CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

South San Francisco Hydrogen Station

Prepared for: California Energy Commission

Prepared by: First Element Fuel, Inc.

Gavin Newsom, Governor

January 2020 | CEC-600-2020-018

California Energy Commission

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Agreement Number: ARV-14-013

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ACKNOWLEDGEMENTS

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

PREFACE

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

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

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

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-607 to fund hydrogen refueling stations. In response to PON-13-607, the recipient submitted an application 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

FirstElement Fuel, Inc. designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station at 248 South Airport Blvd., South San Francisco (San Mateo 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 (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 in 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, have zero tailpipe emissions, and 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 requirement has meant that the auto industry and station development industry have had to develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen FCEVs. 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 CEC, FirstElement Fuel, Inc. was awarded funding for 19 stations. The CEC contributed $1,451,000 of the total $2,254,481 cost to design, engineer, permit, construct, and commission this station.

FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and the CEC'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 is 248 South Airport Blvd., South San Francisco (San Mateo County). A hydrogen refueling station at this location will serve as a core station in Northern California for at least the next 10 years.

The owner of the property in South San Francisco was excited to bring a clean, alternative fuel to his station. Lease terms were negotiated and a lease was executed between FirstElement Fuel, Inc. and the South San Francisco owner on April 23, 2015.

FirstElement Fuel, Inc. developed the site configuration and design, and engineering firm Black & Veatch performed the detailed engineering design. The zoning process in South San Francisco required just one public hearing and approval was granted January 20, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were filed November 10, 2014, and finalized May 1, 2015, for 172 days. Because the South San Francisco station is close to the 101 freeway, the fire authority in this jurisdiction was particularly concerned with an errant vehicle leaving the freeway at speed and hitting the backside of the hydrogen equipment. FirstElement Fuel, Inc. attained approval by implementing an impact wall into one portion of the equipment compound.

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, Inc. from Murrieta (Riverside County) was selected as 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 June 1, 2015 and was complete on October 9, 2015.

The process of making the station operational began on October 8, 2015, and was complete on October 22, 2015. 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 South San Francisco 33 percent renewable hydrogen refueling station project to completion. The following synopsis highlights the most critical items.

Site Acquisition - Construction (Fall 2013 – October 2015)

From fall 2013 through December 2014, 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 CEC'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 January 27, 2014. A binding 10-year lease was later executed December 31, 2014.

FirstElement Fuel, Inc. selected Air Products and Chemicals, Inc. equipment because of the cost, capacity, reliability, and more mature supply chain as compared to other suppliers as detailed in the FirstElement Fuel, Inc. grant application. FirstElement Fuel, Inc. executed a contract with Air Products and Chemicals, Inc. for the equipment on September 16, 2014, and equipment was delivered to the site September 10, 2015.

FirstElement Fuel, Inc. and Black & Veatch surveyed the site to begin the site layout August 12, 2014. They generated initial engineering drawings October 16, 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 22, 2014, Clark Land Surveying performed a detailed engineering survey for the South San Francisco station site, as shown in Figure 2.

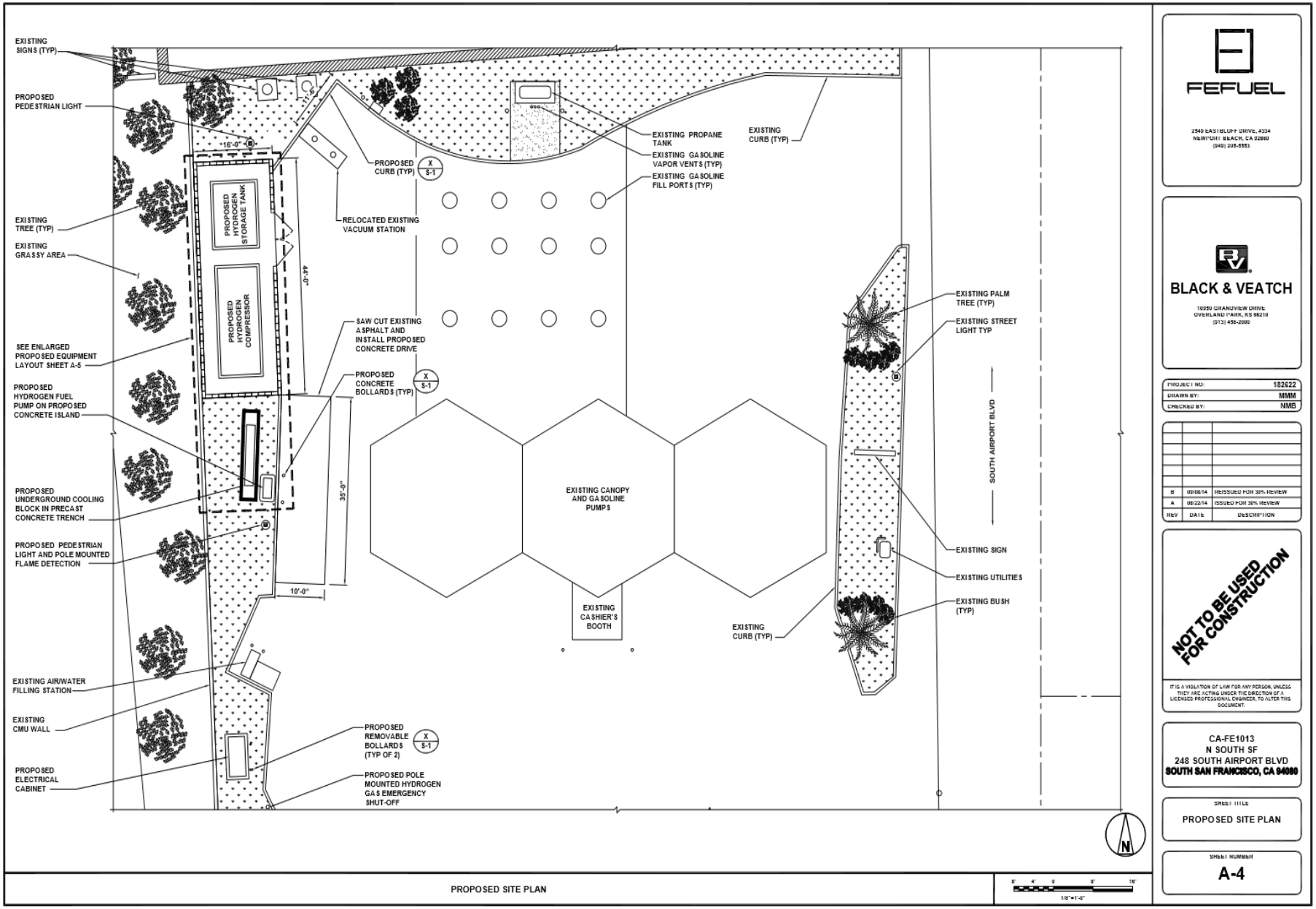
FirstElement Fuel, Inc. and Black & Veatch submitted the zoning application November 10, 2014. The local planning department must verify that the project meets the zoning requirements of the proposed location and approve any aesthetic, landscaping or other details that are important to the community. FirstElement Fuel, Inc. has found that many planning commissions want to minimize the visual impact of hydrogen stations. Surprisingly, South San Francisco had an opposite viewpoint. They wanted to draw attention to the new, clean technology. As a result, the design of the exterior compound walls is bold with an artistic graphic design. Approval was received through public hearing process January 20, 2015.

On November 14, 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.

Because the location of the equipment at the project site is close to the 101 freeway, special consideration was required to obtain the fire permit. The local jurisdiction required the wall of the equipment compound adjacent to the freeway to be a high-strength impact wall.

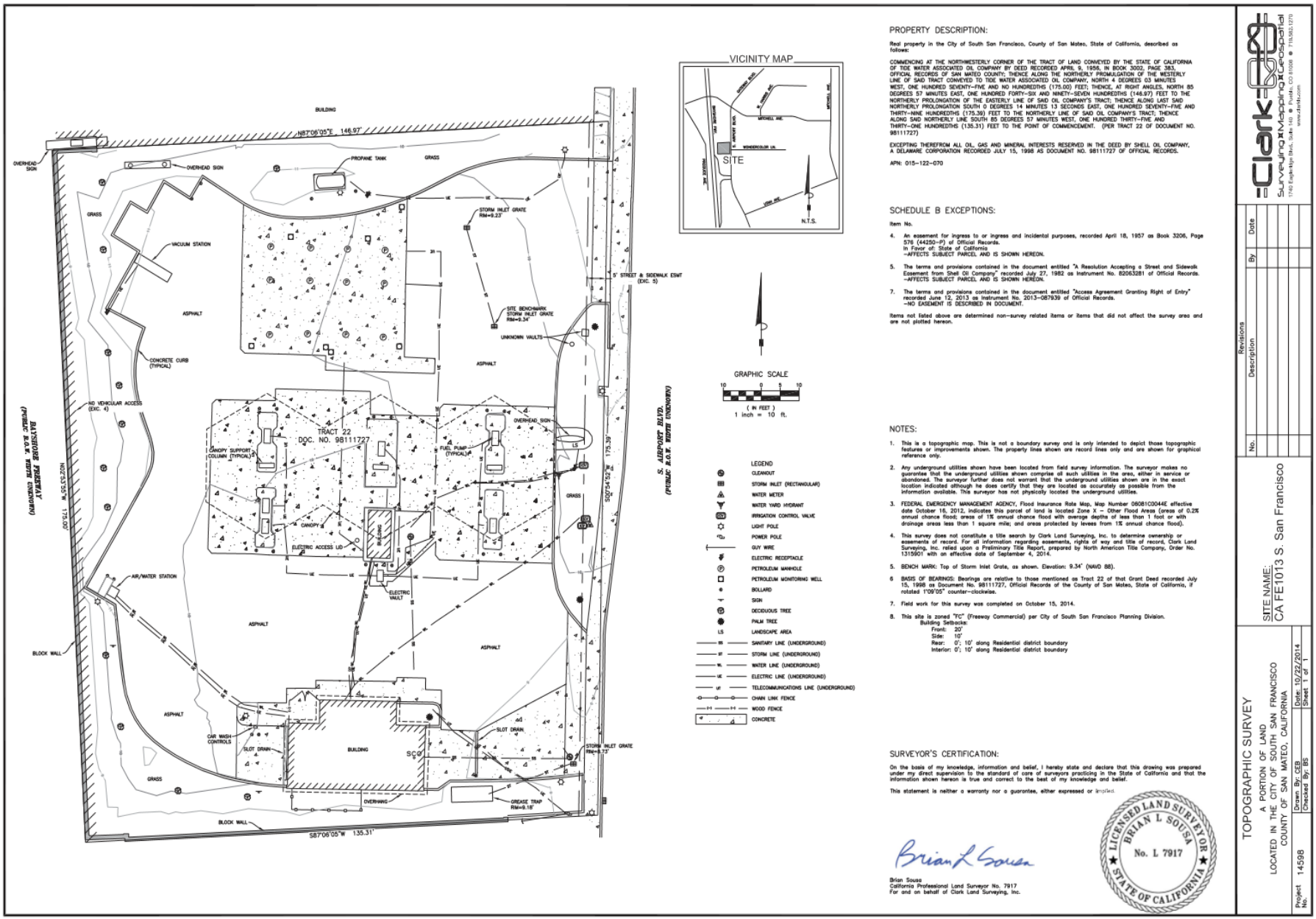
On January 23, 2015, draft final construction drawings (or "construction drawing 90s") were completed that depict all the details required for both construction and the permit review. Final construction drawings (or "construction drawing 100s") were completed, with 60 pages that depict all the minute details required for both construction and the permit review on February 19, 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 set is shown in Figure 4.

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



Source: FirstElement Fuel, Inc.

Figure 2: Survey of South San Francisco Hydrogen Station Location



PROPERTY DESCRIPTION:

Real property in the City of South San Francisco, County of San Mateo, State of California, described as follows:

COMMENCING AT THE NORTHWESTERLY CORNER OF THE TRACT OF LAND CONVEYED BY THE STATE OF CALIFORNIA OF TIDE WATER ASSOCIATED OIL COMPANY BY DEED RECORDED APRIL 9, 1956, IN BOOK 3002, PAGE 383, OFFICIAL RECORDS OF SAN MATEO COUNTY; THENCE ALONG THE NORTHERLY PROMULGATION OF THE WESTERLY LINE OF SAID TRACT CONVEYED TO TIDE WATER ASSOCIATED OIL COMPANY, NORTH 4 DEGREES 03 MINUTES WEST, ONE HUNDRED SEVENTY-FIVE AND NO HUNDREDTHS (175.00) FEET; THENCE, AT RIGHT ANGLES, NORTH 85 DEGREES 57 MINUTES EAST, ONE HUNDRED FORTY-SIX AND NINETY-SEVEN HUNDREDTHS (146.97) FEET TO THE NORTHERLY PROLONGATION OF THE EASTERLY LINE OF SAID OIL COMPANY'S TRACT; THENCE ALONG LAST SAID NORTHERLY PROLONGATION SOUTH 0 DEGREES 14 MINUTES 13 SECONDS EAST, ONE HUNDRED SEVENTY-FIVE AND THIRTY-NINE HUNDREDTHS (175.39) FEET TO THE NORTHERLY LINE OF SAID OIL COMPANY'S TRACT; THENCE ALONG SAID NORTHERLY LINE SOUTH 85 DEGREES 57 MINUTES WEST, ONE HUNDRED THIRTY-FIVE AND THIRTY-ONE HUNDREDTHS (135.31) FEET TO THE POINT OF COMMENCEMENT. (PER TRACT 22 OF DOCUMENT NO. 98111727)

EXCEPTING THEREFROM ALL OIL, GAS AND MINERAL INTERESTS RESERVED IN THE DEED BY SHELL OIL COMPANY, A DELAWARE CORPORATION RECORDED JULY 15, 1998 AS DOCUMENT NO. 98111727 OF OFFICIAL RECORDS.

APN: 015-122-070

SCHEDULE B EXCEPTIONS:

Item No.

4. An easement for ingress to or ingress and incidental purposes, recorded April 18, 1957 as Book 3206, Page 576 (44250-P) of Official Records.
In Favor of: State of California
-AFFECTS SUBJECT PARCEL AND IS SHOWN HEREON.

5. The terms and provisions contained in the document entitled "A Resolution Accepting a Street and Sidewalk Easement from Shell Oil Company" recorded July 27, 1982 as Instrument No. 82063281 of Official Records.
-AFFECTS SUBJECT PARCEL AND IS SHOWN HEREON.

7. The terms and provisions contained in the document entitled "Access Agreement Granting Right of Entry" recorded June 12, 2013 as Instrument No. 2013-087939 of Official Records.
-NO EASEMENT IS DESCRIBED IN DOCUMENT.

Items not listed above are determined non-survey related items or items that did not affect the survey area and are not plotted hereon.

NOTES:

1. This is a topographic map. This is not a boundary survey and is only intended to depict those topographic features or improvements shown. The property lines shown are record lines only and are shown for graphical reference only.
2. Any underground utilities shown have been located from field survey information. The surveyor makes no guarantee that the underground utilities shown comprise all such utilities in the area, either in service or abandoned. The surveyor further does not warrant that the underground utilities shown are in the exact location indicated although he does certify that they are located as accurately as possible from the information available. This surveyor has not physically located the underground utilities.
3. FEDERAL EMERGENCY MANAGEMENT AGENCY, Flood Insurance Rate Map, Map Number 06081C0044E effective date October 16, 2012, indicates this parcel of land is located Zone X – Other Flood Areas (areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood).
4. This survey does not constitute a title search by Clark Land Surveying, Inc. to determine ownership or easements of record. For all information regarding easements, rights of way and title of record, Clark Land Surveying, Inc. relied upon a Preliminary Title Report, prepared by North American Title Company, Order No. 1315901 with an effective date of September 4, 2014.
5. BENCH MARK: Top of Storm Inlet Grate, as shown. Elevation: 9.34' (NAVD 88).
6. BASIS OF BEARINGS: Bearings are relative to those mentioned as Tract 22 of that Grant Deed recorded July 15, 1998 as Document No. 98111727, Official Records of the County of San Mateo, State of California, if rotated 1°09'05" counter-clockwise.
7. Field work for this survey was completed on October 15, 2014.
8. This site is zoned "FC" (Freeway Commercial) per City of South San Francisco Planning Division.
Building Setbacks:
Front: 20'
Side: 10'
Rear: 0'; 10' along Residential district boundary
Interior: 0'; 10' along Residential district boundary

SURVEYOR'S CERTIFICATION:

On the basis of my knowledge, information and belief, I hereby state and declare that this drawing was prepared under my direct supervision to the standard of care of surveyors practicing in the State of California and that the information shown hereon is true and correct to the best of my knowledge and belief.

This statement is neither a warranty nor a guarantee, either expressed or implied.

Brian L Sousa

Brian Sousa
California Professional Land Surveyor No. 7917
For and on behalf of Clark Land Surveying, Inc.

LICENSED LAND SURVEYOR BRIAN L. SOUSA No. L 7917 STATE OF CALIFORNIA

Clark Land Surveying & Geospatial
1740 Eagle Mtn. Blvd., Suite 140 • Pueblo, CO 81008 • 719.583.1270
www.clarkls.com

No.	Description	By	Date
	Revisions		

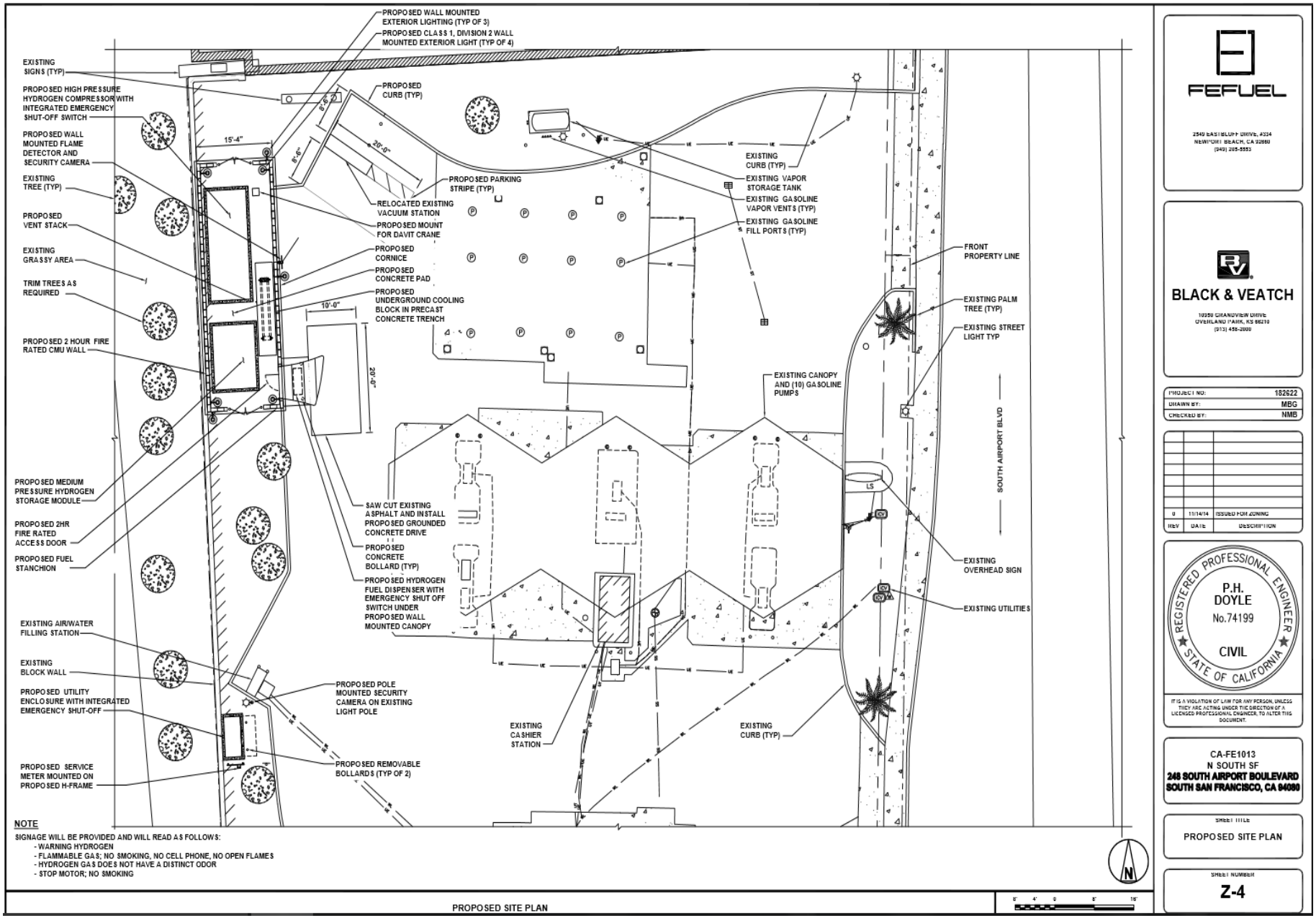
SITE NAME:
CA FE1013 S. San Francisco

TOPOGRAPHIC SURVEY
A PORTION OF LAND
LOCATED IN THE CITY OF SOUTH SAN FRANCISCO
COUNTY OF SAN MATEO, CALIFORNIA

Project No.	Drawn By: CEB	Date: 10/22/2014
14598	Checked By: BS	Sheet 1 of 1

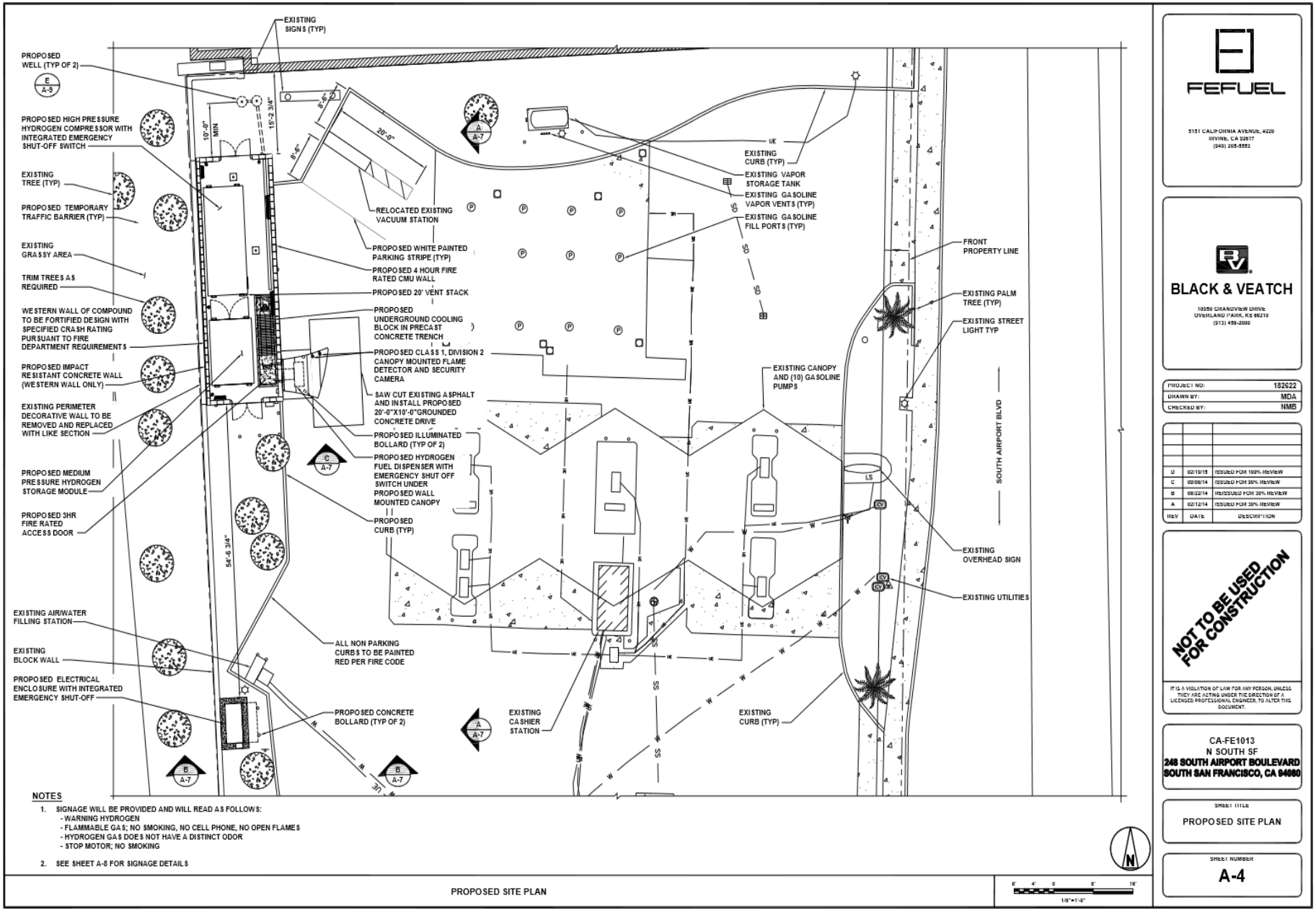
Source: FirstElement Fuel, Inc.

Figure 3: Equipment Compound from Zoning Drawing Set



Source: FirstElement Fuel, Inc.

Figure 4: Equipment Compound from Construction Drawing 100 Set



Source: FirstElement Fuel, Inc.

All building permit applications were submitted on February 10, 2015, and approved on May 1, 2015.

FirstElement Fuel, Inc. and Black & Veatch submitted a detailed bid package to nearly 20 contractors on May 19, 2015. The contract was awarded to Aliantel, Inc. on May 21, 2015. The bulk of Aliantel, Inc.'s construction experience is 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, Inc. provided a reasonable bid, had a desire to get involved with hydrogen projects, and had a willingness to work in Northern California. Construction started June 1, 2015. Figure 5 shows the equipment compound before completion.

Figure 5: Station Equipment Compound Before Completion

Source: FirstElement Fuel, Inc.

Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site September 10, 2015, as shown in Figure 6. Construction was completed October 9, 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 6: Crane Lifting Hydrogen Ground Storage Unit

Source: FirstElement Fuel, Inc.

Commissioning Process (October 8, 2015 – October 22, 2015)

The commissioning of the South San Francisco hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling.

Figure 7: Generator and FirstElement Fuel, Inc. Team During Commissioning

Source: FirstElement Fuel, Inc.

Station Declared Operational (October 30, 2015)

The South San Francisco 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 station's storage tubes with pressurized hydrogen gas, successfully passing a hydrogen quality test (Figure 8), successfully fueling one FCEV with hydrogen, and opening to the public. FirstElement Fuel, Inc. declared the station operational on October 30, 2015.

Figure 8: Hydrogen Fuel Quality Report on October 18, 2015

www.SmartChemistry.com

SAE J2719 Report

FIRST ELEMENT
SOUTH SAN
FRACISCO H70 H_2

@Nozzle sampled on 10/18/2015

	SAE J2719 Limits (µmol/mol)	Smart Chemistry Detection Limits (µmol/mol)	Concentration (µmol/mol)	Analytical Method
Water	5	0.2	**2.64**	ASTM D7649
Total Hydrocarbons (C_1 Basis)	2	1	**0.060**	ASTM D7892
Methane		0.001	0.055	
Acetone			0.0054	
Oxygen	5	1	< 1	ASTM D7649
Helium	300	10	< 10	ASTM D1946
Nitrogen, Argon	100			
Nitrogen		5	< 5	ASTM D7649
Argon		0.5	< 0.5	ASTM D7649
Carbon Dioxide	2	0.5	< 0.5	ASTM D7649
Carbon Monoxide	0.2	0.0005	**0.0093**	ASTM D5466
Total Sulfur	0.004	0.000001	**0.000019**	ASTM D7652
Hydrogen Sulfide		0.000001	0.0000134	ASTM D7652
Carbonyl Sulfide		0.000001	0.0000053	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		0.00001	< 0.00001	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	0.015	< 0.015	ASTM D5466
Ammonia	0.1	0.01	< 0.01	ASTM D5466
Total halogenates	0.05		**0.011**	
Chlorine		0.001	< 0.001	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	0.011	ASTM D7892
Tetrachloro-hexafluorobutanes			0.011	
Particulate Concentration (Particulate Concentration Calculation Sheet is listed in Table II)	1mg/Kg		**0.022 mg/kg**	ASTM D7651
Particulates Found & Size (Images of particulates found is in Table 1)			**Two particulates with sizes of 0.51 and 0.19 mm found.**	ASTM D7634
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 3.6 of SAE J2719)			**99.99973%**	

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

Source: FirstElement Fuel, Inc.

Automaker testing was performed at the South San Francisco hydrogen station to verify correct operation per *SAE J2601 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles.*

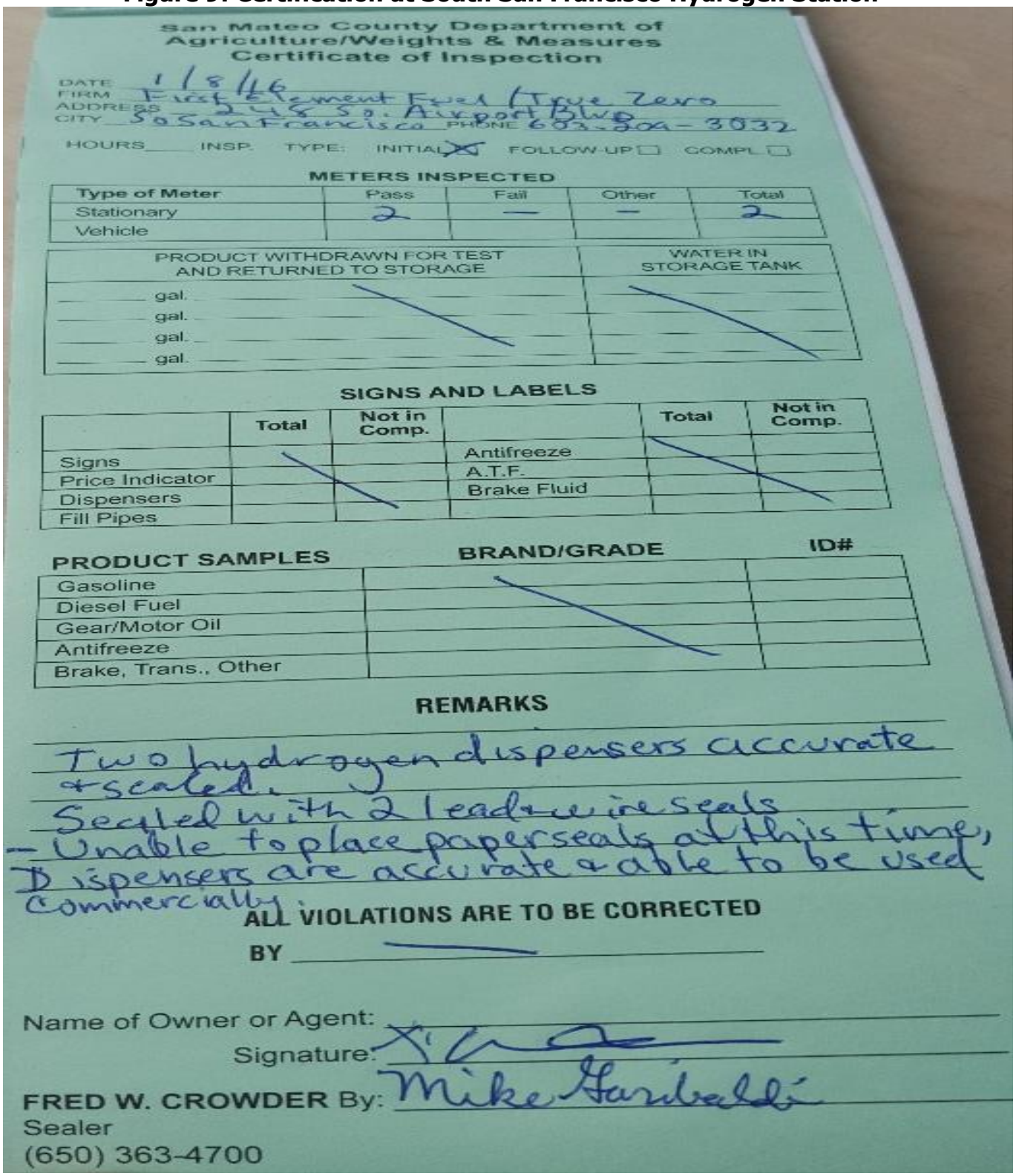
Certification (January 8, 2016)

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 Fuels, Inc. achieved certification by acting as the Registered Service Agent, dispensing a measured amount of fuel, and confirming the quantity dispensed is accurately reflected by the dispenser in accordance with examination procedures (EPO NO. 40-A) as witnessed by the local county weights and measures officer.1

1 EPO NO.40-A (https://www.cdfa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf)

Figure 9: Certification at South San Francisco Hydrogen Station



San Mateo County Department of Agriculture/Weights & Measures
Certificate of Inspection

DATE 1/8/16
FIRM FirstElement Fuel (True Zero
ADDRESS 248 So. Airport Blvd
CITY So San Francisco PHONE 603-804-3032

HOURS ____ INSP. TYPE: INITIAL X FOLLOW-UP ☐ COMPL ☐

METERS INSPECTED

Type of Meter	Pass	Fail	Other	Total
Stationary	2	—	—	2
Vehicle				

PRODUCT WITHDRAWN FOR TEST AND RETURNED TO STORAGE	WATER IN STORAGE TANK
____ gal.	
____ gal.	
____ gal.	
____ gal.	

SIGNS AND LABELS

	Total	Not in Comp.		Total	Not in Comp.
Signs			Antifreeze		
Price Indicator			A.T.F.		
Dispensers			Brake Fluid		
Fill Pipes					

PRODUCT SAMPLES	BRAND/GRADE	ID#
Gasoline		
Diesel Fuel		
Gear/Motor Oil		
Antifreeze		
Brake, Trans., Other		

REMARKS

Two hydrogen dispensers accurate & sealed.
Sealed with 2 lead wire seals
- Unable to place paper seals at this time,
Dispensers are accurate & able to be used Commercially

ALL VIOLATIONS ARE TO BE CORRECTED BY ____

Name of Owner or Agent:
Signature: [signature]

FRED W. CROWDER By: Mike Garibaldi
Sealer
(650) 363-4700

Source: FirstElement Fuel, Inc.

Station Use (October 29, 2015-Present)

Figure 10 shows the first vehicle filled was a Hyundai Tucson on October 29, 2015, and the station became open retail on February 12, 2016. The South San Francisco station dispensed

13 kilograms of hydrogen in November 2015. Sales in December 2015 were 34.6 kilograms, 137.5 kilograms in January 2016, and 92.6 kilograms in February 2016.

Figure 10: First Vehicle Filled on October 29, 2015

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 refueling station status for motorist use.[2] This system is important to FCEV drivers during the development phase of the hydrogen refueling station network because it lets drivers know that the hydrogen station they intend to use is selling fuel before they depart. The San Jose hydrogen station began sending automated updates (FirstElement Fuel, Inc. software) on a regular basis, to the Station Operational Status System on February 12, 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 CEC, 33.3 percent of the hydrogen sold at the South San Francisco hydrogen station will be produced from renewable sources including biogas. Hydrogen is non-toxic, colorless, and odorless so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in case a leak ever occurs. No solid or liquid waste will be produced at this site.

Minimal water was consumed for this project. There was no additional landscaping added for the construction of the hydrogen refueling station, and, therefore, no additional irrigation water will be consumed.

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.

2 Station Operational Status System website (https://m.cafcp.org/)

South San Francisco Station in the Network

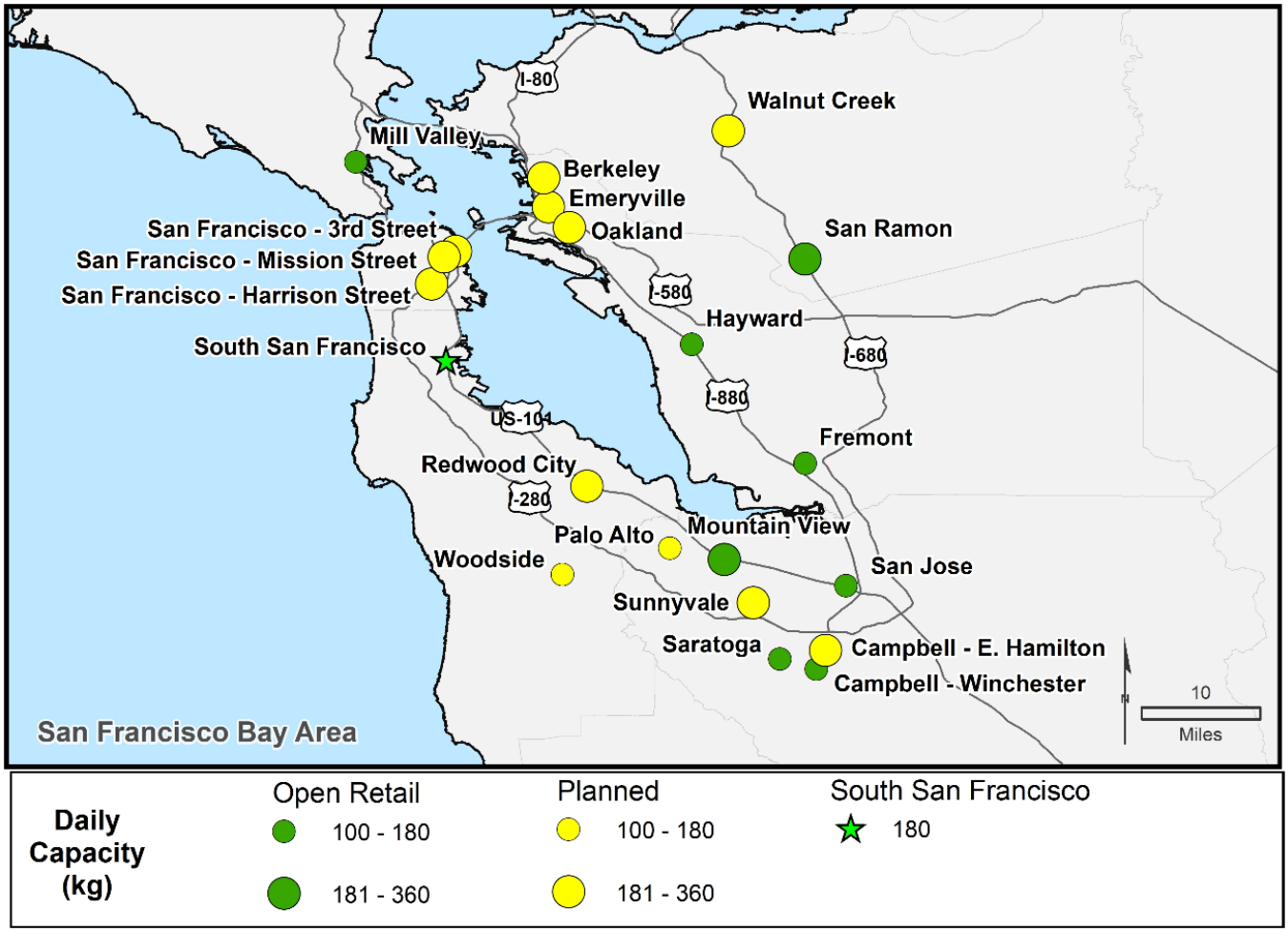
Figure 11 shows the station is open and ready for use.

Figure 11: South San Francisco Hydrogen Station

Source: FirstElement Fuel, Inc.

Figure 12 shows the greater San Francisco area and indicates where the South San Francisco station is situated in relationship to other facilities in the northern part of the state.

Figure 12: San Francisco Area Hydrogen Stations: Open Retail and Planned

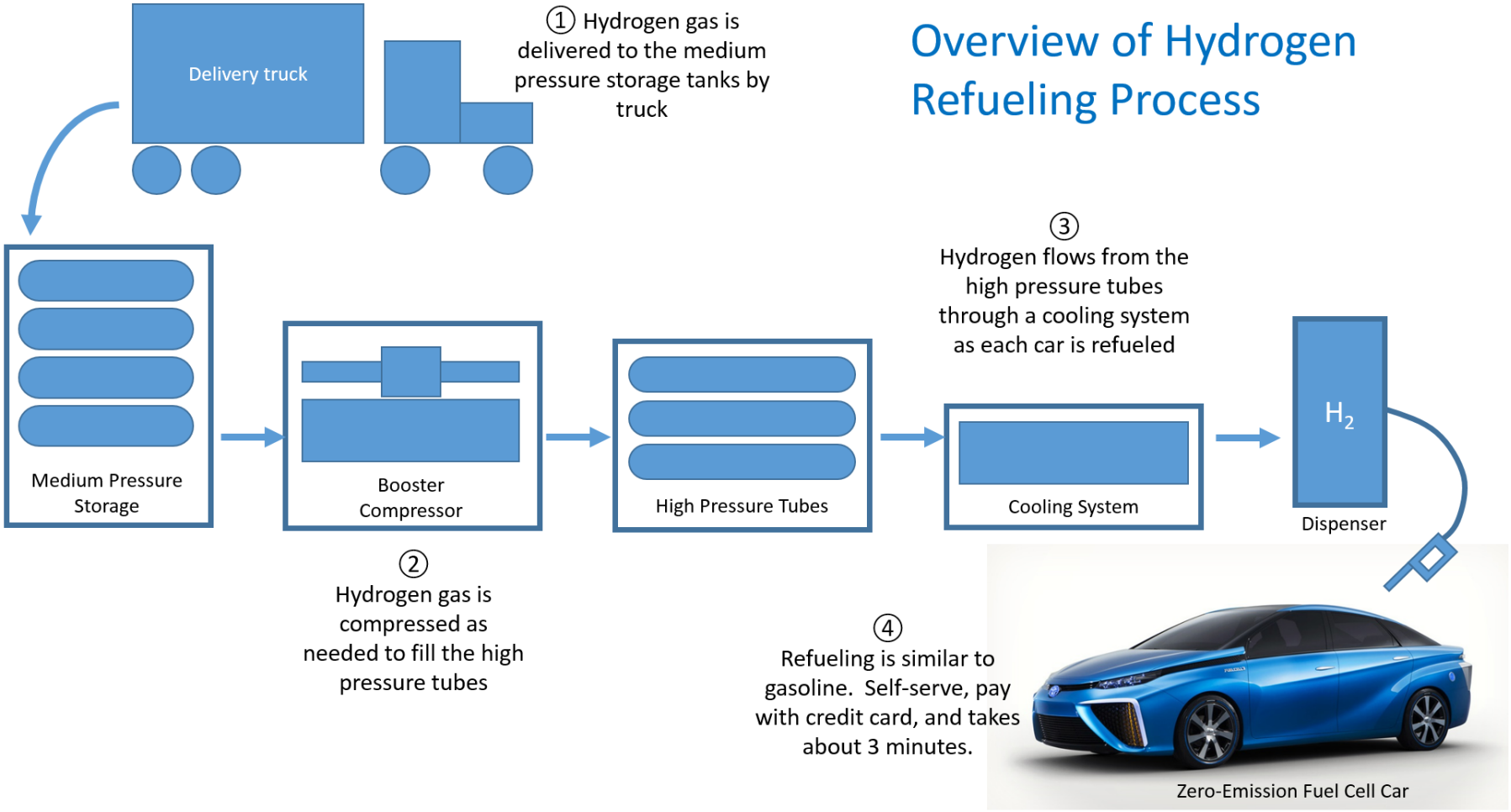


Source: CEC Staff.

Schematic Layout of the South San Francisco Station

Figure 13 depicts an overview of the South San Francisco hydrogen station components and the steps in the refueling process.

Figure 13: Schematic Depicting Hydrogen Station Equipment and Refueling Process

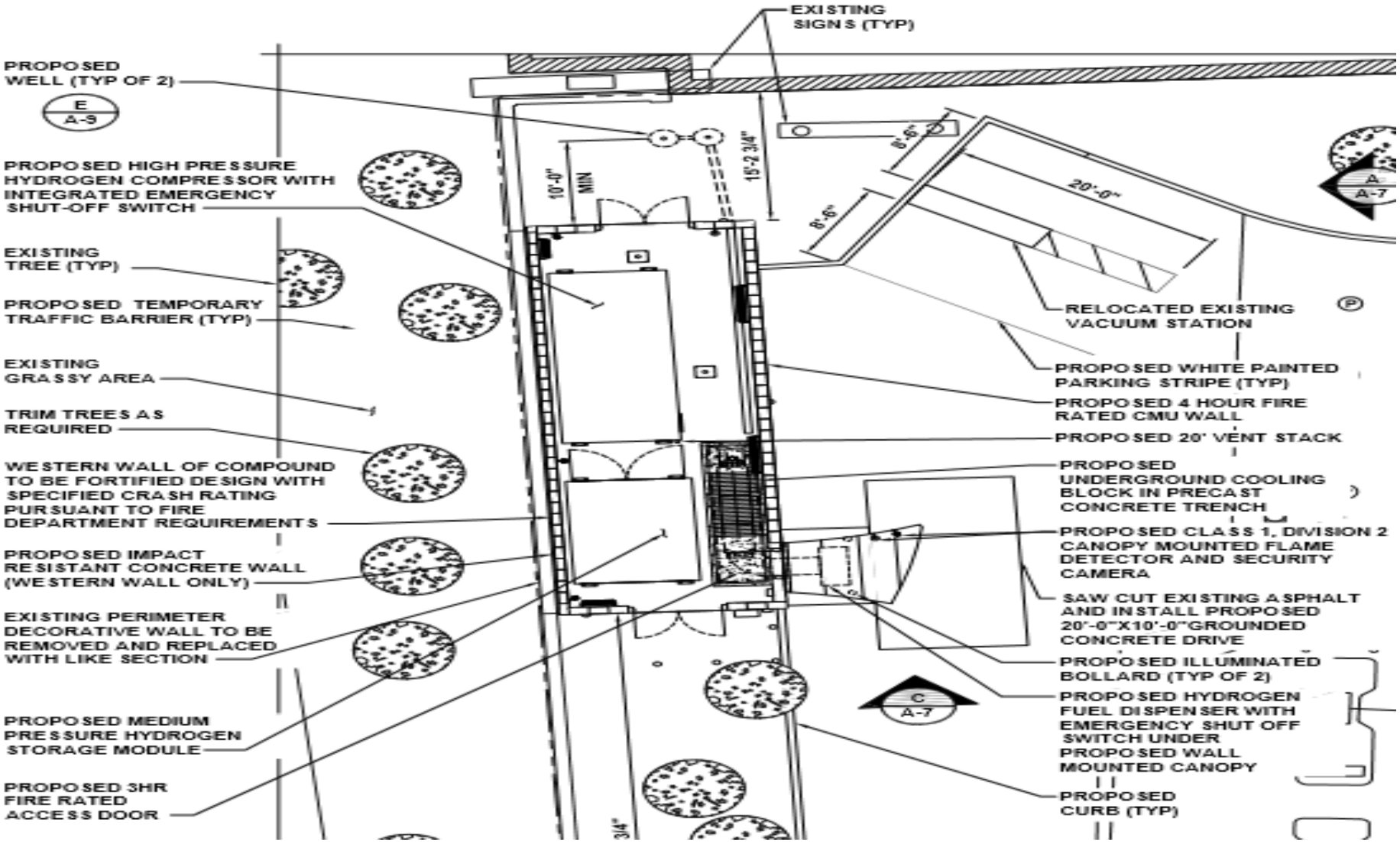


Source: FirstElement Fuel, Inc.

Final Configuration and Budget

Figure 14 shows a detailed view of the actual final, as-built configuration of the South San Francisco station.

Figure 14: Enlarged View of Final South San Francisco Layout



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

Figure 15 shows a detailed view of the budget to construct the South San Francisco hydrogen station.

Figure 15: The Project Grant Funding and Match Funding

Air Products and Chemicals, Inc., Allentown , PA	
H2 station equipment	$1,479,873.57
Black & Veatch, Overland Park, KS	
Construction	$540,351.21
Engineering	$63,505.60
Permitting	$22,229.08
Project Management	$18,197.53
Various Vendors	
Construction Materials (tubing, wire, etc.)	$30,252.04
Fixtures (doors, lights, etc.)	$79,159.81
MSI Tech, Irvine CA	
Data Collection Tool	$3,416.87
Karen Calhoun, Newport Beach, CA	
Legal services	$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	$4,345.13
Total Project Costs	$2,254,480.87
CEC Grant	$1,451,000.00
Remaining match funding provided by FirstElement Fuel, Inc.	$803,480.87
Total CEC cost share	64.4%

Source: FirstElement Fuel, Inc.

CHAPTER 2: Energy Analysis

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

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

Per California Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006), Environmental Standards for Hydrogen Production, at least one-third of the hydrogen dispensed shall be produced from renewable sources. Hydrogen is supplied to the hydrogen fueling stations from Air Products and Chemicals, Inc.'s 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 PON-13-607 and the 33.3 percent renewable hydrogen requirements of Senate Bill 1505 as shown in Table 1. Renewable hydrogen at 100 percent is achievable through the same supply pathway, however typically at a higher cost.

Table 1: 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 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 16. Although California has a substantial amount of biogas, local supply cannot be injected into California pipelines under California Health and Safety Cost Section 25420. Air Products and Chemicals, Inc.'s biogas supply for this project is being sourced outside California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council region that delivers gas into California.3

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

Figure 16: 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.

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

The South San Francisco hydrogen station can dispense 180 kilograms/day, or 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. Assuming that FCEVs average 52 mile/kilograms (taken from *Greenhouse Gases, Regulated*

Emissions, and Energy Use in Transportation Model),4 and consumption of 180 kilograms/day for the next 10 years, the station will offset 8,384 metric tons of total Greenhouse gas compared to the equivalent usage of gasoline vehicles. Furthermore, the South San Francisco hydrogen station will eliminate more than 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon.5

As part of a separate grant agreement for operations and maintenance funding through the CEC (ARV-15-022), data on the operation of the station will be collected and reported quarterly for three years (December 16, 2015 to October 31, 2018). Data collected and reported will include the fuel log, dispensing, compression, storage and delivery, maintenance, and other monthly operating costs such as rent, electricity, property tax, and license and permit fees.

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

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

CHAPTER 3: Future Activities

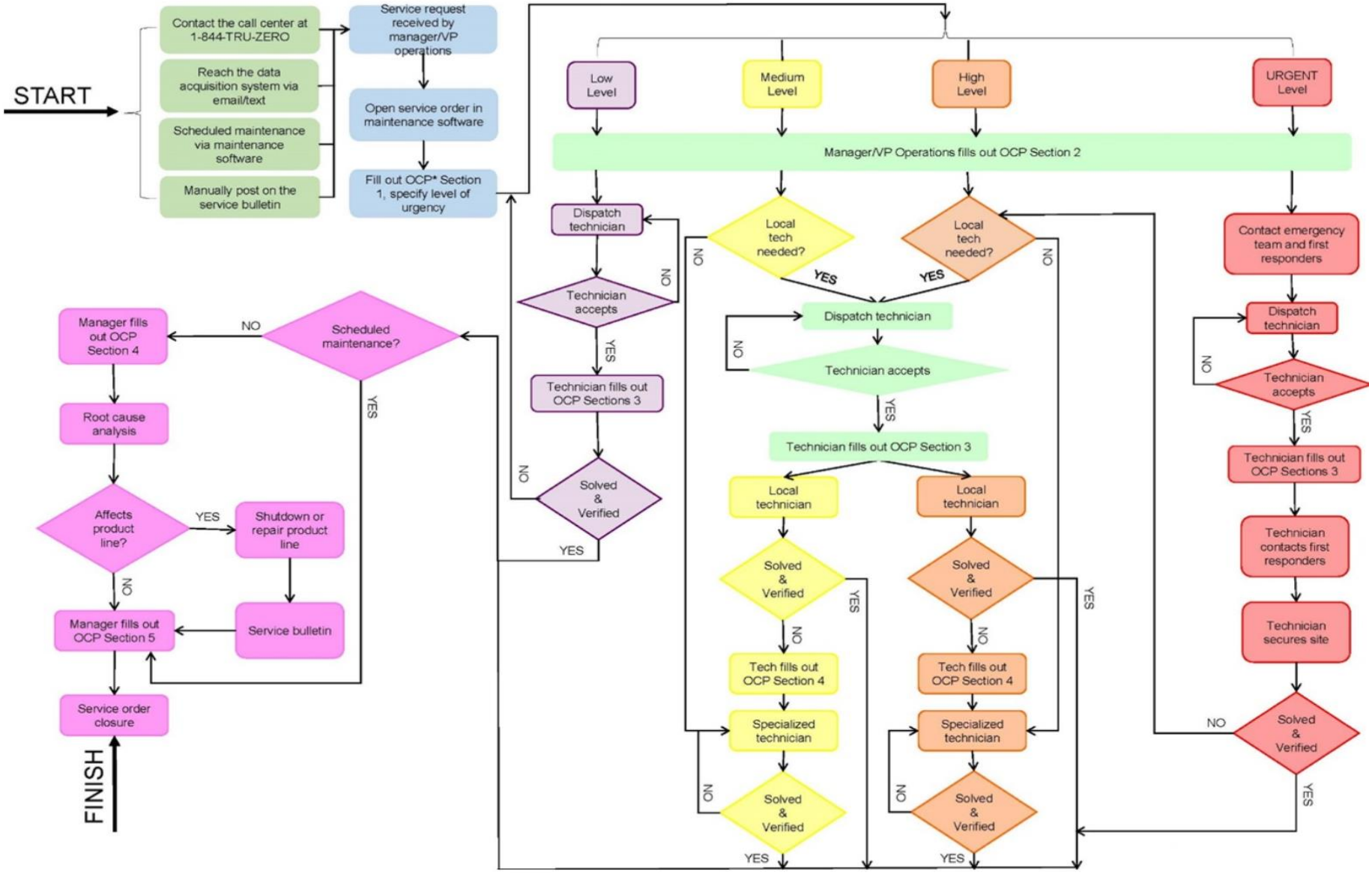
FirstElement Fuel, Inc. intends to own and operate the South San Francisco refueling station for at least 10 years. FirstElement Fuel, Inc. has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement Fuel, Inc. has executed 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 resources to maintain and repair any of our stations as quickly as possible throughout California. Figure 17 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 18 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 per day.

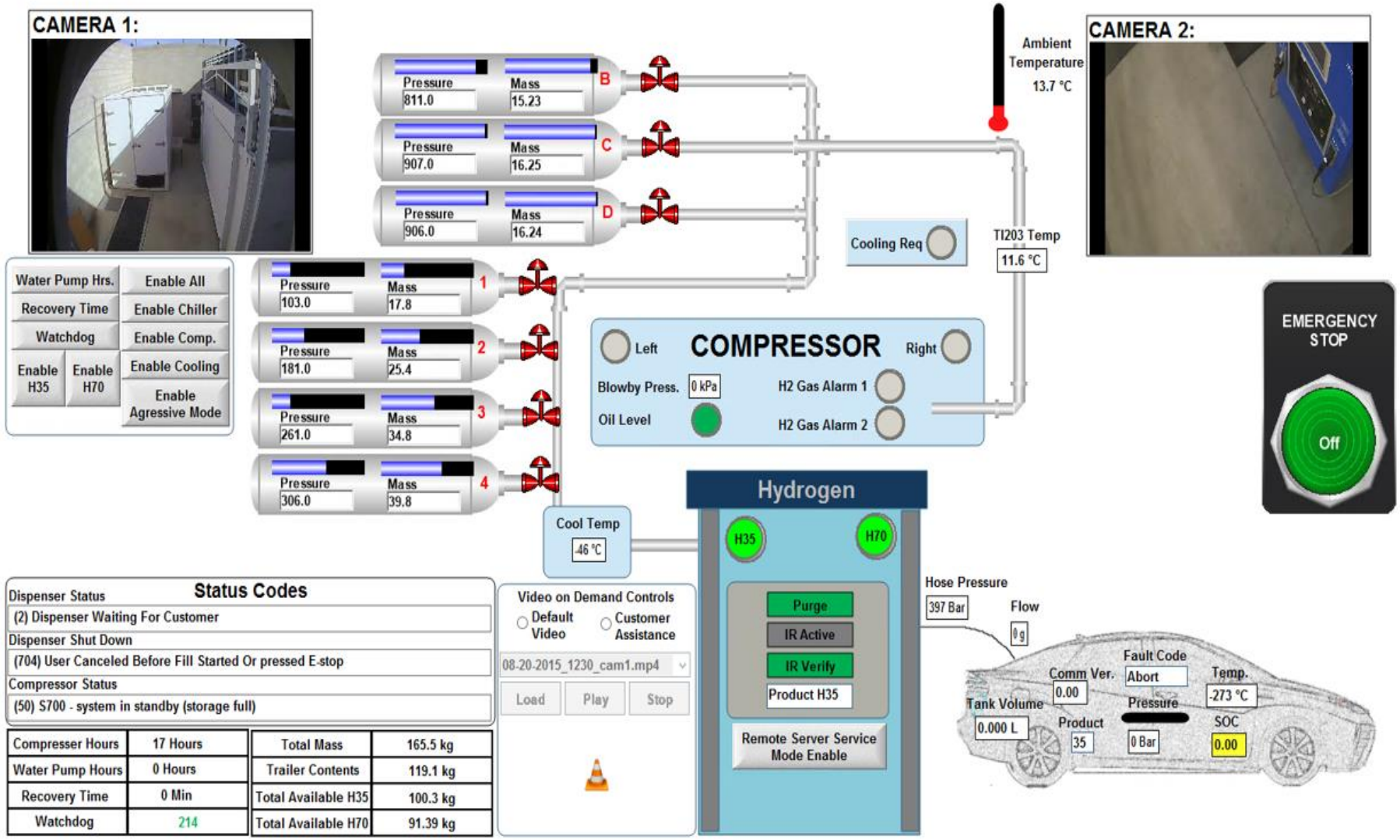
In addition to remote monitoring, FirstElement Fuel, Inc. has implemented rigorous computerized maintenance management systems and enterprise asset management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and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

Figure 17: FirstElement Fuel, Inc. Response Flow Chart



Source: FirstElement Fuel, Inc.

Figure 18: Screenshot of FirstElement Fuel, Inc.'s Remote Monitoring System



Source: FirstElement Fuel, Inc.

CHAPTER 4: Conclusions

The following considers findings from the 33 percent renewable hydrogen South San Francisco hydrogen refueling station project.

Because the location of the equipment at the project site is close to the 101 freeway, special consideration was required to obtain the fire permit. The local jurisdiction required the wall of the equipment compound adjacent to the freeway to be a high-strength impact wall.

FirstElement Fuel, Inc. has found that many planning commissions want to minimize the visual impact of hydrogen stations. South San Francisco had an opposite viewpoint. They wanted to draw attention to the new, clean technology. As a result, the design of the exterior compound walls is bold with an artistic graphic design.

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

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

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

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

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

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

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