CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Costa Mesa Hydrogen Station

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

Gavin Newsom, Governor

November 2019 | CEC-600-2019-042

California Energy Commission

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ACKNOWLEDGEMENTS

The construction of the Costa Mesa hydrogen refueling station has been possible 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 MIT Construction and Engineering, Inc for bringing the project together; Tyson Eckerle for helping push the lease over the goal line; and, of course, Jean Baronas, Phil Cazel, 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 which was proposed for funding in the CEC's notice of proposed awards May 1, 2014 and the agreement was executed as ARV-14-008 on July 22, 2014

ABSTRACT

FirstElement Fuel, Inc., designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station at 2050 Harbor Blvd., Costa Mesa (Orange 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: California Energy Commission, 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. 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 zero-emission vehicle regulation and the Governor's zero-emission vehicle mandate. More actions to bring fuel cell electric vehicles to California markets are specified in former Governor Edmund G. Brown Jr's Zero-Emission Vehicle Action Plan.

FCEVs 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. The technology can be readily scaled up for sports utility vehicles, family passenger vans, pickup trucks, urban package and beverage delivery trucks, and even heavy-duty trucks and buses. Most auto industry analysts and agencies view fuel cell electric drive technology as a complement to battery-electric drive technologies, rather than as a competing technology. Battery- and fuel cell electric vehicle technologies will be needed in California to achieve the zero-emission vehicle deployment goals.

In contrast to battery-electric and plug-in hybrid electric vehicles that can be charged at home, fuel cell electric vehicles require a new network of refueling stations that dispenses pressurized hydrogen for consumer use. This requirement has meant that the auto and station development industries have had to develop two technologies in parallel: hydrogen refueling infrastructure and hydrogen fuel cell electric vehicles (FCEVs). Fuel cell electric vehicles cannot be widely marketed and sold to consumers without a minimum network of refueling stations available.

Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorized the original Assembly Bill 118 funding program (Núñez, Chapter 750, Statutes of 2007) and created new legal requirements for the California Energy Commission's Clean Transportation Program, formerly the Alternative and Renewable Fuel and Vehicle Technology Program. The bill directs the CEC to allocate up to $20 million per year, or up to 20 percent of each fiscal year's available funding, to develop hydrogen refueling stations "until there are at least 100 publicly available hydrogen-fueling stations in operation in California" (Health and Safety Code 43018.9 [e] [1]).

The site selected for this project is 2050 Harbor Blvd., Costa Mesa (Orange County). A hydrogen refueling station at this location will serve as a core station in Southern California for at least the next 10 years. FirstElement Fuel, Inc. accomplished this goal through the steps outlined in this final report.

The site owner at Costa Mesa was excited to bring a clean, alternative fuel to his station. After negotiating lease terms, FirstElement Fuel, Inc. and the site 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. After the zoning process in Playa Del Rey, approval was granted April 27, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were filed November 24, 2014, and finalized August 3, 2015. The permitting process from application to finalization took 251 days

Hydrogen refueling station equipment was purchased from Air Products and Chemicals, Inc., and the remainder of materials were sourced from a variety of general and specialty vendors. MIT Construction and Engineering, Inc. from Oceanside (San Diego County) 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. Construction began on August 17, 2015, and was complete December 2, 2015.

Commissioning began on November 9, 2015, and was complete on December 2, 2015. The FirstElement Fuel, Inc. team performed all commissioning tasks, including cleaning, purging, pressure testing, and starting up.

CHAPTER 1:
Station Design and Construction

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

Site Acquisition—Construction (Fall 2013–December 2015)

Beginning in the fall of 2013, FirstElement Fuel, Inc. began identifying and acquiring appropriate sites for the hydrogen refueling station. FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and the station location areas in PON-13-607 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 16, 2014. FirstElement Fuel and the owner later executed a binding 10-year lease December 31, 2014.

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

FirstElement Fuel, Inc. and Black & Veatch surveyed the site to begin the site layout on August 12, 2014. They generated initial engineering drawings on November 13, 2014. These drawings are referred to as “construction drawing 30s” because they represent 30 percent complete construction drawings and contain only two pages. 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 October 24, 2014, Clark Land Surveying, Inc. performed a detailed engineering survey for the Costa Mesa station site, as shown in Figure 2. The Costa Mesa station is on one of the smallest lots in FirstElement Fuel, Inc.’s network of hydrogen refueling stations. The small, available land posed problems with circulation and parking, but they were overcome with good communication and creative thinking with the local jurisdiction.

On April 1, 2015, zoning drawings were also generated that provide an accurate but relatively high-level depiction of the project for review by planners at the jurisdiction. These drawings were signed and sealed by the professional engineer of record to ensure accuracy and completeness. Figure 3 shows the equipment compound page of the zoning drawings.

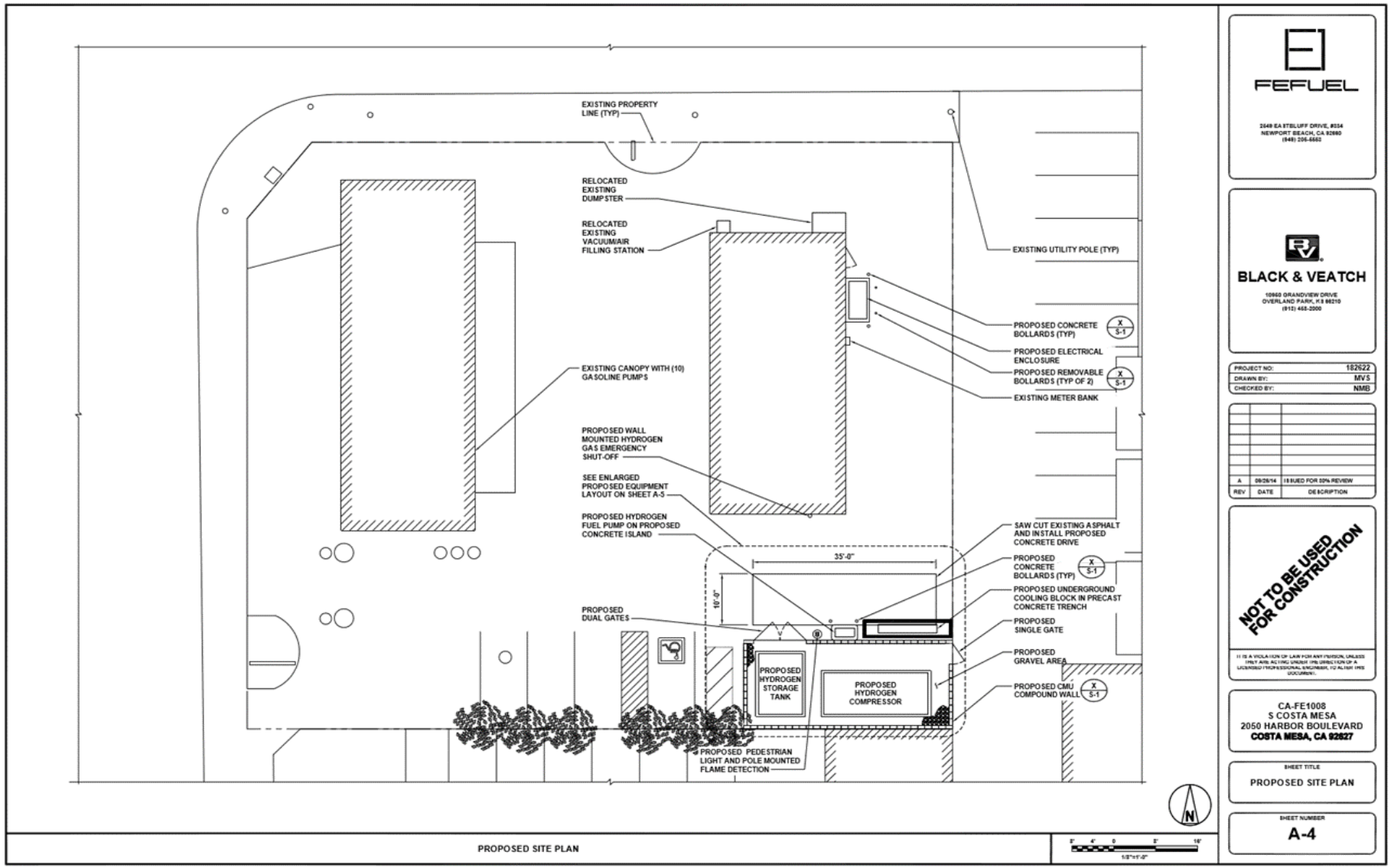
On May 21, 2015, draft final construction drawings (or “construction drawing 90s”) were completed that depict all the details required for construction and the permit review. Final

construction drawings (or “construction drawing 100s”) were completed with 60 pages that depict all the details required for construction and the permit review on December 8, 2015. These drawings were similarly signed and sealed by the professional engineer of record to ensure accuracy and completeness. Figure 4 shows the equipment compound page of the construction drawing 100 set.

FirstElement Fuel, Inc. and Black & Veatch submitted the zoning application to the jurisdiction having authority on November 25, 2014. The local planning department had to verify that the project meets the zoning requirements of the proposed location and approved aesthetic, landscaping, or other details that are important to the community. The planning commission in Costa Mesa is supported this project and easily voted for approval in a unanimous decision during a public hearing on April 27, 2015.

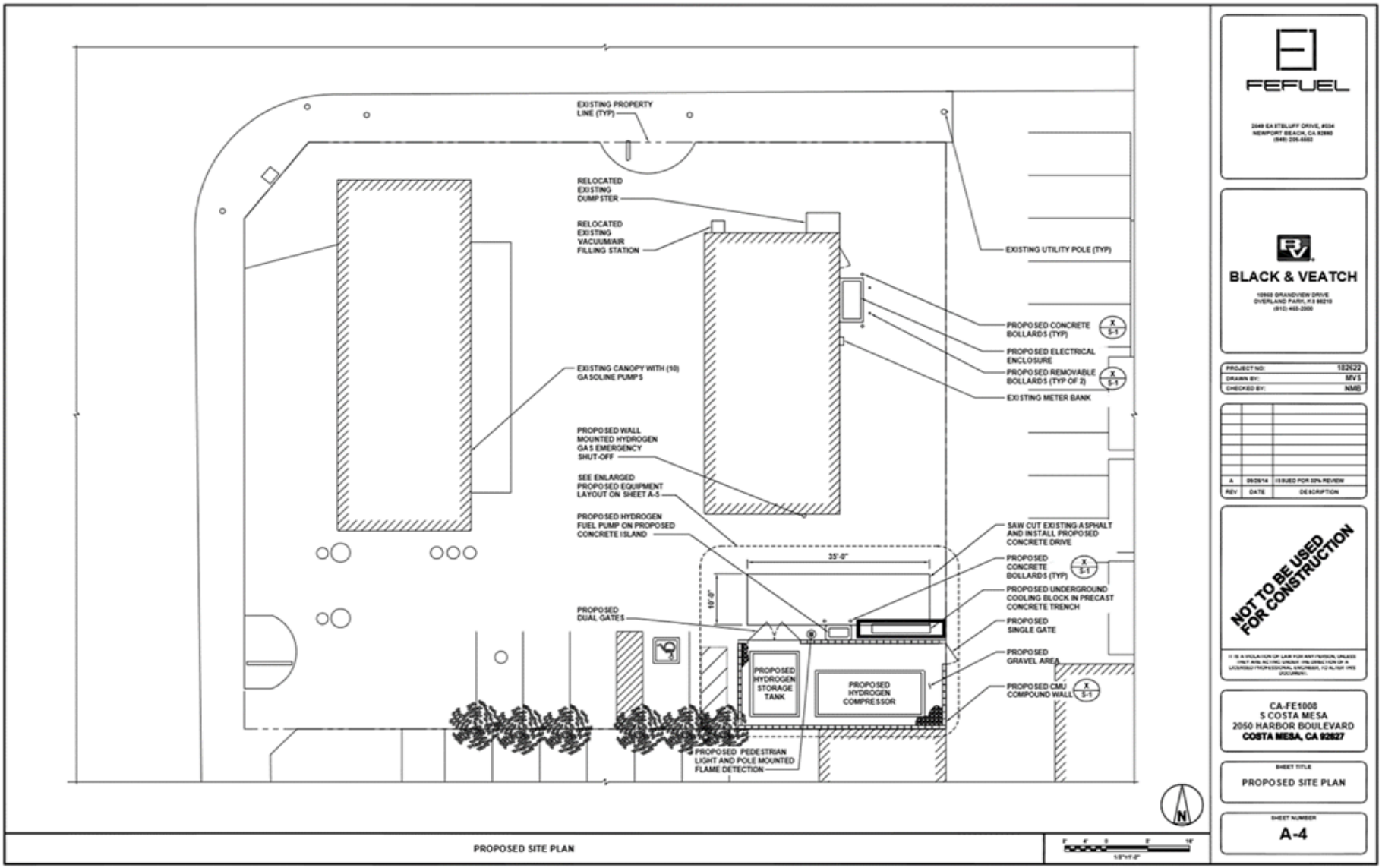
All building permit applications were submitted June 1, 2015, and approved August 3, 2015.

Figure 1: Coarse Detail of equipment Compound from Construction Drawing 30 Set



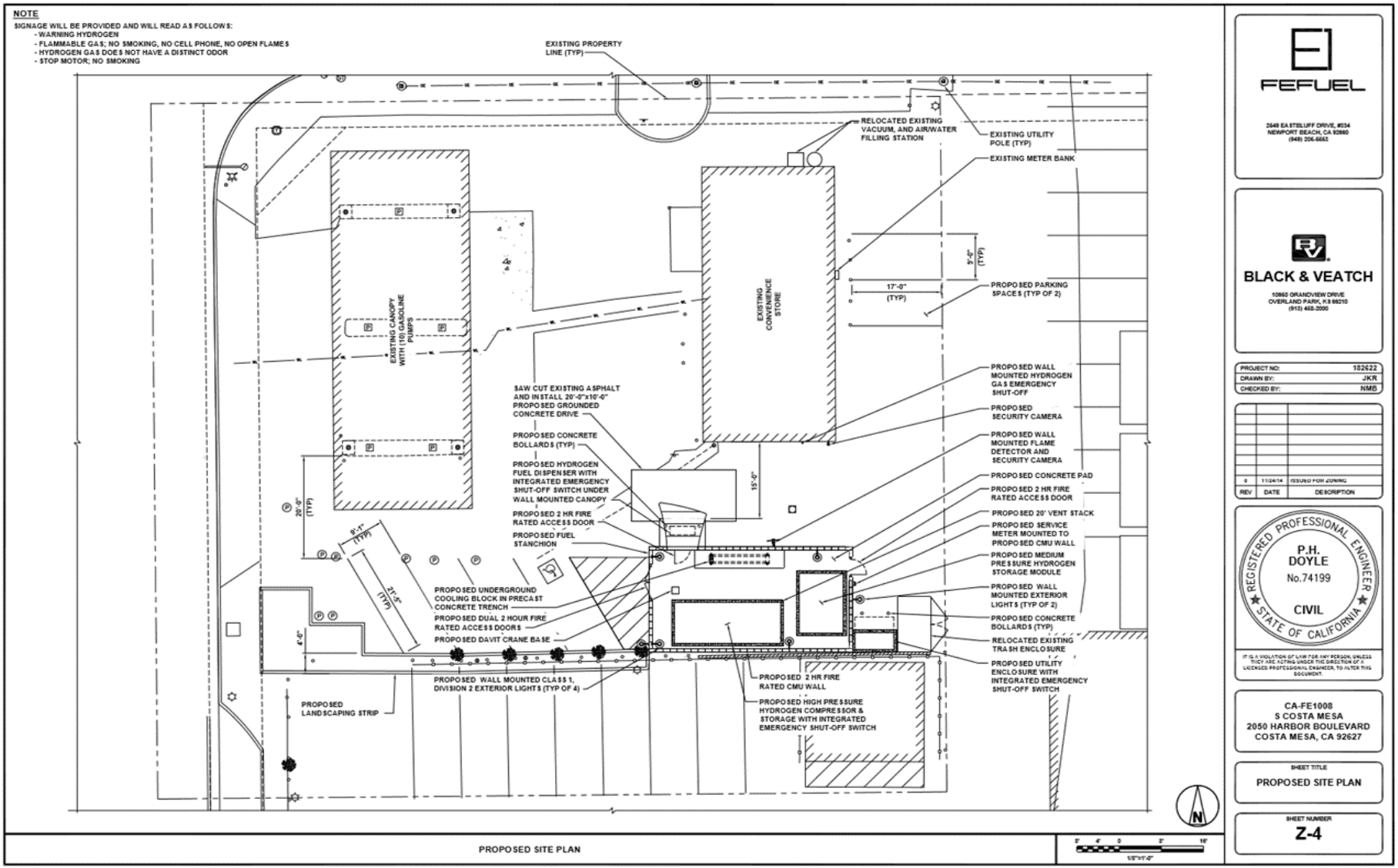
Source: FirstElement Fuel, Inc.

Figure 2: Survey of Costa Mesa Hydrogen Station Location



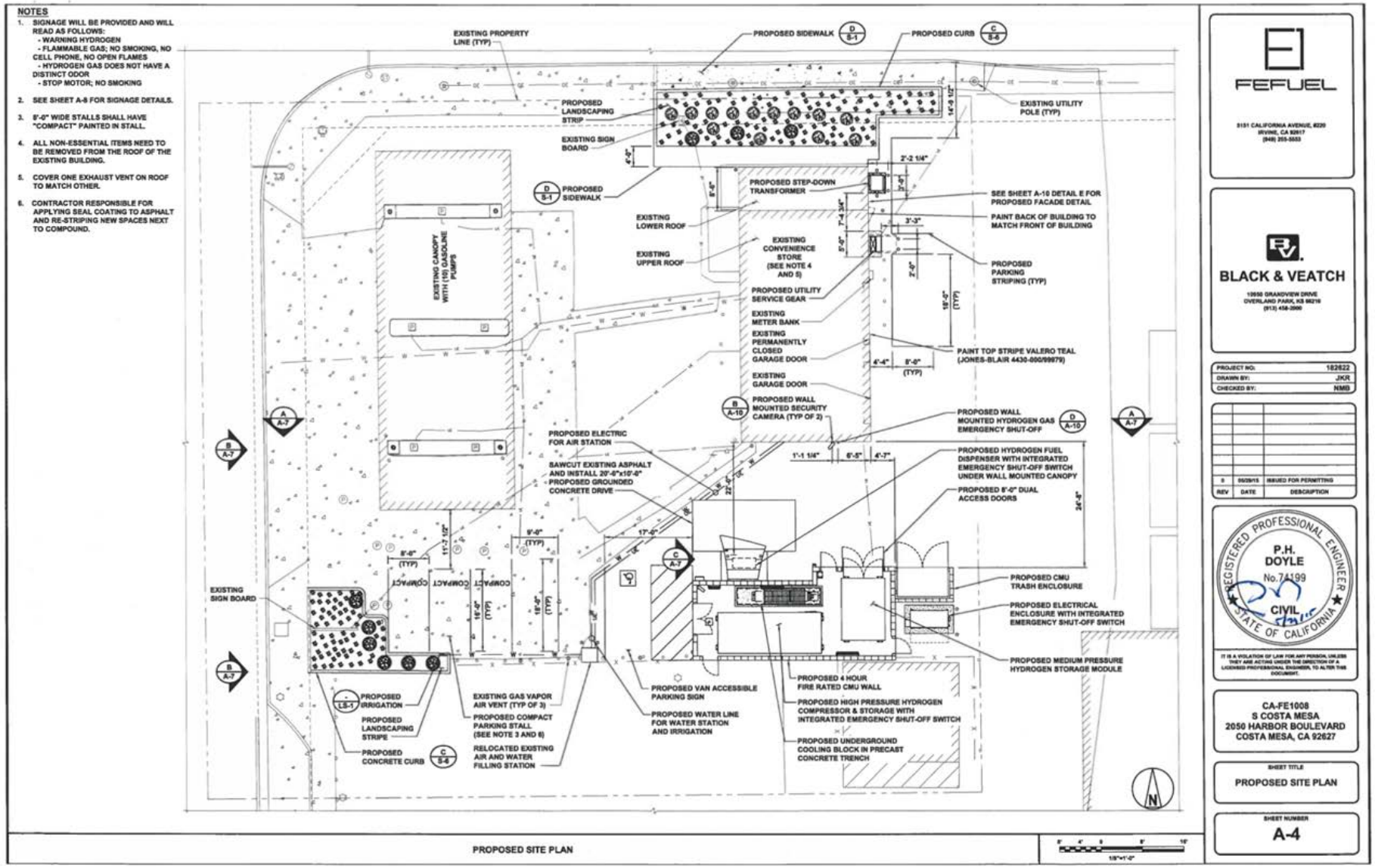
Source: FirstElement Fuel, Inc.

Figure 3: Detail of equipment Compound from Construction drawing 30 Set



Source: FirstElement Fuel, Inc.

Figure 4: Detail of Equipment Compound From Construction Drawing 100 Set



Source: FirstElement Fuel, Inc.

FirstElement Fuel, Inc. and Black & Veatch submitted a detailed bid package to contractors on July 17, 2015. The contract was awarded to MIT Construction and Engineering, Inc on August 12, 2015. The bulk of MIT's construction experience is in building gasoline stations. MIT provided a reasonable bid, had a desire to get involved with hydrogen projects, and had a willingness to work in Costa Mesa. Construction started August 17, 2015. Figure 5 shows the groundbreaking.

Figure 1: Costa Mesa Hydrogen Refueling Station Groundbreaking

Source: FirstElement Fuel, Inc.

Hydrogen storage, compression (Figure 6), cooling, and dispensing equipment was delivered to the site October 13, 2015. Construction was completed December 2, 2015. Construction progressed quickly, 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.

Figure 2: Crane Lifting Hydrogen Compressor Unit off Delivery Truck in Costa Mesa

Source: FirstElement Fuel, Inc.

Commissioning (November 9, 2015–December 2, 2015)

The commissioning of the Costa Mesa hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling. Figure 7 shows electrical testing.

Figure 7: Electric Testing During Commissioning

Source: FirstElement Fuel, Inc.

Station Declared Operational (December 2, 2015)

The Costa Mesa hydrogen station met the definition of operational in PON-13-607 by completing 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), successfully fueling one FCEV with hydrogen, and becoming accessible to the public.

Figure 8: Hydrogen Fuel Quality Report on December 1, 2015

www.SmartChemistry.com

SAE J2719 Report	SAE J2719 Limits (µmol/mol)	Smart Chemistry Detection Limits (µmol/mol)	FIRST ELEMENT COSTA MESA H70 H_2 @Nozzle sampled on 12/01/2015 Concentration	Analytical Method
Water	5	0.2	**1.54**	
Total Hydrocarbons (C_1 Basis)	2	1	**0.11**	ASTM D7892
Methane		0.001	0.069	
Acetone			0.012	
Ethane			0.028	
Oxygen	5	1	< 1	ASTM D7649
Helium	300	10	**23**	ASTM D1946
Nitrogen, Argon	100			
Nitrogen		5	**6.5**	ASTM D7649
Argon		0.5	**0.77**	ASTM D7649
Carbon Dioxide	2	0.5	< 0.5	ASTM D7649
Carbon Monoxide	0.2	0.0005	**0.0011**	ASTM D5466
Total Sulfur	0.004	0.000001	**0.000013**	ASTM D7652
Hydrogen Sulfide		0.000001	0.0000024	ASTM D7652
Carbonyl Sulfide		0.000001	0.0000051	ASTM D7652
Methyl Mercaptan (MTM)		0.00001	< 0.00001	ASTM D7652
Ethyl Mercaptan (ETM)		0.00002	< 0.00002	ASTM D7652
Dimethyl Sulfide (DMS)		0.00002	< 0.00002	ASTM D7652
Carbon Disulfide		0.000005	0.0000053	ASTM D7652
Isopropyl Mercaptan (IPM)		0.00002	< 0.00002	ASTM D7652
Tert-Butyl Mercaptan (TBM)		0.00002	< 0.00002	ASTM D7652
n-Propyl Mercaptan		0.00002	< 0.00002	ASTM D7652
n-Butyl Mercaptan		0.00002	< 0.00002	ASTM D7652
Tetrahydrothiophene (THT)		0.00002	< 0.00002	ASTM D7652
Formaldehyde	0.01	0.001	< 0.001	ASTM D7892
Formic Acid	0.2	0.001	< 0.001	ASTM D5466
Ammonia	0.1	0.02	< 0.02	ASTM D5466
Total halogenates	0.05		**0.0051**	
Chlorine		0.0008	< 0.0008	ASTM D5466
Hydrogen Chloride		0.007	< 0.007	ASTM D5466
Hydrogen Bromide		0.007	< 0.007	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	0.0051	ASTM D7892
Tetrachloro-hexafluorobutanes			0.0051	
Particulate Concentration (Particulate Concentration Calculation Sheet is listed in Table II)	1mg/Kg		< 0.05 mg/kg	ASTM D7651
Particulates Found & Size (Images of particulates found is in Table 1)			No Particulate found	ASTM D7634
Hydrogen Fuel Index The hydrogen fuel index is the value obtained when the amount of aggregate impurities, as, expressed as percent (mole/mole), is subtracted from 100%. (Section 3.5 of SAE J2719)			**99.99680%**	

Source: FirstElement Fuel, Inc.

The project team performed automaker testing at the Costa Mesa hydrogen station to verify correct operation per SAE J2601 Fueling Protocols for Light-Duty Gaseous Hydrogen Surface Vehicles.

Certification (January 20, 2016)

The California Department of Food and Agriculture's Division of Measurement Standards is responsible for enforcing California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California. Figure 9 shows that FirstElement Fuel, Inc. achieved certification by acting as the registered service agent, dispensing a measured amount of fuel, and confirming that 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]

Figure 3: Certification at Costa Mesa Hydrogen Station

Source: FirstElement Fuel, Inc.

Station Use (December 3, 2015–Present)

Figure 10 shows the first vehicle filled was a Mercedes F-Cell on December 3, 2015, and the station has been used regularly since then. Based on an average FCEV use of 0.7 kilograms

1 Examiniation Procedure for Hydrogen Station (https://www.cdfa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf)

per day,[2] the 180-kilogram-per-day dispensing capacity of this station is enough to support up to 260 FCEVs, although this number can vary depending on actual FCEV geographical deployment relative to other open retail station locations and FCEV driver habits. The Costa Mesa station dispensed 116.6 kilograms of hydrogen in December 2015, 223.1 kilograms in January 2016, and 277.4 kilograms in February 2016.

Figure 4: First Use of the Costa Mesa Hydrogen Station

Source: FirstElement Fuel, Inc.

Station Operational Status System

The California Fuel Cell Partnership, station operational status system is a website portal designed to provide hydrogen station status for motorist use.[3] This system is important to

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2 Pratt, Joseph, Danny Terlip, Chris Ainscough, Jennifer Kurtz, and Amgad Elgowainy. National Renewable Energy Laboratory and Sandia National Laboratories, 2015. *H2FIRST Reference Station Design Task, Project Deliverable 2-2.* (http://www.osti.gov/scitech/servlets/purl/1215215)

3 Website Portal for California Fuel Cell Partnership (https://m.cafcp.org/)

FCEV drivers during development of the hydrogen refueling station network because it lets drivers know that the hydrogen station they intend to use is operating before they depart. The Costa Mesa hydrogen station began sending automated updates (FirstElement Fuel, Inc. software) regularly to station operational status system on January 21, 2016.

Environmental Impacts

Hydrogen will be stored as a compressed gas in an aboveground tank concealed behind a wall at this station. In accordance with the funding agreement with the CEC, 33.3 percent of the hydrogen sold at the Costa Mesa hydrogen station will be produced from renewable sources including biogas. Hydrogen is nontoxic, colorless, and odorless, so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in case a leak occurs. No solid or liquid waste will be produced at this site.

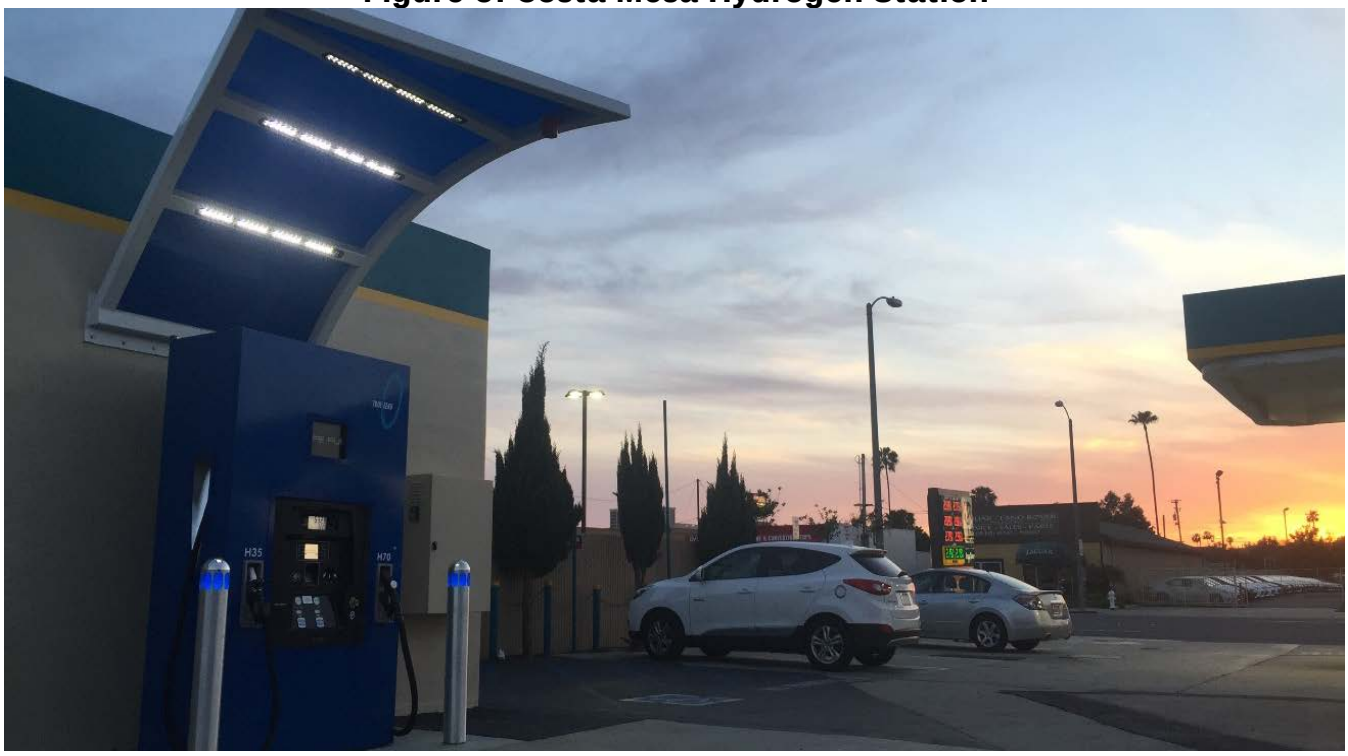
No water was consumed for this project. There was minimal additional landscaping added for the construction of the hydrogen refueling station.

The use will not cause any unsightly appearances, such as noise, glare, dust, or odor. The 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 ease evening fueling.

Costa Mesa Station in the Network

Figure 11 shows the station is open and ready for use.

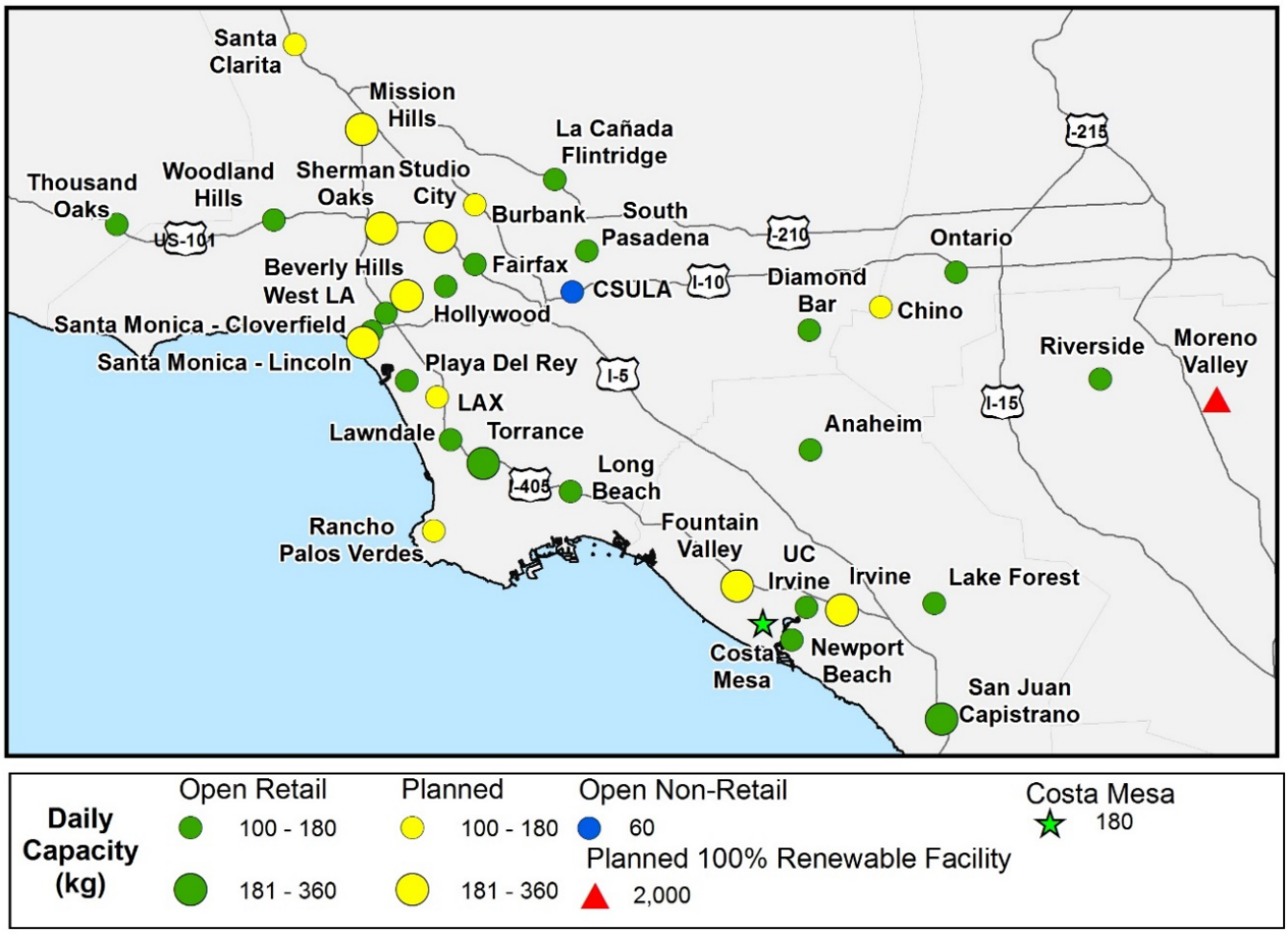
Figure 5: Costa Mesa Hydrogen Station



Source: FirstElement Fuel, Inc.

Figure 12 shows the greater Los Angeles area map that indicates where the Costa Mesa station is situated in relationship to other stations in the southern part of the state. The Costa Mesa station is located near Interstate 405 just off State Route 55 and near the University of California, Irvine, and the Newport Beach hydrogen refueling station.

Figure 6: Hydrogen Stations: Open Retail and Planned

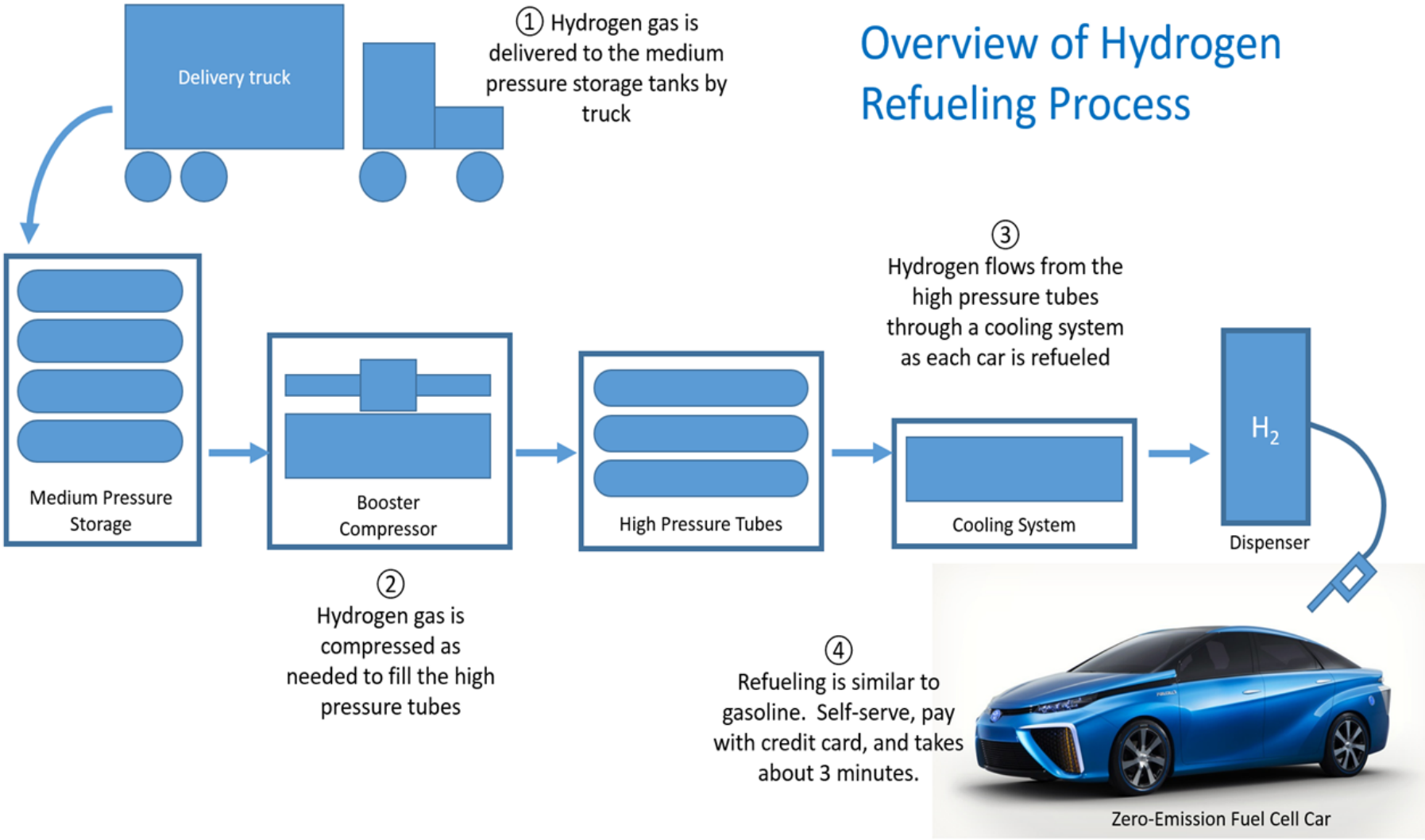


Source: California Energy Commission.

Schematic Layout of the Costa Mesa Station

As shown below, Figure 13 depicts an overview of the Costa Mesa hydrogen station components and the steps in the refueling process.

Figure 7: Schematic Depicting Hydrogen Station Equipment and Refueling Process

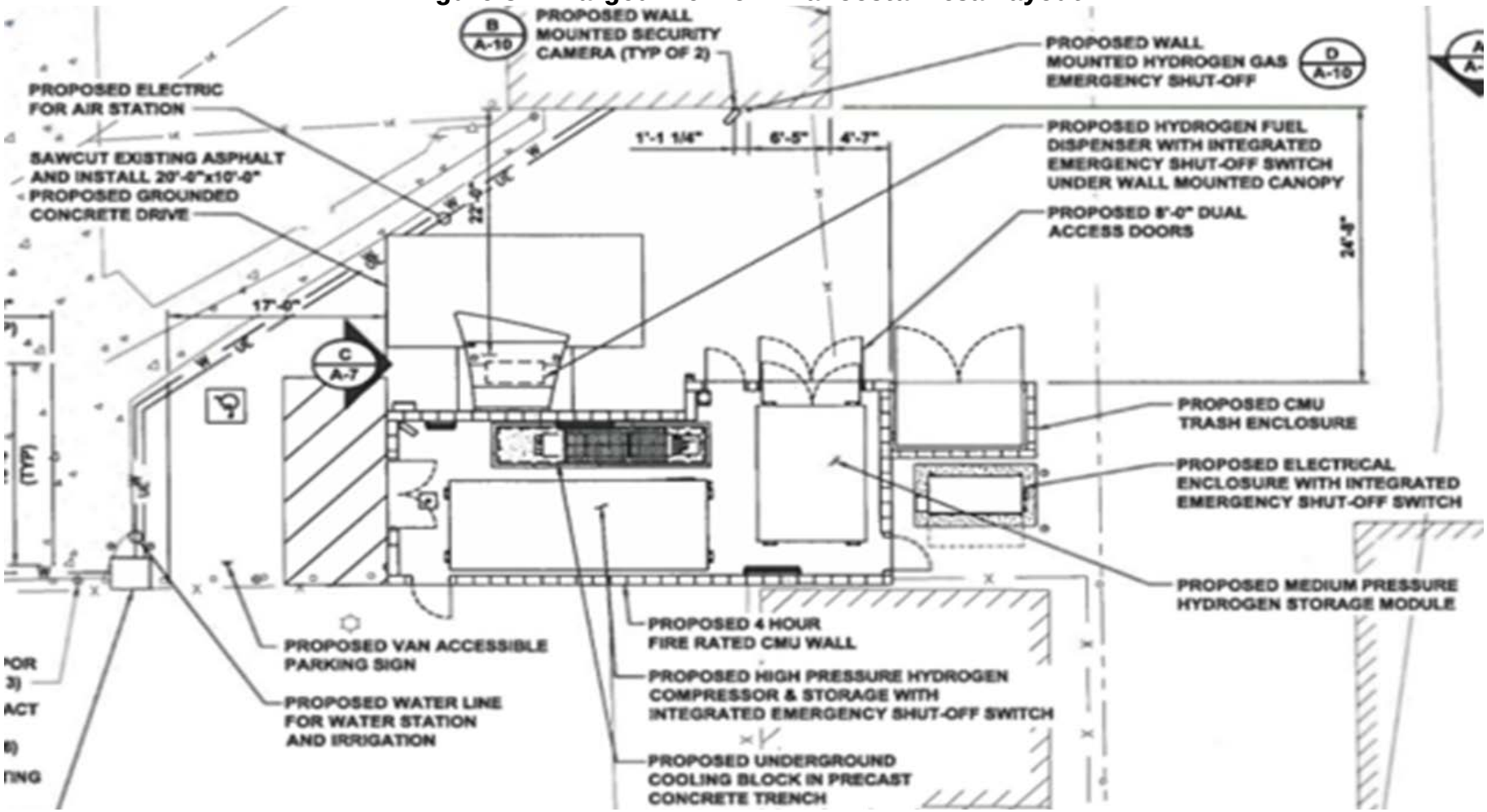


Source: FirstElement Fuel, Inc.

Final Configuration and Budget

Figure 14 shows a detailed view of the actual final, as-built configuration of the Costa Mesa station.

Figure 8: Enlarged View of Final Costa Mesa Layout



Source: FirstElement Fuel, Inc.

Figure 15 shows a detailed view of the budget to construct the Costa Mesa hydrogen station.

Figure 9: The Project Grant Funding and Match Funding

Air Products and Chemicals, Inc., Allentown , PA	
H2 station equipment	$1,480,192.21
Black & Veatch, Overland Park, KS	
Construction	$394,038.15
Engineering	$45,221.20
Permitting	$39,727.09
Project Management	$18,197.53
Various Vendors	
Construction Materials (tubing, wire, etc.)	$18,331.15
Fixtures (doors, lights, etc.)	$55,195.85
MSI Tech, Irvine CA	
Data Collection Tool	$3,582.24
Karen Calhoun, Newport Beach, CA	
Legal services	$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	$4,345.13
Total Project Costs	$2,071,980.58
California Energy Commission Grant	$1,451,000.00
Remaining match funding provided by FirstElement Fuel, Inc.	$620,980.58
Total California Energy Commission cost share	70.0%

Source: FirstElement Fuel, Inc.

CHAPTER 2:
Energy Analysis

The Costa Mesa 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) at least one-third of the hydrogen sold by FirstElement Fuel, Inc.'s state funded hydrogen refueling stations will be produced from renewable sources. Hydrogen is supplied to the hydrogen fueling station from Air Products and Chemicals, Inc.'s hydrogen production facilities in Wilmington/Carson, California. Renewable biogas will be procured as feedstock, resulting in delivered hydrogen product that meets the requirements of PON-13-607 and the 33.3 percent renewable hydrogen requirements of California Senate Bill 1505 (sources of biogas shown in Figure 16). Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

Figure 16: 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: Shell Energy North America (US), L.P. 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); documentation is provided in Figure 17. 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.[4]

Figure 17: Biogas Supply Contract

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 E Beard

Name Printed: Edward Beard

Title: Vice President

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

Date: 3/21/2011

Source: FirstElement Fuel, Inc.

4 The Western Electricity Coordinating Council promotes bulk electric system reliability in the Western Interconnection. (https://www.wecc.biz/Pages/AboutWECC.aspx)

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

The Costa Mesa hydrogen station can dispense 180 kilograms/day. Assuming that FCEVs average 52 miles/kilogram according to *The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model,*[5] 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 Costa Mesa 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.[6]

As part of a separate grant agreement (ARV-17-023) for operations and maintenance funding through the CEC, data on the operation of the station will be collected and reported quarterly for three years (March 1, 2018, to February 28, 2021). Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the actual performance of the project to proposed expectations.

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

6 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

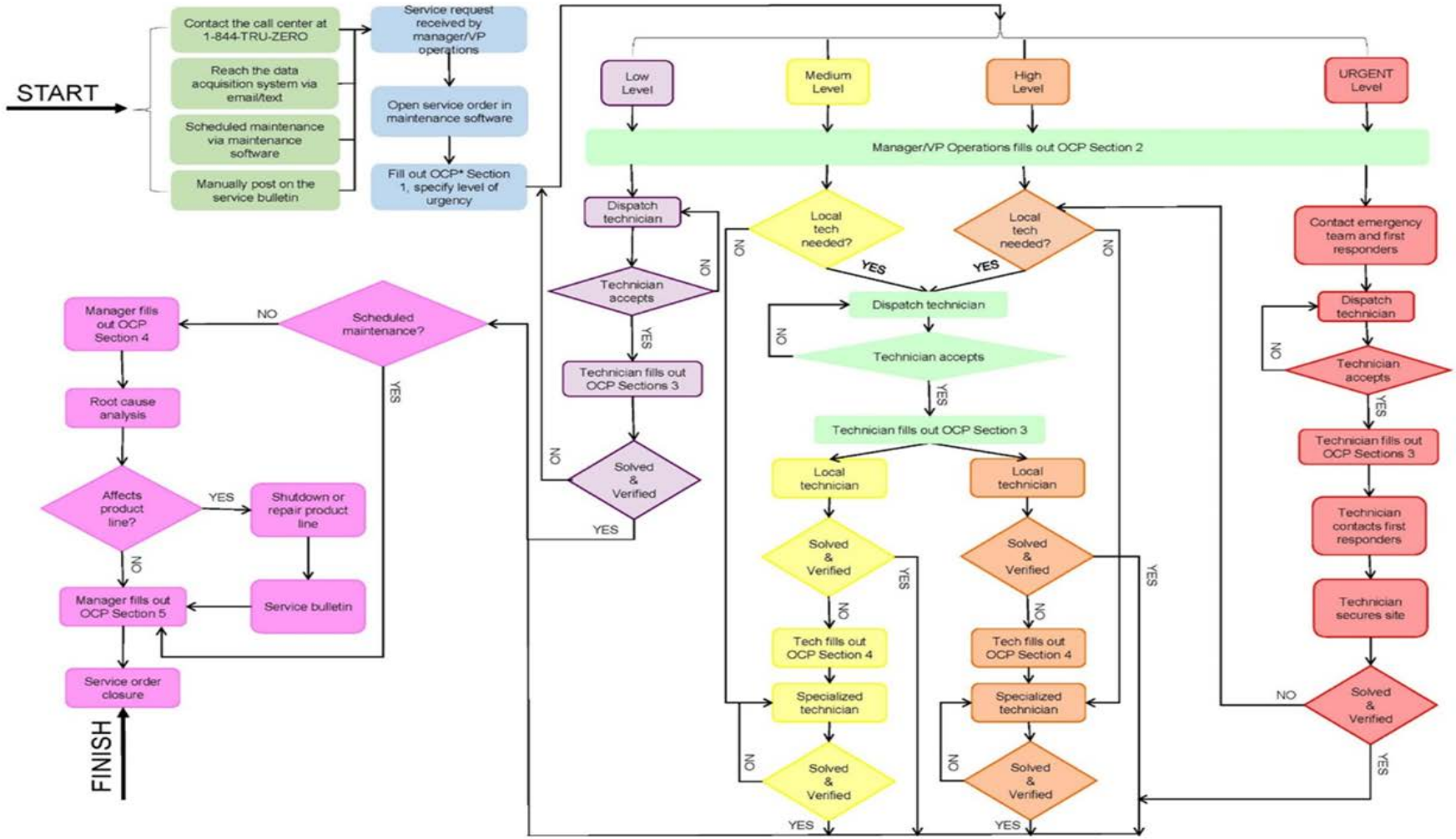
FirstElement Fuel, Inc. intends to own and operate the Costa Mesa refueling station for at least 10 years. FirstElement Fuel, Inc. has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement Fuel, Inc. has executed an initial 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 our stations as quickly as possible throughout California. Figure 18 shows a flow diagram for response from the operations and maintenance team.

To augment onsite personnel across the FirstElement Fuel, Inc. network, a comprehensive data collection and monitoring system has been implemented. Figure 19 shows a screenshot of one page of the system. FirstElement Fuel, Inc. maintenance personnel can access a breadth of real-time performance and sensor data, live video feeds, and historical usage data and can control some features of the station remotely, 24 hours per day.

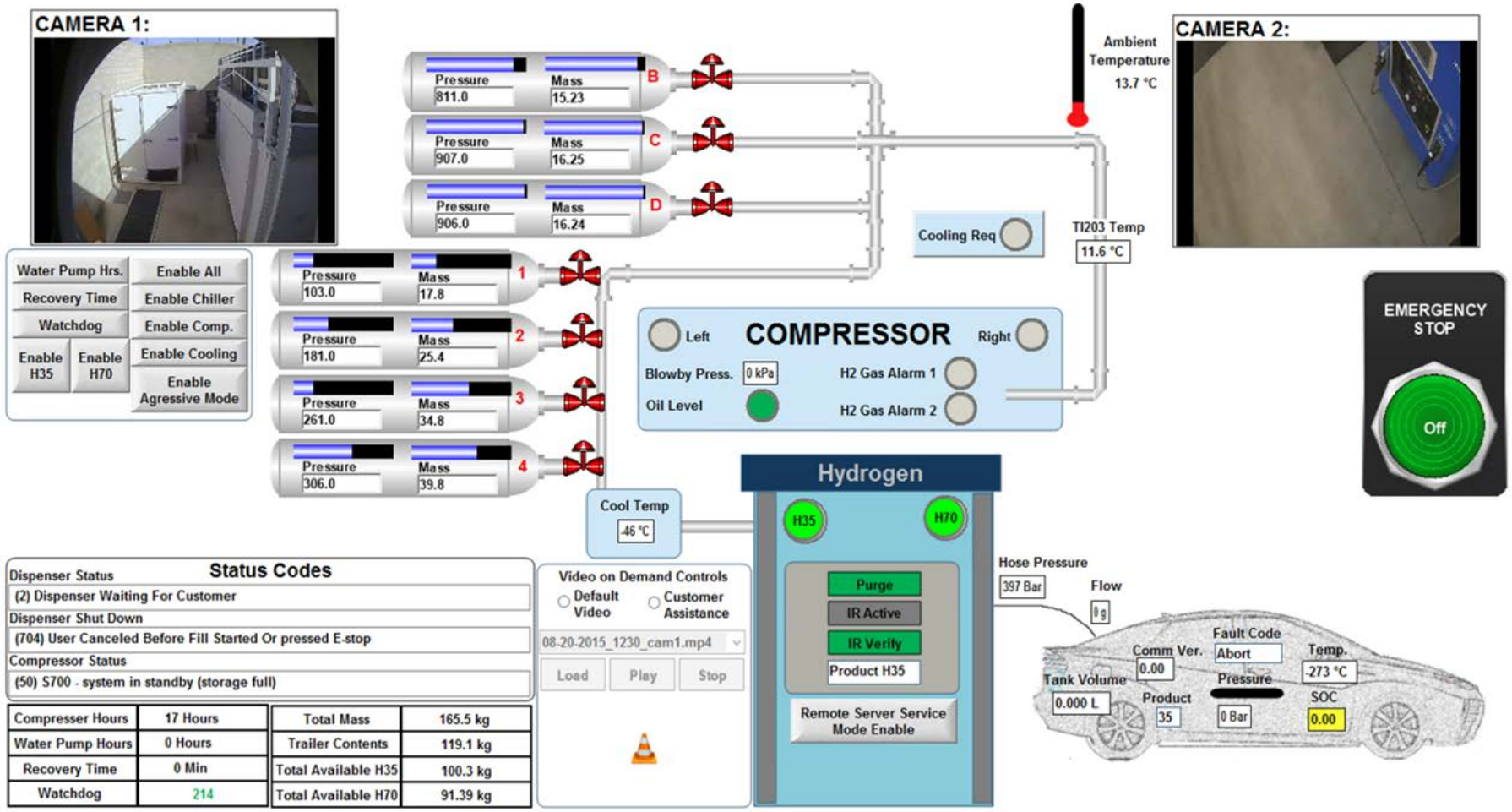
In addition to remote monitoring, FirstElement Fuel, Inc. has implemented rigorous computerized maintenance management systems and enterprise asset management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and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

Figure 18: FirstElement Fuel, Inc. Response Flow Chart



Source: FirstElement Fuel, Inc.

Figure 19: Screenshot of FirstElement Fuel, Inc.'s Remote Monitoring System



Source: FirstElement Fuel, Inc.

CHAPTER 4:
Conclusions

The following considers findings from the 33.3 percent renewable hydrogen Costa Mesa hydrogen refueling station project. The gasoline station owner, convenience store staff, and smog shop operator at the Costa Mesa station have been incredibly helpful, proactive, and a pleasure to work with. The planning commission in Costa Mesa is extremely supportive of this project and easily voted for approval in a unanimous decision.

The Costa Mesa station is located on one of the smallest lots in FirstElement Fuel, Inc.'s network of hydrogen refueling stations. The small, available land posed problems with circulation and parking, but they were overcome with communication and creative thinking with the local jurisdiction.

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.

GLOSSARY

CALIFORNIA ENERGY COMMISSION—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 CEC'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 (CO_2)—A colorless, odorless, nonpoisonous 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. CO_2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO_2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent).

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.

GREENHOUSE GASES (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

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.