CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Saratoga Hydrogen Station

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

March 2022 | CEC-600-2022-051

California Energy Commission

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Agreement Number: ARV-14-013

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ACKNOWLEDGEMENTS

The construction of the Saratoga hydrogen refueling station has only been possible because of the substantial efforts and funds provided by several stakeholders. FirstElement Fuel, Inc. graciously thanks Toyota for their vision and fortitude, Air Products and Chemicals Inc., Black & Veatch, and E-Tech 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, Commissioner 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. 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 for high performance retail 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-14-013 on July 22, 2014.

ABSTRACT

Per the terms of funding agreement ARV-14-013 between the CEC and FirstElement Fuel, Inc., FirstElement designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station located at 12006 Saratoga Ave., Saratoga, CA 95070.

FirstElement 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 vehicle drivers.

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

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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 Zero Emission Vehicle Regulation and the Governor's Zero Emission Vehicle Mandate. More specific actions to bring FCEVs to California markets are specified in the Governor's *Zero Emission Vehicle Action Plan*.

Hydrogen fuel cell electric drive technology offers tremendous potential for the light-duty passenger vehicle market and medium- and heavy-duty truck and bus markets. FCEV passenger vehicles can drive more than 300 miles on a tank of hydrogen and can be refueled in 3 to 4 minutes the way gasoline passenger vehicles are fueled. They have zero tailpipe emissions, while the carbon footprint of these vehicles is nearly the same as plug-in electric vehicles. The technology can be readily scaled up for SUVs, family passenger vans, pick-up 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. Both 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 in home settings, 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 co-develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen fuel cell electric vehicles. FCEVs 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 Alternative and Renewable Fuel and Vehicle Technology Program. The bill directs the Energy Commission to allocate up to $20 million per year, or up to 20 percent of each fiscal year's available funding, for the development of 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 was 12006 Saratoga Ave., Saratoga, California. A hydrogen refueling station at this location will serve as a core station in northern California for at least the next 10 years. FirstElement Fuel accomplished this goal through the steps outlined below.

The owner at Saratoga was excited to bring a clean, alternative fuel to his station. Lease terms were negotiated and a lease was executed between FirstElement Fuel and the Saratoga owner on December 20, 2014.

The site configuration and design were developed by FirstElement Fuel and detailed engineering design was performed by Black & Veatch. The zoning process in Saratoga was difficult because of objections from neighbors and ultimately required two public hearings. The neighbors were not particularly concerned with hydrogen safety or the appearance or

noise of hydrogen equipment, but instead they were trying to use the hydrogen project as a means to remove the gasoline station from their neighborhood. The housing nearby had been built after the gasoline station and the station was consequently grandfathered into the Saratoga zoning plan. After diligent effort by many stakeholders in favor of the hydrogen station including the CEC and GoBiz, approval was garnered July 14, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were finalized on August 12, 2015.

Hydrogen refueling station equipment was purchased from Air Products and Chemicals and the remainder of materials were sourced from a variety of general and specialty vendors. E-Tech from Concord, CA was selected as the contractor for the project because of their relatively low bid, excellent safety record, good standing with Black & Veatch, and willingness to work with FirstElement on multiple projects. Construction began on September 14, 2015 and was complete on February 29, 2015.

Commissioning began on January 19, 2015 and was complete on February 18, 2015. The FirstElement team performed the bulk of the commissioning tasks including cleaning, purging, and pressure testing with Air Products performing final start-up.

CHAPTER 1:
Station Design and Construction

Project Timeline

There were many steps required to bring the Saratoga hydrogen refueling station project to completion. The following synopsis highlights the most critical items, provides detail on each one, and states the timing required for each step for this particular project.

Site Acquisition (Fall 2013 – 12/20/2014)

Beginning in the Fall of 2013, First Element Fuel, Inc. took steps to identify and acquire appropriate sites for the station. FirstElement worked with historic vehicle sales data, academic publications, automakers, and the Energy Commission's Station Location Areas to select desired market locations. FirstElement 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 contacted station owners and operators to negotiate lease opportunities. A Letter of Intent was executed with the property owner at 12006 Saratoga Ave., Saratoga, CA 95070 on January 16, 2014. A binding 10-year lease was later executed on December 20, 2014.

Equipment Procurement (8/16/2014- 12/10/2015)

FirstElement selected Air Products equipment because of the cost, capacity, reliability, and more mature supply chain as compared to other suppliers as detail in the FirstElement PON application. A contract was executed with Air Products for the equipment on September 16, 2014 and equipment was delivered to the site on December 10, 2015.

Site Design and Engineering (8/12/2014 – 10/5/2015)

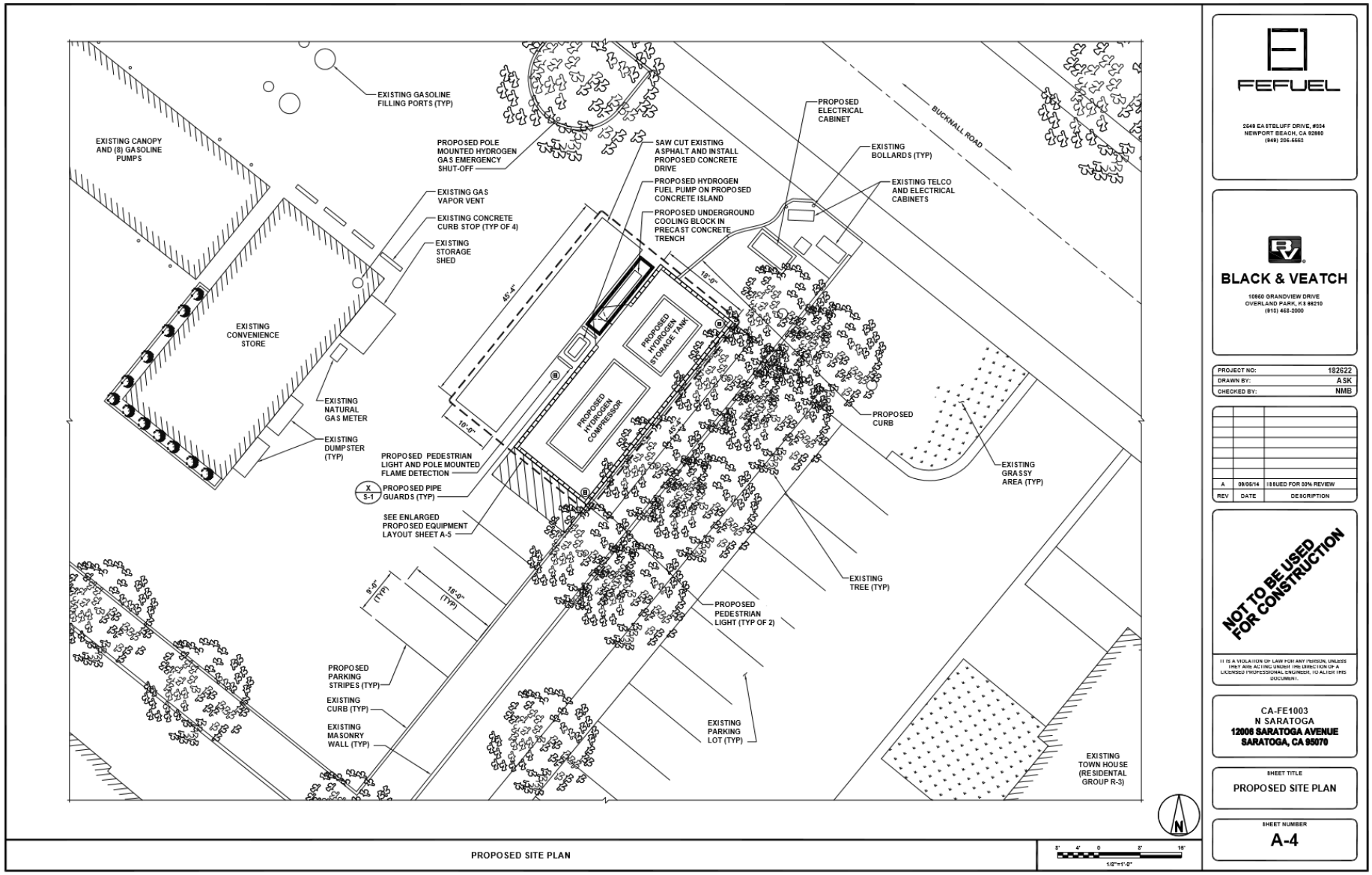
FirstElement and Black & Veatch conducted a preliminary site survey to begin the site layout process on August 12, 2014. Initial engineering drawings were generated on November 5, 2014. These drawings are referred to as "construction drawing 30s" because they represent 30 percent complete construction drawings and contain only 2 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 13, 2014, a detailed engineering survey for the Saratoga station site was subsequently performed by Clark Survey as shown in Figure 2.

On June 8, 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 are signed and sealed by the professional engineer of record to ensure their accuracy and completeness. The equipment compound page of the zoning drawings is shown in Figure 3.

On June 23, 2015, draft final construction drawings (or "construction drawing 90s") were completed that depict all of the minute detailed required for both construction and the permit review process. 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 October 5, 2015. These drawings are similarly signed and sealed by the professional engineer of record to ensure their 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



FEFUEL
2648 EASTBLUFF DRIVE, #334
NEWPORT BEACH, CA 92660
(949) 206-5663

BLACK & VEATCH
10960 GRANDVIEW DRIVE
OVERLAND PARK, KS 66210
(913) 458-2000

PROJECT NO:	182622
DRAWN BY:	ASK
CHECKED BY:	NMB

REV	DATE	DESCRIPTION
A	08/06/14	ISSUED FOR 30% REVIEW

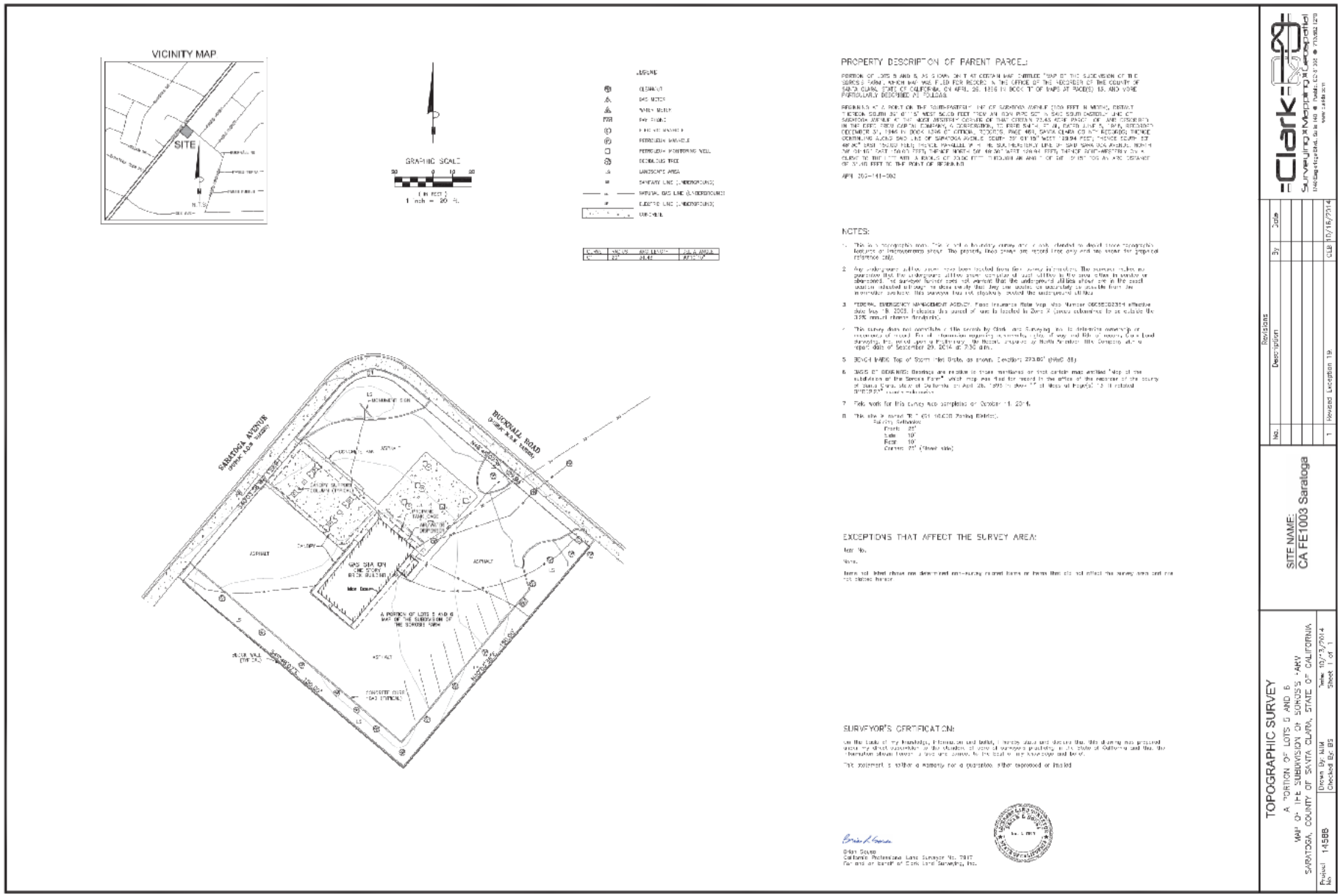
NOT TO BE USED FOR CONSTRUCTION

CA-FE1003
N SARATOGA
12006 SARATOGA AVENUE
SARATOGA, CA 95070

SHEET TITLE
PROPOSED SITE PLAN

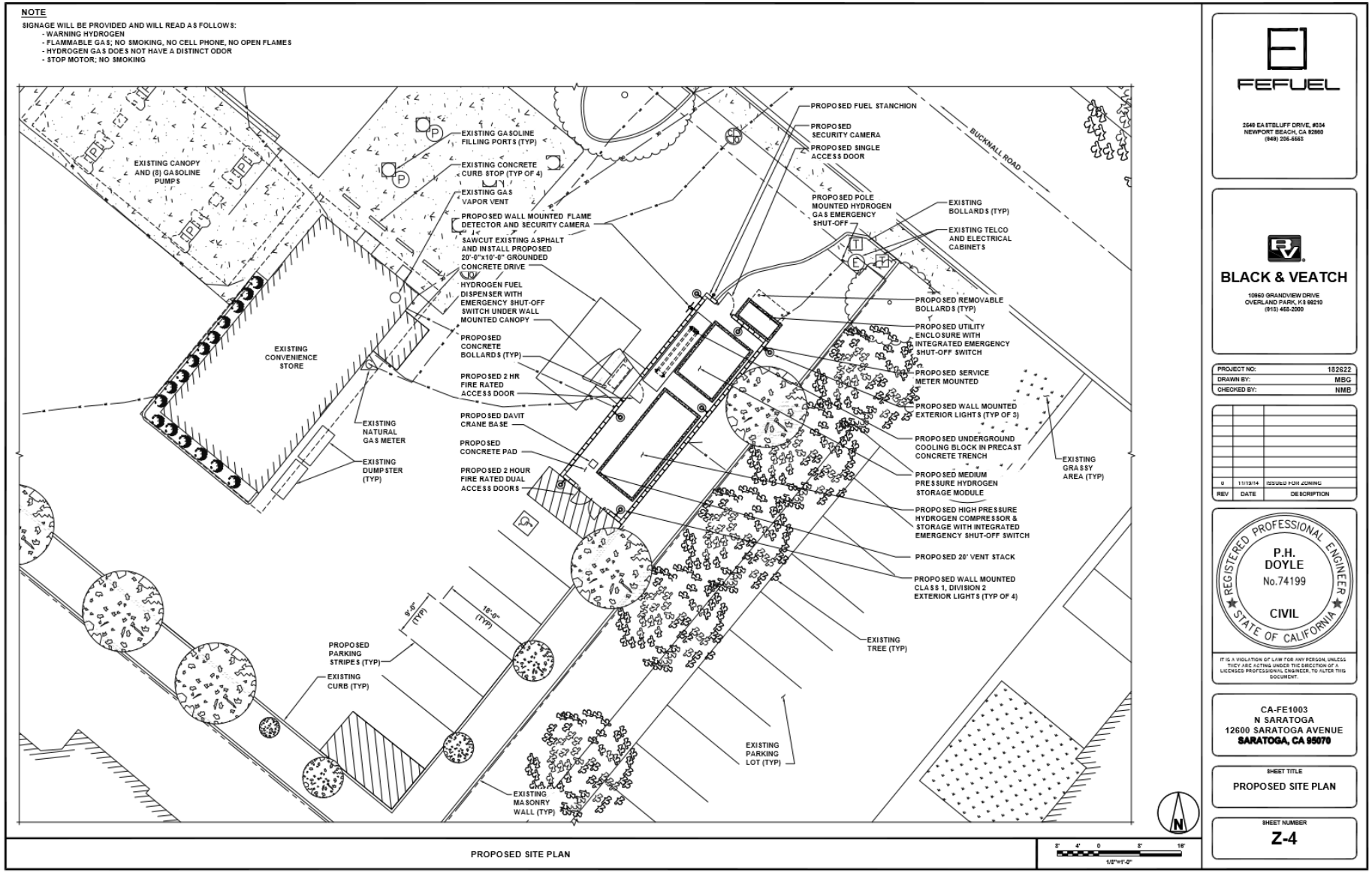
SHEET NUMBER
A-4

Figure 2: Survey of Saratoga Hydrogen Station Location



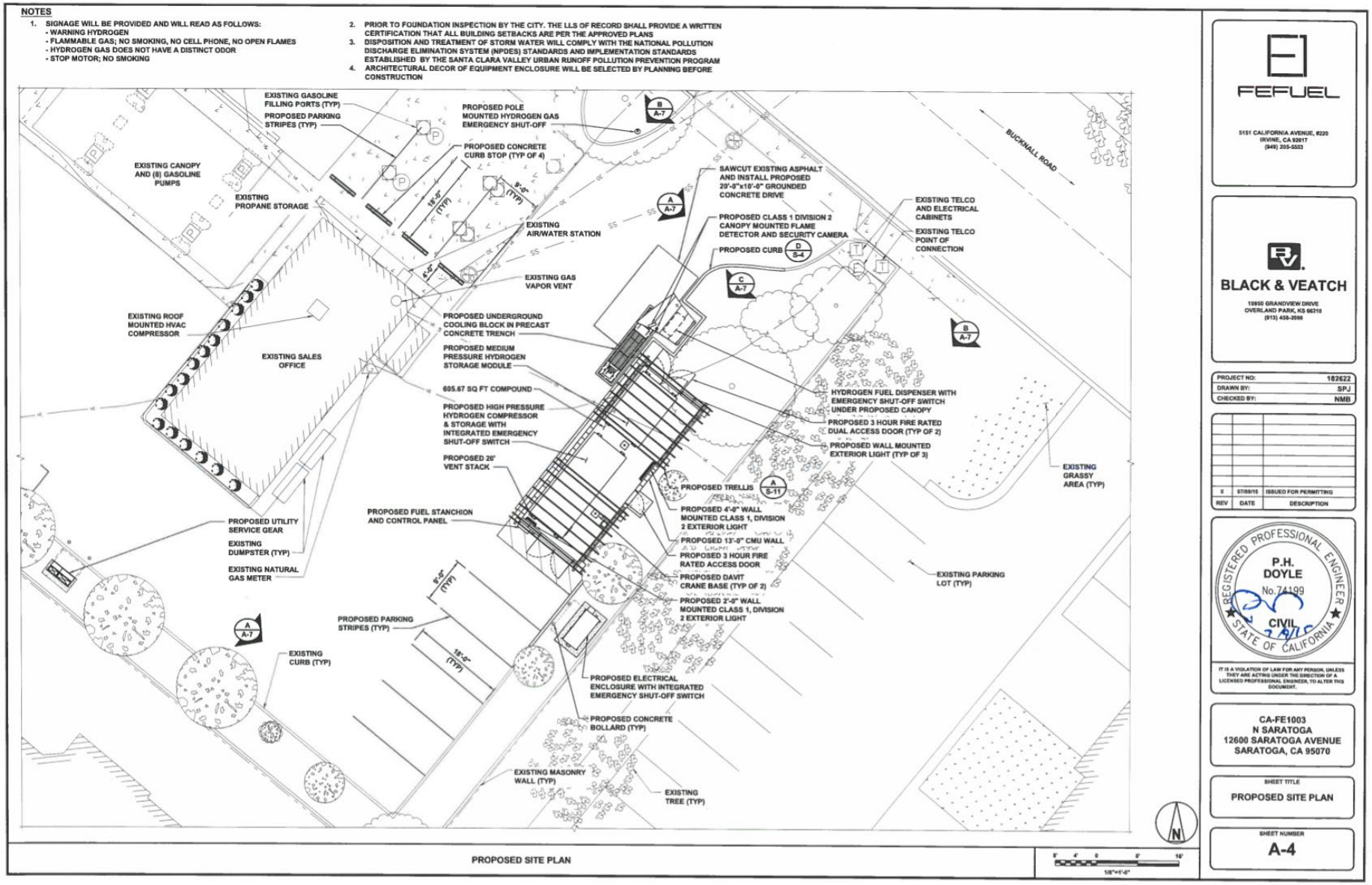
Source: FirstElement Fuel, Inc.

Figure 3: Detail of Equipment Compound from Zoning Drawing Set



Source: FirstElement Fuel, Inc.

Figure 4: Detail of Equipment Compound Showing Complete Detail for Permitting and Construction



Source: FirstElement Fuel, Inc.

Entitlement Process (11/19/2014 – 1/20/2015)

The zoning application was submitted to the appropriate jurisdiction on November 19, 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 a public hearing process on July 14, 2015.

Permit Process (7/10/2015 – 8/12/2015)

All building permit applications were submitted on July 10, 2015 and approved on August 12, 2015.

Construction Process (9/14/2015 – 2/29/2015)

FirstElement and Black & Veatch submitted a detailed bid package on August 27, 2015. The contract was awarded to E-Tech on September 4, 2015. The bulk of E-Tech'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. E-Tech provided a reasonable bid, had a desire to get involved with hydrogen projects, and is based in northern California. Construction started September 14, 2015. Figure 5 shows the equipment compound before completion. Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site on December 10, 2015, as shown in Figure 6. Construction was completed on February 29, 2016.

Figure 5: Station Equipment Compound During Cement Block Work

Source: FirstElement Fuel, Inc.

Figure 6: Crane Lifting Hydrogen Compressor Skid Off of Delivery Truck in Saratoga

Source: FirstElement Fuel, Inc.

The commissioning of the Saratoga hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling. Figure 7 and Figure 8 capture various moments of this process.

Station Declared Operational (2/22/2016)

The Saratoga hydrogen station met the Energy Commission's definition of operational by completing installation of all station/dispenser components, obtaining all of the required permits from the local jurisdiction, filling the station's storage tubes with pressurized hydrogen gas, successfully passing a hydrogen quality test, successfully fueled one fuel cell vehicle with hydrogen, and becoming open to the public.

Figure 7: Generator During Station Commissioning

Source: FirstElement Fuel, Inc.

Figure 8: Hydrogen Fuel Quality Report (2/3/2016)

www.SmartChemistry.com

SAE J2719 Summary

FIRST ELEMENT

SARATOGA H70 H_2

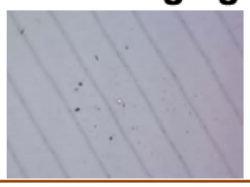
@Nozzle sampled on 02/03/2016

	SAE J2719 Limits (µmol/mol)	Smart Chemistry Detection Limits (µmol/mol)	Concentration (µmol/mol)	Analytical Method
Water	5	1	**1.8**	
Total Hydrocarbons (C_1 Basis)	2	1	**0.115**	ASTM D7892
Methane		0.001	0.064	
Acetone		0.001	0.026	
Ethanol		0.001	0.0070	
Heptane		0.001	0.018	
Isopropyl Alcohol		0.001	0.0028	
Oxygen	5	1	**4.9**	ASTM D7649
Helium	300	10	< 10	ASTM D1946
Nitrogen, Argon	100			
Nitrogen		2	**32**	ASTM D7649
Argon		0.5	**4.0**	ASTM D7649
Carbon Dioxide	2	0.5	< 0.5	ASTM D7649
Carbon Monoxide	0.2	0.0005	**0.0027**	ASTM D5466
Total Sulfur	0.004	0.000001	**0.000027**	ASTM D7652
Hydrogen Sulfide		0.000001	0.0000061	ASTM D7652
Carbonyl Sulfide		0.000001	0.0000096	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	0.000011	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	0.01	< 0.01	ASTM D5466
Total halogenates	0.05		**0.0088**	
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. **Tetrachloro-hexafluorobutanes**		0.001	0.0088 0.0088	ASTM D7892

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

0.029 mg/kg

Particulates Found & Size - ASTM D7634 (Images of particulates found on 12/2 & 10/2015 is are Table I and II, respectively.)



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)

99.99574%

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

Source: FirstElement Fuel, Inc.

Automaker Testing

Automaker testing was performed at the Saratoga hydrogen station to verify correct operation per Society of Automotive Engineers J2601.

Division of Measurement Standards Certification (2/19/2016)

The California Department of Food and Agriculture's Division of Measurement Standards is responsible for enforcement of California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California.

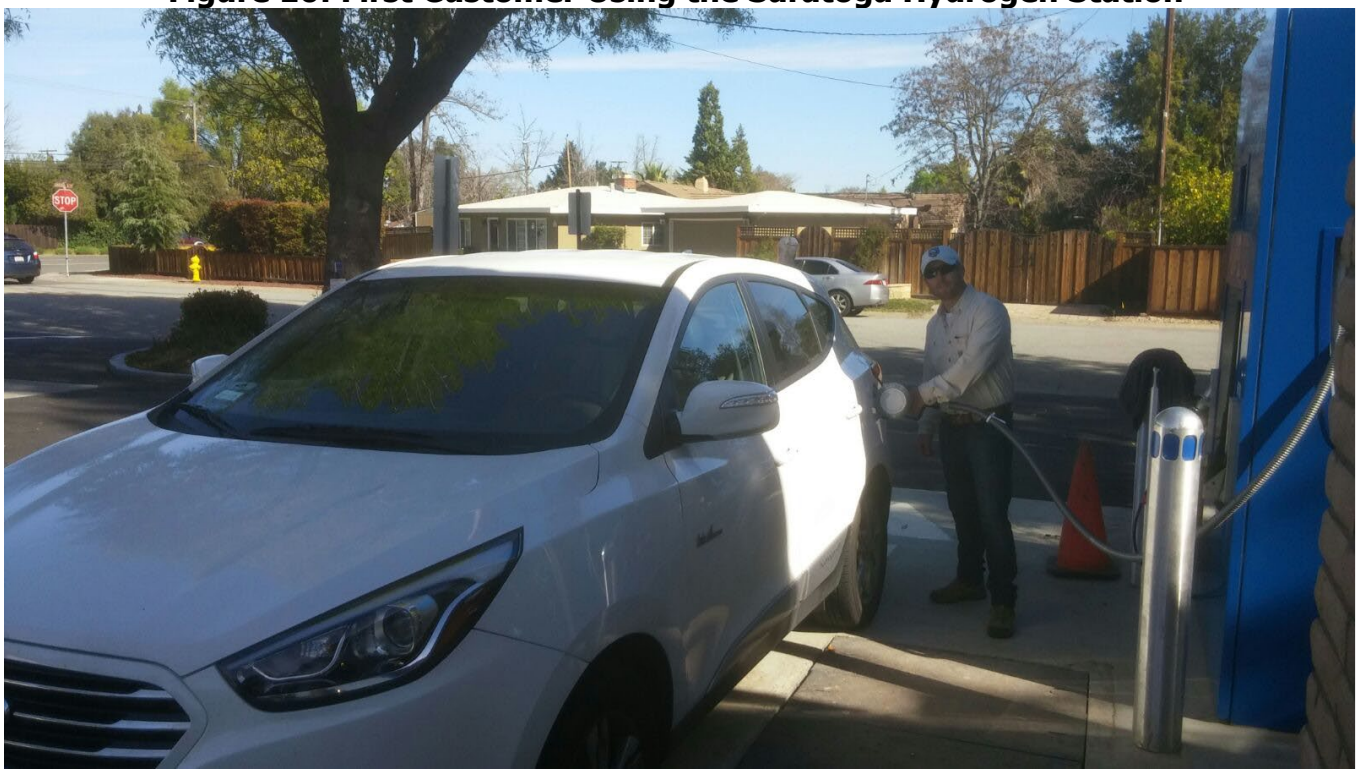
Acting as a Registered Service Agent and working with the local County Weights and Measures Officer as a witness, FirstElement successfully put the dispenser into service as shown in Figure 9.

Figure 9: Division of Measurement Standards Certification at Saratoga Station

Source: FirstElement Fuel, Inc.

The first public customer filled their Hyundai Tucson at the Saratoga station on February 22, 2016, as shown in Figure 10, and the station has been used regularly since then. The Saratoga station dispensed 85.7 kilogram of hydrogen in February 2016.

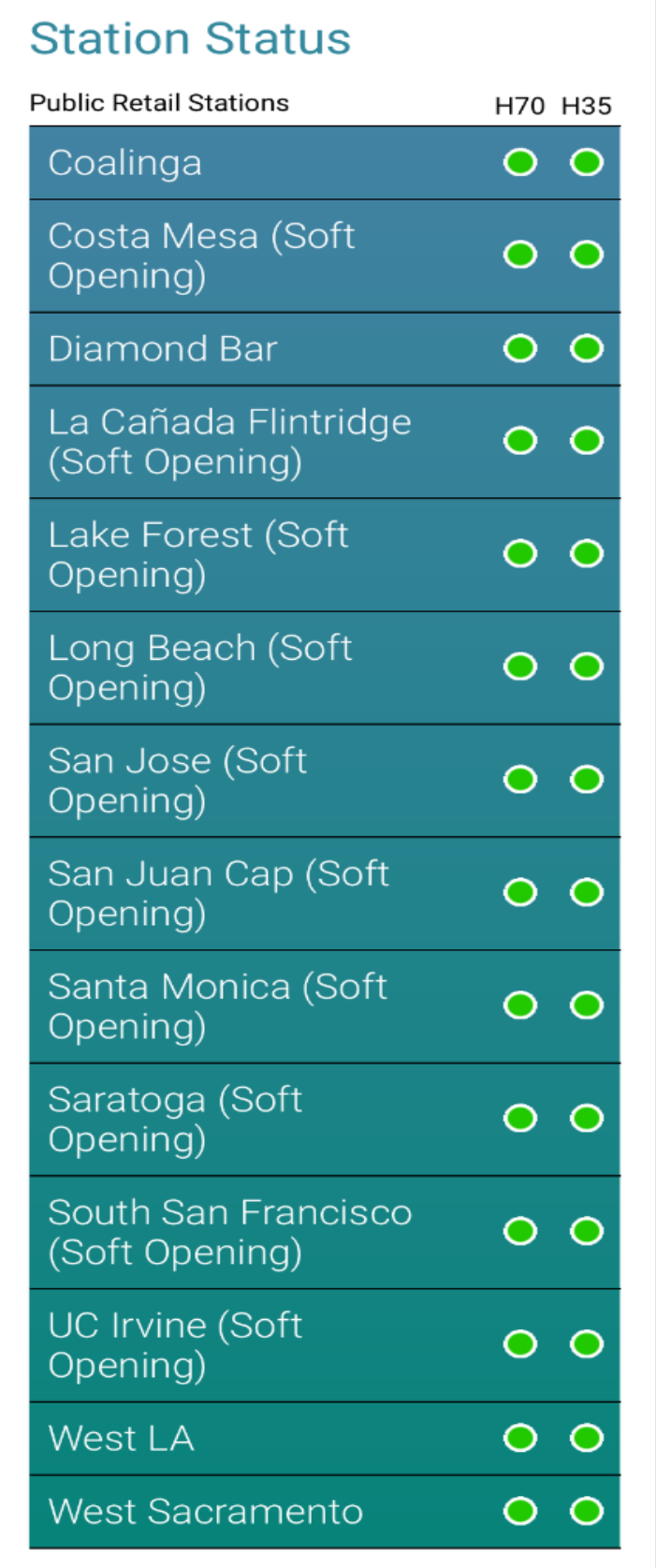
Figure 10: First Customer Using the Saratoga Hydrogen Station



Source: FirstElement Fuel, Inc.

The California Fuel Cell Partnership Station Operational Status System provides regularly updated station status information to fuel cell vehicle drivers. FirstElement developed software in-house that provides the required updates to the Station Operational Status System. The Saratoga hydrogen station began sending regular status updates to Station Operational Status System on 3/14/2016 as shown in Figure 11.

Figure 11: Screenshot of California Fuel Cell Partnership Station Operational Status System Showing Station Status



Source: FirstElement Fuel, Inc.

The station is open and active as shown in Figure 12.

Figure 12: Saratoga Hydrogen Station

Source: FirstElement Fuel, Inc.

Hydrogen will be stored as a compressed gas in an above ground tank concealed behind a wall at this facility. Hydrogen is non-toxic, colorless, and odorless so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in the case that a leak ever occurs. No solid or liquid waste will be produced at this site.

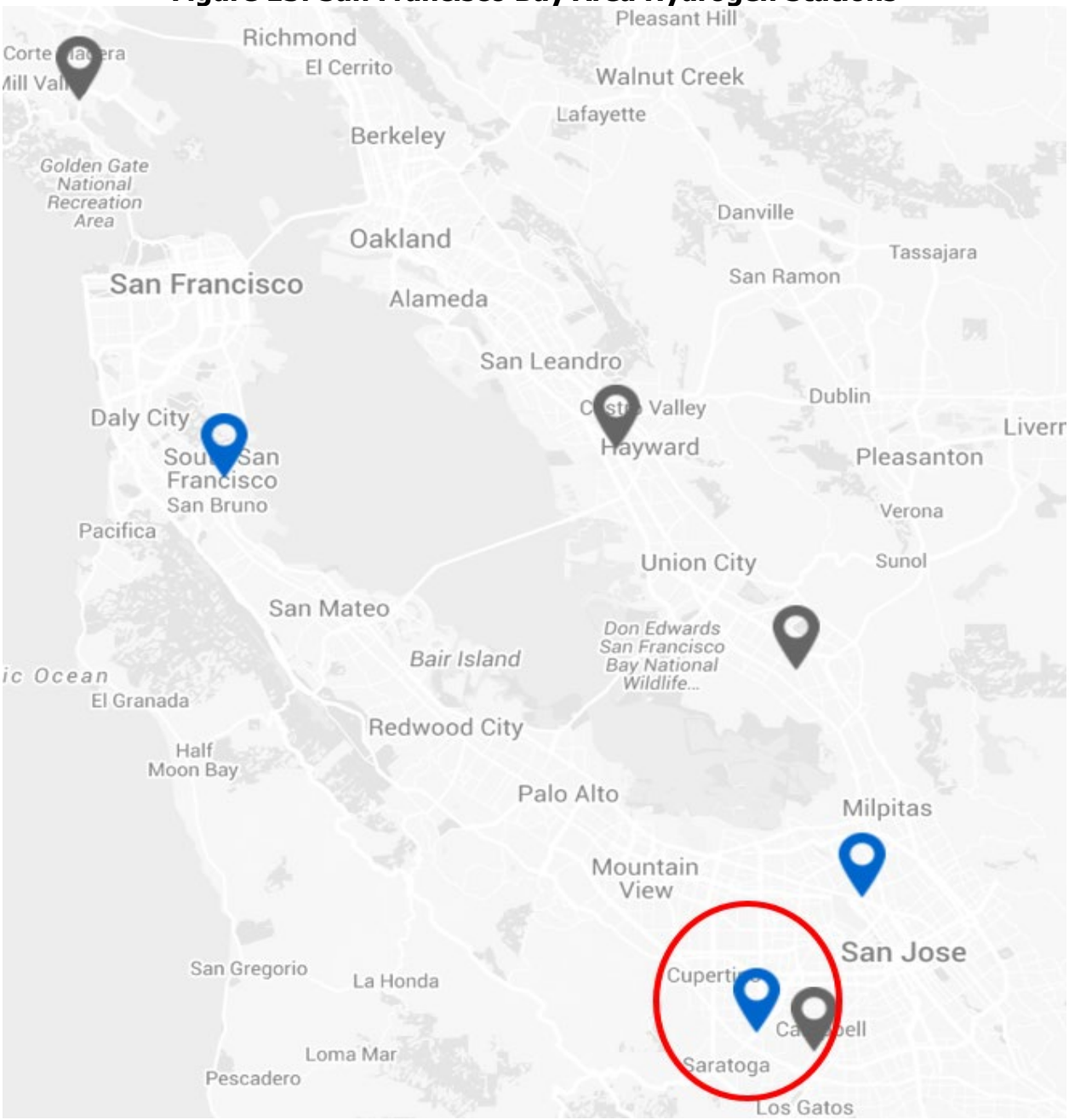
Several non-native trees were removed for this project. The tree removal, and all of the construction earthwork, were performed under the direction of certified arborists from both consultants and the city of Saratoga.

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 aid in evening fueling.

Saratoga Station in the Network

Figure 13 shows the location of the Saratoga hydrogen station at 12006 Saratoga Ave., Saratoga as a primary station in the San Francisco Bay Area.

Figure 13: San Francisco Bay Area Hydrogen Stations

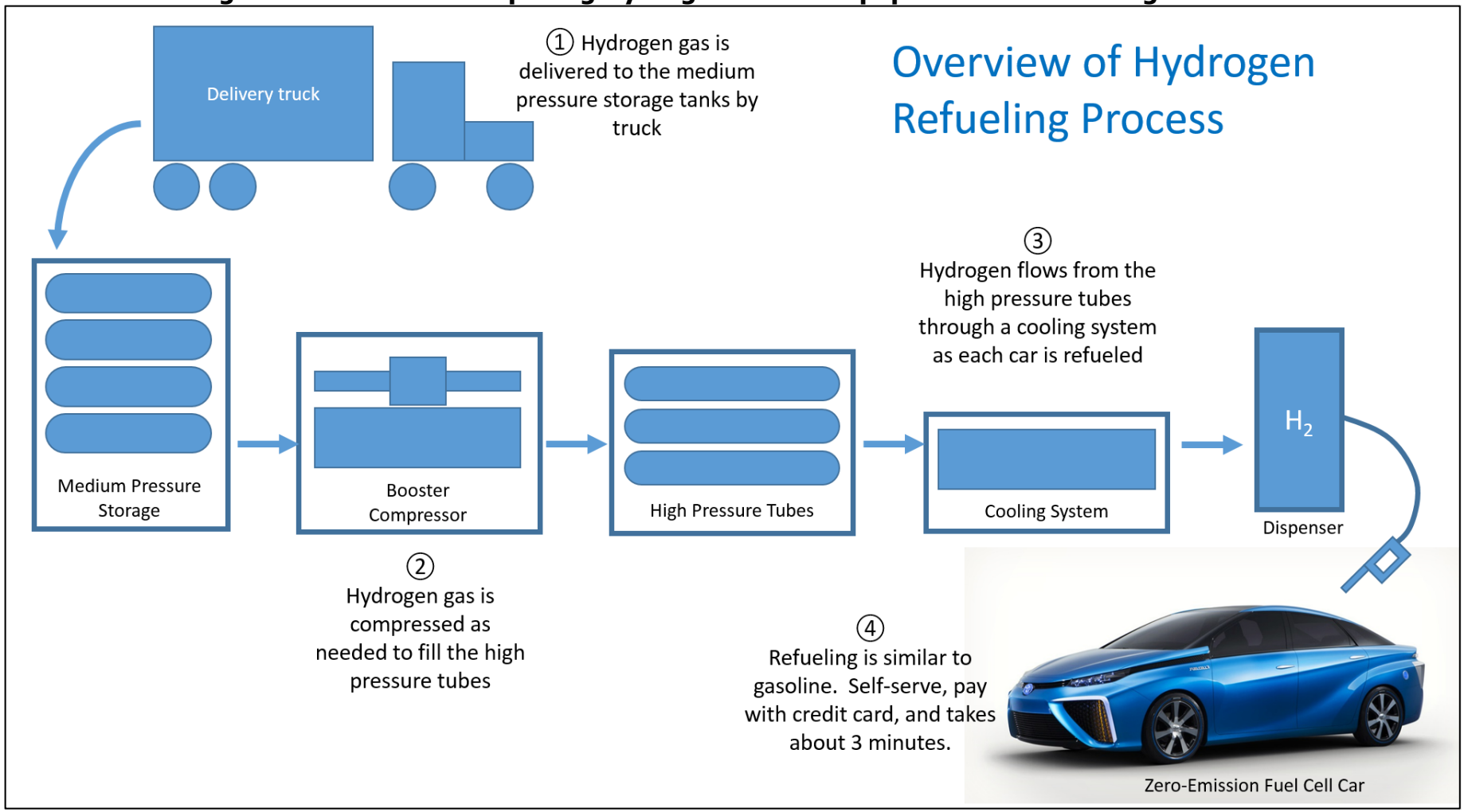


Source: FirstElement Fuel, Inc.

Schematic Layout of the Saratoga Station

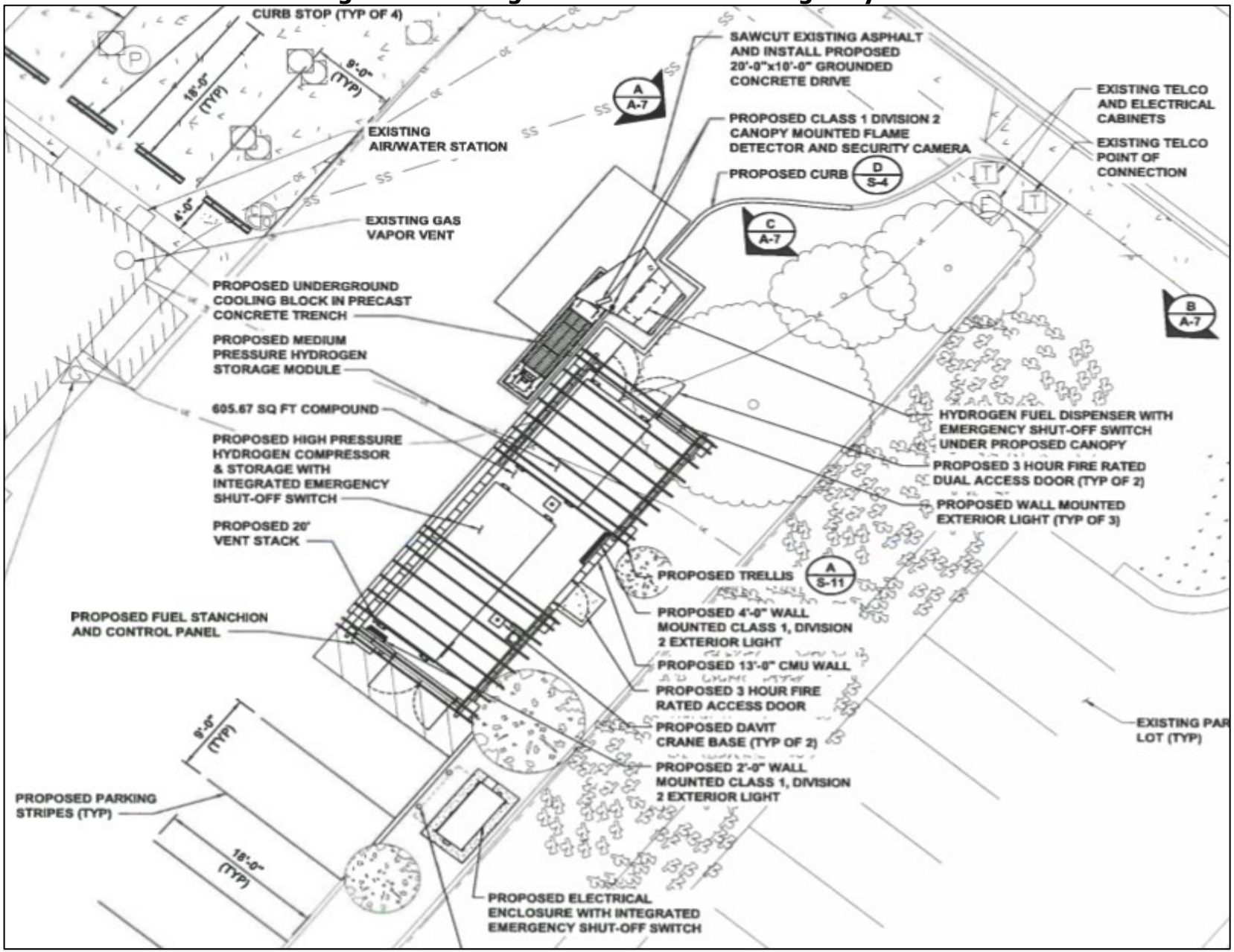
As shown below, Figure 14 depicts an overview of the Saratoga hydrogen station components and the steps involved in the refueling process. Figure 15 shows a detailed view of the actual final, as-built configuration of the Saratoga station.

Figure 14: Schematic Depicting Hydrogen Station Equipment and Refueling Process



Source: FirstElement Fuel, Inc.

Figure 15: Enlarged View of Final Saratoga Layout



Source: FirstElement Fuel, Inc

List of Subcontractors and Budget

Table 1 shows the subcontracts and the budgets under this project.

Table 1: Subcontractors and Budgets

Subcontractors	**Budget**
Air Products and Chemicals, Inc., Allentown , PA	
H2 station equipment	$1,479,873.56
Black & Veatch, Overland Park, KS	
Construction	$569,885.05
Engineering	$50,246.00
Permitting	$113,711.23
Project Management	$18,197.53
Various Vendors	
Construction Materials (tubing, wire, etc.)	$18,211.51
Fixtures (doors, lights, etc.)	$67,186.82
MSI Tech, Irvine CA	
Data Collection Tool	$67,186.82
Karen Calhoun, Newport Beach, CA	
Legal services	$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	$4,345.13
Total Vendor Costs	$2,401,993.68
California Energy Commission Grant	$1,451,000.00
Remaining cash provided by FirstElement	$950,993.68
Total CEC cost share (w/o FirstElement internal costs)	60.4%

Source: FirstElement Fuel, Inc.

CHAPTER 2:
Data Collection and Energy Analysis

The Saratoga hydrogen refueling station is supplied by hydrogen generated via the Steam Methane Reformation process that converts methane (CH_4) and water (H_2O) to hydrogen (H_2) and carbon dioxide (CO_2) as shown in Figure 16.

Figure 16: Stream Methane Reformation Formula

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

Source: FirstElement Fuel, Inc.

Per California Senate Bill 1505, Environmental Standards for Hydrogen Production, at least one third of the hydrogen sold by FirstElement'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, CA. 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 (sources of biogas shown in Table 2). Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

Air Products currently has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1); documentation is provided in Figure 18. Although California has a substantial amount of biogas resources, local supply cannot be injected into California pipelines because of CA Health & Safety Cost Section 25420. Air Products' biogas supply for this project is being sourced outside of California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council region that delivers gas into California.

Table 2: 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, Inc.

Figure 17: Biogas Supply Contract Between APCI and Shell Energy North America

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, Inc.

Hydrogen is delivered to all FirstElement stations (including Saratoga) by a Department of Transportation certified high-pressure delivery trailer.

The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model produced by Argonne National Laboratory was used to determine the energy sources and greenhouse gas emissions data. One third of the energy feedstock is renewable, nearly zero petroleum is used, and the only tailpipe emissions are water compared to the myriad

pollutants emitted by combustion of gasoline. Also, the entire well-to-wheels greenhouse gas emissions are 58 percent lower than similar usage for a typical California gasoline vehicle.

The Saratoga hydrogen station is capable of dispensing 180 kilogram/day. Assuming FCEVs average 52 mile/kilogram (taken from the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model), and consumption of 180 kilogram/day for the next 10 years, the station will offset 8,384 metric tons of total greenhouse gasses compared to equivalent gasoline vehicles. Also, the Saratoga hydrogen station will eliminate over 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon.[1]

Data on the operation of the station will be collected and reported to the CEC throughout the term of an associated operations and maintenance grant through the Alternative and Renewable Fuel and Vehicle Technology Program. Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the project's actual performance to proposed expectations.

[1] Department of Transportation, Bureau of Transportation Statistics; Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles; https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles

CHAPTER 3:
Future Activities

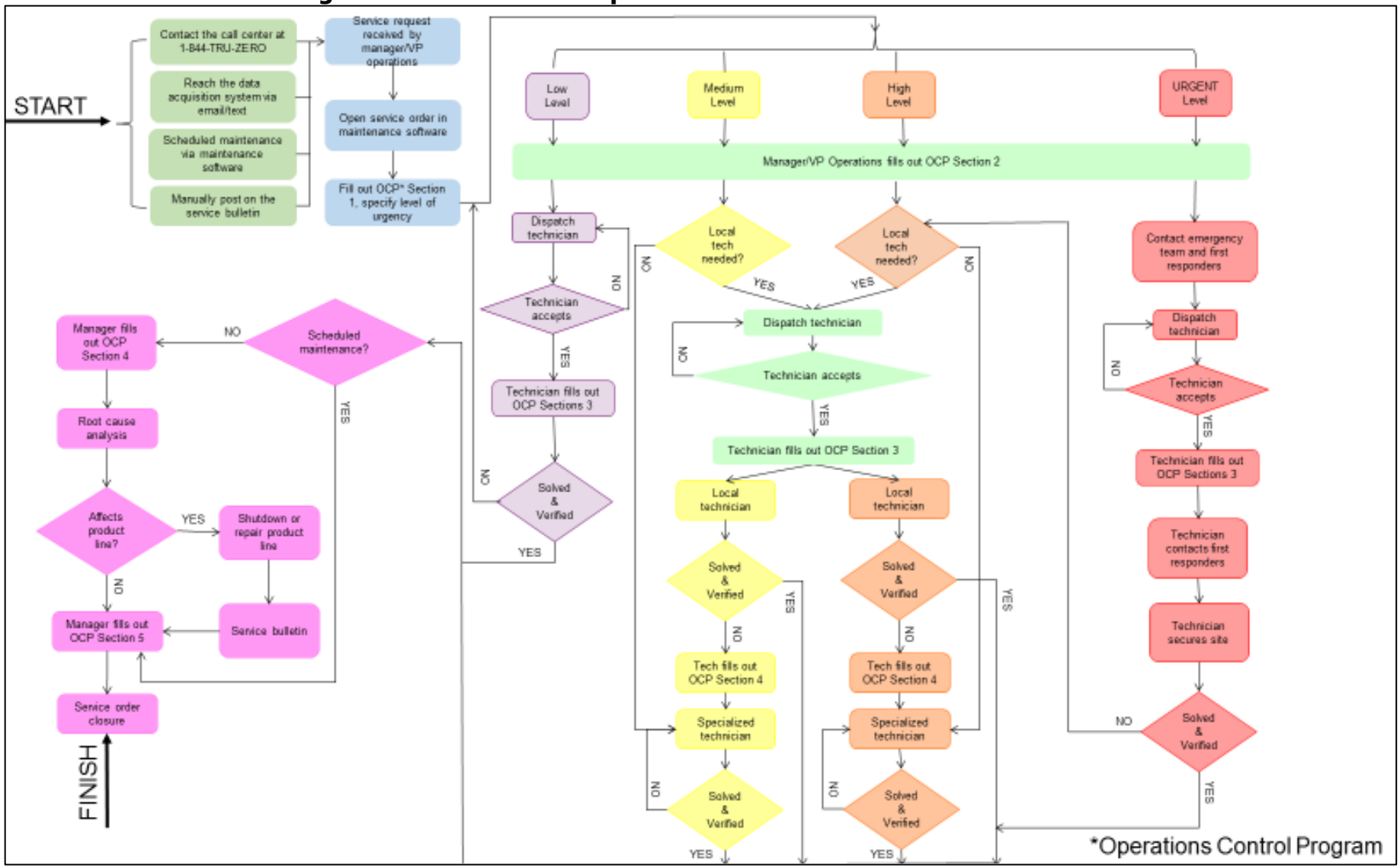
FirstElement intends to own and operate the refueling station at 12006 Saratoga Ave., Saratoga, CA for at least 10 years. FirstElement has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement has executed an initial 10-year lease with the landowner with the possibility for extension.

In addition, FirstElement 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 18 shows a flow diagram for response from the Operations and Maintenance team.

To augment onsite personnel across the FirstElement network, a comprehensive data collection and monitoring system has been implemented. Figure 19 shows a screenshot of one page of the system. FirstElement 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.

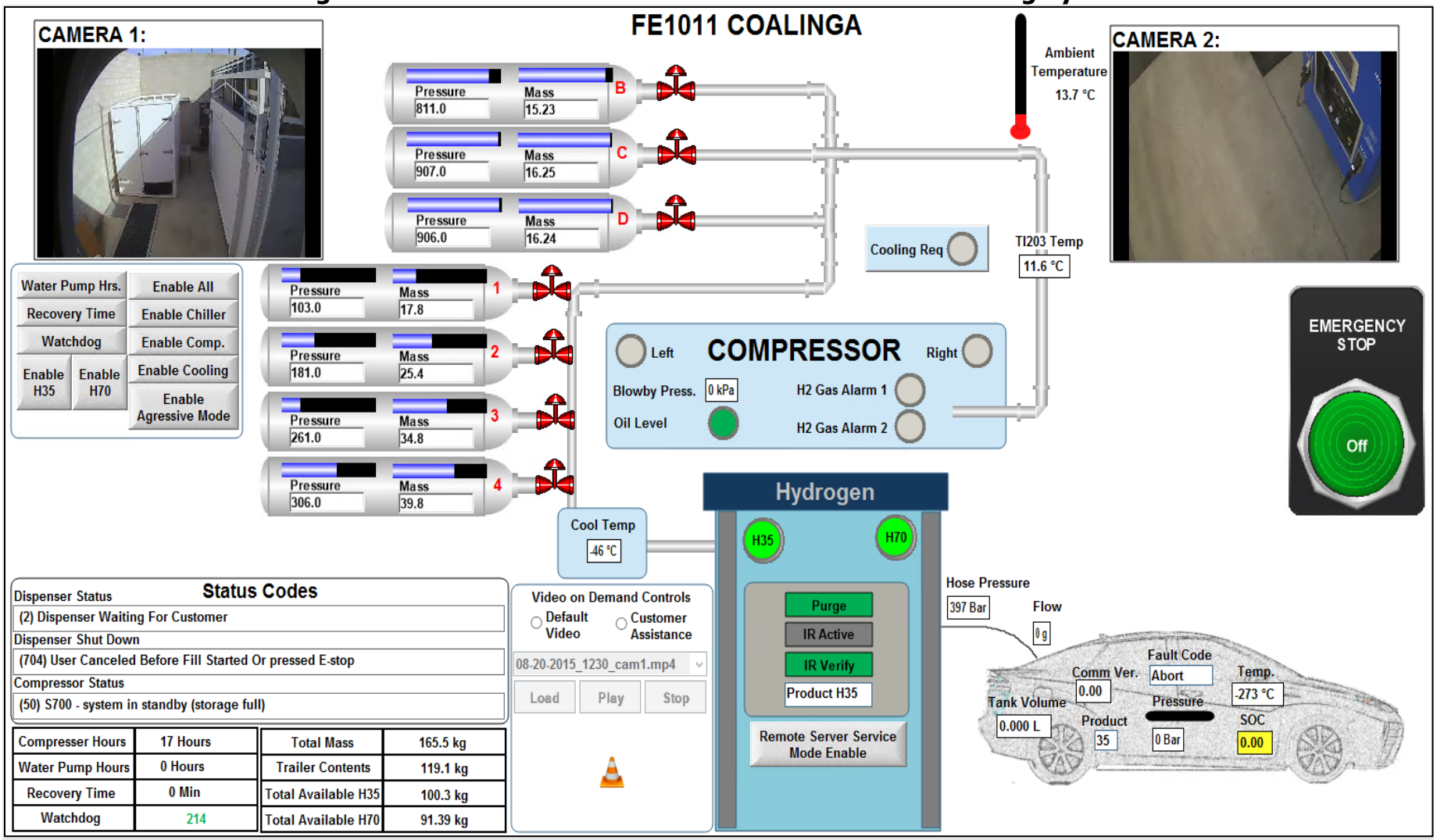
In addition to remote monitoring, FirstElement has implemented rigorous Computerized Maintenance Management Systems and Enterprise Asset Management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and repair activities. This will help to maximize station up-time and enable tracking of key performance indicators.

Figure 18: FirstElement Operations and Maintenance Control Plan



Source: FirstElement Fuel, Inc.

Figure 19: Screenshot of FirstElement's Remote Monitoring System



Source: FirstElement Fuel, Inc.

CHAPTER 4:
Conclusions

The following is a list of important findings from the Saratoga hydrogen station project:

- The zoning process in Saratoga was difficult because of objections from neighbors and ultimately required two public hearings. The neighbors were not particularly concerned with hydrogen safety or the appearance or noise of hydrogen equipment, but instead they were trying to use the hydrogen project as a means to remove the gasoline station from their neighborhood. The housing nearby had been built after the gasoline station and the station was consequently grandfathered into the Saratoga zoning plan.
- National Fire Protection Association 2: Hydrogen Technologies Code is a critical tool for working with permit agencies. The code clearly defines fire safety guidelines that enable local jurisdictions and builders to reach common ground, while also ensuring safety via the rigorous National Fire Protection Association code writing process. The key is for both station builders and station permit agencies to fully understand, and appreciate, the content of National Fire Protection Association 2.

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 CEC's five major areas of responsibilities are:

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

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

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.