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4.0 Alternatives

This section discusses alternatives to the Mojave Solar Project as proposed in this AFC. These alternatives addressed include "no project", alternative project sites, plant design alternatives, and alternative power generation technologies.

4.1 CEQA Requirements

The California Environmental Quality Act (CEQA) requires that "a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives" [14 CCR. 15126.6(a)]. The CEQA Guidelines [14 CCR 15126.6(c)] further provide that among "the factors that may be used to eliminate alternatives from detailed consideration in an Environmental Impact Report (EIR) are:

(i) failure to meet most of the basic project objectives,
(ii) infeasibility, or
(iii) inability to avoid significant environmental impacts

4.2 Alternatives Screening Methodology

MSLLC evaluated a range of potential alternatives to the proposed Project such as location, design alternatives, etc. While the following screening methodology is presented in terms of alternative Project locations (sites), essentially the same process applies to technologies. In accordance with 14 CCR 15126.6 (c), alternatives were not carried forward for further analysis if:

1. The alternative failed to meet most of the basic project objectives, or
2. The alternative would not avoid or substantially lessen significant environmental impacts of the proposed project, or
3. The alternative was not "feasible." Per 14 CCR 15126.6(f)(1), the factors that should be taken into account in determining whether an alternative is feasible are:
    a) Site suitability
    b) Economic viability
    c) Availability of infrastructure
    d) Land use/land use plan consistency or regulatory jurisdictional limitations, and
    e) Site Control

In order to implement this screening process for selecting the Project site, MSLLC needed to:

1. Define the Project objectives,
2. Identify the potential significant environmental impacts associated with the proposed Project, and
3. Further define the feasibility criteria.

These criteria are presented below.

4.2.1 Project Objectives

Project objectives are presented in Section 2.2 and are restated here as follows:

- To help achieve the State of California renewable energy objectives and to support the state's electric utility requirements with the long term production of renewable electric energy,
- To safely and economically construct, operate and maintain an efficient, reliable, and environmentally-sound power generating facility,
- To develop a Project using up-to-date and improved versions of an already-proven renewable energy technology, minimizing technical risk and improving the financial viability of the project,
- To maximize the renewable energy from a site with an excellent solar resource, appropriate slope and grading, availability of water rights and availability of transportation and other infrastructure in order to minimize the cost of renewable energy for consumers,
- To reduce or eliminate potentially significant adverse environmental impacts by locating away from sensitive noise and visual receptors and sensitive species,
- To electrically interconnect to suitable electrical transmission while minimizing environmental impacts associated with interconnection and minimizing cost, and
- To develop a site with close proximity to natural gas infrastructure in order to minimize environmental impacts and cost.

4.2.2 Design to Minimize the Potential for Significant Impacts

Sections 5.2 through 5.18 of the AFC assess in detail MSP's impacts in the full range of environmental topical areas. With the implementation of identified mitigation measures, the AFC finds that the Project impacts would be less than significant in all topic areas. The issues with the greatest potential for impacts that were used as a basis for alternatives screening are summarized below.

- *Biological, cultural and paleontological resources:* Concentrating solar power (CSP) facilities require large land areas to benefit from economies of scale. With approximately 1,700 acres needed to properly develop a site able to generate 250 MW, biological resources, as well as cultural and paleontological resources, are areas of potential impacts.
- *Water Resources:* CSP facilities are thermal power plants that require cooling and therefore have the potential for water consumption and associated impacts.
- *Traffic and Transportation:* CSP facilities require a relatively large workforce to construct the facility and have the potential for related temporary traffic impacts.
- *Visual Resources:* CSP facilities require significant land area to construct the solar collector array and thus have the potential for visual impacts.

Alternatives that could not avoid or substantially lessen potential Project impacts in these areas were dropped from further analysis.

Because of the size, nature, and relative remoteness from population centers of CSP facilities, AFC analyses indicate that impacts in environmental issue areas other than those identified above are minor and readily mitigable.

4.2.3 Site Feasibility Criteria Defined

To meet the project objectives as noted above requires an available site that meets the following criteria:

- Site Suitability:
  - Solar Resource – The site needs to be located where high solar insolation is available to maximize the plant's output and support efficient utilization of the land area that would be affected by Project development. For a project to be economically viable, solar insolation levels of greater than 7.0 kilowatt-hours per day per square meter are desirable.
  - Size and Shape – The site should be large enough (approximately 1,800 acres) to support the construction of a facility that can generate 250 MW of power using solar thermal technology, and arranged in a way that allows an efficient and cost-effective layout of the Project facilities.
  - Slope – The site needs to be relatively flat and level ideally with a slope less than one percent, to minimize grading.
- Economic Viability – The project needs to be economically viable and competitive with other renewable technology projects, including wind, geothermal, and other solar projects. To be viable, the site should be located on property currently available at a reasonable cost and have good solar resources. Sites with excellent solar resources may be able to carry somewhat higher mitigation costs or infrastructure costs.
- Minimization of Environmental Impacts – The site should be located in an area that has been previously disturbed in order to minimize environmental impacts such as impacts to species biological resources.
- Availability of Infrastructure – To minimize cost and potential environmental impacts, the site needs to be located in an area where it can be interconnected with an existing transmission system that minimizes interconnection upgrade costs and "pancaked" transmission rates and avoids the need for new, project–specific, dedicated transmission lines. The site also needs good access to water for power plant cooling and access to a natural gas pipeline.
- Site Control – The land for the power plant site and linear facilities has to be available for purchase or lease prior to investment into detailed environmental studies.

As described in the sections below, application of the above criteria eliminated all other potential project locations from being carried forward for more detailed analysis, as discussed in Section 4.4. This is largely because the proposed Project site is clearly superior to any of the alternative sites from an environmental impact perspective due to the use of

a previously-disturbed site and a relatively short transmission line. The site screening process that led to the selection of the proposed site and the elimination of alternative sites is discussed in the following section.

4.3 No Project Alternative

Under the No Project alternative, the Project would not be constructed, and the electrical power that would have been generated will be generated by other facilities, presumably natural-gas-fired generation. In addition, the lack of generating capacity from the Project would reduce the reliability of California's electricity supply. Because the Project facilities would not exist, its direct environmental impacts would not occur. In such circumstances, however, indirect impacts would result in greater fossil fuel consumption and ultimately additional air pollution (with associated health impacts) and green-house emissions. Because solar power generation is closely coupled to peak load periods of the day, if fossil fuel-fired peaking units such as simple-cycle gas turbines and other rapid starting equipment (e.g., reciprocating engines) were to meet the same power needs of MSP, they would produce higher levels of air emissions than a solar thermal power plant.

The No Project alternative does not support the State's RPS program goals and the nation's drive for energy independence; and as such, would not be an appropriate choice since No Project means that the proposed solar Project would not be developed. The purpose of the Project is to generate renewable solar power and provide electric power to California's electrical users. The No Project alternative does not provide the additional power needed in California in a manner that assists the state in meeting its renewable power and greenhouse gas reduction goals.

4.4 Project Site Alternatives

4.4.1 Alternative Site Selection Criteria

MSLLC conducted initial site selection analyses using Geographic Information System (GIS) software and National Renewable Energy Laboratory (NREL) data to prepare maps of solar energy resources and allow for the application of selection criteria to identify study areas for further analysis. Each of the following parameters were analyzed separately and combined:

- Solar insolation at 0.25 kWh/(m^2-day) intervals,
- Wilderness, parks, military, populated areas, etc.,
- Special status species habitat conservation areas (e.g., BLM Desert Wildlife Management Areas [DWMAs] and USFWS Critical Habitat),
- Slope at 1%, 2% and 3% versus insolation levels,
- Transmission facilities including substations and lines,
- Natural gas pipelines, and
- Transportation infrastructure including road and rail facilities.

From this analysis, and numerous site visits, MSLLC identified public and private lands that had the potential to meet the remaining site suitability and feasibility criteria, namely:

- Size (approximately 1,700 acres),
- Location within 25 miles of an interconnection to a transmission system that could deliver power to the statewide transmission grid, and
- Availability for sale or lease.

4.4.2 Project Site Area Alternatives

From the site screening process described above, seven candidate site locations (including the proposed site) were identified. The approximate locations of the sites including the proposed site are shown on Figure 4-1 and described in Table 4-1.

Table 4-1. Alternative Site Areas Considered

Site Areas	General Description/Location
Harper Dry Lake	Private property in the vicinity of Harper Dry Lake
Superior Dry Lake	BLM, DOD, and private land in the vicinity of Superior Dry Lake
Coyote Dry Lake	BLM and private land in the vicinity of Coyote Dry Lake
Bristol Dry Lake	BLM property near Bristol Dry Lake
Imperial Valley	Private property south of the Salton Sea
Imperial Valley East	BLM property east of Imperial Valley
Northwest of Blythe	BLM property northwest of Blythe

Table 4-2 presents the reasons per CEQA guideline 14 CCR 15126 (c) why these alternatives sites were dropped from further analysis.

Table 4-2. Alternative Site Areas Dropped from Further Analysis

Alternative Site	Reasons Dropped from Further Analysis
Superior Dry Lake	Lack of consistency with Project Objectives: • Includes BLM land and private land which makes site control difficult/uncertain; lengthy electrical interconnection needed; lengthy natural gas line needed; minimal transportation accessibility. Environmental Impacts: • Large undisturbed areas required for development, increasing the likelihood of biological impacts.

Alternative Site	Reasons Dropped from Further Analysis
Coyote Dry Lake	Lack of consistency with Project Objectives: • Includes BLM land and private land which makes site control difficult/uncertain; topography less than ideal for development; Environmental Impacts: • Small to medium sized undisturbed areas required for development, increasing the likelihood of biological impacts.
Bristol Dry Lake	Lack of consistency with Project Objectives: • Marginal solar resource; BLM land which makes site control difficult/uncertain; lengthy electrical interconnection needed; minimal transportation accessibility. Environmental Impacts: • Large undisturbed areas required for development, increasing the likelihood of biological impacts.
Imperial Valley	Lack of consistency with Project Objectives: • Marginal solar resource; lacks transmission capacity. Environmental Impacts: • Similar disturbed nature of site compared to proposed site; therefore, no environmental advantage when compared to proposed site.
Imperial Valley East	Lack of consistency with Project Objectives: • Marginal solar resource; BLM land which makes sites control difficult/uncertain; lacks transmission capacity. Environmental Impacts: • Large undisturbed areas required for development, increasing the likelihood of biological impacts.
Northwest of Blythe	Lack of consistency with Project Objectives: • BLM land which makes site control difficult/uncertain. Environmental Impacts: • Large undisturbed areas required for development, increasing the likelihood of biological impacts.

4.4.3 Project Site Layout Alternatives

Upon selecting the site area to develop, further studies including detailed biological studies were conducted in and around the project area to understand the placement of equipment to arrive at the least impactful project while still meeting the project objectives. Three general development areas were considered for development of the MSP; Area A, Area B, and Area C. The following is a description of the project areas studied as depicted in Figure 4-2.

- Area A: This layout consisted of only using land to the west of Harper Lake Rd. Area A would abut SEGS VIII and IX on its northern border with the western boundary approximately 2.5 miles west of Harper Lake Rd and the southern boundary mostly coincident with Lockhart Ranch Rd. This layout was rejected due to biological constraints in the western half of Area A, along with a lack of site control in the northeast portion of the Area.
- Area B: This layout consisted of only using land to the east of Harper Lake Rd. and south of Lockhart Ranch Rd. Area B would span approximately 2.5 miles east to west and would abut the transmission corridor along its southern boundary. This layout was rejected due to a lack of site control to the east and west of the area, along with biological constraints in the eastern half of Area B.
- Area C: This layout consisted of only using land to the north of Lockhart Ranch Rd. and to the east of Harper Lake Rd. Area B would span approximately 2.5 miles north to south and would abut SEGS VIII and IX on the western boundary. This layout was rejected due to a lack of site control.

The resulting layout presented in Figure 2-3 comprises the eastern half of Area A and a portion of Area C to complete the Alpha Plant. The Beta Plant is a contraction of the east and west boundaries of Area B. An alternate site area for the Alpha Plant (Alpha-ALT) is depicted in Figure 4-2 but was rejected due to site control issues.

4.5 Transmission Interconnection Alternatives

4.5.1 Transmission Gen-Tie Route Alternative

The proposed site has access to two major transmission lines abutting the southern boundary of the site, offering options of access to the statewide transmission. Therefore, no route alternatives were studied since access occurs at the site boundary.

4.5.2 LADWP Interconnection Alternative

An Interconnection System Impact Study (ISIS) was conducted to interconnect the project to the Mead-Adelanto 500 kV Transmission Line (MATL). This study, which is only in draft form at the time of this application, shows that like the SCE interconnection, the minimum facilities required for interconnection are the interconnection substation and communications.

As reported in the draft ISIS performed by LADWP for interconnection to the MATL, system-wide impacts are minimal for this alternative and delivery to the Los Angeles basin

does not require system reinforcements. This study only considers reducing generation in the Los Angeles basin, which is appropriate given the transmission system owner.

Facilities required to interconnect the project (as compared to the selected interconnection) would include:

- Ring-bus interconnection substation at the project boundary as compared to a breaker-and-a-half design specified by SCE.
- Step-up/Step-down transformers for 500 kV service as compared to 230 kV service.
- Transmission pole structures designed for 500 kV service as compared to 230 kV service.
- Other design features consistent with an increase in service voltage.

These design differences result in an increase in the cost of interconnection, thus resulting in an increase cost of the project, reducing the economic viability of the project. Additionally, interconnection substation components are not considered a network upgrade, thus are not reimbursable to the project and further reduce the economic viability of the project.

Exports from the Mead-Adelanto transmission line to the CAISO system through this interconnection require a Transmission Service agreement separate from the Interconnection Agreement. Given that this transmission line has multiple owners, this interconnection alternative increases the cost, complexity and uncertainty of the Project and therefore makes achievement of the Project objectives more difficult.

4.5.3 SCE/CAISO Phased Transmission Interconnection Alternative

Currently the minimum time to interconnect the project as detailed in SCE/CAISO ISIS, Appendix N, may not provide the project the necessary interconnection within the timeline needed. The Project is continually coordinating with SCE and CAISO to achieve Project interconnection and delivery in a timely and cost-effective manner.

An alternative to interconnection as described in Appendix N is to interconnect to the transmission system utilizing a Special Protection System (SPS) and Congestion Management (CM). This approach could allow the project to deliver power to the grid in advance of system-wide reinforcements identified in Appendix N.

As reported in the SCE/CAISO ISIS, system-wide reinforcements include a 37-mile loop line ultimately connecting the Cool Water Substation to the Lugo Substation. This, among other reinforcements, reduces the overload south of the Kramer Substation and provides a more stable network. The project is coordinating with SCE to permit and install system-wide improvements, including typical communications by SCE through the Large Generator Interconnection Procedures (LGIP) administered by the CAISO.

Preliminary discussions with CAISO and SCE indicated that the Phased approach would differ from the approach detailed in Appendix N as follows:

- This approach would require communications infrastructure potentially beyond what is proposed in the Appendix N to perform the SPS and Congestion Management functions while system-wide improvements are made.

- No offsite transmission facilities other than communications would be needed while system-wide improvements are made.

Advantages of this approach include the possibility of an earlier interconnection capable of power delivery. Disadvantages include a higher cost of interconnection including non-reimbursable portions that would ultimately increase the cost of the project. Additionally, the CM approach increases the risk of curtailment, especially at the times when peak demand and peak generation occur. This time coincides with the generation profile for a solar facility and thus increases the risk that the project would be curtailed, affecting the viability of the project.

For this alternative to be acceptable the following would be necessary:

- The risk of curtailment would need to be quantifiable and minimal;
- The timing of interconnection would need to be improved and guaranteed to be improved.

It is anticipated that if this alternative was utilized, SCE would perform the engineering definition and required environmental studies under the authority of a Letter Agreement until a Large Generator Interconnection Agreement was in place and in parallel with continuing the LGIP process for full system upgrades. Should this alternative be used, the environmental studies and results would be provided to the California Energy Commission for CEQA review.

4.6 Gas Pipeline Alternatives

The proposed site has access to natural gas sufficient to supply the project's minimal needs. The gas pipeline intersects the project near the Alpha power island. Therefore, no natural gas pipeline route alternatives are necessary.

4.7 Power Generation Facility Design Alternatives

Alternatives considered for several aspects of the proposed design of the power generation facility are addressed in the following subsections. These subsections include project size, alternative heat rejection (cooling) technologies, and alternative approaches for disposing of non-sanitary wastewater generated by the proposed facilities.

4.7.1 Project Size

The selection of a project to generate 250 MW of solar power considers several factors including available land aggregation, transmission capacity where land can be aggregated, engineering limitations, equipment costs and operational constraints. Further, optimization studies show that the size of a project utilizing parabolic trough technology has multiple cost minima centered on major equipment sizes. These minima are subject to price variations in steam turbines, piping, solar collector array assembly components, heat transfer fluid and the like. In addition, the solar multiple, the size of the solar field relative to the power block, has an optimum that is inextricably linked to the same factors.

To be most economically viable, when including operations and maintenance costs, a 250-MW project should be developed. However, equipment constraints, including appropriate steam turbine availability, suggest that a 125-MW project should be developed. The combination of two 125-MW (net) steam turbines (major maintenance on one steam turbine in the winter months while the second steam turbine can still operate with full thermal input; therefore, this option) was determined to be the optimum project. However, as described below in Project Layout, this last optimization was not realized due to selecting a site that significantly avoids biological impacts. However, other economies of scale are still achieved: reduced development and infrastructure costs, reduced operations and maintenance costs, and economies of scale of construction.

Since the facility's power output is related to the size of the solar collector area, a smaller generation capability would require a smaller site with a smaller footprint and thus, conceptually, lower potential for adverse environmental impacts. However, in this case the site was selected with the potential for generating 250 MW without significant impacts; there is no substantial environmental advantage to a smaller size Project. Thus a smaller project fails to meet the project objective of maximizing the renewable power generation from the site without any commensurate environmental benefit.

For similar site layout reasons, the alternative of building a larger project was also rejected. This Project site is made up of large parcels mostly obtained from one owner. The purchase of additional large parcels in order to develop a much larger project did not meet the project objectives of site control during the time available to develop the Project. Additionally, biological constraints with the property that is owned also limited the size of the project as well as dictated the layout, because of an interest in minimizing impacts.

4.7.2 Heat Rejection (Cooling) Technology Alternatives

As proposed, the power generating equipment will utilize wet cooling technology. The adjudicated groundwater at the site is brackish and will serve as makeup to the cooling tower. Other cooling technology approaches were considered including dry and wet/dry hybrid. The following paragraphs summarize and compare these alternatives.

4.7.2.1 Description of Cooling Technologies

<u>Wet Cooling Description</u>

Wet cooling uses circulating water to condense steam turbine exhaust in a shell and tube heat exchanger (condenser). Cool circulating water enters the tube side of the condenser where it is warmed by the shell-side steam, causing the steam to condense such that condensate pumps may return it to the steam generator feed water system. The warm circulating water then travels to a mechanical-draft wet cooling tower. The cooling tower dissipates heat through circulating water evaporation and contact with ambient air. Once cooled, the remaining circulating water is returned to the condenser to complete the cooling circuit. Makeup water is added to compensate for the evaporated water. For simplicity this approach is referred to below as "Wet Cooling" or "Wet."

Dry Cooling Description

Dry cooling technology uses an air-cooled condenser (ACC) that cools the steam turbine exhaust using a large array of fans that force air over finned-tube heat exchangers. The exhaust from the steam turbine flows through a large-diameter duct to the ACC where it is condensed inside the tubes through indirect contact with the ambient air. The heat is then rejected into the atmosphere by forced convection. No water is evaporated in this cooling process. With the ambient conditions (i.e. warm temperatures) at the Project site, this system would be inadequate to cool auxiliaries so that an additional, alternate method of cooling for auxiliaries would be required. As a result, using only dry cooling would result in an unviable Project that fails to meet key Project objectives.

Wet-Dry Hybrid Cooling Description (typical)

The wet-dry hybrid cooling approach involves the use of a combination of both wet and dry cooling technologies in parallel, and uses all of the equipment involved in both wet and dry cooling. As in a purely wet cooling system, cool water is circulated in a shell-and-tube heat exchanger to condense the turbine exhaust steam; and then a cooling tower is used to dissipate the heat from the warmed water. As in a purely dry cooling system, an air-cooled condenser uses a large array of fans to force air over finned-tube heat exchangers, and the steam is condensed through indirect contact with the ambient air. Hybrid cooling technology divides the cooling function between the wet and dry systems with the dry cooling system always operating and the wet cooling system picking up the remaining cooling load, which varies with environmental and operational conditions. This system was rejected due to the excessive cost when compared to the Wet-Dry Hybrid Cooling approach described below.

Wet-Dry Hybrid Cooling Description (studied)

The studied approach includes dry cooling an ACC to cool the power generation process while a smaller wet-cooling tower is included to cool plant auxiliaries. For simplicity, this approach is referred to below as "Dry Cooling" or "Dry."

4.7.2.2 Comparison of Cooling Technology Alternatives

A comparison of the proposed Wet Cooling approach to the Dry Cooling alternative is provided below. Differences between Wet and Dry and a comparison of their advantages and disadvantages for the Project are presented first. Then, a brief discussion of other environmental areas of concern for Wet and Dry Cooling are briefly discussed.

Capital Cost and Performance Comparison

Wet Cooling technology has a performance advantage over Dry Cooling for the Project. Performance is enhanced because Wet Cooling relies primarily on evaporation to remove heat from the circulating water. Since evaporation occurs at the dew point temperature (the air temperature at 100 percent humidity), Wet Cooling achieves lower condenser back-pressure than Dry Cooling, which is unable to operate below dry bulb temperatures (ambient air temperature). Dry bulb temperatures are generally much higher than dew point temperatures (especially in regions such as the Mojave Desert). As the dry bulb temperature increases and humidity decreases, the Wet Cooling system becomes more

efficient as a heat rejection method. This is the reason that Wet Cooling systems are even more efficient than Dry Cooling systems in areas with low humidity, as is the case at the Project site. When the cooling tower performance is coupled with the cycle efficiency, it is clear that Wet Cooling in arid areas results in improved project performance and maximization of the solar resource.

The lower condensing temperatures achieved with Wet Cooling systems result in improved cycle performance. This is because the lower temperatures result in lower steam turbine generator (STG) back-pressures, which increase the STG's generation output. Conversely, the requirement to operate at the higher temperatures and higher STG backpressures associated with Dry Cooling would adversely affect the Project's power output. A wet-cooling tower would be physically smaller than an ACC because water is more efficient as a heat exchange medium than air. Dry Cooling requires much more surface area and very high flow rates of air to remove the same amount of heat as a Wet Cooling system. In addition, an ACC system has higher auxiliary loads due to the significant number of fans. However, an ACC would not need cooling water circulating pumps and circulating piping as would be needed for a wet tower, and would require a smaller water treatment system (a small (~10%-of-normal-size) wet-cooling tower would be needed for cooling other plant equipment even if an ACC was used for the Project, as discussed previously in the cooling technologies description).

Capital cost estimates are lower for Wet Cooling as compared with Dry Cooling. An ACC system is more expensive than the equipment needed for a Wet Cooling system (condenser, cooling tower, circulating water pumps and piping). In addition, the lower steam cycle efficiency of a Dry-Cooled facility requires increased steam flow in order to maintain the same power output. This results in the need to increase the size of the steam generation and feed water heater systems. Additionally, the HTF flow rate necessary for the Dry Cooling option increases HTF piping sizes, the amount of HTF needed, and associated systems.

Table 4-3 summarizes the cost impacts associated with the Project proceeding as Dry Cooled. The comparison was completed without changing the solar field size. The solar field for CSP projects is typically sized to maximize the output of the project over a wide range of months to better utilize the variable resource throughout the day and year, creating a firmer output. Thus, in summer months when the solar resource is at a maximum, portions of the solar field are not utilized. Additionally, given the site control and biological constraints, solar field upsizing was not considered an option or necessary for the Project.

In addition to capital costs, operating costs have also been considered for comparison. Wet Cooling operating costs include the cost of pumping makeup cooling water (not needed for Dry Cooling) and higher power requirements for circulating pumps and water treatment activities. However, Wet Cooling systems require less parasitic load for fans compared to Dry Cooling.

Table 4-3. Cost Impacts Associated with Dry Cooling (Based on Entire Project)

Impact Component	Impact (Benefit)
Initial Capital Cost Impacts	
Add ACC, Remove Main Circulating Water System, Reduced Size of Wet-Cooling tower[1]	$14,550,000
Increased Steam and Feed Water System Sizes	$13,130,000
Reduced Water/Waste Water Treatment System Sizes	($2,560,000)
Increased HTF Piping, HTF Volume and Associated Systems	$11,590,000
Decrease in Evaporation Pond Size	($1,400,000)
Electrical and I&C System Additions	$1,420,000
Civil Work	($2,910,000)
Operating Impacts[2]	
Net Generation Impact for Dry Cooling[1,3,4,5]	$22,630,000
Cost of Water Extraction[4,5]	($910,000)
Cost of Water Treatment (chemicals and consumables)[4,5]	($3,310,000)
Net Impact of Dry Cooling (PV 2010)	$52,230,000

[1] ACC Assumes two 18 bay systems for each Plant; additional sizes were considered with similar results, all resulting in a detrimental cost impact associated with Dry Cooling.

[2] O&M Staffing and maintenance of equipment assumed similar.

[3] Annual net generation for the Dry Cooled design is based on an hour-by-hour study of the Project's output; the same manner used to estimate the Project's output when Wet Cooled. Result is a reduction in performance of 13,500 MWh.

[4] Assumes $0.15/kWh cost of energy.

[5] Assumes 8% Internal Rate of Return (IRR) over a 30-year term to arrive at Present Value (PV) in 2010.

Visual Impact Comparison

An ACC is much larger (is taller and occupies a greater footprint) than a wet-cooling tower. Because it is larger, the ACC would be more visible and have greater impacts on visual resources. The wet-cooling tower may occasionally produce a visible plume, which would not be the case for a dry cooling tower, increasing the potential for a visual impact. It should be noted that visible plumes would be expected to occur very infrequently at the Project since the plant will only operate during sunny conditions, which correspond to low humidity periods, and thus would not represent a significant impact (see Section 5.15, Visual Resources).

Air Emissions Comparison

An ACC would have less direct emissions than a wet-cooling tower because it would not have the drift emissions of a wet-cooling tower (emissions of fine entrained droplets that contain dissolved solids that evaporate and form fine particles). However, an ACC can cause higher indirect emissions if the resultant power loss is made up by producing the "replacement" power at a fossil-fuel-fired power plant. In addition, the condenser of the proposed Wet Cooling system can be evacuated and the steam seal established quickly for facility start-up, improving overall performance and reducing the amount of replacement power needed.

Noise Comparison

Because an ACC requires more and larger fans than a Wet system, an ACC would produce greater noise emissions than the proposed Wet-Cooling system.

Waste Comparison

Because the Dry Cooling system requires less water, there are less solid wastes generated when processing wastewater.

Water Use Comparison

Since a wet-cooling tower relies on evaporation as the primary mode of heat rejection, water consumption is higher. The wet-cooling tower also requires that a portion of the circulating water be blown down (removed from the system for processing) and replaced to maintain water chemistry. Because an ACC does not rely on evaporation for heat transfer, cooling water supply, treatment, and disposal are not issues of concern for the ACC. Table 4-4 summarizes expected water usage for Wet and Dry Cooling approaches and includes all water usages (cooling, condensate makeup, SCA washing, etc.).

Table 4-4. Annual Project Make-Up Water for Wet and Dry Cooling Approaches

	Wet	Dry
Project Makeup Water Required (acre-feet)	2,154	426

In conclusion, based upon the information presented above and the use of concentrating solar trough technology, the applicant has concluded that the use of Dry Cooling will likely render the Project non-competitive and economically unsound. Moreover, because the

Wet Cooling proposal here would use brackish water, the Dry Cooling option would not result in any savings of inland fresh water. Finally, the Dry Cooling option would increase visual and noise impacts of the Project without a substantial offsetting environmental benefit and is therefore inconsistent with the Project objectives.

4.7.3 Wastewater Disposal Alternatives

Wastewater treatment effluent consists of concentrated brine resulting from several cycles of reuse in the wet cooling tower followed by a series of wastewater treatment processes. MSP plans to employ evaporation ponds for wastewater treatment effluent disposal. An alternative to evaporation ponds would be a zero liquid discharge (ZLD) system consisting of a brine concentrator, a crystallizer, and supporting water treatment equipment such as pumps, tanks, filters, mixing tanks, piping, control system, etc. The following paragraphs compare this alternative (ZLD) to the proposed approach (evaporation ponds).

Both evaporation ponds and a ZLD system eliminate the wastewater treatment effluent waste. The evaporation ponds accomplish this by using solar energy to evaporate wastewater into the atmosphere, leaving the solids in the pond. The evaporation ponds require no energy input (other than solar energy, a renewable resource), and as currently planned, the ponds would be constructed with sufficient capacity that they would not require offsite transport of the dewatered salts during the intended life of the Project. Because the ponds would be lined and wildlife impacts would be carefully monitored (and measures taken to protect wildlife if needed), potential pond impacts are considered minimal.

Alternatively, a ZLD system would concentrate the water treatment effluent stream to produce a wet solid waste product that would require regular offsite truck transport to an appropriately permitted disposal facility. The ZLD system uses an external heat source (e.g., steam or electricity) to evaporate the water. Within the ZLD system, the water removal and crystallization processes occur in closed vessels; the wet solids are removed and stored in containers prior to off-site disposal. The crystallizer has minimal potential for groundwater impacts and wildlife exposure to ponds would not exist; and thus there would be no need for groundwater monitoring or wildlife protection measures.

The crystallizer may use steam or electricity from the power plant and/or the power grid, due to the cycling nature of the solar plant compared with the more continuous operation of the ZLD system. The reduction in plant energy output (either by reducing the available steam or utilizing electricity) would be expected to be a small fraction of the net plant output in the summer and a more significant percentage in the winter, ultimately reducing the overall net energy produced by the project. Additionally, a ZLD system requires significant amounts of electric power to drive the process in addition to the energy needed to heat the process. These demands reduce the available electrical output, decrease the overall net efficiency of the power facility, and would most likely require additional energy purchase during the Project's non-power-generating hours. The evaporation ponds require minimal electrical power and result in higher plant efficiency.

No significant environmental issues have been identified with either option. The evaporation ponds will be required to undergo permitting review from the Lahontan Regional Water Quality Control Board (RWQCB) for issuance of Waste Discharge Requirements (WDR) and will be required to meet stringent regulatory requirements in

terms of construction, materials, leak detection, etc. to ensure appropriate protection to underlying groundwater.

Based on the information above it was determined that mechanical ZLD systems are not an economically-sound alternative to evaporation ponds. In addition, using solar energy to generate steam in order to power a mechanical ZLD system is not an optimal use of renewable energy compared to using solar energy directly (for evaporation).

4.7.4 Solar Thermal Storage

The addition of molten-salt-based thermal energy storage (TES) was considered. Including a TES system allows for time shifting of electrical power generation as well as generation of additional annual energy for a given size power block, depending on field sizing. However, it adds substantial incremental cost, increases the acreage needed for the solar field, and, unless the time shifting of power is of significant value to the system, it is generally not justified. At this time TES is not economically justifiable for the Project by the expected market conditions.

4.8 Cooling Water Supply Alternatives

The groundwater resource available to the applicant through the ownership of adjudicated water rights provides for a viable economic plant design which is required for the project to remain attractive to potential utility customers. The Project has emphasized water conservation measures in its facility design to minimize water consumption associated with the use of Wet Cooling. Additionally, the groundwater is brackish and not considered acceptable for drinking water purposes.

4.8.1 Alternative Sources of Cooling Water

A search was conducted to identify a possible alternative source of cooling water for the Project. This search included inquiries to numerous wastewater treatment facilities in a large radius around the MSP site. The potential candidates for water supply to the facility include the City of Barstow, the Town of Adelanto, and the Victor Valley Wastewater Reclamation Authority. To have the potential to supply cooling water, the supplier's water needs to be tertiary treated and the volume of water needs to be approximately the same or above the demand of the Project. Each of the listed facilities could potentially meet those requirements. Table 4-6 lists the facilities with the potential as a cooling water supply to the Project along with salient information regarding the supply.

Table 4-6. Water Supply Alternative Considered

Organization Name	Delivery Distance	Elevation Above Project	Quality/Quantity
City of Barstow	24-25 miles	-3 ft	Suitable with improvements
Town of Adelanto	34 miles	783 ft	Suitable with improvements

Victor Valley Wastewater Reclamation Authority	33 miles	562 ft	Suitable

The results of the investigation shows that there is currently no reclaimed water source that can be considered a feasible alternative for the Project given the distance to the Project, the elevation difference between the site and the source and the practical aspects of the water source with respect to the demand of the Project; each are discussed in the following sections.

4.8.2 Pipeline Transport of Cooling Water

Discussions with potential reclaimed water suppliers have resulted in the Project concluding that suppliers desire the Project to return groundwater back to them for use as potable water. Given the brackish quality of the groundwater, it would have to be treated to be potable. Moreover, return of groundwater would require a bidirectional pipeline (supply reclaimed water/return groundwater) since the groundwater adjudication only allows for physical conveyance of water from the sub-basin surrounding the Project area. This physical conveyance would either by truck or pipeline. Truck transport was rejected as a cost-prohibitive and infeasible alternative, particularly given the brackish quality of the well water on site.

A study was commissioned and performed by Metcalf and Eddy, Inc. to identify potential routes and the cost including a bidirectional pipeline as part of the Project.

Each potential supplier facility identified in Table 4-6 was considered and routes identified that ranged from approximately 24 to 34 miles in length. For each route considered, a review of lengths under pavement, over bridges, crossing rivers, crossing drainages, crossing highways, and crossing railways to understand the cost of each component was completed.

Topography, elevation, and geologic conditions were considered when designing each pipeline to include costs for additional lift stations and additional costs of excavating soils for pipeline placement. The raw elevation difference between the site and two of the potential suppliers (Adelanto and VVWRA) drives the cost of higher for the dual pipeline due to the cost of returning water to the source at a significant elevation. The cost of a single pipeline to supply the project from any of the three sources is roughly similar.

Faulting and seismic hazards were briefly considered but the risk of supply disruption was not quantified.

Ultimately, the pipeline hydraulic characteristics were determined for each option and pipeline designs were created. Cost of construction was determined and ranges from approximately $15 million (M) to $18M depending on the origin but escalates to $27M to $49M when considering a bidirectional pipeline. When including the associated operations and maintenance of the pipeline (the life cycle cost), the cost escalates to $29M to $35M for a single supply pipeline and $54M to $94M for a bidirectional pipeline.

Given the length of the pipeline and the possibility of disruption of supply due to a number of factors (supplier outage or quality issue, outages along the pipeline, or vandalism), relying on such a facility is not consistent with the Project objectives.

Based on the cost information above it was determined that a reclaimed water source is not an economically sound alternative. In addition, utilizing an offsite source of water would still require a backup source to be identified, which would be groundwater, thus the cost of wells would not be eliminated, further making this alternative economically unsound.

Based on the nature of installing a pipeline of significant length, it is more likely that additional unnecessary environmental impacts would result, which is inconsistent with the Project objectives and would likely be environmentally undesirable.

Lastly, the cost of treatment to bring the return water to potable standards was not included but would further make this alternative economically unsound.

4.8.3 Practical Aspects of Using an Alternate Source of Water

The Project reviewed the potential for water supply from water reclamation facilities as discussed above. In reviewing this alternative it was found that the Project's water demand with respect to the source's supply needs to be well coordinated. It is assumed that the water supply could be readily handled on a daily basis by utilizing onsite tanks. However, on an annual basis the supply and demand do not align.

Wastewater treatment facilities receive a relatively steady supply of influent from anthropogenic activities. These activities do not change significantly throughout the year, thus result in a relatively steady effluent. This effluent is the assumed alternate source of cooling water. This effluent may actually be more available during winter months and less available during summer months due to evaporative losses during processing.

The Project requires more water during the summer months and less water during the winter months. This is due to the cooling water demand being directly linked to the heat rejection rate of the plant, which changes dramatically throughout the year. Thus, a supply of 2154 AF/yr as would be required to supply the Project would need to be mostly available during the summer months. Figure 4-1 illustrates the supply-demand mismatch.

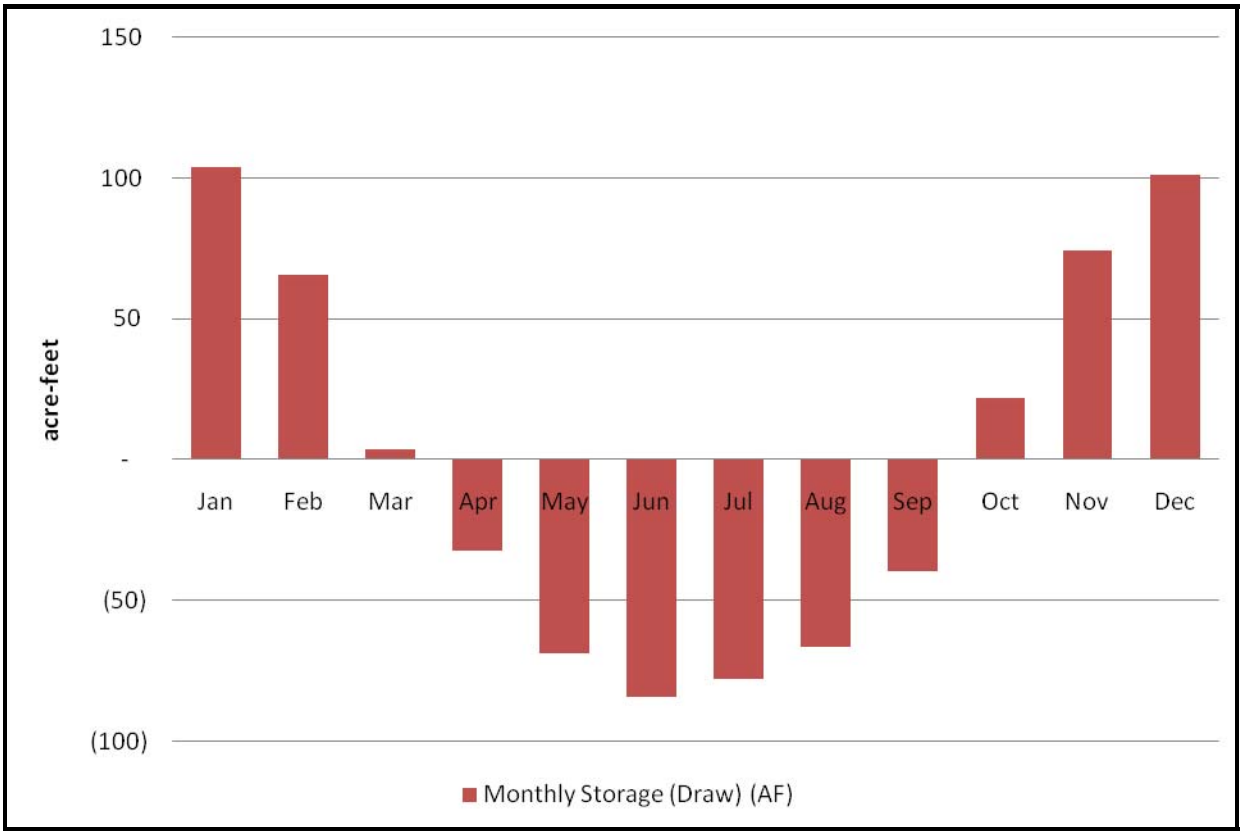


Figure 4-1. Water Banking Needed to Support Use of Reclaimed Water

As illustrated in Figure 4-1, the Project or the reclaimed water supplier would need to store approximately 370 AF (121,000,000 gallons) of water each winter to support the Project for use in the summer. The cost and practical nature of such is inconsistent with the Project Objectives and would further make this alternative economically unsound.

4.9 Power Generation Technology Alternatives

The proposed Project would generate power by using concentrated solar thermal trough technology to produce high-pressure steam to drive a steam turbine generator.

4.9.1 Alternative Solar Technologies

Several solar technologies exist, both on a large and small scale. Concentrated solar power can be adapted to a variety of technologies, including photovoltaic technologies, power tower configuration, and Stirling engine concepts, as well as trough technologies. Abengoa Solar Inc.'s parent company is engaged in developing solar technologies at the Solúcar Platform located in Sanlúcar la Mayor, Sevilla, Spain. At present, there are four plants in use at the platform (Seville PV, Casaquemada, PS10 and PS20), delivering power to the grid in Spain, and another three plants under construction (Solnova 1, Solnova 3 and Solnova 4). The Solúcar platform will generate approximately 300 MW from a variety of solar sources: 50 MW from tower technology, 250 MW from troughs, 1.2 MW produced by photovoltaic technology and 80 kW from dish Stirling technology.

Abengoa Solar is engaged in many other solar developments in the United States and internationally outside of Spain including smaller, similar, and larger scale projects than that proposed for this Project.

The following is a discussion regarding other solar technologies and why they were rejected for this specific Project.

- Photovoltaic (PV) technologies offer a relatively simple method of power conversion. However, PV at present does not offer a cost that would make this technology attractive for this Project. Several designs provide paths to future cost improvements by utilizing concentrating methods such as Fresnel lenses to minimize the more costly components, the PV cell, while maximizing the aperture, resulting in an overall lower cost when compared to other PV concepts. Other improvements in PV include cell technology development, some of which may prove beneficial in the future but are not consistent with this Project's objectives.
- Stirling engines operate on a thermodynamic cycle invented and patented by Robert Stirling in the early 19th century. With this technology the engine is located at the focal point of a paraboloid-shaped collector typically created by an array of smaller mirrors. To scale this technology, the entire system is repeated (multiple engines and collector arrays) many times, as scaling the base array above a size of approximately 50 MW is not currently practical. While this technology can offer higher thermal efficiencies than parabolic troughs because of higher operating temperatures, it involves more complex mechanical equipment and thus increased operational and maintenance difficulties. Also, this technology is not as well proven as parabolic trough mirrors and the current cost of power produced from this technology on a large scale is not well known. Future advances in materials to better accommodate the high temperatures and novel designs for the engine to reduce the number of moving parts may prove beneficial in the future but are not consistent with the Project objectives.
- Power tower configurations concentrate the light on an elevated tower from a large field of mirrors either on one side or multiple sides of a tower; facilities may have multiple fields of mirrors utilizing multiple towers. A power tower approach can offer higher thermal efficiencies than parabolic trough technologies, but is limited in capacity on a single tower due to the distance required to focus light on the aperture. This leads to the combining of tower outputs to achieve the Project objectives, which is less proven and not consistent with the Project Objectives. Also, the height of the tower(s) results in a greater potential for adverse visual impacts and aircraft fight issues than for a parabolic trough facility, particularly in the vicinity of military air bases such as in the eastern San Bernardino County high desert area of California. Given the easements in place on the Project's site for military fly-over and after discussions with the Department of Defense, structures higher than those already in place at the Project site will not be considered, eliminating this as an alternative.

Parabolic trough mirror technology was chosen for this Project primarily because it is the only well proven technology for this scale of power generation. Significant experience at the nine SEGS units takes most of the operational risk out of this technology. In addition, the recent resurge in solar thermal growth has been focused on this technology, including

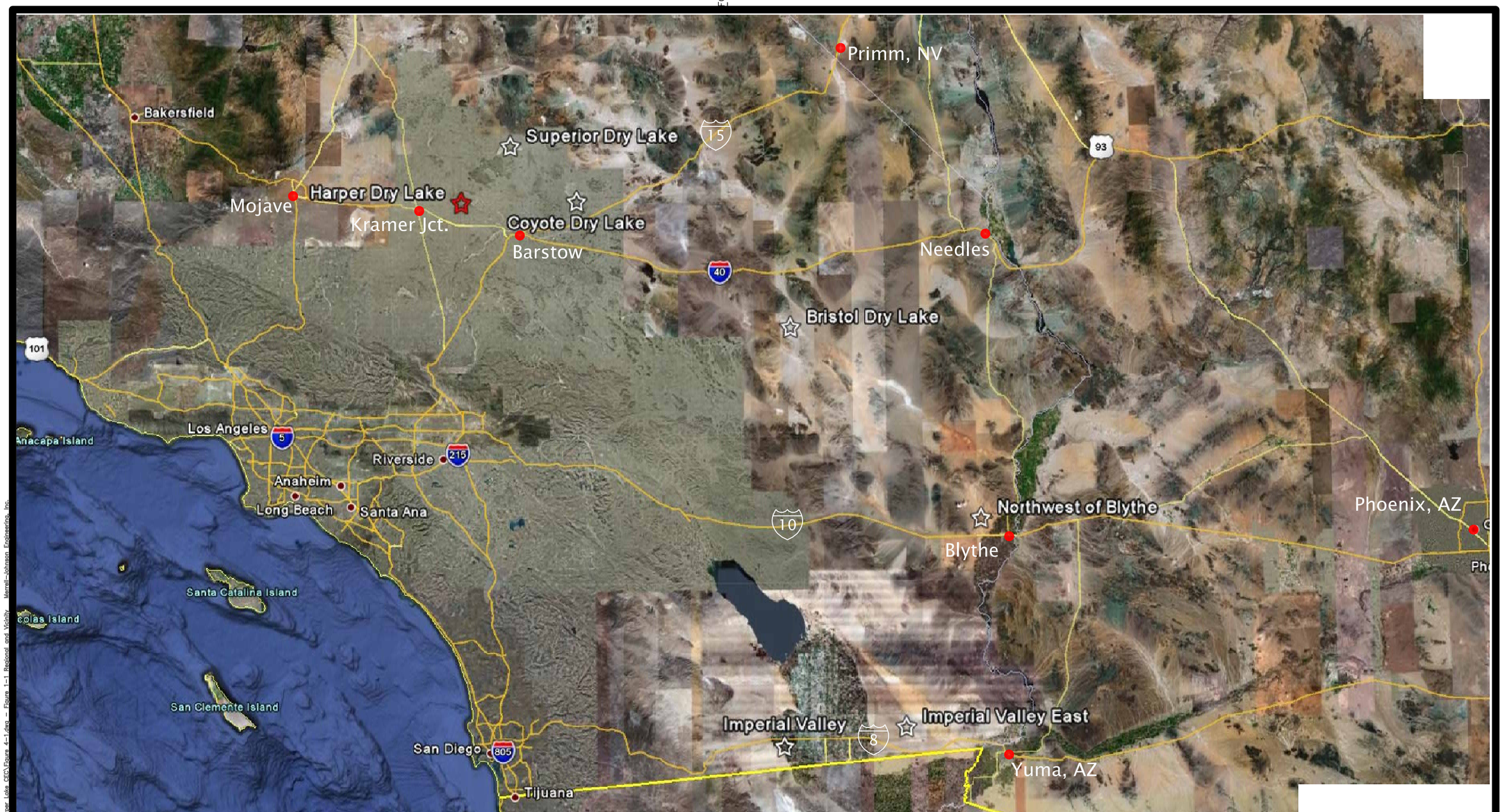
the completed construction of the Nevada Solar One unit and the current construction of several parabolic trough units in Spain. This new growth has also spawned the development of new sources for critical components in addition to the current manufacturers making this technology well suited for development.

4.9.2 Other Renewable Technologies

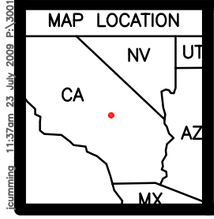
As presented in the project description, one of the project objectives is to develop a new utility-scale solar energy project; therefore, no other renewable technologies were considered for this project. In addition, there is no geothermal resource near the site and the site is far more suitable for a solar facility than a wind facility. Thus, any consideration of wind or geothermal alternatives would require an entirely different site that would present major site control issues.

4.9.3 Non-Renewable Technologies

An objective of the Project is to support the state's policies/goals with respect to increasing the use of renewable energy sources. Fossil fuel technologies (simple cycle, combined cycle, advanced combustion turbine technologies, integrated gas combined cycle, fluidized bed boilers, etc.) by definition do not support these goals and objectives and thus were not considered as alternatives for Project. Nuclear power also is not renewable energy and is prohibited by California law at present because of lack of a long-term storage for fuel waste.



MAP LOCATION



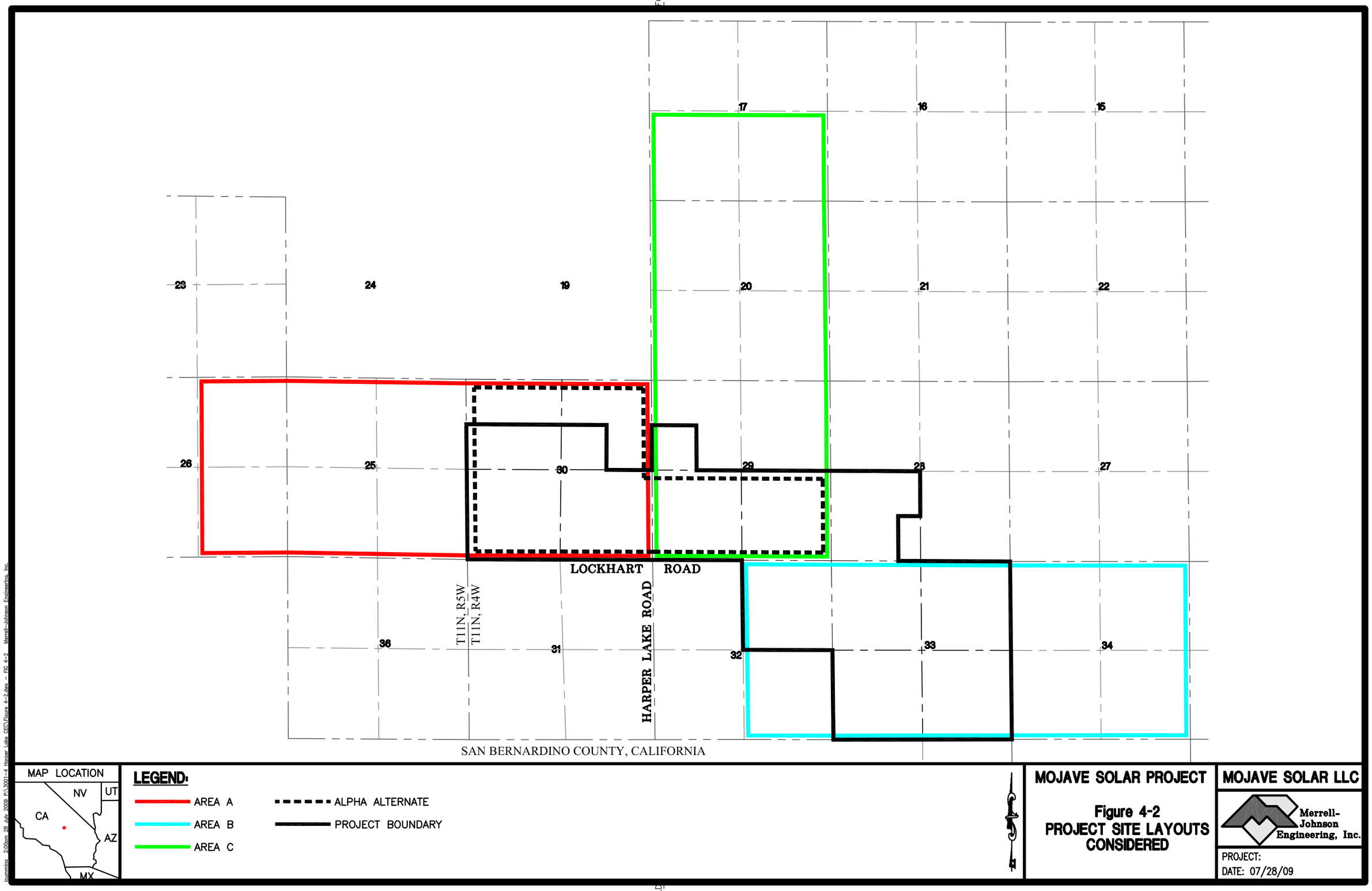
MOJAVE SOLAR PROJECT

Figure 4-1
PROJECT SITE AREA ALTERNATIVES

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/23/09



MOJAVE SOLAR PROJECT

Figure 4-2
PROJECT SITE LAYOUTS CONSIDERED

MOJAVE SOLAR LLC

Merrell-Johnson Engineering, Inc.

PROJECT:
DATE: 07/28/09