H2A Delivery: GH2 and LH2 Forecourt Land Areas

Hydrogen Delivery Analysis Meeting
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Matthew Hooks
hooks.matthew@TIAXLLC.com

TIAX LLC
1601 S. D Anza Blvd.
Cupertino CA, 95014
Tel. 408-517-1550
Reference: D0348

General Assumptions

- **Forecourt stations with fewer than 6 hydrogen dispensers will have both hydrogen and gasoline dispensers on-site (6 total)**
  - Forecourt area (not including convenience store) will be allocated based on relative number of hydrogen/gasoline dispensers
- **All stations with more than 6 hydrogen dispensers will only dispense hydrogen**
  - 100% of forecourt area (not including convenience store) will be allocated to hydrogen delivery
- **Area allocated to hydrogen storage will be in excess of the baseline gasoline station area (not including setback distances)**
- **All stations will maintain a rectangular footprint**
- **Appropriate setback distances are maintained in all scenarios**

Primary Variables

- **Dispensers**
  - Number of dispensers calculated based on daily average demand
  - For small stations (≤ 6 dispensers), area is allocated per dispenser
  - For large stations (> 6 dispensers), area is allocated per fueling island for dispensers in excess of 6
- **Storage**
  - Storage requirements are determined based on the average daily demand
  - Overall storage requirement yields the number of required storage vessels, having known length and width
- **Setback Distances**
  - Setback distances depend on hydrogen type (compressed or liquid), quantity stored and surroundings

Setback Distances

- **Setback distances specified by NFPA 55**

- **Compressed Hydrogen**
  - Wall Opening: 25 ft.
  - Parked Vehicle: 15 ft.
  - Lot Line: 5 ft.

- **Liquid Hydrogen**
  - Operable Wall Opening: 75ft.
  - Public Way: 50 ft.
  - Lot Line: 50 ft.

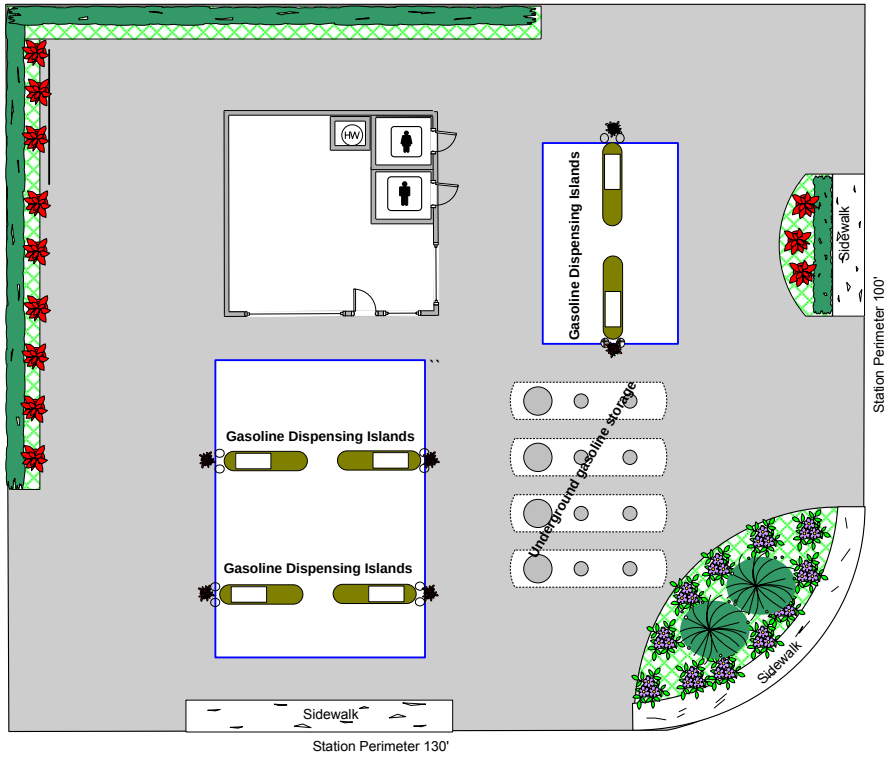
- **The large setback distances associated with LH2 have significant impact on overall land area requirements at the forecourt**

Example of Model Structure

Average Daily Demand	kg/day	300	500	1000	1500
Storage Factor		0.18	0.18	0.18	0.18
Storage Required	kg	54	90	180	270
Storage per Vessel	kg	21.3	21.3	21.3	21.3
Vessel Diameter	in	16	16	16	16
Vessel Length	ft	30	30	30	30
Extra Radius	in	2	2	2	2
Stacked Vessels		6	6	6	6
Cascade Levels		3	3	3	3
Effective Diameter	in	20	20	20	20
Cascade Vessel Groups		1	2	3	5
Total Cascade Vessels		3	6	9	15
# Cascade Vessel Stacks		1	2	2	3
LP Storage Requirement	kg	90	150	300	450
LP Vessel Capacity	kg	300	300	300	300
LP Vessel Width	ft	4	4	4	4
LP Vessel Length	ft	25	25	25	25
Storage Vessel per Stack		2	2	2	2
LP Vessels Required		1	1	1	2
# LP Vessel Stacks		1	1	1	1
Storage Width	m	1.73	2.24	2.24	2.74
Storage Length	m	9.14	9.14	9.14	9.14
Storage Area (no set)	m^2	15.79	20.44	20.44	25.08
Increase Width of Entire Station	Y / N	Y	Y	Y	Y
Station Length	ft	100	100	100	100
Initial Setback from Wall Opening	ft	49	49	49	49
Setback: Wall Opening	ft	25	25	25	25
Setback: Lot Line	ft	5	5	5	5
Setback: Parked Car	ft	15	15	15	15
Setback A (width)	ft	0	0	0	0
Setback B (width)	ft	5	5	5	5
Setback C (length)	ft	5	5	5	5
Setback D (length)	ft	15	15	15	15
Total Storage Width	m	3.3	3.8	3.8	4.3
Total Storage Length	m	30.5	30.5	30.5	30.5
Total Storage Area	**m^2**	**99**	**115**	**115**	**130**
Dispensers		1	1	2	3
Baseline Area (6 dispensers)	m^2	1112	1112	1112	1112
Baseline Dispensers		6	6	6	6
Area per Additional Disp. Island	m^2	186	186	186	186
Total Dispensing Area	**m^2**	**185**	**185**	**371**	**556**
TOTAL FORECOURT AREA	**m^2**	**284**	**300**	**485**	**686**

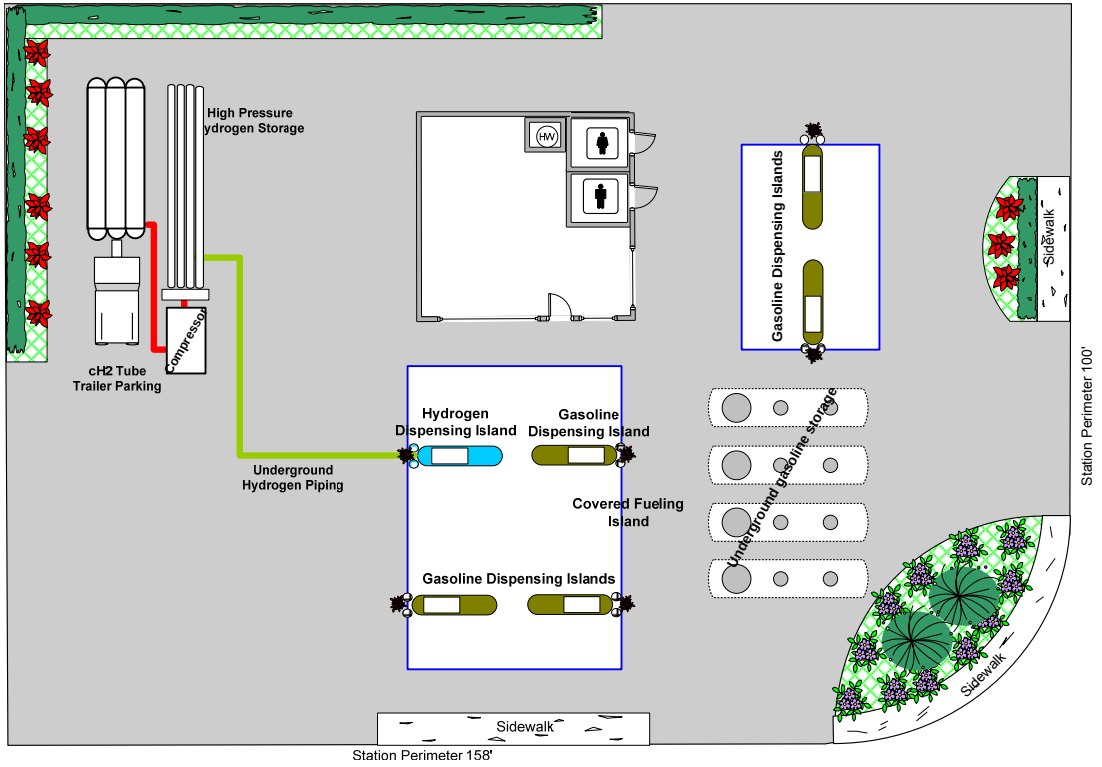
- **Model structure accepts various storage vessel dimensions**
  - Results reflect dimensions from Bruce Kelly, Nexant
- **Pipeline case (shown) also includes area for low-pressure storage**
- **Accepts various setback distances**
- **Allows user to decide if the station should add area or expand as a rectangular footprint**

Gasoline Baseline



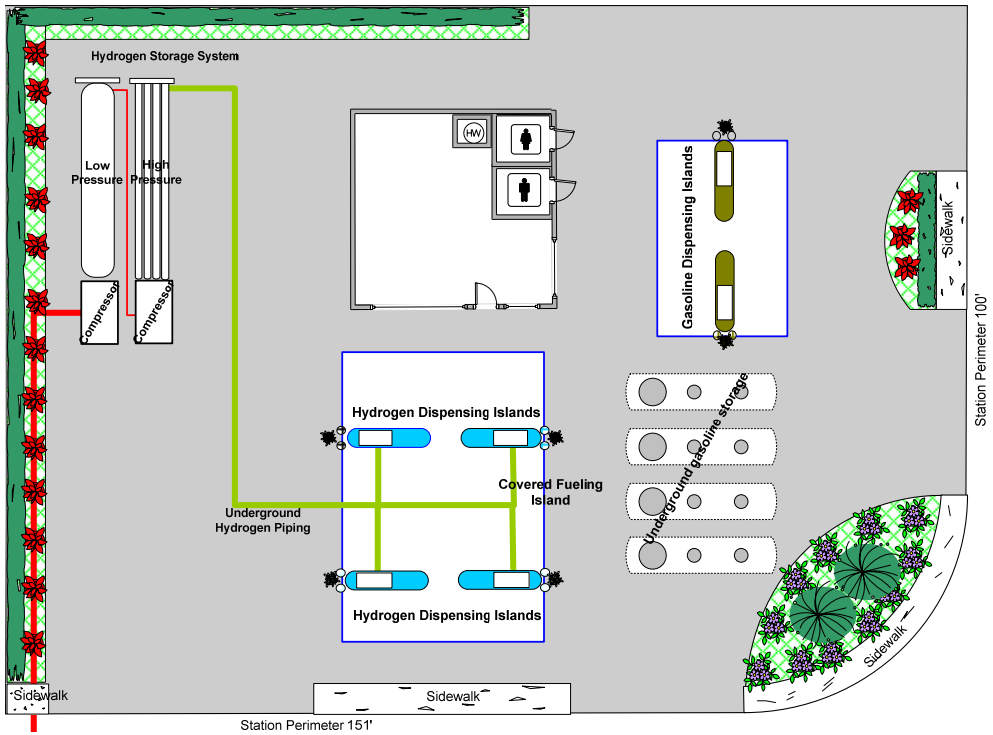
- **The gasoline baseline is a 6 dispenser station with a small convenience store**
- **Convenience store area is not allocated to fuel distribution**

Tube Trailer Delivery



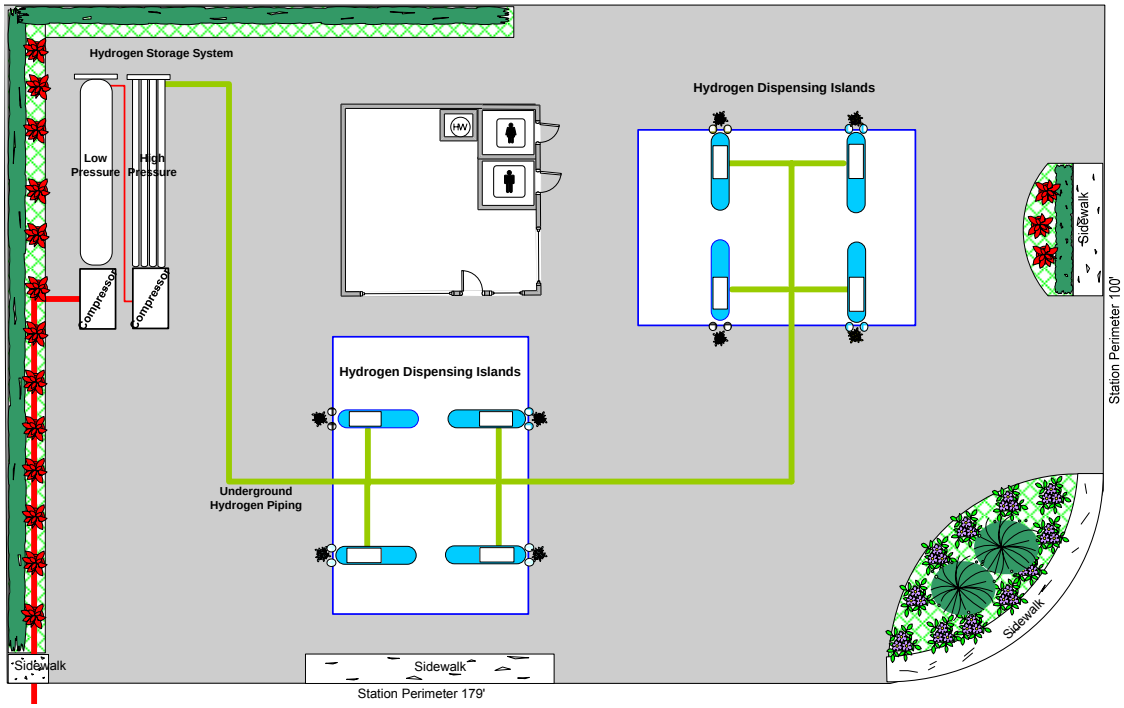
- **Space (10') is allocated on either side of cascade storage tanks to allow for easy pickup & drop-off of tube trailers**

Pipeline Delivery



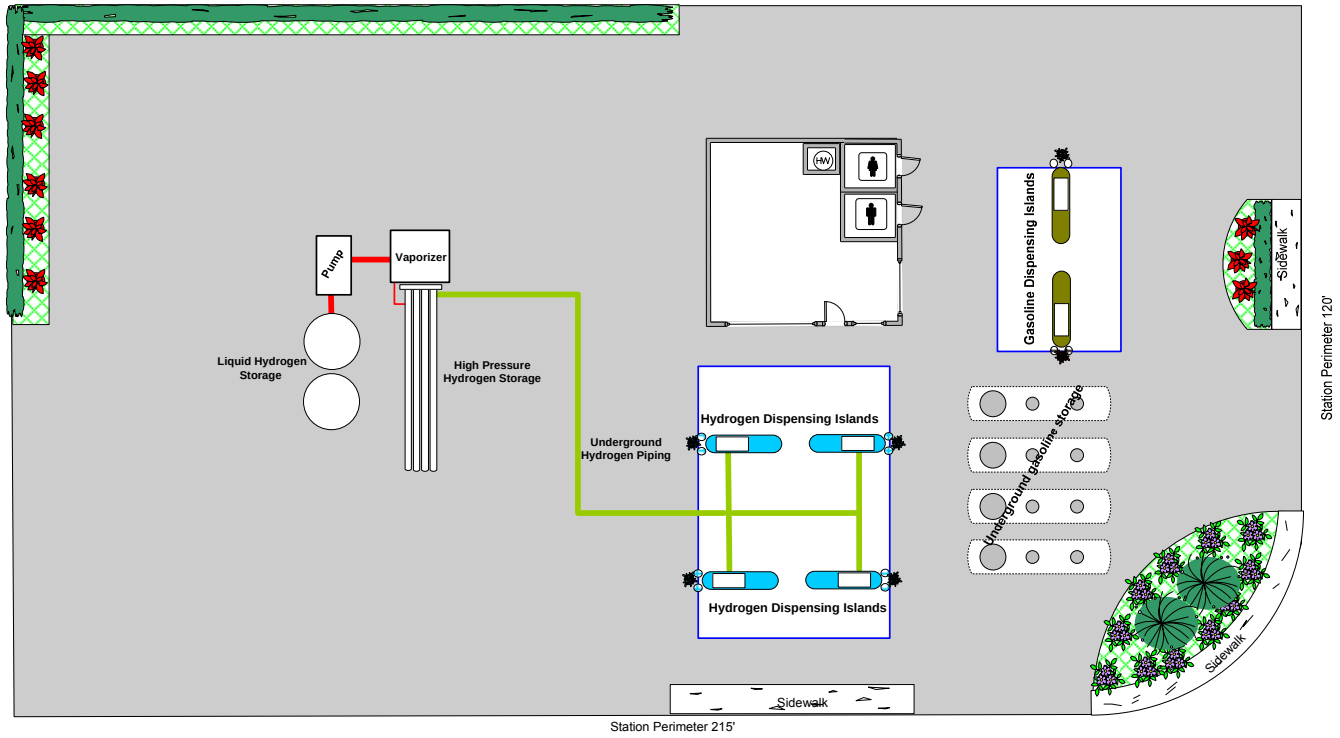
- **There is no requirement for space surrounding the hydrogen storage for vehicle access**
- **Pipeline stations may have more dispensers than tube trailer and liquid stations that are limited by truck capacity**

High-Throughput Pipeline Delivery



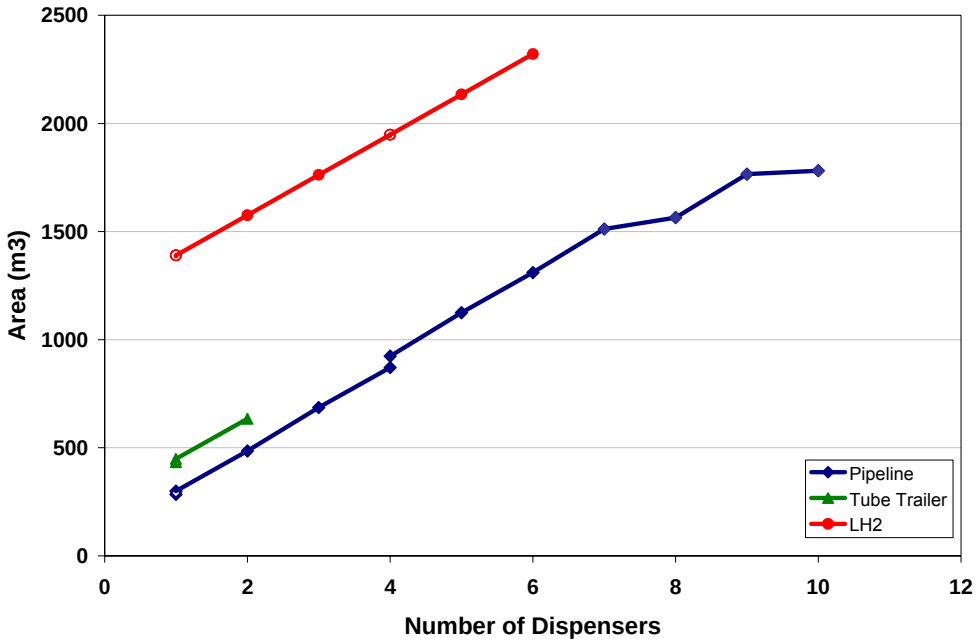
- **Stations with 6+ hydrogen dispensers are designed to distribute hydrogen exclusively**
- **Dispensers in excess of 6 are added to the station in groups of two, causing large forecourts to have 6, 8 or 10 dispensers.**

Liquid Delivery



- **The setback distances are large enough to assume that additional area for truck access does not need to be included**
- **The setback distances are in excess of the baseline station length, therefore the plot is larger in both dimensions**

Forecourt Land Requirements



- **Liquid forecourts require significantly more area as a result of large setback distances**
- **Tube trailers can only serve low demand and require additional area for trailer access and egress**
- **Pipeline step function a result of adding fueling islands for larger stations**