CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Berkeley Hydrogen Station

Prepared for: California Energy Commission

Prepared by: Equilon Enterprises LLC (dba Shell Oil Products US)

December 2025 | CEC-600-2025-042

California Energy Commission

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ACKNOWLEDGEMENTS

At Shell Hydrogen, we are focused on making hydrogen fuel a mainstream and competitive option for zero-emission transportation. Developing the network of hydrogen fueling stations under this grant funding opportunity has accomplished significant progress for fuel cell electric vehicle customers in California, including the fastest delivery of new stations to date in California for improving coverage and capacity in the fueling network, two fueling positions at each station for improving customer service, station reliability through two entirely redundant systems at each station, and integration under the canopy alongside other fuels for safety of traffic flow, convenience, shelter, and the normalcy of refueling. We would like to thank the following individuals and business partners for significant contributions to this success:

- The California Energy Commission (CEC) Lead Transportation Commissioner, Patty Monahan, who provided visionary leadership and direction for the hydrogen mobility in the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program, CEC Hydrogen Unit Supervisor, Jean Baronas, who provided diligent program administration with helpful attention to detail and direct engagement, as well as the various Commission Agreement Managers and Officers who provided thoughtful and constructive oversight of the Mission Street station delivery.
- AU Energy, which is a high-quality and forward-thinking owner and operator of the Shell retail stations in California. Varish Goyal, Sunny Goyal, and Kpish Goyal are important business partners for their successful introduction of hydrogen fuel in California and represent the model of family business in California.
- The leading manufacturers of fuel cell electric vehicles, Craig Scott with Toyota Motors North America and Robert Bienenfeld and Stephen Ellis with American Honda. They are important business partners for their direct financial contributions to these stations as well as their dedication to the introduction of fuel cell electric vehicles. Their ongoing collaboration ensures the highest quality of customer service.
- The Nel Service and Operations teams ("Nel") who are important business partners for increasing the quality and capacity of hydrogen fueling station equipment in these stations and ongoing partnership in the successful operation and maintenance of the stations.
- The Fiedler Group Team who was instrumental in managing the permitting process, which often entailed the challenging task of

introducing jurisdictions to hydrogen refueling stations. Fiedler Group also managed the detailed design and construction on site, drawing from their deep expertise in the retail refueling business.

- The team at Fueling and Service Technologies (Fastech) who did an exceptional job with the construction of the site and was on the front line of managing the daily hazardous aspects of construction.
- The local authorities having jurisdiction for the stations – Sacramento, San Francisco, Berkeley, Walnut Creek, and San Jose – who worked collaboratively throughout the evaluation and permitting of these stations, and in doing so have continued to expand upon the base of experience that will enable continued expansion of the hydrogen fueling network that is an important component of the infrastructure to transition to zero emission transportation.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued grant funding opportunity GFO-15-605 to provide grant funds to expand the network of publicly accessible hydrogen refueling stations that serve California's light duty fuel cell electric vehicles. In response to GFO-15-605, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards February 17, 2017, and the agreement was executed as ARV-17-003 on August 10, 2017.

ABSTRACT

Equilon Enterprises LLC (dba Shell Oil Products US) ("Shell") designed, engineered, permitted, constructed, and made operational a hydrogen refueling station at 1250 University Ave. Berkeley CA 94702 (the "Station"). The Station consists of a concrete reinforced block compound that encloses hydrogen storage, compression, and cooling equipment; two dispensers with one fueling hose each; and two customer payment point of sale (POS) terminals. Hydrogen dispensers are co-located with gasoline dispensers under the canopy of an existing Shell gas station.

Keywords: California Energy Commission, Berkeley, Equilon Enterprises, Shell Oil Products, fuel cell electric vehicles, hydrogen refueling station, infrastructure, FCEV

Author(s): Kelterborn, Madeline; Shkeir, Omar; Leighty, Wayne. Equilon Enterprises, LLC dba Shell Oil Products US. 2021. *Berkeley Hydrogen Station*. California Energy Commission. Publication Number: CEC-600-2025-042.

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EXECUTIVE SUMMARY

Equilon Enterprises LLC (dba Shell Oil Products US) ("Shell") built a hydrogen fueling station at its existing gasoline station located at 1250 University Ave. Berkeley CA 94702 (the "Station"). Under its grant funding oportunity GFO-15-605, the California Energy Commission (CEC) funded 58.9% of the total cost of the Station while Shell provided the balance for a total station cost of $3,971,700. The CEC contributed $2,337,500.

The Station has a refueling capacity of 400 kg per day, dispensed via two single-hose dispensers that are located under the canopy, in the same fueling lanes that gasoline cars use for refueling.

Shell's project team comprised Fiedler Group (as engineer of record), Nel Hydrogen, Herning, Denmark, ("Nel") (as equipment vendor, installer and O&M contractor), and Fueling and Service Technologies (Fastech, as general contractor).

The hydrogen station equipment, supplied by Nel, attained a Underwriter Laboratories Certificate of Compliance on October 25, 2018. This certification applies to all stations conforming to this design.

The station took 46 months to achieve an open retail status, from the time when Fiedler Group initiated preapplication meetings with authorities having jurisdiction to the open retail date of January 12, 2021. The first fueling of a fuel cell electric vehicle was on June 23, 2020. The time to open retail after construction crew mobilized was 24 months.

Shell initiated site acquisition negotiations with AU Energy, the joint owner and operator for the Berkeley Shell gasoline station. A complete agreement was executed on August 17, 2016.

Fiedler Group initiated pre-application meetings with the AHJs in March 2017. An entitlement application package was submitted to the planning department in July 2017. Four rounds of comments were received for the entitlement process. Entitlement approval was received in October 2018. A building permit application was submitted in December 2017. Four rounds of plan check comments were received from the building department. Building department's approval was obtained in December 2018. At the behest of the City, a public outreach meeting was held in March 2018 to answer any questions and concerns from the public.

Shell initiated equipment procurement with Nel in April 2017. Time-phased, on-site delivery and installation of equipment was completed in June 2019.

After a competitive bidding process, Fueling and Service Technologies (Fastech) was awarded the contract for civil construction. Fastech mobilized on January 7,

2019. The Station, with all H2 equipment installed, was ready for a pre-startup safety review (PSSR) on June 19, 2019. Construction schedule was severely impacted by frequent rain and consequential issues with flooding, water management and implementation of erosion control measures.

Pre-commissioning activities began on June 19, 2019 and the first FCEV was filled on June 23, 2020 after obtaining a certificate of accuracy for the dispensers, on October 24, 2019 for Dispenser 1 and February 25, 2020 for Dispenser 2 by the California Department of Food and Agriculture, Division of Measurement Standards (DMS).

Shortly after opening the Station to the public, Shell received notification of vibration felt in an adjacent apartment home while the Station's hydrogen compressors were operating. Shell is committed to working with communities to understand and resolve their concerns. In response to this vibration complaint, Shell thus implemented improvements at the Station to reduce vibration and the Station was re-opened in May 2022.

Shell collected operational data which was submitted to the CEC from January 12, 2021 through September 30, 2022. These data include quarterly reporting of all fueling, maintenance, operations data; hydrogen quality reports; and reports of dispensed renewable hydrogen. If one average hydrogen FCEV takes one average gasoline midsized sedan off the road, the amount of gasoline displaced due to the Station operation during this time period would equal nearly 6,700 gallons displaced.[1]

Shell plans to operate the Station for at least the next 10 years and plans to operate other light-duty stations in California in addition to heavy-duty stations. Shell is a committed participant and supporter of California's vision for the hydrogen refueling station network.

[1] Calculation assumptions are:

- Average mileage of a mid-sized hydrogen FCEV is 312 miles per tank, and one tank is on average 5 kilograms of hydrogen.
- Average mileage of a mid-sized gasoline sedan is 434 miles per tank, and one tank is on average 12 gallons of gasoline.:

CHAPTER 1: Introduction

Objectives

The Berkeley Station ("the Station") is one of seven stations that Shell designed and constructed under awards from the California Energy Commission (CEC), granted under its grant funding opportunity, GFO-15-605. The objective of this project was to design, build, commission, and open a retail hydrogen serviced station co-located at an existing Shell gasoline station at 1250 University Ave. Berkeley CA 94702. The objective of this Station was to demonstrate that a hydrogen refueling station is capable of meeting FCEV consumer convenience needs safely and reliably.

Approach

Shell's overall approach to the development of its hydrogen refueling station infrastructure has the following key elements:

- Make the customers refueling experience as similar as possible to that of refueling gasoline powered vehicles. This is achieved by co-locating hydrogen dispensers and associated point of sale (POS) terminals with the gasoline dispensers under the canopy of its branded gas stations.
- Employ standardized equipment design, and performance characteristics across all its hydrogen refueling stations.
- Employ modular equipment with the smallest possible footprint to permit installation in existing stations that are space constrained. Such stations are typically located in urban, densely developed sites. This allows Shell to bring hydrogen refueling stations to city centers.
- Team with engineering firms, equipment manufacturers, and construction contractors with proven record of designing and building service stations.

Activities Performed

Shell performed the following activities:

- Site Acquisition
- Preliminary Investigations
- Equipment Procurement
- Entitlements
- Design and Permitting
- Bid Solicitation

- Construction
- Commissioning and Startup
- Operational and Open Retail Station
- Data Collection and Analysis

CHAPTER 2:
Station Design, Construction and Startup

Major Activities and Timeline

Construction of the Station required many activities that are listed and described below along with an approximate timeline for their execution. Shell negotiated site acquisition agreement and procured the hydrogen station equipment.

Shell retained Fiedler Group (FG) to prepare documents required for design, entitlements, permitting, bid solicitation, and construction services. FG implemented its phased approach to accomplish the preparation of the documents, exhibits and attain a permit ready to issue (RTI) status. Shell's project team, comprised of Fiedler Group (as engineer of record), Nel (as equipment vendor, installer and O&M contractor) and Fueling and Service Technologies (Fastech, as general contractor), executed the following phases to achieve an open retail station:

- Site Acquisition
- Preliminary Investigations
- Equipment Procurement
- Entitlements
- Design and Permitting
- Bid Solicitation
- Construction
- Commissioning and Startup
- Operational and Open Retail Station

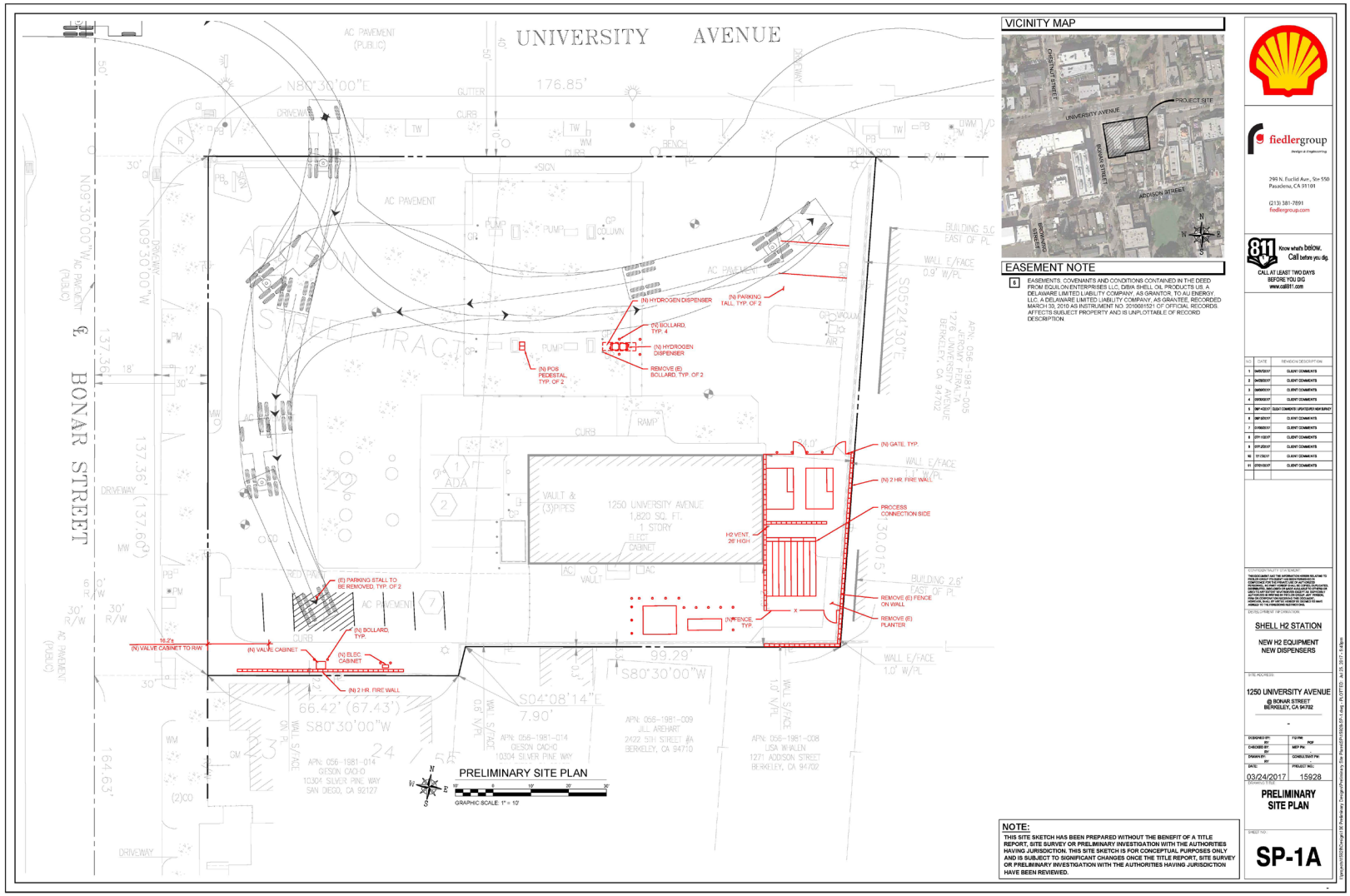
Site Acquisition (August 2016)

The Station is located at an existing Shell branded station operated by AU Energy (AUE). The site is jointly owned by Shell and AUE. Shell and AUE entered into negotiations to build an H2 station and executed a completed agreement on August 17, 2016.

Preliminary Investigations (March 2017 to July 28, 2017)

FG investigated the requirements of various government agencies and utilities. This entailed discovery of requirements, codes, ordinances and regulations that impact entitlements, permitting, and design criteria. A site investigation report was developed based on agency contact. The following agencies were contacted: City of Berkeley, Planning Department, Building Department, Fire Department, Bay Area Air Quality Control District, and local utility PG&E. A preliminary site plan was prepared based on Shell's design requirements, agency findings and site visit. Figure 1 illustrates the preliminary site plan.

Figure 1: Preliminary Site Plan



Source: Fiedler Group/Shell

Equipment Procurement (April 10, 2017 to June 19, 2019)

Shell selected Nel to supply the hydrogen station equipment. Shell contracted with Nel to supply, install, and commission all equipment necessary to achieve an operational hydrogen station. Nel supplied the following major hydrogen station equipment: station module (containing compressor and hydrogen cooling system), storage module and associated valve panels, supply cabinet and associated human machine interface, hydrogen dispensers, and all interconnecting mechanical pipe and tubing between the equipment. The equipment delivery was timed to synchronize with the construction schedule. All the equipment was delivered to the site and installed by June 19, 2019. Shell purchased the POS terminals from COMDATA.

Entitlement Process (July 28, 2017 to October 27, 2018)

FG submitted the entitlements drawing package to the authorities having jurisdiction (AHJ) on July 28, 2017. The planning department verified that the project meets the zoning requirements and approved aesthetic, landscaping, and other details that are important to the community. Four sets of plan-check comments were received and addressed. Shell received approval on October 27, 2018. Figure 2 illustrates the site plan approved by the planning department.

Site Design and Permitting (December 22, 2017 to December 6, 2018)

FG submitted the first design drawing package to the city on December 22, 2017. Four sets of plan-check comments were received and addressed. Shell received final approval of the construction permit on December 6, 2018. Figure 3 illustrates the site plan permitted for construction.

Bid Solicitation (September 14, 2018 to November 8, 2018)

FG prepared a bid solicitation package consisting of the drawing set, technical documents, and project manual. Shell invited three prequalified general contractors to bid. Shell received three bids and evaluated them against an engineer's independent cost estimate. In addition to cost, other factors that Shell used to evaluate bids were prior similar experience and current capability, safety performance, financial strength, and ability to mobilize and complete construction per required schedule. Shell awarded a construction contract to Fueling and Service Technologies, Inc. (Fastech) on November 8, 2018.

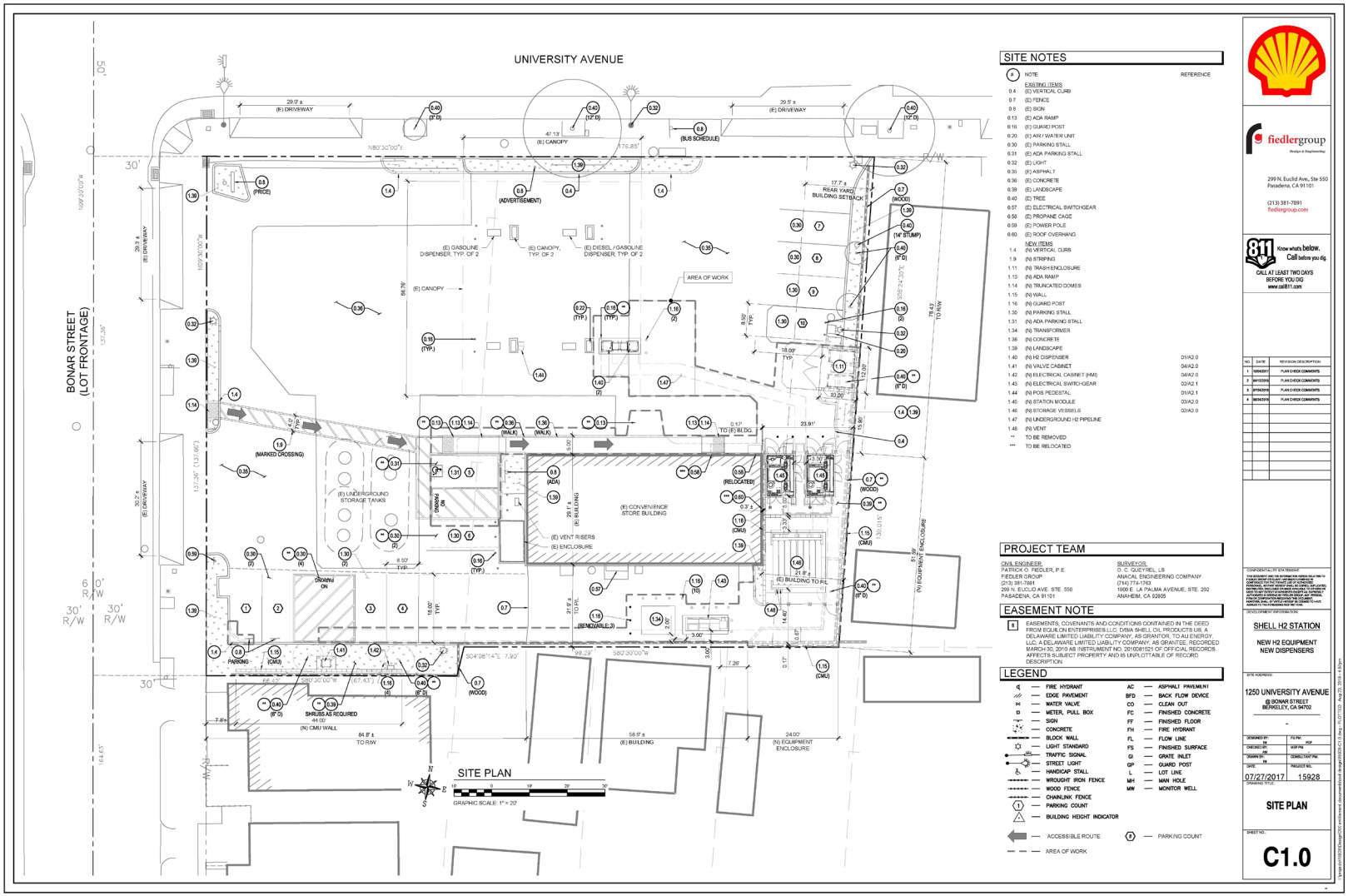
Construction (January 7, 2019 to June 19, 2019)

Construction Contractor, Fastech, mobilized to the site on January 7, 2019. All hydrogen station equipment was installed by June 19, 2019.

Figure 4 Illustrates assembly of the storage module and setting of compressor module on its foundation. Figure 5 illustrates the completed Station.

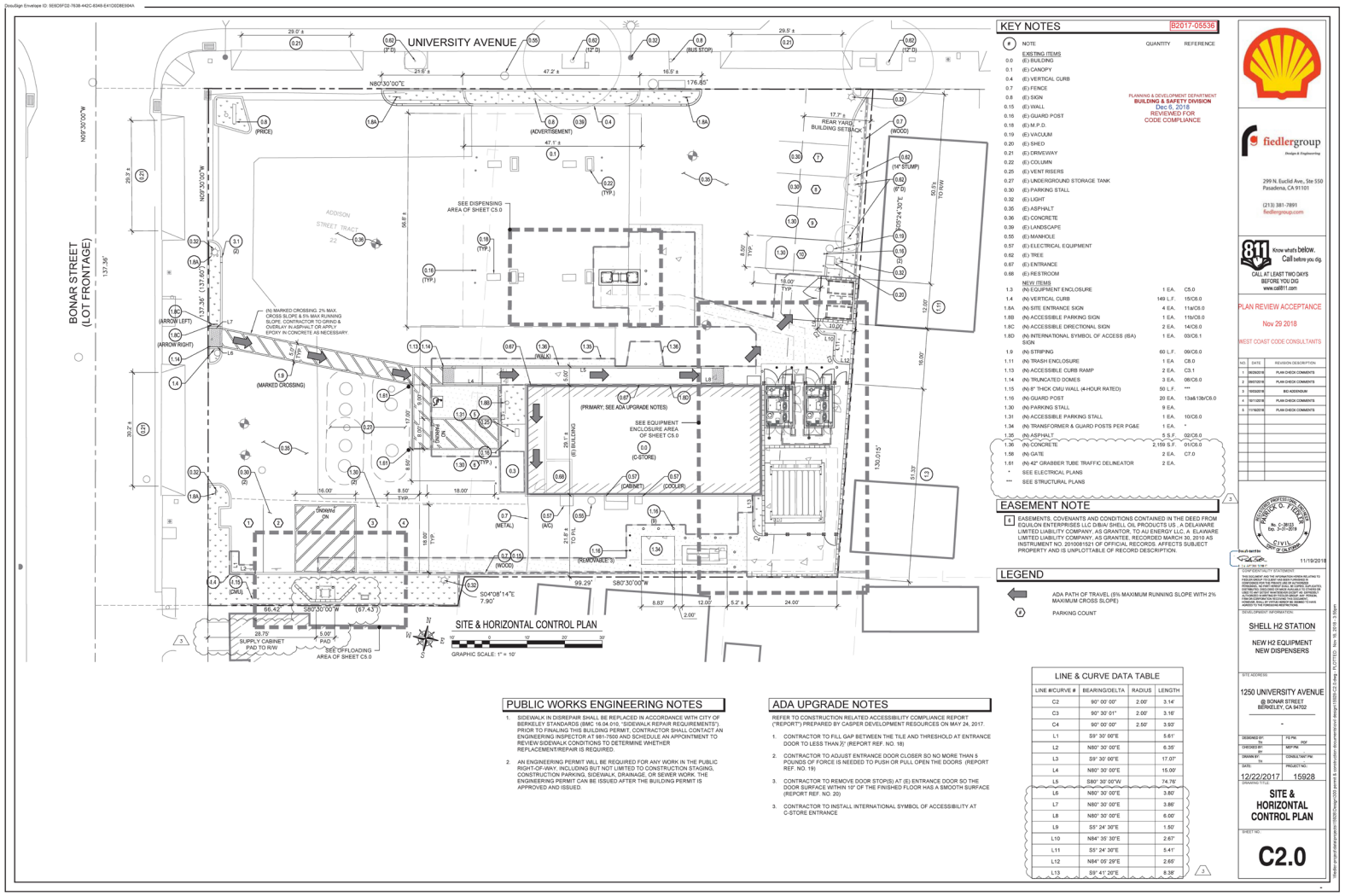
Utility service was energized on June 3, 2019. The pre-startup safety review (PSSR) was conducted by Shell project managers in conjunction with Fastech and the Operations & Maintenance contractor on June 19, 2019 and a checklist of actions was completed.

Figure 2: Site Plan Approved by the Planning Department



Source: Fiedler Group/Shell

Figure 3: Site Plan for Construction



Source: Fiedler Group/Shell

Figure 4: Field Assembly of Storage Module (above); Two Station Modules Under Construction (below)

Source: Fiedler Groups/Shell

Source: Fiedler Group/Shell

Figure 5: View of the Dispensers and POS (above); Fenced Equipment Compound (below)

Source: Fielder Group/ Shell

Commissioning and Startup (June 19, 2019 to June 23, 2020)

PSSR actions that were deemed prerequisite for introduction of hydrogen into the system were completed on September 6, 2019. Hydrogen was introduced on October 1, 2019. The delay in introduction of hydrogen was due to a hydrogen supply disruption experienced by the hydrogen vendor. California Department of Food and Agriculture, Division of Measurement Standards (DMS) certified Dispenser 1 accuracy on October 24, 2019. DMS certified Dispenser 2 on February 25, 2020. Commissioning and startup activities continued until June 23, 2020 when the first FCEV was filled. Figure 6 illustrates the receipt from fueling of the first FCEV. Figure 7 illustrates results of hydrogen purity test.

Operational Station (June 23, 2020)

The project team deemed the Station "operational" on June 23, 2020. Shell achieved connection to the Station Operational Status System (SOSS) on March 1, 2020. Figure 8 illustrates the SOSS status of the Station.

At this time, the station was briefly open to the public, but shut down after the hydrogen supply was depleted. After commissioning, the station's hydrogen supplier paused deliveries due to concerns with the site layout. Shell and the station supplier explored a number of solutions, and the chosen solution was to design, permit, and construct an awning over the top of the offload panel which would serve as a fire barrier in addition to the concrete masonry unit (CMU) wall that was already built around the offload cabinet. The awning construction was completed in December 2021. The supplier then inspected, approved, and re-supplied the site which allowed for a January 12, 2021 retail open date.

Open Retail Station (January 12, 2021)

The first retail customer was served on January 12, 2021 and the Station was deemed retail open as of January 12, 2021. Figure 8 illustrates the SOSS status of the Station.

Shell temporarily closed the Station shortly after opening to the public after Shell received notification of vibration felt in an adjacent apartment home while the Station's hydrogen compressors were operating. Shell is committed to working with communities to understand and resolve their concerns. In response to this vibration complaint: Shell thus contracted a third party to conduct vibration monitoring and aid in the development of a plan to reduce the compressor-driven vibrations. Shell and Nel worked to implement this upgrade plan at site and re-opened the Station in May 2022. Vibration testing after the upgrades showed the upgrades installed at the Station were successful in reducing vibration. Shell continues to communicate with station neighbors to understand and resolve concerns.

Figure 6: First Fueling of an FCEV

Source: Fiedler Group/Shell

Figure 7: Hydrogen Fuel Quality Report (February 21, 2020)

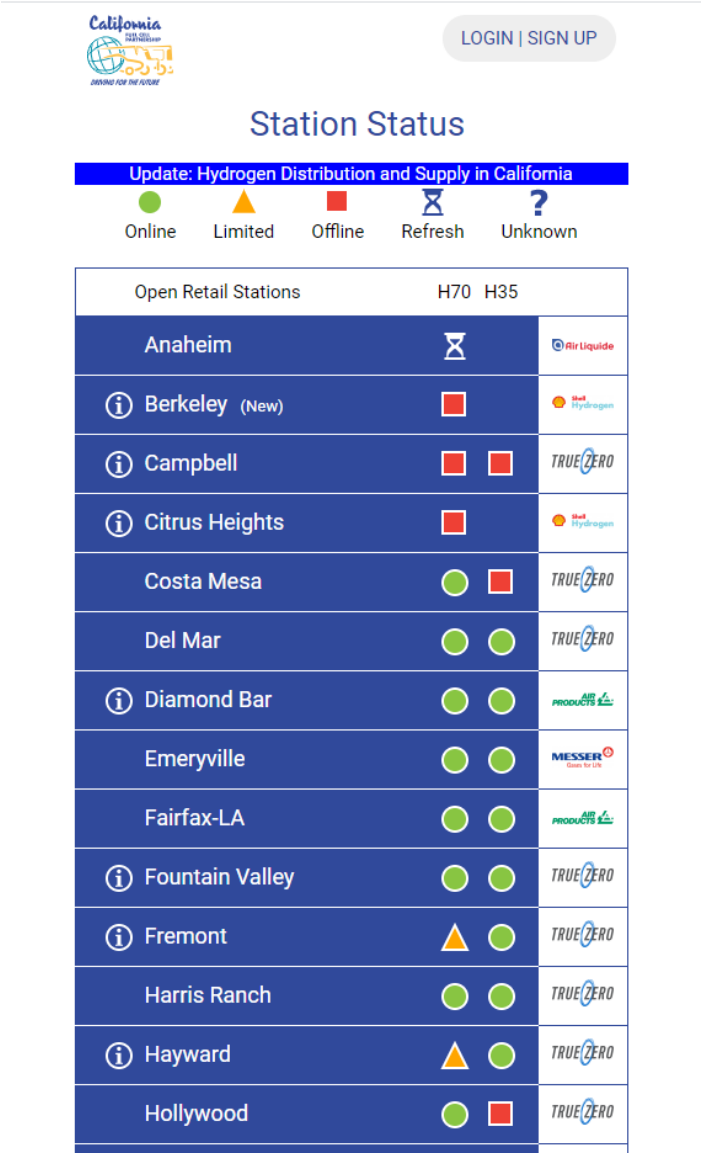
SmartChemistry

SAE J2719 — NEL Berkeley Dispenser#2 H70

SUMMARY	SAE J2719 Limits, µmol/mol	SMART CHEMISTRY Detection Limits, µmol/mol	Concentration (µmol/mol)
H_2O			2.3
Total Non-Methane Hydrocarbons -C_1 Basis			0.089
CH_4			0.069
O_2			< 2
He			23
N_2 Ar			53
N_2			51
Ar			2.1
CO_2			0.061
CO			0.0047
Total S			0.000022
Hydrogen Sulfide			0.0000040
Carbonyl Sulfide			0.0000089
Methyl Mercaptan			< 0.00001
Ethyl Mercaptan			< 0.00001
Dimethyl Sulfide			0.0000033
Carbon Disulfide			0.0000053
Isopropyl Mercaptan			< 0.00001
Tert-Butyl Mercaptan			< 0.00001
n-Propyl Mercaptan			< 0.00001
Thiophene			< 0.00001
Diethyl Sulfide			< 0.00001
n-Butyl Mercaptan			< 0.00001
Dimethyl Disulfide			< 0.00001
Tetrahydrothiophene			< 0.00001
Formaldehyde			< 0.001
Formic Acid			< 0.0005
Ammonia			< 0.02
Total Halogenates			< 0.01
Cl_2			< 0.0001
HCl			< 0.0004
HBr			< 0.0007
Total Organic Halides			< 0.001
Particulate Concentration			0.079 mg/kg
Particulates Found & Size			There are total 104 particulates found in the center (sizes in micrometer) - 59, 54, 50, 48, 47, 43, 42, 41, 37 (2), 34, 32, 30, 26, 25 (4), 24 (2), 23 (2), 22 (2), 21 (6), 18 (7), 17 (13), 15 (7), 13 (45), 12 (2). However, one 670µm Particulate is found outside the center area, as shown left.
			The filter contains two water droplets as shown left. However, these two water droplets are evaporated before the weighing of the filter paper.
	Hydrogen Fuel Index		99.986879%

Source: Shell

Figure 8: Screen Shot of the SOSS Web Page With Berkeley Listed



Source: California Fuel Cell Partnership (https://m.cafcp.org/)

List of Subcontractors and Value

Table 1 and Table 2 list the equipment suppliers and subcontractors and the value of their contracts. Table 3 shows the total project cost and the total CEC cost share.

Table 1: List of Equipment Suppliers and the Value of Their Contracts

Equipment Supplier	Description	CEC Grant	Shell Match	Total Cost Allocated to the Project	Vendor Invoices Total
Nel Hydrogen, San Leandro, CA	Hydrogen station equipment -- supply, install and commission the station	2,283,899.00	557,600.00	2,841,499.00	2,841,499.00
COMDATA, Brentwood, TN	Supply POS terminals for recording sale transactions	34,338.37	0.00	34,338.37	34,338.37
Benfield, White Plains, NY	Supply switchgear for power distribution	19,262.63	8,497.37	27,760.00	27,760.00
Equipment Total		**2,337,500.00**	**566,097.37**	**2,903,597.37**	**2,903,597.37**

Source: Fiedler Group/Shell

Table 2: List of Subcontractors and the Value of Their Subcontracts

Subcontractor	Description	CEC Grant	Shell Match	Total Cost Allocated to the Project	Vendor Invoices Total
Fastech Buena Park, CA	General contractor for civil construction	0.00	1,068,115.63	1,068,115.63	1,099,955.00
Subcontractors Total		**0.0**	**1,068,115.63**	**1,068,115.63**	**1,099,955.00**

Source: Fiedler Group/Shell

Table 3: Total Project Cost and Total CEC Cost Share

Category	CEC Grant	Shell Match	Total Cost Allocated to the Project	Vendor Invoices Total
Equipment Total	2,337,500.00	566,097.37	2,903,597.37	2,903,597.37
Subcontracts Total	0.0	1,068,115.63	1,068,115.63	1,099,955.00
Grand Total	**2,337,500.00**	**1,634,213.00**	**$3,971,713.00**	**4,003,552.37**
Total CEC Cost Share	**58.9%**	**N/A**	**N/A**	**N/A**

Source: Fiedler Group/Shell

CHAPTER 3:
Data Collection and Analysis

Data Reporting

Shell collected over one year of operational data and submitted to the CEC. This includes quarterly reporting of all fueling, maintenance, operations data; hydrogen quality reports; and reports of dispensed renewable hydrogen.

Economic Impact

The project required construction and high-tech firms to build and maintain the Station. The funding was predominantly awarded to California construction and technology firms who had the expertise and qualifications. The workers and firms developed hydrogen dispensing expertise during the construction and support of the refueling station which was valuable and will be directly transferable to other hydrogen refueling station developers in California and abroad for the foreseeable future.

The on-site jobs to handle the initial construction for the Station included roughly 25 full-time temporary positions including local engineering resources, masonry and electrical workers, pipefitters, welders, truck drivers, environmental engineers, and others. Internally, Shell created two full-time permanent roles to manage the construction and project phase of the development of the station, and one full-time permanent role to maintain the station, collect and report the technical data, and support the operations. Shell also created one full-time role to develop future hydrogen refueling station growth within California.

Shell estimates the funding awarded to California-based companies and employees to be about $750,000 for the Station. The California-based companies that Shell contracted with included Nel and Air Products and Chemicals Inc. Nel supplied critical fueling dispenser and equipment for the station and established full-time positions solely to prepare market expansion and provision of equipment for California. The team consists of California-based technicians who are qualified and trained to conduct maintenance as well as any advanced station repair. Air Products and Chemicals Inc. supplies and transports the hydrogen fuel to the Station and manufactures the hydrogen fuel predominantly from California-based operations.

The generation of California taxes is a direct and immediate economic benefit. These taxes can be utilized to provide government services to the disadvantaged communities, which can provide a direct benefit to the community. These taxes were generated upon launch of the project and continues through with the operation of the station.

Environmental Impact

The Station dispensed over 3870 kgs of hydrogen from January 2021 through September 2022. If one average hydrogen FCEV takes one average gasoline midsized sedan off the road, the amount of gasoline displaced due to the Station operation would equal nearly 6,700 gallons displaced.

The resulting air emissions reduction is estimated to be at least 59 metric tons of carbon dioxide equivalent (CO2e) per year. The assumptions used to calculate this emissions reduction are listed below.

- Average mileage of a mid-sized hydrogen FCEV is 312 miles per tank, and one tank is on average 5 kilograms of hydrogen.
- Average mileage of a mid-sized gasoline sedan is 434 miles per tank, and one tank is on average 12 gallons of gasoline.
- The amount of CO2e for a hydrogen FCEV is 145 grams of CO2e per mile.
- The amount of CO2e for a gasoline vehicle is 390 grams of CO2e per mile.
- Both of these CO2e values are simulated per the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model.[2]
- The calculation does not account for any offsets using greenhouse gas credits.

Carbon Intensity Value

The carbon intensity value for the supply chain for the Station is -89.98 grams of CO2 per megajoule. The energy economy ratio for light-duty passenger vehicles is 2.5.

Energy Efficiency Measures

While a Title 24 report was not required for the Berkeley station, Shell monitors and manages energy use and efficiency for continuous improvement and the global greenhouse gas emission inventory is subject to independent assurance.

[2] Argonne National Laboratory. The Greenhouse gases, Regulated Emissions, and Energy use in Technologies Model, https://greet.es.anl.gov/.

CHAPTER 4:
Statement of Future Intent

Shell plans to operate the Station for at least the next 10 years. Shell has further subcontracted with the equipment vendor, Nel, for the operation, maintenance and repairs of the system. Nel has local maintenance and engineering capability and staff in northern California. The system is outfitted with remote monitoring and automatic alarm communication systems that will send alerts to designated Shell, and Nel personnel.

Shell is a committed participant and supporter of California's hydrogen refueling station network. To this end, Shell matched funds with CEC for the construction of six other hydrogen refueling stations in Northern California. Shell's commitment is further demonstrated with its match share for the construction of a heavy-duty vehicle fueling station at the Port of Long Beach, Wilmington, and Ontario, as well as the GFO-19-602 proposed award to build additional light-duty stations in California.

CHAPTER 5:
Findings, Conclusions, and Recommendations

The challenges faced during the Station construction and initial operations contributed to significant learnings for the Shell Project and Operations teams.

Establishing new power service is a time-consuming process and it can very easily become the critical path for project's completion. Early engagement with the utility to obtain a detailed understanding of their process, procedures, inspection milestones and their timeline is recommended.

National Fire Protection Association – Hydrogen Technologies Code (NFPA 2) is a critical tool for working with permit agencies. The code clearly defines fire safety guidelines that enable local jurisdictions and builders to reach common ground while ensuring safety via the rigorous NFPA code writing process. For this project, the station siting and set back decisions were based on the Performance Based Analysis provisions of the NFPA 2 code. This is an important tool in NFPA-2 that makes the construction of H2 stations in an urban environment practical and feasible.

The Station has contributed towards the fulfillment of the goals of CEC's ARFVTP program and specifically towards the goals of GFO-15-605 by expanding the hydrogen infrastructure network to encourage greater FCEV adoption among consumers. This was achieved with extensive teamwork by Shell and contractors. Insights gained from the project are invaluable and will be applied toward future projects to further the success of hydrogen refueling stations.

Retail Open status at the Station was delayed in order to address concerns from the Station's hydrogen supplier regarding site layout, specifically the location and planned path for the hydrogen delivery trailer. A general recommendation for future projects will be early consideration and review of the hydrogen delivery trailer routing and positioning onsite during deliveries.

Building in a densely populated, urban environment presents its own unique challenges. For the Station, the project site was exceptionally small in area and presented considerable obstacles in both design and construction and continues to pose operational challenges.

Significant rainfall occurred over the course of the construction which not only delayed the occurrence of substantial completion but also resulted in significant expenditure for water management and dewatering the site. It also caused

significant erosion and undermining of fence at the property lines, which required expensive remediation work.

Siting the hydrogen equipment, particularly compressors, close to neighboring residential buildings also led to significant Station downtime and design re-work to address compressor vibration complaints that shortly arose after the Station opened. In future projects, vibration and noise measurements should be included in equipment specification, factory acceptance testing, and site acceptance testing.

Despite these challenges, the project was able to be completed thanks to close coordination between engineering, construction, city staff, and Shell. A general recommendation for future site selection considerations is: include property size, proximity to property line, and drainage of surface water from adjoining property on to the construction site. Choosing very small properties may result in additional complications including:

- Disagreement and tensions with adjacent neighbors
- Disruption to existing operations
- Limited space for vehicle queuing
- Significantly increased cost and schedule risk during construction
- Extended AHJ review and permitting obstacles.

GLOSSARY

ALTERNATIVE AND RENEWABLE FUELS AND VEHICLE TECHNOLOGY PROGRAM (ARFVTP)—Created by Assembly Bill 118 (Nunez, Chapter 750, Statutes of 2007), the program with an annual budget of about $100 million supports projects that develop and improve alternative and renewable low-carbon fuels, improve alternative and renewable fuels for existing and developing engine technologies, expand transit and transportation infrastructures, and establishing workforce training programs, conduct public education and promotion, and create technology centers, among other tasks.

AU ENERGY (AUE)—a fuel wholesaler and retailer which owns and operates Shell retail stations in California.

AUTHORITY HAVING JURISDICTION (AHJ)—An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

CALIFORNIA DIVISION OF MEASUREMENT STANDARDS (DMS)—Enforcement of California weights and measures laws and regulations is the responsibility of the Division of Measurement Standards. The Division works closely with county sealers of weights and measures who, under the supervision and direction of the Secretary of Food and Agriculture, carry out the vast majority of weights and measures enforcement activities at the local level. Ensuring fair competition for industry and accurate value comparison for consumers are the primary functions of the county/state programs.

CARBON DIOXIDE EQUIVALENT (CO2e)—A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as "million metric tons of carbon dioxide equivalents (MMTCDE)" or "million short tons of carbon dioxide equivalents (MSTCDE)" The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. MMTCDE= (million metric tons of a gas) * (GWP of the gas) For example, the GWP for methane is 24.5. This means that emissions of one million metric tons of methane is equivalent to emissions of 24.5 million metric tons of carbon dioxide. Carbon may also be used as the reference and other greenhouse gases may be converted to carbon equivalents. To convert carbon to carbon dioxide, multiply the carbon by 44/12 (the ratio of the molecular weight of carbon dioxide to carbon). (EPA)

FUEL CELL ELECTRIC VEHICLE (FCEV)—A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

HUMAN-MACHINE INTERFACE (HMI)—the hardware or software through which an operator interacts with a controller. An HMI can range from a physical control

panel with buttons and indicator lights to an industrial PC with a color graphics display running dedicated HMI software.

HYDROGEN STATION EQUIPMENT PERFORMANCE (HyStEP) DEVICE—a device that has been designed to carry out the test methods of CSA HGV 4.3 to measure that stations follow the fueling protocols standard SAE International J2601.

KILOGRAM (kg)—The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to the mass of 1000 cubic centimeters of water at the temperature of its maximum density.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)—is a global self-funded nonprofit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards.

FUELING AND SERVICE TECHNOLOGIES (Fastech)—the general contractor for the Station

PRE-STARTUP SAFETY REVIEW (PSSR)—a safety review conducted prior to startup of a new or modified facility to ensure that installations meet the original design or operating intent to catch and re-assess any potential hazard due to changes during the detailed engineering construction phase of a project.

READY TO ISSUE (RTI)—The permit application is ready to be issued once the building permit issuance fees are paid.

PACIFIC GAS AND ELECTRIC COMPANY (PG&E)—an electric and gas utility serving the greater San Francisco, California, region.

STATION ONLINE STATUS SYSTEM (SOSS)—a mobile-friendly website that shows station availability and provides other station information such as hours of operation, address, and the hydrogen station operator and developer.