CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Hayward Hydrogen Station

Prepared for: California Energy Commission

Prepared by: First Element Fuel, Inc.

Gavin Newsom, Governor

November 2019 | CEC-600-2019-075

California Energy Commission

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Agreement Number: ARV-14-013

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ACKNOWLEDGEMENTS

The construction of the Hayward hydrogen refueling station has been possible only because of the substantial efforts and funds provided by stakeholders. FirstElement Fuel, Inc. graciously thanks Toyota for its vision and fortitude; Air Products and Chemicals, Inc., Black & Veatch, and Electrical Tech Construction, Inc. for bringing the project together; Tyson Eckerle for helping push the lease over the goal line; and, of course, Jean Baronas, Sarah Williams, Jim McKinney, Vice Chair Janea Scott and many others at the California Energy Commission for tremendous, sustained confidence in clean, alternative transportation.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology 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.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- 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 PON-13-607 to fund hydrogen refueling stations. In response to PON-13-607, the recipient submitted an application that was proposed for funding in the Energy Commission's notice of proposed awards May 1, 2014. The Commission executed the agreement as ARV-14-013 on July 22, 2014.

ABSTRACT

FirstElement Fuel, Inc. designed, engineered, permitted, constructed, and made operational a hydrogen refueling station at 391 A Street, Hayward in Alameda County. FirstElement Fuel, Inc. plans to own and operate the hydrogen refueling station until at least 2025. The station consists of a concrete reinforced block compound that encloses hydrogen storage, compression, and cooling equipment; a dispenser with two fueling hoses; a customer payment interface; a canopy; and a dedicated concrete fueling position for fuel cell electric vehicle drivers.

Keywords: FirstElement Fuel, Inc., hydrogen refueling station, hydrogen infrastructure, fuel cell electric vehicles.

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EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles and hydrogen refueling stations are expected to play key roles in California as the state transitions to lower-carbon and zero-emission vehicle technologies for light-duty passenger vehicles, transit buses, and truck transport fleets. Numerous government regulations and policy actions identify fuel cell electric vehicles as a vehicle technology that will be available to meet the California Air Resources Board's zero-emission vehicle regulation and the specific actions to bring fuel cell electric vehicles to California markets specified in former Governor Edmund G. Brown Jr.'s Zero Emission Vehicle Action Plan.

Fuel cell electric vehicles offer tremendous potential for the light-duty passenger vehicle market and medium- and heavy-duty truck and bus markets. Fuel cell electric passenger vehicles can drive more than 300 miles on a tank of hydrogen, have zero tailpipe emissions, and can be refueled in three to four minutes the way gasoline passenger vehicles are fueled. However, fuel cell electric vehicles require a new network of refueling stations that dispense pressurized hydrogen for consumer use. This requirement has meant that the auto industry and station development industry have had to develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen fuel cell electric vehicles. Fuel cell electric vehicles cannot be widely marketed and sold to consumers without a minimum network of refueling stations available.

In response to PON-13-607 issued by the Energy Commission FirstElement Fuel, Inc. was awarded funding for 19 stations. The Energy Commission contributed $1,451,000 of the total $2,257,977 cost to design, engineer, permit, construct, and commission this station.

The site selected for this project was 391 A Street, Hayward, in Alameda County. A hydrogen refueling station at this location will serve as a core station in Northern California for at least the next 10 years.

The owner of the property in Alameda County was excited to bring a clean, alternative fuel to his station. Lease terms were negotiated, and FirstElement Fuel, Inc. and the property owner executed a lease on December 31, 2014.

FirstElement Fuel, Inc. developed the site configuration and design, and engineering firm Black & Veatch performed the detailed engineering design. The zoning process in Hayward was administrative and required no public hearing. First Element Fuel, inc., attained approval March 4, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were filed December 18, 2014, and finalized July 9, 2015, over 203 days. Because the Hayward station is near a retirement community, the fire authority in this jurisdiction required an aerial locations of hazardous atmospheres study, one extra infrared flame detector and a remote notification system for the fire department. Wired fencing was installed over the top of the equipment to protect against vandalism.

FirstElement Fuel, Inc. purchased hydrogen refueling station equipment from Air Products and Chemicals, Inc., and the remainder of materials were sourced from a variety of general and

specialty vendors. Electrical Tech Construction, Inc. from Concord was selected as the contractor for the project because of its relatively low bid, excellent safety record, good standing with Black & Veatch, and willingness to work with FirstElement Fuel, Inc. on multiple projects. The construction process began June 5, 2015, and was complete November 18, 2015.

Commissioning began December 5, 2015 and was completed February 25, 2016. The FirstElement Fuel, Inc. team performed the bulk of the commissioning tasks, including cleaning, purging, and pressure testing and Air Products and Chemicals, Inc. performed final start-up.

CHAPTER 1:
Station Design and Construction

There were many steps required to bring the Hayward 33 percent renewable hydrogen refueling station project to completion. The following synopsis highlights the most critical items.

Site Acquisition - Construction (Fall 2013 – November 2015)

Beginning in the fall of 2013, FirstElement Fuel, Inc. took steps to identify and acquire appropriate sites for the station. FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and PON-13-607 Station Location Areas to select desired market locations. FirstElement Fuel, Inc. then analyzed specific properties within the target locations to find sites that could meet the space requirements for hydrogen fueling equipment.

After selecting general locations and specific sites, FirstElement Fuel, Inc. contacted station owners and operators to negotiate lease opportunities. FirstElement Fuel, Inc. executed a letter of intent with the property owner on January 13, 2014. A binding 10-year-lease was later executed on December 31, 2014.

FirstElement Fuel, Inc. selected Air Products and Chemicals, Inc. equipment because of the cost, capacity, reliability, and mature supply chain. FirstElement Fuel, Inc. executed a contract with Air Products and Chemicals, Inc. for the equipment on September 16, 2014 and equipment was delivered to the site on October 13, 2015.

FirstElement Fuel, Inc. and Black & Veatch surveyed the site to begin the site layout process on August 13, 2014. They generated initial engineering drawings on November 17, 2014. These drawings are referred to as "Construction Drawing 30s" because they represent 30 percent complete construction drawings. Figure 1 shows the equipment compound drawing from the Construction Drawing 30 drawing set. As shown, the drawing lacks specific detail and serves only to outline the site plan.

On February 17, 2014, zoning drawings were completed to provide an accurate but relatively high-level depiction of the project for review by planners at the jurisdiction. These drawings are signed and sealed by the professional engineer of record to ensure accuracy and completeness. The equipment compound page of the zoning drawings is shown in Figure 2.

On April 2, 2015, draft final construction drawings (or "Construction Drawing 90s") were completed that depict all of the minute detail required for both construction and the permit review process. Final construction drawings (or "Construction Drawing 100s") were completed with 60 pages that depict all the details required for both construction and the permit review on June 26, 2015. These drawings are similarly signed and sealed by the professional engineer of record to ensure accuracy and completeness. The equipment compound page of the Construction Drawing 100 Drawings is shown in Figure 3.

On October 29, 2014, Clark Land Surveying, Inc. performed a detailed engineering survey for the Hayward station site, as shown in Figure 4.

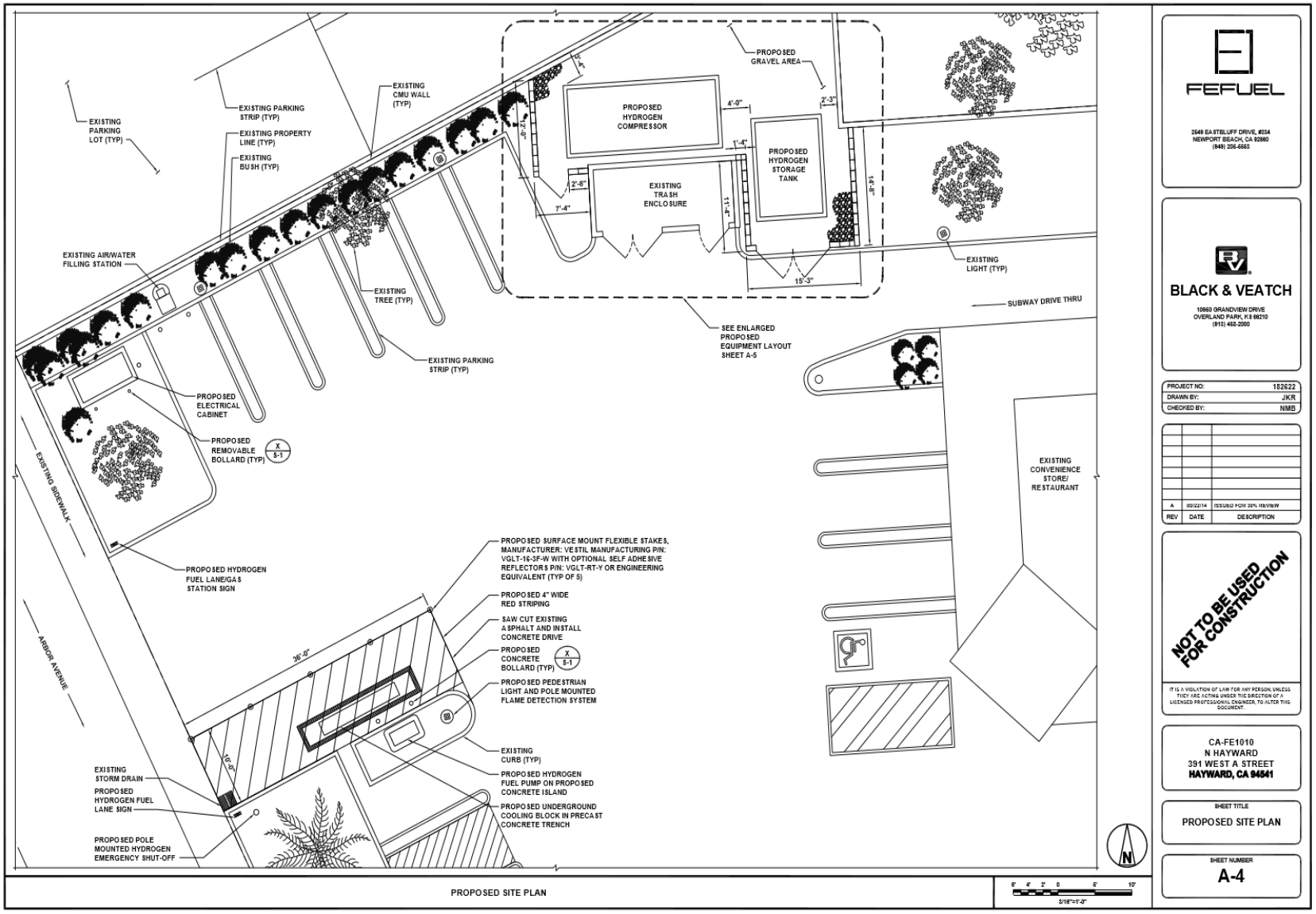
FirstElement Fuel, Inc. and Black & Veatch submitted the zoning application to the jurisdiction having authority on December 18, 2014. The local planning department must verify that the project meets the zoning requirements of the proposed location and approve any aesthetic, landscaping, or other details that are important to the community. Approval was received through an administrative process on March 4, 2015. The administrative entitlement process in Hayward went smoothly and took less time than the public hearing process encountered in other jurisdictions.

All building permit applications were submitted on April 13, 2015 and approved on July 9, 2015.

FirstElement Fuel, Inc. and Black & Veatch submitted a detailed bid package to contractors on June 5, 2015. The contract was awarded to an initial contractor on June 9, 2015. Unfortunately, after beginning the project, the initial contractor pulled out of the project in early August, 2015. FirstElement Fuel, Inc. re-awarded the remainder of the contract to Electrical Tech Construction, Inc. (E-Tech) near the end of August, 2015. The bulk of E-Tech's construction experience lies in cell towers. Cell towers are similar to hydrogen stations in size, have similar foundations and block walls, and have similar electrical requirements. E-Tech provided a reasonable bid, had a desire to get involved with hydrogen projects, and is based in Northern California. Construction started July 14, 2015.

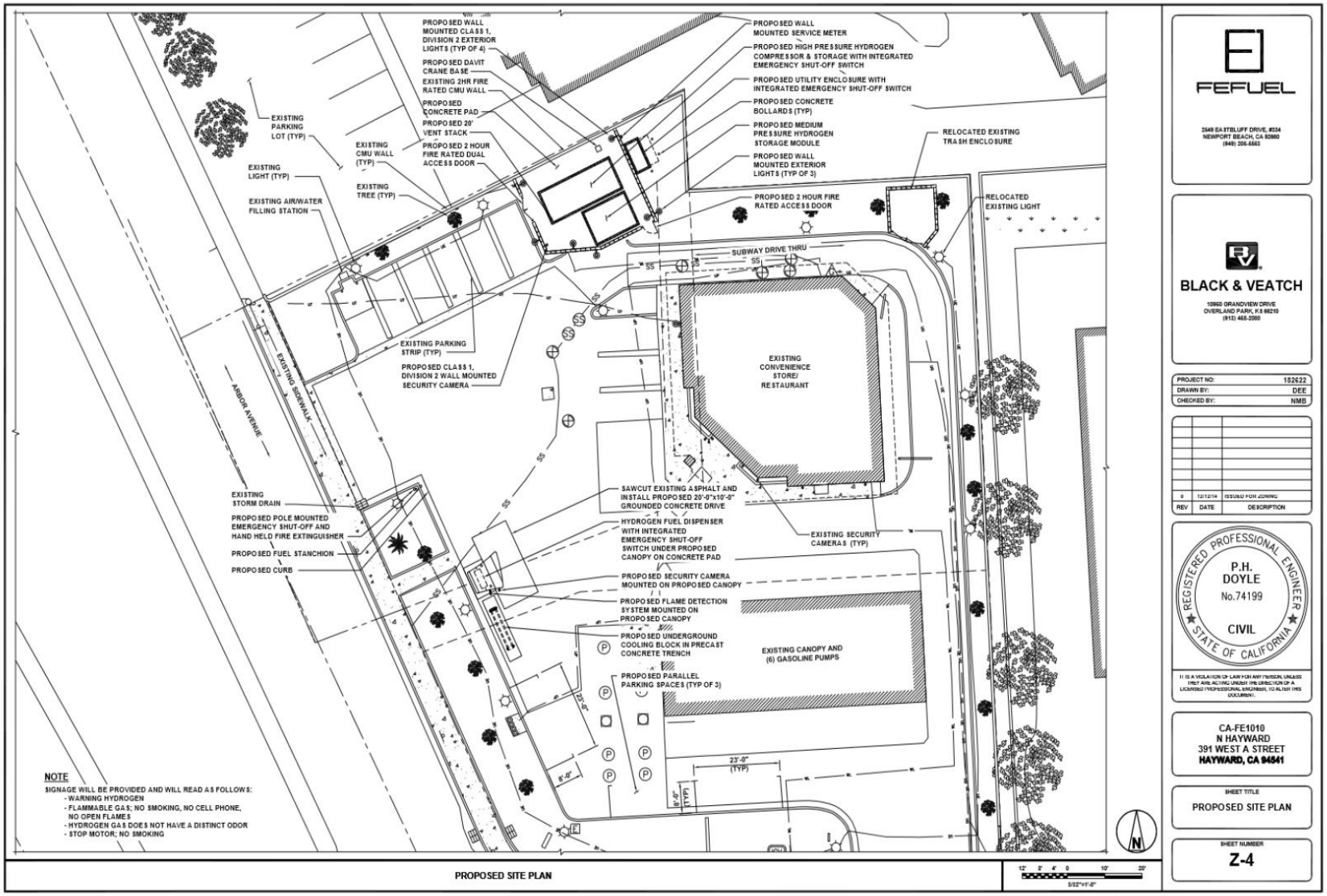
Construction progressed smoothly in part because of the time spent throughout the project to gain a common understanding of project requirements, especially those listed in the National Fire Protection Association hydrogen technologies code. Because the Hayward station is located close to a retirement community, the fire authority in this jurisdiction required an Aerial Locations of Hazardous Atmospheres Study, one extra flame detector and a remote notification system for the fire department. Wired fencing was installed over the top of the equipment to protect against vandalism.

Figure 1: Coarse Detail of Equipment Compound, Construction Drawing 30 Set



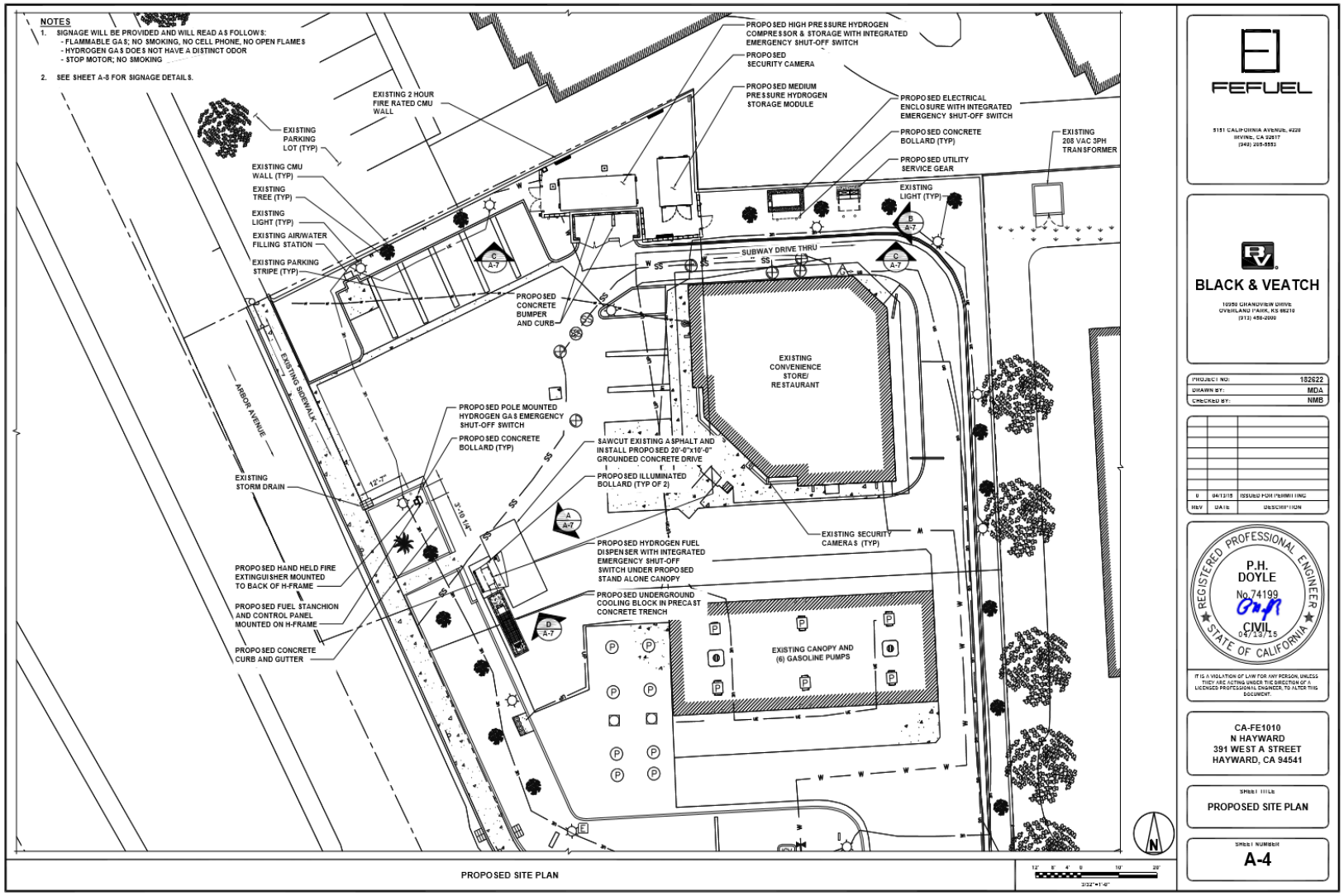
Source: FirstElement Fuel, Inc.

Figure 2: Equipment Compound from Zoning Drawing Set



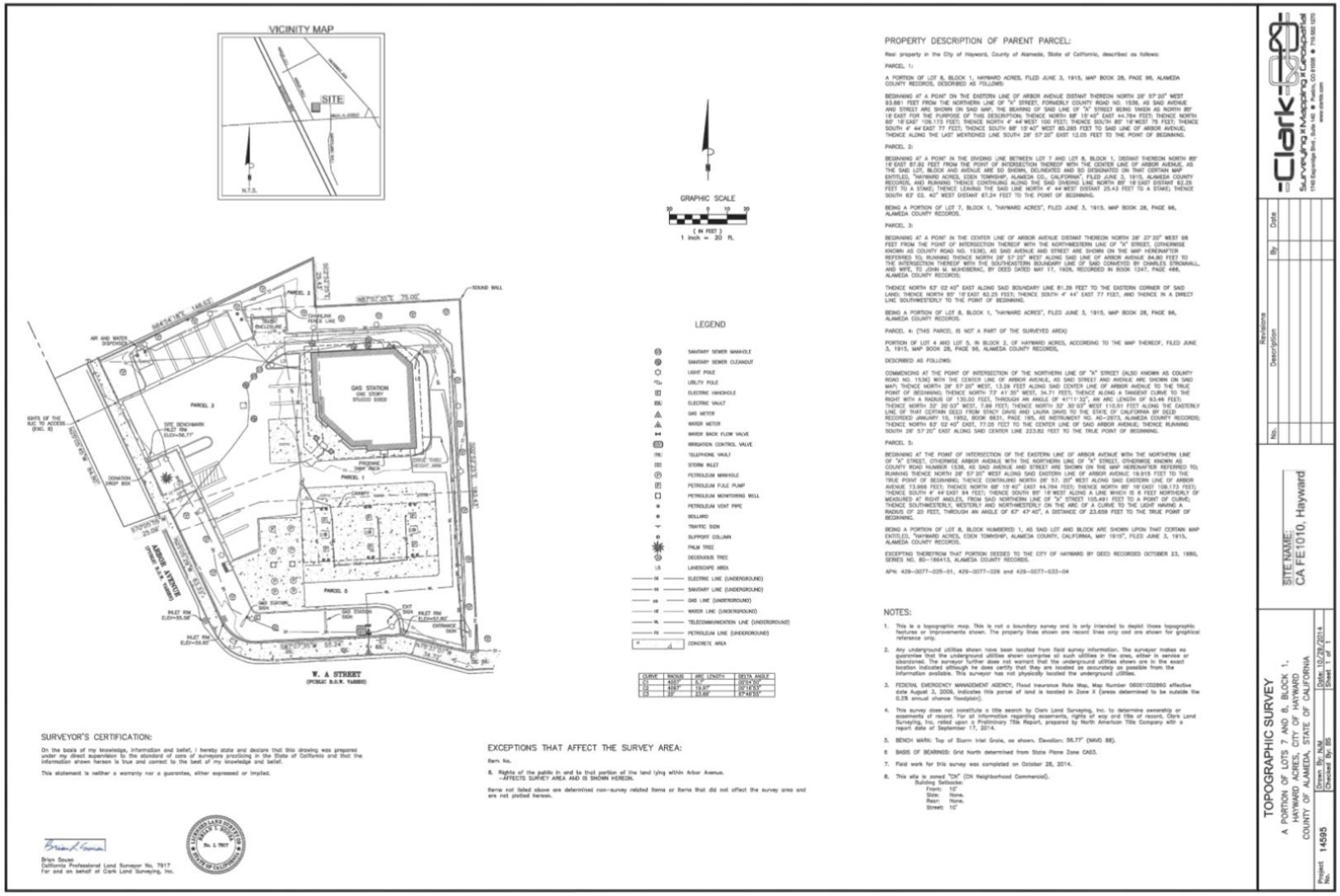
Source: FirstElement Fuel, Inc.

Figure 3: Equipment Compound from Construction Drawing 100 Set



Source: FirstElement Fuel, Inc.

Figure 4: Survey of Hayward Hydrogen Refueling Station Location



Source: FirstElement Fuel, Inc.

Figure 5 shows the Hayward hydrogen refueling station site under construction.

Figure 5: Construction Site

Source: FirstElement Fuel, Inc.

Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site on October 13, 2015. Construction was completed on November 18, 2015. Figure 6 shows a crane lifting an electrical cabinet into place at the Hayward station.

Figure 6: Crane Lifting Electrical Cabinet

Source: FirstElement Fuel, Inc.

Making the Station Operational (December 5, 2015 – February 25, 2016)

The commissioning of the Hayward hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling. Figure 7 shows a technician during the first pressure test.

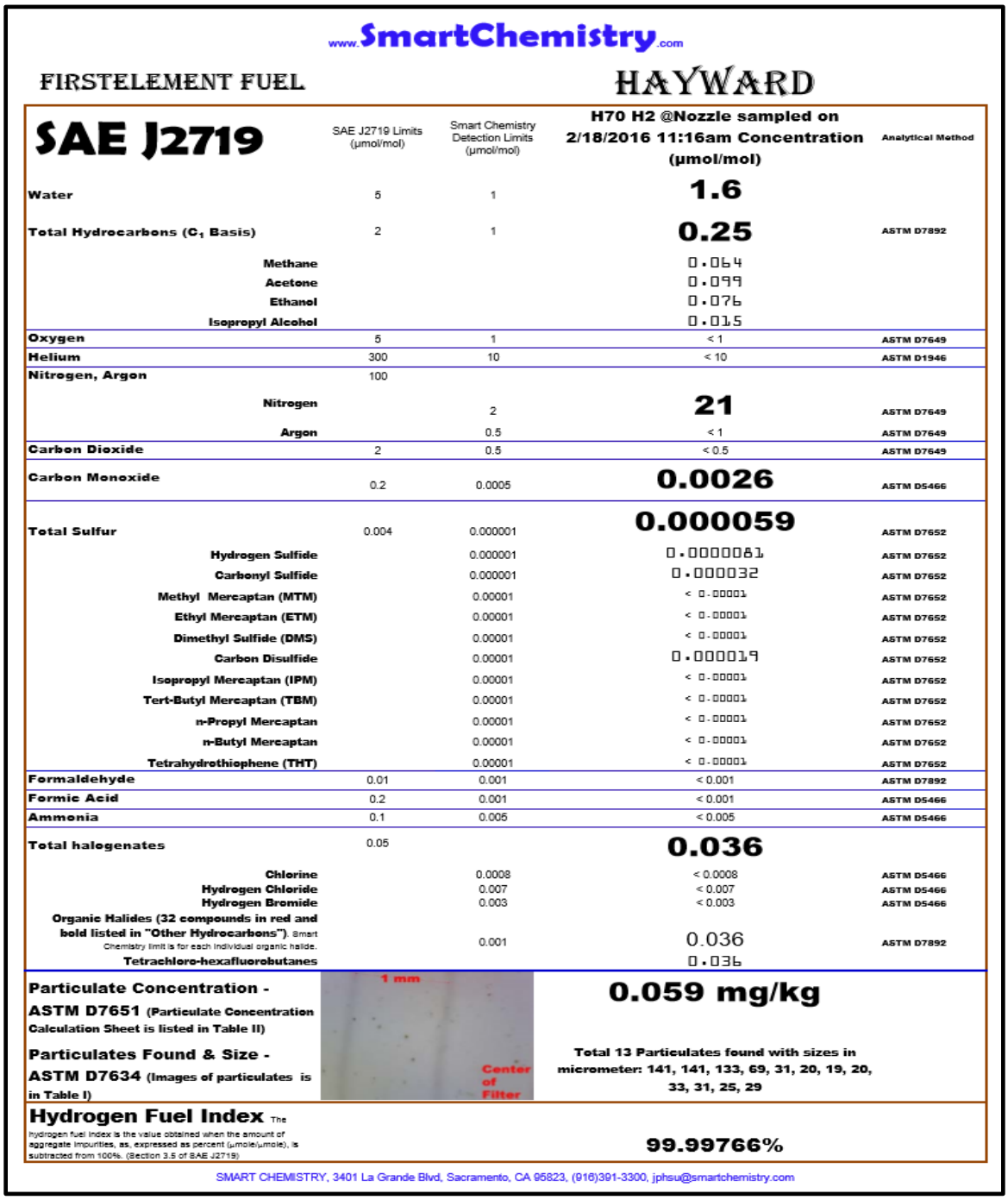
Figure 7: Technician Conducting First Pressure Test during Commissioning

Source: FirstElement Fuel, Inc.

Station Declared Operational (February 26, 2016)

The Hayward hydrogen station met the definition of operational in PON-13-607 by completing the installation of all station/dispenser components, obtaining all the required permits from the local jurisdiction, filling the storage tubes of the station with pressurized hydrogen gas, successfully passing a hydrogen quality test (Figure 8), and fueling one fuel cell electric vehicle (FCEV) with hydrogen (Figure 9). FirstElement Fuel, Inc. declared the station operational February 26, 2016 upon completion of construction.

Figure 8: Hydrogen Fuel Quality Report on February 18, 2016



www.SmartChemistry.com

FIRSTELEMENT FUEL — HAYWARD

SAE J2719	SAE J2719 Limits (µmol/mol)	Smart Chemistry Detection Limits (µmol/mol)	H70 H2 @Nozzle sampled on 2/18/2016 11:16am Concentration (µmol/mol)	Analytical Method
Water	5	1	1.6	
Total Hydrocarbons (C_1 Basis)	2	1	0.25	ASTM D7892
Methane			0.064	
Acetone			0.099	
Ethanol			0.076	
Isopropyl Alcohol			0.015	
Oxygen	5	1	< 1	ASTM D7649
Helium	300	10	< 10	ASTM D1946
Nitrogen, Argon	100			
Nitrogen		2	21	ASTM D7649
Argon		0.5	< 1	ASTM D7649
Carbon Dioxide	2	0.5	< 0.5	ASTM D7649
Carbon Monoxide	0.2	0.0005	0.0026	ASTM D5466
Total Sulfur	0.004	0.000001	0.000059	ASTM D7652
Hydrogen Sulfide		0.000001	0.0000081	ASTM D7652
Carbonyl Sulfide		0.000001	0.000032	ASTM D7652
Methyl Mercaptan (MTM)		0.00001	< 0.00001	ASTM D7652
Ethyl Mercaptan (ETM)		0.00001	< 0.00001	ASTM D7652
Dimethyl Sulfide (DMS)		0.00001	< 0.00001	ASTM D7652
Carbon Disulfide		0.00001	0.000019	ASTM D7652
Isopropyl Mercaptan (IPM)		0.00001	< 0.00001	ASTM D7652
Tert-Butyl Mercaptan (TBM)		0.00001	< 0.00001	ASTM D7652
n-Propyl Mercaptan		0.00001	< 0.00001	ASTM D7652
n-Butyl Mercaptan		0.00001	< 0.00001	ASTM D7652
Tetrahydrothiophene (THT)		0.00001	< 0.00001	ASTM D7652
Formaldehyde	0.01	0.001	< 0.001	ASTM D7892
Formic Acid	0.2	0.001	< 0.001	ASTM D5466
Ammonia	0.1	0.005	< 0.005	ASTM D5466
Total halogenates	0.05		0.036	
Chlorine		0.0008	< 0.0008	ASTM D5466
Hydrogen Chloride		0.007	< 0.007	ASTM D5466
Hydrogen Bromide		0.003	< 0.003	ASTM D5466
Organic Halides (32 compounds in red and bold listed in "Other Hydrocarbons"). Smart Chemistry limit is for each individual organic halide.		0.001	0.036	ASTM D7892
Tetrachloro-hexafluorobutanes			0.036	

Particulate Concentration - ASTM D7651 (Particulate Concentration Calculation Sheet is listed in Table II)

Particulates Found & Size - ASTM D7634 (Images of particulates is in Table I)

0.059 mg/kg

Total 13 Particulates found with sizes in micrometer: 141, 141, 133, 69, 31, 20, 19, 20, 33, 31, 25, 29

Hydrogen Fuel Index The hydrogen fuel index is the value obtained when the amount of aggregate impurities, as, expressed as percent (µmole/µmole), is subtracted from 100%. (Section 3.5 of SAE J2719)

99.99766%

SMART CHEMISTRY, 3401 La Grande Blvd, Sacramento, CA 95823, (916)391-3300, jphsu@smartchemistry.com

Source: FirstElement Fuel, Inc.

Figure 9: First Fueling at the Hayward Station on February 26, 2016

Source: FirstElement Fuel, Inc.

Automaker testing was performed at the Hayward hydrogen station to verify correct fueling according to *SAE J2601 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles.*

Certification (March 17, 2016)

The California Department of Food and Agriculture's Division of Measurement Standards enforces California weights and measures laws and regulations and certifies any device used for metering the sale of commercial items within California. Figure 10 shows that FirstElement Fuel, Inc. achieved certification by acting as the Registered Service Agent dispensing a measured amount of fuel, and confirming the quantity dispensed is accurately reflected by the dispenser in accordance with examination procedures (EPO NO. 40-A) as witnessed by the local county weights and measures officer.[1]

1 California Department of Food and Agriculture Hydrogen Gas Measuring Devices PDF (https://www.cdfa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf)

Figure 10: Dispenser with Certification Stickers at Hayward Station

Source: FirstElement Fuel, Inc.

Station Operational Status System

The California Fuel Cell Partnership, Station Operational Status System is a website portal that provides hydrogen refueling station status for FCEV driver use. [2] This system is important to FCEV drivers during the development phase of the hydrogen refueling station network because it lets drivers know that the hydrogen station they intend to use is selling fuel before they depart. The Hayward hydrogen refueling station began sending automated updates (via FirstElement Fuel, Inc. software) on a regular basis, to Station Operational Status System on April 28, 2016.

Environmental Impacts

Hydrogen will be stored as a compressed gas in an above ground tank concealed behind a wall at this facility. In accordance with the funding agreement with the Energy Commission, 33.3 percent of the hydrogen sold at the Hayward hydrogen station will be produced from renewable sources including biogas. Hydrogen is non-toxic, colorless, and odorless so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in the case of leaks. No solid or liquid waste will be produced at the Hayward station.

Minimal water was consumed for this project. There was no additional landscaping planted at the hydrogen refueling station. No irrigation water will be used.

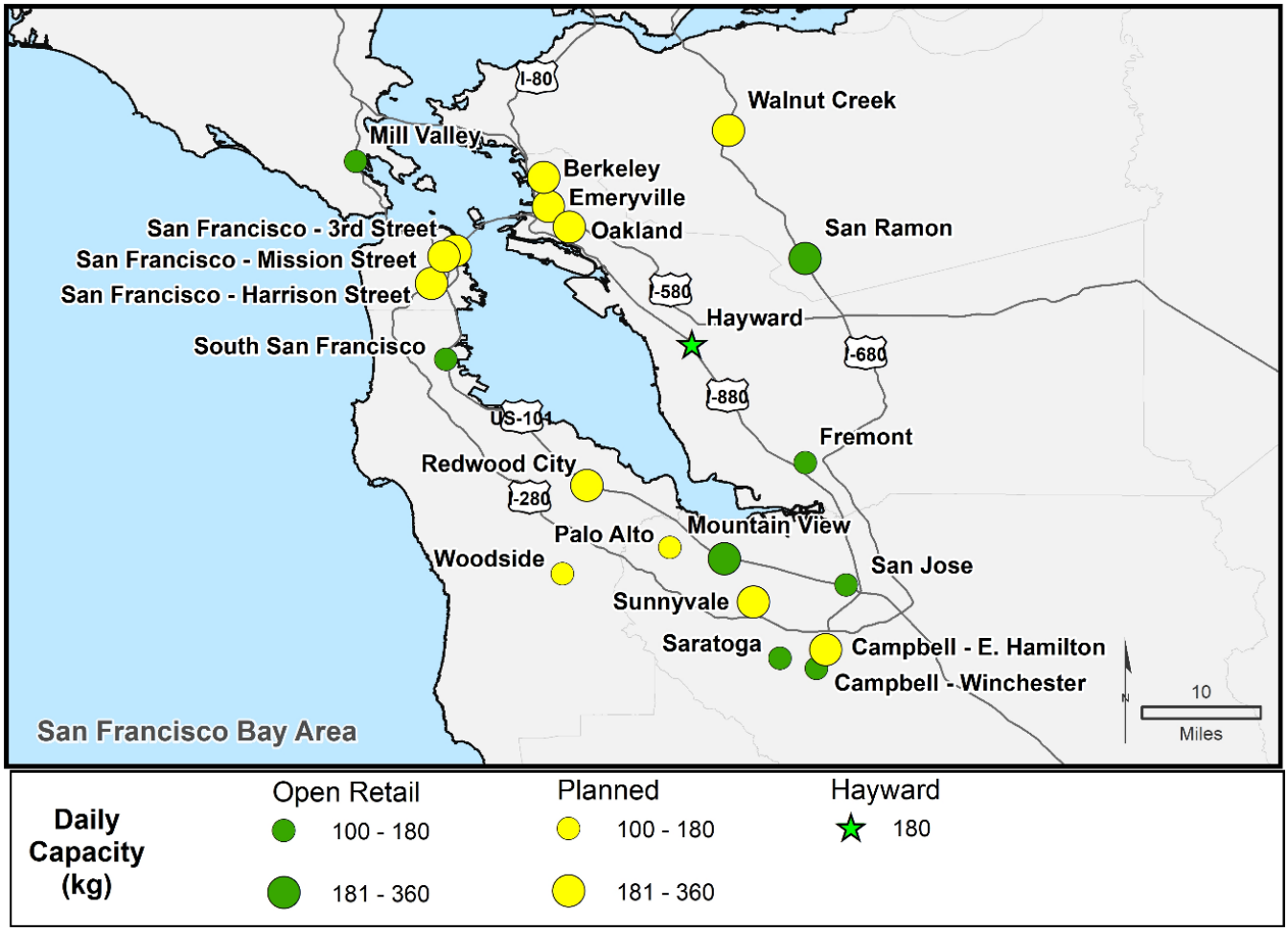
2 California Fuel Cell Partnership Operational Status Webpage (https://m.cafcp.org/)

The station use will not cause objectionable issues such as noise, glare, dust, or odor. The hydrogen station is a modern addition to an existing gasoline station. No outdoor sound amplification systems were installed; however, lighting was installed at the station to aid in evening fueling and accessibility of the station by FCEV drivers.

Hayward Station in the Network

The Hayward hydrogen station at 391 A Street, Hayward California is a primary station in the San Francisco Bay Area. The star in Figure 11 indicates where the Hayward Station is situated in relationship to similar stations in the northern part of the state.

Figure 11: San Francisco Area Hydrogen Stations: Open Retail and Planned

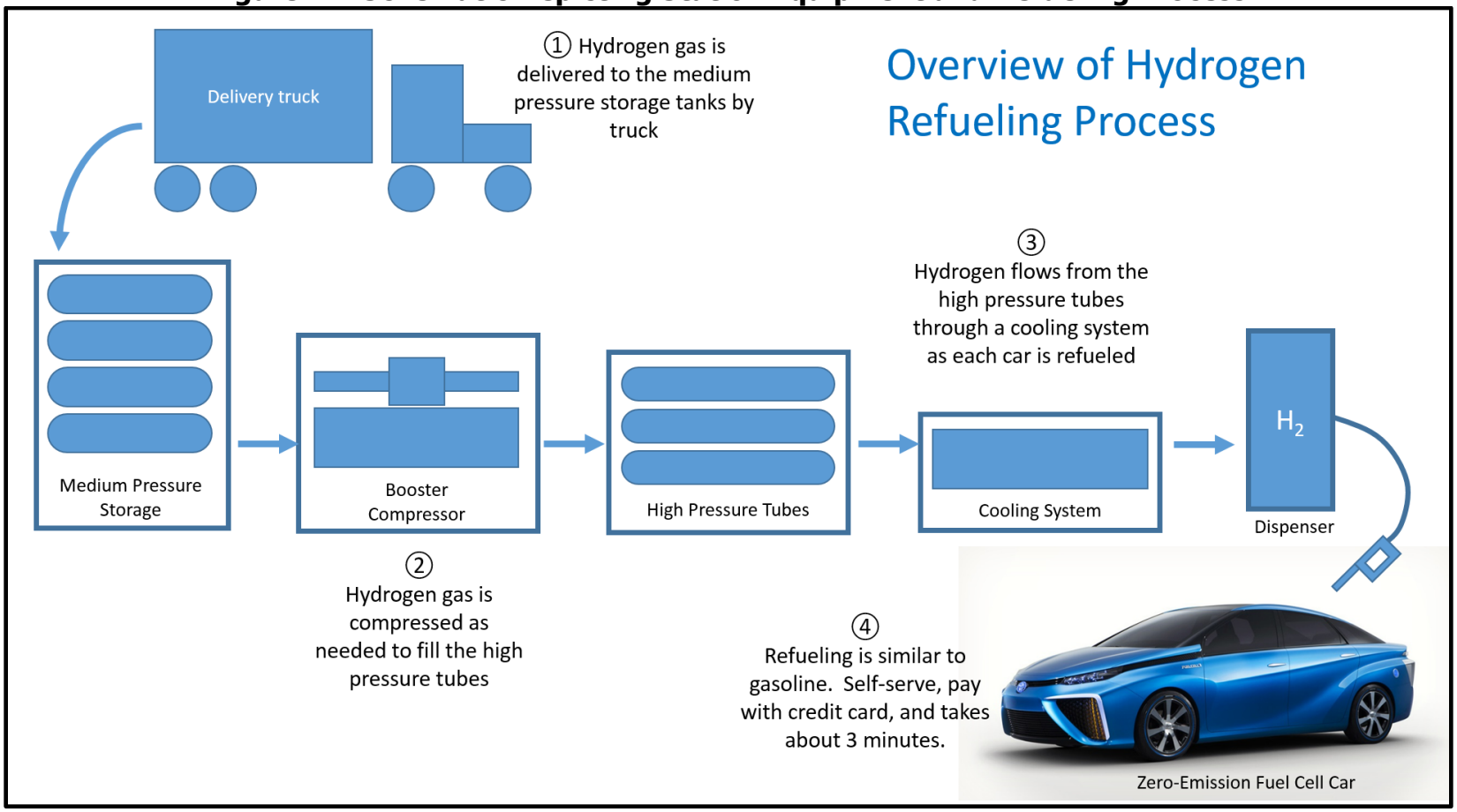


Source: CEC

Schematic Layout of the Hayward Station

Figure 12 depicts an overview of the Hayward hydrogen station components and the steps in the refueling process.

Figure 12: Schematic Depicting Station Equipment and Refueling Process

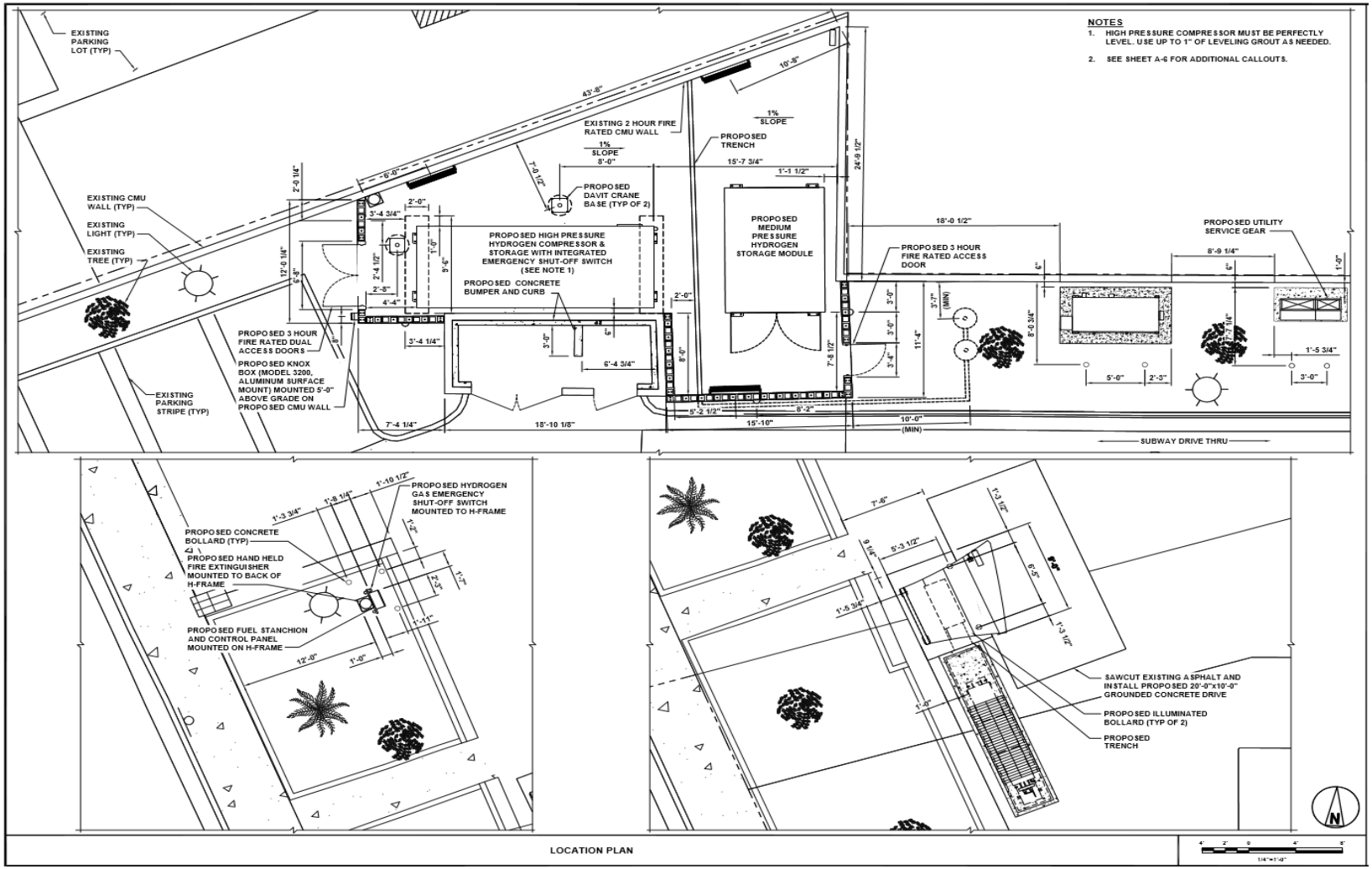


Source: FirstElement Fuel, Inc.

Final Configuration and Budget

Figure 13 shows a detailed view of the final, layout of the Hayward station.

Figure 13: Final Hayward Layout



Source: FirstElement Fuel, Inc.

Table 1 shows project grant funding and match funding.

Table 1: The Project Grant Funding and Match Funding

Air Products and Chemicals, Inc., Allentown, PA	
H2 station equipment	$1,479,873.57
Black & Veatch, Overland Park, KS	
Construction	$569,006.09
Engineering	$53,335.40
Permitting	$21,268.00
Project Management	$18,197.53
Various Vendors	
Construction Materials (tubing, wire, etc.)	$22,912.17
Fixtures (doors, lights, etc.)	$72,456.90
MSI Tech, Irvine CA	
Data Collection Tool	$3,432.87
Karen Calhoun, Newport Beach, CA	
Legal services	$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	$4,345.13
Total Project Costs	$2,257,977.69
California Energy Commission grant	$1,451,000.00
Remaining match funding provided by FirstElement Fuel, Inc.	$806,977.69
Total California Energy Commission cost share	64.3%

Source: FirstElement Fuel, Inc.

CHAPTER 2:
Energy Analysis

The Hayward hydrogen refueling station is supplied by hydrogen generated via steam methane reformation that converts methane (CH_4) and water (H_2O) to hydrogen (H_2) and carbon dioxide (CO_2):

$$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$$

Per California Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006), Environmental Standards for Hydrogen Production, at least one third of the hydrogen sold by state-funded hydrogen refueling stations will be produced from renewable sources. Hydrogen is supplied to the hydrogen refueling stations from Air Products and Chemicals, Inc.'s hydrogen production facilities in Wilmington/Carson, California. Renewable biogas will be procured as feedstock for the plants, resulting in delivered hydrogen product that meets the requirements of PON-13-607 and the 33.3 percent renewable hydrogen requirements of Senate Bill 1505. Table 2 shows the biogas supply sources. Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

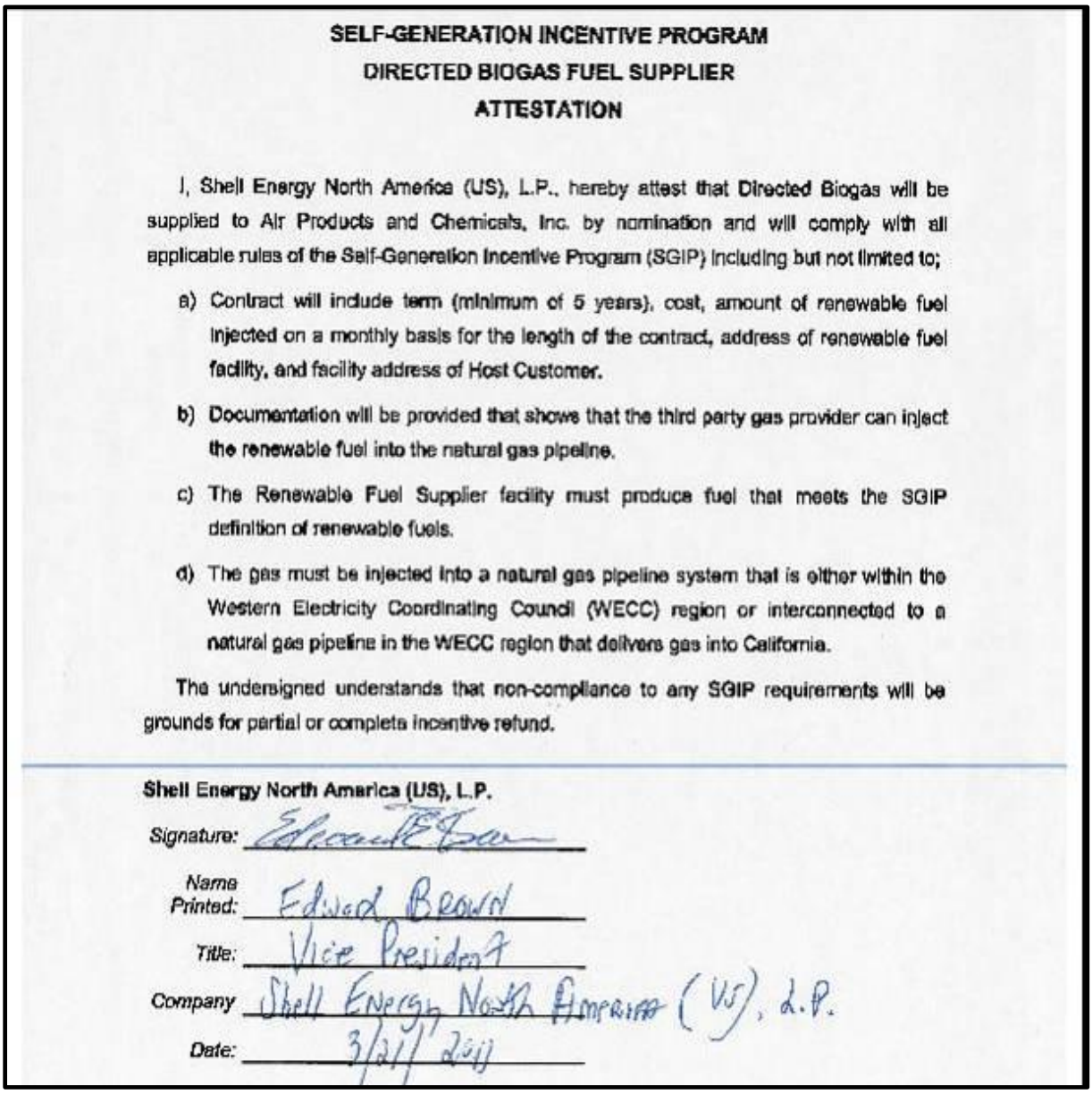
Table 2: Renewable Biomethane Supply Sources

Supply Source	Address	Pipeline/LDC	Receipt	Delivery
Greentree Landfill	635 Toby Road Kersey, PA 15846	National Fuels Gas TETCO NGPL EPNG Socal Gas FAR	Landfill meter Nat Fuel-Bristoria Tetco-Sweet Lake 3825 EPNG Jal 3083 Topock	Bristoria NGPL-Sweet Lake EPNG Jal 3083 Topock Socal Citygate
Imperial Landfill	11 Boggs Road Imperial, PA 15126	National Fuels Gas TETCO NGPL EPNG Socal Gas FAR	Landfill meter Nat Fuel-Bristoria Tetco-Sweet Lake 3825 EPNG Jal 3083 Topock	Bristoria NGPL-Sweet Lake EPNG Jal 3083 Topock Socal Citygate

Source: FirstElement Fuel, Inc.

Air Products and Chemicals, Inc. has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1) (Figure 14).

Figure 14: Biogas Fuel Supplier Attestation



SELF-GENERATION INCENTIVE PROGRAM

DIRECTED BIOGAS FUEL SUPPLIER

ATTESTATION

I, Shell Energy North America (US), L.P., hereby attest that Directed Biogas will be supplied to Air Products and Chemicals, Inc. by nomination and will comply with all applicable rules of the Self-Generation Incentive Program (SGIP) including but not limited to;

a) Contract will include term (minimum of 5 years), cost, amount of renewable fuel injected on a monthly basis for the length of the contract, address of renewable fuel facility, and facility address of Host Customer.

b) Documentation will be provided that shows that the third party gas provider can inject the renewable fuel into the natural gas pipeline.

c) The Renewable Fuel Supplier facility must produce fuel that meets the SGIP definition of renewable fuels.

d) The gas must be injected into a natural gas pipeline system that is either within the Western Electricity Coordinating Council (WECC) region or interconnected to a natural gas pipeline in the WECC region that delivers gas into California.

The undersigned understands that non-compliance to any SGIP requirements will be grounds for partial or complete incentive refund.

Shell Energy North America (US), L.P.

Signature: Edward Beard

Name Printed: Edward Beard

Title: Vice President

Company Shell Energy North America (US), L.P.

Date: 3/21/2011

Source: FirstElement Fuel, Inc.

Air Products and Chemicals, Inc.'s biogas supply for this project is being sourced outside California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council region that delivers gas into California. [3]

Hydrogen is delivered to all FirstElement Fuel, Inc. stations (including Hayward) by a U.S. Department of Transportation and California Department of Transportation-certified high-pressure delivery trailer.

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3 The Western Electricity Coordinating Council promotes Bulk Electric System reliability in the Western Interconnection (https://www.wecc.biz/Pages/AboutWECC.aspx)

The Hayward hydrogen station can dispense 180 kilograms of hydrogen each day. Based on average hydrogen use by FCEVs, the dispensing capacity of this station is enough to support up to 260 FCEVs, depending on driver habits. Assuming that FCEVs average 52 miles/1 kilogram of hydrogen (*The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model*,)[4] and consumption of 180 kilograms/day for the next 10 years, the station will offset 8,384 metric tons of total greenhouse gas compared to equivalent gasoline vehicles. Furthermore, the Hayward hydrogen station will eliminate more than 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon.[5]

As part of a separate grant agreement (ARV-17-024) for operations and maintenance support funding and reported quarterly for three years starting (March 1, 2018 to February 28, 2021). Data collected and reported will include the fuel log, dispensing, compression, storage and delivery, maintenance, and other monthly operating costs such as rent, electricity, property tax, and license and permit fees.

4 GREET® Model (https://greet.es.anl.gov/)

5 U.S. Department of Transportation, Bureau of Transportation Statistics; Table 4-23: Average Fuel Efficiency of U.S. Light-Duty Vehicles
(http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html)

CHAPTER 3:
Future Activities

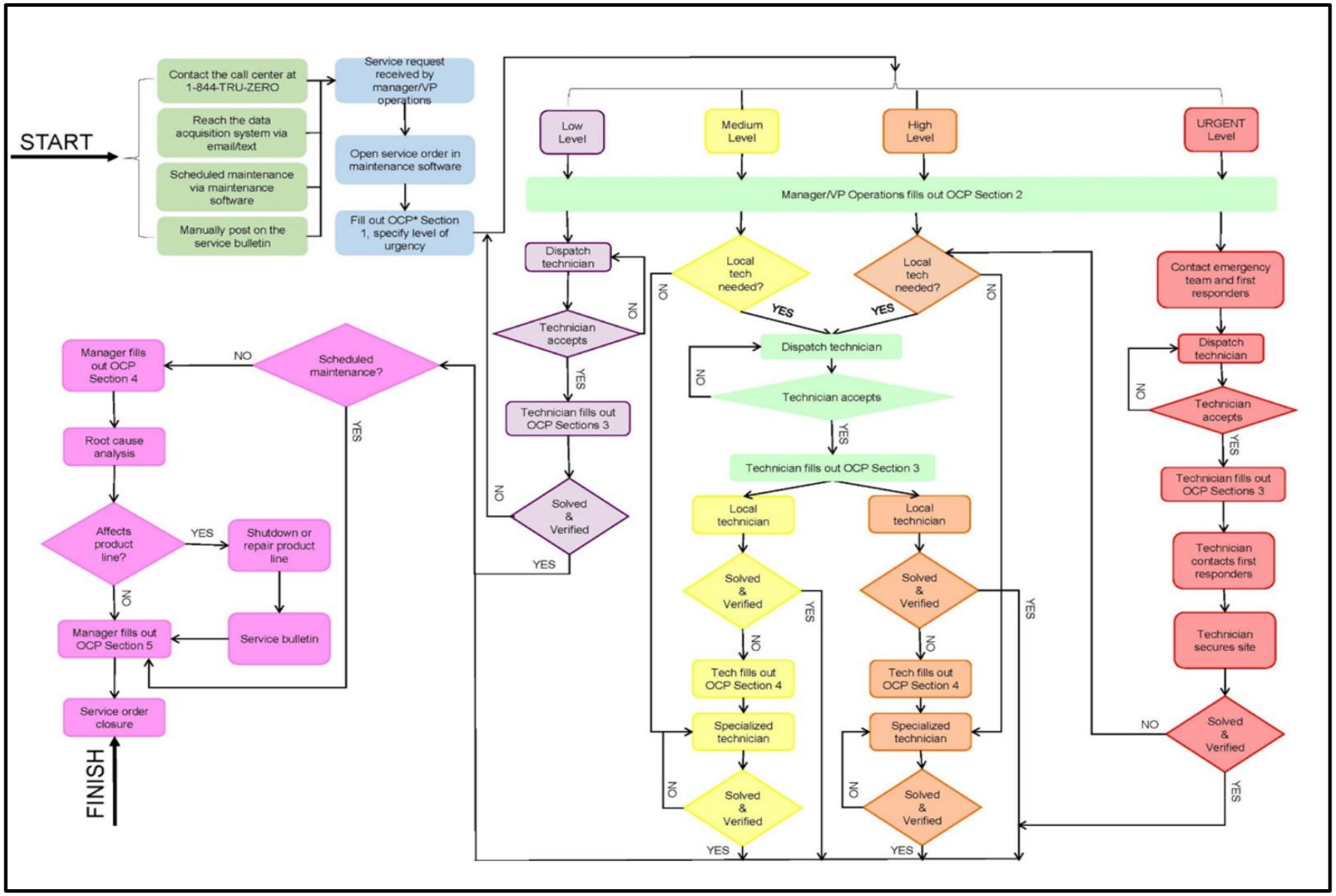
FirstElement Fuel, Inc. intends to own and operate the Hayward refueling station for at least 10 years. FirstElement Fuel, Inc. has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement Fuel, Inc. has executed an initial 10-year lease with the landowner with the possibility for extension.

In addition, FirstElement Fuel, Inc. is building an in-house maintenance team that will have the personnel and equipment to maintain and repair any of the FirstElement Fuel, Inc. stations as quickly as possible throughout California. Figure 15 shows FirstElement Fuel, Inc.'s response and service activity flow chart.

To augment onsite personnel across the FirstElement Fuel, Inc. network, a comprehensive data collection and monitoring system has been implemented. Figure 16 shows a screenshot of one page of the station's remote monitoring system. FirstElement Fuel, Inc. maintenance personnel access real-time performance and sensor data, live video feeds, and historic usage data and can they control some features of the station remotely, 24 hours per day.

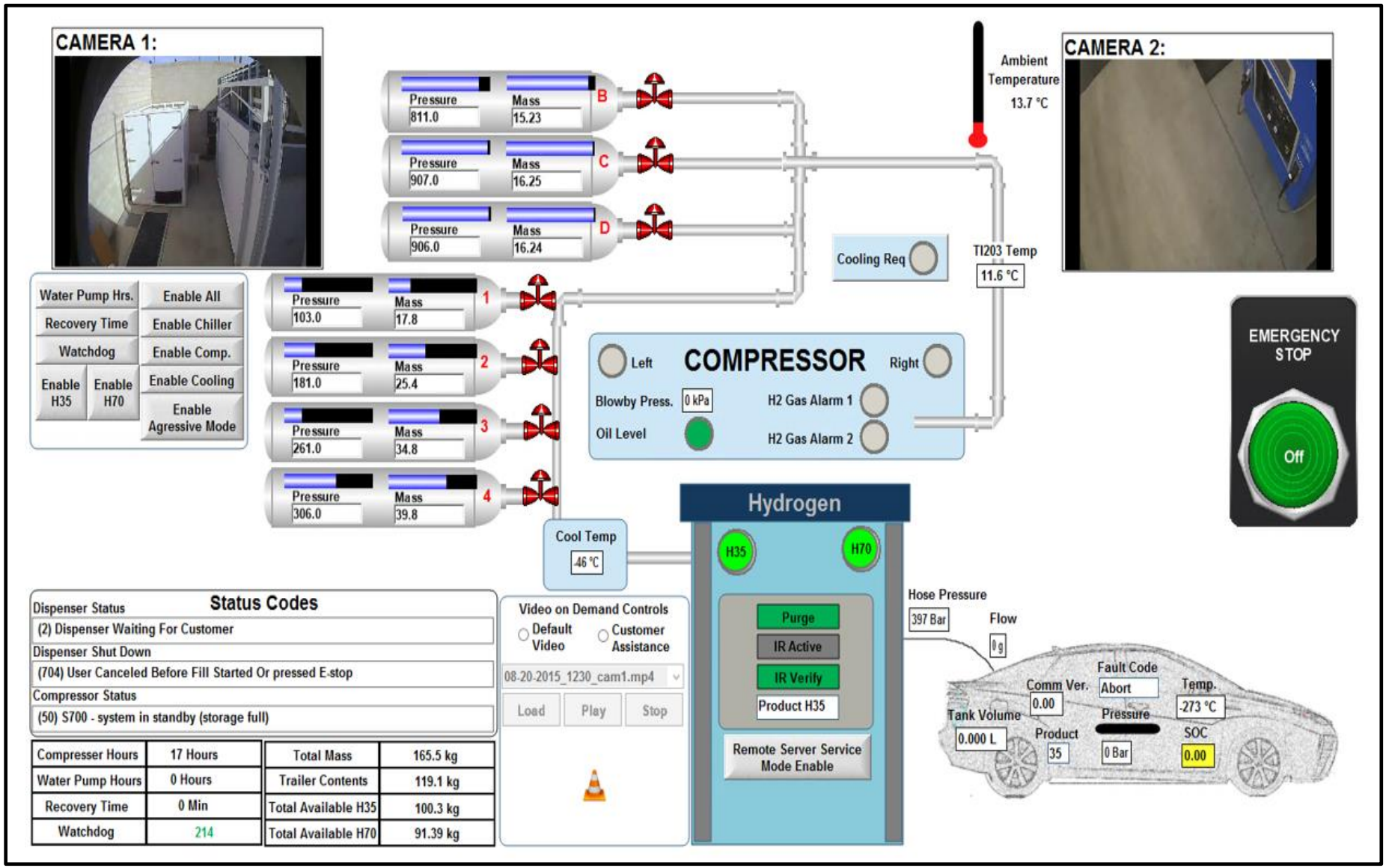
In addition to remote monitoring, FirstElement Fuel, Inc. has implemented rigorous computerized maintenance management systems and enterprise asset management systems to schedule and track maintenance, repairs, and inventory. The work orders will be generated, completed, and logged for all maintenance and repair activities in the computerized maintenance management systems and enterprise asset management systems. This will help maximize station up-time and enable tracking of key performance indicators.

Figure 14: FirstElement Fuel, Inc. Response Flow Chart



Source: FirstElement Fuel, Inc.

Figure 15: Screenshot of Remote Monitoring System



Source: FirstElement Fuel, Inc.

CHAPTER 4:
Conclusions

The following concludes findings from the 33.3 percent renewable hydrogen Hayward hydrogen refueling station project. The administrative entitlement process in Hayward went smoothly and took less time than the public hearing process encountered in other jurisdictions.

The National Fire Protection Association hydrogen technologies code is a critical tool for technical projects of this nature. The code clearly defines fire guidelines that enable local jurisdictions and contractors to uniformly construct hydrogen facilities and ensure safety. The key is for both station builders and station permit agencies to fully understand and appreciate the content of National Fire Protection Association hydrogen technologies code.

Because the Hayward station is located close to a retirement community, the fire authority in this jurisdiction required an Aerial Locations of Hazardous Atmospheres study, one extra flame detector, a remote notification system for the fire department. Wired fencing was installed over top of the equipment to protect against vandalism.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC) - The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

- Forecasting future statewide energy needs
- Licensing power plants sufficient to meet those needs
- Promoting energy conservation and efficiency measures
- Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
- Planning for and directing state response to energy emergencies.

CARBON DIOXIDE (CO2) - A colorless, odorless, non-poisonous gas that is a normal part of the air. Carbon dioxide is exhaled by humans and animals and is absorbed by green growing things and by the sea. CO2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent).

ELECTRICAL TECH CONSTRUCTION, INC. (E-Tech) - Electrical Contracting company servicing the western hemisphere of the United States. E-Tech offers a multi-dimensional list of services ranging from the cell towers in the telecommunications industry, to large commercial Solar Systems.

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.

HYDROGEN (H_2) - A colorless, odorless, highly flammable gas, the chemical element of atomic number 1.

METHANE (CH4) - A light hydrocarbon that is the main component of natural gas and marsh gas. It is the product of the anaerobic decomposition of organic matter, enteric fermentation in animals and is one of the greenhouse gases.