



Airflow Testing Report

Prepared for

Portland Public Schools

November 2021





9700 SW Capitol Hwy, Suite 110
Portland, OR 97219
ameresco.com

PROJECT OVERVIEW

As part of the continuing process to ensure a safe return to in-person learning, Portland Public Schools has contracted with Ameresco to test the airflow and ventilation of all educational and office spaces in each school. The data is reviewed by both Ameresco and PPS personnel to identify any potential shortcomings in the airflow from the HVAC systems. To accomplish this task, Ameresco has partnered with a local NEBB certified Test-Adjust-Balance (TAB) firm, Neudorfer Engineers, who will measure the airflow to each zone with calibrated measurement equipment in accordance with current testing standards and procedures. As part of this effort, HVAC professionals will review the operation of the HVAC equipment serving every educational and office space in each school.

Ameresco is pleased to have partnered with PPS over the last decade as the district's Energy Services Company (ESCO) on six energy efficiency construction projects, four service projects, and numerous energy audits. Our partnership has resulted in reducing over 3,000 tons of CO₂ and other GHG emissions and over \$1,000,000 in utility cost savings per year. Ameresco appreciates this opportunity to play a small role in the safe reopening of schools.

About Ameresco, Inc.

Founded in 2000, Ameresco, Inc. (NYSE:AMRC) is a leading cleantech integrator and renewable energy asset developer, owner and operator. Our comprehensive portfolio includes energy efficiency, infrastructure upgrades, asset sustainability and renewable energy solutions delivered to clients throughout North America and the United Kingdom. Ameresco's sustainability services in support of clients' pursuit of Net Zero include upgrades to a facility's energy infrastructure and the development, construction, and operation of distributed energy resources. Ameresco has successfully completed energy saving, environmentally responsible projects with Federal, state and local governments, healthcare and educational institutions, housing authorities, and commercial and industrial customers. With its corporate headquarters in Framingham, MA, Ameresco has more than 1,000 employees providing local expertise in the United States, Canada, and the United Kingdom. For more information, visit www.ameresco.com.

Explanation of ASHRAE Total Effective Air Changes per Hour (ACH_e) Calculation

ASHRAE has been updating their Building Readiness document to reflect the most current understanding in the engineering community for how to operate and maintain buildings during the pandemic. Their update on 4/27/2021 provided an explanation of the impact air filters and air cleaning devices have on the air in buildings. They provided the methodology, formulas, and an Excel-based tool for determining the equivalent outside air a space is receiving by having a mix of outside air, filtered recirculated air, and additional air filtration or cleaning devices in the room. Here is the explanation from ASHRAE:

Epidemic Conditions in Place



Equivalent Outdoor Air:

The equivalent outdoor air calculation indicates that the outdoor air can be calculated by using the combination of the actual outdoor air, impact of filtration or air cleaning technologies on recirculated air, and the impact of air cleaning technologies in the space.

This is using the principal of filters in series and the effectiveness at reducing particles. For items in series, the initial item would see the recirculated airflow to clean. The second item in the series would see the “cleaned” air from Item 1 and so the impact of Item 1 must be accounted for in Item 2.

As part of the airflow testing project that Portland Public Schools has partnered with Ameresco to complete, we are including the calculation of the Total Effective Air Changes per Hour (ACH_e) to show the impact of the air filtration that is active in nearly all spaces in the PPS schools. The formula for doing so is:

$$ACH_e = (ACH_{oa} + ACH_f) * E_z + ACH_{ir}$$

where:

- ACH_{oa} = air changes per hour of outside air = outside airflow in cubic feet per minute * 60 minutes per hour / room volume in cubic feet
- ACH_f = air changes per hour of clean air from filtered recirculated air with filters of the specified MERV rating as determined by ASHRAE
- E_z = Zone Air Distribution Effectiveness = how effective the HVAC system is at circulating and mixing the air to distribute the clean air throughout the room
- ACH_{ir} = the air changes per hour of clean air from portable air filters in the room = number of filters * CADR * 60 minutes per hour / room volume in cubic feet
 - CADR = Clear Air Delivery Rate = the CFM of clean air as specified by the manufacturer of the air filter

In order to include these calculations in the airflow testing reports, Ameresco and PPS have made the following assumptions as not all the variables are known:

1. PPS is in process of upgrading the air filters in their HVAC systems to MERV 13 and plans to be complete with that project for the start of the '21-'22 school year. In this report and for the sake of the ACH_e calculation, we are using the filters that are in place at the time of the measurements, so some of them are still MERV 8.
2. ASHRAE has guidelines for what should be used for the Zone Air Distribution Effectiveness (E_z) based on the HVAC system configuration, but they do not provide a value for every HVAC system and room configuration. For the majority of PPS rooms, an E_z of 0.8 – 1.0 would be most appropriate, so we have made the conservative assumption of using 0.8 for every space as that yields the lower ACH_e.
3. The CADR for a given air filter is from manufacturer ratings and is based on certain conditions (fan speed, particulate size, filter cleanliness, etc.) that change with operating conditions.



NEUDORFER ENGINEERS INC.

**TEST REPORT TYPE:
SURVEY REPORT**

Portland Public Schools Airflow Testing Lincoln HS

Job Number: 2021-0297

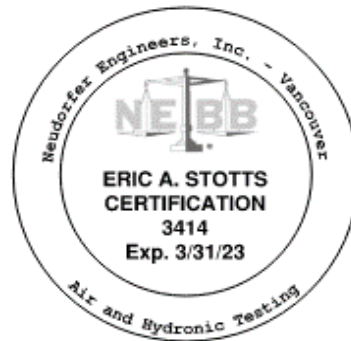
Project Completion Date: November 2021

Revision Date:

-

Revision Number:

-



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Neudorfer Engineers, Inc.

Consulting Engineers Seattle, Washington - Portland, Oregon



www.NeudorferEngineers.com

**Portland Public Schools Airflow Testing
Lincoln HS**

TABLE OF CONTENTS

Title Sheet	3
Report Certification	4
Terms	5
Instrument Calibration	6
Report Summary	7
Airflow Survey Report	8
TAB Notes	15
Floor Layout	16



Neudorfer Engineers, Inc.

Consulting Engineers Seattle, Washington - Portland, Oregon



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REPORT TITLE

CERTIFIED TEST: SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Lincoln HS

NEI Job#: 2021-0297

Mechanical Engineer: NA

Architect: NA

HVAC Contractor: NA

TAB Firm: Neudorfer Engineers Inc
Test Engineer: Zach Mayer



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CERTIFICATION

Portland Public Schools Airflow Testing

The data presented in this report is a record of system measurements and final adjustments that have been obtained in accordance with the current edition of the NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems. Any variances from design quantities, which exceed NEBB tolerances, are noted in the Test-Adjust-Balance Report Project Summary.

Significant / Noteworthy Remarks are noted on the General Remarks and General Field Notes pages. Other remarks are noted on individual test sheets.

Noted deficiencies are not the TAB firms responsibility to repair. Prior to issuance of this report, Deficiency Reports are forwarded to our contracted agent.

Warranty is limited to one year from date of this report. Within that time, any discrepancies, ambiguities, or omissions found in this report will be retested, adjusted, or balanced as needed. A written notification will be required.

Submitted and Certified by:

NEBB TAB Firm: **Neudorfer Engineers Inc**

Certification No: **3414**

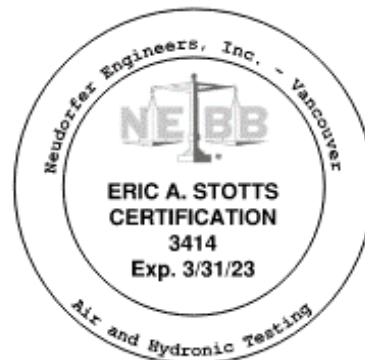
Expiration Date: **March 31, 2023**

Certification Date: **March 31, 2021**

(Date completed) **Signed and Sealed by:**

NEBB Supervisor: **Mike Vawter P.E.**

NEBB Supervisor: **Eric Stotts**





Neudorfer Engineers, Inc.

Consulting Engineers Seattle, Washington - Portland, Oregon



www.NeudorferEngineers.com

TERMS AND ABBREVIATIONS

Project: **Portland Public Schools Airflow Testing**

AC or ACU Air Conditioner or Air Conditioning Unit

AH or AHU Air Handler or Air Handling Unit

ACH Air Changes per Hour

AVG Average

BHP Brake Horsepower

CAV Constant Air Volume

CBV Calibrated Balancing Valve
(Circuit Setter)

CC Cooling Coil

CD Ceiling Diffuser

CFM Cubic Feet per Minute

CH Chiller

CHWS Chilled Water Supply

CHWR Chilled Water Return

CP Circulating Pump

CR Ceiling Register

CRAC Computer Room Air Conditioner

CRU Computer Room Unit

CT Cooling Tower

CU Condenser Unit

CUH Cabinet Unit Heater

CWS Condenser Water Supply

CWR Condenser Water Return

DAT Discharge Air Temperature

DB Dry Bulb

DD Direct Drive

DDC Direct Digital Controls: EMS Control
System for the HVAC

Des. Design

Dia. Diameter

Disch. Discharge

EA Exhaust Air

EAT Entering Air Temperature

Economizer Controls and components that allow an
air handler to logically utilize outdoor air
for cooling as opposed to the use of
mechanical cooling.

EF Exhaust Fan

EG Exhaust Grille

EMCS Energy Management Control System

ERU Energy Recovery Unit

E.S.P. External Static Pressure

HRC Heat Recovery Coil

EWT Entering Water Temperature

FCU Fan Coil Unit

FD Fire Damper

FSD Fire Smoke Damper

FLA Full Load Amperage: Maximum
amperage a motor can draw.

Flow Hood Instrument that captures air and
converts the reading to CFM.

FHT Fume Hood Test

FPB Fan Powered Box

FPM Feet per Minute

FR Field Report

FT Foot, Feet

FTU Fan Terminal Unit

GPM Gallons per Minute

HC Heating Coil

TDH Pressure Difference across the entering
and leaving side of a pump.

HEPA High Efficiency Particulate Absorbing

HP Horsepower

HVAC Heating Ventilation and Air Conditioning

HWS Heating Water Supply

HWR Heating Water Return

HX Heat Exchanger

HZ Hertz, cycle per second

in. inches

in.w.g. inches of water gauge

Kfactor Correction factor to the free area need to
calculate CFM.

KW Kilowatts

LAT Leaving Air Temperature

LBWG Low Wall Grille

LWR Low Wall Register

LWT Leaving Water Temperature

MAU Make-up Air Handling Unit

MBH 1,000 BTUH

N/A Not Applicable

OSA Outside Air

OBD Opposed Blade Damper

ΔP Pressure Drop.

PH Phase

PSI Pounds per Square Inch

RA Return Air

RAT Return Air Temperature

RF Return Fan

RH Relative Humidity

RHC Reheat Coil

RPM Revolutions per Minute

RTU Roof Top Unit

SA Supply Air

SAT Supply Air Temperature

S.F. Service Factor

SF Supply Fan

SFD Smoke/Fire Damper

SP Static Pressure

sq.ft. square feet

Suct. Suction

SWG Sidewall Grille

SWR Sidewall Register

TAB Test; Adjust; and Balance

TSP Total Static Pressure: Difference
between the entering and leaving
static pressure of a fan.

UH Unit Heater

VAV Variable Air Volume; box that
contains a motorized damper that
modulates airflow.

VD Volume Damper

VFD Variable Frequency Drive

Velgrid Instrument that reads used to read
velocity in feet per minute.

VVT Variable Volume Terminal

WC Water Column

W.G. Water Gauge

WB Wet Bulb

INSTRUMENT CALIBRATIONS

Portland Public Schools Airflow Testing

Lincoln HS

Instrument Type	Air Data Meter with Flowhood	Instrument Serial #	M97410
Instrument Manufacturer	Shortridge	Calibration Date	10/4/2021
Instrument Model Number	ADM 860	Calibration Due	10/4/2022
Instrument Type	Differential Pressure Water Meter	Instrument Serial #	W12178
Instrument Manufacturer	Shortridge	Calibration Date	10/4/2021
Instrument Model Number	HDM-250	Calibration Due	10/4/2022
Instrument Type	Psychrometer	Instrument Serial #	181128924
Instrument Manufacturer	Extech	Calibration Date	10/1/2021
Instrument Model Number	RH390	Calibration Due	10/1/2022
Instrument Type	Tachometer	Instrument Serial #	B185B5022P
Instrument Manufacturer	Nidec	Calibration Date	10/1/2021
Instrument Model Number	MT-200	Calibration Due	10/1/2022
Instrument Type	Amp Probe	Instrument Serial #	33380179WS
Instrument Manufacturer	Fluke	Calibration Date	10/1/2021
Instrument Model Number	323 Clamp Meter	Calibration Due	10/1/2022
Instrument Type	Digital Thermometer	Instrument Serial #	45400509WS
Instrument Manufacturer	Fluke	Calibration Date	10/1/2021
Instrument Model Number	52 II	Calibration Due	10/1/2022
Instrument Type	Manometer	Instrument Serial #	M97410
Instrument Manufacturer	Shortridge	Calibration Date	10/4/2021
Instrument Model Number	ADM 860	Calibration Due	10/4/2022
Instrument Type	Thermal Anemometer	Instrument Serial #	AVM440808002
Instrument Manufacturer	Alnor Instruments	Calibration Date	9/22/2021
Instrument Model Number	AVM 440	Calibration Due	9/22/2022
Instrument Type	Ultrasonic Flow Meter	Instrument Serial #	N1F1823T
Instrument Manufacturer	Fuji	Calibration Date	9/20/2021
Instrument Model Number	Portaflow-C	Calibration Due	9/20/2022



PROJECT	Portland Public Schools Airflow Testing
LOCATION	Lincoln HS; 1600 SW Salmon St, Portland, OR 97205

REPORT SUMMARY

This project has been surveyed per plans and specifications using the National Environmental Balancing Bureau (NEBB) standards and procedures.

The scope of work for this project was to assess the current airflows for each classroom, office, and special purpose space. Air changes per hour were calculated along with the % of OSA for the spaces and any deficiencies found for each piece of equipment has been noted in the following report.

All ventilation equipment was commanded to run by the BMS system. Ventilation units were measured with a flowhood on the supply outlets. Outside air was recorded with a flowhood on the OSA louvre where accessible. AK factors were calculated from flowhood readings. The remaining OSA values were recorded with a velgrid. AHU supply air was recorded by a summation of the outlets as recorded by flowhood or velgrid when appropriate. Outside air was recorded with a velgrid or airfoil and calculated by the free area method.

The measured airflows in this report represent the performance of the equipment at the time of measurement, which vary over time based on operating conditions. There are factors outside the control of Neudorfer that impact airflow, and variance in those factors is expected and normal. One significant factor is the MERV rating and condition of the air filters on the equipment. During the summer of 2021, PPS began upgrading the filters on all their fan systems to MERV 13. Those upgraded filters are more effective at capturing particles but also impact the amount of airflow from the equipment. These filter changes were occurring while the airflow measurement project was happening, so some schools had the new filters, and some had the old filters at the time of measurement. On the data page included this report, there is a line stating whether or not the upgraded filters were in place at the time of measurement.



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor																
Rm 2	SF-4	AHU	33.6	47.3	1,621	14.0	22,698	1,460	1,460	100%	3.9	3.9	1	5.6	3.1	
2A	SF-4	AHU	9.9	11.6	115	7.3	838	65	65	100%	4.7	4.7	1	71.7	3.7	
Library 2B	SF-4	AHU	9.2	9.4	86	7.3	631	35	35	100%	3.3	3.3	1	93.0	2.7	
Rm 5	FCU-4 & SF-1	FCU, AHU	23.6	29.7	701	11.1	7,780	1505	1,105	73%	11.6	8.5	1	16.4	9.0	
Rm 6	SF-9	AHU	22.3	42.4	946	9.2	8,699	373	78	21%	2.6	0.5	2	15.0	1.9	
Rm 7	SF-9	AHU	22.1	41.6	919	9.2	8,458	402	84	21%	2.9	0.6	2	15.6	2.1	
Rm 8	SF-9	AHU	22.7	29.5	670	11.2	7,500	284	60	21%	2.3	0.5	1	9.3	1.7	
Cafeteria 13	SF-9	AHU	125.6	130.0	16,328	9.0	59,040	4,420	4,420	100%	4.5	4.5	3	6.5	3.6	Non-rectangular room.
9	SF-8 & 102	AHU	30.6	57.4	1,756	10.6	21,033	5,410	5,410	100%	15.4	15.4	1	15.1	12.3	Non-rectangular room.
9A	SF-9	AHU	9.1	10.4	95	8.1	767	80	17	21%	6.3	1.3	1	79.0	4.6	
9C	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is the walk-in cooler.
9-D	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is the walk-in cooler.
10	-	-	21.3	24.6	524	8.9	4,663	-	-	-	0.0	0.0	1	12.2	0.0	Ventilation provided by adjacent spaces.
11	71G FCU	FCU	18.0	21.6	389	9.3	3,616	425	425	100%	7.1	7.1	1	21.4	5.6	100% OSA. Return damper closed.
Rm 71-A	71G FCU	FCU	23.0	41.3	950	9.3	8,834	495	495	100%	3.4	3.4	2	15.6	2.7	100% OSA. Return damper closed.
Rm 71E	71G FCU	FCU	23.1	40.7	940	9.0	8,462	1,005	1,005	100%	7.1	7.1	1	12.4	5.7	100% OSA. Return damper closed.
74	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
75	EF	EF	8.2	29.6	243	8.0	1,942	-450	0	0%	13.9	0.0	1	39.4	10.0	Served by exhaust fan.
76	SF-6	AHU	11.3	16.5	186	8.0	1,492	206	29	14%	8.3	1.2	1	44.3	6.1	
77	EF	EF	6.6	14.4	95	8.0	760	-110	0	0%	8.7	0.0	1	81.2	6.2	Served by exhaust fan.
78	SF-6	AHU	10.3	15.9	164	8.0	1,310	93	13	14%	4.3	0.6	1	46.6	3.1	
79D	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
79E	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is a mechanical room.
79	SF-6	AHU	10.7	95.5	1,022	7.7	7,868	2,345	328	14%	17.9	2.5	1	20.3	13.1	

Date: 11/11/2021

Readings By: Mayer



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
Lower Level 1																
79A	-	-	22.4	24.8	556	7.9	4,389	-	-	-	0.0	0.0	0	N/A	N/A	This is a restroom.
79A-1	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
77B	-	-	11.9	8.3	99	40.4	3,990	-	-	-	0.0	0.0	0	N/A	N/A	This is a shower.
73	SF-6	AHU	46.1	48.2	2,222	12.7	28,220	3,100	3,100	100%	6.6	6.6	1	7.3	5.3	
16	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is a restroom.
17	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is a restroom.
32	-	-	13.2	29.2	385	9.6	3,700	-	-	-	0.0	0.0	1	15.4	0.0	Ventilation provided by adjacent spaces.
61	SF-6	AHU	28.0	46.0	1,288	17.9	23,055	2,640	2,640	100%	6.9	6.9	1	8.0	5.5	
61A	-	-	7.2	9.4	68	9.4	636	-	-	-	0.0	0.0	1	89.6	0.0	Ventilation provided by adjacent spaces.
62	EF	EF	8.3	42.8	355	8.0	2,842	-775	0	0%	16.4	0.0	1	31.8	11.8	Served by exhaust fan.
63	SF-6	AHU	10.7	95.5	1,022	7.7	7,868	1,555	1,555	100%	11.9	11.9	1	16.7	9.5	
63B	-	-	11.9	8.3	99	40.4	3,990	-	-	-	0.0	0.0	0	N/A	N/A	This is a shower.
63A	SF-6	AHU	14.0	23.0	322	7.6	2,447	350	350	100%	8.6	8.6	1	30.2	6.9	
86B	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
80A	SF-6	AHU	14.0	20.1	281	8.1	2,279	465	465	100%	6.5	6.5	1	18.5	5.2	
80	-	-	9.9	21.3	211	9.5	2,003	-	-	-						This is open to 80A.
81	SF-6	AHU	10.0	21.1	211	9.5	2,005	110	110	100%	3.3	3.3	1	31.1	2.6	
85	SF-6	AHU	11.9	27.7	330	7.9	2,604	250	250	100%	5.8	5.8	1	26.5	4.6	
84	SF-6	AHU	11.9	27.7	330	7.9	2,604	330	330	100%	7.6	7.6	1	28.0	6.1	
84B	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is a restroom.
86	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is covered outdoor storage.
83	SF-6	AHU	11.9	27.7	330	7.9	2,604	320	320	100%	7.4	7.4	1	27.8	5.9	
82	SF-6	AHU	11.9	27.7	330	7.9	2,604	290	290	100%	6.7	6.7	1	27.2	5.3	
69A	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.

Date: 11/11/2021

Readings By: Mayer



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Lower Level 1																
69	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
82A	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
88	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
87	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
68	SF-6	AHU	8.9	11.9	106	8.0	847	180	180	100%	12.7	12.7	1	77.5	10.2	
64	EF	EF	6.4	20.2	129	8.0	1,034	-165	0	0%	9.6	0.0	1	62.0	6.9	Served by exhaust fan.
65	SF-6	AHU	9.5	10.0	95	8.1	770	200	200	100%	15.6	15.6	1	86.5	12.5	
41B	-	-	7.1	7.1	50	8.0	403	-	-	-	0.0	0.0	1	141.3	0.0	Ventilation provided by adjacent spaces.
Conf. Room 41A	EF	EF	10.3	19.0	196	8.2	1,605	-280	0	0%	10.5	0.0	1	43.1	7.5	Served by exhaust fan.
Rm 43A	FCU-1&2, SF-2	AHU, FCUs	19.8	39.1	774	10.8	8,361	610	610	100%	4.4	4.4	1	10.3	3.5	
24	-	-	15.3	27.2	416	8.9	3,704	-	-	-	0.0	0.0	1	15.4	0.0	Ventilation provided by adjacent spaces.
Rm 43	SF-2	AHU	26.0	57.0	1,363	10.8	16,872	285	285	100%	0.9	0.9	1	3.7	0.7	
43B	-	-	14.5	17.0	247	8.9	2,194	-	-	-						This is open to Rm 43.
25	SF-2	AHU	7.7	14.4	111	7.0	776	115	115	100%	8.9	8.9	1	80.6	7.1	
Rm 48	FCU-3 & SF-2	AHU, FCU	21.3	35.5	756	9.3	7,032	375	375	100%	3.2	3.2	2	18.8	2.6	Split level ceiling.
Lower Level 1																
Rm 163	-	-	-	-	-	-	-	-	-	-	0.0	0.0	-	N/A	N/A	This room does not exist.
Auditorium 154	SF-3	AHU	57.4	63.0	3,244	26.4	80,826	8,875	8,076	91%	3.7	3.4	2	3.7	2.9	Non-rectangular room.
Stage 162	-	-	32.4	57.9	1,876	33.2	62,282	-	-	-						Open to Auditorium.
Rm 153	-	-	23.8	26.0	619	17.7	10,953	-	-	-	0.0	0.0	1	5.2	0.0	Ventilation provided by adjacent spaces.
Rm 152	SF-4	AHU	25.3	28.5	721	10.5	7,571	390	390	100%	3.1	3.1	1	10.0	2.5	
Rm 151	SF-4	AHU	24.5	28.8	706	10.5	7,168	490	490	100%	4.1	4.1	1	11.2	3.3	Split level floor.
Rm 168	SF-4	AHU	18.7	32.1	600	10.5	6,303	385	385	100%	3.7	3.7	1	12.0	2.9	
Rm 169	SF-4	AHU	31.3	38.6	1,208	10.5	12,686	690	690	100%	3.3	3.3	1	7.1	2.6	

Date: 11/11/2021

Readings By: Mayer



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor																
169A	SF-4	AHU	8.5	17.4	119	8.1	963	100	100	100%	6.2	6.2	1	64.2	5.0	Non-rectangular room.
Rm 140	SF-1	AHU	25.9	29.6	767	10.4	7,973	720	720	100%	5.4	5.4	1	11.5	4.3	
Rm 147	SF-1	AHU	25.9	29.6	767	10.4	7,973	690	690	100%	5.2	5.2	1	11.3	4.2	
Rm 141	SF-1	AHU	25.9	29.6	767	10.5	8,050	780	780	100%	5.8	5.8	1	11.7	4.7	
Rm 146	SF-1	AHU	31.2	38.7	1,207	10.5	12,678	690	690	100%	3.3	3.3	1	7.1	2.6	
Rm 142	SF-1	AHU	25.5	29.6	755	10.5	7,925	710	710	100%	5.4	5.4	1	11.5	4.3	
Rm 145	SF-1	AHU	25.8	29.5	761	10.4	7,915	545	545	100%	4.1	4.1	1	10.5	3.3	
Rm 143	SF-1	AHU	25.5	29.8	760	10.5	7,979	700	700	100%	5.3	5.3	1	11.4	4.2	
Rm 144	SF-1	AHU	26.5	25.0	663	10.5	6,956	570	570	100%	4.9	4.9	1	12.1	3.9	
Rm P1	FC-2 (P1)	FCU	26.8	28.3	758	9.9	7,509	543	233	43%	4.3	1.9	1	10.9	3.3	
Rm P2	FC-1 (P2)	FCU	26.8	28.3	758	9.9	7,509	590	250	42%	4.7	2.0	1	11.1	3.6	
Rm P3	FC-2 (P3)	FCU	26.8	28.3	758	9.9	7,509	1,095	370	34%	8.8	3.0	1	14.1	6.5	
Rm P4	FC-1 (P4)	FCU	26.8	2.3	62	9.0	555	1,175	480	41%	127.1	51.9	1	198.4	95.6	
Conf. Room 101	SF-1	AHU	15.7	21.5	338	9.4	3,173	275	275	100%	5.2	5.2	1	22.1	4.2	
100A	SF-1	AHU	11.5	19.0	219	9.4	2,054	185	185	100%	5.4	5.4	1	32.1	4.3	
Conf. Room 100	SF-1	AHU	20.5	28.7	683	9.4	6,423	705	705	100%	6.6	6.6	1	14.1	5.3	
100B	-	-	11.3	18.7	211	9.3	1,965	-	-	-	0.0	0.0	1	29.0	0.0	Ventilation provided by adjacent spaces.
100C	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is storage.
100D	-	-	5.7	14.6	83	8.5	707	-	-	-	0.0	0.0	1	80.6	0.0	Ventilation provided by adjacent spaces.
102A	SF-1	AHU	9.2	14.5	133	9.4	1,254	95	95	100%	4.5	4.5	1	49.1	3.6	
104	SF-1	AHU	21.0	29.7	190	9.0	1,707	115	115	100%	4.0	4.0	1	36.6	3.2	
102B	SF-1	AHU	10.8	14.5	157	9.4	1,472	105	105	100%	4.3	4.3	1	42.1	3.4	
134	SF-1	AHU	8.1	13.3	108	8.4	905	125	125	100%	8.3	8.3	1	69.6	6.6	
Conf. Rm 133A	AHU-101	AHU	6.1	10.2	62	8.3	516	90	79	88%	10.5	9.2	1	118.6	8.3	

Date: 11/11/2021

Readings By: Mayer



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH _e) with Portable Filter	Total Effective Air Changes per Hour (ACH _e) without Portable Filter	
First Floor																
Conf. Rm 133B	AHU-101	AHU	9.2	18.0	166	9.3	1,540	120	106	88%	4.7	4.1	2	77.7	3.7	
Conf. Rm 133C	AHU-101	AHU	9.2	14.0	129	9.4	1,211	95	84	88%	4.7	4.1	1	50.8	3.7	
Conf. Rm 133E	AHU-101	AHU	9.2	14.0	129	9.4	1,211	100	88	88%	5.0	4.4	1	51.0	3.9	
Conf. Rm 133G	AHU-101	AHU	9.2	14.0	129	9.3	1,198	110	97	88%	5.5	4.8	1	51.9	4.4	
133H	AHU-101	AHU	9.2	18.8	173	9.0	1,557	135	119	88%	5.2	4.6	1	40.7	4.1	
133	AHU-101, SF-1&2	AHU	22.4	51.3	1,221	8.5	10,380	940	905	96%	5.4	5.2	1	9.8	4.3	Non-rectangular room.
133L	SF-1	AHU	8.0	9.9	79	8.4	665	125	125	100%	11.3	11.3	1	94.7	9.0	
133K	SF-1	AHU	6.6	9.6	63	8.4	532	117	117	100%	13.2	13.2	1	117.6	10.6	
Conf. Room 133J	SF-2	AHU	13.0	17.3	220	8.0	1,763	115	115	100%	3.9	3.9	1	35.5	3.1	Non-rectangular room.
105	SF-7	AHU	29.3	30.9	905	10.4	9,416	665	665	100%	4.2	4.2	1	9.4	3.4	
Rm 106	SF-7	AHU	28.6	29.6	847	10.5	8,889	240	240	100%	1.6	1.6	1	7.7	1.3	
Rm 107	SF-7	AHU	28.6	23.5	672	10.5	7,057	200	200	100%	1.7	1.7	1	9.4	1.4	
Rm 108	SF-7	AHU	28.6	29.6	847	10.5	8,889	450	450	100%	3.0	3.0	1	8.8	2.4	
Rm 109	SF-7	AHU	28.5	29.6	782	10.6	8,285	690	690	100%	5.0	5.0	1	10.9	4.0	Non-rectangular room.
Gym 110	SF-5	AHU	105.5	106.2	11,204	22.8	255,453	15,462	15,462	100%	3.6	3.6	1	3.1	2.9	
Rm 115	SF-2	AHU	25.2	30.5	769	10.5	8,070	390	390	100%	2.9	2.9	1	9.4	2.3	
Rm 116	SF-2	AHU	25.2	29.5	743	10.5	7,806	460	460	100%	3.5	3.5	1	10.1	2.8	
Rm 117	SF-2	AHU	25.2	29.5	743	10.5	7,806	520	520	100%	4.0	4.0	1	10.5	3.2	
126	SF-2	AHU	10.4	11.1	115	8.8	1,016	310	310	100%	18.3	18.3	1	70.8	14.6	
126D	-	-	9.6	10.2	98	10.6	1,038	-	-	-	0.0	0.0	1	54.9	0.0	Ventilation provided by adjacent spaces.
126E	-	-	9.6	10.2	98	10.6	1,038	-	-	-	0.0	0.0	1	54.9	0.0	Ventilation provided by adjacent spaces.
126B	SF-2	AHU	6.7	20.7	139	10.6	1,470	245	245	100%	10.0	10.0	1	46.8	8.0	
Rm 125	SF-2	AHU	25.2	49.2	1,240	11.1	13,762	740	740	100%	3.2	3.2	1	6.7	2.6	
Rm 120	SF-2	AHU	25.7	29.6	761	10.5	7,988	480	480	100%	3.6	3.6	1	10.0	2.9	

Date: 11/11/2021

Readings By: Mayer



AIRFLOW SURVEY REPORT

Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH					Notes
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	
First Floor																
Rm 124	SF-2	AHU	25.6	37.7	965	10.5	10,134	650	650	100%	3.8	3.8	1	8.7	3.1	
Rm 121	SF-2	AHU	25.7	48.8	1,254	10.4	13,043	615	615	100%	2.8	2.8	1	6.6	2.3	
Rm 123	SF-2	AHU	23.5	39.6	931	10.5	9,771	760	760	100%	4.7	4.7	1	9.6	3.7	
Rm 122	SF-2	AHU	25.7	48.4	1,244	10.5	13,061	750	750	100%	3.4	3.4	1	7.1	2.8	
Second Floor																
Auditorium 238	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	Volume included in Auditorium recording.
Rm 236	SF-1	AHU	19.4	25.9	502	10.6	5,326	540	540	100%	6.1	6.1	1	15.6	4.9	
Rm 229	SF-1	AHU	25.5	29.6	755	10.6	8,001	580	580	100%	4.3	4.3	1	10.6	3.5	
Rm 235	SF-1	AHU	25.9	29.6	767	10.6	8,126	530	530	100%	3.9	3.9	1	10.1	3.1	
Rm 230	SF-1	AHU	25.6	36.9	897	10.6	9,504	780	780	100%	4.9	4.9	1	9.9	3.9	Non-rectangular room.
Rm 234	SF-1	AHU	25.9	29.6	767	10.6	8,126	540	540	100%	4.0	4.0	1	10.2	3.2	
Rm 231	SF-1	AHU	24.4	48.7	1,188	10.6	12,596	710	710	100%	3.4	3.4	1	7.2	2.7	
Rm 233	SF-1	AHU	25.0	29.6	740	10.6	7,844	535	535	100%	4.1	4.1	1	10.5	3.3	
Rm 232	SF-1	AHU	25.9	29.4	761	10.6	8,071	510	510	100%	3.8	3.8	1	10.1	3.0	
206A	-	-	4.7	8.1	38	8.3	316	-	-	-	0.0	0.0	1	180.4	0.0	Ventilation provided by adjacent spaces.
206C	-	-	9.1	10.7	97	10.0	974	-	-	-	0.0	0.0	1	58.5	0.0	Ventilation provided by adjacent spaces.
Library 206	SF-1 & 2	AHU	20.4	125.4	2,344	10.5	24,614	1,565	1,565	100%	3.8	3.8	3	10.0	3.1	Non-rectangular room.
225D	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	This is a telecom closet.
225	AHU-101	AHU	18.9	23.1	437	10.6	5,219	410	361	88%	4.7	4.1	1	14.6	3.7	Non-rectangular room.
Rm 224	AHU-101	AHU	28.7	36.0	1,033	10.5	10,849	130	114	88%	0.7	0.6	1	5.8	0.6	
Rm 223	AHU-101	AHU	28.7	36.0	1,033	10.5	10,849	155	136	88%	0.9	0.8	1	5.9	0.7	
222	AHU-101	AHU	18.8	23.0	432	10.5	5,757	485	427	88%	5.1	4.4	1	13.9	4.0	Non-rectangular room.
Balcony 237	SF-2	AHU	20.3	24.3	481	10.5	5,054	305	305	100%	3.6	3.6	1	14.2	2.9	
Balcony 207	-	-	-	-	-	-	-	-	-	-	0.0	0.0	0	N/A	N/A	Volume included in Gym recording.

Date: 11/11/2021

Readings By: Mayer

Project:	Portland Public Schools Airflow Testing
Location:	Lincoln HS; 1600 SW Salmon St, Portland, OR 97205
Filter Status:	Upgraded

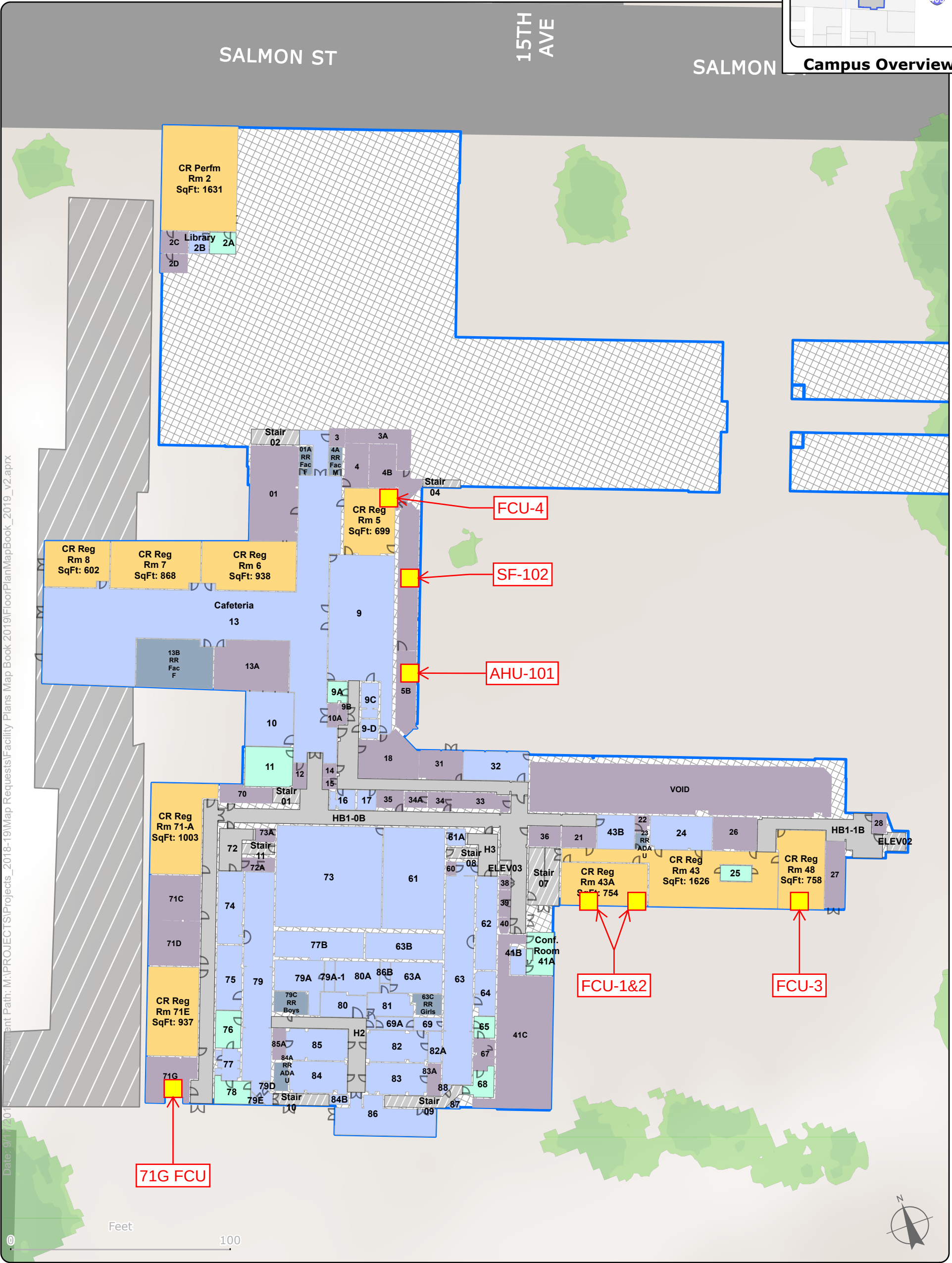
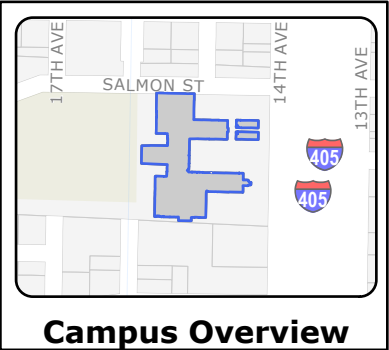
Date: 11/11/2021



Project: Portland Public Schools Airflow Testing
Location: Lincoln HS; 1600 SW Salmon St, Portland, OR 97205

NOTE #	NOTE DESCRIPTION

LINCOLN: Lower Level 1



Space Use	School Grounds
Classroom	Campus Footprints
Office	Athletic Field
Rest Room	Playground: Paved
Special Purpose	Playground: Unpaved
Corridor	Streets
Other	Doors
Stairs/Elevator	

Total Number Of Rooms By Classification

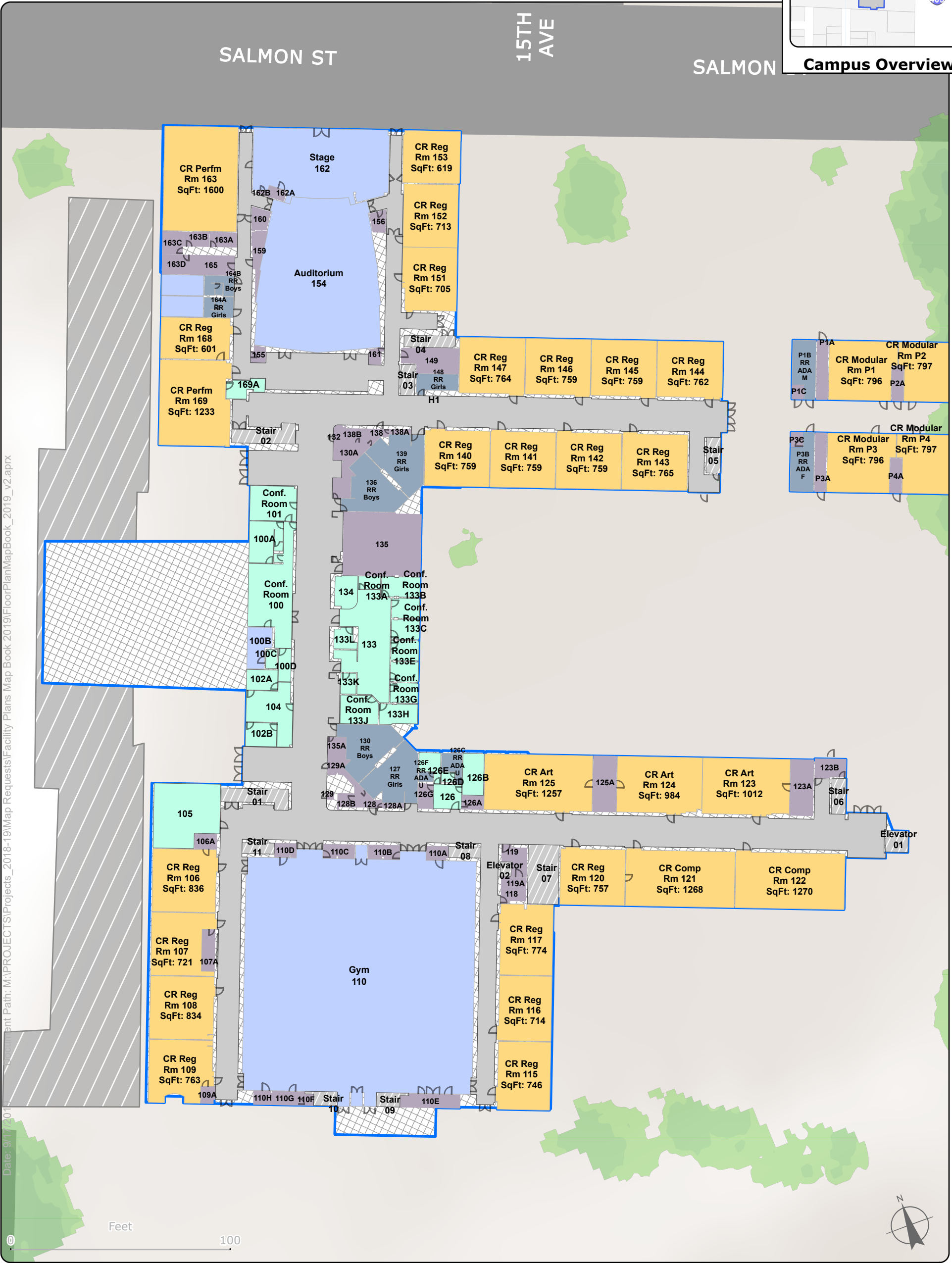
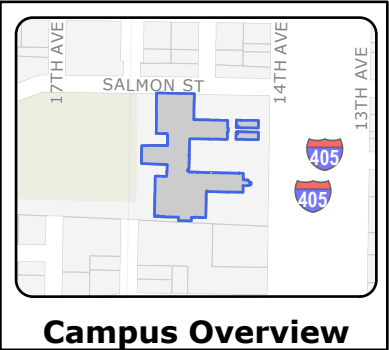
Classrooms: 10

Special Purpose: 44

Office Spaces: 9

Storage: 32

LINCOLN: First Floor

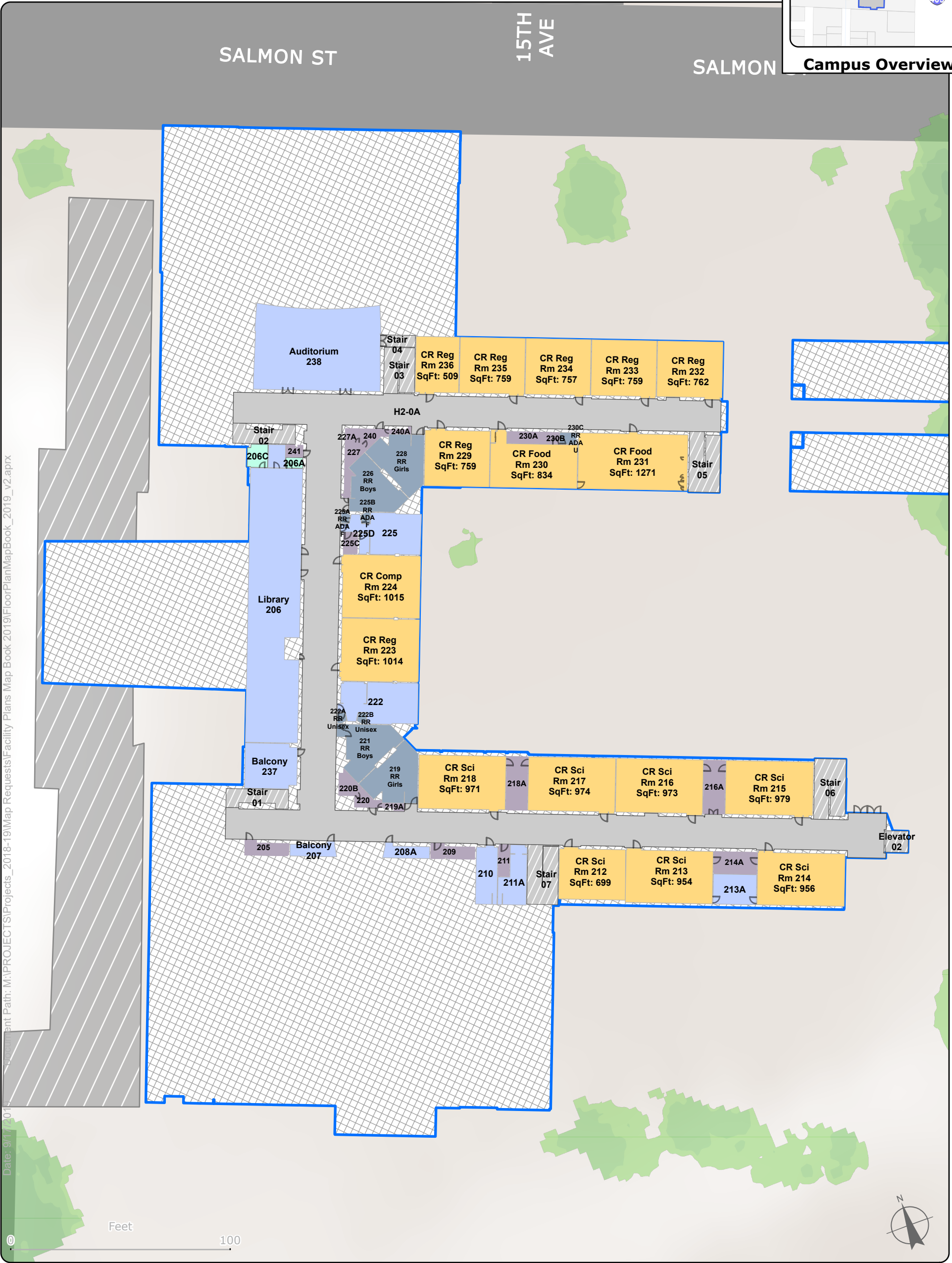
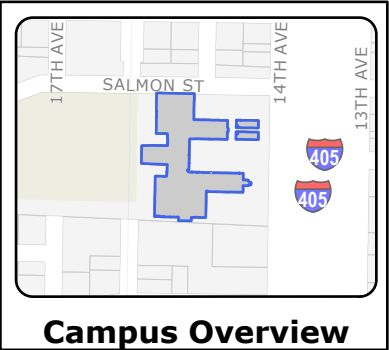


Space Use	School Grounds
Classroom	Campus Footprints
Office	Athletic Field
Rest Room	Playground: Paved
Special Purpose	Playground: Unpaved
Corridor	Streets
Other	Doors
Stairs/Elevator	

Total Number Of Rooms By Classification

Classrooms: 27	Special Purpose: 6
Office Spaces: 27	Storage: 36

LINCOLN: Second Floor



Space Use

Classroom

Office

Rest Room

Special Purpose

Corridor

Other

Stairs/Elevator

School Grounds

Campus Footprints

Athletic Field

Playground: Paved

Playground: Unpaved

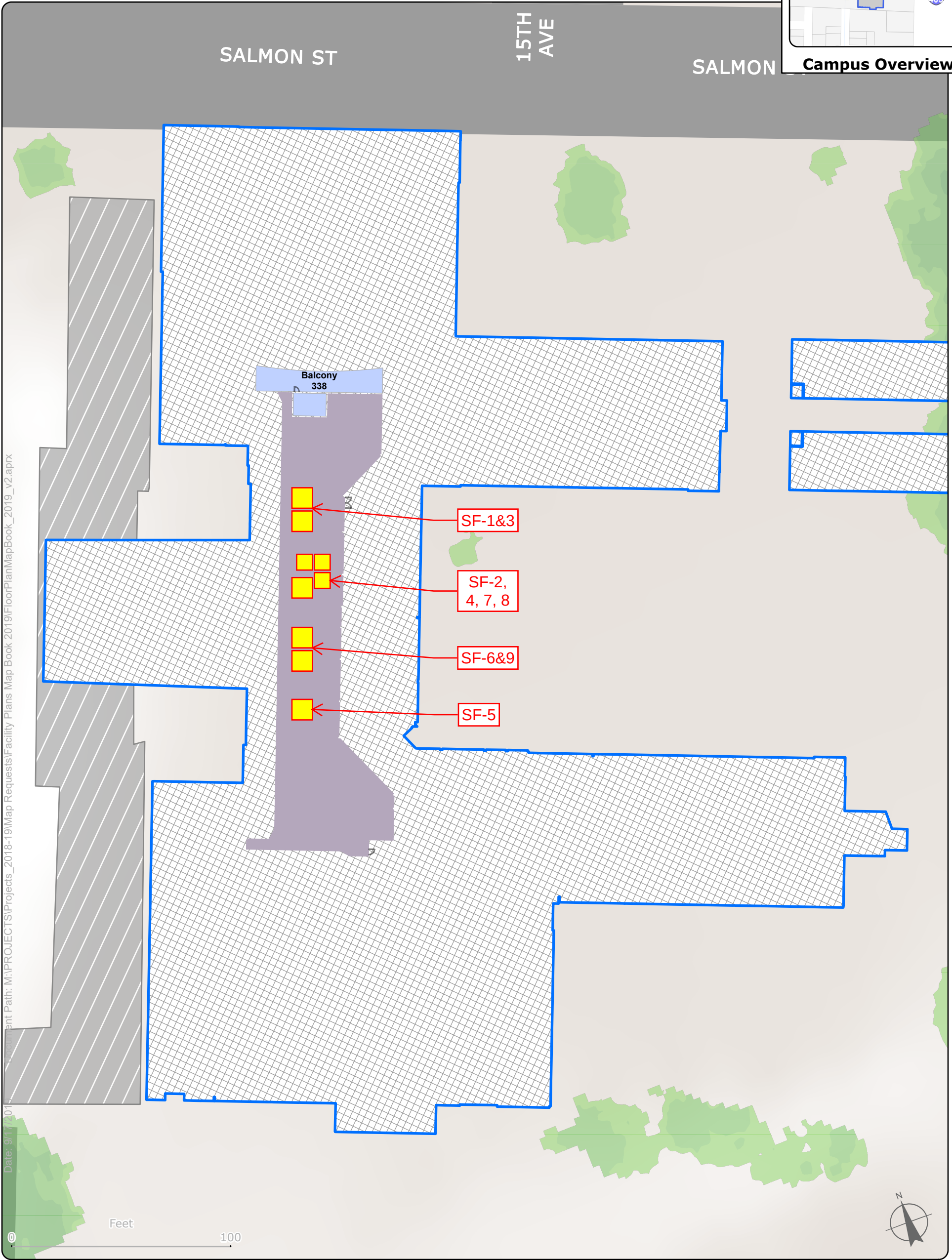
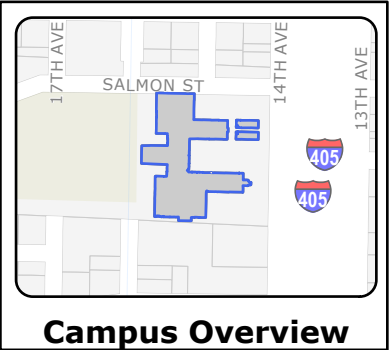
Streets

Doors

Total Number Of Rooms By Classification			
Classrooms: 17		Special Purpose: 12	
Office Spaces: 2		Storage: 12	

Page 18 of 19

LINCOLN: Third Floor



Space Use	School Grounds
Classroom	Campus Footprints
Office	Athletic Field
Rest Room	Playground: Paved
Special Purpose	Playground: Unpaved
Corridor	Streets
Other	Doors
Stairs/Elevator	

Total Number Of Rooms By Classification

Classrooms: 0	Special Purpose: 2
Office Spaces: 0	Storage: 0