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Responses to PSA/DEIS Information Requests, Set 1

Amended Application for Certification for HYDROGEN ENERGY CALIFORNIA (08-AFC-8A) Kern County, California

Prepared for:
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hydrogen energy california

Submitted to:

California Energy Commission

U.S Department of Energy

Prepared by:

URS

August 2013

RESPONSES TO PSA/DEIS INFORMATION REQUESTS

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LIST OF ACRONYMS AND ABBREVIATIONS USED IN RESPONSES

AF	Availability Factor
AFC	Application for Certification
AGR	acid gas removal
ASU	air separation unit
BACT	Best Available Control Technology
BTU/hr	British thermal units per hour
BVWSD	Buena Vista Water Storage District
CAISO	California Independent System Operator
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CCS	carbon capture and storage
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPUC	California Public Utilities Commission
CT	combustion turbine
CTG	combustion turbine generator
DEIS	Draft Environmental Impact Statement
DESCP	Drainage, Erosion and Sediment Control Plan
DOE	U.S. Department of Energy
EAF	Equivalent Availability Factor
EHOF	Elk Hills Oil Field
EOR	enhanced oil recovery
EPS	emission performance standard
°F	Fahrenheit
FDOC	Final Determination of Compliance
FEIS	Final Environmental Impact Statement
FSA	Final Staff Assessment
GHG	greenhouse gas
GS	gasification solids
HDD	horizontal directional drilling
HECA	Hydrogen Energy California
HRSG	heat-recovery steam generator
IGCC	integrated gasification combined-cycle
ISDD	Intermediate Storm Design Discharge
lb/MWh	pounds per megawatt-hour
LHV	lower heating value
LTGC	low-temperature gas cooling
MHI	Mitsubishi Heavy Industries
MMBtu/hr	million British thermal units per hour
MW	megawatts
MWh	megawatt-hour
MWh/yr	megawatt-hour per year
OEHI	Occidental of Elk Hills, Incorporated
petcoke	petroleum coke
PSA	Preliminary Staff Assessment
PSA	Pressure Swing Adsorption
RWQCB	Regional Water Quality Control Board

SB	Senate Bill
SJVAPCD	San Joaquin Valley Air Pollution Control District
SO_X	sulfur oxides
SRU	sulfur recovery unit
ST	steam turbine
STLC	Soluble Threshold Limit Concentration
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
syngas	synthesis gas
TCLP	Toxicity Characteristic Leaching Procedure
TTLC	Total Threshold Limit Concentration
UAN	urea ammonium nitrate
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
ZLD	zero liquid discharge

Introduction

The California Energy Commission (CEC) and U.S. Department of Energy (DOE) issued the Preliminary Staff Assessment (PSA)/Draft Environmental Impact Statement (DEIS) for the Hydrogen Energy California Project (08-AFC-8A) on June 28, 2013. CEC Staff identified additional information that they feel is needed from the Applicant to finalize their analyses and prepare the Final Staff Assessment (FSA)/Final Environmental Impact Statement (FEIS). These additional information requests are summarized in the Executive Summary, as well as in individual technical sections of the PSA/DEIS. Executive Summary – Table 2 identified 13 technical areas for which Staff requested additional information. In addition, the Applicant is providing additional clarification related to Visual Resources and Alternatives.

Hydrogen Energy California (HECA), the Applicant, herein provides responses to the PSA/DEIS information requests related to air quality; biological resources; carbon sequestration and greenhouse gas emissions; cultural resources; land use; soil and surface water; traffic and transportation; waste management; geology and paleontology; power plant efficiency; power plant reliability; transmission system engineering and alternatives. A tracking number has been assigned to each of the information requests for reference. HECA will be submitting additional responses for the remaining information requests by the end of August 2013.

ENVIRONMENTAL ASSESSMENT

Technical Area: Air Quality

INFORMATION REQUEST

AQ-1. Staff requires the following information to complete the FSA/FEIS.

- ***A revised emissions estimate for HECA that matches the current project description, including but not necessarily limited to: the removal of the ammonia product shipping emissions; and the addition of the limestone fluxant. The revised emissions estimate should include the shipping, handling, and storage emissions from the fluxant and should address the shipping emissions for potential alternative shipping locations for the gasifier solids that have been provided to staff in other data responses.***

RESPONSE

Revised emissions reflecting the current project description are provided in the Updated Emissions and Modeling Report, docketed with the CEC on May 20, 2013 (see Docket Number 70895). Criteria pollutants and transportation emissions are addressed in Appendix A, Revised Operational Criteria Pollutant Emissions; Appendix C, Revised Operational Transportation Emissions for Alternative 1; and Appendix D, Revised Operational Transportation Emissions for Alternative 2.

The Project has commissioned a study of the potential for beneficial use of the gasification solids (GS), which includes identification of potential off-takers for the GS. That completed study is included in Attachment WM-2-1 of this response. The study confirms the suitability of the GS for beneficial use at locations consistent with the information on shipping locations that was presented in Appendices C and D to the Updated Emissions and Modeling Report.

INFORMATION REQUEST

AQ-2. Staff requires the following information to complete the FSA/FEIS.

- ***The applicant provided Energy Commission staff with updated operating data in an e-mail message for a telephone conference held May 10, 2013. During that conference, the applicant requested Energy Commission staff to prepare a set of written questions on this updated operating data so that they could respond completely to Energy Commission staff needs. These questions cover air quality, carbon sequestration and facility reliability topics. They are listed in the Carbon Sequestration and Greenhouse Gas Emissions Section because most of them relate to that topic.***

RESPONSE

These questions were included as Information Request CS-7 in the Carbon Sequestration and Greenhouse Gas Emissions section of the PSA/DEIS, and have been answered below under that section.

INFORMATION REQUEST

AQ-3. Staff requires the following information to complete the FSA/FEIS.

- ***The District's FDOC that addresses staff's comments on the PDOC, including but not limited to: the need to provide conditions for the limestone fluxant receiving and handling; the addition of federal MATS regulation conditions; and the inconsistencies regarding the SO_X for PM interpollutant offset ratio.***

RESPONSE

The San Joaquin Valley Air Pollution Control District (SJVAPCD) Final Determination of Compliance (FDOC) was released on July 8, 2013 and docketed with the CEC on July 16, 2013. It includes conditions for fluxant handling, mercury and air toxics standards compliance, and discussion of the sulfur oxides (SO_X) for particulate matter interpollutant offset ratio.

Technical Area: Biological Resources

INFORMATION REQUEST

BIO-2. Additional focused protocol-level botanical surveys (CDFG 2009) along all linear routes and additional baseline botanical data, primarily the proposed carbon dioxide pipeline route;

RESPONSE

HECA attempted to conduct protocol-level botanical surveys in 2012 and again in 2013. During both years, the low precipitation totals prevented the completion of the surveys. The target species are all annual species that germinate only in years when the timing and quantity of precipitation is adequate. During 2012 and 2013, protocol surveys were canceled after HECA biologists conducted visits to reference populations of the target species and concluded that the species were not evident or identifiable. Focused, protocol-level botanical surveys are proposed to be conducted in spring 2014. Due to the seasonal timing requirements of these surveys, the results will not be available until after the anticipated issuance of the FSA. HECA will develop mitigation measures in coordination with the CEC and Occidental of Elk Hills, Incorporated (OEHI); these measures will address potential occurrences of special status plant species, if they are detected during the planned botanical surveys, to ensure that significant impacts to special-status plant species are avoided or mitigated to less-than-significant levels.

INFORMATION REQUEST

BIO-3. Extent of CDFW Section 1600 jurisdiction and impacts to state waters (ephemeral drainages) in the project area, including all linear routes and ephemeral drainages that may occur along the proposed carbon dioxide pipeline route;

RESPONSE

The extent of California Department of Fish and Wildlife (CDFW) Section 1600 jurisdiction and impacts to state waters is described in the application submitted to the CDFW on May 2, 2013, and docketed with the CEC on May 3, 2013. CDFW is currently reviewing the application.

INFORMATION REQUEST

BIO-4. Extent of U.S. Army Corps of Engineers Section 404 jurisdiction in the project area and impacts to Waters of the U.S.;

RESPONSE

The extent of U.S. Army Corps of Engineers (USACE) Section 404 jurisdiction in the project area and of anticipated impacts to Waters of the United States was submitted as part of the USACE Nationwide Permit Pre-Construction Notification package. This was submitted to the USACE on March 6, 2013, and docketed with the CEC on March 7, 2013. A site visit with Jason Deters of the USACE was conducted on June 19, 2013.

Additional jurisdictional delineation information from OEHI was provided to the USACE on July 30, 2013, and docketed with the CEC on August 1, 2013. The USACE is currently reviewing the OEHI submittal. HECA will provide an update to Staff once additional information becomes available from the USACE.

Technical Area: Carbon Sequestration and Greenhouse Gas Emissions

OVERVIEW OF ALLOCATION OF CARBON DIOXIDE EMISSIONS FOR DETERMINING COMPLIANCE WITH THE EMISSION PERFORMANCE STANDARD (SB 1368)

1.0 PURPOSE

The purpose of this overview is to provide further information for the responses to the Carbon Sequestration and Greenhouse Gas Information Requests. It includes the rationale, structure, and calculations to allocate the greenhouse gas (GHG) attribute among the principle product streams for the purpose of calculating the Senate Bill (SB) 1368 emission performance standard (EPS).

HECA, and the associated enhanced oil recovery (EOR) at Elk Hills Oil Field (EHOF) by OEHI, is a multifaceted industrial project. Power production is just one aspect of this project; fertilizer and carbon dioxide (CO_2) for EOR are two other key products.

The electricity and agricultural fertilizers produced by HECA use techniques that result in very low GHG emissions. This low-carbon footprint is accomplished by capturing more than 90 percent of the CO_2 in the synthesis gas (syngas) and transporting CO_2 for use in EOR at EHOF, which results in simultaneous sequestration (storage) of the CO_2 in a secure geologic formation. As an integrated gasification combined-cycle (IGCC) and polygeneration facility, the HECA power plant and agricultural fertilizer manufacturing complex are highly integrated with units that exchange products, electricity, steam, fuel, water, and other utilities within the complex.

As we describe below, casting a wide net to include emissions and power consumption from sources *not directly involved in power production* is inconsistent with SB 1368, and will create the illusion that use of carbon capture and storage (CCS) for an IGCC power plant is more GHG-intensive than a natural gas power plant without CCS, which is not accurate. SB 1368 limits the applicable CO_2 emissions to those directly involved in electricity production. Although we recognize that Staff is attempting to conservatively complete its consistency review of laws, ordinances, regulations, and standards for SB 1368, an overly broad interpretation of what CO_2 emissions are to be included will set an adverse precedent that could discourage further development of power generation projects with CCS by EOR in California. Specifically, an artificially high EPS that is essentially equal to that of a natural gas power plant without CCS would remove any incentives to develop such a facility. If the power being sold does not have a lower CO_2 footprint than existing natural gas plants, any incentive for public utilities to buy that power, and therefore for developers to build that plant, has been removed.

Moreover, inclusion of emissions and power consumption from sources associated with production of industrial products, such as fertilizer, will discourage polygeneration facilities that are inherently energy efficient, discouraging viable GHG reduction options. Section 2 of this document explains the background of CCS, the HECA facility, and how CO_2 emissions are directly related to the flow of syngas. Section 3 describes the applicable CO_2 emissions and allocation of these CO_2 emissions to sources within the HECA facility. Section 4 describes the facility's GHG limit, and Section 5 describes the reporting and verification methodology for ensuring compliance with SB 1368.

2.0 BACKGROUND

2.1 Applicable CO_2 Emissions under SB 1368

SB 1368 directed the CEC, in consultation with the California Public Utilities Commission (CPUC) and the California Air Resources Board (CARB), to establish a GHG EPS for all baseload generation of local publicly owned electric utilities at a rate of emissions of GHGs that is no higher than the rate of emissions of GHGs for combined-cycle natural gas baseload generation (Perata, 2006; Chapter 598). SB 1368 precludes utilities from procuring power under a long-term contract that has a CO_2 attribute higher than 1,100 pounds of CO_2 per megawatt-hour (MWh).

SB 1368 expressly limits the applicable CO_2 emissions for purposes of determining compliance. SB 1368, which adopted Sections 8340 and 8341 of the Public Utilities Code, explicitly limits the applicable CO_2 emission to "the net emissions *resulting from the production of electricity by the baseload generation*."[1] The definition of "baseload generation" incorporates the definition of "powerplant," which means "a facility for the generation of electricity, and includes one or more generating units at the same location." Moreover, "[c]arbon dioxide that is injected in geological formations, so as to prevent releases into the atmosphere, in compliance with applicable laws and regulations, shall not be counted as emissions of the powerplant in determining compliance with the greenhouse gases emissions performance standard."[2] Emissions or power associated with the CO_2 injection into geological formations (sequestration) are included in the EPS. Specifically, HECA has included the emissions from the CO_2 vent and the power used by the CO_2 compressor for sequestration, but not the additional emission and power needed for EOR processes, in the calculations outlined in subsequent sections.

There is little ambiguity under SB 1368 about which CO_2 emissions apply. The CO_2 emissions are limited to emissions resulting from the production of electricity at a baseload powerplant, which is narrowly defined to include the generating facility. SB 1368 does not expressly or impliedly cover CO_2 emissions from nonpowerplant sources. Nothing in SB 1368 expressly or impliedly supports that CO_2 emissions from EOR activities or an interrelated manufacturing complex would be included in the compliance calculation.

The CEC's own regulations implementing SB 1368 reinforce this conclusion. The CEC regulations state that "a powerplant's annual average CO_2 emissions are the amount of CO_2 produced on an annual average basis by each fuel used in any component *directly involved in electricity production* [emphasis added]. Fuels used in ancillary equipment, including, but not limited to, fire pumps, emergency generators, and vehicles shall not be included."[3] The CEC regulations also describe that "a powerplant's annual average electricity production in MWh shall be the sum of the net electricity available for all of the following: use onsite or at a host site in a commercial or industrial process or for sale or transmission from the powerplant."[4]

Based on a plain read of the CEC regulations, the applicable CO_2 emissions are limited to those *directly involved in electricity production*. Ancillary emissions are not applicable.

Applying the clear standard of SB 1368 and the CEC regulations to HECA evidences that CO_2 emissions from sources involved in power production (e.g., turbine/heat-recovery steam generator [HRSG]) and sequestration (e.g., CO_2 vent) should count towards the compliance calculation.

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1 Public Utilities Code Sections 8341(d)(2) and 8341(e)(3) (emphasis added).
2 Public Utilities Code Sections 8341(d)(5) and 8341(e)(6).
3 Title 20, California Code of Regulations, Section 2904(a).
4 Title 20, California Code of Regulations, Section 2904(b).

CO_2 emissions from sources not directly related to the generation of electricity, such as the Manufacturing Complex and EOR facilities, should not be included in the compliance calculation. The evaluation of HECA's CO_2 emissions is further explained in subsequent sections.

As noted in the information provided in SB 1368 and the implementation guide, the standard regulates CO_2 emissions from power production and associated with the process of geological sequestration. It does not regulate emissions or associated power use from commercial or manufacturing processes. It also does not regulate emissions or associated power use from products used at the power generation facility.

Because the standard does not regulate CO_2 emissions from the Manufacturing Complex or the production of oil at EHOF, it is necessary to separate the CO_2 emissions associated only with the export of electricity to the California Independent System Operator (CAISO) grid. This document quantifies the allocation of CO_2 emissions from power, the CO_2 product stream, and fertilizer production. All of the energy and GHG emissions associated with the sequestration of CO_2 (e.g., production, recovery, compression, and transportation) are included and allocated to either the production of electricity or agricultural fertilizers based on how the syngas is used, for computation of the SB 1368 EPS. CO_2 emissions and power requirements for EOR purposes and fertilizer production are not included in the computation of the SB 1368 EPS, because these are separate industrial processes.

A natural gas power plant is not required to include the power necessary to pump water to the facility for cooling purposes, nor is it required to include the power needed to extract, treat, and pump the natural gas to the site, because these are products used by the facility. Therefore, emissions and power requirements for products used at HECA, such as oxygen from the air separation unit (ASU), are not included in the computation of the SB 1368 EPS.

2.2 Carbon Capture and Storage

EOR using CO_2 is widely recognized as the best platform for the early demonstration of commercial-scale CCS.

On February 3, 2010, President Obama established an Interagency Task Force on CCS co-chaired by the DOE and the U.S. Environmental Protection Agency (USEPA). In his memorandum the President said, "Rapid commercial development and deployment of clean coal technologies, particularly CCS, will help position the United States as a leader in the global clean energy race" (Obama, 2010). The President also issued this directive: "The Task Force shall develop … a proposed plan to overcome the barriers to the widespread, cost-effective deployment of CCS within 10 years, with a goal of bringing 5 to 10 commercial demonstration projects online by 2016" (Obama, 2010). HECA is one of the projects designated by the task force.

Key findings from the CCS Task Force report are: CCS is viable; a carbon market is critical to developing CCS; federal agency action is needed, both with regulatory and financial support; and long-term stewardship needs to be strengthened while limiting long-term liability. The report also noted that "some of this cost [for developing CCS] could be offset by the use of CO_2 for EOR for which there is an existing market" (CCS Task Force, 2010).

More recently, on June 25, 2013, President Obama issued his Climate Action Plan, which pledges to reduce GHG emissions and combat climate change. To cut carbon pollution in America, the plan encourages federal investments in projects that can avoid, reduce, or sequester anthropogenic emissions of GHGs, including clean coal technologies (Obama, 2013).

Recognizing the importance of CCS for California's industrial and electricity sectors, the CEC, CPUC, and CARB formed the CCS Review Panel, which concluded that "there is public benefit from long-term geologic storage of CO_2 for reducing GHG emissions" (California CCS Review Panel, 2010a). The panel had the following findings:

- "CCS is a technology that may need to be deployed on a significant scale to curb CO_2 emissions from power plants and industrial sources."
- "For power plants that do not use natural gas, it [CCS] is also the only option for meeting CO_2 emission limits under the Emissions Performance Standard established in 2006 under Senate Bill 1368."
- "CCS is recognized as a compliance option under the implementing rules for the Emissions Performance Standard under SB 1368 by the CPUC and the Energy Commission."

The CCS Review Panel's technical report found that "permitting CO_2 injection for EOR and sequestration is arguably consistent with DOGGR's dual mandate to increase the recovery of oil and gas resources within the state and protect the environment. California permitting agencies are developing this approach for the proposed [OEHI] CO_2-EOR project associated with the proposed Hydrogen Energy California (HECA) project" (California CCS Review Panel, 2010b).

The President, along with many federal and state agencies including the CEC, has recognized that CCS has significant potential as an effective way to reduce GHG emissions from electricity generators. Many studies found that CCS would not happen without additional financial incentives such as EOR.

As noted in Section 3.1, CO_2 emissions and power requirements for EOR purposes should not be included in computation of the SB 1368 EPS, because this is a separate industrial process. The EPS is for power generation only. Inclusion of CO_2 emissions and power consumption from the EOR process in the EPS would increase the pounds per megawatt-hour (lb/MWh) value significantly, which would remove the incentive for power projects to choose EOR for CCS in California.

2.3 HECA Facility

The HECA Project produces electricity and agricultural fertilizers using hydrogen-rich gas that is produced using the energy contained in coal and petroleum coke (petcoke). Carbon found in these solid feedstocks is converted to CO_2 in a closed process that includes the gasification and shift reaction, and the CO_2 is subsequently removed for use in EOR, resulting in sequestration.

As noted by CEC staff in the PSA/DEIS, "the petcoke and coal are not directly used as fuels but rather as feedstock to make the fuel" (CEC, 2013; page 4.3-41). HECA agrees that the fuel for the turbine and subsequent power generation is hydrogen-rich fuel, not petcoke and coal. Hydrogen is one of the cleanest-burning fuels that can be combusted to generate electricity, especially with regard to particulate and GHG emissions. The HECA Project is revolutionary in the advancement of clean fuel production and electricity generation.

As indicated in the overall process flow diagram (Figure CS-1), the production of electricity and fertilizers occur in the Power Block and Manufacturing Complex, respectively. The Combined Cycle Power Block will generate more than 400 megawatts (MW) of gross power (dependent upon ambient conditions and the mode of operation), and will provide up to 300 MW output of low-carbon baseload electricity to the grid. The remaining power will be used on site to meet the facility's internal loads, and routed to the Manufacturing Complex for fertilizer manufacture. The Power Block will consist of:

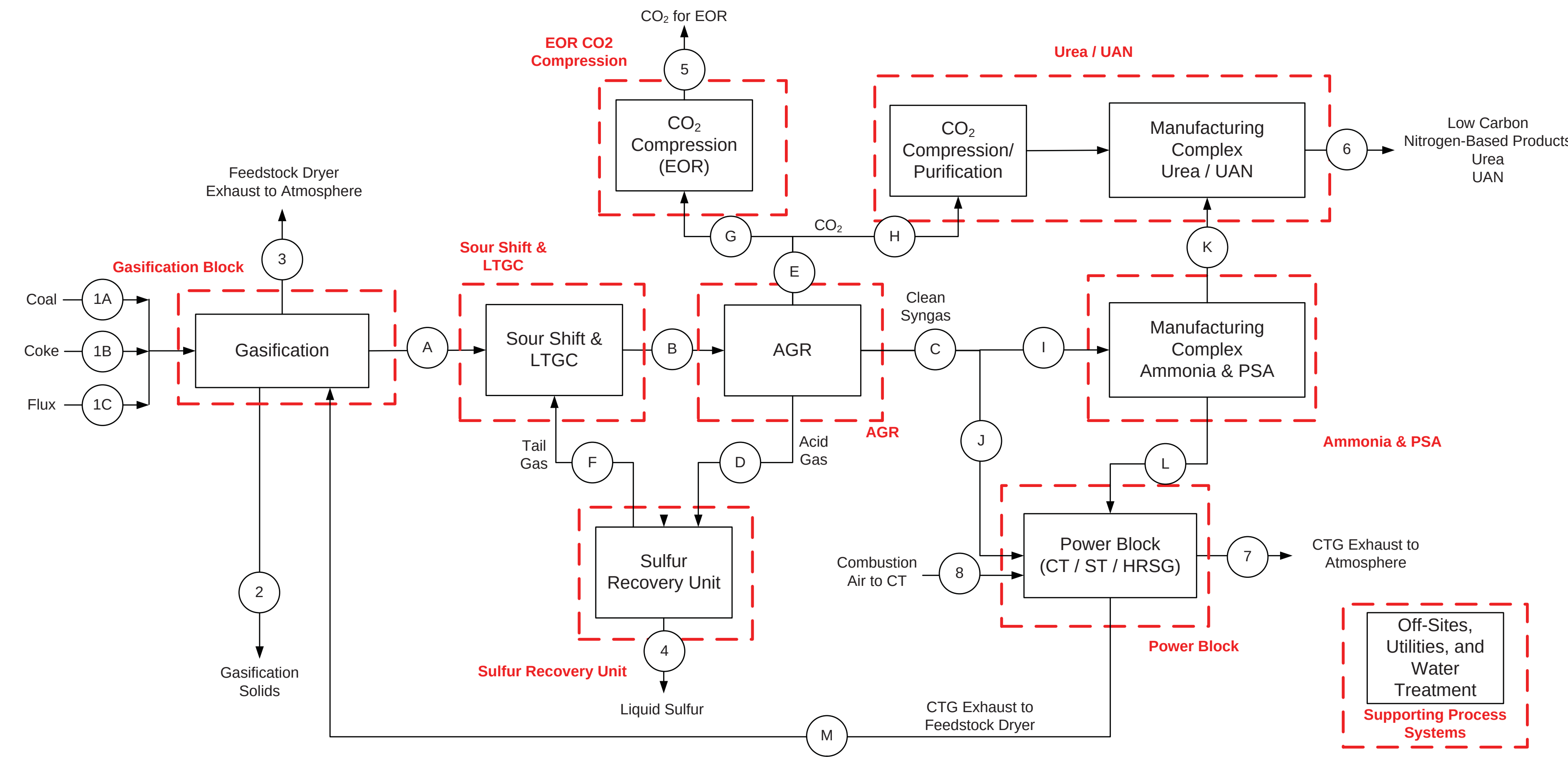
- One Mitsubishi Heavy Industries, Ltd. (MHI) 501GAC® combustion turbine generator (CTG) that will fire hydrogen-rich fuel from the gasification plant, and natural gas as a backup fuel;
- A HRSG with duct firing on a combination of hydrogen-rich fuel and Pressure Swing Adsorption (PSA) off-gas; and
- A condensing steam turbine (ST) generator.

The Manufacturing Complex is an integrated complex that will produce approximately 1 million tons per year of nitrogen-based products, including urea and urea ammonium nitrate (UAN) solutions for use in agricultural applications. The chemical composition of these products (Urea and UAN) are identical to those currently used in the agricultural industry and produced by other fossil fuel based technologies, except with corresponding lower GHG manufacturing emissions than other processes. The process units used in producing the low-carbon, nitrogen-based fertilizers are the PSA, Carbon Dioxide Purification and Compression, Ammonia Synthesis, Urea, Urea Pastillation and Storage, Nitric Acid, Ammonium Nitrate and UAN Units, and associated utilities.

One of the benefits of the HECA polygeneration facility is the integration of the different production units and the energy efficiency gained from this integration. The USEPA stated, in their March 2011 GHG Best Available Control Technology (BACT) guidance, that a more energy-efficient technology burns less fuel than a less energy-efficient technology to achieve the same output (USEPA, 2011). Therefore, considering the most energy-efficient technologies helps reduce the products of combustion, both GHGs and criteria pollutants.

2.4 HECA Conversion of Fossil Fuels to Hydrogen-rich Gas

CO_2 is produced when carbon in fossil fuel is reacted with oxygen in a gasification reaction. This reaction releases energy that is used to convert water into hydrogen and produce steam for the generation of electricity and for use by the process units. By choosing to use the gasification instead of a combustion reaction, fossil fuels are converted into hydrogen and CO_2 in a closed process where the process conditions are optimal to support the removal of CO_2 and impurities. In the Simplified Block Flow Diagram (Figure CS-1) the gasification, sour shift & LTCC, acid gas removal (AGR), sulfur recovery, and CO_2 compression are the units that perform these functions. All of these processes are used to covert solid fossil fuels into clean hydrogen-rich gas, and they have no direct GHG or other air emissions during steady-state operations and only minor, insignificant GHG emissions during start-up and shut-down from the flares, thermal oxidizer, and CO_2 vent. Their function of producing clean hydrogen-rich gas is common and supports both the Power Block and Manufacturing Complex. Because each of these common process units require electricity and/or steam to operate, a portion of the GHG emissions from the Power Block that is commensurate with their auxiliary power and steam use needs to be allocated to Electricity and Fertilizer products.



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SIMPLIFIED BLOCK FLOW DIAGRAM

July 2013
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Hydrogen Energy California (HECA)
Kern County, California

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FIGURE CS-1

2.5 CO_2 Allocation Needs to Follow the Hydrogen-Rich Gas Allocation and the Internal Consumption of Electricity and Steam

The small portion of carbon that is not captured from the hydrogen-rich gas becomes part of the fuel supplied to the gas turbine and HRSG, where it is eventually discharged to the atmosphere as part of the exhaust. Most of the HECA project CO_2 emissions are emitted from the gas turbine/HRSG exhaust. On average, 65 percent of the hydrogen-rich gas produced at HECA is combusted by the gas turbine/HRSG. The remaining 35 percent of syngas, on average, is used as feedstock in the manufacture of fertilizers.

As indicated previously, not all electricity produced by the Power Block is exported as electricity to the grid; auxiliary power is used by the Common units, Manufacturing Complex, CO_2 compression, and supporting process systems such as the water treatment plant. This creates a need to allocate the physical CO_2 emissions created at the Power Block back to units in proportion to their electricity use. This allocation is done along the lines of the hydrogen-rich gas allocation (65 percent to the production of electricity and 35 percent to the production of fertilizers). In the case of the water treatment power use, the allocation is based on water consumption.

3.0 ALLOCATION METHODOLOGY

The plant is divided into three sections: Common, Manufacturing Complex, and Power. The Common section produces clean syngas. The clean syngas flows to the Manufacturing Complex section and the Power section. The CO_2 emissions from the production of the syngas are allocated between the fertilizer production and power production according to the respective portion of clean syngas used. The allocation is performed on a lower heating value basis.

Gross power generation has been attributed to the Power Block, except for the portion of power generated which is attributable to the steam used by or produced by the Manufacturing Complex. Steam integration with the Manufacturing Complex increases the output of the ST above that which would be achieved without steam integration. The power attributable to steam integration with the Manufacturing Complex is noted and subtracted from the gross generator output to give the portion attributable to the Power Block.

The auxiliary loads are also segregated into the three sections noted above. The Common auxiliary loads are further allocated to Power or Manufacturing according to the portion of clean syngas used by the Power Block or fertilizer units.

Power net output is the gross generation allocation to power, less the auxiliary loads attributable to power. The Manufacturing Complex power consumption is the gross generation allocation to fertilizer, less the auxiliary loads attributable to fertilizer. The daily average net output of syngas fired power production was multiplied by 8,000 hours of operation per year to obtain the MWh of power produced per year. Natural-gas–fired power generation was calculated at 336 hours per year (2 weeks), times 300 MW net output. The total net power output is the sum of power generated from operation on syngas, plus power generated from operation on natural gas. Conservatively the net output does not include the power output during start-up or shut-down operations. In addition, the net output does not include the power use for the ASU. The ASU is owned by a third party and produces the oxygen and nitrogen that is used by HECA in the gasification process to produce the hydrogen-rich fuel. The oxygen and nitrogen from the ASU are purchased products that HECA will use in the operation of the facility, just like fluxant or water treatment chemicals, hence there is no basis for including the energy needed to produce these (or any other) products in the calculations.

The CO_2 emissions are split according to the respective portion of clean syngas used. The CO_2 emitted when burning natural gas in the turbine to produce power is allocated only to the Power section. The CO_2 emitted from the urea unit vent or when burning natural gas in the ammonia start-up heater is allocated only to the Manufacturing Complex. The remaining CO_2 emissions are considered Common, and split between the Power section and Manufacturing Complex.

The plant is designed to be operated in two modes of operation.

- Maximum Power Mode 16 hours out of 24
- Maximum Fertilizer Mode 8 hours out of 24

The gross power output, hydrogen-rich gas, and auxiliary loads all vary between the two modes of operation; thus, two operating mode allocations were made. In addition, like other combustion turbine (CT)-based power plants, the gross power output will vary with ambient temperature. To account for this, the annual average ambient temperature was used for the two operating mode allocations.

4.0 GHG EMISSIONS LIMIT

The removal of carbon and its subsequent use for urea production and for EOR ensures that the generation of electric power and nitrogen-based products starts from a very low-carbon syngas, ultimately substantially lowering the GHGs associated with the generation of these products.

HECA achieves low GHG emissions by using only hydrogen-rich fuel, or CPUC-regulated natural gas as backup fuel, to produce electricity, both of these fuels are recognized as low in carbon content. By restricting operation of the facility to low carbon fuels and limiting the quantity of CO_2 that may be vented during equipment down-time, the GHG performance of the HECA project is largely determined. A sensitivity analysis of this is presented in Section 5.0, Reporting/Verification Methodology.

In addition to removing sulfur from the syngas, the plant's AGR system will capture more than 90 percent of the carbon in the raw syngas during steady-state operation, and separate it into a high-purity CO_2 product stream. Because the CO_2 product from this facility is an integral part of the Project's economics, the plant will be designed to provide reliability of the purification and compression facilities needed to deliver it to the transfer point for use in EOR. However, it is not possible to guarantee 100 percent availability of the pipeline and EOR systems. The CO_2 stream will need to be vented during down-times, such as outages of the CO_2 compressor or pipeline; when OEHI is unable to accept the CO_2 stream; and during gasifier start-up and shut-down.

The discharge pressure provided by the HECA compressors is sufficient for transport *and* direct sequestration of CO_2 in the reservoir. Therefore, additional power needed for EOR activities at EHOF has not been included. The flow rate during periods of venting will be measured, and will be included in the HECA overall recordkeeping requirements under the Project's applicable CEC and SJVAPCD permits. In addition, venting quantities will be directly limited by conditions in the SJVAPCD permit.

Annual CO_2 emissions and power output were estimated for the three operating scenarios, as described below:

- **Early Operations –** expected to last approximately 2 years, during which time hydrogen-rich fuel availability will be approximately 65 to 75 percent. During this period, all sources are expected to be operated at maximum operating conditions, including two plant start-ups and shut-downs. The CO_2 vent is included, with maximum permitted venting emissions of up to 504 hours at full capacity. Power output includes 8,000 hours/year of syngas operation and 336 hours/year of natural gas operation.

- **Mature Operations –** expected to occur after the first 2 years of commercial operation, when the hydrogen-rich fuel availability will be approximately 85 percent. At this stage, significantly less venting is expected to occur; therefore, CO_2 vent emissions are estimated based on approximately 10 days of venting at 50 percent capacity (or 120 hours of venting at 100 percent capacity). All other sources are operated at maximum operating conditions, including two plant start-ups and shut-downs. Power output includes 8,000 hours/year of syngas operation and 336 hours/year of natural gas operation.

- **Steady-State Operations –** expected occur in the same time frame as mature operations; that is, after the 2 years of early operation. In this scenario, emissions are estimated based on maximum operating conditions, excluding start-ups, shut-downs, and CO_2 venting. Emissions from operation of the CTG/HRSG on syngas are included; no natural gas use is included. Power output includes 8,000 hours/year of syngas operation.

Table CS-1 compares the CO_2 emissions of the Project with the SB 1368 emission standard for the three scenarios. CO_2 emissions from the electricity production at HECA are approximately 150 lb/MWh during steady-state operations on hydrogen-rich fuel. The maximum CO_2 emissions during early operations, including emissions from natural-gas operation, start-up, shut-down, and CO_2 venting, would be approximately 300 lb/MWh. Detailed calculations are provided in Attachment CS-7-1.

Table CS-1
Annual CO_2 Emissions for SB 1368 Emission Performance Standard

Operating Parameter	Early Operations (Maximum Permitted)[1]	Mature Operations[2]	Steady-State Syngas Operations[3]
Total CO_2 Annual Emissions Attributable to Power Production (tons per year)	386,494	290,865	188,228
Net Power Output (MWh)	2,565,374	2,565,374	2,464,574
CO_2 EPS (lb/MWh)	301	227	153

Notes:

1 Early operations emissions include two periods of start-up and shut-down, natural gas use in the CTG, and 504 hours of CO_2 venting.

2 Mature operations emissions include two periods of start-up and shut-down, natural gas use in the CTG, and 120 hours of CO_2 venting.

3 During steady-state operation, the CTG and duct burners will fire only hydrogen-rich fuel and PSA off-gas; no start-ups and shut-downs, no natural gas backup use, and no CO_2 venting.

CO_2 = carbon dioxide
CTG = combustion turbine generator
EPS = emission performance standard
MWh = megawatt-hour
lb/MWh = pounds per megawatt-hour
syngas = synthesis gas

5.0 REPORTING/VERIFICATION METHODOLOGY

5.1 Differences between Natural Gas Power Plants

The potential for GHG emissions is much different for an IGCC plant with CCS, such as the HECA Project, than for a natural gas power plant. In a carbon capture setting, the level of GHG capture has the largest effect on potential GHG emissions. As the carbon content of the fuel is lowered, increases in energy efficiency do not provide the same incremental reduction in GHG emissions, and no benefit in the case where carbon is completely removed from the fuel. A comparison of the impacts from carbon capture and energy efficiency to major project sources is shown in Table CS-2. HECA expects to remove greater than 90 percent of the carbon from fuel, and this reduces GHG emissions well below that of a comparable natural gas power plant.

Table CS-2
Hypothetical Change in CO_2 Emissions with Small Changes to Project Sources

Change	CO_2 Emissions Impact (Tonnes per year)	Change in Plant-Wide CO_2 Emissions (percent)
1 percent change in CO_2 capture rate in syngas production	35,000	6.60
1 percent change in Gas Turbine efficiency	1,600	0.30
1 percent change in Auxiliary boiler efficiency	90	0.02

Notes:
CO_2 = carbon dioxide
syngas = synthesis gas

There are several variables that directly affect the majority of the potential GHG emissions from this type of facility:

- The amount of carbon remaining in the hydrogen-rich gas delivered to the CT and HRSG.
- The quantity of CO_2 that must be vented due to equipment down-time.
- The quantity of higher carbon content natural gas fuel that is used.

As shown in Table CS-2, a small reduction in CO_2 capture rate has a large impact on the overall CO_2 emission profile of the project. This is why SJVAPCD has written conditions to enforce the 90 percent capture rate and limit CO_2 venting. It is appropriate to recognize the differences between IGCC with CCS and natural gas facilities when preparing emissions monitoring and reporting requirements.

In the HECA facility itself, one can see the difference in carbon footprint between IGCC with CCS and natural gas without CCS. Because the facility runs on natural gas as a backup fuel, emissions and power production from both syngas and natural gas can be compared. When running on natural gas, no carbon is captured upstream of the CT and it is all part of the fuel combusted then released to the atmosphere. Table CS-3 shows what the EPS would be if only the natural gas backup fuel is combusted in the turbine, using data that can be found in Attachment CS-7-1. The EPS during steady-state operations on hydrogen-rich fuel is approximately 150 lb/MWh, significantly lower than during natural gas only combustion.

Table CS-3
Estimation of EPS from Natural Gas Backup Fuel

Emissions/Generation	Natural Gas
Turbine CO_2 Emission (pounds per year)[1]	98,582,000
Annual Net Generation (MWh per year)[1]	100,800
EPS (pounds CO_2 per MWh)	978

Notes:
[1] Data can be found in Attachment CS-7-1.
CO_2 = carbon dioxide
EPS = emission performance standard
MWh = megawatt-hour

5.2 Monitoring and Verification

The overwhelming majority of GHG emissions in the HECA project can be monitored and controlled at just a few key points. The following paragraphs describe how HECA intends to monitor and report GHG performance on the HECA project.

GHG emission sources have been placed into two groups. The first group (Group 1) includes major GHG sources that will have composition measurement and metering in place to track the flow of carbon and GHG emissions for the major GHG emissions sources. Miscellaneous small and relatively constant sources that are not practicable to measure are listed in Group 2, and these should be handled using an emission factor method. The methods listed below are in line with the conditions included in the SJVAPCD FDOC.

Group 1 – Large Emission Sources

- All hydrogen-rich gas combustion sources (CGT, HRSG duct burners, flares, etc.);
- CO_2 Vent;
- Turbine operation on natural gas; and
- Auxiliary Boiler.

Monitors to Verify Carbon Capture Percentage

- Syngas gas chromatograph in place to measure carbon monoxide (CO), CO_2, and methane concentrations upstream of the AGR;
- AGR effluent gas chromatograph provided to measure CO, CO_2, and methane concentrations in hydrogen-rich gas exiting AGR; and
- Syngas flow rate measured and calculation provided to establish capture percentage.

Monitors to Verify Turbine, Duct Fuel, Flares, and Fertilizer Plant GHG Emissions

- AGR effluent gas chromatograph provided to measure CO, CO_2 and methane concentrations in the hydrogen-rich gas exiting the AGR; and

- Hydrogen-rich gas flow measurement provided and used to calculate total carbon mass flow. Carbon component mass flows converted to CO_2 stoichiometrically for reporting as carbon dioxide equivalent (CO_2e) emissions.

Monitors to Verify CO_2 Vent GHG Emissions

- CO_2 vent flow rate metering provided;
- CO_2 custody transfer meter analysis can be used and/or CO_2 vent grab sampler to provide CO_2 concentration; and
- Calculate and report CO_2e emissions.

Monitors to Verify Natural-Gas-Related GHG Emissions

- Measure the purchased natural gas usage at the natural gas custody transfer meter to calculate and report CO_2e emissions for the following equipment:

  a. Gas Turbine Backup Operations on natural gas;
  b. Auxiliary boiler;
  c. Flare pilots; and
  d. Other miscellaneous equipment.

Group 2 – Miscellaneous GHG Emission Sources

- Fugitives; and
- SF6 gas circuit breaker insulation fugitives.

These sources would be reported using standard fugitive emission factors and measured content of gas streams associated with process fugitives.

Monitoring of the power use in the site and power generation to the grid is an integral part of the HECA design to ensure efficient operation of the facility. For SB 1368 demonstration purposes, power use and generation will be recorded and presented annually in the requested compliance monitoring plan.

6.0 CONCLUSION

There is general agreement amongst federal and state agencies, including the CEC, that CCS is an effective way to reduce GHG emissions from electricity generators, and that EOR is a cost-effective way to implement CCS. Energy efficiency is also an effective way to reduce GHG emissions.

HECA is a first-of-its-kind facility in California, and the CEC should consider the implications of developing accurate calculations techniques for enforcing the SB 1368 EPS. If CO_2 emissions and power consumption from sources not directly involved in power production are included in this calculation, CCS by EOR and polygeneration facilities may chose not to locate in California.

Based on the clear requirements of SB 1368 and the CEC regulations, only sources directly related to power production and sequestration of CO_2 are regulated by the EPS. CO_2 emissions and power requirements for EOR purposes should not be included in computation of the SB 1368 EPS, because EOR is a separate industrial process that does not fall within the sources of CO_2 emissions contemplated by SB 1368. That EOR is a separate process is further evidenced by the fact that OEHI has been conducting EOR, and has conducted a pilot test EOR with CO_2, in the absence of the HECA project. CO_2 emissions and power requirements for fertilizer production should not be included in computation of the SB 1368 EPS, because this is a separate industrial process. CO_2 emissions and power requirements for products used at HECA should not be included in the computation of the SB 1368 EPS.

Inclusion of CO_2 emissions and power consumption from the EOR process, fertilizer production, and products used at HECA in the EPS would increase the lb/MWh value significantly and ensure that no power project would chose EOR for CCS or develop a polygeneration facility in California. Proper calculation of the EPS shows that the HECA facility will be well below the EPS, at approximately 150 lb CO_2/MWh during steady-state operations on hydrogen-rich fuel.

7.0 REFERENCES

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INFORMATION REQUEST

CS-2. A complete electrical energy balance estimate for HECA that includes the complete gross electrical production and complete parasitic load for the plant by major functional area, including the air separation unit, in MWh for both hydrogen rich fuel and natural gas operation. Staff cannot complete its determination of compliance with the SB 1368 EPS without this information.

RESPONSE

Much of this information can be found in the response to Information Request CS-7. An electrical energy balance by major functional area is presented in Figure CS-7-3, On-Peak and Off-Peak Block Flow Diagram of Auxiliary Loads. Parasitic load from the ASU in On-Peak and Off-Peak operation is presented in Table CS-7-4, ASU Auxiliary Loads. Net power output (MWh) for early, mature, and steady-state syngas operations is presented in Table CS-7-3, SB1368 Emission Performance Standard.

INFORMATION REQUEST

CS-3. A revised greenhouse gases emissions estimate for HECA that matches the current project description, including but not necessarily limited to: the removal of the ammonia product shipping emissions; the addition of the limestone fluxant shipping and use; and that addresses the shipping emissions for potential alternative shipping locations for the gasifier solids.

RESPONSE

Revised GHG emissions reflecting the current project description are provided in the Updated Emissions and Modeling Report (Appendix E, Revised Operational Greenhouse Gas Emissions), docketed with the CEC on May 20, 2013.

The Project has commissioned a study of the potential for beneficial use of the GS, which includes identification of potential off-takers for the GS. That completed study is included in Attachment WM-2-1 of this response. The study confirms the suitability of the GS for beneficial use at locations consistent with the information on shipping locations that was presented in Appendices C and D to the Updated Emissions and Modeling Report.

INFORMATION REQUEST

CS-4. The District's FDOC that addresses staff's comments on the PDOC, specifically revising the combined-cycle power generating permit unit condition 86 to be based on the District's CO_2 BACT determination rather than the SB 1368 EPS.

RESPONSE

The SJVAPCD FDOC was released on July 8, 2013 and docketed with the CEC on July 16, 2013. Conditions for Permit Unit 26 have been revised to reflect the District's GHG BACT determination.

INFORMATION REQUEST

CS-6. Please provide information detailing how the applicant would comply with the proposed allowable CO_2 venting hours without a back-up CO_2 injection zone.

RESPONSE

The project would comply by shutting the plant down if the venting limit is reached and additional venting was needed.

BACKGROUND

Since the Amended AFC was filed there have been a number of changes to project design including a change to the power output of the combustion turbine, the addition of fluxant to the gasification process and the discontinuation of exporting ammonia as a stand-alone product. In addition, the applicant presented revised SB 1368 emission calculations in an e-mail sent to staff on May 10, 2013. Therefore Energy Commission staff needs additional information to revise air quality and greenhouse gas (GHG) emissions for consistency with the assumptions and data provided in these new calculations and to account for all revisions to the project design and operation assumptions that have occurred since the Amended AFC was submitted. The following information is still needed to complete the analysis for the Final Staff Analysis/Final Environmental Impact Report. Some of the terms below such as “Power,” “Fertilizer,” and “Common” refer to computations in the new material presented in spreadsheets provided by e-mail on May 10, 2013.

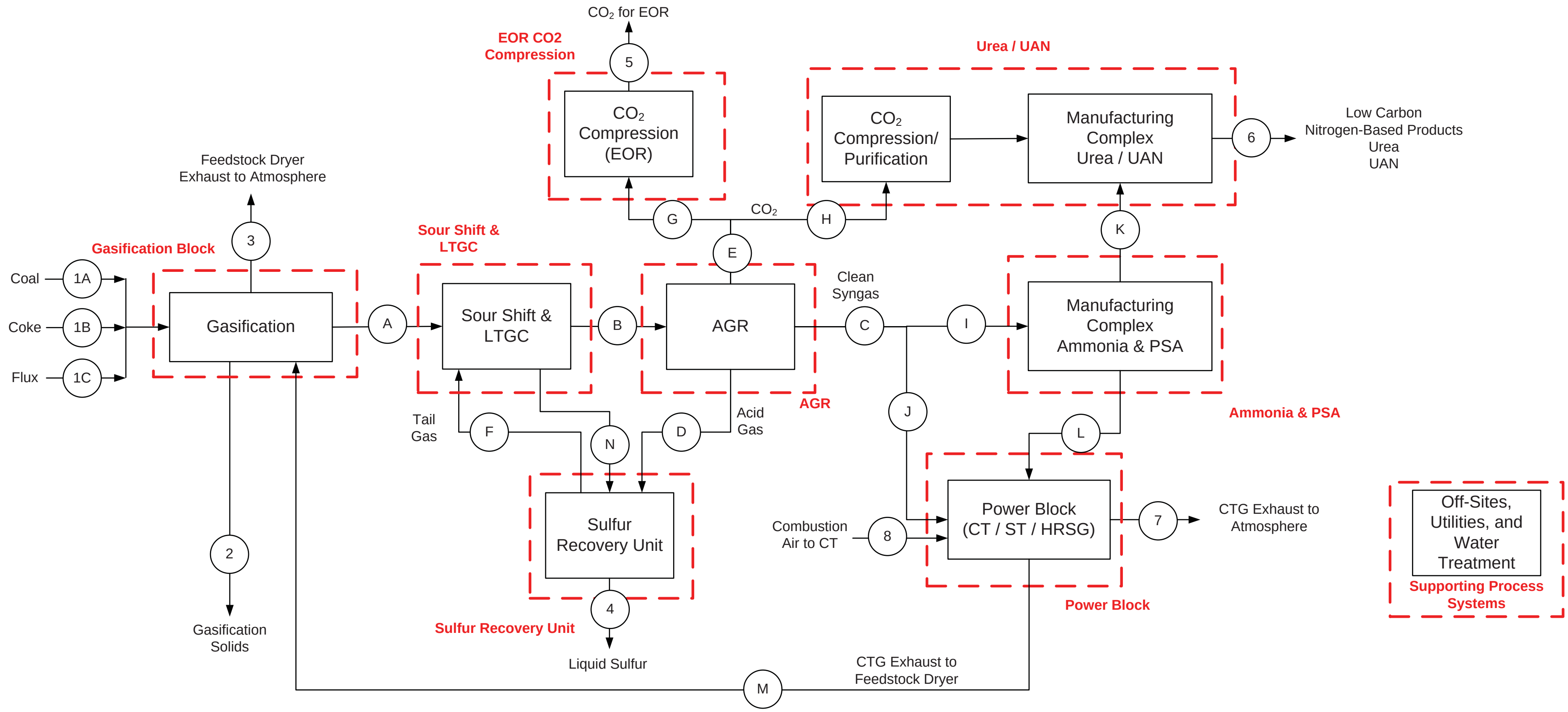
INFORMATION REQUEST

CS-7A. Please provide a carbon balance for HECA demonstrating the complete flow of carbon from the introduction of feedstock to the coal dryer to the products (including carbon dioxide [CO_2]) and waste streams. Please provide this carbon balance for both the On- and Off-Peak operating cases. This carbon balance should be more detailed than what was previously provided in the Amended AFC and data responses, clearly identifying the carbon in all the streams between major processes and process units where carbon flows change.

RESPONSE

Figures CS-7-1 and CS-7-2 show the updated carbon balance flow diagrams for the on-peak and off-peak cases. These show the internal carbon flows between each major unit grouping during steady state operation. The on-peak operation will occur approximately 16 hours per day, and represents peak power generation with reduced fertilizer production. The off-peak operation represents off-peak, or reduced, power generation with maximum fertilizer production.

Simplified Block Flow Diagram
Atomic Carbon Balance – On Peak, 65° F
Steady-State Normal Operation



On Peak Carbon Balance (Basis: atomic carbon)					
In		Out		Internal Streams	
Stream #	Flow Rate (lb/hr)	Stream #	Flow Rate (lb/hr)	Stream #	Flow Rate (lb/hr)
1A	198,020	2	270	A	268,050
1B	68,650	3	3,180	B	271,060
1C	1,650	4	-	C	22,330
8	590	5	208,670	D	3,010
		6	37,050	E	245,720
		7	19,740	F	4,210
				G	208,670
				H	37,050
				I	7,340
				J	14,990
				K	-
				L	7,340
				M	3,180
				N	1,200
Total In:	268,910	Total Out:	268,910		

ON-PEAK CARBON BALANCE BLOCK FLOW DIAGRAM

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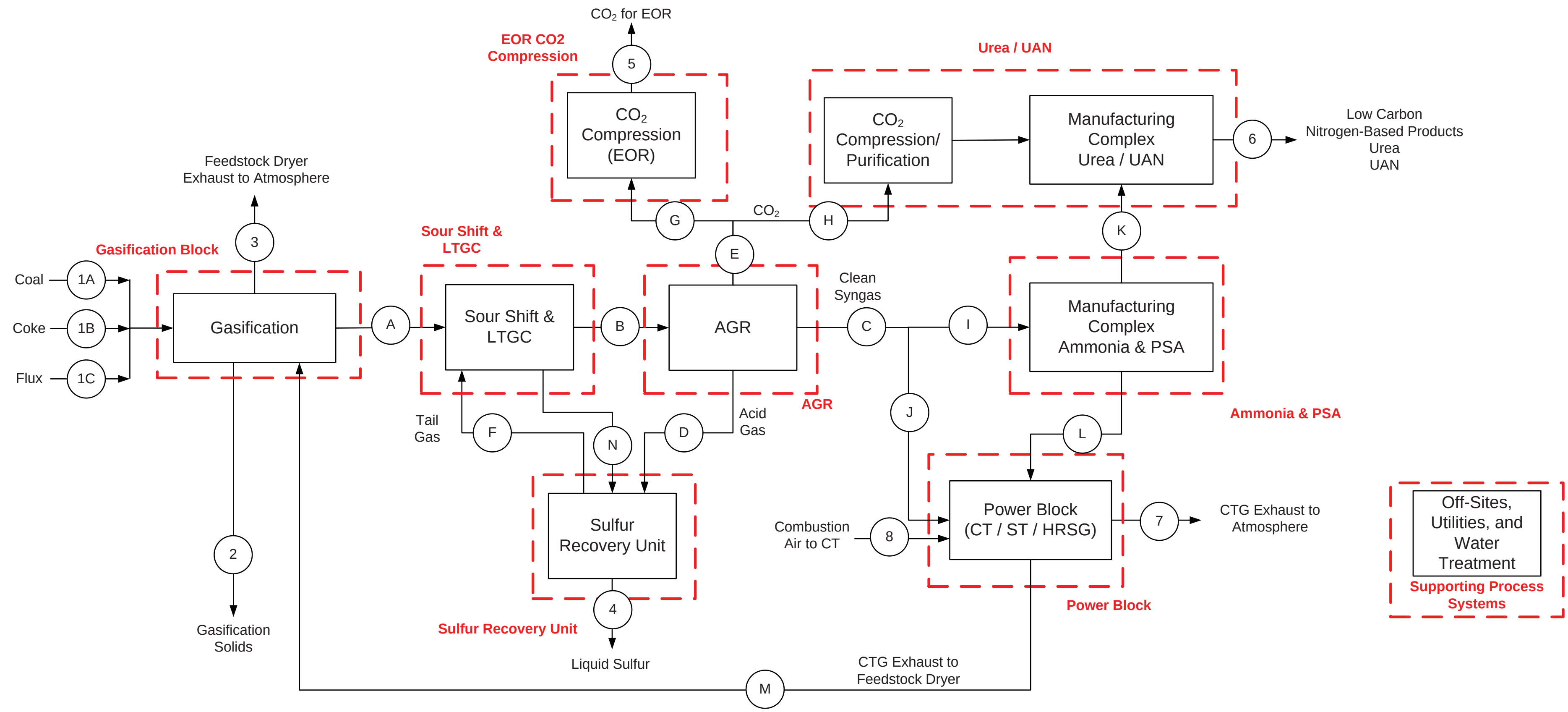
FIGURE CS-7-1

Simplified Block Flow Diagram
Atomic Carbon Balance – Off Peak, 65° F
Steady-State Normal Operation



Off Peak Carbon Balance (Basis: atomic carbon)					
In		Out		Internal Streams	
Stream #	Flow Rate (lb/hr)	Stream #	Flow Rate (lb/hr)	Stream #	Flow Rate (lb/hr)
1A	198,020	2	270	A	268,050
1B	68,650	3	3,670	B	271,060
1C	1,650	4	-	C	22,330
8	540	5	208,670	D	3,010
		6	37,050	E	245,720
		7	19,200	F	4,210
				G	208,670
				H	37,050
				I	12,240
				J	10,090
				K	-
				L	12,240
				M	3,670
				N	1,200
Total In:	268,860	Total Out:	268,860		

OFF-PEAK CARBON BALANCE
BLOCK FLOW DIAGRAM

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FIGURE CS-7-2

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INFORMATION REQUEST

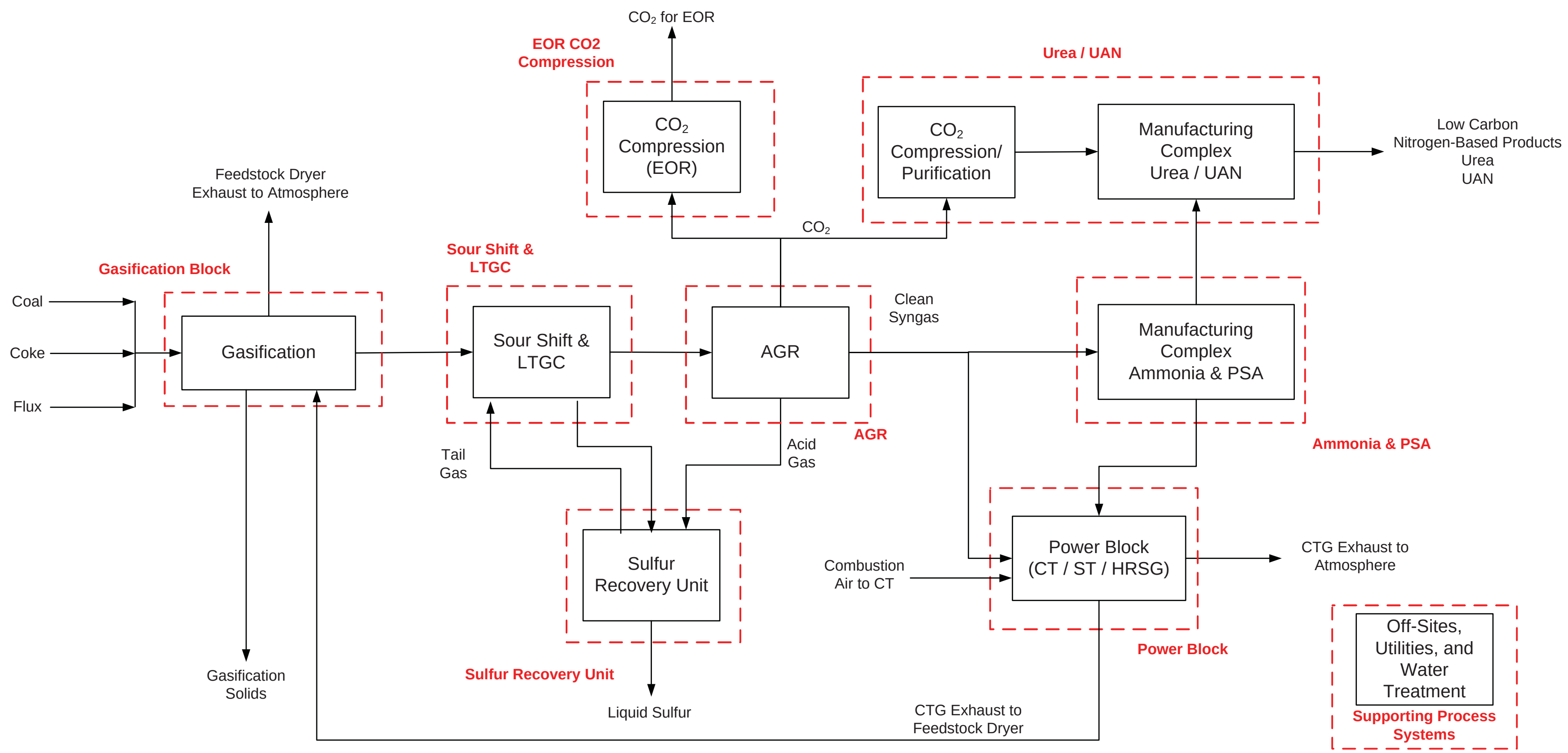
CS-7B. Please provide detailed background information supporting the latest applicant-sponsored SB 1368 calculations. Please provide the following:

- ***A detailed list of the project equipment indicating each piece of equipment's power consumption value; and***
- ***Project equipment allocation (Power, Fertilizer or Common) for each listed piece of project equipment.***

RESPONSE

Figure CS-7-3 presents a block flow diagram of the auxiliary loads at HECA for both on-peak and off-peak operation. The following units are associated with the production of syngas and are considered common: Gasification, Sour Shift & LTCC, AGR, Sulfur Recovery unit, and EOR CO_2 compression. The PSA/Ammonia and Urea/UAN units are associated solely with the fertilizer complex, and the power block is associated with power. The power consumption of the common units is allocated according to the syngas usage of the power and fertilizer units. During On-Peak operation, 71.3 percent of the syngas is used by the power block and 28.7 percent of the syngas is used by the fertilizer complex. During Off-Peak operation, 52.1 percent of the syngas is used by the power block and 47.9 percent of the syngas is used by the fertilizer complex.

Simplified Block Flow Diagram
Auxiliary Loads
Steady-State Normal Operation



ON-PEAK, 65°F, STEADY STAT					
	ux Load				
Unit	Total	Common	Power	Fertilizer	Generation
	(MW)	(MW)	(MW)	(MW)	(MW)
Gasification	12.1	12.1			
Shift & LTGC	0.9	0.9			
AGR	19.3	19.3			
SRU	2.0	2.0			
EOR CO2 Compressor	36.1	36.1			
PSA/Ammonia	33.3			33.3	3.5
CO2 Purification	6.1			6.1	
Urea/UAN	6.0			6.0	
Power Block	5.7		5.7		412.5
Water Treatment	6.4	2.0	3.0	1.4	
Power Cooling Tower	4.0		4.0		
Process Cooling Tower	9.7	5.0		4.6	
Fertilizer Storage/Handling	0.6			0.6	
Other Supporting Systems	8.3	8.3			
Sum:	150.5	85.7	12.7	52.1	416.0
Syngas to Power	71.3%				

OFF-PEAK, 65°F, STEADY STATE					
	Aux Load				
Unit	Total	Common	Power	Fertilizer	Generation
	(MW)	(MW)	(MW)	(MW)	(MW)
Gasification	12.1	12.1			
Shift & LTGC	0.9	0.9			
AGR	19.3	19.3			
SRU	2.0	2.0			
EOR CO2 Compressor	36.1	36.1			
PSA/Ammonia	46.8			46.8	11.3
CO2 Purification	6.1			6.1	
Urea/UAN	6.0			6.0	
Power Block	5.4		5.4		303.9
Water Treatment	6.4	2.0	3.0	1.4	
Power Cooling Tower	4.0		4.0		
Process Cooling Tower	9.7	5.0		4.6	
Fertilizer Storage/Handling	0.6			0.6	
Other Supporting Systems	8.7	8.7			
Sum:	164.1	86.0	12.4	65.6	315.2
Syngas to Power	52.1%				

ON-PEAK AND OFF-PEAK BLOCK FLOW DIAGRAM OF AUXILIARY LOADS

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FIGURE CS-7-3

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INFORMATION REQUEST

CS-7C. Please provide the gross and net megawatt (MW) assumptions for the three available ambient cases (39, 65 and 97 degrees F). Include the On- Peak, Off-Peak and Daily Average categories.

RESPONSE

Table CS-7-1 presents gross and net power for On-Peak and Off-Peak operation at all three ambient temperatures. It also presents this information for the daily average, which is based on an ambient temperature of 65°Fahrenheit (°F) and 16 hours of on-peak operation and 8 hours of off-peak operation.

Table CS-7-1
Representative Heat and Material Balances

Parameter	Units	Hydrogen-Rich Fuel						
		Maximum Power Production	Maximum Ammonia Production	Maximum Power Production	Maximum Ammonia Production	Maximum Power Production	Maximum Ammonia Production	Daily Average
		On-Peak	Off-Peak	On-Peak	Off-Peak	On-Peak	Off-Peak	
Ambient Temperature	°Fahrenheit	97	97	39	39	65	65	65
Gross Power Generation (CT/ST)	MW	421.8	320.9	409.1	309.2	416.0	315.2	382.4
Power Generation Fertilizer Contribution	MW	3.5	11.3	3.5	11.3	3.5	11.3	6.1
Power Generation Less Fertilizer Contribution	MW	418.3	309.6	405.6	297.9	412.5	303.9	376.3
Total Auxiliary Load	MW	150.5	164.1	150.5	164.1	150.5	164.1	155.0
Gasification	MW	12.1	12.1	12.1	12.1	12.1	12.1	12.1
Shift and LTGC	MW	0.9	0.9	0.9	0.9	0.9	0.9	0.9
AGR	MW	19.3	19.3	19.3	19.3	19.3	19.3	19.3
SRU	MW	2.0	2.0	2.0	2.0	2.0	2.0	2.0
EOR CO_2 Compression	MW	36.1	36.1	36.1	36.1	36.1	36.1	36.1
PSA and Ammonia Units	MW	33.3	46.8	33.3	46.8	33.3	46.8	37.8
CO_2 Purification	MW	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Urea/UAN	MW	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Power Block	MW	5.7	5.4	5.7	5.4	5.7	5.4	5.6
Water Treatment	MW	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Power Cooling Tower	MW	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Process Cooling Tower	MW	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Fertilizer Storage/Handling	MW	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Other Supporting Systems	MW	8.3	8.7	8.3	8.7	8.3	8.7	8.4
Net Power Export	MW	271	157	259	145	266	151	227

Notes:

AGR = acid gas removal
CO_2 = carbon dioxide
CT = combustion turbine
EOR = enhanced oil recovery
LTGC = low-temperature gas cooling
PSA = Pressure Swing Adsorption
SRU = sulfur recovery unit
ST = steam turbine
UAN = urea ammonium nitrate

INFORMATION REQUEST

CS-7D. Please describe how the fertilizer power generation values, which appear to be different than the previously presented 5 MW value, were determined for the On-Peak and Off-Peak Cases.

RESPONSE

The fertilizer power generation values were revised during design refinement. These updated values are presented in Figure CS-7-3.

The gross power generation attributable to the fertilizer complex was determined as follows:

- Steam is generated and consumed by the units in the fertilizer complex. The steam generated by or consumed by the fertilizer complex adds to or reduces the ST generator output and impacts gross generation by the same amount.
- The thermodynamic model of the combined cycle includes the impact of integration of all steam generated or consumed in the entire facility.
- The thermodynamic model of the combined cycle was selected for the set of conditions in question, either On-Peak or Off-Peak.
- The selected model was then modified by setting the steam flows to and from the fertilizer complex to zero and the model calculated a new value for gross output.
- The difference in gross output between the unmodified base case and the case with the steam flows to and from the fertilizer complex set to zero is the gross generation attributable to the fertilizer complex.

This process was repeated for On-Peak or Off-Peak.

INFORMATION REQUEST

CS-7E. Please provide detailed calculations and rationale for the Syngas Allocation percentages allocated to power block and fertilizer in the HECA Power Generation for SB 1368 Emission Performance Standard Table for each project case (On-Peak, Off-Peak, and Daily Average).

RESPONSE

The syngas allocation to power during on-peak and off-peak operation is shown in Table CS-7-2. The remainder of the syngas is allocated to fertilizer production. The daily average is based on 16 hours of on-peak operation and 8 hours of off-peak operation with 64.9 percent of the syngas allocated to power.

Table CS-7-2
Syngas Allocation to Power during On- and Off-Peak Operation

On-Peak Power Syngas Allocation		
Total Syngas Energy from AGR (C)	3.32E+09	BTU/hr (LHV)
Clean Syngas from AGR to CTG (J)	2.23E+09	BTU/hr (LHV)
PSA Off-Gas to Power (L)	1.37E+08	BTU/hr (LHV)
Total Energy to Power (J + L)	2.37E+09	BTU/hr (LHV)
% Syngas to Power (J + L) / C	71.3%	
Off-Peak Power Syngas Allocation		
Total Syngas Energy from AGR (C)	3.32E+09	BTU/hr (LHV)
Clean Syngas from AGR to CTG (J)	1.50E+09	BTU/hr (LHV)
PSA Off-Gas to Power (L)	2.29E+08	BTU/hr (LHV)
Total Energy to Power (J + L)	1.73E+09	BTU/hr (LHV)
% Syngas to Power (J + L) / C	52.1%	

Notes:
Please refer to Figure CS-7-3, where:

C = Total Syngas
J = Clean Syngas
L= PSA Off-Gas to Power.

AGR = acid gas removal
BTU/hr = British thermal units per hour
CTG = combustion turbine generator
LHV = lower heating value
PSA = Pressure Swing Adsorption
syngas = synthesis gas

INFORMATION REQUEST

CS-7F. Please provide detailed calculations and rationale for the calculations used to determine the Syngas Allocation to Power and Fertilizer that were used to determine the CO_2 emissions by emissions source. Please confirm this value is for the Daily Average case, and provide the values for the On-Peak and Off-Peak cases.

RESPONSE

The syngas allocation to power and fertilizer presented in the response to Information Request CS-7E were used to determine the split of CO_2 emissions.

The following emission sources are included in the common category: CTG/HRSG burning syngas/PSA off-gas, CO_2 Vent, flares, thermal oxidizer, auxiliary boiler and fugitive emissions. Only the CTG burning natural gas is included exclusively in the power category. The ammonia start-up heater, urea absorber vents, and nitric acid unit are included in the fertilizer category.

Three emission scenarios were examined: Early Operations, Mature Operations, and Steady-State Operations. Early Operations are expected to occur for the first 2 years of operation, and include all emissions from all sources at maximum permitted levels, as outlined in Attachment CS-7-1. Mature Operations are expected to occur after the first 2 years, and include the same emissions as Early Operations except lower CO_2 vent emissions. Steady State Operations occur during the same time frame as Mature Operations and are based on maximum operating conditions, excluding start-ups, shut-downs, turbine use of natural gas, and CO_2 venting.

Attachment CS-7-1 shows the detailed SB 1368 calculations. Table CS-7-3 presents the SB 1368 EPS, as calculated for the three emission scenarios. The information provided is for the daily average case based on an ambient temperature of 65°F, and 16 hours of on-peak operation and 8 hours of off-peak operation.

Table CS-7-3
SB 1368 Emission Performance Standard

	Early Operations (Maximum Permitted)	Mature Operations	Steady-State Syngas Operations
Total CO_2 Annual Emissions Attributable to Power Production (tons per year)	386,494	290,865	188,228
Net Power Output (MWh)	2,565,374	2,565,374	2,464,574
CO_2 EPS (lb/MWh)	301	227	153

Notes:
CO_2 = carbon dioxide
EPS = emission performance standard
lb/MWh = pounds per megawatt-hour
MWh = megawatt-hour
syngas = synthesis gas

ATTACHMENT CS-7-1
SB 1368 CALCULATIONS

HECA Annual CO_2 Emissions for SB 1368 Emission Performance Standard

Sources of CO_2	Total	Power	Fertilizer	Allocation
	CO_2 Emissions (tons/year)			
CTG/HRSG burning syngas/PSA off-gas	283,104	183,734	99,369	C
CTG/HRSG burning natural gas	49,291	49,291	-	P
CO_2 Vent	193,394	125,512	67,881	C
Flares pilot	564	366	198	C
Flares Start-Up/Shut-Down	8,531	5,537	2,995	C
Thermal Oxidizer standby	6,322	4,103	2,219	C
Thermal Oxidizer Start-Up/Shut-Down, maintenance	337	219	118	C
Emergency Engines	115	-	-	exempt
Auxiliary Boiler	27,283	17,707	9,576	C
Ammonia Start-Up Heater	459	-	459	F
Urea Absorber Vents	128	-	128	F
Nitric Acid Unit	0	-	-	F
Fugitives	39	25	14	C
Total Emissions attributable to each Section				
Total Early Operations	569,566	386,494	182,957	
Total Mature Operations	422,218	290,865	131,238	
Total Steady State Operations	290,271	188,228	101,928	

Syngas allocation by section (daily average)		
P	Power	64.9%
F	Fertilizer	35.1%
C	Common	

Notes:

CO_2 = carbon dioxide
CTG = combustion turbine generator
HECA = Hydrogen Energy California
HRSG = heat-recovery steam generator
PSA = Pressure Swing Adsorption
SB = senate bill
syngas = synthesis gas

HECA Power Generation for SB 1368 Emission Performance Standard

Power Balance	Unit	On-Peak	Off-Peak	Daily Average
Power Generation				
Gross Output	MW	416.0	315.2	382.4
Allocation to Power	MW	412.5	303.9	376.3
Allocation to Fertilizer	MW	3.5	11.3	6.1
Auxiliary Power				
Common	MW	85.7	86.0	
Power	MW	12.7	12.4	
Fertilizer	MW	52.1	65.6	
Syngas Allocation				
To Power Block	%	71.3%	52.1%	64.9%
To Fertilizer	%	28.7%	47.9%	35.1%
Power Allocation				
IGCC Net Output (w/o Fertilizer)	MW	338.7	246.6	308.1
IGCC Net Output	MWh/year			2,464,574
Natural Gas-Fired Net Power Output	MW			300
Natural Gas-Fired Power Production	MWh/year			100,800
Fertilizer Power Consumption	MW	(73.2)	(95.5)	(80.6)

Notes:

HECA = Hydrogen Energy California
IGCC = integrated gasification combined-cycle
MW = megawatt
MWh/yr = megawatt-hour per year
SB = senate bill
syngas = synthesis gas

SB 1368 Emission Performance Standard

	Early Operations (Maximum Permitted)	Mature Operations	Steady-State Syngas Operations
Total CO_2 Annual Emissions Attributable to Power Production (tons per year)	386,494	290,865	188,228
Net Power Output (MWh)	2,565,374	2,565,374	2,464,574
CO_2 EPS (lb/MWh)	301	227	153

Notes:

Emissions presented include CO_2 from the turbine during start-ups and shut-downs.

Emissions from the emergency engines are exempt from the SB1368 standard.

The annual power output does not include the megawatts generated during start-up and shut-down, thus the EPS may be conservatively high.

Scenario definitions:

Early Operations – expected to last approximately 2 years, during which time hydrogen-rich fuel availability will be approximately 65 to 75 percent. During this period, all sources are expected to be operated at maximum operating conditions, including two plant start-ups and shut-downs. The CO_2 vent is included with maximum permitted venting emissions of up to 504 hours at full capacity.

Mature Operations – expected to occur after the first 2 years of commercial operation, when the hydrogen-rich fuel availability will be approximately 85 percent. At this stage, significantly less venting is expected to occur; thus, CO_2 vent emissions are estimated based on approximately 10 days of venting at 50 percent capacity (or 120 hours of venting at 100 percent capacity). All other sources are operated at maximum operating conditions, including two plant start-ups and shut-downs.

Steady State Operations – which occur in the same time frame as mature operations; that is, after the 2 years of early operation. In this scenario, emissions are estimated based on maximum operating conditions, excluding start-ups, shut-downs and CO_2 venting. Emissions from operation of the CTG/HRSG on syngas are included; no natural gas use is included.

CO_2 = carbon dioxide
EPS = emission performance standard
lb/MWh = pounds per megawatt-hour
MWh = megawatt-hour
SB = senate bill
syngas = synthesis gas

INFORMATION REQUEST

CS-7G. Please provide additional background information explaining the syngas allocation method used to determine CO_2 emissions from the fertilizer plant. This additional detail should explain the methodology sufficiently to ensure that CO_2 emissions from the fertilizer plant are not double counted when CO_2 emissions are sequestered in the urea produced.

RESPONSE

Please refer to the syngas allocation details provided in the response to Information Request CS-7E, and the carbon balances provided in the response to Information Request CS-7A.

Refer to the Overview of Allocation of CO_2 Emissions at the beginning of the responses to the Information Requests for Carbon Sequestration for the details of the methodology. As can be seen from the carbon balance, Figures CS-7-1 and CS-7-2, the captured CO_2 is sent for use in EOR or for the production of urea. There is no double counting.

INFORMATION REQUEST

CS-7H. The syngas allocation by section (see spreadsheet provided by applicant for May 10, 2013 meeting, attached to TN 70829) does not include a value for the Common allocation. The CO_2 emissions from components identified elsewhere in the spreadsheet designated as "Common" are calculated using the Power Allocation percentage in the spreadsheet. Please confirm or provide the correct Common allocation percentage.

RESPONSE

HECA confirms that the "common allocation" is the same as the "syngas allocation" shown in the calculation. Common areas are allocated to either Power or Fertilizer based on the Syngas Allocation.

INFORMATION REQUEST

CS-7l. Please provide the air separation unit's power consumption value expected for the On-Peak, Off-Peak, and Daily Average cases. This can be presented with apportionment to the power block and fertilizer plant if detailed calculations and rationale for that apportionment basis (based on use of the produced oxygen and nitrogen and its later products, hydrogen and CO_2, used for power and fertilizer production) are provided.

RESPONSE

Table CS-7-4 presents the ASU auxiliary loads for On-Peak and Off-Peak operation at average ambient temperature conditions. The common portion is used for syngas production. The portion of nitrogen which is not common is used as noted.

Table CS-7-4
ASU Auxiliary Loads

Auxiliary Load	On-Peak	Off-Peak
Common (MW)	77.0	76.7
Nitrogen for Power (MW)	27.6	18.6
Nitrogen for Ammonia (MW)	4.4	7.3
Total (MW)	**109.0**	**102.6**

Notes:
ASU = air separation unit
MW = megawatt

INFORMATION REQUEST

CS-7K. A review of the emissions tables indicates that there are changes to some of the emissions calculation assumptions provided in Appendix E, such as the fuel consumption in the gas turbine and duct burners.

- ***Please update Appendix E as necessary to include all of these changes as well as the other recent changes to project (addition of fluxant, removal of ammonia export).***
- ***Please provide emissions calculation (AQ and GHG) for both the on- peak and off-peak cases clearly showing fuel flow to the combustion turbine and duct burners for each case.***
- ***Please show how HECA off-peak operations would impact other emission sources and provide information on changes to the major component stream flows that may occur during these operating conditions (such as, does amount of CO_2 shipped to OEHI go up during off-peak operations, or does the CO_2 concentration in the hydrogen rich fuel go up to maintain a constant CO_2 emissions profile for the HRSG and coal dryer stacks for On- and Off-Peak operations?).***

RESPONSE

- Appendix E was updated to reflect all project refinements to date, and was provided in the Updated Emissions and Modeling Report (Appendix A, Revised Operational Criteria Pollutant Emissions), docketed with the CEC on May 20, 2013.
- This appendix outlines that the maximum fuel input to the turbine is 2,583 million British thermal units per hour (MMBtu/hr) of syngas, and to the duct burners is 278 MMBtu/hr of syngas and PSA off-gas. As also described in this appendix, the maximum criteria pollutant emissions are based on the operating scenario that generates the maximum emission rate; this varies per pollutant.

  As presented in the Updated Emissions and Modeling Report (Appendix E, Revised Operational Greenhouse Gas Emissions), GHG emissions are based on average ambient temperature conditions for on-peak operation. The turbine emissions are based on a heat input rate of 2,537 MMBtu/hr of syngas; the duct burner emissions are based on 165 MMBtu/hr of syngas and 149 MMBtu/hr of PSA off-gas.
- CO_2 flow to OEHI is the same for On-Peak and Off-Peak. As seen in the response to Information Request CS-7A, the total carbon to the power block (clean syngas plus PSA off-gas) is constant; therefore, the carbon output from the CTG/HRSG plus feedstock dryer (streams 3 plus 7) is constant.

INFORMATION REQUEST

CS-7L. Based on Table 2-10 provided in the Amended AFC, during maximum ammonia production, referred to as off-peak operation, production of the other fertilizer components do not increase.

- ***Please provide data/calculations confirming the plant will have adequate ammonia storage facilities capable of handling the increased ammonia that would be produced during off-peak operations.***
- ***Please indicate if the rate of ammonia consumed by the plant varies with respect to the fertilizer products during on-peak and off-peak operations, and if so please provide the on- and off-peak operation case production rates for nitric acid, urea, and UAN production.***
- ***Please clearly indicate if HECA's ammonia use is higher than its production rate during on-peak operations, or if other components of fertilizer production, including the intermediate products like nitric acid, would increase with the increase in ammonia production during off- peak periods of operation.***

RESPONSE

On-Peak ammonia production (16 hours per day) is 52.2 tons per hour. Off-Peak ammonia production (8 hours per day) is 87.0 tons per hour. Ammonia consumption by the Urea and UAN process units and the power block selective catalytic reduction is constant at 63.8 tons per hour. The average daily consumption of ammonia is equal to the average daily production. During On-Peak operation, consumption is greater than production, and the difference is drawn from storage at the rate of 11.6 tons per hour above the production rate. The tank contents are reduced by 186 tons over the 16-hour On-Peak period. During Off-Peak operation, production is greater than consumption, and the difference increases the inventory in storage at the rate of 23.2 tons per hour above the consumption rate. The tank inventory increases by 186 tons over the 8-hour Off-Peak period. The net result is that the storage inventory is neutral over any 24-hour period, but fluctuates up and down each day by 186 tons or 1.7 percent of the storage capacity. Except for ammonia, the production rates during On-Peak and Off-Peak operation are constant for the fertilizer final products (urea pastilles and UAN) and fertilizer intermediate products (urea solution, nitric acid, and ammonium nitrate.)

INFORMATION REQUEST

CS-7N. As an adjunct to GHG, please confirm the current planned and unplanned outage as the basis for reliability. Currently, our understand is as follows:

- ***Planned: Two 1‑week planned maintenance outages with 15‑hour ramping allowance for 351 hours***
- ***Planned: Two cold-start cycles, each 4 days long for a total of 192 hours***
- ***Unplanned: 219 hours of outage based on 91.3% equivalent availability factor (EAF), calculated as follows: (1-0.913) x 8760 = 762 hours of total outage. 762 (hours of total outage) –351 (maintenance outage hours) –192 (cold start-up hours) = 219 hours (unplanned outage hours).***

RESPONSE

HECA plans to have one facility-wide plant shut-down annually to perform maintenance. The CTG/HRSG operation is nominally 8,000 hours per year interval between maintenance, and this sets the shut-down frequency and duration. The duration of the maintenance turnaround varies between 17 and 40 days, depending on the type of maintenance specified by the equipment supplier for a particular year. Additionally, a second unplanned facility-wide shut-down and start-up has been accommodated in the shut-down/start-up emission estimates. The turbine start-up/shut-down cycles last 13.5 hours, or 27 hours per year for two cycles. It takes the entire facility up to 157 hours for a cold start-up cycle; the turbine start-up only lasts for 4.5 of these hours, although the turbine could operate on natural gas during that time. During planned facility maintenance, the turbine can continue to operate on natural gas backup fuel.

Emission estimates include 336 hours of natural gas firing in the CTG/HRSG to allow continued power production to complete contracted power deliveries during maintenance periods.

Technical Area: Cultural Resources

INFORMATION REQUEST

CUL-1. For the EOR components: all of the information required for cultural resources in the Energy Commission Siting Regulations, Appendix B (20 Cal. Code Regs., §1704(b)(2), App. B).

RESPONSE

Please see OEHI Responses to Data Requests A85-88 and A141-146, docketed confidentially with the CEC on July 26, 2013. Also see OEHI Responses to Data Requests A189 and A190, which were submitted to the CEC on May 9, 2013.

Technical Area: Land Use

INFORMATION REQUEST

LU-1. Staff also needs additional information to determine project compliance with Section 19.12.070 (setbacks) and 19.12.100 (parking) of the Kern County Zoning Code. A site plan drawn to scale of all proposed structures demonstrating compliance with the sections of the zoning ordinance.

RESPONSE

Setbacks

As presented in Amended Application for Certification (AFC) Section 5.4, the minimum front yard setback prescribed for the Exclusive Agriculture (A) zoning district in Kern County Zoning Ordinance Section 19.12.070 is 55 feet from the legal centerline of any existing or proposed public or private local street or access easement. The minimum side yard setback is 5 feet, except on the street side of corner lots, where a minimum of 10 feet is required. The Updated Emissions and Modeling report docketed with the CEC on May 17, 2013, included Revised Figure 1-2, HECA Plot Plan with Emission Source Locations. Revised Figure 1-2 is a scaled site plan that presents the location of buildings/structures that would be constructed for the Project. The nearest building to the centerline of a street shown on Revised Figure 1-2 is the Maintenance and Warehouse Building, which is set back approximately 60 feet from the centerline of Dairy Road.

Parking

Off-street parking requirements for the Exclusive Agriculture (A) zoning district are included in Kern County Zoning Ordinance Section 19.82. However, the proposed land use is not listed in Zoning Ordinance Section 19.82.020; therefore, parking needs must be determined specifically for the HECA Project.

Revised Figure 1-2, HECA Plot Plan with Emission Source Locations, is a scaled site plan that identifies approximately 225 parking spaces adjacent to the Maintenance and Warehouse Building and Control, Administration, Laboratory, and Medical Aid Building along Dairy Road. These parking spaces will adequately serve the HECA Project, and will accommodate staff parking for a full-day shift, overlap that may occur during a shift change, and surplus parking.

Technical Area: Soil and Surface Water

INFORMATION REQUEST

SSW-1. Additional Information for the draft DESCP: The applicant has identified that HDD would be used to pass the CO_2 pipeline under the Outlet Canal, the Kern River Flood Control Channel (KRFCC), and the California Aqueduct (Aqueduct), as shown on Soil & Surface Water Figure 9. In addition, the draft DESCP states that an assessment of the crossing methods (conventional open trenching or HDD) would be made for all water bodies, such as irrigation canals, along other pipeline routes. If additional HDD locations are anticipated, staff needs to analyze the proximity of potential resources at and in the vicinity of these locations. Please show all potential locations of HDD activities in the DESCP and update the disturbed soil estimates of entry/exit pits. If HDD sites are not yet finalized, please be conservative and include all potential sites.

RESPONSE

As described in the Amended AFC, responses to Data Requests, the draft Drainage, Erosion and Sediment Control Plan (DESCP), and in various permit applications (e.g., the USACE Pre-Construction Notification, preliminary jurisdictional determination report, the Regional Water Quality Control Board Application for 401 Water Quality Certification and Waste Discharge Requirements, and the CDFW Notification of Lake and Streambed Alteration), there would be four entry/exit pits associated with the horizontal directional drilling (HDD) to be used to install the CO_2 pipeline. No additional HDD locations are anticipated.

INFORMATION REQUEST

SSW-2. Staff notes that some of the lined retention basins at the HECA site are calculated to have drawdown times that exceed the Kern County maximum of seven days (Kern County Hydrology Manual – Section 408.08.01). Please adjust the basin design and/or operations to comply with the Kern County basin standard. Also revise the DESCP and hydrology report to reflect these changes.

RESPONSE

Kern County Hydrology Manual Section 408-8.01 states the following: "Retention basins shall not be permitted unless it can be demonstrated, to the satisfaction of the Director, that the basin will completely drain the design volume within seven (7) days." According to Section 408-1 of the Manual, the design volume for storm water retention basins shall be based on the runoff from the Intermediate Storm Design Discharge (ISDD) 5-day storm event. The Manual defines the ISDD as "that flow determined based upon a precipitation event having a 10 percent probability of being equaled or exceeded in any given year, commonly referred to as the 10-year storm."

In the 2012 Draft DESCP and PSA/DEIS Soils and Surface Water Table 5, all unlined basins were designed to meet the cited criteria. However, Table 5 shows that Basin 7 (9.7 days) and Basin 9 (28.7 days) exceed the 7-day drawdown for the 10-year event. These two basins are lined to serve as process water ponds, where stormwater can potentially be reused as makeup water for the cooling system or process water. Because this water is collected as run-off from the process units, a minor possibility for contamination exists. The water that collects in these lined ponds will be analyzed. The water would then be sent to the water treatment/zero liquid discharge (ZLD) plant for treatment. As such, the outflow from the basins depends on the operation of the water treatment/ZLD plant. Due to the process water nature of these lined ponds, they do not fall under the authority of the Kern County Hydrology Manual. This has been confirmed by the Applicant with the County.

In accordance with proposed Condition of Certification SOILS-1, the project owner will prepare an update to the DESCP that will incorporate the final design, including hydrologic calculations, for all retention basins.

INFORMATION REQUEST

SSW-3. Proposed Rail Spur Impacts to Offsite Flooding

Construction of the proposed rail spur could potentially alter existing storm water drainage patterns and possibly result in increased flooding of adjacent areas. Please provide additional information:

- ***Maps and drawings that show locations where construction would cross drainages, canals, and other water bodies. Identify what local and/or permits would be required for these crossings.***

RESPONSE

Construction of the proposed rail spur will not alter existing stormwater drainage patterns, and will not result in increased flooding of adjacent areas. There are no streams or other natural water features along the proposed rail spur. The rail spur does not cross any natural streams and does not cross through a designated floodplain (see response to Information Request SSW-5).

The proposed rail spur would cross several irrigation canals, including the East Side Canal. These canals are owned and operated by the Buena Vista Water Storage District. Descriptions and figures that show the locations where the proposed rail spur would cross these canals were included in the preliminary Jurisdictional Delineation Report (see Figures 5 and 7 in the application), submitted to the USACE on March 6, 2013, and docketed with the CEC on March 7, 2013. The information was also included in the Notification of Lake and Streambed Alteration (see Figure 4 in the application), submitted to CDFW on May 2, 2013, and docketed with the CEC on May 3, 2013.

The permits that could be required for the crossings along the rail spur are summarized in Table SSW-3-1.

Table SSW-3-1
Permits that may be Required for Canals Crossed by the Rail Spur

Permit/Approval	Agency	Activities Regulated	Status/Notes
Lake and Streambed Alteration Agreement (Cal. Fish and Game Code Section 1600)	CDFW	Modification of irrigation canals.	Submitted Notification to CDFW. However, authorization will be subsumed under the CEC permitting process.
404 Nationwide Permit	USACE	Placement of fill in waters of the United States.	Submitted Pre-Construction Notification and Jurisdictional Delineation to USACE. Pending confirmation by the USACE, it is anticipated that there are no jurisdictional features along the rail spur, and no permit will be required.
401 Water Quality Certification/Waste Discharge Requirements	RWQCB	Placement of fill in waters of the United States and waters of the State.	Submitted application to RWQCB. Pending confirmation by the USACE, it is anticipated that there are no jurisdictional waters of the United States along the rail spur, but the canals may be considered waters of the State. Authorization for placement of fill in waters of the State would be subsumed under the CEC permitting process.
Construction General Storm Water Permit	SWRCB	Projects that disturb an area equal to or greater than 1 acre.	Construction contractor will prepare a SWPPP and file a Notice of Intent with the SWRCB.
Encroachment Permit	BVWSD	Construction across canals.	Permit application will need to be submitted to BVWSD prior to construction.

Notes:

BVWSD = Buena Vista Water Storage District
CDFW = California Department of Fish and Wildlife
CEC = California Energy Commission
RWQCB = Regional Water Quality Control Board
SWPPP = Storm Water Pollution Prevention Plan
SWRCB = State Water Resources Control Board
USACE = U.S. Army Corps of Engineers

INFORMATION REQUEST

SSW-4. Description of typical methods proposed for accommodating flows under or around the rail bed. Include maps that show locations of drainage features and indicate what flows they would be designed to handle.

RESPONSE

As described in the response to Information Request SSW-3, the rail spur would cross irrigation ditches and canals, including the East Side Canal. There are no intermittent or perennial stream features along the proposed rail spur.

The construction of the railroad spur would require a bridge crossing over the East Side Canal. Construction of a bridge would require the installation of permanent concrete or steel abutments and support structures. Although the installation of the railroad bridge would result in permanent fill in the bed and banks of the canal, the canal is an engineered irrigation conveyance facility that is intensively managed. The final design of the crossing has not been established, but may include support piles in the canal. The bridge would be designed to maintain the hydraulic conveyance capacity of the existing canal. Aside from the site of the railroad bridge, all of the potential impacts to the East Side Canal would be temporary, and the bed and banks would be restored following construction. The bridge across the East Side Canal would be constructed when the canal is dry to minimize or avoid potential impacts to water conveyance or water quality.

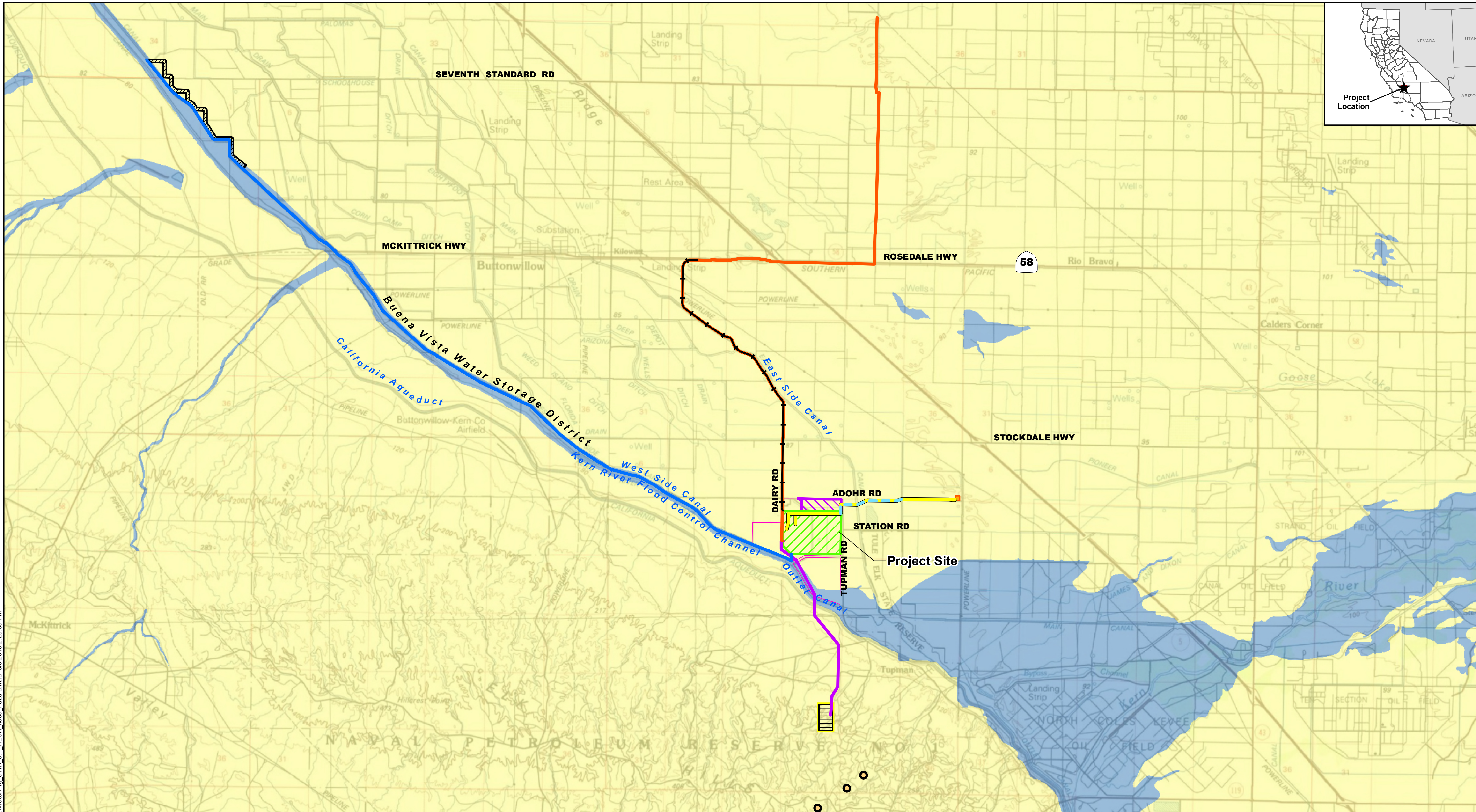
For other crossings, culverts would be installed at canals and ditches. Culverts would be designed to maintain or provide greater hydraulic conveyance capacity of the existing canal or ditch.

INFORMATION REQUEST

SSW-5. Identify whether the rail bed would be constructed in or near a FEMA 100-year floodplain Zone A. If so, discuss the measures that would be required to ensure no upstream or downstream impacts.

RESPONSE

As shown on Figure SSW-5-1, the proposed rail spur does not cross through or near a Federal Emergency Management Agency-designated 100-year floodplain (i.e., Zone A).



Project Site
Construction Staging Area
Controlled Area
BVWSD Well Field
Electrical Switching Station
EOR Processing Facility
EOR Satellite Gathering Station
Carbon Dioxide
Natural Gas
Potable Water
Process Water
Railroad
Transmission

FEMA FIRM Flood Zones

Zone A – Special Flood Hazard Area subject to inundation by the 1% annual chance flood (100-year flood)

Zone X – Other areas determined to be outside the 0.2% annual chance floodplain

N

0 1 2 Miles

FLOOD HAZARD ZONES

Hydrogen Energy California (HECA)
Wetland Delineation
Kern County, California

August 2013
28068052

URS

FIGURE SSW-5.1

ed/lcd U:\GIS\HECA\Projects\HECA_2012\Water\Fig_SWA_5.1_HECA_flood_hazard.mxd 8/9/2013 2:20:59 PM

Source: USGS 30'x60' quads: Taft 1982, Delano 1982; FIRM flood hazard data, Fema, 2009.

Technical Area: Traffic and Transportation

INFORMATION REQUEST

TRA-1. The applicant recently identified in their proposal to add storage of limestone and ammonium nitrate at the project site. These revisions would change the number of truck trips to and from the project site. Staff needs additional information from the applicant regarding how this revision in the number of truck trips could also change the potential impacts related to traffic and transportation. Specifically, staff requests the applicant provide revised truck trip numbers for both with the rail spur and without the rail spur and identify changes to the LOS at intersections and roadway segments that would occur with the revised truck trips. This issue will be addressed in the Final Staff Assessment (FSA).

RESPONSE

Since the filing of the Amended AFC in May 2012, the Applicant received comments from Kern County Roads Department and prepared a revised traffic analysis to respond to these comments. Subsequently, the California Department of Transportation (Caltrans) expressed concerns regarding the proposed signalization of State Route 119/Tupman Road. As a result of this coordination with the Roads Department and Caltrans, the traffic analysis for the Project has been revised. Please see the July 2013 Traffic Study Technical Memorandum (Revision 2), prepared in concurrence with Kern County Roads Department and Caltrans; and subsequently docketed with the CEC on August 1, 2013. This traffic study provides current traffic volumes and routing for the HECA Project and supersedes the traffic data and analyses presented in the May 2012 Amended AFC.

INFORMATION REQUEST

TRA-2. Staff has raised a question regarding the need to expand the Wasco coal servicing facility to serve the project's demand. Potential components of the coal servicing facility initially considered by staff include the possible need for additional storage silos and/or receiving lane for trains and/or haul trucks. Staff requests the applicant identify specific components that would need to be expanded at the coal servicing facility in Wasco. The project's potential demand for expanding the Wasco coal servicing facility will be addressed in the FSA.

RESPONSE

Although the through-put of the Wasco coal servicing facility will increase to serve the HECA Project, there are no physical changes proposed for the Wasco facility. The Wasco terminal has the capacity to service HECA without expansion.

INFORMATION REQUEST

TRA-4. Additionally, the applicant must provide an analysis discussing the need for each of the private at-grade crossings proposed, the potential risks involved in proposing this many private crossings in such a small area, and whether, upon further examination, any crossings can be eliminated. This analysis should also discuss potential impacts to the movement of farm machinery and equipment due to reducing the crossings, and should identify to what extent lands on either side of the proposed spur are owned and maintained by the same person or entity, and, thus, could possibly be impacted by reduced connectivity.

RESPONSE

Several railroad spur routing options were evaluated for the HECA Project. As described in Amended AFC, Section 6.3.2.2, the proposed rail spur route was selected based on the following considerations:

- **Main line.** The route ties into the San Joaquin Valley Railroad main railroad line.
- **Land availability.** The proposed route represents the most feasible alignment, based on land availability and on HECA's discussions with landowners.
- **Safety and proximity to potential sensitive receptors.** The proposed route is sited in less-populated areas, and there are minimal occupied buildings (i.e., residences, schools, day-care centers, etc.) along the entire proposed route.

Land in the vicinity of the rail spur route is primarily used for farming purposes (mainly alfalfa, cotton, wheat, and corn cultivation) and orchards for the cultivation of pistachios. As such, there are numerous farm roads in the area, and private crossings will be needed for farmers' access to crop lands.

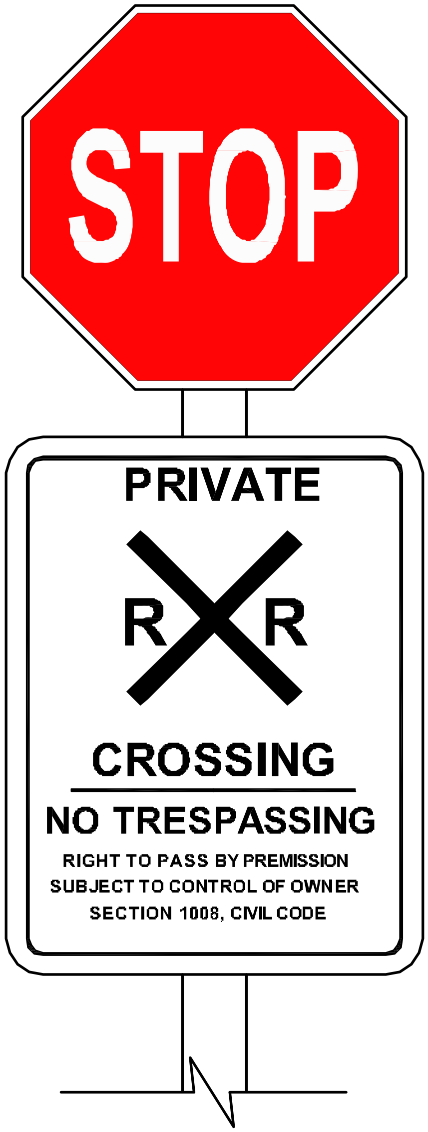
The rail spur would require private at-grade crossings. Warning devices for all of the proposed private at-grade crossings would consist of CPUC standard No. 1X private crossing signs (see Figure TRA-1).

Roadway surface across the track will be concrete, and similar to the material proposed for the public crossings. The railroad spur bed would be minimized to 22 feet in width to minimize interference with the existing land uses.

The Project would include a maximum of two trains a day traveling to and from the Project Site; therefore, these private roads would be crossed up to four times per day.

Figure TRA-2 shows the property owners along the rail spur alignment. The Applicant is working closely with Landowners A, B, and C shown on the figure (where the two northernmost crossings are located) to determine whether farm machinery and equipment can use other routes within the properties, and if the landowner could potentially abandon use of these private crossings in the future. The Applicant will work with the remaining two landowners to minimize the remaining four proposed private crossings once easement discussions with those landowners resume.

Based on the proposed warning signs, the low frequency of trains crossings these roads, and the ongoing landowner discussions, impacts to the movement of farm machinery and equipment, landowner connectivity, and potential safety risks are expected to be less than significant.



CPUC STANDARD 1-X
PRIVATE RAILROAD CROSSING SIGN

PROPOSED INDUSTRY RAILROAD SPUR
CPUC STANDARDS

August 2013
28068052

Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE TRA-1

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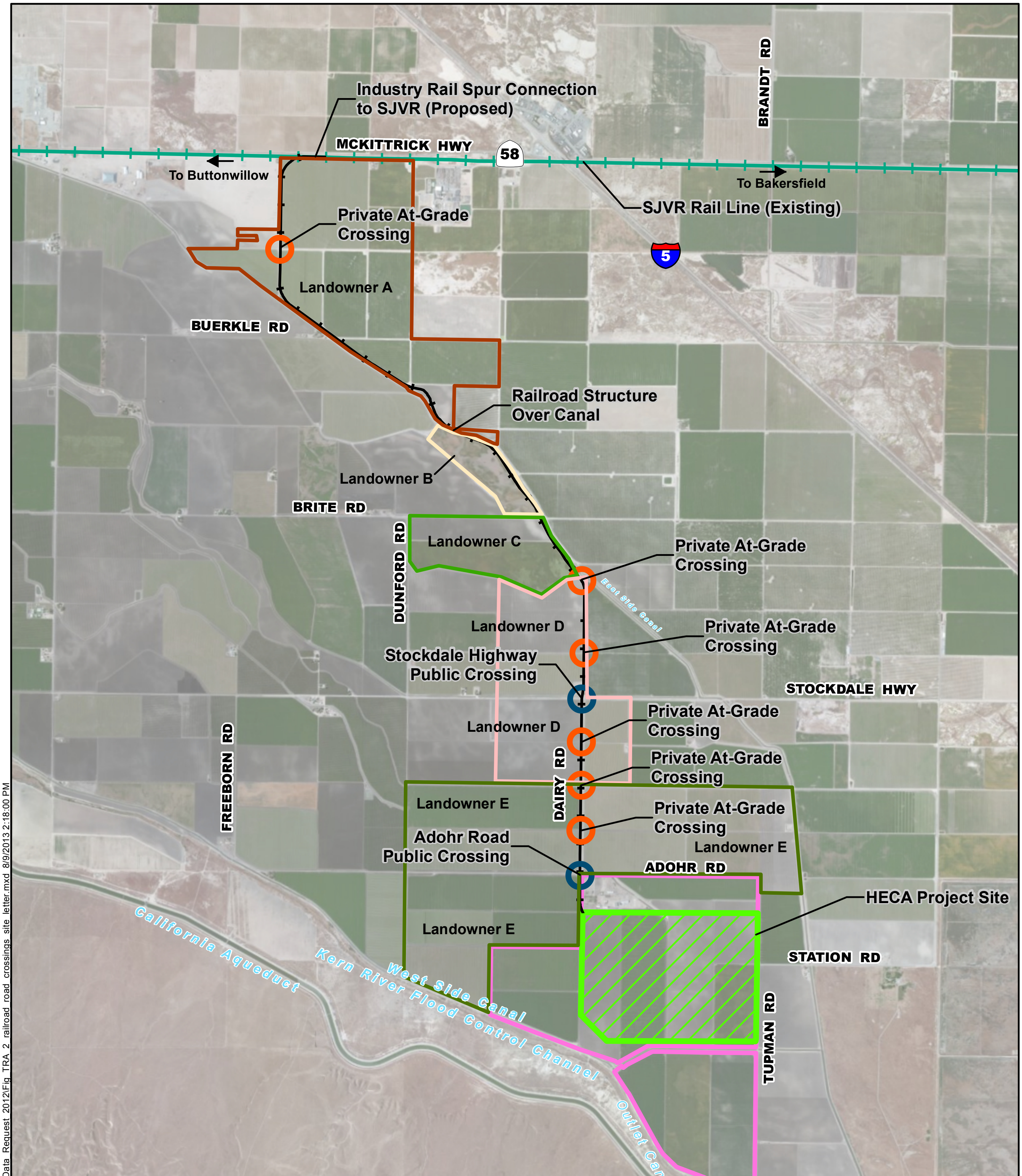

Project Site
Controlled Area
Industry Rails Spur (Proposed) - 5.27 Miles
SJVR Rail Line (Existing)

Railroad Public Crossing
Railroad Private Crossing

Note:
SJVR = San Joaquin Valley Railroad

0 2,000 4,000 FEET

N

PROPOSED RAILROAD AND ROAD CROSSINGS NEAR THE HECA PROJECT SITE

August 2013
28068052

Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE TRA-2

Source: Esri World Imagery, 2013

vsa U:\GIS\HECA\Projects\HECA 2012\Data Request 2012\Fig TRA 2 railroad road crossings site letter.mxd 8/9/2013 2:18:00 PM

Technical Area: Waste Management

INFORMATION REQUEST

WM-2. Staff needs the results of waste characterization tests in accordance with to Title 22, California Code of Regulations, Division 4.5, section 66262.10 on coal and petcoke mixes using the Mitsubishi gasifier in Japan using processing methods representative of those to be used for project operation. The purpose of the testing is to determine whether the gasification F72solids would be hazardous or non-hazardous. This information is needed to further evaluate how the waste can be disposed of and whether it is feasible to market the solids for other uses. The information should include a description of the waste stream, an evaluation of where the residual material is suitable for disposal, identification of facilities that would accept the volume of waste generated, a letter from the facility demonstrating they would accept the waste, and evidence the disposal of the waste would be in compliance with Kern County waste disposal requirements. If the project owner proposes to market the solids for use as Supplementary Cementitious Materials or other purposes, then a detailed report indicating what uses can be marketed and letters of intent from prospective purchases should be included.

RESPONSE

Beneficial reuse of the HECA GS remains the Project's primary intent. The Project has commissioned a study of the potential for beneficial use of the GS, which includes identification of potential off-takers for the GS (see Attachment WM-2-1). The study confirms the suitability of the GS for beneficial use at locations consistent with the information on shipping locations that was presented in Appendices C and D to the Updated Emissions and Modeling Report. This study also provides a description of the gasifier solids, results of the waste characterization tests, an evaluation of where the residual material is suitable for disposal, and an identification of facilities that would accept the volume of waste generated. Negotiations are progressing on an expression of interest from a broker/off-taker to accept the full volume of the HECA GS for beneficial reuse.

As part of the attached Market Analysis, HECA obtained samples of test GS generated by an operational pilot facility at MHI Nagasaki in Japan. To produce GS samples that would be representative of that from the operational HECA facility, the feedstock used for this analysis consisted of approximately 75 percent New Mexico subbituminous coal and 25 percent petcoke from southern California refineries. In addition, the Nagasaki pilot facility uses the same gasification process as the HECA Plant, both produced by MHI.

Samples of the GS materials were tested at a California-based certified lab for specific parameters required to characterize the mineral solids, including Total Threshold Limit Concentration (TTLC), Soluble Threshold Limit Concentration (STLC), and Toxicity Characteristic Leaching Procedure (TCLP); laboratory results are provided in Attachment WM2-1. As detailed in the Market Analysis, the concentrations present in GS material are significantly less than the regulatory limits, and are therefore nonhazardous based on the trace metals concentrations. Based on the composition and physical characteristics of the material, the GS from the full-scale HECA facility is expected to pass all California waste criteria tests including ignitability, corrosivity, reactivity, and toxicity analyses.

From the testing performed on HECA GS that are routinely performed on IGCC plant GS, it is expected that the GS material will meet all relevant California criteria to be classified as a nonhazardous waste. The TTLC testing shows the HECA slag concentrations are typically 1 percent of the regulatory limit to be classified as hazardous. The STLC and TCLP testing shows the HECA slag concentrations are typically 10 percent of the regulatory limit. Based on the mineral composition of glassy matrix and chemical character of the GS, acute aquatic tests for bio-toxicity were not performed because all testing methods showed the HECA mineral slag concentrations to be less than 10 percent of the regulatory limit.

Staff requested information about "a letter from the facility demonstrating they would accept the waste" and "letters of intent from prospective purchases." Negotiations are progressing on an expression of interest from a broker/off-taker to accept the full volume of the HECA GS for beneficial reuse. However, the Applicant does not anticipate that this information will be available prior to the preparation of the FSA.

ATTACHMENT WM2-1
MARKET ANALYSIS FOR GASIFICATION SOLIDS

Market Analysis of Potential Beneficial Re-use of HECA Gasifier Solids

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Louisville, KY

and

J. Groppo
Center for Applied Energy Research
University of Kentucky
Lexington, KY

June 30, 2013

Introduction

The Hydrogen Energy California Project (HECA) Plant is a 300 megawatt (MW) integrated gasification combined cycle (IGCC) power plant currently under development in Kern County, CA. In the IGCC process, coal and petroleum coke are ground to a fine size, introduced into a pressurized vessel along with oxygen and converted into syngas. The syngas is further shifted to hydrogen and carbon dioxide and then delivered to a gas treatment system where the carbon dioxide and impurities are removed. The hydrogen rich gas is combusted in a gas turbine to produce electricity with correspondingly low greenhouse gas and criteria pollutant emissions. As a result of the gasification process, the HECA plant will produce gasification solids, a glassy mixture of aluminum and silica fused together at the high temperatures achieved in the gasifier. Figure 1 is a schematic of the IGCC process.

Based on fuel conversion of the plant design, it is anticipated that the plant will produce up to 940 dry ton per day of gasification solids (GS). Based on a projected capacity factor of eighty five percent (85%), approximately 300,000 tons per year of GS will be generated. This study examined and reports on the potential beneficial uses for the volume of GS resulting from the HECA Plant.

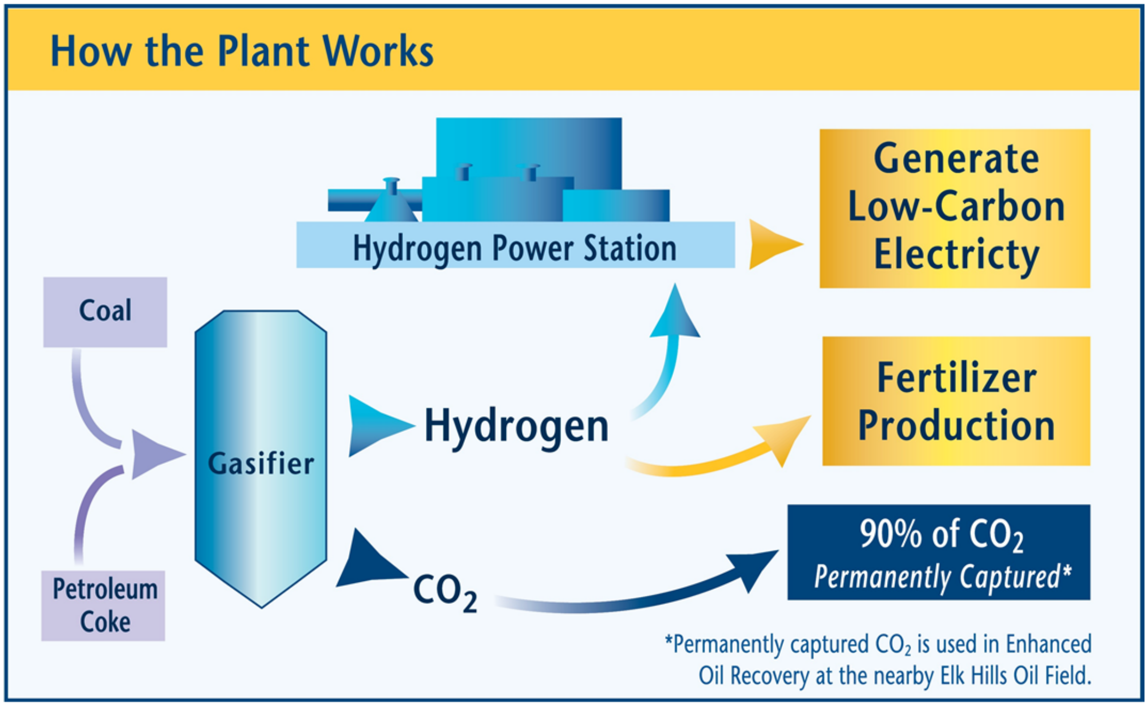

Figure 1. Diagram of Gasification.[1]

Executive Summary

The purpose of the study was to evaluate the market potential for beneficial use and to identify prospective customers for beneficial use of the HECA gasification solids. As part of the study, Charah received gasification solids samples produced by a Mitsubishi Heavy Industries (MHI) pilot plant in Nagasaki, Japan that tested the same solid fuel sources that HECA will process during actual operations. Charah processed the samples to perform laboratory analyses on the chemical character of the solids, prepared samples to meet the specifications of potential beneficial use applications, distributed samples to potential industry users, and performed technical reviews with specific industry manufacturers to determine the potential volumes of the GS that can be beneficially used. Charah completed a beneficial use evaluation and identified the regional re-use market potential to absorb the entire volume of gasification solids that would be produced by the HECA facility. Charah also had sample waste characteristic testing performed to identify how the material would be expected to be handled during any periods of time when the material may not be recycled. Samples of the GS materials were tested at a California based certified lab for specific parameters required to characterize the mineral solids, including Total Threshold Limit Concentration (TTLC), Soluble Threshold Limit Concentration (STLC), and Toxicity Characteristic Leaching Procedure (TCLP). The test results indicate the GS material is non-hazardous based on the trace metals concentrations.

Four probable market opportunities for re-use were identified and evaluated. Selection was based on criteria such as expected quantity and quality of the GS that will be produced, as well as location and knowledge of existing and emerging markets. The re-use opportunities and their approximate capacity are shown in the Table 1.

Table 1. Potential Re-use Opportunities for GS Material.

Market	Volume Potential (Tons per Year (TPY))	Number of Facilities	Location
Roofing Granules	300,000 to 400,000	8	<300 miles
Blasting Grit	100,000 to 200,000	4 distributors	within 250 miles
Cement Manufacture	550,000 to 2,200,000	11	Majority ≤170 miles
Ready Mix	200,000 to 500,000	>500	<200 miles

In summary

- Eight asphalt shingle manufacturing plants are located within 300 miles of the HECA gasification plant (Table 6 and Figure 5); the closest is Elk Corporation's facility in Shafter, CA located 26 miles away. Each of these locations would be a potential end-user of processed HECA frit.
- There are 4 blasting grit distributors within 250 miles of the HECA gasification plant. Information regarding the specific raw materials used for blasting grit, and manufacturing or processing capabilities by these distributors was unavailable. The processing, sizing and packaging of the general industry will be similar.
- Ground gasification solids are used to produce a dry sand blasting product that is essentially the same as commercial product Black Beauty with respect to chemical and physical characteristics. Chemical and physical properties of the HECA frit should be similar to commercial blasting grit products. Screening would be necessary to produce the coarse and medium size products while grinding would be necessary to produce the finer-size products and would only be considered if the regional market requires a finer blasting grit. Other commercial scale IGCC plants of similar size to HECA take 100 percent of the gasification product and beneficially utilize the material for sand blasting operations.
- There are 11 cement manufacturing companies in California and these companies source recycled material for some portion of their feed in order to reduce cost and improve product characteristics. Eight of these plants are within 170 miles distance from the

HECA gasification plant and have a combined potential usage rates of gasification slag of up to 1.6 million tons a year which is 5 times the HECA GS annual production volume.

- Testing of the material for use in the ready mix market was performed. The data indicated that the strength gain of the concrete using GS shows a trend similar to that of ordinary Portland cement concrete and exceeds 4,000 psi at an age of 28 days. The strength performance of the processed GS material means that this product can act as a cement replacement in concrete, should be considered an alternate "other cementitious material" (OCM), and has the potential to be classified as an OCM. As an OCM, the utilization potential is tied to cement usage within the economic transport radius for pozzolans or ground granulated blast furnace slags. The estimated usage of OCMs within a 200 mile radius of the HECA facility could reach 200,000 to 500,000 ton per year.

Properties and Uses for Gasification Solids

"Gasification Solids" refers to the solid by-product generated from the gasification of carbonaceous feedstocks including coal and petroleum coke. During the gasification process, most of the hydrocarbons in the fuel are converted to the gaseous phase while the inorganic components melt into a viscous slag. This molten slag is periodically removed from the gasification vessel and rapidly quenched resulting in a fine-grained, vitreous by-product. In many gasification plants the gasification solids (GS) are comprised of two distinct mineralogical phases; a high carbon-content char and a low carbon-content frit. Often the frit component is much coarser than the char component, a characteristic that can be exploited in order to enable utilization.[2] The MHI technology recycles the high carbon-content char to the process eliminating the need to dispose or recycle this stream. Characteristics and beneficial use of the coarse frit component is the primary focus of this report.

Sample Acquisition and Physical/ Chemical Testing

In order to make an assessment of the marketability of the gasification solids that will be produced by the HECA gasification plant, it was necessary to obtain a sample of test GS generated by the pilot facility at MHI Nagasaki in Japan, using the same fuels supply as will be utilized by the HECA Plant. The fuel consists of approximately 75 percent of El Segundo coal and 25 percent Santa Maria petcoke. The pilot facility utilizes the same gasification process as the HECA Plant, both produced by MHI. After an outage, when all other coal sources and the resulting by-products were purged out of the system, MHI conducted a test using the HECA coal and petcoke source. HECA arranged for the shipping of 13 - 55 gallon drums of the GS from the pilot test to Charah's lab in Louisville, Kentucky. The GS materials have been analyzed for particle size and the results are typical for GS products. The resultant slag was collected and shipped back to the U.S. for testing and analysis.

Figure 2 shows pictures of resultant coal gasification solids in various contexts. Figure 3 shows a SEM photomicrograph of coal gasification frit from another IGCC sample (not the frit from the MHI pilot facility). The GS anticipated to be produced at the HECA plant are anticipated to have similar characteristics to the frit shown in Figure 3. The results of moisture content, loss on ignition (LOI), and free liquids testing performed are given in Table 2. These results were performed on representative samples obtained from each of the 13 drums of material. Constituent components of the GS from the MHI pilot facility are provided in Table 3. Additional testing of the material conducted by Charah indicated similar results. The gradation of the material is shown in Figure 4. This gradation is the average of 13 sieve analyses performed on the material.

Figure 2A. Raw slag in shipment container.

Figure 2B. Raw slag.

Figure 2C. Graded slag.

Figure 2D. Large slag particles.

OC\1669191.1

Figure 2E. Fine and graded particles.

Figure 2. Gasification Solids from MHI pilot facility trial in various contexts.

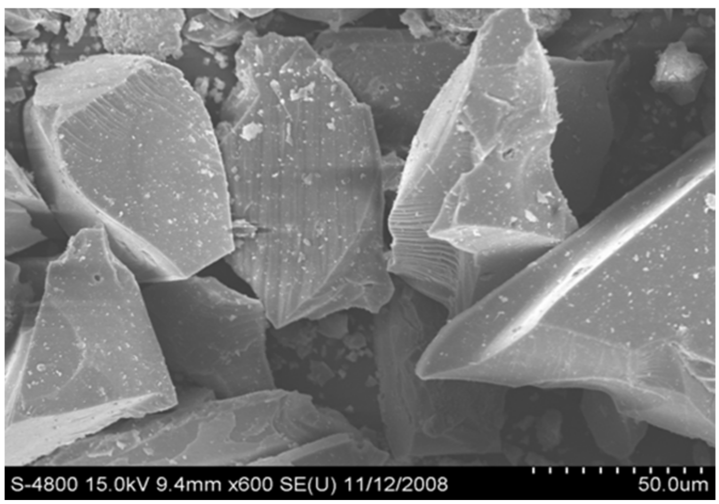

Figure 3. SEM Photomicrograph of Coal Gasification Solids. (Note: particles in this image are pieces of crushed larger particles)

Table 2. Moisture Content, Loss on Ignition, and Free Liquids Test Results of GS Material As-Received.

Drum Number	Moisture Content (%)	Loss on Ignition (%)	Free Liquids? (Yes/No)
1	1.6	0.2	No
2	2.4	0.5	No
3	2.6	0.7	No
4	2.7	0.5	No
5	2.2	0.4	No
6	2.0	0.3	No
7	1.3	0.3	No
8	1.4	0.5	No
9	1.0	0.4	No
10	1.2	0.4	No
11	4.0	0.6	No
12	1.3	0.3	No
13	1.9	0.7	No
High	4.0	0.7	
Low	1.0	0.2	
Average	2.0	0.4	
Standard Deviation	0.8	0.2	

Table 3. Physical/Chemical Properties of the GS after a Trial at MHI Pilot Facility Utilizing the Coal and Petcoke Source for the HECA Plant.

Tests	Result	Unit	Method
AA Basis	Dry		ASTM D 4326
Aluminum Oxide Al2O3	23.72	%	ASTM D 4326
Barium Oxide BaO	0.14	%	ASTM D 4326
Calcium Oxide CaO	8.36	%	ASTM D 4326
Iron Oxide Fe2O3	7.07	%	ASTM D 4326
Magnesium Oxide MgO	1.16	%	ASTM D 4326
Phosphorus Pentoxide P2O5	0.07	%	ASTM D 4326
Potassium Oxide K2O	1.01	%	ASTM D 4326
Silicon Dioxide SiO2	56.05	%	ASTM D 4326
Sodium Oxide Na2O	0.59	%	ASTM D 4326
Strontium Oxide SrO	0.10	%	ASTM D 4326
Titanium Dioxide TiO2	0.95	%	ASTM D 4326
Manganese Oxide MnO2	0.05	%	ASTM D 4326
Sulfur, Sulfite	0.33	%	ASTM E 1915
Carbon Dioxide	0.35	%	ASTM E 1915
Loss on Ignition	0.40		ASTM D 7348B

Sample Notes:
Sum = 100.00%
Other = <0.01%

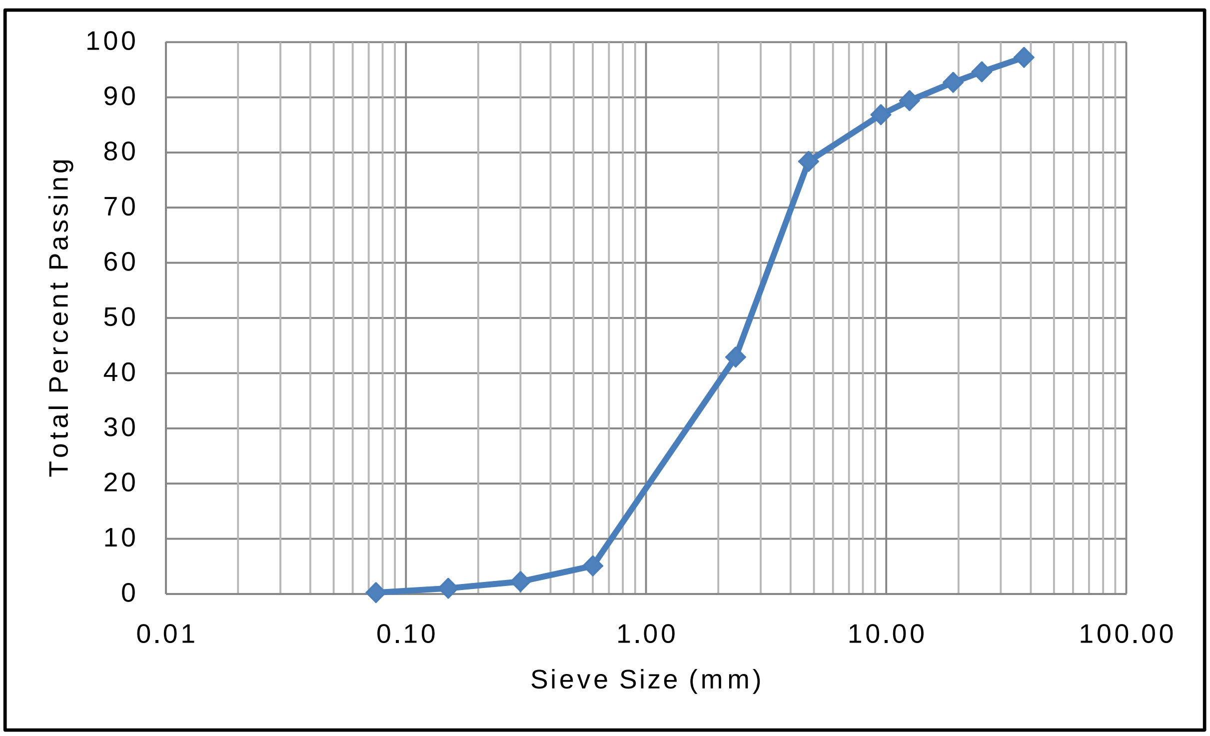

Figure 4. Average gradation of GS from MHI pilot facility trial.

In order to complete the study of utilization potential for the HECA GS materials, samples of the material were sent to laboratories that specialize in analysis of cement manufacturing raw feed materials for development of data to assess the cement utilization potential. A sample of HECA GS was sent to SGS North America Inc, Mineral Services Division for analysis for use in cement manufacturing. Table 3 shows the results of the analysis. To determine the potential for use as a sand blasting grit and roofing shingle granule, samples were prepared to match the specification of the products currently used for these industry applications and the prepared samples will be provided to industrial manufacturers to evaluate in their respective production scenarios.

Markets Evaluated

Table 4 shows potential uses for the GS material. Four of the most probable uses were selected from this list for more detailed consideration as potential markets for gasification solids that will be generated at the HECA gasification plant. Selection was based upon criteria such as expected quantity and quality of the solids that will be produced, as well as location and knowledge of existing and emerging markets. The four uses selected were:

Roofing Granules
Blasting Grit
Cement Manufacture
Ready Mix Concrete Admixture

Utilization of coal gasification slag has been the subject of numerous investigations for many years. As a result, many uses for this material have been suggested and evaluated.[3,4] A list of potential products and uses described in literature are shown in Table 4. Included with this list is the type of processing that would be necessary in order to produce a product suitable for these uses. The extent of processing ranges from essentially ‘none’ for applications such as drainage media for erosion control or cement additive to ‘extensive’ for use as lightweight aggregate.

Table 4. Summary of Uses for Gasification Slag.		
Product	Uses	Processing Required
Road Base and Sub-base	base in pavement construction	screening and grinding
Stabilized Base Aggregate	blend aggregate w/ cementitious material to bind aggregate	remove pyrite, screen to size, control moisture
Embankment or Backfill Material	structural fill for highway embankments, backfilling, abutments, retaining walls, trenches or as pipe bedding	optimum moisture content,
Flowable Fill Aggregate	low compressive strength mixes	minimum
Asphalt Ingredient	aggregate in asphalt mix	screening, minimize moisture
Slag Lightweight Aggregate (SLA)	in lightweight concrete products, i.e. roofing tiles, blocks, loose fill insulation structural concrete,	Expanded by heating under controlled conditions. Size controlled by grinding and pelletizing before expansion.
Ultralightweight Aggregate (ULA)	insulating concrete	Similar to SLA
Masonry Block Aggregate	aggregate in masonry block manufacture	Size, control staining potential
Sand Aggregate	replacement for sand in various applications	Sizing, moisture content
Roofing Granules, Blasting Grit	raw material for finished product	Varies: sizing, grinding
Cement Manufacturing	raw kiln feed component	none
Mining Backfill	backfill mining voids	none
Concrete Aggregate	aggregate component for concrete	sizing
Drainage Media	erosion control	none
Anti-Skid	surface component for asphalt	crushing, sizing
Mineral Filler	Additive in plastics, foams, etc.	fine grinding, classification
Mineral Admixture	pozzolanic admixture for concrete	fine grinding, classification
Plaster Soil Additive	soil modifier	fine grinding
Waste Stabilization	improve soil cohesion	grinding

Roofing Granules

The asphalt roofing manufacturing industry utilizes mineral fillers and aggregates in the manufacture of asphalt roofing shingles. Mineral fillers are utilized in the asphalt matrix that coats the paper and mineral aggregates are utilized for making the coarse granular surface that is exposed to the weather and exposed to the surface in the under-shingle area, sometimes referred to as the “head-lap” portion of the shingle. The mineral granules utilized for the surface coating need to have sufficient hardness to withstand the weather impacts and need to stable appearance to avoid color change under the long term UV light exposure. Coal combustion byproduct slags from certain type boilers are commonly used to manufacture roofing granules. To utilize the coal combustion byproduct, the “as produced” slag must be processed to remove the fines and size the product to the desired gradation used for the roofing shingle.

As noted above, roofing granules refer to the graded particles pressed onto the surface of asphalt shingles to protect the shingle from solar and environmental degradation as well as provide an aesthetically pleasing appearance. Reed Materials, Inc. was the first company in the US to convert coal utility slag into roofing granules used for asphalt shingles. Reed Materials was acquired by Harsco Corporation in 1983[5] and is currently known as Harsco Minerals International, a leading supplier of roofing granules in the US. Desired raw material properties for their finished product are summarized in Table 5 and these data are compared to HECA processed frit. As evidenced in the table, physical characteristics of the HECA frit (density, bulk density, hardness and leaching potential) meet or exceed Harsco Minerals specifications. Other specifications (top size, bottom size, LOI, staining potential and breakdown) will be satisfied by proper processing that ensures efficient screening and adequate water to remove soluble impurities.

Table 5. Desired Raw Material Properties for Roofing Granules.

Parameter	Harsco Minerals Specs	HECA Processed Frit
Top Size	<2% +1/2"	OK
Bottom Size	<1% -50 mesh	OK
Density	2.60 g/cm^3	2.6 to 2.8 g/cm^3
Bulk Density	>80 lbs/ft^3	90-95 lb/ft^3
Staining Potential	<4 stains/ft^2	OK
Barrett Hardness	+60%	No Data Available
Breakdown	<2%	No Data Available
LOI	<1%	<1%
Mohs Hardness	>6	6-7
Leaching	TCLP Compliant	TCLP Compliant

There are eight asphalt shingle manufacturing plants within 300 miles of the HECA gasification plant (Table 6 and Figure 5); the closest is Elk Corporation's facility in Shafter, CA located 26 miles away. Each of these locations would be a potential end-user of processed HECA frit.

Table 6. Location of Asphalt Shingle Plants Closest to HECA Gasification Plant.		
Company	Location	Distance from HECA Plant, miles
Elk Corp.	Shafter , CA, Kern County	26
Celotex Corporation	Los Angeles, CA Los Angeles County	123
GS Roofing Company, Inc	Southgate, CA Los Angeles County	133
Owens Corning	Compton, CA, Los Angeles County	137
GS Roofing Company, Inc	Wilmington, CA, Orange County	141
GAP Materials Corp.	Fontana, CA, San Bernardino County	165
Celotex Corporation	Fremont, CA, Alameda County	242
Pabco Roofing	Richmond, CA, Contra Costa County	272

Figure 5. Location of asphalt shingle manufacturing plants relative to the HECA Plant.

The GS material from HECA has many of the physical and appearance characteristics of coal combustion slags and therefore the GS materials offer the same utilization potential. Using the same approach described for blasting grit, GS from the MHI pilot facility were ground and sieved into numerous size fractions and blended to match the size specifications of roofing granules, specifically #11 Roofing Granules supplied by 3M Corporation. A comparison of the roofing granules derived from the pilot facility and 3M #11 is shown in Table 7. Both products were essentially identical with respect to relevant product specifications including dust, moisture, Mohs Hardness, bulk density and specific gravity. The only significance was in color; 3M roofing granules are available in various colors while HECA slag derived roofing granules would likely be limited to black.

Table 7. Comparison of 3M #11 Roofing Granule Specs and Processed Mitsubishi Gasification Slag.

Specification		% Retained Specifications			HECA Slag
U.S. Sieve No	**Nominal Opening**	Minimum	**Maximum**	**Typical**	
8	**2.36 mm**	0.0	0.1	-	0.0
12	**1.70 mm**	4.0	10.0	-	5
16	**1.18 mm**	-	-	30 – 50	40
20	**850 µm**	-	-	20 – 40	30
30	**600 µm**	-	-	10 – 30	20
40	**425 µm**	-	-	1 – 10	5
-40	**-425 µm**	0.0	2.0	-	0.0
Dust, <100 Mesh		-	0.2%		<0.2%
Moisture		-	0.3%		<0.3%
Mohs Hardness				6 to 7	6 to 7
Bulk Density, lb/ft3				94 to 100	95
Specific Gravity				2.60 – 2.75	2.65
Colors				Various	Black

Based on the experience of slag utilization in the coal combustion byproduct market and the test characteristics of the processed HECA GS materials, the roofing shingle manufacturing industry is a good candidate for utilization of the processed GS materials. Since the typical roofing shingle plant can utilize up to 50,000 to 100,000 tons per year of mineral fillers for granules, this market can serve as user of large quantities of GS material.

Since roofing shingles utilize different colors for each color of shingle, the black color of the HECA GS materials would limit the uses of the granules to shingles which utilize black granules. This color is the most used color among all roofing granules. With 8 manufacturing plants in the California market area of HECA it is estimated that 300,000 – 400,000 tons per year of roofing granules could be consumed by area plants.

Blasting Grit

The sandblasting of metal surfaces to prepare the metal surface for painting or coatings requires granular abrasives be propelled through an air jet to impinge upon the metal surface with enough force to dislodge the existing surface paint, rust or other coatings. Abrasives are usually of mineral composition with angular surfaces and a hardness that allows the granule to cut the surface coatings during a sandblasting operation. Sandblasting abrasives and media are specified by the Society of Protective Coatings. The applicable specification is the "Abrasive Specification No 1- Minerals and Slag Abrasives." Abrasive blasting utilizes high pressure air to impinge media against the surface to be cleaned. Examples of large-scale applications include bridge or cargo ship corrosion removal and surface preparation for painting. In these types of applications, the abrasive media used is frequently slag produced by coal-burning cyclone boilers. The slag is collected, possibly crushed, screened into a variety of size fractions and dried to produce a range of products for a variety of cleaning applications.

The key specification requirements under the Abrasive Specification No 1 are summarized below. The abrasives are intended for one time use. Abrasives are categorized into two types, three classes and five grades depending on the type of material, level of crystalline silica and grades of cutting depth when used on metal surfaces. Type I abrasives include natural minerals. Type II abrasives include slags byproducts from coal combustion and some foundry slags. The HECA slag is categorized as a Type II Slag Abrasive. The Classes of abrasives A, B, or C are determined by the level of crystalline silica found in the slag with Class A ≤ 1.0%, Class B ≤ 5.0% and Class C Unrestricted.

Four blasting grit distributors within 250 miles of the HECA Plant were identified:

- Kleen Blast
  Rancho Cucamonga, CA
- Kleen Industrial Services
  Danville, CA
- Media Blast & Abrasive. Inc.
  Brea, CA
- Manufacturer's Service, Inc. (MSI)
  South El Monte, CA

Based on Charah's experience in processing blasting grit at other locations in the US, it is assumed that the processes are in general equivalent and that HECA GS will be equivalent to alternate materials used in the current blasting granule production at each of the processors.

The specifications of several commercial slag-derived blasting grit products are summarized in Table 8 and compared to the frit that is likely to be produced by the HECA gasifier. Chemical and physical properties of the HECA frit should be similar to commercial blasting grit products. Screening would be necessary to produce the coarse and medium size products while grinding would be necessary to produce the finer-size products and would only be considered if the regional market requires a finer blasting grit. Size analysis of blasting grit is shown in Figure 6.

Table 8. Comparison of Blasting Grit Specifications.

Product Name	Blackblast[6]	Patriot-Blast[7]	Airblast[8]	Black Beauty[9]	Black Magic[10]	HECA GS
Supplier	Opta Minerals	Ensio Resources	Airblast B.V.	Harsco Minerals	Target Products	Coal/Pet Coke Fuel
Chemical Composition						
SiO_2, Total %	46.5	48.8	45 – 52	47.2		56
Al_2O_3, %	22.5	21	24 – 31	21.4		24
Fe_2O_3, %	19	19.1	7 – 11	19.2		7
CaO, %	5.5	6	3 – 8	6.8		8
LOI, %	3					-
MgO, %	1	1	2-3	1.5		<1
K_2O	1	1.7	2 – 5	1.6		1
TiO_2, %	1	1	0 -2	1		1
SiO_2,Crystalline,%	<1.0	<1.0	<1.0	<1.0	<0.2	<1
Physical Characteristics						
Color	Black	-	Brown/black	Black	Black	Black
Bulk Density, lb/ft^3	90	75 to 100	2.4 to 2.6 kg/m3	75 to 100	80 to 95	90-95
Grain Shape	Angular	Angular	Angular	Angular	Angular	Angular to Rounded
Solubility	Insoluble					Insoluble
Mohs Hardness	>7	6 to 7	7	6 to 7	6.5 to 7	>6
Specific Gravity	-	2.7	-	2.7	2.85	2.6 to 2.8
Product Sizes, mesh						
Coarse	4	-	-	30	12	See Figure 6
Medium	28	32	-	28	24	See Figure 6
Fine	20	34	-	20	30	See Figure 6
Extra Fine	30	40	-	30	20	See Figure 6
Super Fine	100	50	-	-	-	See Figure 6

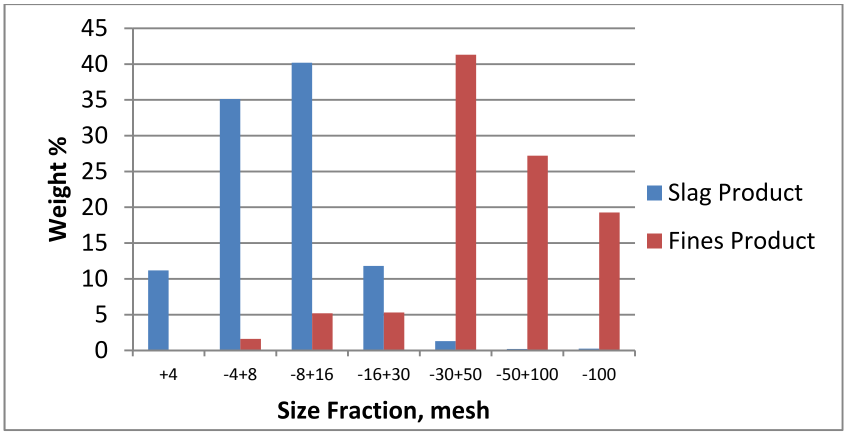

Figure 6. Size analysis of typical blasting grit samples.

Table 9 summarizes specifications for Black Beauty™, a commercial blasting grit supplied by Reed Minerals. Black Beauty™ is available as several products, differing in their size gradation. Two Black Beauty™ products were selected for comparison; Fine and Extra Fine. These specific products were selected as most appropriate to match the size distribution resulting from grinding GS from the MHI pilot facility. Approximately 20 kg of GS from the MHI pilot facility ground and dry sieved into numerous size fractions. Size fractions were then combined to generate 5 kg samples of products matching the size distribution of Black Beauty™ Fine and Extra Fine blasting grit. The prepared HECA Fine and Extra Fine blasting grit samples were then characterized to directly compare chemical and physical properties to the corresponding Black Beauty™ products as summarized in Table 9.

Comparing chemical composition, the HECA products had higher silica content and lower iron content. Other major chemical components were quit similar. Comparing physical characteristics, HECA products were also quite similar. In summary, blending ground HECA gasification slag will produce a product that is essentially the same as Black Beauty™ with respect to chemical and physical characteristics. The major difference would be in chemical composition, with Black Beauty™ containing lower silica and higher iron.

Table 9. Comparison of Black Beauty Product Specs and Processed Mitsubishi Gasification Slag.				
Product Name	**Black Beauty Fine**	**HECA Fine**	**Black Beauty Extra Fine**	**HECA Extra Fine**
Supplier	**Sil Industrial Minerals, Reed Minerals**	**Charah**	**Sil Industrial Minerals, Reed Minerals**	**Charah**
Chemical Composition				
SiO2, Total %	47.2	56.1	47.2	56.1
Al2O3, %	21.4	23.7	21.4	23.7
Fe2O3, %	19.2	7.1	19.2	7.1
CaO, %	6.8	8.4	6.8	8.4
MgO, %	1.5	1.1	1.5	1.1
K2O	1.6	1.0	1.6	1.0
TiO2, %	1.0	1.0	1.0	1.0
SiO2, Crystalline, %	<1.0	?	<1.0	?
Physical Characteristics				
Color	Black	Black	Black	Black
Bulk Density, lb/ft3	75 to 100	80 to 85	75 to 100	80 to 85
Grain Shape	Angular	Angular	Angular	Angular
Mohs Hardness	6 to 7	6 to 7	6 to 7	6 to 7
Specific Gravity	2.7	2.65	2.7	2.65
Product Sizes, mesh	-20 + 40	-20 + 40	-30 + 60	-30 + 60

The Tampa Electric Company (TECO) Polk Power Station, located approximately 40 miles southeast of Tampa in Polk County, Florida, began commercial operation in 1996. The Polk Power Station utilizes a IGCC process similar to the one under consideration at the HECA Plant. Anchor Sandblasting and Paint (Anchor), located in Tampa, Florida, is currently taking 100 percent of the Polk Power Station gasification coal product and beneficially utilizing the material for sand blasting operations. A similar market application would be suitable for the HECA GS.

Cement Manufacturing

Portland cement is a versatile construction material manufactured from raw materials containing primarily calcium, aluminum, silicon and iron. At the high temperatures present in a cement kiln, essentially all of the components of the raw ingredients are either driven off in gaseous form or converted to an oxide mineral form. There are a variety of ways to represent cement minerals, some of which are summarized in Table 10.

Table 10. Summary of the different ways to represent some cement minerals and products.

Chemical Name	**Chemical Formula**	**Oxide Formula**	**Cement Notation**	**Mineral Name**
Tricalcium Silicate	Ca_3SiO_5	$3CaO.SiO_2$	C_3S	Alite
Dicalcium Silicate	Ca_2SiO_4	$2CaO.SiO_2$	C_2S	Belite
Tricalcium Aluminate	$Ca_3Al_2O_6$	$3CaO.Al_2O_3$	C_3A	Aluminate
Tetracalcium Aluminoferrite	Ca_2AlFeO_5	$4CaO.Al_2O_3.Fe_2O_3$	C_4AF	Ferrite
Calcium hydroxide	$Ca(OH)_2$	$CaO.H_2O$	CH	Portlandite
Calcium sulfate dihydrate	$CaSO_4.2H_2O$	$CaO.SO_3.2H_2O$	$C\bar{S}H_2$	Gypsum
Calcium oxide	CaO	CaO	C	Lime

The raw materials that provide the calcium, silicon, aluminum and iron can come from a variety of sources, as shown in Table 11. Selection of the specific sources utilized balances a number of parameters including chemistry, availability and cost. When available, coal combustion ash is frequently used as a source of silicon and aluminum. Similar considerations are appropriate for the use of gasification frit as a raw material for Portland cement manufacture.

Table 11. Examples of raw materials used for Portland cement manufacturing.

Calcium	**Silicon**	**Aluminum**	**Iron**
Limestone	Clay	Clay	Clay
Marl	Marl	Shale	Iron ore
Calcite	Sand	Fly ash	Mill scale
Aragonite	Shale	Aluminum ore refuse	Shale
Shale	Fly ash		Blast furnace dust
Sea Shells	Rice hull ash		
Cement kiln dust	Slag		

Table 12 presents the chemical composition of a coal combustion bottom ash that would be desirable for use as kiln feed for manufacturing Portland cement. As described in Table 11, the primary beneficial components are Si and Al. For comparison, the composition of processed gasification frit is also listed in Table 12. Although lower in both Si and Al when compared to bottom ash, gasification frit does represent a potential source for Si, Al and Fe, all of which are necessary for producing Portland cement. However, trace element composition is also an important consideration when selecting raw material candidates.

Table 12. Comparison of Desirable Bottom Ash Characteristics for Cement Kiln Feed with Processed Gasification Solids Characteristics.

Compound, %	Bottom Ash	Coal Gasifier Fuel
SiO_2	60.5	56
Al_2O_3	26.8	24
Fe_2O_3	4.7	7
TiO_2	1.4	1
CaO	2.2	8
MgO	1.0	1
K_2O	2.4	1
Na_2O	0.6	1
SO_3	0.05	0.3
P_2O_5	0.2	0.1
SrO	0.1	-
BaO	0.2	-
MnO_2	0.02	-
LOI	1.91	0.4

As shown in Table 13, elevated concentrations of even minor compounds can have a detrimental effect on Portland cement properties.[11]

Table 13. Comparison of Typical Portland Cement Clinker and Gasification Solids Compositions.			
Compound	Portland Cement	Coal/Petcoke GS	Effect of Compounds at Concentrations Found in Clinker
Major Compounds, %			
SiO_2	21.1	44-46	
Al_2O_3	5.6	12-18	
Fe_2O_3	3	9-13	
CaO	65.5	5-9	
Minor Compounds, %			
MgO	1.5	1.2-6.3	>5% can crystallize out from flux as periclase causing poor long term durability
K_2O	0.7	0.5-2	
SO_3	0.8	1.9-3.7	
Na_2O	0.16	1-1.3	>0.6% produce expansive gel causing cracking and premature failure
TiO_2	0.27	0.8-1	>1% inhibits early strength development
Mn_2O_3	0.06	0.03-0.1	>0.5% reduces early strength
P_2O_5	0.1	0.1-0.3	>1% causes reduction of C_3S formation
SrO	0.09	<.01-0.15	2.5% maximum to prevent reducing free lime due to conversion of C_3S to $(CSr)_2S$ and free lime
Minor Compounds, ppm			
ZnO	120		0.01 to 0.2% increases reactivity of C_3A and leads to setting time problems
Cr_2O_3	103	1,250-1,750	4,000 ppm increases alite and belite crystal size causing increase in 28 day strength due to reduction in free lime. >5,000 ppm increases free lime as alite transforms to belite
Cl	90		
As_2O_3	56	10-40	
CuO	55	<1-35	
PbO	16	20-3,200	<1,000ppm to prevent set or hardening problems
CdO	0.5	1	
Ni		3,400-4,000	
LOI	0.05	0.4	

Figure 7 illustrates the location of cement manufacturing facilities in California. Their distance from the HECA gasification plant is presented Table 14, along with potential usage rates of gasification slag. There are three cement plants within 100 miles of the HECA gasification plant, each with a potential usage rate of 40,000 to 160,000 tons per year (tpy).

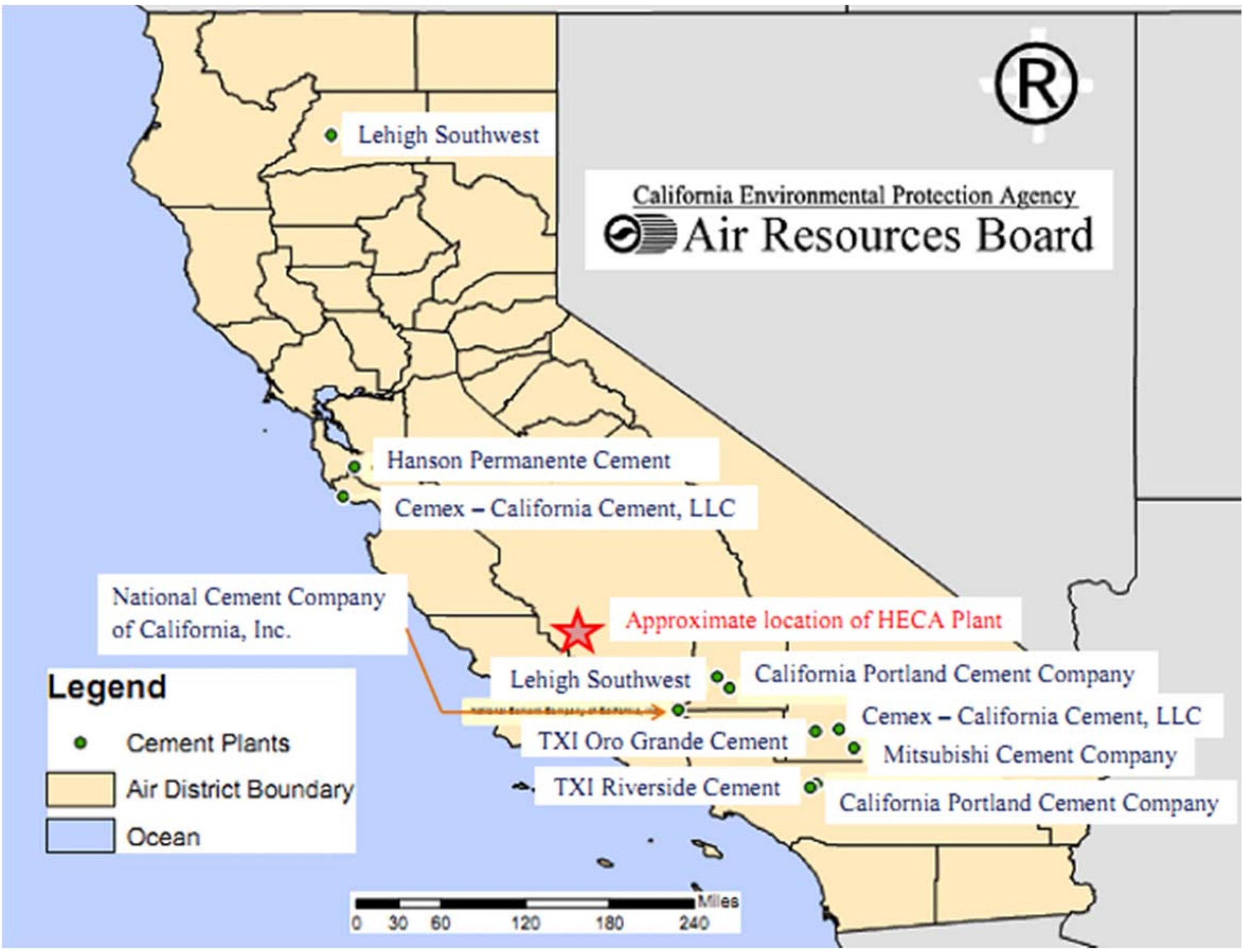

Figure 7. Location of Cement Manufacturing Facilities near the Proposed HECA Gasification Plant.[12]

Table 14. Location, Capacity and Potential Gasification Solids Usage Rate of Cement Plants in California.					
Company	**Cement Plant Location**	**Distance from Bakersfield, miles**	**Capacity tpy**	**Potential Gasification Solids Usage Rate, tpy**	
				Low end (5%)	**High end (20%)**
Lehigh Southwest Cement Co.	Tehachapi, CA	40	>800k	40,000	160,000
CalPortland	Mojave, CA	60	>800k	40,000	160,000
National Cement Co. of California	Encino, CA	100	>800k	40,000	160,000
CEMEX	Victorville, CA	135	>800k	40,000	160,000
Texas Industries Inc.	Oro Grande, CA	130	2.1 Million	105,000	420,000
CalPortland	Colton, CA	165	>800k	40,000	160,000
Texas Industries Inc.	Riverside, CA	170	400k - 800k	30,000	120,000
Mitsubishi Cement Corporation	Lucerne Valley, CA	160	1.5 Million	75,000	300,000
Hanson Permanente Cement	Cupertino, CA	250	1.6 Million	80,000	320,000
CEMEX	Davenport, CA	260	400k - 800k	30,000	120,000
Lehigh Southwest Cement Company	Redding, CA	440	400k - 800k	30,000	120,000
Total				550,000	2,200,000

Portland Cement Replacement

The use of concrete admixtures to replace a portion of the cement is a commonly specified application within the US concrete industry. The use of "Other Cementitious Materials" (OCMs) that can replace cement in manufacture of ready mixed concrete include fly ash ground slags. The use of cement in the US market totaled just under 81 million tons in 2012 which is down substantially from the peak usages in 2005-2008 prior to the housing downturn. Figure 8 shows the US Cement usage over recent years.

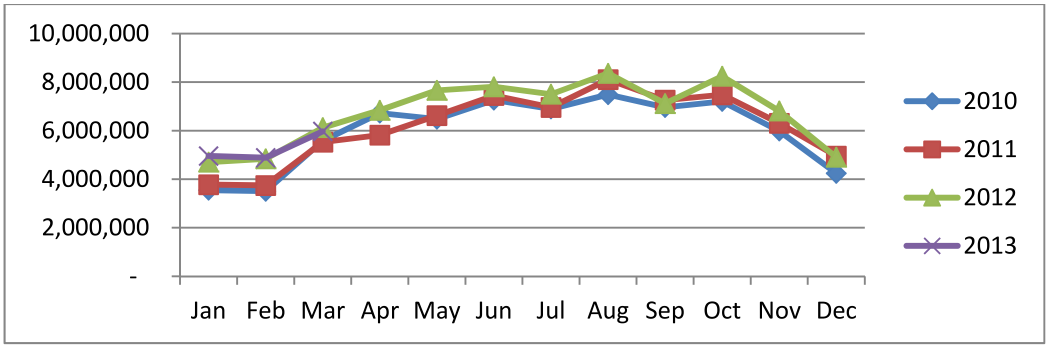

Figure 8. Monthly cement usage in US from 2010 to 2013 (year to date).

Cement consumption in California and the western states that can be served by OCMs are shown in Table 15 and show a total consumption of approximately 11.5 MM tons of cement in 2012 of which 65% was consumed in California. On a per capita basis approximately 0.20 tons of cement was utilized in California for each of 38 million people (over 7 MM tons per year). As discussed in the next section the market potential for material such as GS is about 30% of market for cement or about 2 MM tons/year.

Table 15. Cement Consumption in California and Other Western States.

State	2012 Cement Consumption* (% of tot.)		2012 Cement Tons/Person
Washington	1,378,043	12%	0.200
Oregon	578,589	5%	0.148
California	7,535,037	65%	0.198
Montana	312,211	3%	0.311
Idaho	353,822	3%	0.222
Nevada	1,045,762	9%	0.379
Wyoming	315,394	3%	0.547
TOTALS	11,518,858		0.210

***Figures based on 2012 data from the U.S. Census Bureau Population Estimates and the USGS Mineral Industry Surveys. Cement consumption values are the sum of portland, blended, and masonry cements.**

The HECA GS material has the chemical characteristics that match the constituents of granulated blast furnace slag and coal combustion byproduct fly ash. Charah reviewed the potential for manufacturing a cementitious material that can be used as a pozzolan in ready mixed concrete. Pozzolans that are routinely used in ready mixed concrete include Class F fly ash, Class C fly ash and ground granulated blast furnace slag (GGBF Slag). All three cementitious materials have a powder like appearance and typically have physical size characteristics similar to cement. The specification for pozzolans used in concrete are described in ASTM C-618 which identify the chemical and physical properties required to be an approved pozzolan. The California Department of Transportation (CalTrans) is the approval authority for pozzolans that are allowed in concrete purchased for state projects such as highways and bridges. The Cementitious Material Prequalification Program for CalTrans is provided in Section 90 of the Caltrans Standard Specifications. Use of OCMs in the production of concrete offers an attractive beneficial use alternative for GS materials provided the chemistry matches the needs for OCMs and the performance in concrete is demonstrated. The use of cement in the manufacture of concrete in California is a good indicator of the potential market for OCMs which could include processed GS materials. Table 16 shows the cement usage for California and the estimated usage for fly ash based national averages for replacement of cement and an estimate for potential processed GS material usage based on normal replacement ratios for slag materials which similar performance characteristics.

Table 16. Cement, Fly Ash, and estimated GS Admixture Usage in California.

2012 Totals (ton)						
Location	Portland Cement Consumption	Blended Cement Consumption	Masonry Cement Consumption	Total Cement Consumption	Estimated Fly Ash Usage	Estimated Processed GS Admixture Usage
N. California	2,563,976	48	34,474	2,598,498	363,790	636,632
S. California	4,804,058	0	132,481	4,936,539	691,115	1,209,452
California Total	7,368,034	48	166,955	7,535,037	1,054,905	1,846,084

In order to determine the potential for use of the GS as a possible replacement for Portland cement, Charah processed HECA GS materials. A sample of the GS was ground to pass a #20 mesh screen and a portion of this sample was delivered to Irving Materials, Inc. (IMI) for use in Portland cement concrete. The ground GS was incorporated as a 30% replacement for Portland cement in a trial batch of concrete mixed under laboratory conditions. The mix design for the trial batch was a 4000 psi mix without air-entrainment and is given in Table 17. As can be seen, the water-cementitious materials ratio (w/cm) was 0.54 (288 lb. water/ (380 lb. Portland cement + 160 lb. ground GS)) and the ground GS accounted for 30 percent (160 lb. ground GS / (380 lb. Portland Cement + 160 lb. ground GS)) of the cementitious materials.

Table 17. Mix Design for Concrete Batch Incorporating Ground GS.

Component	Quantity/Dosage
Type I/II Portland Cement	380 lbs.
Ground GS	160 lbs.
#57 Coarse Aggregate	1840 lbs.
Fine Aggregate	1400 lbs.
Water	288 lbs.
PS 1583 Water Reducer	2 oz./cwt. of cementitious

Sixteen cylinders were made from the batch and tested for compressive strength at 3, 7, 28, and 56 days, with two cylinders being tested at each age. The results of this testing are shown in Figure 9, where the strength at each age is the average of the two cylinders. It can be seen that the strength gain of the concrete shows a trend similar to that of ordinary Portland cement concrete and exceeds 4,000 psi at an age of 28 days. Based the initial concrete cylinder testing of the processed HECA GS Materials, the performance in concrete indicates that the processed solids can serve as a cementitious additive in ready mixed concrete to replace cement. The replacement ratio of the mix design was 30% of the cement at one pound for one pound replacement and the strengths exceeded the standard mix design based on straight cement. The performance indicates that a higher replacement ratio is likely to be successful near the same levels that a granulated blast furnace slag would be utilized.

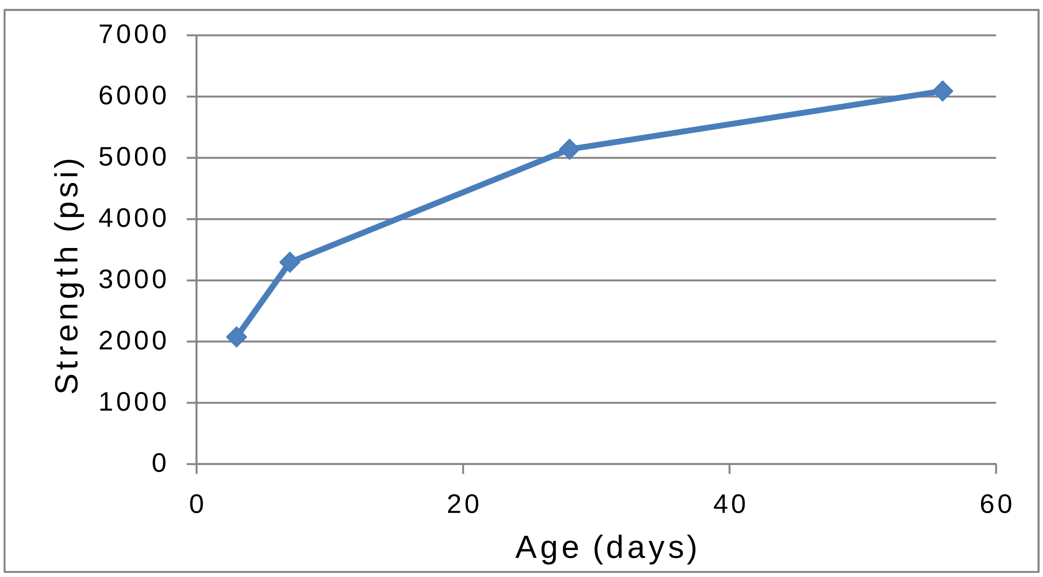

Figure 9. Compressive strength of concrete containing GS as an ingredient at 3, 7, 28 and 56 days.

Disposal Evaluation

Environmental Testing of Samples

While the primary plan is to beneficially re-use the GS materials generated from the HECA Plant, the materials were analyzed to determine available disposal options should beneficial re-use of 100% of the GS material prove infeasible.

A sample of the GS materials obtained from the HECA fuel supply pilot plant processing has been tested at a California based certified lab for TTLC, STLC, and TCLP. The laboratory results are attached in Appendix A. The glassy mineral solids from IGCC plants are not considered reactive, corrosive or ignitable. The sample test results indicate the GS material is non-hazardous based on the trace metals concentrations. Based on the composition and physical characteristics of the material, the material from the full scale HECA IGCC Plant is expected to pass all California waste criteria tests including Ignitability, Corrosivity, Reactivity, and Toxicity and will be classified as non-hazardous. The results of the TTLC, STLC, and TCLP tests along with the regulatory limits are summarized in Tables 18 through 20. As can be seen, the concentrations present in GS material are significantly less than the regulatory limits.

Table 18. TTLC Results with Regulatory Limits

Contaminant	Regulatory Limit[1] (mg/kg)	HECA Slag Concentration[2] (mg/kg)	Within Reg. Limit
Antimony	500	<10	Yes
Arsenic	500	<2.0	Yes
Barium	10,000	28	Yes
Beryllium	75	<0.51	Yes
Cadmium	100	<0.51	Yes
Chromium	2,500	1.6	Yes
Cobalt	8,000	1.3	Yes
Copper	2,500	2.7	Yes
Lead	1,000	<2.0	Yes
Molybdenum	3,500	2.8	Yes
Nickel	2,000	98	Yes
Selenium	100	<2.0	Yes
Thallium	700	<10	Yes
Vanadium	2,400	35	Yes
Zinc	5,000	<5.1	Yes
Silver	500	<1.0	Yes
Mercury	20	<0.020	Yes

[1]Limits taken from Table I and Table II of CCR Title 22 Chp. 11
[2]Entries with the < symbol followed by a value were not detected at the reporting limit. The value given is the reporting limit.

Table 19. STLC Results with Regulatory Limits

Contaminant	Regulatory Limit[1] (mg/L)	HECA Slag Concentration[2] (mg/L)	Within Reg. Limit
Antimony	15	<0.20	Yes
Arsenic	5.0	<0.20	Yes
Barium	100	0.83	Yes
Beryllium	0.75	<0.080	Yes
Cadmium	1.0	<0.10	Yes
Chromium	5	<0.10	Yes
Cobalt	80	<0.20	Yes
Copper	25	<0.20	Yes
Lead	5.0	<0.10	Yes
Molybdenum	350	<0.40	Yes
Nickel	20	7.3	Yes
Selenium	1.0	<0.20	Yes
Thallium	7.0	<0.20	Yes
Vanadium	24.0	1.2	Yes
Zinc	250.0	0.46	Yes
Silver	5.0	<0.20	Yes
Mercury	0.2	<0.0020	Yes

[1]Limits taken from Table I and Table II of CCR Title 22 Chp. 11
[2]Entries with the < symbol followed by a value were not detected at the reporting limit. The value given is the reporting limit.

Major and minor elemental composition of the GS, as determined by X-ray fluorescence (XRF) is shown in Table 21. It is important to note that while elemental components are presented as oxides, chemical components can be present in other forms as well. Nevertheless, it is apparent that the gasification slag from the pilot facility is comprised principally of Si and Al, with lesser amounts of Ca and Fe, followed by minor or trace amounts of other elements in a glass or fine-grained vitreous melt with essentially no carbon present (LOI <0.4%). There does not appear to be any significant differences in chemical composition or physical properties with respect to size.

From the testing performed on HECA GS, that are routinely performed on IGCC Plant GS, it is determined that the GS material will meet all the California criteria to remain as a non-hazard waste in the event that it had to be handled as a waste. The TTLC testing shows the HECA slag concentrations are typically 1 percent of the regulatory limit to be classified as hazardous. The STLC and TCLP testing shows the HECA slag concentrations are typically 10 percent of the regulatory limit. Based on the mineral composition of glassy matrix and chemical character of the GS, acute aquatic tests for bio-toxicity were not performed since all testing methods showed the HECA mineral slag concentrations to be less than 10 percent of the regulatory limit.

Table 20. TCLP Results with Regulatory Limits

Contaminant	Regulatory Limit[1] (mg/L)	HECA Slag Concentration[2] (mg/L)	Within Reg. Limit
Antimony	-----	<0.20	
Selenium	1.0	<0.10	Yes
Molybdenum	-----	<0.40	
Lead	5.0	<0.10	Yes
Zinc	-----	<0.40	
Vanadium	-----	<0.20	
Thallium	-----	<0.10	
Nickel	-----	1.4	
Copper	-----	<0.20	
Cobalt	-----	<0.20	
Chromium	5.0	<0.10	Yes
Cadmium	1.0	<0.10	Yes
Beryllium	-----	<0.080	
Barium	100.0	0.21	Y
Arsenic	5.0	<0.20	Y
Silver	5.0	<0.20	Y
Mercury	0.2	<0.0020	Y

[1]Limits taken from Table I and Table II of CCR Title 22 Chp. 11
[2]Entries with the < symbol followed by a value were not detected at the reporting limit. The value given is the reporting limit.

Table 21. XRF Analysis of Mitsubishi Gasification Slag.		
Test	Result, %	Method
Aluminum Oxide, Al_2O_3	23.72	ASTM D 4326
Barium Oxide, BaO	0.14	ASTM D 4326
Calcium Oxide, CaO	8.36	ASTM D 4326
Iron Oxide, Fe_2O_3	7.07	ASTM D 4326
Magnesium Oxide, MgO	1.16	ASTM D 4326
Phosphorus Pentoxide, P_2O_5	0.07	ASTM D 4326
Potassium Oxide, K_2O	1.01	ASTM D 4326
Silicon Dioxide, SiO_2	56.06	ASTM D 4326
Sodium Oxide, Na_2O	0.59	ASTM D 4326
Strontium Oxide, SrO	0.10	ASTM D 4326
Titanium Dioxide, TiO_2	0.95	ASTM D 4326
Manganese Dioxide, MnO_2	0.05	ASTM D 4326
Sulfur, Sulfite	0.33	ASTM E 1915
Carbon Dioxide	0.35	ASTM E 1915
Loss on Ignition	0.40	ASTM D 7348B

Charah also secured a sample of a gasification slag resulting from the gasification of a Chinese coal mine, referred to as "second sample". The second sample came from a commercial operating IGCC plant and was reviewed for physical and chemical character comparison to the US based coal. The physical properties were similar in appearance and size range. The full scale plant produces a similar GS Material as the pilot plant. Table 22 shows a comparison of XRF data from the Mitsubishi gasification slag sample as shown in Table 21 and the second sample derived from Chinese coal. The major difference is Ca, which suggests that the Chinese coal is probably a lower rank than the HECA US coal used for fuel for the first sample. Other than Ca, the samples are not significantly different with respect to major elements, although it does appear that the Chinese coal had higher trace element concentrations of Mg, P, K, Na Mn and Sr.

Table 22. XRF Analysis of Mitsubishi Gasification Slag

Test	HECA Sample 1, %	HECA Sample 2, %
Aluminum Oxide, Al_2O_3	23.72	19.10
Barium Oxide, BaO	0.14	0.09
Calcium Oxide, CaO	8.36	17.07
Iron Oxide, Fe_2O_3	7.07	6.56
Magnesium Oxide, MgO	1.16	1.52
Phosphorus Pentoxide, P_2O_5	0.07	0.33
Potassium Oxide, K_2O	1.01	1.51
Silicon Dioxide, SiO_2	56.06	53.10
Sodium Oxide, Na_2O	0.59	0.78
Strontium Oxide, SrO	0.10	0.28
Titanium Dioxide, TiO_2	0.95	0.71
Manganese Dioxide, MnO_2	0.05	0.10
Sulfur, Sulfite	0.33	<0.01
Carbon Dioxide	0.35	-
Loss on Ignition	0.40	-

Disposition of GS as a Waste

Charah has surveyed the available disposal sites that are currently permitted to accept industrial wastes similar to the GS materials. Sites were reviewed based on several criteria as follows: (1) Permit acceptance for non-hazardous industrial wastes, (2) Site capability to handle projected volumes of GS materials from HECA, (3) Transportation method from the HECA site. The sites are identified below along with a brief summary of the key cost items. Any needed due diligence would be conducted prior to shipment of the GS materials.

Columbia Ridge: The Columbia Ridge Recycling and Landfill (Columbia Ridge) is located in Arlington, Oregon and is owned and operated by Waste Management. Columbia Ridge is a Subtitle D landfill permitted to accept industrial and special wastes.

The landfill is rail served by a dedicated train or unit train railroad and has an on-site rail spur.

Roosevelt Regional Landfill: The Roosevelt Regional Landfill is located in Klickitat County, Washington. The landfill is the largest waste-by-rail system in the United States. Rail service is supplies 95 to 98 percent of the landfill yearly. The landfill is owned and operated by Allied Waste North America. The Roosevelt Landfill is supplied primarily by a dozen transfer stations located near the landfill. The rail service is operated by BNSF railway. Waste is received primarily in inter-modal containers, which are unloaded from flatbed rail cars and placed on trucks for a 4.5 mile short haul to the landfill along the private haul road. The landfill accepts more than 2.5 million tons of waste per year, including industrial wastes.

Sawyer Landfill: The Sawyer Landfill is located in Sawyer North Dakota approximately 20 miles south of Minot North Dakota. The Sawyer landfill is owned and operated by Allied Wastes Systems and is permitted as a non-hazardous industrial waste site. The Sawyer Landfill has rail service into a transfer station located near the landfill. Rail service is supplied by the Soo Railroad, an affiliate of the Canadian Pacific railroad.

Simco Road Regional Landfill: The Simco Road Regional Landfill is located 25 east of Boise, just off interstate 84 in a rural, dry area with less than 10 inches of annual precipitation. The landfill is owned by Idaho Waste Systems Inc. The commercially licensed, Federal Subtitle D landfill, which opened in 1999, is permitted and regulated by the Idaho Department of Environmental Quality and the Central District Health Department. Simco Road is served by both railroad and major highways. The site is located on Union Pacific's main rail line with an 8,000 foot rail spur and 2,000 foot auxiliary spur on site. The landfill is located adjacent to the Union Pacific main line with over 10,000 feet of rail spur. A container handler is on site to unload containers for disposal at the landfill, or a negotiated rate for intermodal transfers. There is also capability to unload open top hoppers and gondolas.

Finley Buttes Landfill. Finley Buttes Landfill is located in Morrow County, Oregon, approximately 180 miles east of Clark County and approximately 12 miles south of Boardman, Oregon. The facility is owned and operated by Finley Buttes Landfill Company and is the designated disposal site for MSW generated within Clark County. The landfill is designed, constructed and operated to be in compliance with all requirements of the Oregon DEQ and EPA Subtitle D MSW landfill requirements. Finley Buttes Landfill occupies a permitted 510 acre site. The estimated available fill capacity at the site, as currently permitted by the Oregon DEQ, is 90 million tons of waste. The landfill does not have a rail system but is permitted to allow this service.

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Appendix A

Laboratory Results

SGS

Analysis Report

January 11, 2013

Charah, Inc
12601 Plantside Drive
Louisville, KY 40299
USA

Client Sample ID:	HECA Coal Slag Composite	**Date Sampled :**	12/26/2012
Date Received:	01/03/2013	**Kind of Sample :**	Slag
Matrix:	Unknown	**Sample Type :**	1/4"
Net Sample Weight:	588.40 g	**Time Sampled :**	10:30 am

SGS Minerals Sample ID: 072-66081-001

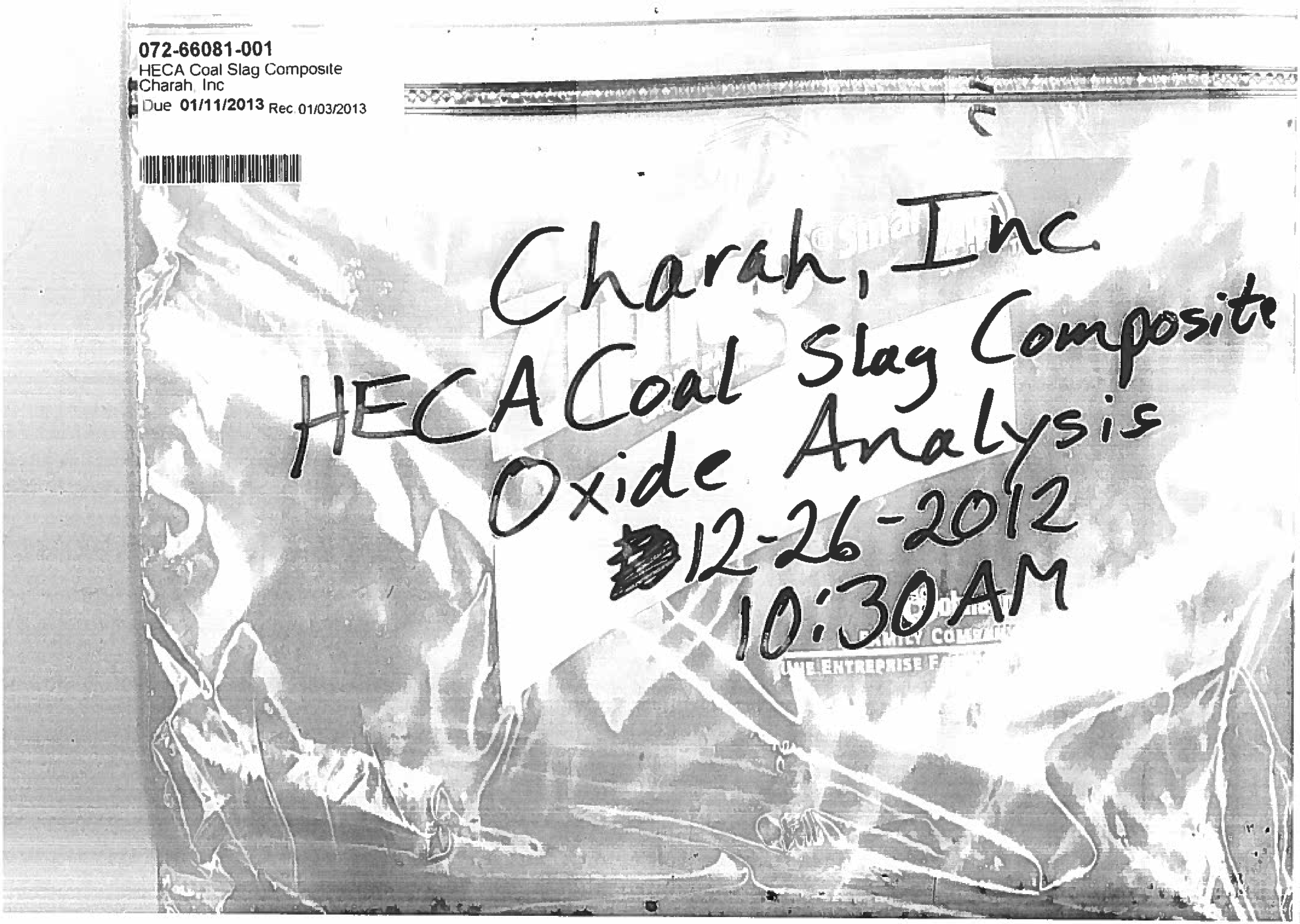
		As Received
% Moisture, Total	[ASTM D 3302]	2.15

Tests	Result	Unit	Method
AA Basis	Dry		ASTM D 4326
Aluminum Oxide Al2O3	23.72	%	ASTM D 4326
Barium Oxide BaO	0.14	%	ASTM D 4326
Calcium Oxide CaO	8.36	%	ASTM D 4326
Iron Oxide Fe2O3	7.07	%	ASTM D 4326
Magnesium Oxide MgO	1.16	%	ASTM D 4326
Phosphorus Pentoxide P2O5	0.07	%	ASTM D 4326
Potassium Oxide K2O	1.01	%	ASTM D 4326
Silicon Dioxide SiO2	56.05	%	ASTM D 4326
Sodium Oxide Na2O	0.59	%	ASTM D 4326
Strontium Oxide SrO	0.10	%	ASTM D 4326
Titanium Dioxide TiO2	0.95	%	ASTM D 4326
Manganese Oxide MnO2	0.05	%	ASTM D 4326
Sulfur, Sulfite	0.33	%	ASTM E 1915
Carbon Dioxide	0.35	%	ASTM E 1915
Loss on Ignition	0.40		ASTM D 7348B

Sample Notes:
Sum = 100.00%
Other = <0.01%

Somer Rodriguez, Denver Laboratory

SGS North America Inc. | Minerals Services Division
4665 Paris St Suite B-200 Denver CO 80239
t (303) 373-4772 f (303) 373-4791 www.sgs.com/minerals
Member of SGS Group


072-66081-001
HECA Coal Slag Composite
Charah, Inc
Due 01/11/2013 Rec 01/03/2013
Charah, Inc
HECA Coal Slag Composite
Oxide Analysis
12-26-2012
10:30AM

CHAIN OF CUSTODY RECORD

Client Name: **Charah, Inc.**

Client Address: **12601 Plantside Dr., Louisville, KY 40299**

Project Name/Number: **HECA Solids Re-Use**

Project Location:

Sampler (Print Name/Affiliation): **Bobby Marples**

Sampler's Signature: Bobby Marples

Send Results/Report To: **Karl Beckemeier kbeckemeier@charah.com**

TAT/Due Date:

Laboratory/Destination: **SGS - Denver**

Field Sample No./Identification	Date	Time	Type: COMP	Type: GRAB	Sample Container	Matrix	Analysis Requested: Oxide Analysis								Comments
HECA Coal Slag Composite	12/26/2012	10:30 AM	X		1-gallon bag	slag	1								

Relinquished By (Print Name/Affiliation)	Date / Time	Received By (Print Name/Affiliation)	Date / Time
Bobby Marples/Charah, Inc. Signature: Bobby Marples	Date: 12/26/2013 Time: 1:15 PM	Karl Beckemeier/Charah, Inc. Signature: Karl Beckemeier	Date: 12/26/2013 Time: 1:15 PM
Karl Beckemeier/Charah, Inc. Signature: Karl Beckemeier	Date: 12/26/2013 Time: 3:40 PM	Signature: [signature]	Date: 1/3/13 Time: 1000
Signature:	Date: Time:	Signature:	Date: Time:
Signature:	Date: Time:	Signature:	Date: Time:

Sample Shipped Via: (UPS) Courier FedEx USPS Other______

Additional Notes:

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

1 2 3 4 5 6 7 8 9 10 11 12

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Irvine
17461 Derian Ave
Suite 100
Irvine, CA 92614-5817
Tel: (949)261-1022

TestAmerica Job ID: 440-33744-1
Client Project/Site: Ash Analysis

For:
Charah, Inc
12601 Plantside Drive
Lousville, Kentucky 40299

Attn: Karl Beckemeier

Authorized for release by:
1/14/2013 9:26:27 AM

Jonathan Bousselaire
Project Manager I
jonathan.bousselaire@testamericainc.com

LINKS

Review your project results through Total Access

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Sample Summary

Client: Charah, Inc
Project/Site: Ash Analysis

TestAmerica Job ID: 440-33744-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
440-33744-1	HECA Coal Slag Composite	Solid	12/26/12 10:30	12/28/12 09:10

Job ID: 440-33744-1

Laboratory: TestAmerica Irvine

Narrative

Job Narrative
440-33744-1

Comments
No additional comments.

Receipt
The sample was received on 12/28/2012 9:10 AM; the sample arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 22.0º C.

Metals
Method(s) 6010B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for batch 77329 were outside control limits. The associated laboratory control sample (LCS) recovery met acceptance criteria. Analytes affected: Ag, Ba, Sb, Se.

Method(s) 6010B: The method blank for preparation batch 440-77261 contained zinc above the reporting limit (RL). None of the following samples associated with this method blank (HECA Coal Slag Composite (440-33744-1)) contained the target compound; therefore, re-extraction and/or re-analysis of samples were not performed.

Method(s) 6010B: The following sample(s) was diluted due to high Mn : HWK 1-02-Backwash Tank Sludge (440-33630-1). Elevated reporting limits (RLs) are provided.

Method(s) 6010B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries of Cu for batch 77197 were outside control limits. The associated laboratory control sample (LCS) recovery met acceptance criteria.

No other analytical or quality issues were noted.

General Chemistry
No analytical or quality issues were noted.

Organic Prep
No analytical or quality issues were noted.

Client: Charah, Inc
Project/Site: Ash Analysis

TestAmerica Job ID: 440-33744-1

Client Sample ID: HECA Coal Slag Composite
Date Collected: 12/26/12 10:30
Date Received: 12/28/12 09:10

Lab Sample ID: 440-33744-1
Matrix: Solid
Percent Solids: 97.7

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		10		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Arsenic	ND		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Barium	**28**		1.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Beryllium	ND		0.51		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Cadmium	ND		0.51		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Chromium	**1.6**		1.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Cobalt	**1.3**		1.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Copper	**2.7**		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Lead	ND		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Molybdenum	**2.8**		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Nickel	**98**		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Selenium	ND		2.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Thallium	ND		10		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Vanadium	**35**		1.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Zinc	ND		5.1		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5
Silver	ND		1.0		mg/Kg	☼	01/07/13 08:17	01/07/13 16:27	5

Method: 6010B - Metals (ICP) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Selenium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:47	1
Molybdenum	ND		0.40		mg/L		01/06/13 16:12	01/07/13 17:47	1
Lead	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:47	1
Zinc	ND		0.40		mg/L		01/06/13 16:12	01/07/13 17:47	1
Vanadium	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Thallium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:47	1
Nickel	**1.4**		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Copper	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Cobalt	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Chromium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:47	1
Cadmium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:47	1
Beryllium	ND		0.080		mg/L		01/06/13 16:12	01/07/13 17:47	1
Barium	**0.21**		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Arsenic	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1
Silver	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:47	1

Method: 6010B - Metals (ICP) - STLC Citrate

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.20		mg/L			01/07/13 15:43	20
Arsenic	ND		0.20		mg/L			01/07/13 15:43	20
Barium	**0.83**		0.20		mg/L			01/07/13 15:43	20
Beryllium	ND		0.080		mg/L			01/07/13 15:43	20
Cadmium	ND		0.10		mg/L			01/07/13 15:43	20
Chromium	ND		0.10		mg/L			01/07/13 15:43	20
Cobalt	ND		0.20		mg/L			01/07/13 15:43	20
Copper	ND		0.20		mg/L			01/07/13 15:43	20
Lead	ND		0.10		mg/L			01/07/13 15:43	20
Molybdenum	ND		0.40		mg/L			01/07/13 15:43	20
Nickel	**7.3**		0.20		mg/L			01/07/13 15:43	20
Selenium	ND		0.20		mg/L			01/07/13 15:43	20

Client Sample ID: HECA Coal Slag Composite

Lab Sample ID: 440-33744-1

Date Collected: 12/26/12 10:30

Matrix: Solid

Date Received: 12/28/12 09:10

Method: 6010B - Metals (ICP) - STLC Citrate (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Thallium	ND		0.20		mg/L			01/07/13 15:43	20
Vanadium	**1.2**		0.20		mg/L			01/07/13 15:43	20
Zinc	**0.46**		0.40		mg/L			01/07/13 15:43	20
Silver	ND		0.20		mg/L			01/07/13 15:43	20

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0020		mg/L		01/08/13 10:10	01/08/13 17:03	1

Method: 7470A - Mercury (CVAA) - STLC Citrate

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0020		mg/L		01/08/13 10:10	01/08/13 17:15	1

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.020		mg/Kg	☼	01/08/13 15:45	01/08/13 17:53	1

Lab Chronicle

Client: Charah, Inc
Project/Site: Ash Analysis

TestAmerica Job ID: 440-33744-1

Client Sample ID: HECA Coal Slag Composite

Date Collected: 12/26/12 10:30
Date Received: 12/28/12 09:10

Lab Sample ID: 440-33744-1

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
STLC Citrate	Leach	CA WET Citrate			50.2 g	500 mL	77197	01/04/13 21:50	CH	TAL IRV
STLC Citrate	Analysis	6010B		20			77466	01/07/13 15:43	MP	TAL IRV
Total/NA	Prep	3050B			2.02 g	50 mL	77329	01/07/13 08:17	DT	TAL IRV
Total/NA	Analysis	6010B		5			77477	01/07/13 16:27	TK	TAL IRV
TCLP	Leach	1311			100.05 g	2000 mL	77261	01/05/13 21:34	CH	TAL IRV
TCLP	Prep	3010A			5 mL	50 mL	77284	01/06/13 16:12	SN	TAL IRV
TCLP	Analysis	6010B		1			77494	01/07/13 17:47	TK	TAL IRV
Total/NA	Prep	7471A			0.50 g	50 mL	77671	01/08/13 15:45	MM	TAL IRV
Total/NA	Analysis	7471A		1			77742	01/08/13 17:53	DB	TAL IRV
TCLP	Prep	7470A			2 mL	20 mL	77398	01/08/13 10:10	MM	TAL IRV
TCLP	Analysis	7470A		1			77743	01/08/13 17:03	DB	TAL IRV
STLC Citrate	Prep	7470A			2 mL	20 mL	77421	01/08/13 10:10	MM	TAL IRV
STLC Citrate	Analysis	7470A		1			77743	01/08/13 17:15	DB	TAL IRV
Total/NA	Analysis	Moisture		1			77122	01/04/13 11:30	XL	TAL IRV

Laboratory References:

TAL IRV = TestAmerica Irvine, 17461 Derian Ave, Suite 100, Irvine, CA 92614-5817, TEL (949)261-1022

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 440-77329/1-A ^5
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 77477
Prep Batch: 77329

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		9.9		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Copper	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Lead	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Cobalt	ND		0.99		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Molybdenum	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Chromium	ND		0.99		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Nickel	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Cadmium	ND		0.50		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Selenium	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Beryllium	ND		0.50		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Thallium	ND		9.9		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Barium	ND		0.99		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Vanadium	ND		0.99		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Arsenic	ND		2.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Zinc	ND		5.0		mg/Kg		01/07/13 08:17	01/07/13 16:19	5
Silver	ND		0.99		mg/Kg		01/07/13 08:17	01/07/13 16:19	5

Lab Sample ID: LCS 440-77329/2-A ^5
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 77477
Prep Batch: 77329

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	49.8	44.7		mg/Kg		90	80 - 120
Copper	49.8	44.3		mg/Kg		89	80 - 120
Lead	49.8	45.7		mg/Kg		92	80 - 120
Cobalt	49.8	46.1		mg/Kg		93	80 - 120
Molybdenum	49.8	43.9		mg/Kg		88	80 - 120
Chromium	49.8	45.3		mg/Kg		91	80 - 120
Nickel	49.8	47.2		mg/Kg		95	80 - 120
Cadmium	49.8	45.4		mg/Kg		91	80 - 120
Selenium	49.8	43.2		mg/Kg		87	80 - 120
Beryllium	49.8	45.8		mg/Kg		92	80 - 120
Thallium	49.8	45.7		mg/Kg		92	80 - 120
Barium	49.8	46.5		mg/Kg		94	80 - 120
Vanadium	49.8	44.6		mg/Kg		90	80 - 120
Arsenic	49.8	44.6		mg/Kg		90	80 - 120
Zinc	49.8	44.5		mg/Kg		89	80 - 120
Silver	24.9	22.2		mg/Kg		89	80 - 120

Lab Sample ID: MB 440-77261/1-B
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: TCLP
Analysis Batch: 77494
Prep Batch: 77284

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Copper	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Lead	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:32	1
Cobalt	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: MB 440-77261/1-B
Matrix: Solid
Analysis Batch: 77494

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 77284

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Molybdenum	ND		0.40		mg/L		01/06/13 16:12	01/07/13 17:32	1
Chromium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:32	1
Nickel	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Cadmium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:32	1
Selenium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:32	1
Beryllium	ND		0.080		mg/L		01/06/13 16:12	01/07/13 17:32	1
Thallium	ND		0.10		mg/L		01/06/13 16:12	01/07/13 17:32	1
Barium	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Vanadium	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Arsenic	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1
Zinc	0.595		0.40		mg/L		01/06/13 16:12	01/07/13 17:32	1
Silver	ND		0.20		mg/L		01/06/13 16:12	01/07/13 17:32	1

Lab Sample ID: LCS 440-77261/2-B
Matrix: Solid
Analysis Batch: 77494

Client Sample ID: Lab Control Sample
Prep Type: TCLP
Prep Batch: 77284

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	2.00	1.82		mg/L		91	80 - 120
Copper	2.00	1.89		mg/L		95	80 - 120
Lead	2.00	1.85		mg/L		92	80 - 120
Cobalt	2.00	1.85		mg/L		92	80 - 120
Molybdenum	2.00	1.84		mg/L		92	80 - 120
Chromium	2.00	1.85		mg/L		93	80 - 120
Nickel	2.00	1.92		mg/L		96	80 - 120
Cadmium	2.00	1.89		mg/L		94	80 - 120
Selenium	2.00	1.74		mg/L		87	80 - 120
Beryllium	2.00	1.93		mg/L		97	80 - 120
Thallium	2.00	1.78		mg/L		89	80 - 120
Barium	2.00	1.90		mg/L		95	80 - 120
Vanadium	2.00	1.89		mg/L		94	80 - 120
Arsenic	2.00	1.90		mg/L		95	80 - 120
Zinc	2.00	2.05		mg/L		103	80 - 120
Silver	1.00	0.916		mg/L		92	80 - 120

Lab Sample ID: MB 440-77197/1-A ^20
Matrix: Solid
Analysis Batch: 77466

Client Sample ID: Method Blank
Prep Type: STLC Citrate

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	ND		0.20		mg/L			01/07/13 15:33	20
Copper	ND		0.20		mg/L			01/07/13 15:33	20
Lead	ND		0.10		mg/L			01/07/13 15:33	20
Cobalt	ND		0.20		mg/L			01/07/13 15:33	20
Molybdenum	ND		0.40		mg/L			01/07/13 15:33	20
Chromium	ND		0.10		mg/L			01/07/13 15:33	20
Nickel	ND		0.20		mg/L			01/07/13 15:33	20
Cadmium	ND		0.10		mg/L			01/07/13 15:33	20
Selenium	ND		0.20		mg/L			01/07/13 15:33	20

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: MB 440-77197/1-A ^20
Matrix: Solid
Analysis Batch: 77466

Client Sample ID: Method Blank
Prep Type: STLC Citrate

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Beryllium	ND		0.080		mg/L			01/07/13 15:33	20
Thallium	ND		0.20		mg/L			01/07/13 15:33	20
Barium	ND		0.20		mg/L			01/07/13 15:33	20
Vanadium	ND		0.20		mg/L			01/07/13 15:33	20
Arsenic	ND		0.20		mg/L			01/07/13 15:33	20
Zinc	ND		0.40		mg/L			01/07/13 15:33	20
Silver	ND		0.20		mg/L			01/07/13 15:33	20

Lab Sample ID: LCS 440-77197/2-A ^20
Matrix: Solid
Analysis Batch: 77466

Client Sample ID: Lab Control Sample
Prep Type: STLC Citrate

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Antimony	20.0	18.4		mg/L		92	80 - 120
Copper	20.0	18.2		mg/L		91	80 - 120
Lead	20.0	18.0		mg/L		90	80 - 120
Cobalt	20.0	18.3		mg/L		91	80 - 120
Molybdenum	20.0	19.1		mg/L		95	80 - 120
Chromium	20.0	18.1		mg/L		90	80 - 120
Nickel	20.0	18.5		mg/L		92	80 - 120
Cadmium	20.0	18.4		mg/L		92	80 - 120
Selenium	20.0	17.8		mg/L		89	80 - 120
Beryllium	20.0	18.8		mg/L		94	80 - 120
Thallium	20.0	17.1		mg/L		85	80 - 120
Barium	20.0	18.3		mg/L		91	80 - 120
Vanadium	20.0	18.6		mg/L		93	80 - 120
Arsenic	20.0	19.1		mg/L		95	80 - 120
Zinc	20.0	18.2		mg/L		91	80 - 120
Silver	10.0	8.81		mg/L		88	80 - 120

Method: 7470A - Mercury (CVAA)

Lab Sample ID: MB 440-77261/1-D
Matrix: Solid
Analysis Batch: 77743

Client Sample ID: Method Blank
Prep Type: TCLP
Prep Batch: 77398

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0020		mg/L		01/08/13 10:10	01/08/13 16:50	1

Lab Sample ID: LCS 440-77261/2-D
Matrix: Solid
Analysis Batch: 77743

Client Sample ID: Lab Control Sample
Prep Type: TCLP
Prep Batch: 77398

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.0800	0.0731		mg/L		91	80 - 120

Method: 7470A - Mercury (CVAA) (Continued)

Lab Sample ID: MB 440-77197/1-B — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: STLC Citrate**
Analysis Batch: 77743 — **Prep Batch: 77421**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.0020		mg/L		01/08/13 10:10	01/08/13 17:05	1

Lab Sample ID: LCS 440-77197/2-B — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: STLC Citrate**
Analysis Batch: 77743 — **Prep Batch: 77421**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.0800	0.0709		mg/L		89	80 - 120

Lab Sample ID: 440-33744-1 MS — **Client Sample ID: HECA Coal Slag Composite**
Matrix: Solid — **Prep Type: STLC Citrate**
Analysis Batch: 77743 — **Prep Batch: 77421**

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	ND		0.0800	0.0678		mg/L		85	70 - 130

Lab Sample ID: 440-33744-1 MSD — **Client Sample ID: HECA Coal Slag Composite**
Matrix: Solid — **Prep Type: STLC Citrate**
Analysis Batch: 77743 — **Prep Batch: 77421**

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Mercury	ND		0.0800	0.0707		mg/L		88	70 - 130	4	20

Method: 7471A - Mercury (CVAA)

Lab Sample ID: MB 440-77671/1-A — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 77742 — **Prep Batch: 77671**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.020		mg/Kg		01/08/13 15:45	01/08/13 16:56	1

Lab Sample ID: LCS 440-77671/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 77742 — **Prep Batch: 77671**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.800	0.726		mg/Kg		91	80 - 120

Metals

Leach Batch: 77197

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	STLC Citrate	Solid	CA WET Citrate	
440-33744-1 MS	HECA Coal Slag Composite	STLC Citrate	Solid	CA WET Citrate	
440-33744-1 MSD	HECA Coal Slag Composite	STLC Citrate	Solid	CA WET Citrate	
LCS 440-77197/2-A ^20	Lab Control Sample	STLC Citrate	Solid	CA WET Citrate	
LCS 440-77197/2-B	Lab Control Sample	STLC Citrate	Solid	CA WET Citrate	
MB 440-77197/1-A ^20	Method Blank	STLC Citrate	Solid	CA WET Citrate	
MB 440-77197/1-B	Method Blank	STLC Citrate	Solid	CA WET Citrate	

Leach Batch: 77261

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	TCLP	Solid	1311	
LCS 440-77261/2-B	Lab Control Sample	TCLP	Solid	1311	
LCS 440-77261/2-D	Lab Control Sample	TCLP	Solid	1311	
MB 440-77261/1-B	Method Blank	TCLP	Solid	1311	
MB 440-77261/1-D	Method Blank	TCLP	Solid	1311	

Prep Batch: 77284

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	TCLP	Solid	3010A	77261
LCS 440-77261/2-B	Lab Control Sample	TCLP	Solid	3010A	77261
MB 440-77261/1-B	Method Blank	TCLP	Solid	3010A	77261

Prep Batch: 77329

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	Total/NA	Solid	3050B	
LCS 440-77329/2-A ^5	Lab Control Sample	Total/NA	Solid	3050B	
MB 440-77329/1-A ^5	Method Blank	Total/NA	Solid	3050B	

Prep Batch: 77398

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	TCLP	Solid	7470A	77261
LCS 440-77261/2-D	Lab Control Sample	TCLP	Solid	7470A	77261
MB 440-77261/1-D	Method Blank	TCLP	Solid	7470A	77261

Prep Batch: 77421

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77197
440-33744-1 MS	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77197
440-33744-1 MSD	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77197
LCS 440-77197/2-B	Lab Control Sample	STLC Citrate	Solid	7470A	77197
MB 440-77197/1-B	Method Blank	STLC Citrate	Solid	7470A	77197

Analysis Batch: 77466

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	STLC Citrate	Solid	6010B	77197
LCS 440-77197/2-A ^20	Lab Control Sample	STLC Citrate	Solid	6010B	77197
MB 440-77197/1-A ^20	Method Blank	STLC Citrate	Solid	6010B	77197

Analysis Batch: 77477

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	Total/NA	Solid	6010B	77329

Metals (Continued)

Analysis Batch: 77477 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 440-77329/2-A ^5	Lab Control Sample	Total/NA	Solid	6010B	77329
MB 440-77329/1-A ^5	Method Blank	Total/NA	Solid	6010B	77329

Analysis Batch: 77494

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	TCLP	Solid	6010B	77284
LCS 440-77261/2-B	Lab Control Sample	TCLP	Solid	6010B	77284
MB 440-77261/1-B	Method Blank	TCLP	Solid	6010B	77284

Prep Batch: 77671

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	Total/NA	Solid	7471A	
LCS 440-77671/2-A	Lab Control Sample	Total/NA	Solid	7471A	
MB 440-77671/1-A	Method Blank	Total/NA	Solid	7471A	

Analysis Batch: 77742

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	Total/NA	Solid	7471A	77671
LCS 440-77671/2-A	Lab Control Sample	Total/NA	Solid	7471A	77671
MB 440-77671/1-A	Method Blank	Total/NA	Solid	7471A	77671

Analysis Batch: 77743

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	TCLP	Solid	7470A	77398
440-33744-1	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77421
440-33744-1 MS	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77421
440-33744-1 MSD	HECA Coal Slag Composite	STLC Citrate	Solid	7470A	77421
LCS 440-77197/2-B	Lab Control Sample	STLC Citrate	Solid	7470A	77421
LCS 440-77261/2-D	Lab Control Sample	TCLP	Solid	7470A	77398
MB 440-77197/1-B	Method Blank	STLC Citrate	Solid	7470A	77421
MB 440-77261/1-D	Method Blank	TCLP	Solid	7470A	77398

General Chemistry

Analysis Batch: 77122

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
440-33744-1	HECA Coal Slag Composite	Total/NA	Solid	Moisture	
440-33744-1 DU	HECA Coal Slag Composite	Total/NA	Solid	Moisture	

Client: Charah, Inc
TestAmerica Job ID: 440-33744-1
Project/Site: Ash Analysis

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
☼	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
DL, RA, RE, IN	Indicates a Dilution, Reanalysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
EDL	Estimated Detection Limit
EPA	United States Environmental Protection Agency
MDA	Minimum detectable activity
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Certification Summary

Client: Charah, Inc
Project/Site: Ash Analysis

TestAmerica Job ID: 440-33744-1

Laboratory: TestAmerica Irvine

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alaska	State Program	10	CA01531	06-30-13
Arizona	State Program	9	AZ0671	10-13-13
California	LA Cty Sanitation Districts	9	10256	01-31-13
California	NELAP	9	1108CA	01-31-13
California	State Program	9	2706	06-30-14
Guam	State Program	9	Cert. No. 12.002r	01-23-13
Hawaii	State Program	9	N/A	01-31-13
Nevada	State Program	9	CA015312007A	07-31-13
New Mexico	State Program	6	N/A	01-31-13
Northern Mariana Islands	State Program	9	MP0002	01-31-13
Oregon	NELAP	10	4005	09-12-13
USDA	Federal		P330-09-00080	06-06-14
USEPA UCMR	Federal	1	CA01531	01-31-13

Irvine
17461 Derian Ave
Suite 100
Irvine, CA 92614
phone 949.261.1022 fax 949.260.3299

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Client Contact	Project Manager: Jonathan Bousselaire	Site Contact: Karl Beckemeier	Date: 12-26-2012	COC No:
Charah, Inc.	Tel/Fax:	Lab Contact:	Carrier:	____ of ____ COCs
12601 Plantside Drive	Analysis Turnaround Time			Job No. 440-33744
Louisville, KY 40299	Calendar (C) or Work Days (W) ___W___			
(502) 245-1353 Phone	TAT if different from Below ____			SDG No.
(502) 245-7398 FAX	■ 2 weeks			
Project Name: Ash Analysis	☐ 1 week			
Site:	☐ 2 days			
P O #	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample	Total Metals	TCLP Metals	STLC Metals	Sample Specific Notes:
HECA Coal Slag Composite	12/26/12	10:30 AM	Composite	Soil	1		X	X	X	Collected in EST time zone.

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ________

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* *Poison B* ☐ *Unknown* ☐

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ■ *Disposal By Lab* ☐ *Archive For* ________ *Months*

Special Instructions/QC Requirements & Comments: The above listed sample is for testing outlined in quote #44007596.

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Karl Beckemeier	Charah, Inc.	12-26-12 4:30PM	[signature]	TAI 220	12/28/12 9:10
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Login Sample Receipt Checklist

Client: Charah, Inc

Job Number: 440-33744-1

Login Number: 33744

List Source: TestAmerica Irvine

List Number: 1

Creator: Robb, Kathleen

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

INFORMATION REQUEST

WM-3. The project owner should enter into an Agreement with DTSC for the purpose of fully characterizing and if necessary remediating the site property so that it is in the appropriate condition to allow for future use. In addition based on the type of agreement with DTSC the applicant should conduct the necessary site characterization to determine if site remediation is needed and if so what the scope of remediation would be prior to the FSA.

RESPONSE

As discussed with Department of Toxic Substances Control Staff and the CEC on March 25, 2013, the Applicant has an Option to Purchase, but does not yet own the Project Site. As such, the Applicant cannot make commitments for the current site owner prior to the FSA. As a condition of certification, the Applicant will fully characterize and, if necessary, remediate the site property so that it is in the appropriate condition for future use.

INFORMATION REQUEST

WM-4. Staff needs information on additional waste streams that would result from the addition of the limestone fluxant such as total tons and cubic yards. The applicant shall also provide information on the increased amount of gasification solids in tons and cubic yards.

RESPONSE

The addition of the limestone fluxant does not result in any substantial increase in the amount of wastes generated by the Project that was presented in Section 5.13 of the Amended AFC.

The GS are expected to increase by about 90 tons per day as a result of the fluxant addition (i.e., from approximately 850 tons per day as stated in the Amended AFC to 940 tons per day). This is equivalent to approximately 81 cubic yards per day of solids.

ENGINEERING ASSESSMENT

Technical Area: Geology and Paleontology

INFORMATION REQUEST

GEO-1. Limestone would be mined and transported to the site to be used as a fluxant to reduce sulfur emissions. Currently it is unknown where the limestone is being mined, the entity that permitted the mine's operation, the capacity of the mine's resource and the estimated consumption of limestone during the project's design life.

RESPONSE

The most likely source of the limestone is a distribution center in Riverside County. As such, the Applicant does not have information on the origin of the limestone sold by the material distribution center.

Technical Area: Power Plant Efficiency

INFORMATION REQUEST

PPE-1 Reconciliation of the 405 MW gross power generation originally submitted in the AFC and the 431 MW power level currently under discussion elsewhere in this document;

RESPONSE

The gross power output of the Combined-Cycle Power Block is now expected to be up to 431 MW of gross power generation. The additional gross output is the result of optimization and improvement in heat recovery, and there is no additional fuel input or emissions. The gross power output may range from 405 to 431 MW, with the net power output ranging from 267 to 300 MW. Engineers are designing to optimize to the higher end of these ranges, but for some emission factor calculations it is more conservative to use the low-end value (e.g., for the Mercury and Air Toxics Standards).

INFORMATION REQUEST

PPE-2. Update of the mass and energy balance for the entire project boundary that uses all contemporaneous conditions, including the enhanced oil recovery (EOR) field, air separation (ASU), and the introduction of calcium carbonate to the feedstock blend, based on the 431 MW rating.

RESPONSE

The updated carbon balance provided in Figures CS-7-1 and CS-7-2 includes the carbon from the addition of fluxant (calcium carbonate) to the feedstock blend. The updated energy balance is provided in Figure CS-7-3. ASU auxiliary loads are provided in Table CS-7-4. Mass and energy balance information for EOR can be found in OEHI's Supplemental Environmental Information, included as Appendix A-1 to the Amended AFC.

INFORMATION REQUEST

PPE-3. Identification and description of the major power block components, including the gasifier, based on the 431 MW rating.

RESPONSE

Major power block components and associated MW rating are identified in Figure CS-7-3. Descriptions of the power block components can be found in Section 2, Project Description, in the Amended AFC.

Technical Area: Power Plant Reliability

INFORMATION REQUEST

PPR-1. The applicant has failed to assign an AF (availability factor) to the gasification system and ancillary systems upon which the power block is dependent. The applicant needs to assign this AF, demonstrate how it was derived, and explain how it affects the 91.3 percent AF assigned to the power block.

RESPONSE

The Availability Factor (AF) reflects annual planned outages, while the Equivalent Availability Factor (EAF) includes both unplanned and planned outages. The 91.3 percent is the expected EAF for the Power Block. MHI has indicated that an EAF of 85 percent for the gasifier island could be expected. Regarding ancillary systems, the ASU is a mature industrial process, and the Applicant would expect the availability (AF) to be greater than 98 percent.

Technical Area: Transmission System Engineering

INFORMATION REQUEST

TSE-1. The Transition Cluster Phase II Interconnection Study Report (Phase II Study) for HECA.

RESPONSE

HECA has withdrawn from the CAISO Cluster 5, and has submitted a new application to become a member of Cluster 6. There will be no changes to the Project's transmission routing, capacities, or design. HECA anticipates that the findings and required verifications from the Cluster 5 Phase I Report should remain the same.

For Cluster 6, the HECA SCS project has been assigned the Cluster queue position of Q#1000.

Below are the key schedule dates for Cluster 6.

Phase I Study Complete:	December 18, 2013
Phase II Study Complete:	December 5, 2014

ALTERNATIVES

Technical Area: Alternatives

ALT-1. Demonstrate advanced solid fuel based technologies that can generate clean, reliable, and affordable electricity in the United States: the applicant has not shown that the electricity produced by HECA would be priced at a low enough price to meet their stated annual hours of operation and at a high enough price to make their facility operate reliably.

RESPONSE

HECA will sell electricity to investor-owned utilities under bilateral agreements. These bilateral agreements will ensure that the revenue generated will be sufficient to meet the project's required financing parameters by requiring the utilities to purchase a minimum amount of electricity at an agreed price. The utilities gain the assurance of constant noninterruptible low carbon electricity and the demonstration of a reliable low carbon electricity source that can be replicated to the benefit of California consumers.

INFORMATION REQUEST

ALT-2. HECA has not shown that its facility would reduce the carbon footprint of power generation facilities likely to be located in California. HECA has not shown that their facility would facilitate development of hydrogen infrastructure in California.

RESPONSE

a. As listed in the Amended AFC, reducing the carbon footprint of power generation facilities likely to be located in California is a component of several key objectives of the HECA Project. Specifically, the Project has been designed to achieve the following goals:

- to provide dependable, low-carbon baseload electricity;
- to help meet future electrical power needs and to support a reliable power grid that is an essential component to meeting California's GHG reduction goals for 2020 and beyond; and
- to mitigate impacts related to climate change by dramatically reducing GHG emissions relative to those emitted from conventional power generation and nitrogen-based product manufacturing by capturing and sequestering CO_2 emissions.

The method by which the Project accomplishes these objectives is primarily through the pre-combustion capture of greater than 90 percent of the CO_2 from produced syngas and subsequent transport of CO_2 for EOR and resulting sequestration. A full GHG BACT determination for the Project is provided in Appendix C, Greenhouse Gas BACT Analysis of the Authority to Construct Permit Application and Supplemental Information for the Prevention of Significant Deterioration Permit Application, and was submitted to the CEC in May 2012. In addition, the SJVAPCD's GHG BACT analysis can be found in the FDOC, released in July 2013. In addition to providing technical details on the capture of the carbon in the raw syngas for use in EOR and resulting sequestration, this analysis details many additional design features that have been implemented to conserve and reuse thermal energy, and in so doing, reduce GHG emissions.

Furthermore, information on the annual amount of operational CO_2 emissions emitted due to the export of electricity is detailed in the responses to Information Requests related to Carbon Sequestration and Greenhouse Gas Emissions. As listed in Table CS-1, the annual CO_2 emissions for steady state syngas operations will be approximately 153 lb/MWh, which is well below the 1,100 lb CO_2/MWh threshold requirement of SB 1368. These emissions are also well below the average CO_2 emission rates from U.S. natural gas-fired generation facilities (1,135 lb/MWh per USEPA, 2013).

b. HECA has shown that their facility would facilitate development of hydrogen infrastructure in California.

As listed in the Amended AFC, a stated Project objective for HECA is to facilitate and support the development of hydrogen infrastructure in California by supplementing the quantities of hydrogen available for future energy and transportation technologies.

As defined in Ogden's 1999 seminal paper, "a hydrogen energy infrastructure is defined as the system needed to produce hydrogen, store it, and deliver it to users" (Ogden, 1999) The HECA Project will directly facilitate development of this infrastructure through the production of hydrogen-rich fuel. Figure 2-3 of the Amended AFC is an Overall Block Flow Diagram illustrating the mechanical process of converting raw feedstocks into hydrogen-rich fuels for the production of low-carbon baseload electricity and nitrogen-based products. Through this process and as detailed in Table 2-10 of the Amended AFC (Representative Heat and Materials Balance), the Project will produce approximately 273 million standard cubic feet per day of hydrogen during operations. HECA will use this hydrogen to produce two important products: low-carbon electricity and low-carbon fertilizers.

References

Ogden, J.M., 1999. Prospects for Building a Hydrogen Energy Infrastructure. PU/CEES Report No. 318. Princeton University. https://www.princeton.edu/pei/energy/publications/reports/No.318.pdf.

USEPA (U.S. Environmental Protection Agency), 2013. Website. Natural Gas. Accessed July 25, 2013. http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html.

INFORMATION REQUEST

ALT-4. Carbon sequestration and GHG: Yet to be studied is whether operation of the No Fertilizer Manufacturing Complex Alternative facility's electricity would meet California's Environmental Performance Standard developed in response to SB 1368. This may depend on the facility's ability to operate reliably without swinging gasifier output between electricity production and fertilizer manufacturing.

RESPONSE

California SB 1368, Greenhouse Gases EPS, precludes investor-owned utilities from procuring power under a long-term contract that has a CO_2 attribute higher than 1,100 pounds of CO_2 per hour (MWh). Because the standard does not regulate CO_2 emissions from the Integrated Manufacturing Complex, it is necessary to separate the GHG emissions associated only with the export of electricity to the CAISO grid.

Information on the annual amount of operational CO_2 emissions due to the export of electricity is detailed in the response to Information Request CS-7. As listed in Table CS-7-3, the annual CO_2 emissions for steady-state syngas operations will be approximately 153 lb/MWh, which is well below the 1,100 pounds of CO_2 per MWh threshold requirement of SB 1368 and the New Source Performance Standards of 1,000 pounds of CO_2 per MWh threshold proposed by the USEPA.

INFORMATION REQUEST

ALT-5. Because the applicant has not yet provided staff with adequate information to assess the proposed project's impacts on buried archaeological resources and cultural resources in the EOR components of the proposed project, staff cannot analyze the impacts of the reduced project alternative on such resources.

RESPONSE

This information is provided in OEHI's responses to CEC Information Requests A85 through A88 and A141 through A146, which were submitted confidentially to CEC on July 26, 2013.