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Appendix (in Volume II)

Appendix X Water Usage Minimization Study

6.1 INTRODUCTION

This section of the Application for Certification addresses requirements of the Warren-Alquist State Energy Resources Development and Conservation Act (Public Resources Code Section 25500 et seq.) and implementing regulations (Title 20 California Code of Regulations Section 1701 et seq.) as well as the requirements of the California Environmental Quality Act (Public Resources Code Section 25500 et seq.) and implementing regulations (Title 14 California Code of Regulations Section 15000 et seq.) that an applicant discuss a range of reasonable alternatives to the project or the location of the project, including the no project alternative, 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 an evaluation of the comparative merits of the alternatives.

California is the most populous state in the United States. Its population is projected to continue to grow at a rate of just over 1 percent per year until 2030, putting California above the national population growth rate of about 0.8 percent per year. The combination of continued population growth and long-term economic prosperity will result in robust growth in energy demand. The California Energy Commission (CEC) estimates that to meet peak energy demand growth, the state will need to add more than 9,000 megawatts (MW) in capacity between 2008 and 2018 (CEC, 2007).

At the same time, the state has set aggressive environmental objectives, including reductions in levels of greenhouse gas emissions. The Hydrogen Energy California (HECA or Project) represents an opportunity to satisfy several of California's environmental policy objectives regarding low-carbon power generation and greenhouse gas reduction while supporting sustainable economic growth. The Project will respond to the future energy demands of California, and will play an important role in eventually meeting the state's objective of reducing carbon dioxide (CO_2) emissions to 1990 levels by 2020.

6.1.1 Project Objectives

A critical component of the alternatives analysis is the ability of the alternatives to feasibly attain most of the basic objectives of the project. Project objectives are summarized as follows:

- Provide an efficient, reliable, and environmentally sound power generating facility to help meet future electrical power needs.

- Mitigate impacts related to climate change by dramatically reducing average annual greenhouse gas (GHG) emissions relative to the GHG emitted from a conventional power plant by capturing and sequestering carbon dioxide emissions.

- Facilitate and support the development of hydrogen infrastructure in California by supplementing the quantities of hydrogen available for future energy and transportation technologies.

- Conserve domestic energy supplies and enhance energy security by using a by-product from the oil refining process to generate electricity, and enhancing production of domestic petroleum reserves.

- Minimize environmental impacts associated with the construction and operation of the Project through choice of technology, project design and implementation of feasible mitigation measures, if necessary.

- Site the Project at a location over which Hydrogen Energy International (HEI) is reasonably likely to obtain control, and which offers reasonable access to necessary infrastructure, including natural gas and non-potable water supply, transmission interconnection, and geologic formations appropriate for CO_2 enhanced oil recovery (EOR) and sequestration (storage)[1].

- Ensure the economic viability of the Project by minimizing costs while achieving other Project objectives.

In determining whether or not a particular alternative could feasibly obtain the objectives set forth above, additional specific evaluation criteria were used to evaluate alternative Project Sites and linear facilities, generating technologies, and water supplies. These additional criteria are set forth below in the relevant subsections.

6.2 NO PROJECT ALTERNATIVE

Under the No Project Alternative, the Project would not be developed. The potential environmental impacts identified in this Revised Application for Certification associated with the construction and operation of the Project would not occur. However, the analysis contained herein concludes that with feasible mitigation all of the potential impacts associated with the Project would be reduced below the level of significance.

The No Project Alternative fails to achieve almost all of the Project objectives identified above related to production of energy, advancement of technology, and enhancement of energy security. Failure to achieve the Project objectives would also mean that the No Project Alternative would not further the important state laws and policies discussed below.

In 2005, the state energy agencies issued Energy Action Plan II (EAP II). EAP II emphasized "[the] need to develop and tap advanced technologies to achieve [the] goals of reliability, affordability and an environmentally sound energy future." The Project capital and operating costs, as well as the associated environmental benefits, were balanced such that the Project could provide baseload low-carbon power and some new technology development. This technology development would not be advanced under the No Project Alternative.

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[1] This carbon dioxide will be compressed and transported via pipeline to the custody transfer point at the adjacent Elk Hills Field, where it will be injected. The CO_2 EOR process involves the injection and reinjection of carbon dioxide to reduce the viscosity and enhance other properties of the trapped oil, thus allowing it to flow through the reservoir and improve extraction. During the process, the injected carbon dioxide becomes sequestered in a secure geologic formation. This process is referred to herein as CO_2 EOR and Sequestration.

California Assembly Bill 32 (AB 32) requires reduction of greenhouse gas emissions to 1990 levels by 2020. Furthermore, Executive Order S-3-05 sets a state target of reducing greenhouse gas emissions to 80 percent below 1990 levels by 2050. AB 32 requires the California Air Resources Board (CARB) to assign emissions targets to each sector in the California economy and to develop regulatory and market methods to ensure compliance, which take effect in 2012. The California Public Utilities Commission (CPUC) and California Energy Commission (CEC) are to develop specific proposals to CARB for implementing AB 32 in the electricity sector, and possibly including a cap-and-trade program.

The satisfaction of AB 32 and Executive Order S-3-05 will require zero- or low-carbon power generation for facilities that are brought on-line in the next decade. In the absence of new low-carbon technologies policies, the state will miss its greenhouse gases reduction targets by a large margin. The Project's reliable, low-carbon baseload generation will help California meet its greenhouse gases goals. The No Project Alternative does not advance these goals.

Senate Bill 1368 (SB 1368), passed in 2006, established an Emission Performance Standard (EPS) for greenhouse gas emissions from power plants used to serve baseload power in California. One of the requirements of SB 1368 is that utilities may only sign long-term contracts (5 years or more) with power plants that produce no more greenhouse gas emissions than a natural gas combined cycle (NGCC) power plant. Pursuant to SB 1368, the CPUC has set the EPS at 1,100 pounds of carbon dioxide per megawatt hour (MWH) of electricity generated by the power plant. This law effectively prohibits California utilities from owning or contracting long term with coal-fired power plants, in- or out-of-state, unless they are operated with carbon capture and sequestration (CCS). The intended effect of SB 1368 is to encourage baseload low-carbon power production. The Project's greenhouse gas emissions will be well below this threshold requirement.

AB 1925, passed in 2006, requires the CEC to provide a report to the California legislature by November 2007 "with recommendations for how the state can develop parameters to accelerate the adoption of cost-effective geologic carbon sequestration strategies." This type of legislation clearly demonstrates California's commitment to supporting and encouraging in-state CCS demonstration technology. Again, the No Project Alternative would hinder the execution of this legislative mandate.

The use of petroleum coke (petcoke) or a blend of petroleum/coal blend feedstock provides the power plant the greatest operational and commercial flexibility. The Project will add a nominal 250 MW of baseload low-carbon power to the grid, provide environmental benefits in regards to greenhouse gases (among others), and help California meet its obligations under AB 32, SB 1368 and AB 1925. In contrast, the No Project Alternative fails to meet the basic Project Objectives, and therefore fails to advance these goals. As a result, the No Project Alternative was rejected in favor of the proposed Project.

6.3 SITE AND LINEAR FACILITIES LOCATION ALTERNATIVES

In determining whether or not alternative site and linear facilities locations would feasibly attain the Project objectives, the Applicant used the following site evaluation criteria:

- Environmental impacts;
- Safety (proximity to residents, schools, day care centers, etc.);
- Proximity to sensitive receptors (population and sensitive species);
- Environmental justice considerations;
- Economic feasibility;
- Site acreage (300+ acres), topography, lowest elevation (to maximize power generation);
- Proximity to carbon dioxide customer for CO_2 EOR and Sequestration;
- Minimize impacts on transportation corridors;
- Feasibility of land acquisition;
- Proximity to infrastructure to minimize impacts from Site access and linear facilities; and
- Proximity to raw water supply.

6.3.1 Proposed and Alternative Sites

The Project Site (1,101 acres being purchased, of which 473 acres will be utilized for the Project Site) is located in an agricultural area in Kern County, California near the Elk Hills Field. The Project Site is contiguous land bounded by Adohr Road to the north, Tupman Road to the east, an irrigation canal to the south, and the Dairy Road right-of-way to the west. The Project Site is in a sparsely populated area. There are only a few homes within a mile of the Project Site and the unincorporated community of Tupman is 1.5 miles from the site. Primary access will be from Interstate 5, to Stockdale Highway west, to Dairy Road then south to Adohr Road. The topography of the Project Site is flat. The geology at the Project Site has been determined suitable for power plant construction.

The Project Site was selected based upon, among other things, the available land, proximity to a carbon dioxide storage reservoir, and the existing natural gas transportation, electric transmission, and brackish groundwater supply infrastructure that could support the proposed 250 MW of baseload low-carbon power generation. The Project Site was also chosen for its reasonable proximity to Interstate 5, State Routes (SR) 58 and 119, and Stockdale Highway. While SR 119 and SR 58 are not the preferred access routes for the Project, they provide another major personnel ingress/egress route in the event of an emergency. The geology in the vicinity of the Project Site makes it one of the premier locations in the United States for CO_2 EOR and Sequestration.

HEI submitted its initial Application for Certification (AFC) (08-AFC-8) to the CEC on July 30, 2008, which proposed the Project on a different site. HEI subsequently decided to move the Project when it discovered the existence of previously undisclosed sensitive biological resources at the prior site. As a result, the Applicant was required to conduct an alternative site analysis that was not merely theoretical, but was in fact necessary to identify an alternative site for the Project, which has now become the Project Site and is the subject of this Revised AFC. In the process, several alternative sites in the vicinity of the unincorporated communities of Buttonwillow and Tupman were considered. However, the alternative sites were rejected for various reasons, including (1) topography, (2) distance from the proposed carbon dioxide custody transfer point, (3) lengths of linear facilities, (4) sensitive environmental receptors and/or (5) land availability. These sites and the relevant information are presented in Table 6-1, Alternative Sites Reviewed and Status.

Table 6-1
Alternative Sites Reviewed and Status

Property	Status
Project Site	Project Site – Submitted in the AFC
Former Project Site	Eliminated – due primarily to concentration of California threatened species identified (Blunt-Nosed Leopard Lizard)
Alternate 1	Eliminated – Owner not willing to sell
Alternate 2	Eliminated – Sold to another buyer
Alternate 3	Eliminated – Less desirable due to close proximity to Interstate 5.
Alternate 4	Eliminated – due primarily to length of linears and number of private land owners involved

Figure 6-1, Alternative Site, will be submitted under separate confidential cover and will show the locations of the above alternative sites.

Based on the above analysis, no alternative sites were identified that were environmentally superior to the Project Site, and would allow attainment of most of the Project objectives. Thus, the Project Site was selected.

6.3.2 Project Linear Facilities

The Project Site maximizes the use of existing rights-of-way (ROW) for linear facilities while minimizing the number of private land owners involved. The raw water supply pipeline will be located within an existing ROW owned by Buena Vista Water Storage District (BVWSD). The natural gas and potable water pipelines are primarily located within the existing Tupman Road ROW. And finally, both transmission linear alternatives have been sited to limit the number of miles of transmission and number of land owners that will be impacted by the Project. The routing of the linear facilities was thoroughly reviewed to limit the environmental impacts associated with the Project.

6.3.2.1 Electrical Transmission Line

An electrical transmission line will interconnect the Project to Pacific Gas & Electric's (PG&E) Midway Substation. As discussed in Section 4, Electrical Transmission, four transmission routes were assessed as part of the Project. The interconnection voltage is 230 kilovolts (kV) and the new transmission line will be approximately 8 miles long, extending from the western edge of the Project Site to the north, and west to the north side of the substation.

Four initial route alternatives were screened for the transmission line between the Project Site and the substation. Of these four alternatives, two have been fully evaluated as viable alternatives for this Revised AFC. Other transmission features that were evaluated included the following:

- Transmission structure types;
- Conductor sizes and conductor families;

- Circuit bundle configurations;
- Ground wires;
- Insulators; and
- Construction methods.

Section 4.0, Electrical Transmission of this Revised AFC provides the details of these alternatives and their evaluations.

6.3.2.2 Natural Gas Line and Freshwater Line

The natural gas line and potable water line will enter the Project Site from the south, after travelling northwest partly along Tupman Road, and after tying into the existing source lines located near the intersection of Tupman Road and SR 119. Some variations on the proposed route were considered. However, routing options are limited in this area, given the location of the main supply pipeline.

6.4 ALTERNATIVE GENERATING TECHNOLOGIES AND CONFIGURATIONS

HEI was formed to develop a material business consisting of the production of low-carbon hydrogen-rich fuel from solid feedstocks for the generation of low-carbon power with high-level carbon capture and CO_2 EOR and Sequestration. These particular Project objectives drove the generation technology selection. Accordingly, the Integrated Gasification Combined Cycle (IGCC) technology was selected because of its unique ability to produce low-carbon hydrogen-rich fuel for baseload power generation, as well as for its superior carbon-capture features. The technology selection was driven by the following objectives: (1) proving commercial scale IGCC-with carbon-capture operability, and (2) proving associated economic viability. A key aspect is delivering a high reliability operating plant within a minimum period after initial startup. Other generating technologies, such as solar, wind, geothermal, hydroelectric, and nuclear, were not selected because they fundamentally fail to achieve the Project objectives.

6.4.1 General Electric Gasification Technology

IGCC with carbon capture is the only technology which meets the goal of the Project to generate low-carbon power using hydrogen-rich fuel produced from a solid feedstock. Other technologies such as pulverized coal technology and oxyfuel technology do not meet this goal. Furthermore, pulverized coal technology with carbon capture is an unproven technology at the Project's scale, and has lower efficiency, higher water usage, and higher emissions.

General Electric's (GE) gasification technology forms the initial section of the IGCC power plant. Other gasification technology options were considered, including those of Shell and ConocoPhillips. GE's quench gasification process was selected for the following reasons:

- GE has the most experience designing solid fuel gasifiers (GE had more than 10 operating facilities at the time of selection).

- GE gasification has the most IGCC and petrochemical operating hours on U.S. coals and the greatest experience of U.S. coals, petcoke and coal/petcoke blend operations.

- GE historically has the most operating experience with 100 percent petcoke gasifiers (four at the time of selection).

- The quench gasification process is best suited for high levels of carbon dioxide capture because of a simple arrangement whereby the steam required by the shift reaction to produce carbon dioxide is generated by water quench of the synthesis gas (syngas).

- GE quench gasification technology was identified as the best fit for the specific requirements of the proposed Project, when taking into account key decision criteria including the life cycle cost of electricity and reducing technology risk through demonstrated commercial operation with similar (petcoke and coal) feedstocks, at similar capacity and operating conditions.

Based on the above reasons, GE is the selected technology supplier.

6.4.2 Acid Gas Removal System

Two important design criteria for the acid gas removal (AGR) system were: (1) removal of sulfur in the hydrogen-rich fuel to a target of less than 5 ppm by volume (ppmv) total sulfur (a level compatible with state-of-the-art SCR technology); and (2) production of a high-purity carbon dioxide stream that contains over 90 percent of the total carbon in the raw syngas. There are numerous AGR technologies available, but only a few have found wide-spread acceptance for gasification projects. The three most commonly selected technologies are methyldiethanolamine (MDEA), Selexol®, and Rectisol.

For the reasons discussed below, Rectisol was selected because of its ability to meet the Project's target levels for sulfur removal and purity of the carbon dioxide stream. All three of these solvents are capable of selective removal of hydrogen sulfide from a sour syngas stream. However, the sulfur slip (H_2S + COS) in the treated syngas is highest for methyldiethanolamine (MDEA) (an order of magnitude higher than the desired target level). For this reason, MDEA did not meet the requirements of the Project.

Selexol® is commonly selected for IGCC applications where the gasifier pressure is relatively high and where the depth of sulfur removal is sufficient to allow the use of conventional selective catalytic reduction (SCR) catalysts in the heat recovery steam generators (HRSG). There are several Selexol® units in commercial operation treating syngas. However, Selexol® loses its capital cost advantage when either very deep sulfur removal or high-purity carbon dioxide capture is required. As previously stated, both are required. Furthermore, as compared with Rectisol, only one Selexol® plant is understood to be operating at sulfur levels less than 5 ppmv in the hydrogen-rich gas at a scale smaller than that required for the Project. There is sufficiently more of an experience base showing that Rectisol is more likely to achieve the Project's design criteria for sulfur recovery.

Additionally, Rectisol is the more common selection when the syngas is used for chemical manufacturing and when very deep sulfur removal is required. Rectisol solvent is often used in the production of commercial grade methanol; it is low cost and is available from multiple suppliers. Rectisol is commercially proven with 50 Rectisol plants in operation, and with many

power plants demonstrating sulfur removal at, or better than the design criteria for the Project. Another important factor in the selection of Rectisol is its ability to remove trace contaminants, such as carbonyl sulfide (COS), hydrogen cyanide (HCN), ammonia (NH_3), mercaptans, mercury (Hg), iron (Fe) and nickel (Ni) carbonyls; and mixtures of benzene, toluene, and xylene (BTX).

As a result of the extensive evaluation performed by HEI, it chose Rectisol for the Acid Gas Removal (AGR) system. With its significant sulfur removal capability, proven operating experience demonstrating sulfur removal consistent with the Project's design criteria, and removal of trace contaminants, Rectisol was deemed superior to Selexol® for the Project.

6.4.3 General Electric 7FB Combustion Turbine

GE's 7FB was selected as the combustion turbine for the following reasons. The F class offers higher efficiency (>4 percent) than the E class, and GE has demonstrated more than 100,000 hours on F class turbines in syngas service at the SG-Solutions Wabash IGCC and the TECO Polk IGCC power plants. GE originally developed the 7FB combustion turbine for natural gas-fired combined cycle applications. The first commercial unit started operating in 2002. There are now eight operating 7FB (60 Hertz [Hz]) units in the United States with a total of greater than 20,000 hours of operational history. There also are four operating comparable 9FB (50 Hz) units in Europe with a total of greater than 15,000 hours of operational history. As the 7FB unit is being adapted for different fuel service, rather than undergoing a fundamental redesign and resizing, scale-up is not a concern. GE will provide a full commercial offering for the 7FB turbines that includes performance guarantees on both hydrogen and natural gas.

6.4.4 Conclusion

In conclusion, a thorough review of alternative generation technologies and configurations was conducted. Based on this review, none of the alternatives satisfied the basic Project Objectives, as described above, without resulting in increased adverse impacts to the environment or impaired project feasibility as compared to the proposed Project. As a result, the alternative generation technologies and configurations were rejected in favor of the proposed Project's generation technology.

6.5 ALTERNATIVE WATER SUPPLIES

Several potential alternative water supplies were studied for the Project, as well as potential technologies for reducing water demand.

The water supply options considered included:

- Ocean Water
- Brackish Water
  - Industrial Wastewater
  - Semitropic Water Storage District
  - Buena Vista Water Storage District
- Inland Wastewaters

- Municipal Effluent
- Agricultural Wastewater

- Other Inland Waters
  - State Water Project;
  - Fresh Groundwater
  - Municipal Water Supply

In addition to evaluating the ability of the alternatives to feasibly attain the general Project objectives, the Applicant used the following water supply specific criteria as a means of evaluating potential water supply alternatives:

- Environmental impacts
- Beneficial impact to local groundwater quality and agriculture
- Economic feasibility
- Feasibility of land acquisition
- Proximity to raw water supply
- Minimization of the parasitic electrical demand.

In addition, the analysis took into consideration California State Water Resources Control Board Resolution No. 75-58[2], referred to as the California Water Policy, which addresses the use and disposal of inland waters used for power plant cooling.

6.5.1 Water Supply Alternatives Decision Analysis

The following hierarchy of "tests" was applied to each water supply alternative:

Test 1 – Is the alternative water supply feasibly available at the Project Site? (If not, then disregard this alternative. If yes, proceed to Test 2.)

Test 2 – Will the subject water supply alternative satisfy California Water Policy? (If not, then disregard this alternative. If yes, proceed to Test 3.)

Test 3 – Is the subject water supply alternative technologically sufficient (quantity and quality) to guarantee high safety and reliability (98 percent availability?) (If no, then disregard this alternative. If yes, proceed to Test 4.)

For water supply alternatives passing Tests 1 through 3, apply Tests 4 through 6:

Test 4 – Rate other impacts associated with each water supply alternative, including transportation, biological, energy, health and safety, etc., (high, medium, and low).

Test 5 – Rate relative capital costs of each remaining water supply alternative (high, medium, and low).

[2] Water Quality Control Policy on the Use and Disposal of Inland Waters Used for Power Plant Cooling, Resolution 75-58, State Water Resources Control Board, June 19, 1975.

Test 6 – Rate relative operation and maintenance (O&M) costs of each of the remaining water supply alternatives (high, medium, and low).

Tests 1 through 3 address "fatal flaw" criteria. Alternatives that did not pass Test 1, 2, or 3, were not evaluated further. For alternatives passing Tests 1 through 3, the evaluations from application of Tests 4 through 6 were evaluated for each water supply alternative, with the alternative with the highest evaluation being selected.

6.5.2 Wastewater Being Discharged to the Ocean

The Project Site is located approximately 75 miles from a significant source of ocean disposed wastewater. While this supply is large and technology for its successful use proven, the capital cost for transporting, and treating the wastewater from this option is high (>$500 million). This alternative water supply failed Test 1 as it is not feasibly available at the Project Site. This alternative was eliminated from further consideration.

6.5.3 Ocean Water

The Project Site is located approximately 75 miles from the Pacific Ocean. While this supply is limitless and technology for its successful use proven, the capital cost for transporting, treating, and disposing of this option is high (>$500 million). This alternative water supply failed Test 1 as it is not feasibly available at the Project Site. This alternative was eliminated from further consideration.

6.5.4 Brackish Water

6.5.4.1 Industrial Wastewater

Industrial wastewater in the form of produced water is available from the oilfields within 10 miles of the Project Site. Produced water refers to water that is "co-produced" from the many oil wells in the Kern County region. Produced water is an industrial wastewater that is separated from crude oil in the oil production process. Kern County oil well output is often 8 parts water to 1 part oil, leading to a large excess of produced water which the local oil producers must dispose of. The produced water is currently disposed by re-injection and discharge to evaporation ponds. There is approximately 15 million gallons per day (mgd) of produced water available when drawn from multiple locations within a radius of 10 miles of the Project Site. Producers of these waters indicated they were willing to provide this water to the Project. However, they are reluctant to guarantee specific quantities of future water supply. The business purpose of these organizations is oil production, and not water production and they are unwilling to complicate the former for the sake of the latter. Commercial discussions determined that a reliable produced water supply is not readily available and therefore this alternative failed Test 1. Under the test hierarchy, previously described, this conclusion ends consideration of this alternative. Nevertheless, for the purposes of this analysis, the ability of this alternative to meet subsequent tests was evaluated.

As inland wastewaters are identified in California State Water Resources Control Board Resolution No. 75-58 as a preferred alternative source of water supply, the produced water is consistent with the California Water Policy. Therefore, this supply does pass Test 2.

The produced water exhibits Total Dissolved Solids (TDS) concentrations ranging from 10,000 to 40,000 mg/L, and have elevated concentrations of potentially problematic ionic species including silicon (Si), strontium (Sr), and barium (Ba), as well as possessing significant oil and grease issues. Given the quality and ionic constituents of these supplies, the optimal technology for processing this raw water to Project standards is a "thermal process." The thermal process uses a mechanical vacuum pump and heat input to boil the water and recover a good quality stream sufficient for utility purposes. This utility water stream must then be treated further with reverse osmosis (RO) and demineralization to achieve the Project demineralized water standard. Produced water will require significant treatment prior to use. This treatment is not unprecedented, but only one such example is known to HEI. This provides a higher level of technology risk than the Project is comfortable with. However, such treatment does appear to be technologically feasible so this supply passed Test 3.

It is estimated that the capital cost to construct a water plant to process this raw water supply could be $200 million. The costs to operate this water plant are anticipated to be high and could result in a nearly 15 MW additional parasitic load over use of brackish groundwater (due to the steam diversion from the STG cycle to operate the water plant). These capital and operating costs are substantial and they negatively impact the Project's economics.

The thermal treatment technology will produce a concentrated brine waste stream. Based upon quality data already obtained, it is possible that this reject stream will have constituents at sufficient levels to trigger classification of the brine waste stream as hazardous waste. This waste generation would conflict with the intent of the Project design to minimize the production of hazardous waste to the extent feasible.

While oilfield produced water appears to be technologically possible as a water supply to the Project, it is not the preferred option due to availability, environmental, waste disposal and cost considerations.

6.5.4.2 Semitropic Water Storage District

The Semitropic Water Storage District (Semitropic) is located in northwest Kern County. It has a groundwater storage capacity of 1.65 million acre-feet and there is 650,000 acre-feet of capacity remaining.

Agriculture in a portion of the Semitropic District is impacted by shallow, brackish groundwater conditions resulting from agricultural irrigation. This impacted area is located approximately 10 miles to the west/northwest of Wasco and affects an area of roughly 10 square miles.

Similar to the BVWSD, use of this water supply alternative is consistent with the California Water Policy in that the ultimate water supply will be brackish groundwater and passed Test 2. However, in conversations with Semitropic, they were unable to verify the water supply quantity

and composition and were therefore unable to provide a firm water supply commitment for this Project. Therefore, Tests 1 and 3 could not be performed and this alternative was rejected.

6.5.4.3 Buena Vista Water Storage District

The Project Site is located within the southern portion of the BVWSD. Areas in BVWSD are impacted by brackish groundwater conditions. The BVWSD has proposed to supply the Project with brackish groundwater from a system of wells that will be designed to manage groundwater quality in a portion of the district, and has provided documentation indicating their interest (see Appendix O2, Groundwater Model Documentation). Redundant wells will be installed to provide emergency backup protection in case of primary wells failing. The brackish groundwater to be provided is not otherwise used for beneficial purposes.

The District has stated that it will be able to provide brackish groundwater to the Project for the estimated life of the Project (see will-serve letter in Appendix O1, Water Resources Information). As there is sufficient brackish groundwater available to meet the needs of the Project, this alternative passed Test 1. The use of brackish groundwater is consistent with the California Water Policy and passed Test 2.

The District's brackish water supply system will include a "picket fence" of wells to intercept the brackish water plume entering the District from the west. As it is technologically feasible to obtain and treat the brackish groundwater to Project standards, this alternative passed Test 3.

As discussed in Section 5.14 (Water Resources) of this Revised AFC, this alternative does not result in any significant adverse environmental impacts. The relative capital costs and O&M costs associated with this water supply alternative are not insignificant. However, this option is economically feasible. Based on this evaluation, brackish water provided by BVWSD has been identified as the preferred process water supply for the Project.

6.5.5 Inland Wastewaters

6.5.5.1 Municipal Effluent

The Project Site is located approximately 17 miles northeast of the city of Bakersfield Wastewater Treatment Plant #3. This plant treats a large portion of the municipal effluent generated from the city of Bakersfield.

HEI had discussions with the city regarding their interest and availability in supplying water to the Project. Currently, the city is selling its treated effluent to local farmers for irrigation purposes. They do not have excess capacity outside of existing contracts which can supply the Project with its total water needs. They do have some excess production (approximately 1 mgd), which is expected to increase in the intervening time between Project permit submission and startup. This growth rate is estimated at approximately 0.25 mgd per year, resulting in another 1 mgd available by startup in 2014. This amount is insufficient for project needs and would have to be augmented by an additional water supply.

Given that this supply is insufficient for Project needs it failed Test 1, and was not selected as the preferred process water supply for the Project.

6.5.5.2 Agricultural Wastewater

Agricultural wastewater (i.e., tile drainage) is excess water from irrigation practices. This wastewater is not available in sufficient quantities in the vicinity of the Project Site, nor is it sufficiently reliable for use at the Project due to water quality variability. Therefore, this alternative failed Tests 1 and 3 and was eliminated from further consideration.

6.5.6 Other Inland Waters

6.5.6.1 State Water Project

The State Water Project's California Aqueduct is located approximately 1,900 feet south of the Project Site. This source failed Test 1 as the Project does not have an allocation for the use of water from the State Water Project. In addition, it is anticipated that this source would fail to pass Test 2 since the availability of other viable sources of water would make use of this freshwater source inconsistent with the California Water Policy (State Water Resources Control Board Resolution No. 75-58). Direct use of water from the State Water Project was therefore eliminated from further consideration.

6.5.6.2 Fresh Groundwater

Fresh groundwater is found in the vicinity of the Project Site. As this alternative water supply is feasibly available to the Project, it passed Test 1. Given the availability of other viable sources of water, use of this freshwater supply would be inconsistent with the California Water Policy, and this alternative water supply failed Test 2. It was, therefore, eliminated from further consideration.

6.5.6.3 Municipal Water Supply

Given the availability of other viable sources of water, use of a municipal freshwater supply would be inconsistent with the California Water Policy. This alternative water supply failed Test 2 and was eliminated from further consideration.

6.6 WATER USAGE MINIMIZATION STUDY

Air cooling of the steam turbine exhaust has been evaluated by HEI to determine suitability of air cooling for Project heat rejection. The resultant study of this option is included in Appendix X, Water Usage Minimization Study. Air cooling of the STG was not selected because it results in a substantial increase in parasitic electrical demand, an increase in capital costs, and a dramatic decrease in STG output. All of these effects result in a markedly negative impact on cost and availability of electricity. The results for air cooling the STG cycle decrease power plant output by greater than 25 MW on hot days. Based on the negative commercial impact of lost production, air cooling was not included for the Project.

The results from application of Tests 4 through 6 are summarized in Table 6-2, Evaluation of Water Supply Options.

Table 6-2
Evaluation of Water Supply Options

Supply Option	Test #1 Availability (pass?)	Test # 2 Satisfy LORS? (pass?)	Test #3 Technologically Feasible? (pass?)	Test #4 Environ -mental Impacts	Test #5 Relative Capital Costs	Test #6 Relative O&M Costs
Wastewater discharged to ocean	No	N/A	N/A	N/A	N/A	N/A
Ocean	No	N/A	N/A	N/A	N/A	N/A
Brackish water						
Industrial wastewater	No	Yes	Yes	Medium	High	High
Semitropic	No	Yes	ND	Low	Medium	Medium
BVWSD	Yes	Yes	Yes	Low	Medium	Medium
Municipal Effluent	No	Yes	Yes	Low	Medium	Medium
Agricultural wastewater	No	N/A	N/A	N/A	N/A	N/A
State Water Project	Yes	No	N/A	N/A	N/A	N/A
Fresh groundwater	Yes	No	N/A	N/A	N/A	N/A
Municipal supply	No	N/A	N/A	N/A	N/A	N/A

Source: HECA Project

Notes:
BVWSD = Buena Vista Water Storage District
HECA = Hydrogen Energy California
LORS = laws, ordinances, regulations, and standards
ND = Not determined at this time
N/A = not applicable as alternative failed fatal flaw test
O&M = operations and maintenance

In conclusion, a thorough review of alternative water supplies was conducted. The preferred water supply for the Project is brackish groundwater from the Buena Vista Water Storage District (BVWSD).

6.7 ALTERNATIVE WASTEWATER DISPOSAL OPTIONS

Following is a summary of the wastewater disposal alternatives that were evaluated:

- Zero Liquid Discharge (ZLD) system – A mechanical system using evaporation and crystallization to effectively reduce liquid wastes to a dry waste for landfill disposal.

- Evaporation pond – Large, lined surface impoundment for disposal of wastewater via atmospheric drying, resulting in a sludge that must be disposed of in a landfill system.

- Class I non-hazardous injection well – Disposal of wastewater via well discharge to a geologic formation that is unsuitable for potable water production and isolated from drinking water aquifers.

- Disposal to wastewater treatment plant – Discharge to a treatment works for removal of pollutants.

- Surface discharge – Discharge of wastewater to the ground or receiving waters, including lakes, rivers, and streams.

- Off-site treatment – Routing of the wastewater to a facility in another location employing one or more of several technologies by a contracted service company.

6.7.1 Wastewater Disposal Alternatives Decision Analysis

The following hierarchy of "tests" was applied to each alternative:

Test 1 – Is the wastewater disposal alternative feasibly available at the Project? (If not, then disregard this alternative. If yes, proceed to Test 2.)

Test 2 – Will the subject alternative satisfy applicable LORS? (If not, then disregard this alternative. If yes, proceed to Test 3.)

Test 3 – Is the subject alternative technologically sufficient to guarantee high safety and reliability (98 percent availability? If no, then disregard this alternative. If yes, proceed to Tests 4 through 6.)

Tests 1 through 3 address "fatal flaw" criteria. Alternatives that did not pass Test 1, 2, or 3, were not evaluated further. For alternatives passing Tests 1 through 3, Tests 4 through 6 were applied and scored as high, medium, or low:

Test 4 – Rate other environmental impacts, including transportation, biological, energy, health and safety, etc.

Test 5 – Rate relative capital costs of each remaining alternative.

Test 6 – Rate relative O&M costs of each remaining alternative.

The ratings from application of Tests 4 through 6 were evaluated for each alternative, with the highest rated alternative selected.

6.7.2 ZLD System

A ZLD system is a mechanical system using a mechanical vapor compression evaporator and crystallization to effectively reduce liquid wastes to a dry solid waste for landfill disposal. ZLD enables water to be reused within the plant and it eliminates wastewater. Although this option is technologically feasible, it is energy, operational, and capital intensive.

6.7.3 Evaporation Pond

An evaporation pond would consist of a large, lined surface impoundment for disposal of wastewater via atmospheric drying, resulting in a sludge that must be disposed in an approved landfill. A very large evaporation pond would be required for disposal of the large volume of wastewater produced by the Project. Due to space, economic, and environmental considerations, this alternative was determined to not be feasible. Therefore, this alternative was eliminated from further consideration.

6.7.4 Injection Disposal Well

This alternative includes the disposal of wastewater via wells that discharge to a geologic formation that is unsuitable for potable water production and is isolated from aquifers. The following geologic conditions protective of underground source of drinking water are required to obtain a permit to construct a Class I Non-hazardous Injection Well:

- A thick sequence of permeable sediments capable of accepting the injected wastewater.
- A thick sequence of impermeable sediments that will confine the injected wastewater and prevent migration towards underground source(s) drinking water.
- The injection operation should not facilitate the fracturing of the rocks or the integrity of the injection well.

Deep well injection (DWI) is used widely on the west side of Kern County. Local subsurface strata are well understood and large amounts of geologic data are available to define the appropriate wastewater disposal system. DWI for the rates expected would require a network of approximately 15 disposal wells (with five additional wells for redundancy), with multiple high head booster pumps to enable injection. This infrastructure would be expensive to build and operate. Constructing this infrastructure either on site or off site would involve significant commercial negotiations. Because lengthy commercial discussions may disrupt the Project timeline, and considering that the ZLD was available at similar cost with no negative schedule impact, this DWI option was not selected.

6.7.5 Disposal to Wastewater Treatment Plant

The city of Bakersfield wastewater treatment plant is located approximately 17 miles southeast of the Project Site. This alternative failed to pass Test 1 due to the distance and insufficient capacity at the wastewater treatment plant.

6.7.6 Surface Discharge

This alternative would involve the discharge of wastewater to the ground or receiving waters including lakes, rivers, and streams. This method failed to pass Test 2 as the quality of the wastewater will not meet state and federal discharge limitations for direct discharge to surface waters. This alternative was eliminated from further consideration.

6.7.7 Off-Site Treatment

This alternative would involve the transport of the wastewater produced by the Project to an off-site facility for treatment and/or disposal. This wastewater disposal alternative failed to pass Test 1 as it is not feasibly available at the Project Site due to the volume of wastewater produced and the absence of a treatment or disposal facility in the vicinity.

The evaluations from application of Tests 4 through 6 were totaled for each alternative, with the alternative with the highest evaluation selected. Wastewater disposal options are evaluated in Table 6-3, Evaluation of Wastewater Disposal Options.

Table 6-3
Evaluation of Wastewater Disposal Options

Wastewater Option	Test #1 Availability (pass?)	Test # 2 Satisfy LORS? (pass?)	Test #3 Technologically Feasible? (pass?)	Test #4 Environmental Impacts	Test #5 Relative Capital Costs	Test #6 Relative O&M Costs
ZLD	Yes	Yes	Yes	Low	High	High
Evaporation pond	No	N/A	N/A	N/A	N/A	N/A
Deep injection well	Yes	Yes	Yes	Low	High	High
WWTP	No	N/A	N/A	N/A	N/A	N/A
Surface discharge	No	N/A	N/A	N/A	N/A	N/A
Off-site treatment facility	No	N/A	N/A	N/A	N/A	N/A

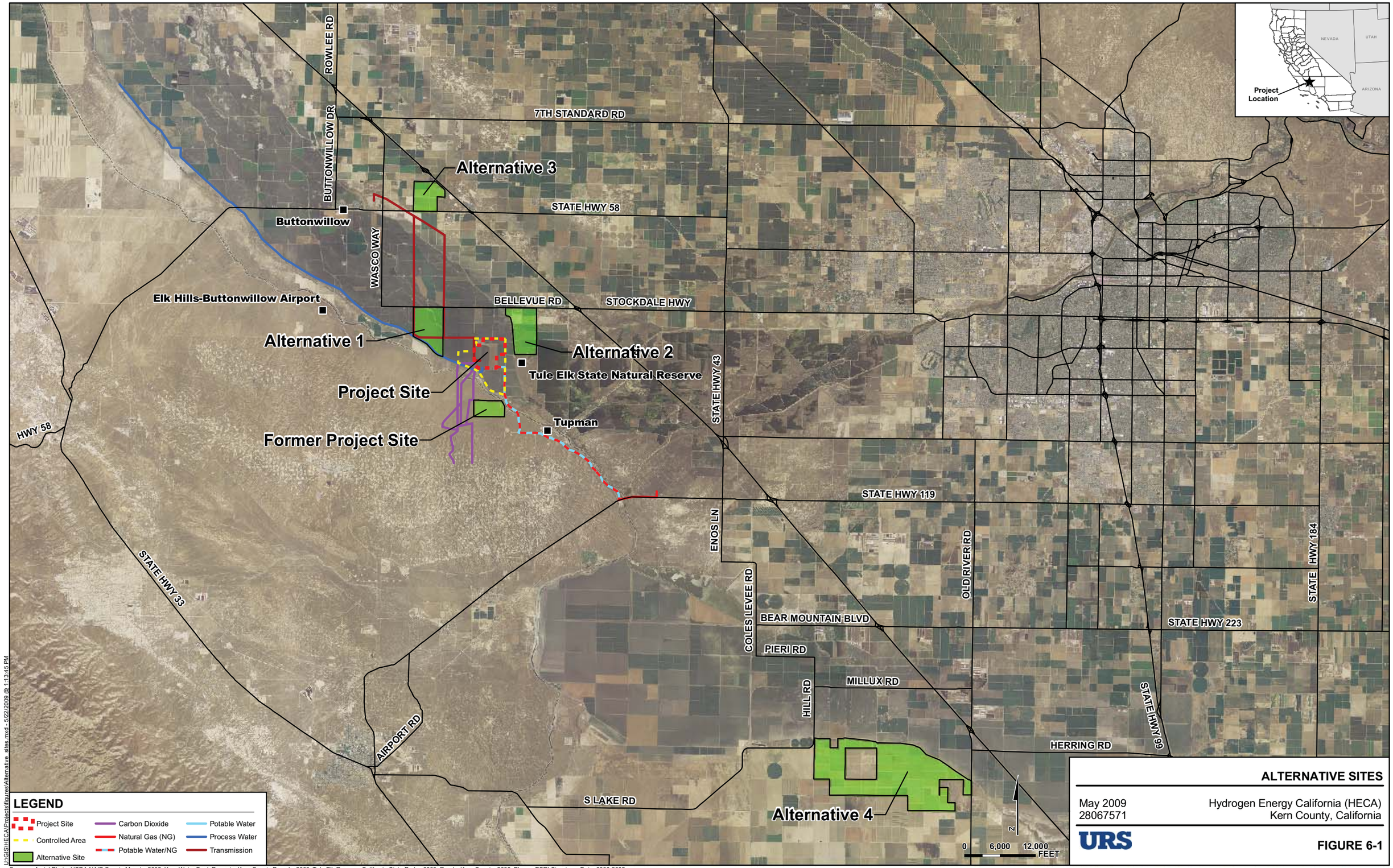
Source: HECA Project

Notes:
LORS = laws, ordinances, regulations, and standards
N/A = not applicable as alternative failed fatal flaw test
O&M = operation and maintenance
WWTP = wastewater treatment plant
ZLD = zero liquid discharge

Lifecycle costs for ZLD are roughly similar to a DWI system. However, ZLD is more straightforward from a commercial perspective in comparison to DWI. On the basis of similar costs, and ease of commercial arrangements, the proposed project includes a ZLD system for disposal of water treatment wastes and cooling tower blowdown.

6.8 REFERENCES

California Energy Commission, 2007. *2007 Integrated Energy Policy Report.* Report Number CEC-100-2007-008-CMF-ES



Sources: Aerial Photo, USDA NAIP County Mosaic, 2005; Kern Water Bank Property, Kern County Parcels, 2008; Tule Elk Reserve, California State Parks, 2008; Roads, Kern County, 2008; Places, ESRI Streetmap Data, 2000-2005.

ALTERNATIVE SITES

May 2009
28067571

Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE 6-1

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. 0 Date ____

Technical Area: **Alternatives** Project: ____ Technical Staff: ____

Project Manager: ____ Docket: ____ Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (b) (1) (D)	A description of how the site and related facilities were selected and the consideration given to engineering constraints, site geology, environmental impacts, water, waste and fuel constraints, electric transmission constraints, and any other factors considered by the applicant.	Section 6.3, p. 6-3 Section 6.5, p 6-8		
Appendix B (f) (1)	A discussion of the range of reasonable alternatives to the project, or to the location of the project, including the no project alternative, 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 an evaluation of the comparative merits of the alternatives. In accordance with Public Resources Code section 25540.6(b), a discussion of the applicant's site selection criteria, any alternative sites considered for the project, and the reasons why the applicant chose the proposed site.	Section 6.2, p. 6-2 Section 6.3, p. 6-3 Section 6.5, p. 6-8		
Appendix B (f) (2)	An evaluation of the comparative engineering, economic, and environmental merits of the alternatives discussed in subsection (f)(1).	Section 6.2, p. 6-2 Section 6.3, p. 6-3 Section 6.5, p. 6-8		