



**CALIFORNIA  
ENERGY COMMISSION**



**CALIFORNIA  
natural  
resources  
AGENCY**

California Energy Commission  
Clean Transportation Program

## **FINAL PROJECT REPORT**

# **LAKE FOREST HYDROGEN STATION**

**Prepared for: California Energy Commission**

**Prepared by: FirstElement Fuel, Inc.**

**Gavin Newsom, Governor**

**November 2019 | CEC-600-2019-048**

# California Energy Commission

Tim Brown

Patti Kohler

**Primary Author(s)**

FirstElement Fuel, Inc.

5151 California Ave., Suite 220

Irvine, CA 92617

[www.firstelementfuel.com](http://www.firstelementfuel.com)

**Agreement Number: ARV-14-008**

Phil Cazel

**Project Manager**

John P. Butler

**Office Manager**

**Advanced Vehicle Infrastructure Office**

Kevin Barker

**Deputy Director**

**FUELS AND TRANSPORTATION**

Drew Bohan

**Executive Director**

## **Disclaimer**

Staff members of the California Energy Commission prepared this report. As such, it does not necessarily represent the views of the Energy Commission, its employees, or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Energy Commission nor has the Commission passed upon the accuracy or adequacy of the information in this report.

## **ACKNOWLEDGEMENTS**

The construction of the Lake Forest hydrogen refueling station has only been possible because of the substantial efforts and funds provided by a number of stakeholders. FirstElement Fuel, Inc. graciously thanks Toyota for their vision and fortitude, Air Products and Chemicals Inc., Black & Veatch, and Aliantel 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 provide funding opportunities under the Clean Transportation Program for 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 located at 20731 Lake Forest Dr., Lake Forest (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.

Please use the following citation for this report:

Brown, Tim. Kohler, Patti. FirstElement Fuel, Inc. 2019. Lake Forest Hydrogen Station. California Energy Commission. Publication Number: CEC-600-2019-048.

# TABLE OF CONTENTS

	Page
Acknowledgements .....	i
Preface.....	ii
Abstract .....	iii
Table of Contents.....	iv
Executive Summary.....	1
CHAPTER 1: Station Design and Construction .....	3
CHAPTER 2: Achieving an Operational Station .....	10
CHAPTER 3: Certifying the Station .....	12
CHAPTER 4: Completing the Station.....	13
Environmental Impacts .....	13
CHAPTER 5: Energy Analysis .....	19
CHAPTER 6: Future Activities.....	22
CHAPTER 7: Conclusions .....	25
Glossary .....	26

## LIST OF FIGURES

	Page
Figure 1: Coarse Detail of Equipment Compound from Construction Drawing 30 Set .....	4
Figure 2: Survey of Lake Forest Hydrogen Station Location .....	5
Figure 3: Equipment Compound from Zoning Drawing Set.....	6
Figure 4: Equipment Compound from Construction Drawing 100 Set.....	7
Figure 5: Initial Demolition and Earthwork.....	8
Figure 6: Crane Lifting the Hydrogen Compression Unit.....	9
Figure 7: Hydrogen Fuel Quality Report on February 10, 2016 .....	11
Figure 8: Performing Certification Testing.....	12
Figure 9: Lake Forest Hydrogen Station.....	14
Figure 10: Hydrogen Stations in Southern California: Open Retail and Planned .....	15
Figure 11: Schematic Depicting Hydrogen Station Equipment and Refueling Process .....	16
Figure 12: Enlarged View of Final Lake Forest Layout .....	17
Figure 13: The Project Grant Funding and Match Funding .....	18
Figure 14: Renewable Biomethane Supply Sources.....	19
Figure 15: Biogas Supply Contract.....	20
Figure 16: FirstElement Fuel, Inc. Response Flow Chart .....	23

Figure 17: Screenshot of FirstElement Fuel, Inc.'s Remote Monitoring System .....	24
---	----





# EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles (FCEVs) 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 FCEVs as a vehicle technology that will be available to meet the California Air Resources Board's zero-emission vehicle regulation and former Governor Edmund G. Brown Jr.'s goal of 5 million zero-emission vehicles by 2030.

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, they have zero tailpipe emissions, and they can be refueled in three to four minutes the way gasoline passenger vehicles are fueled. However, FCEVs require a new network of refueling stations that dispense pressurized hydrogen for consumer use. This has meant that the auto industry and station development industry have had to develop two new technologies in parallel: hydrogen FCEVs and hydrogen refueling infrastructure. FCEVs 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 California Energy Commission, FirstElement Fuel, Inc. was awarded funding for a total of 19 stations. The California Energy Commission contributed \$1,451,000 of the total \$2,237,180 cost to design, engineer, permit, construct, and commission the station.

FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and the Energy Commission's 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. The site selected for this project was 20731 Lake Forest Dr., Lake Forest (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.

The owner at Lake Forest was excited to an alternative fuel to his station and negotiated lease terms resulting in an executed lease with FirstElement Fuel, Inc. on December 31, 2015.

FirstElement Fuel, Inc. developed the site configuration and design, and engineering firm Black & Veatch performed the detailed engineering design. The zoning process in Lake Forest required just one public hearing and approval was granted May 15, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were filed on June 2nd, 2015 and were finalized August 6, 2015 for a total period of 65 days.

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. Aliantel from Murrieta, California 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 August 31, 2015, and was complete January 8, 2016.

Station commissioning began January 27, 2016 and was complete February 27, 2016. The FirstElement Fuel, Inc. team performed the bulk of the commissioning tasks including cleaning, purging, and pressure testing with Air Products and Chemicals Inc. performing final start-up.



# CHAPTER 1:

## Station Design and Construction

---

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

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 the Energy Commission's 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 was executed with the property owner on January 27, 2014. A binding 10-year lease was later executed on December 31, 2014.

FirstElement Fuel, Inc. selected Air Products and Chemicals Inc. (Air Products) equipment because of the cost, capacity, reliability, and more mature supply chain as compared to other suppliers as detailed in the FirstElement Fuel, Inc. application. FirstElement Fuel, Inc. executed a contract with Air Products for the equipment on September 16, 2014, and equipment was delivered to the site on October 14, 2015.

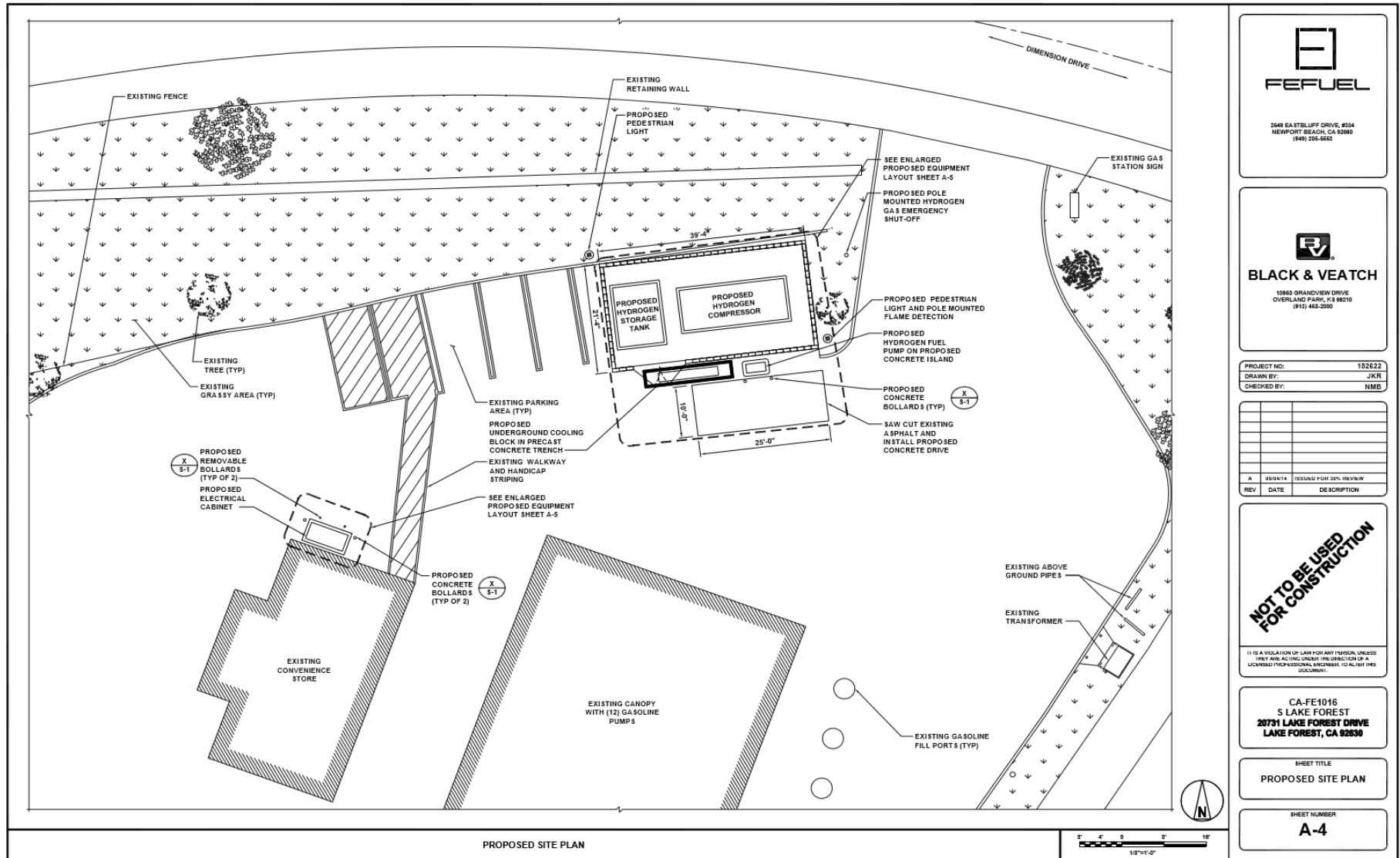
FirstElement Fuel, Inc. and Black & Veatch surveyed the site to begin the site layout on August 11, 2014. They generated initial engineering drawings on November 18, 2014. These drawings are referred to as "construction drawing 30s" because they represent 30 percent complete construction drawings and 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 28, 2014, Clark Land Surveying, Inc. performed a detailed engineering survey for the Lake Forest station site, as shown in figure 2.

On December 19, 2014, 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 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 3.

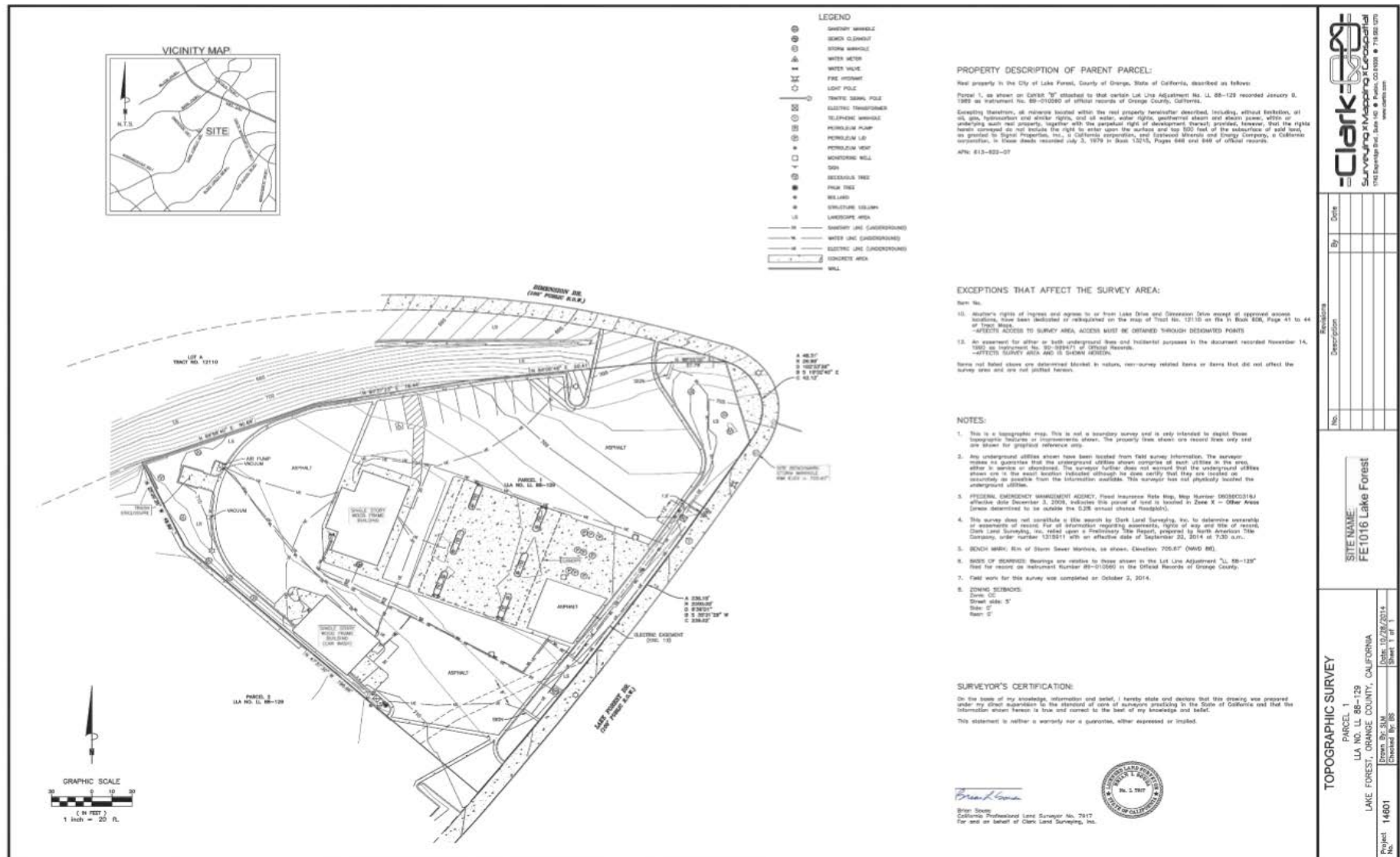
On May 20, 2015, draft final construction drawings (or "construction drawing 90s") were completed that depict all the details required for both construction and the permit review. Final construction drawings (or "construction drawing 100s") were completed with 60 pages that depict all of the minute detailed required for both construction and the permit review process on August 5, 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 is shown in figure 4.

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



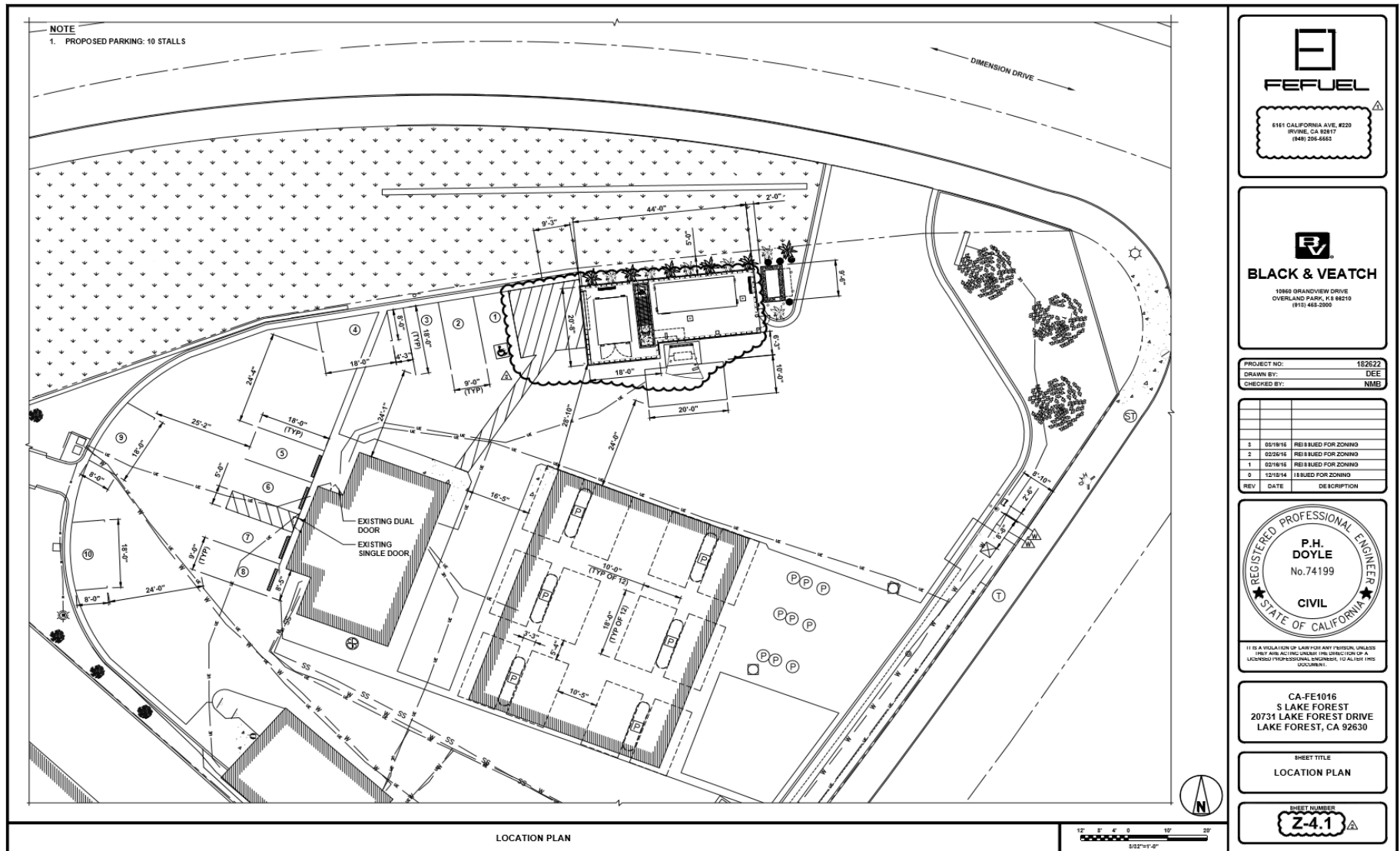
Source: FirstElement Fuel, Inc. Original figure is higher resolution

**Figure 2: Survey of Lake Forest Hydrogen Station Location**



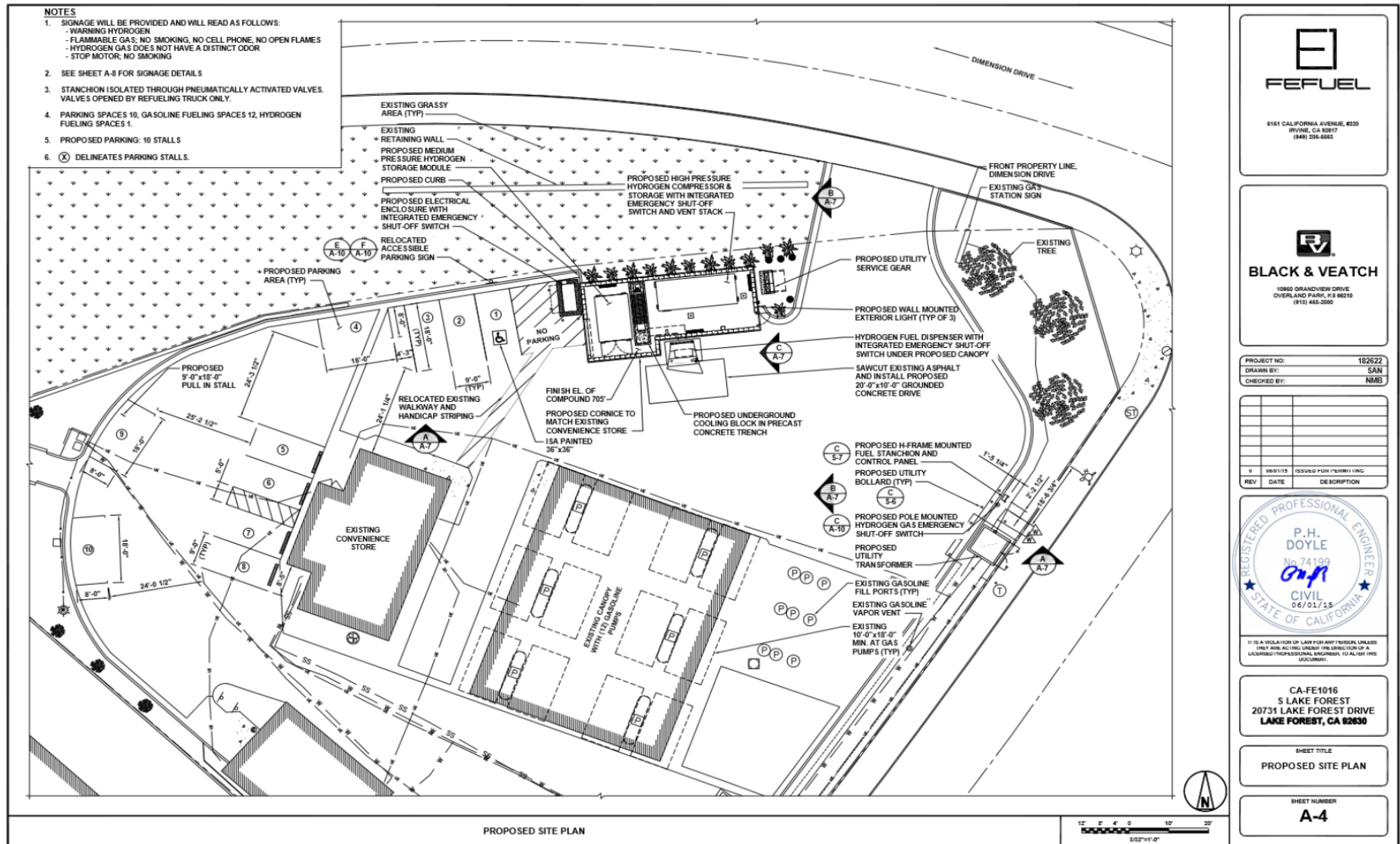
Source: FirstElement Fuel, Inc. Original figure is higher resolution

Figure 3: Equipment Compound from Zoning Drawing Set



Source: FirstElement Fuel, Inc. Original figure is higher resolution

Figure 4: Equipment Compound from Construction Drawing 100 Set



Source: FirstElement Fuel, Inc. Original is higher resolution



FirstElement Fuel, Inc. and Black & Veatch submitted the zoning application to the appropriate jurisdiction on December 23, 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. The meticulous up-front effort demanded by the planner resulted in a smooth, drama-free approval process. Approval was received through public hearing process on May 15, 2015.

All building permit applications were submitted on June 2, 2015, and approved on August 6, 2015 for a total period of 65 days.

FirstElement Fuel, Inc. and Black & Veatch submitted a detailed bid package to contractors on July 22, 2015. The contract was awarded to Aliantel on August 20, 2015. The bulk of Aliantel's construction experience lies in cell towers. Cell towers are roughly similar to hydrogen stations in size, have similar foundations and block walls, and have similar electrical requirements. Aliantel provided a reasonable bid, had a desire to get involved with hydrogen projects, and had a willingness to work in southern California. Construction started August 31, 2015. Figure 5 shows the equipment compound before completion. Hydrogen storage, compression (Figure 6), cooling, and dispensing equipment was delivered to the site October 14, 2015.

**Figure 5: Initial Demolition and Earthwork**



Source: FirstElement Fuel, Inc.



**Figure 6: Crane Lifting the Hydrogen Compression Unit**



Source: FirstElement Fuel, Inc.

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. Construction was completed January 8, 2016.

## **CHAPTER 2:**

# **Achieving an Operational Station**

---

FirstElement Fuel, Inc., commissioned the Lake Forest hydrogen station which included cleaning and purging lines, pressure testing, and hydrogen sampling (Figure 7). The station met the operational definition in PON-13-607 on February 10, 2016 when FirstElement completed installing all station/dispenser components, obtained the required permits from the local jurisdiction, filled the station's storage tubes with pressurized hydrogen gas, passed a hydrogen quality test and filled an FCEV with hydrogen. FirstElement Fuel, Inc. declared the station operational on February 20, 2016.

Figure 7: Hydrogen Fuel Quality Report on February 10, 2016

<b>SAE J2719 Summary</b>		<b>FIRST ELEMENT LAKE FORREST H<sub>70</sub> H<sub>2</sub></b>		<b>@Nozzle sampled on 02/10/2016</b>
	SAE J2719 Limits (μmol/mol)	Smart Chemistry Detection Limits (μmol/mol)	Concentration (μmol/mol)	Analytical Method
<b>Water</b>	5	1	<b>1.9</b>	
<b>Total Hydrocarbons (C<sub>1</sub> Basis)</b>	2	1	<b>1.1</b>	ASTM D7892
Methane		0.001	1.06	
Acetone		0.001	0.012	
Propane		0.001	0.025	
<b>Oxygen</b>	5	1	< 1	ASTM D7649
<b>Helium</b>	300	10	<b>38</b>	ASTM D1946
<b>Nitrogen, Argon</b>	100			
Nitrogen		2	< 2	ASTM D7649
Argon		0.5	<b>4.3</b>	ASTM D7649
<b>Carbon Dioxide</b>	2	0.5	< 0.5	ASTM D7649
<b>Carbon Monoxide</b>	0.2	0.0005	<b>0.0023</b>	ASTM D5466
<b>Total Sulfur</b>	0.004	0.000001	<b>0.000066</b>	ASTM D7652
Hydrogen Sulfide		0.000001	0.00000903	ASTM D7652
Carbonyl Sulfide		0.000001	0.0000114	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	0.0000455	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
<b>Formaldehyde</b>	0.01	0.001	< 0.001	ASTM D7892
<b>Formic Acid</b>	0.2	0.001	< 0.001	ASTM D5466
<b>Ammonia</b>	0.1	0.005	< 0.005	ASTM D5466
<b>Total halogenates</b>	0.05		<b>0.015</b>	
Chlorine		0.0008	< 0.0008	ASTM D5466
Hydrogen Chloride		0.007	< 0.007	ASTM D5466
Hydrogen Bromide		0.003	< 0.003	ASTM D5466
<b>Organic Halides (32 compounds in red and bold listed in "Other Hydrocarbons"). Smart Chemistry limit is for each individual organic halide.</b>		0.001	0.015	ASTM D7892
Tetrachloro-hexafluorobutanes			0.015	
<b>Particulate Concentration -</b>			<b>0.050 mg/kg</b>	
<b>ASTM D7651 (Particulate Concentration Calculation Sheet is listed in Table II)</b>				
<b>Particulates Found &amp; Size -</b>			<b>Only one particulate with size of 0.76mm found</b>	
<b>ASTM D7634 (Images of particulates found on 12/2 &amp; 10/2015 is are Table I and II, respectively.)</b>				
<b>Hydrogen Fuel Index</b>				
<small>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)</small>			<b>99.99546%</b>	

Source: FirstElement Fuel, Inc. Original figure is higher resolution

## CHAPTER 3:

# Certifying the Station

---

The California Department of Food and Agriculture Division of Measurement Standards enforces California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California. Figure 8 shows FirstElement Fuel, Inc. testing the station and achieving certification by acting as the registered service agent. They dispensed 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. <sup>1</sup>

**Figure 8: Performing Certification Testing**



Source: FirstElement Fuel, Inc.

---

<sup>1</sup> [Weights and Measures Examination Procedures](https://www.cdffa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf)

([https://www.cdffa.ca.gov/dms/programs/devices/Hydrogen\\_Gas-Measuring\\_Devices\\_EPO-40.pdf](https://www.cdffa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf))



## CHAPTER 4:

# Completing the Station

---

The first vehicle filled was a Hyundai Tucson on February 20, 2016, and the station has been used regularly since. The Lake Forest station dispensed 22.7 kilograms of hydrogen in February 2016. Sales in March 2016 were 113.4 kilograms, 202 kilograms in April, and 159.8 kilograms in May.

The California Fuel Cell Partnership, Station Operational Status System is a website portal that provides hydrogen refueling station status for FCEV driver use.<sup>2</sup> The Lake Forest hydrogen refueling station began sending automated updates (via FirstElement Fuel, Inc. software) on a regular basis, to the Station Operational Status System on March 18, 2016.

### Environmental Impacts

Hydrogen will be stored as a compressed gas in an above ground tank concealed behind a wall at this station. In accordance with the funding agreement with the Energy Commission, 33.3 percent of the hydrogen sold at the Campbell hydrogen refueling 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 case a leak occurs. No solid or liquid waste will be produced at this site.

Minimal 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 facility is a modern addition to an existing gasoline station. No outdoor sound amplification systems were installed; however, lighting was installed at the facility to ease evening fueling.

The station is open and ready for use as shown in figure 9.

---

<sup>2</sup> [Station Operational Status System](https://m.cafc.org/) (<https://m.cafc.org/>)

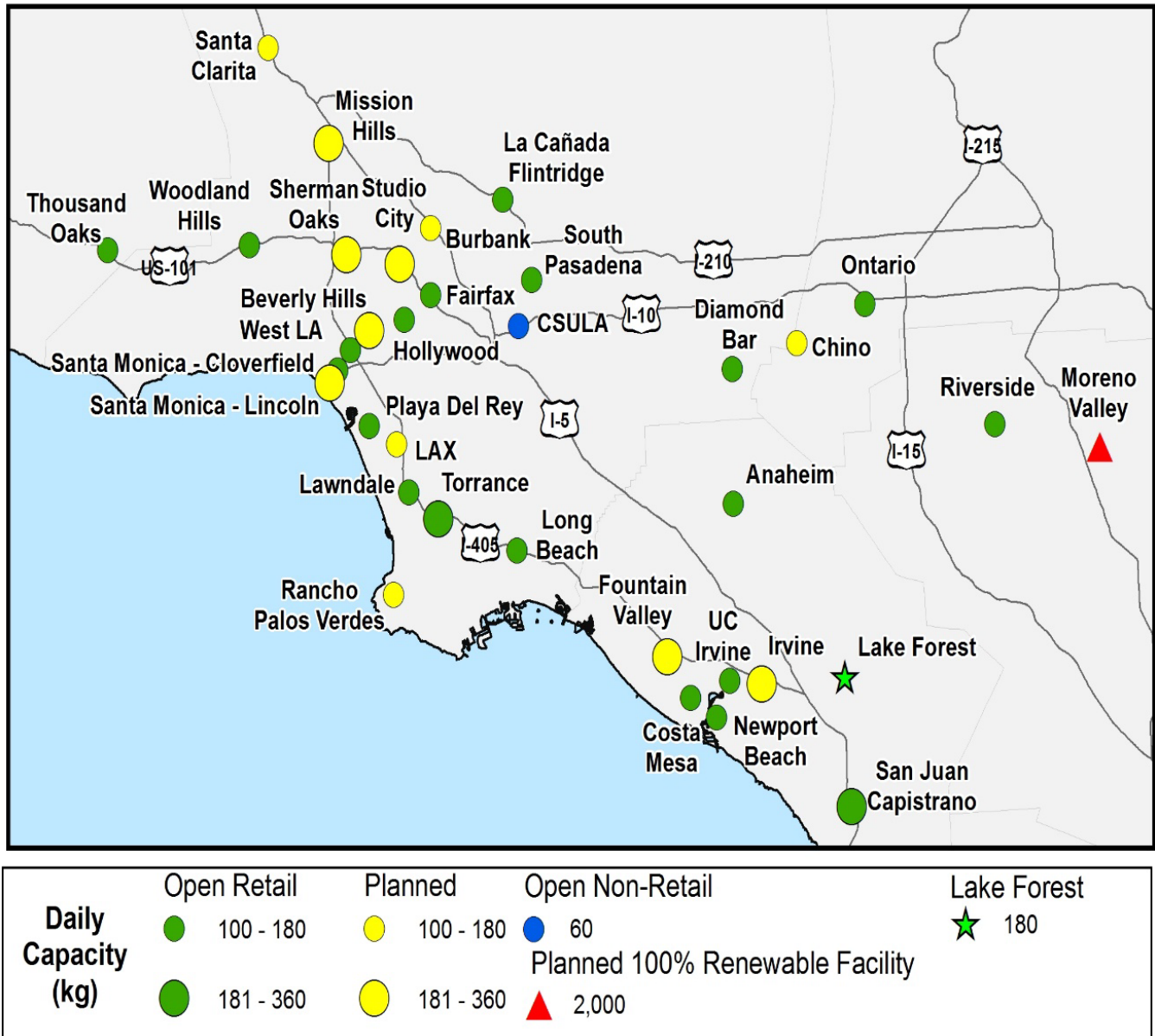
**Figure 9: Lake Forest Hydrogen Station**



Source: FirstElement Fuel, Inc.

Figure 10 shows the greater Los Angeles area and indicates where the Lake Forest Station is situated in relationship to other facilities in the southern part of the state.

Figure 10: Hydrogen Stations in Southern California: Open Retail and Planned

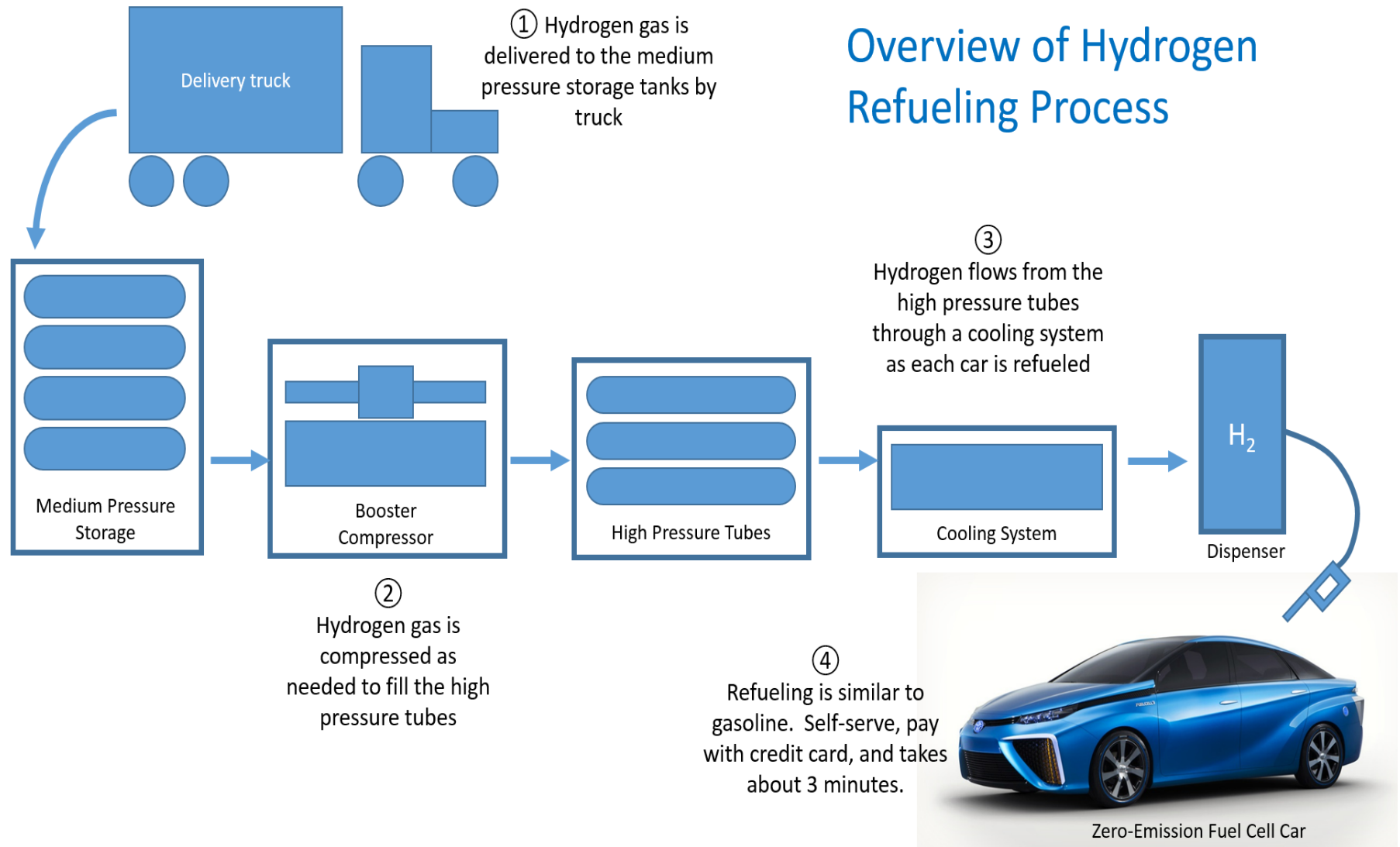


Source: CEC Staff.

## Schematic Layout of the Lake Forest Station

Figure 11 depicts an overview of the Lake Forest hydrogen station components and the steps in the refueling process.

**Figure 11: Schematic Depicting Hydrogen Station Equipment and Refueling Process**



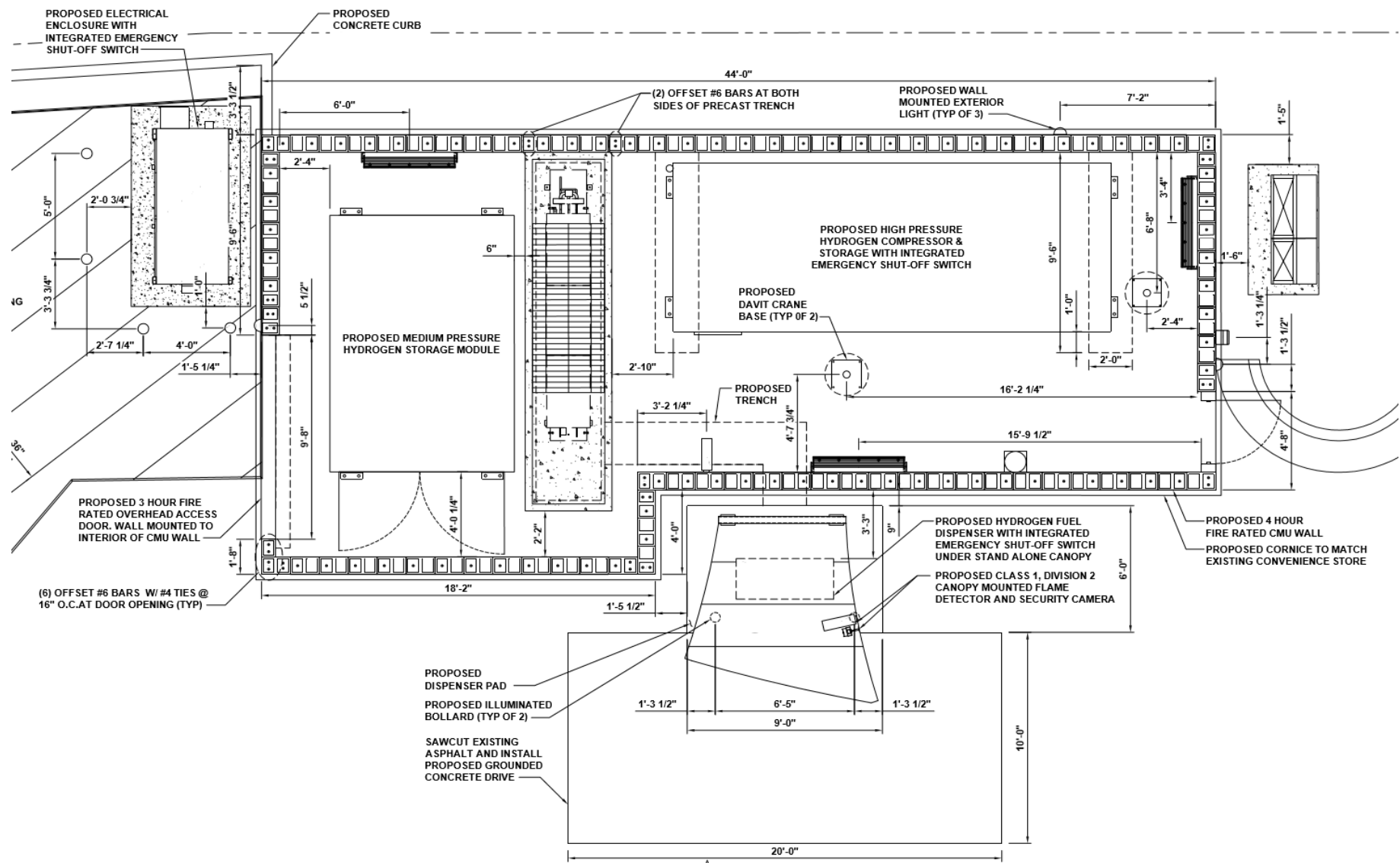
Source: FirstElement Fuel, Inc.



## Final Configuration and Budget

Figure 12 shows a detailed view of the actual final, as-built configuration of the Lake Forest station.

**Figure 12: Enlarged View of Final Lake Forest Layout**



Source: FirstElement Fuel, Inc. Original is higher resolution

Figure 13 shows a detailed view of the budget to construct the Hayward hydrogen station.

**Figure 13: The Project Grant Funding and Match Funding**

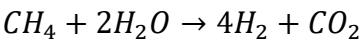
<b>Air Products and Chemicals, Inc., Allentown, PA</b>	
H2 station equipment	\$1,480,192.21
<b>Black &amp; Veatch, Overland Park, KS</b>	
Construction	\$542,708.64
Engineering	\$52,859.60
Permitting	\$50,025.01
Project Management	\$18,197.53
<b>Various Vendors</b>	
Construction Materials (tubing, wire, etc.)	\$10,940.17
Fixtures (doors, lights, etc.)	\$61,346.11
<b>MSI Tech, Irvine CA</b>	
Data Collection Tool	\$3,416.38
<b>Karen Calhoun, Newport Beach, CA</b>	
Legal services	\$13,150.03
<b>Vertical Advisors LLP, Newport Beach, CA</b>	
Financial services	\$4,345.13
<b>Total Project Costs</b>	<b>\$2,237,180.81</b>
<b>California Energy Commission Grant</b>	<b>\$1,451,000.00</b>
<b>Remaining match funding provided by First Element Fuel, Inc.</b>	<b>\$786,180.81</b>
<b>Total California Energy Commission cost share</b>	<b>64.9%</b>

Source: FirstElement Fuel, Inc.

# CHAPTER 5:

## Energy Analysis

The Lake Forest hydrogen refueling station is supplied by hydrogen generated via steam methane reformation that converts methane (CH<sub>4</sub>) and water (H<sub>2</sub>O) to hydrogen (H<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>):



Per California Senate Bill 1505, Environmental Standards for Hydrogen Production, 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 stations from Air Products’ hydrogen production facilities in Wilmington/Carson, California. Renewable biogas will be procured as feedstock for the facilities, resulting in delivered hydrogen product that meets the requirements of this PON and the 33.3 percent renewable hydrogen requirements of California Senate Bill 1505 as shown in figure 14. Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

**Figure 14: Renewable Biomethane Supply Sources**  
 Shell Energy North America (US), L.P.

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 has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1); documentation is provided in figure 15. Although California has a substantial amount of biogas, local supply cannot be injected into California pipelines under California Health and Safety Code Section 25420. Air Products’ 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.<sup>3</sup>

**Figure 15: 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: 

Name Printed: Edward Brown

Title: Vice President

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

Date: 3/21/2011

Source: FirstElement Fuel, Inc.

<sup>3</sup> [The Western Electricity Coordinating Council](https://www.wecc.biz/Pages/AboutWECC.aspx) (https://www.wecc.biz/Pages/AboutWECC.aspx)

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

The Lake Forest hydrogen station can dispense 180 kilograms/day. Based on average hydrogen use by FCEVs, this station's dispensing capacity is enough to support up to 260 FCEVs, depending on driver habits. Assuming that FCEVs average 52 mile/kilograms (taken from *Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model*),<sup>4</sup> 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 Lake Forest 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 according to US Department of Transportation.

As part of a separate grant agreement for operations and maintenance funding through the Energy Commission (ARV-17-029), 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 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.

---

<sup>4</sup> [GREET® Model](https://greet.es.anl.gov/) (<https://greet.es.anl.gov/>)

## CHAPTER 6:

### Future Activities

---

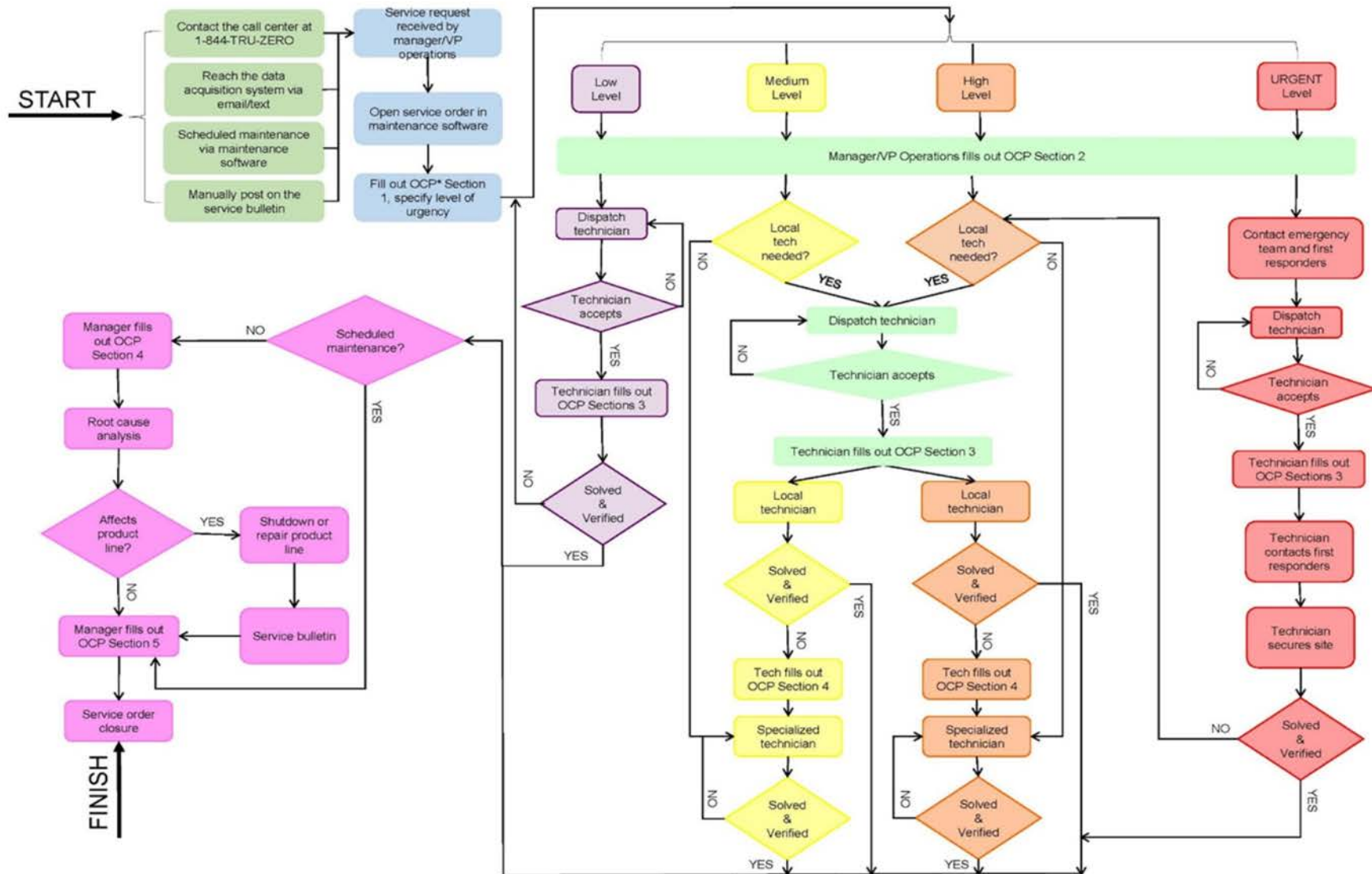
FirstElement Fuel, Inc. intends to own and operate the Lake Forest refueling station for at least 10 years. FirstElement Fuel, Inc. has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement Fuel, Inc. has executed an initial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

FirstElement Fuel, Inc. is building an in-house maintenance team that will have the personnel and equipment resources to maintain and repair any of our stations as quickly as possible throughout California. Figure 16 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 17 shows a screenshot of one page of the system. FirstElement Fuel, Inc. maintenance personal can access a breadth of real-time performance and sensor data, live video feeds, and historic usage data, and can control some features of the station remotely, 24 hours a 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 to maximize station up-time and enable tracking of key performance indicators.

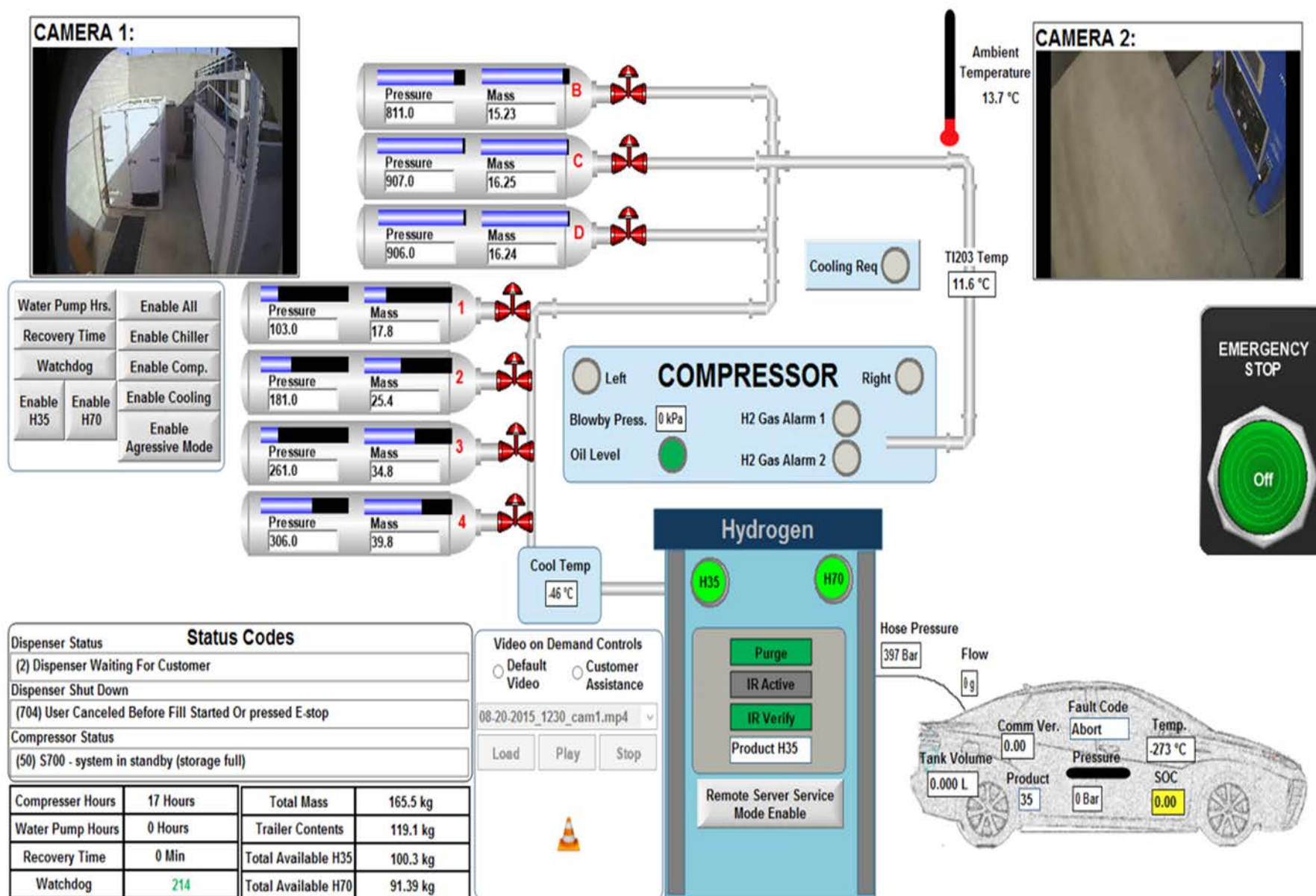
Figure 16: FirstElement Fuel, Inc. Response Flow Chart



Source: FirstElement Fuel, Inc.



Figure 17: Screenshot of FirstElement Fuel, Inc.'s Remote Monitoring System



Source: FirstElement Fuel, Inc.



## CHAPTER 7:

# Conclusions

---

The CTP funded hydrogen refueling station, at 20731 Lake Forest Dr. in Lake Forest, is now open and providing 33.3 percent renewable hydrogen to the general public in south eastern Orange County.

The city planner assigned to the Lake Forest hydrogen refueling station project was extremely organized and detail-oriented. At first, this appeared to a burden on the approval portion of the project but the FirstElement Fuel, Inc. team quickly realized that the meticulous up-front effort, demanded by the planner, resulted in a smooth approval process. Future projects should include extra attention in the planning process to identify and clear up potential problems before they happen.

Recently the project team found that 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. This project (and others) progressed through the construction phase quickly because team members now know that the key is for both station builders and station permit agencies to fully understand and appropriately apply the content of National Fire Protection Association hydrogen technologies code.

This new facility is now one of many on a growing list of refueling stations serving the residents of California that are collectively helping to attain the state's climate change policies.

## GLOSSARY

**CALIFORNIA ENERGY COMMISSION (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 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 (CO<sub>2</sub>)** - 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. CO<sub>2</sub> is the greenhouse gas whose concentration is being most affected directly by human activities. CO<sub>2</sub> also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent).

**CLEAN TRANSPORTATION PROGRAM (CTP)** (also known as the **ALTERNATIVE AND RENEWABLE FUELS AND VEHICLE TECHNOLOGY PROGRAM**) - 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.

**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 infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), halogenated fluorocarbons (HCFCs), ozone (O<sub>3</sub>), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

**HYDROGEN (H<sub>2</sub>)** - A colorless, odorless, highly flammable gas, the chemical element of atomic number 1.

**METHANE (CH<sub>4</sub>)** - 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.