K2 Engineering, Inc.
43995 FALMOUTH CT • ASHBURN • VIRGINIA • 20147

FIRE PROTECTION SYSTEMS NARRATIVE
780 CMR – 902.1.1

To: Aine Naughton
McMahon Architects

From: Adam R. Kovach, PE, LEED AP BD & C

Date: October 14, 2022

Subject: Tatte Bakery
645 Massachusetts Avenue
Arlington, MA 02476
K2 Project № 0721-18

(1.a) BASIS (METHODOLOGY) OF DESIGN

Section 1 – Building Description

1. Building use group is a two story mixed use building with roof directly above the second floor.
2. Construction type is a mixed of non-combustible and combustible materials.
3. Site access for Emergency Vehicles – Via Massachusetts Avenue.

Section 2 – Applicable Laws, Regulations and Standards

The following Laws, Regulations and Standards were reviewed in preparation of the fire protection and fire alarm system plans and specifications for this facility:

a) 780 CMR, 9th Edition code sections "Fire Alarm and Fire Protection System Requirements".
b) NFPA Standards for the design of fire alarm and fire protection systems.
   - NFPA 13 – *Installation of Sprinkler Systems* - 2015 edition
   - NFPA 72 – *National Fire Alarm Code* – 2015 edition
   - NFPA 241 – *Standard for Safeguarding Construction, Alteration, and Demolition Operations*- 2015 edition
c) The applicability of Sections M.G.L., Chapter 148, "Fire Protection".
d) The applicability of Section of 527 CMR "Fire Prevention Regulations" and NFPA 1, 2015 Edition.
e) The applicability of local by-laws and ordinances.
f) The applicability of Federal Laws (OSHA, ADA)

The applicable Laws, Regulations and Standards have been reviewed and incorporated in the design.

Section 3 – Design Responsibility for Fire Protection Systems

K2 Engineering, Inc., as the Professional Engineer (PE) will provide a partial (preliminary) design including design criteria and drawings to be used by the installing subcontractor. The installing subcontractor will produce shop drawings and calculations of the proposed system installation as well as manufacturer's data sheets on products that will be installed. The PE will review and approve the installing contractor's final layout and equipment selection. K2 Engineering, Inc. (PE) is the engineer of record and will review the system design and installation for code compliance.

Fire Protection System:	Adam R. Kovach, PE, LEED AP BD & C
Fire Alarm System:	MA PE # 51186
HVAC:	K2 Engineering, Inc.
	43995 Falmouth Court • Ashburn, VA 20147

Section 4 – Fire Protection Systems (Existing to be modified)

FIRE SPRINKLER SYSTEMS

System Description:

Automatic sprinkler protection is existing throughout the entire building. Renovations in the scope areas will be in accordance with NFPA 13, 2015 edition, as required by MGL 148 and 780 CMR, 9th edition, chapter 9.

Automatic sprinkler systems in areas of light hazard occupancy will be designed with a minimum design density of 0.10 GPM per square foot over the 2,500 square feet tenant space. Maximum protection area per sprinkler head will be 225 square feet for upright and pendant sprinkler heads, and 196 feet for sidewall sprinkler heads. Hose allowance is 100 GPM.

Automatic sprinkler systems in areas of ordinary hazard occupancy will be designed with a minimum design density of .20 GPM per square foot over the most hydraulically demanding 1,500 square feet. Maximum protection area per sprinkler head will be 120 square feet for upright and pendent sprinkler heads. Hose allowance of 250 GPM

The fire service for the double check backflow preventer shall remain as installed.

FIRE ALARM SYSTEM

System Description:

The existing standalone fire alarm system shall continue to operate and be expanded per the new tenant build-out in accordance with all-applicable codes and standards including NFPA 13, 72, 90A, and
9th Edition of the Massachusetts State Building Code.

The existing fire alarm system is an intelligent analog/addressable fire control panel and alarm system with complete audio (Horns) and visual occupant notification. Municipal reporting is via central station monitoring service.

Each initiating point (smoke detector, duct-mounted smoke detector, heat detector, flow switch, tamper switch, monitoring module, relay and/or manual pull station) is individually addressable. Upon activation, the specific device address, type, status and location will be presented at an LCD annunciator integral to the FACP and the remote annunciator located at the space entry.

Related Systems Interface:

The new fire alarm system will interface with the AC"s in order to conduct the required fan shut down as required by NFPA 90A.

The new fire alarm system will interface with the new cook line hood control panel initiation circuit via a micro switch relay, which will also shut down all equipment below the hood.

The new Fire Alarm System shall monitor the Hood Suppression System activation and initiate the Fire Alarm sequence per sequence of operation matrix.

The new fire alarm system shall interface to the existing fire protection system by monitoring each existing, individual water flow and tamper switch via dedicated addressable modules and monitor the hood control and Ansul systems.

HVAC

System Description:

The HVAC system is designed in accordance with the Massachusetts State Building Code, 780 CMR, 9th Edition, the Massachusetts Plumbing and Fuel Gas Code, and NFPA 90A.

The heating, ventilating and air conditioning is provided by new and existing split system heat pumps..

A new bathroom exhaust fans discharges thru existing louver in back of building.

Kitchen Exhaust fan serves the cook line hood. The exhaust duct discharges in the back of building and exhaust ductwork routes up side of building and discharges at roof level.

A DOAS unit is provided on grade out back of building and serves as HVAC to condition the kitchen and also provides make-up air for the hood.

Air System Smoke Detection is designed in accordance with the Massachusetts Building Code, 9th Edition, and NFPA 90A. Return air smoke detection will be provided by a duct smoke detector at the return intake of the RTU's. Upon detection of smoke, the unit will stop. If any RTU return duct smoke detector is initiated, an alarm shall also be generated to the building's fire alarm system.

There is no atrium for this project.

Section 5 – Features Used in the Design Methodology
N/A

Section 6 – Special Consideration and Description

There is no intent to deviate from the prescriptive code requirements of regulatory codes and standards with alternative methods.

(1.b) SEQUENCE OF OPERATION

FIRE SPRINKLER SYSTEMS

Wet Pipe Sprinkler System: Heat produced from a fire melts the fusible link or glass bulb on a single sprinkler head or group of sprinkler heads causing the sprinkler(s) to open. Water from the water filled pipe is discharged immediately from the sprinkler head(s) to control the fire. The fire department may pump either of the two fire department connections to supplement the system. Sprinkler system water flow alarms activate upon system flow and indicate to the FACP an alarm condition. The sprinkler(s) continue to flow water until manually shut off.

FIRE ALARM SYSTEM

In accordance with the Massachusetts State Building Code, the activation of:

1. Manual pull station shall:

    a. Sound alarm at pull station activated.
    b. Identify the station activated and sound alarm at control panel and at remote annunciator.
    c. Initiate horn/strobe devices.
    d. Notify local fire department.

2. Smoke detectors shall:

    a. Sound alarm at device activated.
    b. Identify the device activated and sound alarm at control panel and at remote annunciator.
    c. Initiate horn/strobe devices.
    d. Notify local fire department.

3. Heat detectors and sprinkler flow switches shall:
    a. device activated and sound alarm at control panel and at remote annunciator.
    b. Initiate horn/strobe devices.
    d. Smoke/fire dampers shall close.
    f. Notify local fire department.

4. Duct mounted smoke detector shall:
    a. Shut down dedicated mechanical unit device is associated with.
    b. Initiate remote indicator.
    c. Identify the device activated and sound alarm at control panel and at remote annunciator.
    d. Initiate horn/strobe devices.
    e. Release door holders.
    f. Smoke/fire dampers shall close.
    g. Initiate elevator recall.
    h. Notify local fire department.

5. Supervisory circuit shall:
    a. Identify the location of supervisory condition at control panel and remote annunciator.
    b. Initiate supervisory audible/visual signal at control panel and remote annunciator.

6. Trouble circuit shall:

a. Identify the location of trouble condition at control panel and remote annunciator.
b. Initiate trouble audible/visual signal at control panel and remote annunciator.

7. All events shall be recorded at the fire alarm control panel and shall indicate time and date of occurrence and list device initiated.

HVAC

Sequence of Operation (New RTU's):

AC Unit shut down upon detection of smoke: There are existing/new smoke detectors in the return air ductwork at the AC's. All smoke detectors are hard-wired to the fan starter and shall stop the AC's, whenever smoke is detected. Smoke detectors shall be wired to the fire alarm panel by the Electrical Contractor. Existing systems are not modified by this project.

(1.c) TESTING CRITERIA

Section 1 – General Testing Criteria

The general contractor has overall responsibility for setting up and coordinating all acceptance testing with authorities having jurisdiction. All testing will be in accordance with NFPA requirements, the Massachusetts State Building Code, 9th Edition, the Massachusetts Mechanical Code, Massachusetts Fire Prevention Code NFPA 1 with amendments, the NFPA National Electrical Code, and the contract specifications.

FIRE SPRINKLER SYSTEM

The sprinkler contractor is responsible for setting up and coordinating all sprinkler system acceptance testing. All testing will be in accordance with NFPA 13, 20, 24 the Massachusetts State Building Code, Contract Specification and all authorities having jurisdiction.

FIRE ALARM SYSTEM

The completed system will be subject to the final test and acceptance, UL certification and periodic inspection and testing, and the Massachusetts State Building Code, NFPA 72 and all authorities having jurisdiction as follows:

- The test shall be conducted by a UL certified testing company. Each and every device shall be functionally tested.
- Upon function test of each device, the corresponding programmed event sequences shall be verified. Subsequent events shall include occupant notification, system annunciation, elevator recall, HVAC control sequences, door release, and Proprietary Station reporting.
- Proper visual notification shall be verified.
- Audible sound pressure levels shall be measured and recorded.
- Fault conditions shall be simulated and verified as to their proper reporting and system response. These shall include loss of AC power, UPS/battery standby operation, and wiring faults of each and every circuit.
- A complete report demonstrating the activation and subsequent acknowledgement of each activation shall be generated.

An annual test and inspection contract will be in evidence at the time of final testing. The final system

acceptance test shall be conducted by the holder of the test contract and witnessed by the local authority having jurisdiction. Upon successful test and acceptance, a final report and certificate of compliance shall be issued by the testing company.

Testing and inspection shall be conducted by the testing company of record as described and in accordance with NFPA 72. In addition to device testing, maintenance (sensitivity) reports shall be generated directly from the system during each quarterly test. These reports shall include a complete listing of each analog device in the system, their corresponding programmed sensitivity setting, and their current sensitivity level and the number of times each device has entered alarm verification mode.

HVAC

Upon completion and prior to acceptance of the installation, all AC's, KEF's, DOAS, bathroom exhaust fans and all associated duct systems shall be thoroughly tested and balanced in accordance with the Massachusetts State Building Code, 9th edition. A certificate of approval and acceptance shall be submitted to the architect by the HVAC Contractor. All tests are to be witnessed by the authority having jurisdiction and the architect.

Section 2 - Equipment and Tools

FIRE SPRINKLER SYSTEM

The sprinkler contractor shall be responsible for providing all required equipment and tools including but not limited to: hydrostatic testing equipment, pressure gauges, hoses, nozzles, manufacturer's instructions, radios, etc.

FIRE ALARM SYSTEM

The Electrical Contractor shall provide all tools necessary to complete the successful testing of the Fire Alarm systems.

HVAC

The HVAC Contractor shall provide all tools necessary to complete the successful testing of the HVAC systems including, as necessary, lifts, gauges, pitot pressure sensors and other CFM reading and balancing equipment, adjustable and fixed sheave drives and belts (for adjusting fans), rpm and electrical meters, etc. HVAC Systems shall be balanced to be within 10% of design criteria. AC's, KEF's, HMUA and bathroom exhaust shall be balanced to cfm shown on plans.

Section 3 - Approval Requirements

Construction Contractor will obtain written approval of all acceptance testing from the serving Boston Fire Department. Report all system failures to the general contractor, serving Boston Fire Department, and design engineer. Provide the serving Boston Fire Department with copies of NFPA 13, 14, 20, and 72 testing certificates, instruction manuals and as-built drawings. The owner shall submit to the serving Boston Fire Department the names and telephone numbers of emergency contacts.

Initial Construction Control Document

To be submitted with the building permit application by a
Registered Design Professional
for work per the ninth edition of the
Massachusetts State Building Code, 780 CMR, Section 107

Project Title: Tatte Bakery **Date:** 2022-10-13

Property Address: 645 MASS AVE, ARLINGTON, MA 02476

Project: Check (x) one or both as applicable: [x] **New construction** **[x] Existing Construction**

Project description: Tenant build-out of a new Tatte Bakery, 2,755+/- sf of front of house space, and 2,907+/- sf of back of house space within existing core and shell space. The main space will include café dining, pastry counter area, barista bar, restrooms, and auxiliary spaces. The work will consist of new interior partitions, finishes and new MEP throughout to connect to building services provided.

I David R. McMahon MA Registration Number: 9789 Expiration date: 2023-08-31, am a registered design professional,and I have prepared or directly supervised the preparation of all design plans, computations and specifications concerning:

[x]**Architectural**	**Structural**	**Mechanical**
Fire Protection	**Electrical**	**Other:**

for the above named project and that to the best of my knowledge, information, and belief such plans, computations and specifications meet the applicable provisions of the Massachusetts State Building Code, (780 CMR), and accepted engineering practices for the proposed project. I understand and agree that I (or my designee) shall perform the necessary professional services and be present on the construction site on a regular and periodic basis to:

1. **Review**, for conformance to this code and the design concept, shop drawings, samples and other submittals by the contractor in accordance with the requirements of the construction documents.
2. **Perform** the duties for registered design professionals in 780 CMR Chapter 17, as applicable.
3. **Be present** at intervals appropriate to the stage of construction to become generally familiar with the progress and quality of the work and to determine if the work is being performed in a manner consistent with the approved construction documents and this code.

Nothing in this document relieves the contractor of its responsibility regarding the provisions of 780 CMR 107.

When required by the building official, I shall submit field/progress reports (see item 3.) together with pertinent comments, in a form acceptable to the building official.

Upon completion of the work, I shall submit to the building official a **'Final Construction Control Document'**.

Enter in the space to the right a "wet" or electronic signature and seal:

Phone number: 617-482-5353 **Email: david@mcmahonarchitects.com**

Building Official Use Only

Building Official Name: **Permit No.:** **Date:**

Note 1. Indicate with an 'x' project design plans, computations and specifications that you prepared or directly supervised. If 'other' is chosen, provide a description.

Initial Construction Control Document

To be submitted with the building permit application by a
Registered Design Professional
for work per the ninth edition of the
Massachusetts State Building Code, 780 CMR, Section 107

Project Title: Tatte Bakery - Boston **Date: 10/12/22**

Property Address: 645 Massachusetts Ave.• Arlington, MA 02476

Project: Check (x) one or both as applicable: ( ) **New construction** (X) **Existing**

Construction Project description: Installation of automatic sprinklers.

I Scott Henderson MA Registration Number: 46553 Expiration date: 6/30/24 , am a ***registered design professional***, and I have prepared or directly supervised the preparation of all design plans, computations and specifications concerning[1]:

Architectural	**Structural**	**Mechanical**
X Fire Protection	**Electrical**	**Other:**

for the above named project and that to the best of my knowledge, information, and belief such plans, computations and specifications meet the applicable provisions of the Massachusetts State Building Code, (780 CMR), and accepted engineering practices for the proposed project. I understand and agree that I (or my designee) shall perform the necessary professional services and be present on the construction site on a regular and periodic basis to:

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When required by the building official, I shall submit field/progress reports (see item 3.) together with pertinent comments, in a form acceptable to the building official.

Upon completion of the work, I shall submit to the building official a **'Final Construction Control Document'**.

Enter in the space to the right a "wet" or
electronic signature and seal:

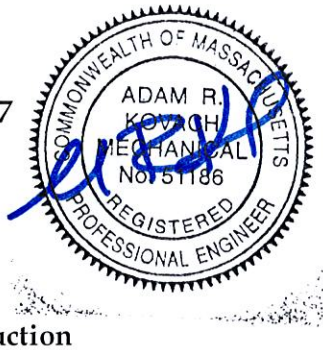
S.J. Design Inc.
Phone number: 857-891-1488 **Email: scott_henderson@charter.net**

Building Official Use Only

Building Official Name: **Permit No.:** **Date:**

Initial Construction Control Document

To be submitted with the building permit application by a
Registered Design Professional
for work per the ninth edition of the
Massachusetts State Building Code, 780 CMR, Section 107



Project Title: Tatte Bakery **Date:** 10/12/22

Property Address: 645 Massachusetts Avenue • Arlington, MA 02476

Project: Check (x) one or both as applicable: **New construction X Existing Construction**

Project description: Bakery / Cafe

I Adam R Kovach, PE, LEED AP BD&C MA Registration Number: 51186 Expiration date: 6/30/24, am a ***registered design professional***, and I have prepared or directly supervised the preparation of all design plans, computations and specifications concerning[1]:

	Architectural		**Structural**	**X**	**Mechanical**
X	**Fire Protection**	**X**	**Electrical**	**X**	**Other: Plumbing**

for the above named project and that to the best of my knowledge, information, and belief such plans, computations and specifications meet the applicable provisions of the Massachusetts State Building Code, (780 CMR), and accepted engineering practices for the proposed project. I understand and agree that I (or my designee) shall perform the necessary professional services and be present on the construction site on a regular and periodic basis to:

1. **Review**, for conformance to this code and the design concept, shop drawings, samples and other submittals by the contractor in accordance with the requirements of the construction documents.
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Nothing in this document relieves the contractor of its responsibility regarding the provisions of 780 CMR 107.

When required by the building official, I shall submit field/progress reports (see item 3.) together with pertinent comments, in a form acceptable to the building official.

Upon completion of the work, I shall submit to the building official a **'Final Construction Control Document'**.

Enter in the space to the right a "wet" or electronic signature and seal:

Phone number: (703) 675-6440 **Email:** akovach@k2mep.com

Building Official Use Only

Building Official Name: **Permit No.:** **Date:**

Note 1. Indicate with an 'x' project design plans, computations and specifications that you prepared or directly supervised. If 'other' is chosen, provide a description.

Hydraulic Summary

Job

Job Number: 022-55	Design Engineer: SJ DESIGN INC
Job Name: TATTE BAKERY	State Certification/License Number:
Address 1: 645 MASSACHUSETTS AVE.	AHJ: FIRE DEPARTMENT
Address 2: ARLINGTON, MA	Job Site/Building: EXISTING
Address 3: BAKERY FIT-OUT	Drawing Name: R1_Tatte Bakery - 645 Mass Ave-Arlington, MA.cad

System

Most Demanding Sprinkler Data: 5.6 K-Factor 19.50 at 12.125

Hose Allowance At Source: 250.00

Additional Hose Supplies

Node	Flow(gpm)

Total Hose Streams: 250.00

System Flow Demand	Total Water Required (Including Hose Allowance)
292.03	542.03

Maximum Pressure Unbalance In Loops: 0.000

Maximum Velocity Above Ground: 15.62 between nodes 271 and 215

Maximum Velocity Under Ground	
3.02 between nodes 2 and 5	

Volume capacity of Wet Pipes	Volume capacity of Dry Pipes
1005.64gal	

Remote Area(s)

Occupancy	Job Suffix
Ordinary Group I	

Density	Area of Application
0.150gpm/ft²	970.06ft² (Actual 970.06ft²)

Number Of Sprinklers Calculated	Coverage Per Sprinkler
14	130.00ft²

Supplies

Node	Name	Hose Flow (gpm)	Static (psi)	Residual (psi)	@	Flow (gpm)	Available (psi)	@	Total Demand (gpm)	Required (psi)	Safety Margin (psi)
2	Water Supply	250.00	62.000	56.000		919.00	59.741		542.03	41.591	18.150

Contractor

	Contractor Number	Contact Name	Contact Title

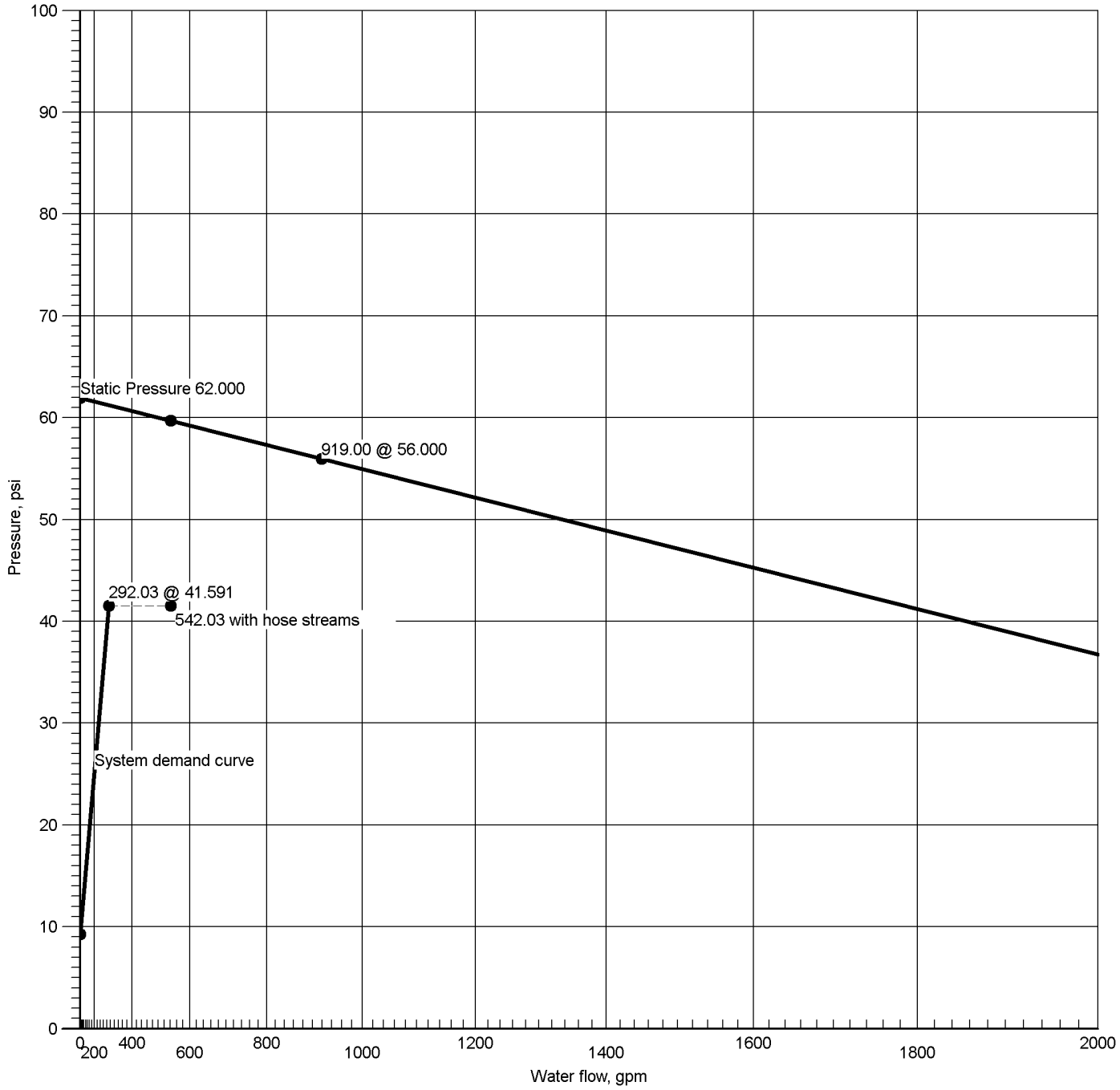
Name of Contractor:	Phone	Extension

Address 1	FAX

Address 2	E-mail

Address 3	Web-Site

Water Supply at Node 2



Hydraulic Graph	Water Supply at Node 2
Static: Pressure	62.000
Residual: Pressure	56.000 @ 919.00
Available Pressure at Time of Test	59.741 @ 542.03
System Demand	41.591 @ 292.03
System Demand (Including Hose Allowance at Source)	41.591 @ 542.03

Summary Of Outflowing Devices

Job Number: 022-55
Report Description: BAKERY TENANT FITOUT

Device	Actual Flow (gpm)	Minimum Flow (gpm)	K-Factor (K)	Pressure (psi)		
Sprinkler 450	21.29	19.50	5.6	14.456		
Sprinkler 452	20.67	15.00	5.6	13.618		
Sprinkler 474	22.10	19.50	5.6	15.579		
Sprinkler 484	21.53	19.50	5.6	14.781		
Sprinkler 500	21.17	19.50	5.6	14.288		
Sprinkler 519	21.07	19.50	5.6	14.152		
Sprinkler 535	20.47	15.00	5.6	13.356		
Sprinkler 560	21.06	15.00	5.6	14.146		
Sprinkler 563	21.01	19.50	5.6	14.076		
Sprinkler 565	22.05	19.50	5.6	15.498		
Sprinkler 577	20.62	19.50	5.6	13.564		
Sprinkler 590	19.92	19.50	5.6	12.650		
Sprinkler 609	19.58	19.50	5.6	12.223		
Sprinkler 620	**19.50**	**19.50**	**5.6**	**12.125**		

⇨ Most Demanding Sprinkler Data

Node Analysis

Job Number: 022-55
Report Description: BAKERY TENANT FITOUT

Node	Elevation(Foot)	Fittings	Pressure(psi)	Discharge(gpm)	
2	-8'-0	S	41.591	292.03	
450	13'-6	Spr(-14.456)	14.456	21.29	
452	13'-6	Spr(-13.618)	13.618	20.67	
474	13'-6	Spr(-15.579)	15.579	22.10	
484	13'-6	Spr(-14.781)	14.781	21.53	
500	13'-6	Spr(-14.288)	14.288	21.17	
519	13'-6	Spr(-14.152)	14.152	21.07	
535	13'-6	Spr(-13.356)	13.356	20.47	
560	13'-6	Spr(-14.146)	14.146	21.06	
563	13'-6	Spr(-14.076)	14.076	21.01	
565	13'-6	Spr(-15.498)	15.498	22.05	
577	13'-6	Spr(-13.564)	13.564	20.62	
590	13'-6	Spr(-12.650)	12.650	19.92	
609	13'-6	Spr(-12.223)	12.223	19.58	
620	13'-6	Spr(-12.125)	12.125	19.50	
5	-8'-0	LtE(7'-10¾)	41.567		
151	12'-5½	PO(5'-0)	15.385		
152	12'-5½	PO(5'-0)	15.479		
154	12'-5½	mecT(9'-10¾)	16.242		
177	12'-5½	PO(5'-0)	16.276		
215	12'-5½	T(5'-0)	16.276		
250	12'-5½	PO(5'-0)	16.892		
259	11'-5	mecT(9'-10¾)	20.577		
261	11'-5	PO(6'-0)	20.578		
264	12'-5½	T(9'-10¾)	17.631		
267	11'-5	mecT(12'-3¾)	20.632		
271	12'-5½	E(2'-0)	19.171		
276	12'-5½	PO(5'-0)	16.978		
297	12'-5½	PO(5'-0)	14.849		
308	12'-5½	PO(5'-0)	16.135		
332	12'-5½	PO(5'-0)	15.615		
336	12'-5½	PO(5'-0)	13.883		
358	12'-5½	PO(5'-0)	15.471		
373	12'-5½	PO(5'-0)	13.433		
396	12'-5½	PO(5'-0)	13.329		

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt / Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
• • • • • **Route 1** • • • • •							
SP	1.0490	19.50	7.24	120	0.124177	1'-0½	Pf 0.751
620	13'-6	19.50	5.6	12.125	Sprinkler,	5'-0	Pe 0.453
396	12'-5½			13.329	PO(5'-0)	6'-0½	Pv
BL	1.6820	19.50	2.82	120	0.012458	8'-4	Pf 0.104
396	12'-5½			13.329			Pe
373	12'-5½			13.433		8'-4	Pv
BL	1.6820	39.08	5.64	120	0.045079	10'-0	Pf 0.451
373	12'-5½	19.58		13.433	Flow (q) from Route 2		Pe
336	12'-5½			13.883		10'-0	Pv
BL	1.6820	59.00	8.52	120	0.096584	10'-0	Pf 0.966
336	12'-5½	19.92		13.883	Flow (q) from Route 3		Pe
297	12'-5½			14.849		10'-0	Pv
BL	1.6820	79.62	11.50	120	0.168180	6'-7¾	Pf 2.782
297	12'-5½	20.62		14.849	Flow (q) from Route 4	9'-10¾	Pe
264	12'-5½			17.631	T(9'-10¾)	16'-6½	Pv
BL	2.1570	164.09	14.41	120	0.190852	1'-0½	Pf 2.548
264	12'-5½	84.47		17.631	Flow (q) from Route 8	12'-3¾	Pe 0.453
267	11'-5			20.632	mecT(12'-3¾)	13'-4¼	Pv
CM	4.2600	292.03	6.57	120	0.020159	157'-7¼	Pf 12.519
267	11'-5	127.94		20.632	Flow (q) from Route 5	215'-5	Pe 8.415
5	-8'-0			41.567	12fE(8'-11½), 3E(13'-2), 5Z, T(26'-4), f(-0.000), ALV(26'-4), 2LtE(7'-10¾), BFP(-5.000)	373'-0	Pv
UG	6.2800	292.03	3.02	140	0.002290	10'-4¾	Pf 0.024
5	-8'-0			41.567			Pe
2	-8'-0			41.591	Water Supply	10'-4¾	Pv
		250.00			Hose Allowance At Source		
2		542.03					
• • • • • **Route 2** • • • • •							
SP	1.0490	19.58	7.27	120	0.125106	1'-0½	Pf 0.756
609	13'-6	19.58	5.6	12.223	Sprinkler,	5'-0	Pe 0.453
373	12'-5½			13.433	PO(5'-0)	6'-0½	Pv
• • • • • **Route 3** • • • • •							
SP	1.0490	19.92	7.39	120	0.129138	1'-0½	Pf 0.781
590	13'-6	19.92	5.6	12.650	Sprinkler,	5'-0	Pe 0.453
336	12'-5½			13.883	PO(5'-0)	6'-0½	Pv
• • • • • **Route 4** • • • • •							
SP	1.0490	20.62	7.66	120	0.137744	1'-0½	Pf 0.833
577	13'-6	20.62	5.6	13.564	Sprinkler,	5'-0	Pe 0.453
297	12'-5½			14.849	PO(5'-0)	6'-0½	Pv
• • • • • **Route 5** • • • • •							
SP	1.0490	21.01	7.80	120	0.142549	5'-3	Pf 1.747
563	13'-6	21.01	5.6	14.076	Sprinkler,	7'-0	Pe 0.453
215	12'-5½			16.276	E(2'-0), T(5'-0)	12'-3	Pv
BL	1.0490	42.07	15.62	120	0.515076	3'-7½	Pf 2.895
215	12'-5½	21.06		16.276	Flow (q) from Route 14	2'-0	Pe -0.000
271	12'-5½			19.171	E(2'-0)	5'-7½	Pv
BL	1.3800	42.07	9.02	120	0.135468	1'-0½	Pf 0.954
271	12'-5½			19.171		6'-0	Pe 0.453
261	11'-5			20.578	PO(6'-0)	7'-0½	Pv
ST	4.2600	127.94	2.88	120	0.004379	12'-4¾	Pf 0.054
261	11'-5	85.87		20.578	Flow (q) from Route 6		Pe
267	11'-5			20.632		12'-4¾	Pv
• • • • • **Route 6** • • • • •							
SP	1.0490	21.07	7.82	120	0.143261	1'-0½	Pf 0.866
519	13'-6	21.07	5.6	14.152	Sprinkler,	5'-0	Pe 0.453
358	12'-5½			15.471	PO(5'-0)	6'-0½	Pv
BL	1.6820	21.07	3.04	120	0.014373	10'-0	Pf 0.144
358	12'-5½			15.471			Pe
332	12'-5½			15.615		10'-0	Pv
BL	1.6820	42.23	6.10	120	0.052043	10'-0	Pf 0.520
332	12'-5½	21.17		15.615	Flow (q) from Route 7		Pe
308	12'-5½			16.135		10'-0	Pv
BL	1.6820	63.76	9.21	120	0.111517	7'-6¾	Pf 0.843
308	12'-5½	21.53		16.135	Flow (q) from Route 9		Pe
276	12'-5½			16.978		7'-6¾	Pv
BL	1.6820	85.87	12.40	120	0.193401	3'-10¾	Pf 3.146
276	12'-5½	22.10		16.978	Flow (q) from Route 11	12'-4½	Pe 0.453
259	11'-5			20.577	LtE(2'-5¾), mecT(9'-10¾)	16'-3¼	Pv

Pipe Type / Downstream / Upstream	Diameter / Elevation	Flow / Discharge	Velocity / K-Factor	HWC / Pt	Pn	Friction Loss / Fittings	Length / Eq. Length / Total Length	Pressure Summary
ST	4.2600	85.87	1.93	120		0.002094	0'-7¼	Pf 0.001
259	11'-5			20.577				Pe
261	11'-5			20.578			0'-7¼	Pv
• • • • • Route 7 • • • • •								
SP	1.0490	21.17	7.86	120		0.144535	1'-0½	Pf 0.874
500	13'-6	21.17	5.6	14.288		Sprinkler,	5'-0	Pe 0.453
332	12'-5½			15.615		PO(5'-0)	6'-0½	Pv
• • • • • Route 8 • • • • •								
SP	1.0490	21.29	7.90	120		0.146105	2'-4¼	Pf 1.368
450	13'-6	21.29	5.6	14.456		Sprinkler,	7'-0	Pe 0.453
177	12'-5½			16.276		E(2'-0), PO(5'-0)	9'-4¼	Pv
BL	2.1570	62.42	5.48	120		0.031929	10'-8	Pf 0.616
177	12'-5½	41.13		16.276		Flow (q) from Route 12	8'-7½	Pe 0.000
250	12'-5½			16.892		2fE(4'-3¾)	19'-3½	Pv
BL	2.1570	84.47	7.42	120		0.055871	0'-11	Pf 0.739
250	12'-5½	22.05		16.892		Flow (q) from Route 10	12'-3¾	Pe
264	12'-5½			17.631		T(12'-3¾)	13'-2¾	Pv
• • • • • Route 9 • • • • •								
SP	1.0490	21.53	7.99	120		0.149138	1'-0½	Pf 0.902
484	13'-6	21.53	5.6	14.781		Sprinkler,	5'-0	Pe 0.453
308	12'-5½			16.135		PO(5'-0)	6'-0½	Pv
• • • • • Route 10 • • • • •								
SP	1.0490	22.05	8.18	120		0.155818	1'-0½	Pf 0.942
565	13'-6	22.05	5.6	15.498		Sprinkler,	5'-0	Pe 0.453
250	12'-5½			16.892		PO(5'-0)	6'-0½	Pv
• • • • • Route 11 • • • • •								
SP	1.0490	22.10	8.21	120		0.156574	1'-0½	Pf 0.946
474	13'-6	22.10	5.6	15.579		Sprinkler,	5'-0	Pe 0.453
276	12'-5½			16.978		PO(5'-0)	6'-0½	Pv
• • • • • Route 12 • • • • •								
SP	1.0490	20.47	7.60	120		0.135789	1'-7¼	Pf 1.576
535	13'-6	20.47	5.6	13.356		Sprinkler,	10'-0	Pe 0.453
151	12'-5½			15.385		T(5'-0), PO(5'-0)	11'-7¼	Pv
BL	1.6820	20.47	2.96	120		0.013623	6'-11	Pf 0.094
151	12'-5½			15.385				Pe
152	12'-5½			15.479			6'-11	Pv
BL	1.6820	41.13	5.94	120		0.049555	5'-6	Pf 0.763
152	12'-5½	20.67		15.479		Flow (q) from Route 13	9'-10¾	Pe
154	12'-5½			16.242		mecT(9'-10¾)	15'-4¾	Pv
BL	2.1570	41.13	3.61	120		0.014757	2'-4	Pf 0.034
154	12'-5½			16.242				Pe -0.000
177	12'-5½			16.276			2'-4	Pv
• • • • • Route 13 • • • • •								
SP	1.0490	20.67	7.67	120		0.138253	3'-2¼	Pf 1.408
452	13'-6	20.67	5.6	13.618		Sprinkler,	7'-0	Pe 0.453
152	12'-5½			15.479		E(2'-0), PO(5'-0)	10'-2¼	Pv
• • • • • Route 14 • • • • •								
SP	1.0490	21.06	7.82	120		0.143207	1'-8½	Pf 1.677
560	13'-6	21.06	5.6	14.146		Sprinkler,	10'-0	Pe 0.453
215	12'-5½			16.276		2T(5'-0)	11'-8½	Pv

Equivalent Pipe Lengths of Valves and Fittings (C=120 only)

$$\left(\frac{\text{Actual Inside Diameter}}{\text{Schedule 40 Steel Pipe Inside Diameter}}\right)^{4.87} = \text{Factor}$$

C Value Multiplier

Value Of C	100	130	140	150
Multiplying Factor	0.713	1.16	1.33	1.51

Pipe Type	Diameter	Flow	Velocity	HWC		Friction Loss	Length	Pressure
Downstream	Elevation	Discharge	K-Factor	Pt	Pn	Fittings	Eq. Length	Summary
Upstream							Total Length	

Pipe Type Legend

AO	Arm-Over
BL	Branch Line
CM	Cross Main
DN	Drain
DR	Drop
DY	Dynamic
FM	Feed Main
FR	Feed Riser
MS	Miscellaneous
OR	Outrigger
RN	Riser Nipple
SP	Sprig
ST	Stand Pipe
UG	Underground

Units Legend

Diameter	Inch
Elevation	Foot
Flow	gpm
Discharge	gpm
Velocity	fps
Pressure	psi
Length	Foot
Friction Loss	psi/Foot
HWC	Hazen-Williams Constant
Pt	Total pressure at a point in a pipe
Pn	Normal pressure at a point in a pipe
Pf	Pressure loss due to friction between points
Pe	Pressure due to elevation difference between indicated points
Pv	Velocity pressure at a point in a pipe

Fittings Legend

ALV	Alarm Valve
AngV	Angle Valve
b	Bushing
BalV	Ball Valve
BFP	Backflow Preventer
BV	Butterfly Valve
C	Cross Flow Turn 90°
cplg	Coupling
Cr	Cross Run
CV	Check Valve
DelV	Deluge Valve
DPV	Dry Pipe Valve
E	90° Elbow
EE	45° Elbow
Ee1	11¼° Elbow
Ee2	22½° Elbow
f	Flow Device
fd	Flex Drop
FDC	Fire Department Connection
fE	90° FireLock(TM) Elbow
fEE	45° FireLock(TM) Elbow
flg	Flange
FN	Floating Node
fT	FireLock(TM) Tee
g	Gauge
GloV	Globe Valve
GV	Gate Valve
Ho	Hose
Hose	Hose
HV	Hose Valve
Hyd	Hydrant
LtE	Long Turn Elbow
mecT	Mechanical Tee
Noz	Nozzle
P1	Pump In
P2	Pump Out
PIV	Post Indicating Valve
PO	Pipe Outlet
PRV	Pressure Reducing Valve
PrV	Pressure Relief Valve
red	Reducer/Adapter
S	Supply
sCV	Swing Check Valve
Spr	Sprinkler
St	Strainer
T	Tee Flow Turn 90°
Tr	Tee Run
U	Union
WirF	Wirsbo
WMV	Water Meter Valve
Z	Cap

Flow Diagram (Top View)