated the percolation performance control of the existing cover at C Deck is comparable to that of the currently approved ET final soil cover described in Revision IV of Volume IV of IV Replacement Amendment to Final Closure Plan (Geosyntec, 2008a). It was recommended to the agencies considering approval of the existing soil cover as the ET final cover. On August 9, 2011, CalRecycle accepted the recommendation (CalRecycle, 2011).

After landfill closure, the waste will continue biodegradation and compression under gravity load. As a result, the landfill undergoes significant settlement during operation and following closure. The expected total settlement for the Lopez Canyon Landfill has been estimated to be in excess of 30 percent of waste thickness over a 50-year period (Geosyntec, 2008b). At C Deck, the estimated total settlement is approximately 50 feet (15.2 meter) over a 50-year period, or an average annual settlement of approximately 1 foot (0.3 meters).

[2]http://www.lacitysan.org/srpcd/LF_lopezCanyon

Figure 8: Lopez Canyon Landfill Potential Installation Sites: C Deck

Parsons has reviewed the 2012 as-built topographic map (LOPEZ2011ASBUILTTOPO.dwg). The map shows that C Deck will cover approximately 5 percent. No other topographic or survey data was located by Parsons to determine the landfill settlement or settlement rate that has occurred since closure. Parsons has also reviewed the landfill gas system drawings dated Dec 12, 2011 (Lopez Gas System_working_08292011 Model (1).pdf).

The landfill cover will serve as foundation for the solar system and associated equipment. From a geotechnical perspective, two loading conditions need to be considered for the design of the solar system. The first loading condition is for the construction phase. Loads from vehicles and equipment will be considered to determine the proper type of vehicle and equipment to protect the landfill covers. In addition, the loads from the solar system, wind, seismic activity, and to prevent sliding will be evaluated to design a proper ballasted system or other type of support. The second loading condition is for the post-installation phase. Long-term total settlement and differential settlement will be evaluated to mitigate their impact on the operation of the solar system. This analysis will facilitate the electrical design with settlement tolerance requirement and limitations on equipment (e.g., transformers, conduits) layout.

For the two loading conditions, the geotechnical evaluation will include three major components:

- **Landfill cover load bearing capacity analysis.** It is essential to protect the covers' structural integrity from the construction load and solar system load. Adding material to the existing cover will likely change its evapotranspirative property, revegetation plan, and drainage pattern, and thus should be minimized to the extent practical. This analysis will determine the proper support system for the solar panels and equipment, and to select proper construction equipment with minimal change to the cover profile.

- **Slope stability analysis.** Similar to the load bearing capacity issue, additional loads from the solar system and construction activities may cause slope instability. This analysis will mainly focus on cap veneer stability on the side slopes under static and seismic loads. The results will be used to optimize the solar system layout.

- **Total settlement and differential settlement analysis.** The cover will serve as the foundation for the solar system. Long-term settlement of the cover, if not managed properly, will become a significant maintenance and repair issue for the solar system operation as the system will settle with the cover. Large settlement will cause instability of the solar panels, breakage of the supporting structures, and breakage of rigid conduit (if used). This analysis will estimate the settlement the cover will experience during the solar system's service life. Results will be incorporated into the system design to accommodate the settlement.

Parsons performed a high-level review of the existing geotechnical data and identified data gaps. There are extensive soil compaction data available for the covers from the construction quality assurance programs (Geosyntec, 2004, 2010b). Cone Penetrometer Tests (CPTs) on C Deck also have been conducted during the characterization of the existing cover (Geosyntec, 2010b). The compaction test data and CPT data can be used to derive soil strength parameters required for the loading bearing analysis.

Shear strength of the municipal solid waste has been developed in previous analyses (Geosyntec, 1996). The solid waste data set, in combination with the soil cover shear strength data, will be used for the slope stability analyses.

Although previous analysis showed the landfill will have approximately 50 feet of settlement in 50-year period, collection and analysis of recent field monitoring data will be needed to verify this calculation. Given the highly heterogeneous nature of municipal solid waste, the actual settlement and settlement rate could vary from this original estimate significantly. It is critical to include real monitoring data as part of the design input. The missing settlement monitoring data is a significant data gap that will need to be addressed as part of the design phase. Parsons recommends starting a topographic survey program for the covers and side slopes, taking measurements every three months for at least two years. The survey program can be implemented in parallel with the initial design. Once the settlement behavior has been verified and evaluated, the design can be finalized.

The PV support frames for the Lopez Canyon Landfill can be installed on ballasted ground-mount systems; that is, concrete blocks (or ballasts) installed on top of the landfill cover without disturbing the cover, to support the PV frames' weight and to also anchor them down to resist wind and seismic loading.

Ballasts can be precast on an off-site facility and transported to the landfill site, or they can be cast-in-place using simple forming on top of the cover at the desired location according to the array layout. The choice of using precast ballast blocks or using cast-in-place ballasts should be left to the preference of the installer.

In the event there is excessive differential settlement that affects the performance of the PV system, the PV frames and ballasts should be designed to be removable in modules to allow for localized repair of the landfill cover. After repair of the landfill cover is completed, the ballasts, PV frames, and panels can be reinstalled and reconnected.

Electrical wiring is normally routed through conduit installed and supported above grade and via an overhead distribution line. The supporting structure for the PV modules shall be adjustable to maintain optimal orientation in case of differential settlement.

CIVIL SITE WORK CONSIDERATIONS

The design and construction of the proposed Lopez Canyon Landfill solar PV system must take into consideration the landfill-specific site conditions; in particular, the system must be designed and construction conducted such that the landfill caps are not damaged in any way. As part of the design phase, the landfill caps must be evaluated for their ability to support the anticipated loads from the solar PV system, as well as the vehicle loads during both construction and maintenance activities.

Temporary construction equipment loads should be considered and carefully coordinated. The transportation or storage of equipment at the site would further add additional temporary construction weight onto the landfill.

The implementation of construction activities will require a complete analysis due to the sensitivity of the landfill site. A carefully coordinated construction plan should be developed and implemented to prevent unnecessary loading on the cap.

Considerations during construction may include restrictions on the number of vehicles on top of the landfill at one time; limitations on the size and type of construction equipment allowing for maneuverability; spacing and layout of the panels, including clearance for maintenance roads; using georgic material or other types of aggregate to stabilize the soil and prevent damage to the cap; and other construction methods.

Maintenance activities will generally be low impact, requiring only personal vehicles/passenger trucks and inspection on foot. The cleaning of the panels, which typically occur one to two times per year, will likely include the use of temporary water trucks to spray water on the panels. Mitigation measures to avoid excessive infiltration or water runoff may be required and should be negotiated with the operations and maintenance (O&M) contractor.

ELECTRICAL CONSIDERATIONS

Lopez Canyon Landfill currently has one Southern California Edison (SCE) meter and four Los Angeles Department of Water and Power (LADWP) meters. As discussed in Section 10, it is recommended that LADWP FiT incentives be pursued. As such, the solar PV system will need to be connected to at least one of the LADWP meters.

EXISTING ELECTRICAL SYSTEM

Currently, two of the existing LADWP electrical meters are located at the flare station which is adjacent to the C Deck for the proposed 4 MW solar PV system. These electrical meters are supplied via LADWP-owned 35 KV overhead and underground lines to a 2,000 KVA utility transformer. This step-down transformer feeds two 480Y/277V 3 phase, four wire switchboards: “MDP-1” and “MDP-2.” The main circuit breaker in “MDP-1” is rated at 2000A, and the switchboard is equipped with a 2000A LADWP meter. The main circuit breaker in “MDP-2” is rated at 800A, but only with a 400A LADWP.

The configuration of the other two LADWP electrical meters are unknown at this time, and further investigation is required to determine if either of these two electrical meters is more suitable than the other for interconnection to the LADWP utility grid.

A discussion of the electrical needs for the recommended 4 MW installation is found in the following section VII.

THIS PAGE INTENTIONALLY LEFT BLANK.

VII. SYSTEM LAYOUT

Based on the acreage and other siting requirements, one location was identified as the most favorable for the PV system: C Deck. By using C Deck (see Figure 9 below), approximately 22 acres of land are available for the solar PV system. Typically, a fixed tilt system requires roughly 4 to 6 acres per megawatt (MW). Depending upon the layout and the panel ratings, it is anticipated that a system of up to 5 MW may be able to be installed in the proposed area. However, as mentioned before, LASAN staff requested that we limit the capacity recommendation to 4 MW for this feasibility study.

This section will identify the key project requirements, including connections, electrical conduit routing, power feed alternatives, and constraints when developing preliminary civil site plans, including general arrangement of the PV system.

PV SYSTEM

A typical PV system is made up of several key components, including: PV modules, inverters, and the balance of system components. PV systems use solar cells to capture the sun's rays and convert that energy into direct current (DC) electricity. The solar cell is the basic block of PV technology, and solar cells are aggregated to form a PV panel. A group of PV panels wired together into strings is called a PV array. Several PV arrays are connected to an inverter that converts the direct current produced by PV panels into alternating current (AC) and can connect seamlessly to the utility grid.

In a PV system, a central inverter (for centralized inverter architecture) and string inverter (for distributed inverter architecture) are both commonly used in utility-scale, grid-connected system. Central inverter architecture uses fewer, but a larger size of, inverters. Distributed inverter architecture uses more but smaller inverters to convert DC to AC power. In addition to the PV panels and inverters, PV systems also include several other pieces of equipment called the balance of system (BOS) components. BOS components typically include racks and other mounting equipment for the solar panels, wiring for electrical connections, medium switchgear, step-up transformer, low-voltage board, panel boards, and etc., for electrical distribution.

Typically, electrical wiring from the solar arrays to inverters and from inverters to electrical equipment/ utility grid point of interconnection runs through underground conduit/raceways. In landfill applications, electrical wiring may be required to run through conduit/cable tray supported above grade and via overhead distribution lines due to the site loading, settlement, and soil disruption restrictions. A concrete equipment pad will be laid directly on top of grade, and PV panel supporting structure shall be adjustable to maintain optimal orientation to incoming solar radiation in case of differential settlement.

It is also important to note that coordination with LADWP for utility interconnection requirements and further investigations/studies are required to identify the locations and to characterize the total and available carrying capacity of the existing utility distribution and transmission lines near the Lopez Canyon Landfill. The investigations and studies shall determine the impact of the solar PV system on the LADWP utility grid and whether distribution/transmission lines upgrades or additional interconnection equipments is required for interconnection.

Typically, underground electrical conduit or overhead lines are installed to connect the solar PV arrays to the electrical equipment at the main meter. However, an alternative connection scheme may need to be developed for this particular system due to the site loading and soil disruption restrictions.

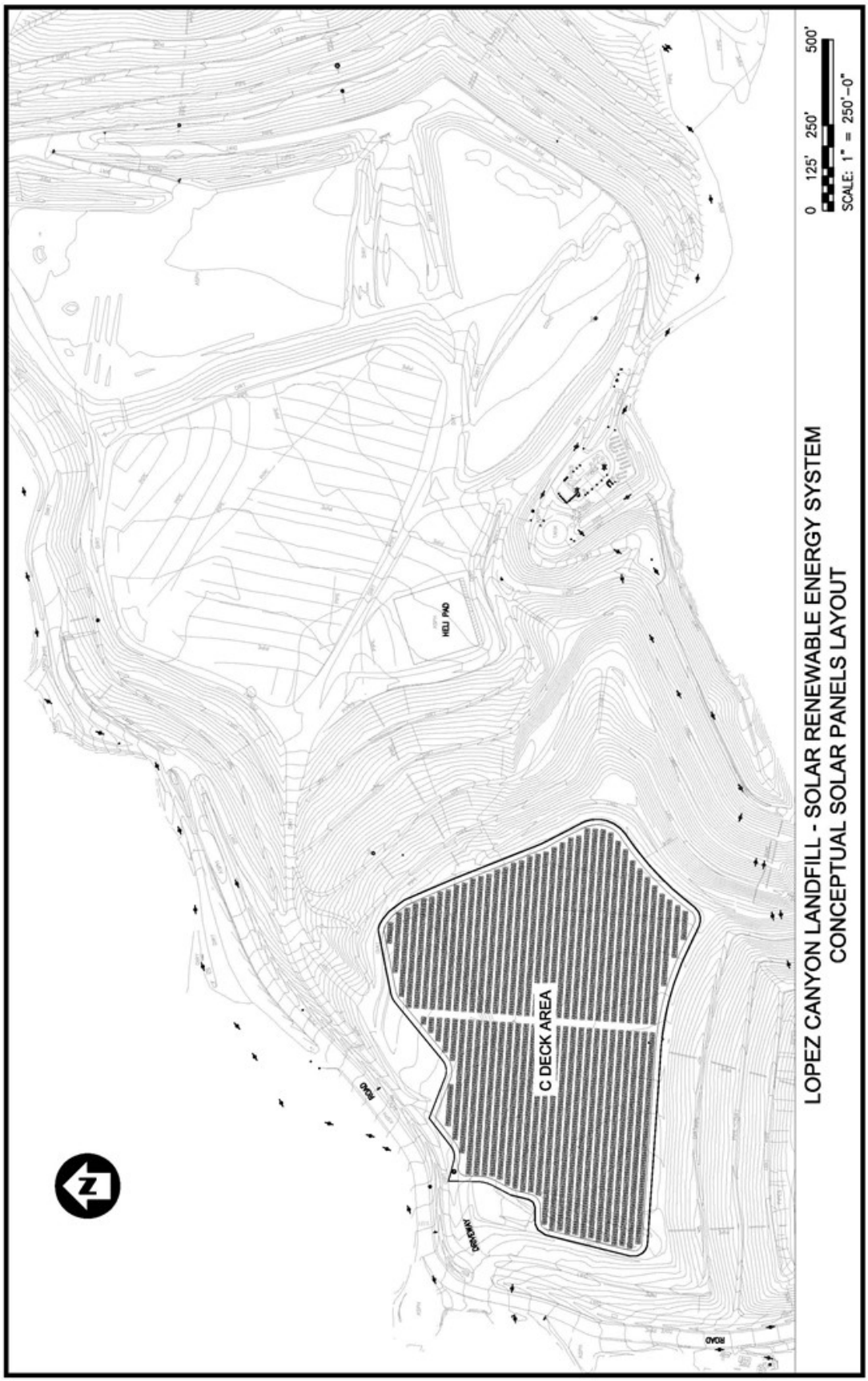

Figure 9: Lopez Canyon Landfill Solar Renewable Energy System – Conceptual Solar Panels Layout

ELECTRICAL INFRASTRUCTURE REQUIREMENTS

As previously discussed, the Lopez Canyon Landfill currently has one Southern California Edison (SCE) meter and four Los Angeles Department of Water and Power (LADWP) meters. As discussed in Section 10, it is recommended that LADWP FiT incentives be pursued. As such, the solar PV system will need to be connected to at least one of the LADWP meters.

Currently, two of the existing LADWP electrical meters are located at the flare station, which is in between the available C Deck for the proposed 4MW solar PV system. These electrical meters are supplied via LADWP owned 35KV overhead/ underground lines to a 2,000 KVA utility transformer. This step-down transformer feeds two 480Y/277V 3 phase, 4 wires switchboards - "MDP-1" and "MDP-2." The main circuit breaker in "MDP-1" is rated at 2000A and the switchboard is equipped with a 2000A LADWP meter. The main circuit breaker in "MDP-2" is rated at 800A but only with a 400A LADWP meter. At the flare station, the existing LADWP 2,000 KVA step-down transformer capacity is lower than the expected output of the 4 MW solar facilities; the existing power system will need to be modified before the PV solar facility can be interconnected at this location. To install a 6MW solar PV system, the proposed electrical system modifications include:

- Disconnect the existing LADWP 35 KV overhead line at the 2,000 KVA transformer and reuse the overhead line to feed the new 35 KV main electrical service switchgear. Back feed the existing 2,000 KVA transformer for flare station electrical distribution system from the new 35 KV main electrical service switchgear. The existing electrical system at the flare station shall remain unchanged.
- Interconnect the new 4 MW solar PV facility to LADWP utility grid at the new 35 KV main electrical service switchgear.
- The proposed electrical system modification shall be reviewed and approved by LADWP.
- Also, further investigation and coordination with LADWP is required to determine the current carrying capacity of the existing distribution/transmission line. This information will dictate whether the existing line can be used for the interconnection or whether this line needs to be upgraded also.

THIS PAGE INTENTIONALLY LEFT BLANK.

VIII. SHADE STUDY

The Lopez Canyon Landfill is located in the foothills near Kagel Canyon surrounded by mountains and hills. Due to its close proximity to and location within a valley, shade onto any solar panel installation from the surrounding environment could potentially reduce the amount of energy generated at different times of the day. Seasonal variance was also taken into account due to the changing position of the sun throughout the year. During winter months when days are shorter, solar power generation is lower than in summer months. A preliminary study assessed the shade results at the potential locations of the PV system. Three different days of the year were selected as they were determined to be representative of the varying seasons: June 21st, September 9th, and December 21st. Average sunrise and sunset times for these months near Lopez Canyon Landfill are summarized in Table 4.

Table 4: Average Sunrise and Sunset Times

Month	Average Sunrise Time (PST)	Average Sunset Time (PST)
June	5:45 AM	8:00 PM
September	6:30 AM	7:00 PM
December	6:45 AM	4:45 PM
Source: Calculated from Lat/Long Coordinate 34.286957, -118.401036 http://www.fcc.gov/encyclopedia/local-sunrise-sunset-calculations		

Generally, the solar panels will generate power between the hours of 7:00 AM to approximately 7:30 PM. As the Earth rotates, shading from the hills will cast shadows onto C Deck. C Deck, due to its lower elevation, will be shaded by AB+ Deck during the early daytime hours of the day. The renderings below depict the setting for the three dates near its average sunrise and sunset times.

Figure 10: Shade Study, June 21st Morning

Figure 11: Shade Study, June 21st Evening

Figure 12: Shade Study, September 9th Morning

Figure 13: Shade Study, September 9th Evening

Figure 14: Shade Study, December 21st Morning

Figure 15: Shade Study, December 21st Evening

The United States Energy Information Administration (EIA) published an article on the average hourly renewable electricity production in California from 2013 to May 2014. The data source used to make conclusions presented in this article is from the California Independent System Operator's Daily Renewable Watch. The trends indicate that the peak production occurs around noon during the day, with lower production rates in the early morning and late evening, resembling a bell curve. Though this is for the entire state of California, similar conclusions can generally be applied, with considerations for specific site conditions such as shade, for individual sites. As shown in the graphs below, higher power production is anticipated during the summer and fall seasons while lower production is expected in the winter season. All three days reveal the same conclusion that the lowest production occurs during the first hour after sunrise and during the last hour before sunset. On June 21, 2014, the first hour and last hour of the day produce approximately 0.9% and 0.5%, respectively, of the total solar PV power production during the day. On September 9, 2014, the first hour and last hour of the day produce approximately 0.0% and 1.2%, respectively, of the total solar PV power production during the day. On December 21, 2014, the first hour and last hour of the day produce approximately 2.3% and 3.8%, respectively, of the total solar PV power production during the day.

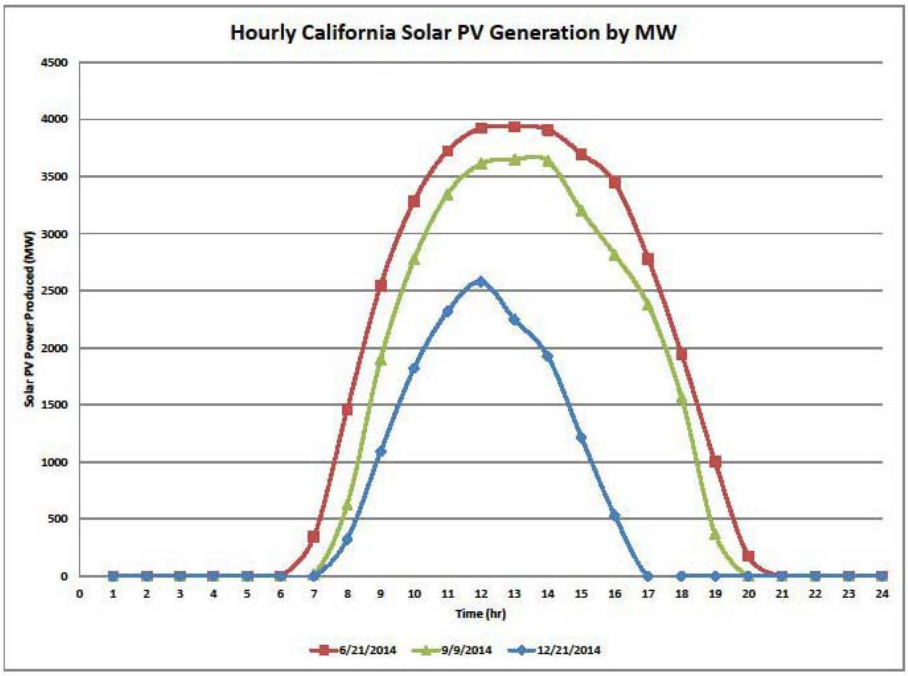

Figure 16: Hourly Solar PV Generation in California

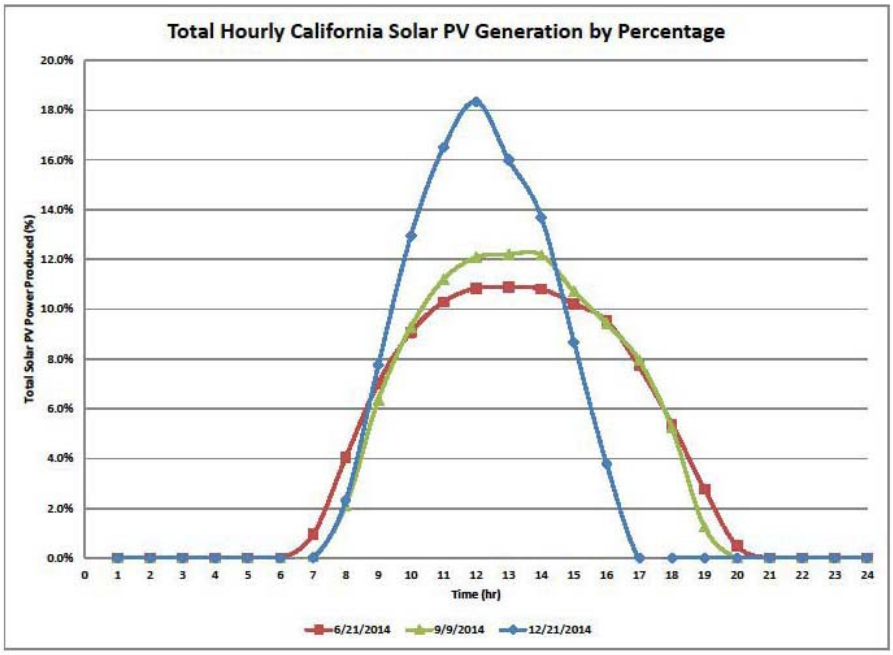

Figure 17: Hourly Percentage of Total Solar PV Generation in California

The CAISO hourly breakdowns of renewable resources are provided as Appendix B.

Although C Deck will be partially shaded during the day, the shading will occur primarily during the first and last hour of daylight, which corresponds to the period of marginal system production. During the winter season when the day is shorter, shading has a greater impact to the solar PV generation. Despite this impact (which only affects a portion of C Deck), this amounts to only approximately 6% of the total power generation during the winter. As such, shading of the C Deck does not significantly impact the overall expected production of a solar PV system.

REFERENCES

- http://www.eia.gov/todayinenergy/detail.cfm?id=16851
- http://www.caiso.com/market/Pages/ReportsBulletins/DailyRenewablesWatch.aspx

THIS PAGE INTENTIONALLY LEFT BLANK.

IX. ENVIRONMENTAL CONSIDERATIONS

ENVIRONMENTAL CLEARANCES REQUIRED

The proposed installation of a solar facility at the landfill could be subject to the preparation of both a Phase 1 Environmental Site Assessment and/or a Mitigated Negative Declaration (MND). These two documents are separate studies serving different purposes, as discussed herein.

PHASE I ENVIRONMENTAL SITE ASSESSMENT

A Phase I Environmental Site Assessment, or a Phase I site investigation, is typically prepared to document the physical condition of a property that is being considered for development, sale, or lease. This study is conducted to determine if there have been or are currently any environmental concerns resulting from the storage, use, release, and disposal of hazardous substances and petroleum products and their derivatives. The study also documents general environmental site conditions as observed on the date of the inspection, or as known from a review of the literature. This study is prepared in accordance with American Society for Testing and Materials (ASTM) E 1527-13 Phase I Environmental Site Assessment Protocol to document environmental conditions of the affected property to qualify for liability protection under Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The environmental site assessment establishes a baseline for use by LASAN in making decisions concerning real property transactions. Although primarily a management tool, an environmental site assessment assists the LASAN in meeting its obligations under the CERCLA, 42 United States Code (U.S.C.) Section 9620(h) (1), as amended by the Community Environmental Response Facilitation Act (CERFA) (Public Law 102-426).

The environmental site assessment is prepared based on information obtained through record searches, a visual site inspection, and interviews. The records searches include a review of available government agency records, including environmental restoration and compliance reports, records, audits, and inspections. The environmental site assessment also includes an evaluation of the environmental conditions of properties immediately adjacent to or relatively near the subject parcel(s) that could pose environmental concerns and/or affect the subject property.

It is often recommended that a Phase 1 Environmental Site Assessment be conducted to identify existing site conditions of the property before construction. While contamination is not expected at the Lopez Canyon Landfill site, the Phase 1 study is a good method for documenting site conditions. It is possible that LASAN may opt to prepare this study in the event that the property for the solar facility will be leased to an operator.

CEQA AND NEPA REQUIREMENTS

To address the potential requirement for a Mitigated Negative Declaration (MND), LASAN will be required to comply with applicable California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements pertinent to construction and operation of a new solar facility on the existing LASAN site. It is important to note that the proposed solar facility is a new project (i.e., a project subject to discretionary approvals by government agencies) and an activity that is subject to CEQA.

CEQA. The MND is one type of CEQA document; LASAN will initiate an Initial Study Checklist to first determine if the proposed solar facility will qualify for a Negative Declaration. In the event the project qualifies, a Negative Declaration can be prepared. In the event that potentially significant impacts are identified, and effective mitigation measures can be identified to avoid or

reduce impacts to a less than significant level, then such mitigation measures will be incorporated into an MND. Mitigation measures included in the MND will be made conditions of approval and must be implemented during construction and operation. It is possible that the proposed solar facility will qualify for a MND based on the past projects proposed at this landfill that also were evaluated in the form of MNDs, the existence of considerable previous studies of the landfill area, and the potential for mitigating all potentially significant environmental impacts to a less than significant level. In the event that the Initial Study Checklist indicates that the project does not qualify for a Negative Declaration, then an Environmental Impact Report (EIR) must be prepared. The EIR process can be considerably lengthier with defined opportunities for agency and community input. LASAN may opt to use the EIR process for this project because of the known community opposition to a solar facility at the landfill site.

Categorical Exemption. Section 15300 of CEQA Guidelines provides an exemption to CEQA for classes of projects that do not have a significant effect on the environment. Such projects may be declared to be categorically exempt from the requirement for preparation of environmental documents. Passage of Senate Bill 226 in 2011 added Section 21080.35 to the Public Resources Code and created a new categorical exemption under CEQA for solar energy systems on the roof of an existing building or at an existing parking lot, limited to equipment that does not occupy more than 500 square feet of ground surface and does not include a substation. This exemption cannot be applied if the solar project will impact certain protected plants or trees or requires an individual permit from certain federal or state agencies. The exemption would not apply to any transmission or distribution facility or connection. It is not expected that the proposed solar facility can qualify for a Categorical Exemption.

NEPA. The proposed solar facility may be subject to federal environmental regulations, including NEPA, depending on whether the project will involve federal funding, federal land, or require permits or approvals from federal agencies. In the event that there is a federal component, applicable NEPA evaluations may be integrated into the CEQA document. The Lopez Canyon Landfill has been subject to U.S. Forest Service approval of its Special Use Authorization; therefore, it would be expected that this federal agency will have discretionary approval.

The proposed solar facility may also be subject to design, construction, and operation in consideration of applicable mitigation measures that have been included in prior CEQA documents approved for the landfill site. These mitigation measures, including the original mitigation measures in the Supplemental EIR certified by the City Council in 1991, will require review for relevancy and feasibility.

OTHER ENVIRONMENTAL CLEARANCES POTENTIALLY REQUIRED

The proposed solar facility would require new and updated environmental clearances from regulatory agencies. Existing permits and approvals may require notification to the regulatory agency or the filing of new applications.

California Regional Water Quality Control Board Order No. R4-2004-0176. The LASAN will be required to submit a CEQA evaluation of the proposed solar facility and submit a request for an amendment to its Final Closure Plan to the RWQCB in accordance with the waste discharge requirements adopted by the Board for the landfill site. This request will need to describe construction aspects consistent with the prescriptive covers, as well as the amount and characteristics of solar panel wash water that would be disposed of at the site. Additional monitoring of new discharge water may be required. No change to location or frequency of the existing groundwater monitoring wells would be expected.

Zoning. A Conditional Use Permit (CUP) or amendment to the existing CUP may be required for the placement of solar panels on land that is zoned as "open space." Zoning designation OS (open space) does not currently allow for solar energy generating facilities.

FAA. The proposed solar facility may be subject to review by the U.S. Federal Aviation Administration (FAA). The FAA has broad authority for airspace review and the evaluation of any solar project that could pose a potential hazard to air navigation. The proposed solar facility would not be expected to include structures rising 200 feet or greater above the land surface and, therefore would not require an airspace review. Because the proposed LASAN site is approximately 2.5 miles from the nearest airport/airfield, the potential effects of reflectivity or glare from solar panels may be a concern because it can cause a brief loss of vision or flash blindness. Although PV panels are primarily absorptive, reflectivity should be studied during project design (i.e., a glare hazard analysis). If a solar installation creates glare that interferes with aviation safety, the FAA could require the airport to pay for the elimination of solar glare by removing or relocating the solar facility. Even though the site would be an off-airport activity, LASAN may be required to file a notice with the FAA to review potential safety or navigational problems with the proposed solar facility.

Forest Service Special Use Authorization. The U.S. Forest Service would be another federal agency with discretionary approval authority and an interest in the proposed solar facility project. The LASAN may be required to submit an application for authorization of National Forest Service land for activities that could include road and utility rights-of-way. The proposed solar facility may be subject to a continued compliance with conditions of the existing Special Use Authorization for the landfill.

CUPA. The Los Angeles Fire Department would be required to revise its Hazardous Waste and Hazardous Material Management Program to integrate the new solar facility at this site. Revised Consolidated Permit conditions would not be expected, assuming that there will be no new storage of Hazardous Materials or generation of Hazardous Waste.

Post-closure Maintenance. The proposed solar facility would be subject to review under the terms and conditions of the Final Post-closure Maintenance Plan.

PERMITS/APPROVALS NOT ANTICIPATED TO BE REQUIRED

It is not anticipated that the proposed solar facility will require any changes to the following permits and approvals:

- **South Coast Air Quality Management District (SCAQMD) Air Sampling.** Landfill gas sampling and ambient air sampling in accordance with SCAQMD Rule 1150.1 Compliance Plan.
- **Pesticide Management.** Use of pesticides (strychnine and aluminum phosphide) for rodent control in accordance with Los Angeles County Department of Agriculture Restricted Material Permits.
- **Landfill Leachate Monitoring.** Discharge limitations and landfill leachate monitoring are required in accordance with LASAN Industrial Wastewater Permits for the truck wash, clarifier at the scale house, condensate system, and leachate storage/neutralization tanks.
- **Surface Water Monitoring.** In accordance with the General Industrial Stormwater National Pollution Discharge Elimination System (NPDES) Permit Stormwater Management. Stormwater generated at the site is monitored and managed in accordance with the Stormwater Pollution

Prevention Plan (SWPPP), which includes best management practices, preventive maintenance, housekeeping, and inspection and recordkeeping requirements.

- **CalRecycle Permit for Lopez Canyon Landfill.** Quarterly inspections of closed landfill would continue. It will be important to ensure that specific mitigation measures are included in applicable requests for proposals (RFPs), specifications, plans, drawings, and procedures issued for construction of the solar facility. Project mitigation measures are commitments of the project that serve as the basis for the determination that environmental impacts of the project are considered less than significant. This determination serves as the basis for project approval.

MAINTENANCE IMPACTS AND RECOMMENDED MITIGATIONS

From an asset management perspective, maintenance of the solar facility is critical to optimize production of energy in compliance with applicable regulatory requirements and a reduction of risks. Many specific environmental requirements will be included in permits and approvals to be obtained for the facility.

SOLAR POWER GENERATION SYSTEM MAINTENANCE CONSIDERATION

The primary objective of maintenance activities will be to clean solar panels and service electrical equipment and infrastructure to maintain an operating solar PV system. In parallel, the landfill staff will be conducting landfill maintenance activities to repair the landfill cover in response to emissions of landfill gases and conduct effective grading to correct for differential settlement of the landfill surface.

Once the solar facility has been constructed, LASAN would need to implement a maintenance program with a two-fold objective:

- Avoid the generation of environmental impacts from operation of the solar facility
- Avoid impacts from conducting maintenance activities

Operational Impacts. Potential impacts during operation of the solar facility are:

- **Glare.** The primary concern of a solar facility is the potential for glare, which can cause temporary vision impairment. Although it is expected that the solar panels will be procured with an anti-reflective coating to avoid glare, it is possible that, over time, the antireflective coating may break down and wear off (in part, from continued washing), resulting in a loss of antireflective properties and possible glare until panels are replaced. This is a concern that can be addressed as part of maintenance.
- **Biological Resources.** Glass surfaces have long been known as a major cause of bird mortality; solar panels represent additional glass surfaces in the environment. Increased animal mortality (i.e., birds and butterflies) at large solar facilities have recently been observed; among the causes of death at solar facilities were trauma, solar flux, and predation. Exposure to solar flux and injury or death (i.e., hazards from singeing feathers, loss of flying ability, and death from impact to the ground) would not be expected to result from the proposed solar facility because it does not include a power tower with concentrated heat. Some degree of animal mortality could be expected at the solar facility, and this potential impact would require consideration during maintenance activities.
- **Land Use/Recreational Resources.** In the event operation of the solar facility overlaps with planned recreational use and activities at the site, there will be unique compatibility and safety

considerations. Access to recreation facilities/campgrounds could be an area of concern in consideration of the project location. This is a potential impact that would require consideration during maintenance activities.

- **Water Supply.** Water required for washing solar panels represents an environmental impact to water supplies. Depending on the final number of solar panels, weather conditions, and other factors, it is estimated that approximately 27,000 gallons of water per year would be used for the washing of panels. Use of water for washing would require consideration during maintenance activities.
- **Discharge of Wash Water.** The effect of the disposal of solar panel wash water will be evaluated to determine if water quality or storm water management would be impacted.
- **Operational Noise and Traffic.** Maintenance vehicles, including vehicles used during the washing of solar panels would generate noise and traffic in the immediate area. This impact is not considered to be significant; however, maintenance considerations should be incorporated to reduce the potential for impacts, especially because of ongoing activities for landfill gas and ambient air sampling and leachate and surface water monitoring.
- **Geotechnical Considerations.** Geotechnical site characteristics will be given consideration to ensure long-term durability of the solar facility at this location.
- **Waste Generation.** The primary concern would be disposal of solar panels at change out/replacement or at the end of their useful life (i.e., 25 years). Generally not recyclable, the LASAN could identify the best practice for the disposal of glass panels at that time.

RECOMMENDED MITIGATIONS

Specific mitigation measures would be identified in the Mitigation Monitoring and Reporting Program (MMRP) to be included in the CEQA document for the solar facility. Mitigation measures expected to be included are as follows:

- **Glare.** Routine inspections of the antireflective condition of solar panels will be important to ensure that glare is not created from the site.
- **Biological Resources.** The MMRP would include a protocol for the reporting of bird and bat deaths as an ongoing maintenance activity at the solar facility. To determine the cause of mortality, carcasses should be collected and preserved as soon as possible after death. Animal deaths should be reported to the regulatory agency in accordance with the MMRP. Depending on the extent of animal deaths, protective measures may need to be integrated into the design and procurement of solar panels.
- **Land Use/Recreational Resources.** LASAN may need to identify general park-type operating conditions or rules to accommodate recreational use adjacent to solar power generation, particularly for public access to any future trails, equestrian areas, or other uses.
- **Water Supply.** Specific water-use guidelines at the site can be incorporated into maintenance plans. This can include standard management practices that should be implemented at the site.
- **Discharge of Wash water.** The effect of the disposal of solar panel wash water will be evaluated to determine if water quality or storm water management would be impacted.
- **Operational Noise and Traffic.** Maintenance vehicles, including vehicles used during the washing of solar panels would generate noise and traffic in the immediate area. This impact is

not considered to be significant; however, maintenance considerations should be incorporated to reduce the potential for impacts, especially because of ongoing activities for landfill gas and ambient air sampling and leachate and surface water monitoring.

- **Geotechnical Considerations.** LASAN would incorporate periodic inspections by a licensed geologist, and these inspections would routinely review differential settlement of the landfill.
- **Water Resources.** LASAN would identify specific mitigation measures to conserve water and ensure the proper disposal of wastewater from the site.
- **Noise and Traffic.** LASAN would provide a toll-free number for community concerns and have contingency available in the event noise monitoring is requested. Maintenance staff would retain information on daily vehicle trips to and from the site and allow for adequate parking.

In addition to mitigation measures, the maintenance program for the solar facility would need to integrate applicable, ongoing conditions and activities that would include but not be limited to:

- **California Regional Water Quality Control Board Order No. R4-2004-0176**. Additional monitoring of new discharge water may be required. No change to the location or frequency of the existing groundwater monitoring wells would be expected.
- **Conditional Use Permit.** New conditions and requirements may be issued as part of the new Conditional Use Permit or amendment to the existing CUP for the placement of solar panels on land that is zoned as "open space."
- **U.S. Forest Service Special-Use Authorization.** The proposed solar facility may be subject to new conditions for compliance with a Special-Use Authorization.
- **Post-closure Maintenance.** The proposed solar facility would be subject to any applicable terms and conditions of the Final Post-closure Maintenance Plan.
- **Landfill Leachate Monitoring.** Discharge limitations and landfill leachate monitoring as required by the LASAN Industrial Wastewater Permits for the truck wash, clarifier at the scale house, condensate system, and leachate storage/neutralization tanks.
- **Surface Water Monitoring.** In accordance with General Industrial Stormwater NPDES Permit.
- **Stormwater Management.** Stormwater generated at the site is monitored and managed in accordance with the Stormwater Pollution Prevention Plan (SWPPP), which includes best management practices, preventive maintenance, housekeeping, and inspection and recordkeeping requirements. Discharge of wash water from the cleaning of solar panels may require recording and reporting.
- **Pesticide Management.** The use of pesticides (strychnine and aluminum phosphide) for rodent control in accordance with Los Angeles County Department of Agriculture Restricted Material Permits.

It will be important to ensure that specific mitigation measures are included in applicable requests for proposals (RFPs), specifications, plans, drawings, and procedures issued for construction of the solar facility. Project mitigation measures are commitments of the project that serve as the basis for the determination that environmental impacts of the project are considered less than significant. This determination serves as the basis for project approval.

X. PROJECT ECONOMICS INCENTIVES AND FINANCIAL OPTIONS

Project economics often drive design and sizing decisions for solar renewable energy projects. Factors that affect project economics include initial upfront cost, financing rates, long-term operation costs, offset energy benefits, and incentives offered by the utility. The estimated overall return on investment (ROI) for a project compiles all of these factors and can be used as basis for decision-making when evaluating multiple project options. This section discusses the financing and incentive alternatives currently available and their applicability to this project.

ESTIMATED PROJECT COSTS

Approximate typical costs for solar installations are provided below:

- **Fixed Tilt:** $3.25 per watt installed ($13,000,000 for a 4 MW AC [alternating current] system)
- **Single-axis Tracker:** $4.25 per watt installed ($17,000,000 for a 4 MW AC system)
- **Dual-axis Tracker:** $5.00 per watt installed ($20,000,000 for a 4 MW AC system)

These costs are based on recently observed industry data in Southern California and include labor and materials for design, construction, and operation and maintenance (O&M) for the first 10 years of operation. Site preparation, environmental mitigation, project management, construction management, and operations and maintenance costs after the first 10 years of operation are not included. Current market conditions, material availability, and siting limitations may impact project costs.

FINANCIAL ASSESSMENT INCLUDING COST ESTIMATE

A preliminary financial assessment and cost estimate for a potential 4 MW fixed tilt system at the Lopez Canyon Landfill is provided below.

A preliminary cost estimate is provided in Table 5 for the major electrical equipment. Please note that these costs are estimates only; prices may vary depending upon the specific equipment and panels selected, and may be subject to pricing changes at the time of procurement. These estimates do not include any modifications that may be required by LADWP at the time of implementation.

Table 5: Preliminary 4 MW Fixed Tilt PV System Electrical Equipment Cost Estimate

Description of Item	Quantity	Unit	Unit Cost	Total Cost ($)
1000 kW Inverter	4	EA	$130,000	520,000
480 V Switchboard	2	EA	$200,000	400,000
3 MVA Step-up Transformer	2	EA	$140,000	280,000
38 kV Class Switchgear	1	EA	$1,000,000	1,000,000
Racking systems, balance of systems hardware, earthwork, system design, and installation labor	1	LS	$4,000,000	4,000,000
Solar Panels	17,000		$400	6,800,000
Total estimated cost ($)				13,000,000

INCENTIVE OPTIONS

A number of incentive programs are available for commercial solar installations. Incentive funding is offered by the state and allocated to each utility agency. Here in Los Angeles County, the primary utility agencies are LADWP and SCE. Lopez Canyon Landfill is located in LADWP's service territory; therefore, the incentive portion will focus on the incentives available in LADWP's service area. However, all solar programs available in Los Angeles County will be referenced, providing a visibility of the solar incentive program as a whole.

The following incentive programs are applicable in LADWP territory:

FEED-IN-TARIFF (FIT)

On January 11, 2013, the Board of Water and Power Commissioners (Board) approved the 100 MW FiT Set Pricing Program as the first component of the 150 MW FiT Program. LADWP's 100 MW FiT Set Pricing Program seeks to encourage renewable energy development within the Los Angeles Basin and help meet the 33 percent Renewable Portfolio Standard mandate by 2020. The FiT Program will allow the LADWP to partner with program participants to purchase, under a standard power purchase contract, energy generated from a participant's renewable energy generating system. These systems will be located within the LADWP's service territory and interconnected to the LADWP electrical distribution system. All the energy generated by these systems will be purchased at a fixed price, subject to time-of-delivery multipliers, for a term of up to 20 years.

The 100 MW FiT Set Pricing Program is the successor to the LADWP's 10 MW FiT Demonstration Program, which was approved by the Board on April 17, 2012, and launched on May 17, 2012. The Demonstration Program helped gauge market pricing and tests the initial program's structure. It restricted projects to solar energy systems between 30 kW to 999 kW. Projects under the Demonstration Program were selected under a bid pricing mechanism. LADWP received 26 applications totaling 7.2 MW, of which 14 were eligible for contract signing. The weighted average bid price of the 14 projects is $0.175/kWh.

The current bid price is $0.13/kWh.

NET ENERGY METERING (NEM) RATE BENEFITS

Net energy metering (NEM) is a type of distributed generation that allows customers with an eligible power generator to offset the cost of their on-site electric usage with the energy that they export to the grid. In this scenario, a specially programmed "net meter" is installed to measure the electricity a customer uses (purchases) and the electricity exported to the grid.

Systems greater than 1 MW are not eligible for NEM in LADWP territory. Systems greater than 1 MW are placed on an appropriate parallel generation rate: either schedule CG-2 or schedule CG-3. This rate is an NEM account that works with a second rate schedule, which is referred to as an otherwise-applicable-rate schedule (OAS). The OAS determines the rates and charges for setting up the NEM meter and the calculation of the NEM bills. The OAS may be one of two meter rate schedules for which the meter would be eligible if a generation facility did not exist; the rate schedule is determined as part of the Interconnection Agreement for the PV system. Upfront cash requirements, risks, and penalties associated with shortfalls in energy production and operations and maintenance of the system may not be desirable or permissible for the owner.

The combination of the low site usage and proposed kWh production of a 4 MW system is incompatible with the NEM program. Therefore, LASAN would not be eligible for NEM benefits for a proposed 4 MW system.

SENATE BILL 1 (SB1)

LADWP's solar incentive program (SIP), as governed by Senate Bill 1 (SB1), currently offers a one-time incentive for government projects at $1.40 per watt installed, up to 1 MW, during the first year of operation. While this incentive is limited to only up to one MW per billing meter, the actual system size may be larger. As such, this option is not the best option for the 4 MW system being proposed.

RENEWABLE ENERGY CREDITS

All grid-tied renewable energy generators produce both electricity and renewable energy credits (RECs, also called renewable energy certificates or Green Tags), which are accumulated at a rate of one REC per 1,000 kWh generated (epa.gov). RECs are accounted for and verified through REC Tracking Systems or REC contracts with an audit of the chain of custody (epa.gov), and can be of value for an organization that requires emission reductions and offsets as a resale market for RECs that exist in certain regions of the United States. This allows organizations to support renewable energy development and protect the environment when green power products are not locally available.

The Following incentive programs are not applicable in LADWP territory:

CALIFORNIA SOLAR INITIATIVE PROGRAM

The California Solar Initiative (CSI) is a solar rebate program established for all electric customers of the three California investor-owned utilities (IOU): Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E) (GoSolarCalifornia.com). Note that the Los Angeles Department of Water and Power (LADWP) is not part of the CSI program. The California Public Utility Commission (CPUC) oversees the CSI program, which is designed to install approximately 2,000 MW of solar generation capacity between the years of 2007 and 2016. The program's total budget is approximately $2.2 billion, which funds both solar PV and solar thermal-energy-generating technologies.

All funding has been exhausted in all three territories for the CSI program.

RULE 21 SMALL GENERATOR

If LASAN were to install a solar PV system with the purpose of exporting to the SCE grid, LASAN could pursue a small renewable generation power purchase agreement (PPA, described below). Under such a PPA, SCE would purchase power from LASAN for a generation system up to 1.5 MW. In this scenario, SCE would pay the LASAN for energy generated, but not applied to serve on-site load. SCE would pay the Market Price Referent (MPR), a per-kWh price that is determined periodically in the Renewable Portfolio Standard (RPS) proceeding. The MPR value will be multiplied by a time-of-day factor to reflect the increased value of electricity produced during peak times. SCE would own any renewable energy credits (RECs, discussed in Section 7.4.4 below) for power that it purchases under the PPA. A generator on a net metering tariff may not sign into a PPA. Under the PPA, the generator must sell all of its generated energy.

LOCAL GOVERNMENT RENEWABLE ENERGY SELF-GENERATION BILL CREDIT TRANSFER PROGRAM (RES-BCT)

In the Investor Owned Utilities service territories, the RES-BCT program allows a local government with one or more eligible renewable generating facilities to export up to 5 MW of energy to the grid and receive generation credits to the benefitting accounts of the same local government.

Special Note:

This project would not be eligible for this program, because it is not offered by LADWP.

FINANCING OPTIONS:

CASH PURCHASE

In a cash purchase, the owner purchases a PV system outright using its own capital to finance the total project installation and subsequent operation. In this model, the owner realizes the full benefits of available utility incentives, energy savings, and renewable energy credits. This is the preferred method of renewable energy ownership and operation because it maximizes the overall financial benefit to the owner. However, the burdens of upfront cash requirements, risks, and penalties associated with shortfalls in energy production, and operations and maintenance of the system may not be desirable or permissible for the owner.

POWER PURCHASE AGREEMENT

A power purchase agreement (PPA) is an alternative financial agreement in which a third-party developer (solar integrator) will install, own, and manage a photovoltaic (PV) system on a host's property. In exchange for the use of the host's land, the solar integrator provides electricity generated by the PV system to the host at a predetermined rate that is typically less than the market utility rate from the grid. The solar integrator designs, constructs, and manages all permits and utility coordination required for installation, including utility grid interconnection and net metering requirements.

A PPA is a performance-based financial agreement in which the host pays only for the energy actually produced by the system. The solar integrator is responsible for the system's operation, maintenance, and performance, with a guarantee of a minimum energy generation level as negotiated under the agreement. The contract term for most PPAs ranges from a minimum of six years (at which time the solar integrator will have realized the maximum value of tax incentives available for the project) to the life of the system (approximately 20 years).

Special Note:

LADWP does not allow Power Purchase Agreements at this time.

TAX-EXEMPT MUNICIPAL LEASE

Another financing structure available to LASAN is to enter a municipal lease. These leases typically work through one-year renewable obligations whereby the equipment is sold directly to the lesser and the title of the equipment passes to the lessee upfront. Under this agreement, the lease holder benefits from being able to deduct the interest earnings and other costs from their federal income taxes, making the agreement more attractive. However, this option is not recommended, as it would result in a higher total cost over the lifespan of the lease and equipment, unless LASAN cannot make a cash purchase of the installation.

XI. POTENTIAL ENVIRONMENTAL AND COMMUNITY CONCERNS ASSOCIATED WITH A SOLAR FACILITY AT THE LANDFILL

POTENTIAL ENVIRONMENTAL CONCERNS

The concept of a solar energy generation facility at the Lopez Canyon Landfill site was evaluated for potential environmental impacts from both a construction and operational perspective. This proposed project is unique because of its site location/setting and long history as a landfill, and the complex environmental compliance conditions under which this property is currently managed. From a CEQA/NEPA perspective, many environmental resources and sensitivities must be considered if this project is further developed. The key environmental resources of concern that should be considered are:

Alternatives. To ensure that the proposed solar facility is properly sited, it may be prudent to consider a range of reasonable alternatives in terms of site size (multiple sites vs. single site), configurations, and options for meeting energy conservation goals. There may be viable alternatives for the placement of access roads and transmission of water lines. Land Use and Recreational Resources. The consistency of the proposed project with existing and planned land use of the site would be evaluated in consideration of LASAN's commitment to provide a recreational area within 30 years since the landfill closed. The placement of a solar facility in proximity to future recreational activities may not represent a compatible use or the best use of limited land resources. This is because, from a recreational user perspective, the recreational experience can be constricted and diminished by the presence of a solar generating facility in proximity to trails and ball fields. Access to recreation facilities/campgrounds could be an area of concern in consideration of the project location.

Aesthetics. The visual appearance of the solar facility will be evaluated to determine if the visual quality of the site and its surroundings will be substantially degraded. Glare is also considered in this evaluation.

- **Biological Resources**. While federal- or State-listed species of plants or wildlife would not likely be affected by the placement of solar panels, the potential for "lake effect" (where birds and insects mistakenly perceive a solar facility as a water body) would need to be evaluated. To reduce the potential for bird and bat deaths, protective measures may need to be integrated into the design and procurement of solar panels.
- **Water Supply.** The amount of water required for washing solar panels will be estimated to determine if water supplies would be impacted. The frequency of washing required will be examined to identify if any environmental impacts would result.
- **Water Quality.** The effect of the disposal of solar panel wash water will be evaluated to determine if water quality or stormwater management would be impacted
- **Construction Noise and Traffic.** Construction impacts, primarily construction-related noise and traffic, would be evaluated in consideration of sensitive receptors in the immediate area. Potential for health effects during construction would be studied in consideration of ongoing landfill gas and ambient air sampling and leachate and surface water monitoring.
- **Community Concerns.** Addressing community concerns is essential for the success of the project. A summary of community concerns from neighboring residents was provided by LASAN staff. An evaluation of the community concerns provided by LASAN staff is listed in the following section.

POTENTIAL COMMUNITY CONCERNS

According to information provided to Parsons by LASAN staff, the proposed project was presented to approximately 40 community members at a community meeting on June 4, 2014. At this meeting, the community voiced concerns on the following topics:

- Home solar power credit for generation of unused energy
- Compatibility of solar panels on open space land and parkland
- Size of the solar facility
- Aesthetics and intrusions on the landscape
- Settling of the landfill
- Preference for solar panels on roofs instead of using open space
- Definition of the 30-year period prior to conversion to recreation space
- A previous proposal by LASAN for a truck driving facility at the landfill
- LADWP FIT Program
- Status of equestrian trails and staging area
- Beneficiaries of income from solar production
- Incorporation of community feedback in the feasibility study
- Distraction to pilots
- Leachate spill
- Tree roots penetrating the landfill

It is possible that additional community comments may have been sent to the Community Liaison. Each of the above concerns can be addressed within the context of the CEQA document and would be evaluated within the appropriate resource category. In general, the comments fell under the following categories:

- **Aesthetics and Visibility**: Community members are concerned that a solar installation will negatively impact the natural landscape, be unsightly, and be visible from their homes. As discussed above, the analysis determined a solar renewable energy system can be located on C Deck. The C Deck layout would not be visible from Upper or Lower Kagel Canyon, or from the below Lake View Terrace community, as verified during the viewing impact analysis site visit.
- **Benefit to the Community:** Community members are under the impression that their home solar generation should be able to sell back to the LADWP and there is a policy that prevents selling home generated solar power back into the power grid. This is inaccurate. According to the City Charter, LADWP must own the title to all electricity generated within its control area. All electricity generated by this asset would be sold to LADWP under the Feed in Tariff, and LASAN would receive that financial benefit. It would not be accurate to say that the solar power can be distributed to the community. The most appropriate application of public benefit for this specific project is that it will reduce the operating costs of LASAN, enabling them to potentially reduce existing fees or to mitigate future fee increases. Another potential public benefit is that this asset would bring the City of Los Angeles, the State, and LADWP closer to the statewide goal of 33 percent renewable energy by 2020.
- **Open Space Definition:** The City has zoned the landfill site as “open space” after 30 years of closure; LASAN would develop the landfill site into a recreational area. With the available electrical infrastructure and acreage, LASAN is currently evaluating the feasibility of constructing and operating a photovoltaic (PV) solar power generation system on the C Deck of the Lopez Canyon Landfill site.

- **Public Comment:** Community members have observed solar projects in their neighborhoods approved and fast tracked by Planning without public comment, despite the fact that they were not wanted by all members of the community. According to California State Law, any building or property owner can install a code-compliant solar project regardless of the objections of neighbors or other businesses. It is up to the property owner to allow public comment if they so choose. LADWP and the City of Los Angeles have been urged by solar project owners to fast track projects to achieve the solar incentives or Feed in Tariff dollars at specific levels, and they have the legal authority to do so. The belief that a solar installation would degrade the space is a matter of opinion; there are many who believe that the utilization of renewable energy on redeveloped open space is one of the most appropriate uses of that land. Information provided that homeowners cannot sell their generation back to LADWP is completely erroneous and without merit; in fact, under the City Charter, solar owners who installed a code-compliant and interconnected system with LADWP ***must*** sell their generation to LADWP regardless if they own or lease their asset, and LADWP compensates the solar owners either through SB1 incentives with Net Metering or the Feed in Tariff.

Zoning Requirements: At the present time, the Lopez Canyon Landfill currently meets the required criteria for The City of Los Angeles Department of Building and Safety zoning ordinance, No. 182110 – Amending Sections 12.21, 12.21.1, and 12.24 of the Los Angeles Municipal Code to provide increased flexibility for structures used solely to support solar energy systems not otherwise permitted, and to make other technical corrections. A Zoning Administrator may, upon application, permit structures that solely support solar energy systems that deviate from any regulation.

THIS PAGE INTENTIONALLY LEFT BLANK.

XII. ON-SITE EQUIPMENT DIESEL TO ELECTRIC CONVERSION PRELIMINARY ASSESSMENT

In addition to the landfill's current electricity demand, some of the equipment used by the existing composting facility at the landfill could potentially be converted to electric power in order to more directly utilize electricity generated by a solar power generation system on-site. This section evaluates the potential for diesel to electric conversion of the existing Lopez Canyon Landfill composting facility through the review of equipment details and the diesel-electric conversion.

EXISTING COMPOSTING FACILITY EQUIPMENT

The composting facility at the Lopez Canyon Landfill utilizes the equipment provided in Table 6. The most recent available fuel usage logs (from August 2013) were reviewed and are summarized below.

Table 6: August 2013 Fuel Usage Logs Summary

LASAN Equipment Number	Equipment Description	Fuel	Gallons Used (August 2013)
40347	Extec Trommel	N/A	N/A
40492	McCloskey Trommel	Diesel	122
40551	McCloskey Trommel	Diesel	552
40552	McCloskey Trommel	Diesel	334
40553	McCloskey Trommel	Diesel	694
59635	Diamond Z Grinder	Diesel	2,016
59675	Diamond Z Grinder	Diesel	307
Hertz 0001	Case Loader	Diesel	246
Hertz 0003	Case Loader	Diesel	351
Hertz 0005	JD 744 Loader	Diesel	287
Hertz 0011	JD 644 Loader	Diesel	138
Hertz 5001	JD 744 Loader	Diesel	134
	TOTAL MONTHLY USAGE	DIESEL	5,181

In 2013, this equipment required approximately 5,200 gallons of diesel per month.

PRELIMINARY ELECTRICAL LOAD ESTIMATE FOR POWER COMPOSTING FACILITY EQUIPMENTS

Currently (in 2015), the composting facility utilizes slightly different equipment than in August 2013. The diesel-powered equipment identified that could be electrified is provided in Table 7, below. An estimate of the equivalent electric-power requirement to replace the existing diesel-powered equipment is shown. Note that loaders were not determined to be viable for electrification due to technology limitations at this time.

Table 7: Electrical Power Requirement for the Electric-Powered Equipment at Composting Facility

LASAN Equipment Number	Equipment Description	Engine Break Horsepower (BHP)	Kilowatt (kW)*
40347	Extec 830 Trommel Screen	127.4	95.0
40492	McCloskey 733 Trommel Screen	174.0	129.8
59675	Diamond Z E6000B Grinder	1050.0	783.3
59635	Diamond Z E6000B Grinder	1050.0	783.3
40361	Wildcat Compost Turner TS616- 260	275.0	205.2
40551	McCloskey 733 MCI733RE Trommel Screen	225.0	167.9
40552	McCloskey 733 MCI733RE Trommel Screen	225.0	167.9
40553	McCloskey 733 Trommel Screen	225.0	167.9
Total		3351.4	2500.3
*Note that it is assumed that 1 BHP = 1 Horsepower (HP) and 1 HP = 0.746 kW			

PROPOSED ELECTRICAL SYSTEM

A new electrical distribution system would be required to power the Composting Facility. A new electrical distribution system shall include but not be limited to new:

- 35 kV overhead distribution line
- Medium-voltage switchgears
- Step-down transformers
- Low-voltage switchboard

The new 35 kV overhead distribution line shall be interconnected to the new 35 KV main electrical service switchgear at the existing flare station. Table 8 provides a preliminary cost estimate for electrical distribution equipment required to power the electrified equipment.

Table 8: Preliminary Electrical Distribution Equipment Cost Estimate at Composting Facility

Lopez Canyon Landfill

Preliminary Electrical Distribution Equipment Cost Estimate at Composting Facility

Description of Item	Quantity	Unit	Unit Cost	Total Cost ($)
Equipment				
480V Switchboard	1	EA	$80,000	$80,000
5KV Class Switchgear	1	EA	$200,000	$200,000
2.5 MVA Step-down transformer, 35KV – 5 KV	1	EA	$100,000	$100,000
1 MVA Step-down transformer, 5KV – 480V	1	EA	$50,000	$50,000
Overhead Distribution	1	LS	$160,000	$160,000
Total Construction COST ($)				$590,000

XIII. PEER REVIEW

Under Task Order Solicitation No. 69 - Solar Power Feasibility Study at the Lopez Canyon Landfill, LASAN requested that Parsons solicit the services of an outside expert with specific experience with solar power facilities at landfill sites to conduct a peer review of the feasibility study developed by Parsons.

Parsons conducted a search for candidates to conduct this peer review and found several companies that have relevant technical expertise with installing solar systems on landfills. However, in discussions with the companies contacted, all identified candidates indicated they were not interested in performing this peer review service, since either or both:

1. The scope of work requested was below the contracting threshold per their company policy (i.e., this service is not within the company's line of business and is of too low a dollar value for them to pursue), and/or

2. The company would be interested in acting in a larger role (i.e., design-build contractor or solar project developer) later in the project, and did want to preclude themselves from being eligible to bid by being involved in the initial design. As such, an acceptable third-party reviewer could not be identified to conduct this peer review.

In lieu of a third-party peer review, the project team utilized Parsons' in-house technical expertise on a national level to provide supplemental internal peer review of this feasibility study, to include geotechnical review and consulting by engineers from our Pasadena, Northern California, and Boston offices.

To further ensure an appropriate and acceptable final solar system design for the landfill, it is recommended that the criterion is included during a contractor prequalification or request for proposal (RFP) process that the design-builder has technical expertise and experience in solar system design specifically for landfills.

THIS PAGE INTENTIONALLY LEFT BLANK.

XIV. CONCLUSIONS AND OVERALL RECOMMENDATIONS

CONCLUSIONS

The scope of this feasibility study was limited to evaluating: the project background; solar technologies; site selection; system layout and equipment design; environmental considerations; maintenance impacts and recommended mitigations; project economics, incentives, and financing options; potential public concerns; visibility study; diesel to electric conversion of the composting facility; and a peer review. This study was conducted in close coordination with LASAN.

Overall, this feasibility study concludes that the installation of a solar power generation system at the Lopez Canyon Landfill is technically and financially feasible. The most feasible and financially viable option was determined to be the installation of a 4 MW fixed tilt photovoltaic or flexible solar photovoltaic system (estimated annual production of more than 6,700,000 kWh/year) on C Deck, at an estimated cost of $13,000,000. If desired, this energy could be utilized to power some of the equipment used by the composting facility, if that equipment is converted to use electric power. Again, depending upon the system layout and the rated capacity of the panels, the C Deck site may allow for the installation of an up to 5 MW system.

RECOMMENDATIONS

Based on this evaluation, it is recommended that LASAN:

- Determine their preference for financing (cash purchase, lease, or other)
- Install a fixed tilt photovoltaic solar system on C Deck
- Pursue financial incentives through the Feed-in-Tariff program
- As part of the design phase, further evaluate the identified engineering challenges, including:
  - Geotechnical conditions and site settlement
  - Electrical infrastructure requirements
  - System racking and wiring design to mitigate movement due to settlement
- Comply with permitting and compliance requirements, as applicable, and ensure necessary mitigation measures are included in contractor requests for proposals.

Note that, throughout the project development and upon receipt of proposals from solar installers, it is recommend that LASAN revisit the project economic assumptions that were factored into the financial evaluation and recommendations to verify that the proposed project continues to be financially viable prior to contracting a solar installer. Significant variance in the design and installation costs, utility rates, or available incentives could affect the cumulative benefit of the project.

APPENDICES

Appendix A: PV Watts Output for a 4 MW Fixed Tilt System
Appendix B: CAISO Hourly Breakdowns of Renewable Resources

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A: PV WATTS OUTPUT FOR 4 MW FIXED TILT SYSTEM

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A: PV Watts Output for a 4 MW Fixed Tilt System

PVWatts Calculator

NREL

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

RESULTS **6,682,825 kWh per Year ***

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	3.45	373,332	48,645
February	4.44	436,696	56,901
March	5.18	561,871	73,212
April	6.02	628,049	81,835
May	6.64	711,379	92,693
June	6.79	700,850	91,321
July	7.04	745,234	97,104
August	6.82	718,086	93,567
September	5.49	559,158	72,858
October	4.67	497,130	64,776
November	3.81	394,849	51,449
December	3.34	356,190	46,412
Annual	5.31	6,682,824	$ 870,773

Location and Station Identification

Requested Location	11950 Lopez Canyon Road, Lakeview Terrace, California
Weather Data Source	(TMY2) LOS ANGELES, CA 24 mi
Latitude	33.93° N
Longitude	118.4° W

PV System Specifications *(Residential)*

DC System Size	4400 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	10°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX B: CAISO HOURLY BREAKDOWNS OF RENEWABLE RESOURCES

THIS PAGE INTENTIONALLY LEFT BLANK.

Appendix B: CAISO Hourly Breakdowns of Renewable Resources

Appendix B - 20140621_DailyRenewablesWatch.txt 06/21/14
Hourly Breakdown of Renewable Resources (MW)

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS	SMALL	HYDRO	WIND TOTAL	SOLAR	PV	SOLAR
	1	889	342	200	196		3815	0		0
	2	890	344	198	198		3694	0		0
	3	891	343	198	196		3514	0		0
	4	890	342	198	194		3167	0		0
	5	891	346	199	193		3125	0		0
	6	892	347	199	193		2911	0		0
	7	893	355	199	206		2467	342		0
	8	892	352	200	230		2153	1462		69
	9	892	341	200	232		1846	2546		388
	10	891	352	200	233		1235	3285		519
	11	887	356	199	235		848	3725		590
	12	884	348	198	260		744	3923		593
	13	884	354	199	275		990	3939		617
	14	881	365	200	266		1694	3911		610
	15	880	365	200	247		2769	3700		617
	16	883	364	199	248		3165	3447		597
	17	882	362	198	290		3394	2781		275
	18	883	362	199	294		3709	1948		117
	19	882	364	199	295		3576	1002		0
	20	884	365	201	289		3004	175		0
	21	885	367	201	292		2968	0		0
	22	885	367	201	292		3272	0		0
	23	886	361	201	239		3325	0		0
	24	889	350	202	201		3070	0		0

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS	SMALL	HYDRO	WIND TOTAL	SOLAR	PV	SOLAR

Hourly Breakdown of Total Production by Resource Type (MW)

Hour	RENEWABLES	NUCLEAR	THERMAL	IMPORTS	HYDRO
1	5442	2282	7212	8876	1351
2	5325	2282	6402	8625	1218
3	5142	2281	5632	8753	1118
4	4793	2281	5537	8602	1085
5	4755	2282	5519	8531	1070
6	4542	2282	5547	8698	1089
7	4463	2281	6326	7817	1341
8	5359	2281	6416	7724	1458
9	6444	2281	6429	7878	1624
10	6714	2281	7139	7778	1877
11	6840	2281	8151	7824	2116
12	6951	2280	9164	7820	2186
13	7256	2279	9909	7626	2337
14	7927	2279	9822	7951	2351
15	8779	2279	9656	8064	2377
16	8903	2279	10145	7696	2788
17	8183	2281	10831	7505	3217
18	7512	2282	11000	7792	3415
19	6319	2282	11278	8200	3573
20	4919	2283	11556	8446	3478
21	4713	2283	11673	8330	3336
22	5017	2283	11064	8342	2951
23	5012	2283	9380	8622	2323
24	4712	2282	8235	8516	1689

Appendix B - 20140909_DailyRenewablesWatch.txt 09/09/14
Hourly Breakdown of Renewable Resources (MW)

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS		SMALL	HYDRO	WIND TOTAL	SOLAR		PV	SOLAR	
	1	882	357	218	148			2592	0				0
	2	880	355	218	111			2448	0				0
	3	882	357	218	111			2296	0				0
	4	870	359	216	111			2376	0				0
	5	848	356	216	121			2140	0				0
	6	849	337	215	164			2030	0				0
	7	847	334	215	174			1805	13				0
	8	833	335	212	199			1522	627				0
	9	835	350	213	200			1415	1899			111	
	10	834	356	215	200			1394	2776			265	
	11	833	360	215	211			1196	3347			268	
	12	832	357	215	210			1093	3612			337	
	13	831	364	215	229			1358	3650			444	
	14	830	368	214	248			1475	3638			460	
	15	829	370	215	251			1784	3203			524	
	16	829	373	215	252			2018	2817			582	
	17	827	374	216	289			2169	2375			565	
	18	827	374	217	310			2353	1564			499	
	19	830	373	217	317			2512	373			155	
	20	851	371	213	282			2854	0				17
	21	875	370	200	269			3039	0				22
	22	881	363	201	265			2863	0				15
	23	881	354	213	193			2254	0				0
	24	881	352	219	175			1700	0				0

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS	SMALL	HYDRO	WIND TOTAL	SOLAR	PV	SOLAR

Hourly Breakdown of Total Production by Resource Type (MW)

Hour	RENEWABLES	NUCLEAR	THERMAL	IMPORTS	HYDRO
1	4197	2268	11047	6677	476
2	4012	2268	10104	6733	478
3	3864	2268	9848	6469	458
4	3932	2269	9843	6011	448
5	3681	2270	10600	6020	580
6	3595	2272	11068	6600	711
7	3388	2271	12224	7449	906
8	3728	2270	13027	7625	891
9	5024	2271	13403	7602	860
10	6040	2264	14035	7340	812
11	6429	2261	14523	7467	1052
12	6656	2261	14562	8004	1480
13	7090	2261	15020	7972	1685
14	7232	2261	15755	8398	1808
15	7176	2262	17000	8586	1603
16	7085	2262	16970	9246	2079
17	6815	2263	17350	9343	2341
18	6145	2265	17192	9573	2418
19	4777	2264	17133	9509	2533
20	4588	2269	16907	9956	2311
21	4775	2263	16604	9630	2067
22	4588	2260	15408	8769	1773
23	3896	2263	14668	7559	1110
24	3326	2268	13330	6749	798

Appendix B - 20141221_DailyRenewablesWatch.txt 12/21/14
Hourly Breakdown of Renewable Resources (MW)

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS	SMALL	HYDRO	WIND TOTAL	SOLAR	PV	SOLAR
	1	1014	260	172	226		1642	0		0
	2	1053	253	172	184		1561	0		0
	3	1052	251	172	183		1652	0		0
	4	1050	260	172	182		1766	0		0
	5	1053	260	172	183		2017	0		0
	6	1054	261	172	222		1948	0		0
	7	1052	272	172	242		1802	0		0
	8	1052	275	171	242		1929	324		0
	9	1050	266	170	239		1947	1091		0
	10	1048	254	170	239		1953	1821		1
	11	1045	270	169	242		2003	2320		0
	12	1043	267	169	239		1984	2578		0
	13	964	255	168	245		2136	2250		0
	14	1037	250	170	261		2308	1925		0
	15	1040	255	170	261		2228	1219		0
	16	1040	281	171	286		2126	532		0
	17	1041	285	171	292		2364	0		0
	18	1044	283	172	353		2627	0		0
	19	1045	270	172	367		2551	0		0
	20	1049	267	172	330		2266	0		0
	21	1050	269	173	325		2121	0		0
	22	1050	267	173	294		2087	0		0
	23	1051	263	173	284		1998	0		0
	24	1053	259	172	258		2115	0		0

THERMAL	Hour	GEOTHERMAL	BIOMASS	BIOGAS	SMALL	HYDRO	WIND TOTAL	SOLAR	PV	SOLAR

Hourly Breakdown of Total Production by Resource Type (MW)

Hour	RENEWABLES	NUCLEAR	THERMAL	IMPORTS	HYDRO
1	3314	2138	7201	8556	439
2	3223	2139	6968	8171	322
3	3309	2139	6394	8162	185
4	3429	2140	6332	7842	164
5	3685	2140	6157	7883	97
6	3657	2140	6043	8102	383
7	3540	2141	6101	8649	512
8	3993	2141	5737	8458	769
9	4763	2140	5589	8650	880
10	5487	2141	5873	8486	751
11	6050	2140	6183	8251	587
12	6278	2139	6093	8437	267
13	6018	2138	6242	8448	248
14	5951	2139	6426	8115	403
15	5172	2142	7304	7630	669
16	4436	2142	7350	8269	946
17	4154	2142	7734	8964	1375
18	4479	2141	9638	9530	1737
19	4406	2143	10051	9594	1816
20	4085	2144	10001	9700	1824
21	3937	2143	10054	9240	1760
22	3871	2143	9276	9206	1441
23	3769	2143	8164	8840	1252
24	3856	2144	7058	8557	732

THIS PAGE INTENTIONALLY LEFT BLANK.

Sustainability is a Parsons Core Value

Sustainability is a Parsons Core Value. We are continuously mindful of our impact on the environment and we help our customers do the same by providing clean, efficient, healthy, and effective solutions. If Parsons provided this document in printed form, it consists of 100% post-consumer recycled paper and section tabs, with cover cardstock and coils containing recycled materials.

PARSONS

100 W. Walnut Street
Pasadena, CA 91124
626.440.2000

www.parsons.com