Lexington High School

PBC Meeting

05/01/2025

smma dw DORE + WHITTIER Turner

Site Design – Introduction & Discussion

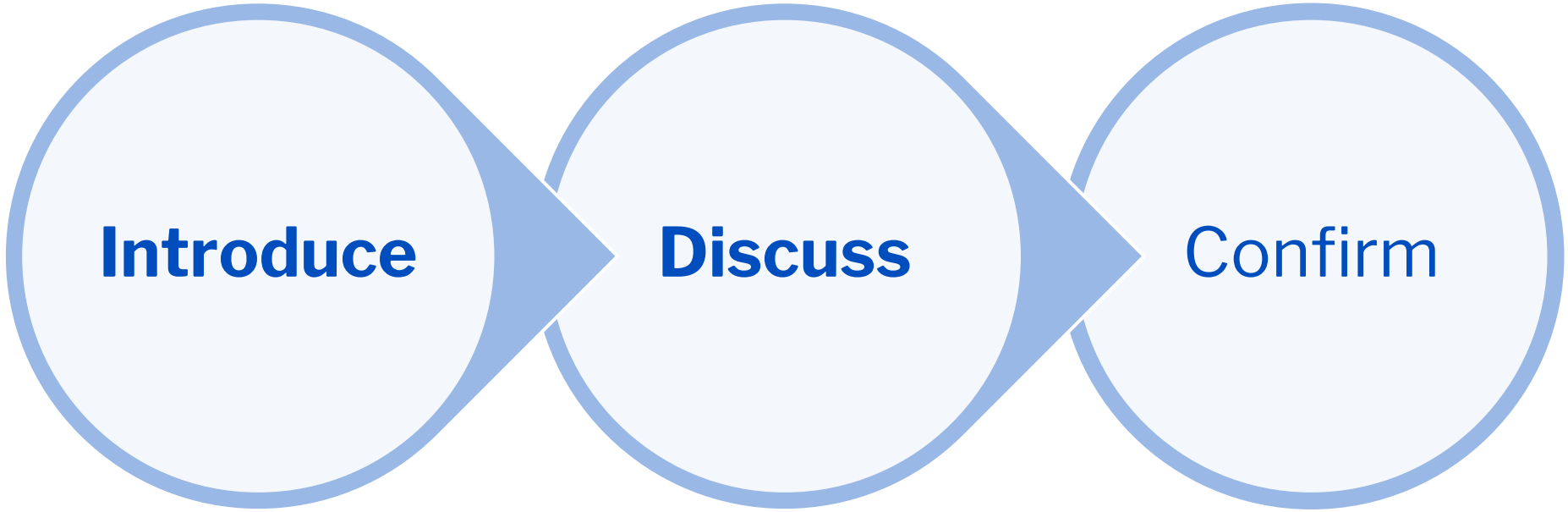
- ❑ Goals, Process, and Program
- ❑ Site Diagrams
- ❑ Site Design Options
- ❑ Feature Space Design: Outdoor Learning Environments, Entrance Plazas, Quad & Roof Terrace

Renewable Energy – Discussion

- ❑ Energy Storage Battery Location
- ❑ EV Charging Station Quantity

HVAC Design – Confirmation

- ❑ LCCA for HVAC Option
- ❑ Select Basis of Design HVAC Option

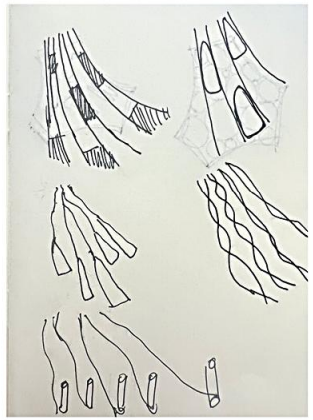

Introduce
Discuss
Confirm
May 1, 2025
May 1, 2025
May 22, 2025

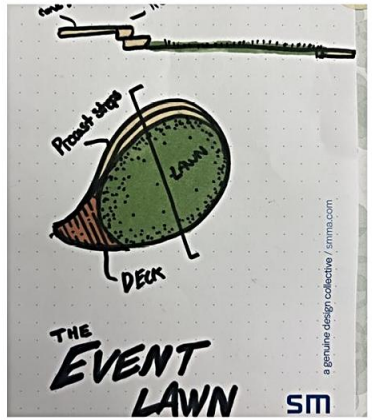
Goals, Process, and Program

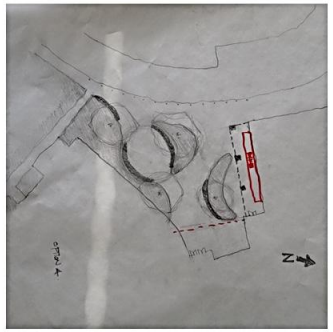
Goals

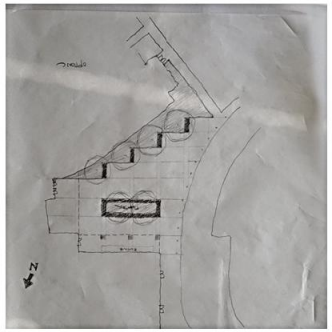
- ***Placemaking*** that tells a story
- ***Total Design*** approach that shapes the student experience
- ***Reimagine*** the campus as part of the larger recreation complex, blending identity, resilience, and modern needs
- ***Create*** a campus that is both participatory and educational, creating a strong campus identity
- ***Celebrate*** Lexington High School's values
- ***Develop*** a cohesive campus with an open narrative- a living "page" where every student is free to write their own story
- ***Intentional*** narrative "canvas", sparking curiosity and inviting movement
- ***Program*** outdoor spaces based on needs of the users
- ***Students, Faculty and Staff*** drive the program through a dynamic participatory model
- ***Goal*** is not just functional spaces, but living spaces, created with and by its users

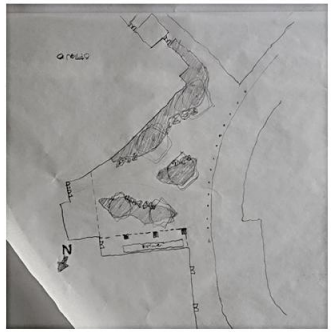
Process / From Concept to Refinement

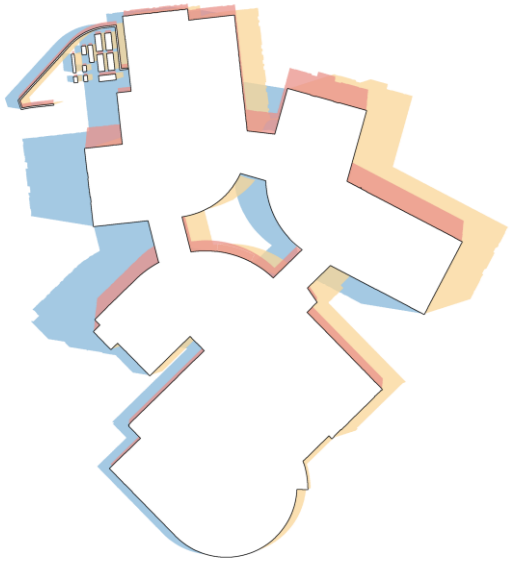






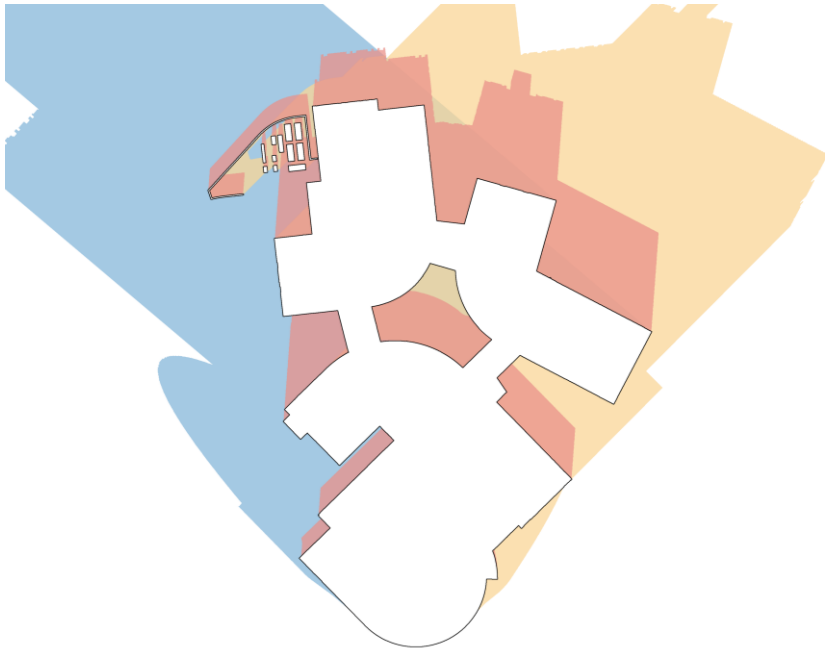






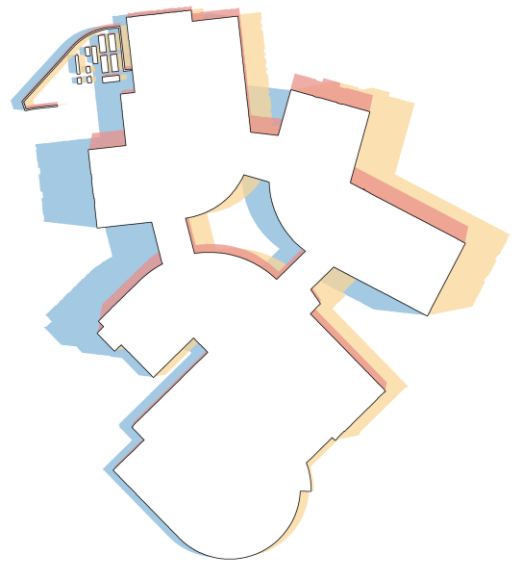
First Week of School

August



Winter Solstice

December



Last Week of School

June

8am **12pm** **3pm**

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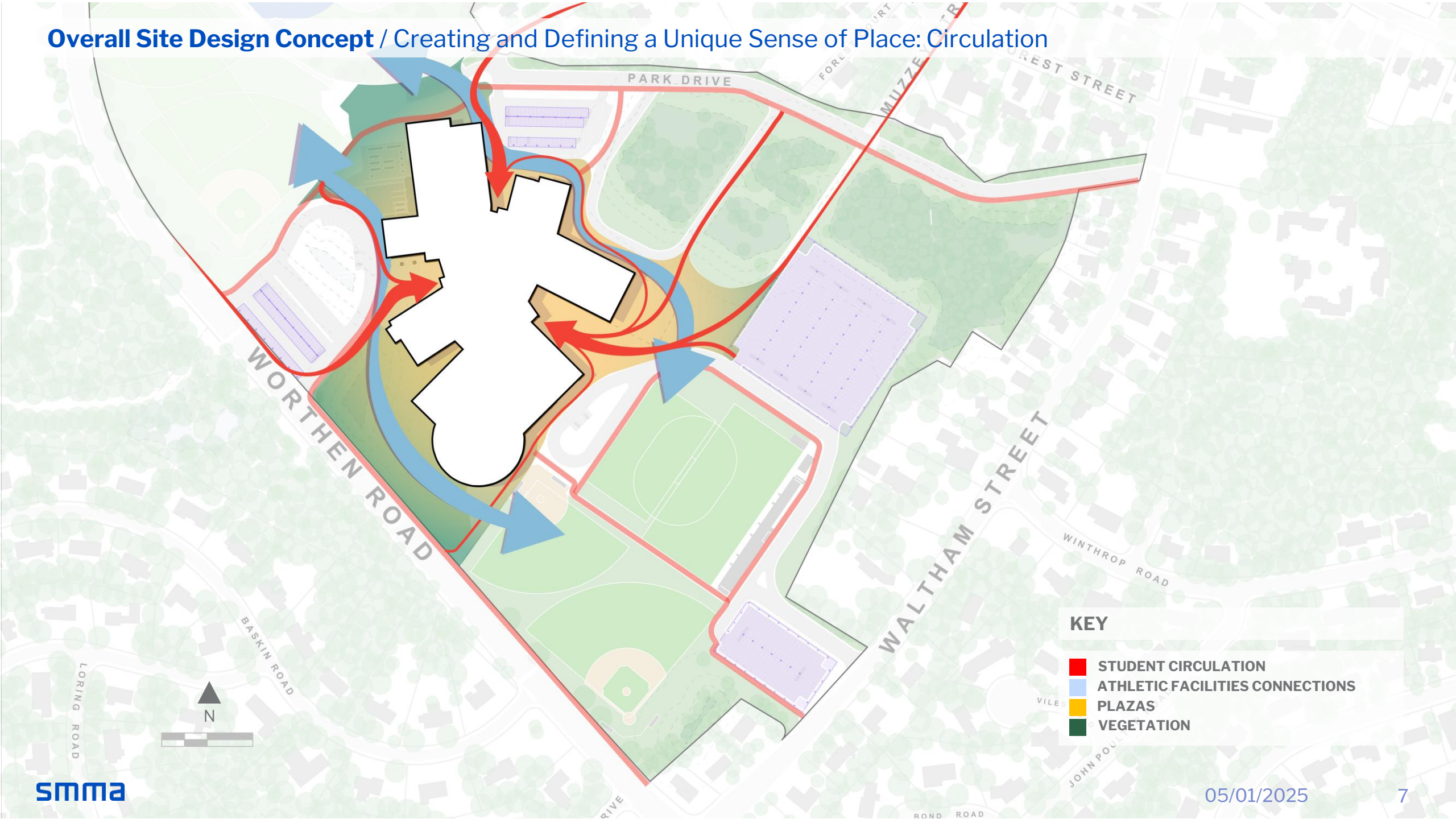
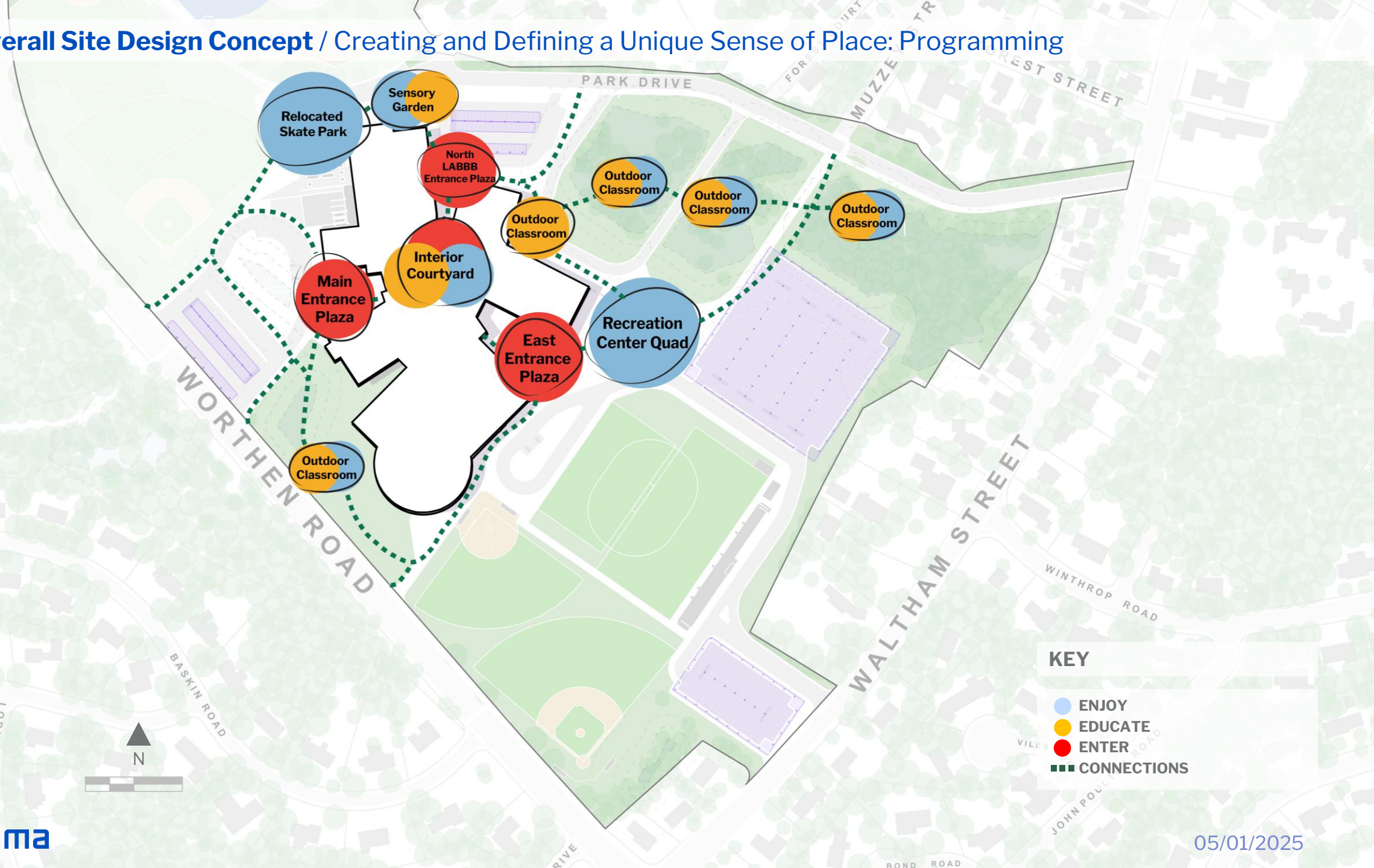
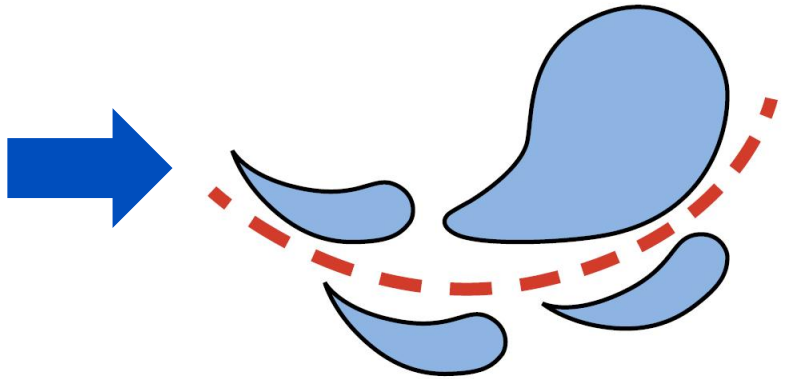
Overall Site Design Concept / Creating and Defining a Unique Sense of Place: Circulation



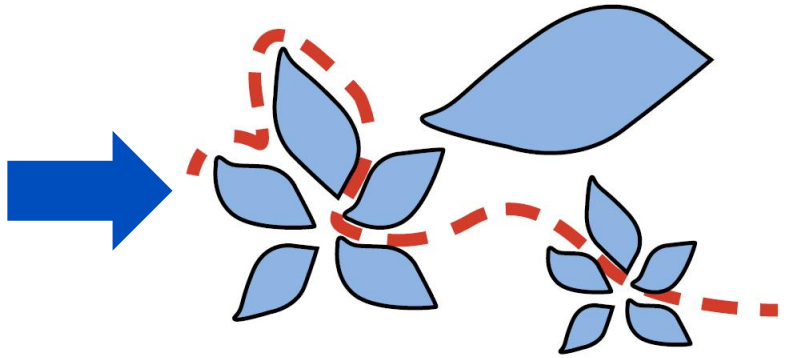
Overall Site Design Concept / Creating and Defining a Unique Sense of Place: Programming



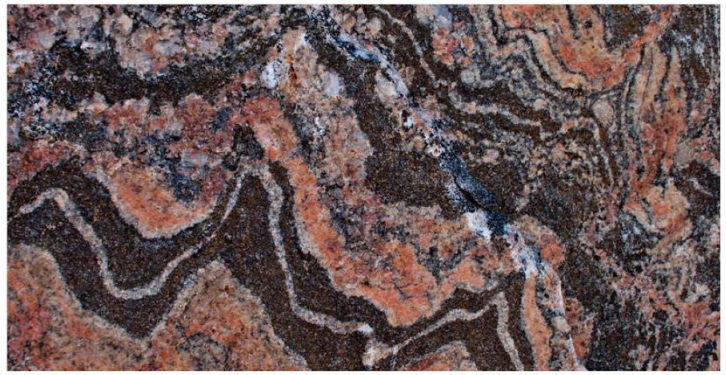

Fluid

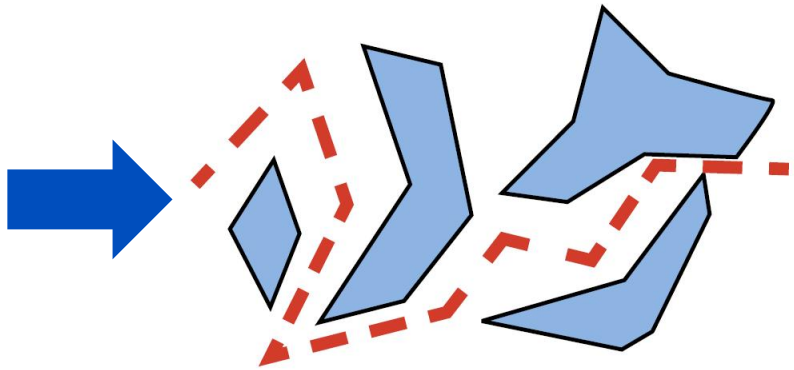



Understory

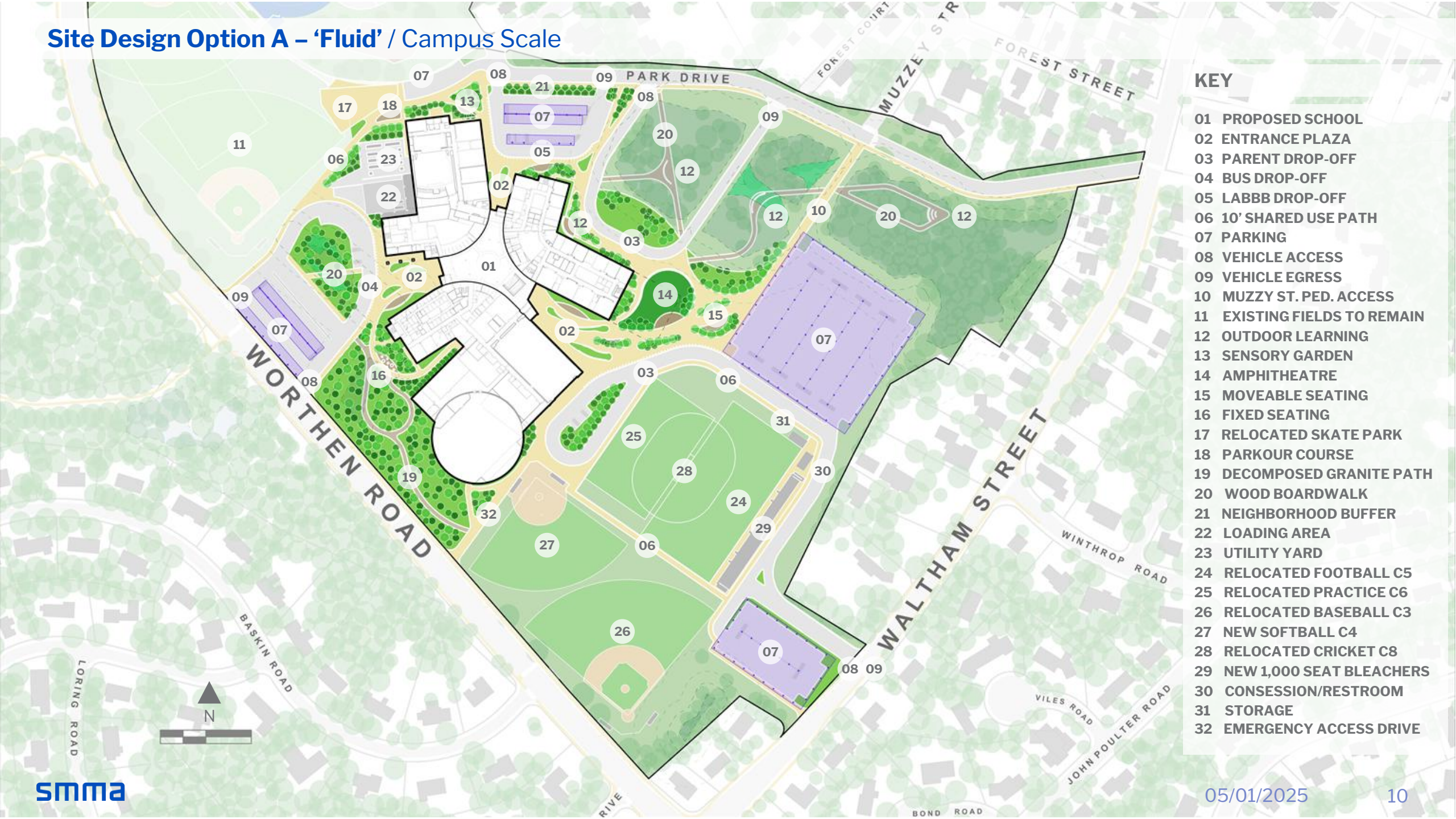



Tectonic





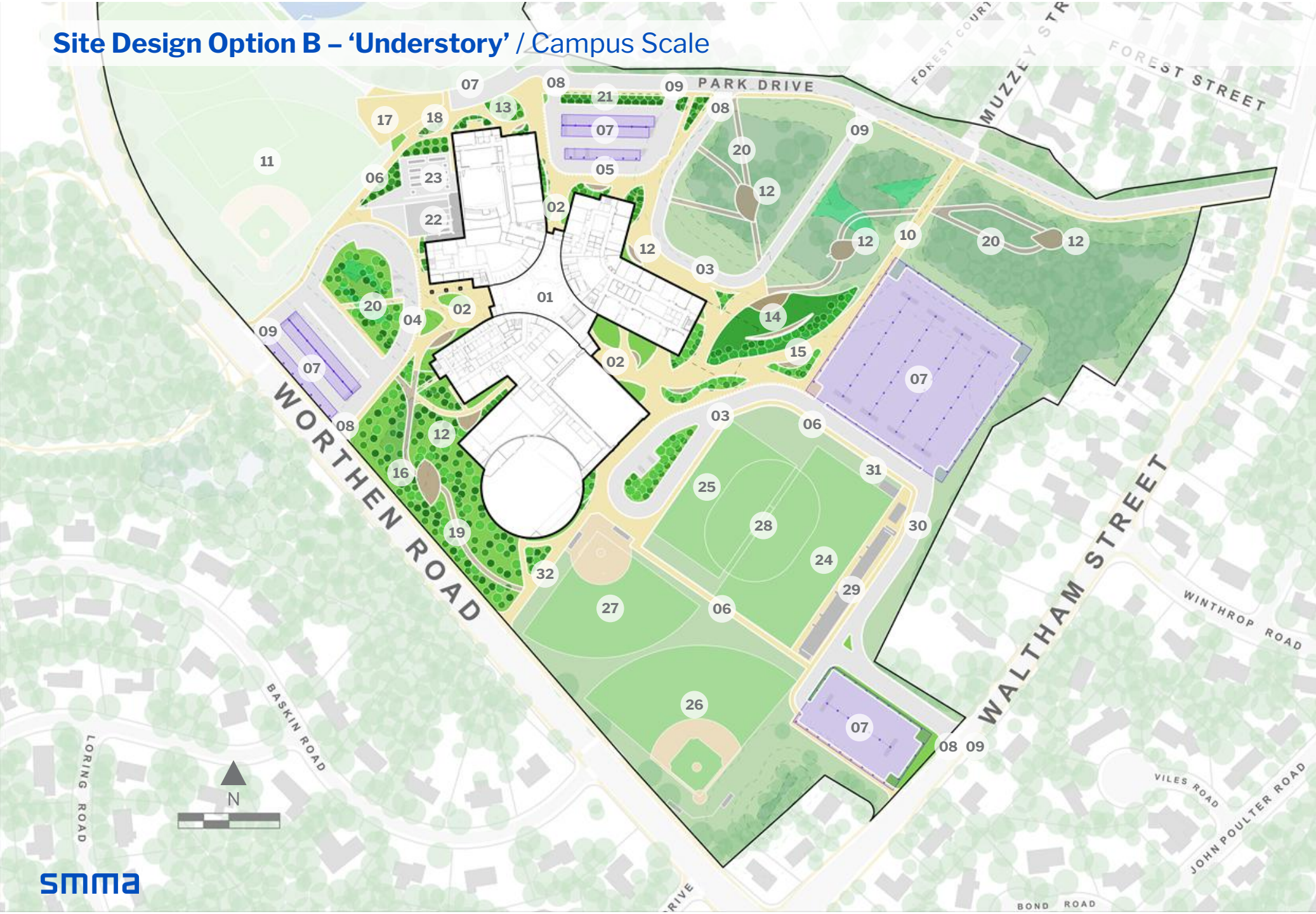
Site Design Option A – 'Fluid' / Campus Scale



KEY

01 PROPOSED SCHOOL
02 ENTRANCE PLAZA
03 PARENT DROP-OFF
04 BUS DROP-OFF
05 LABBB DROP-OFF
06 10' SHARED USE PATH
07 PARKING
08 VEHICLE ACCESS
09 VEHICLE EGRESS
10 MUZZY ST. PED. ACCESS
11 EXISTING FIELDS TO REMAIN
12 OUTDOOR LEARNING
13 SENSORY GARDEN
14 AMPHITHEATRE
15 MOVEABLE SEATING
16 FIXED SEATING
17 RELOCATED SKATE PARK
18 PARKOUR COURSE
19 DECOMPOSED GRANITE PATH
20 WOOD BOARDWALK
21 NEIGHBORHOOD BUFFER
22 LOADING AREA
23 UTILITY YARD
24 RELOCATED FOOTBALL C5
25 RELOCATED PRACTICE C6
26 RELOCATED BASEBALL C3
27 NEW SOFTBALL C4
28 RELOCATED CRICKET C8
29 NEW 1,000 SEAT BLEACHERS
30 CONSESSION/RESTROOM
31 STORAGE
32 EMERGENCY ACCESS DRIVE

Site Design Option B – ‘Understory’ / Campus Scale



KEY

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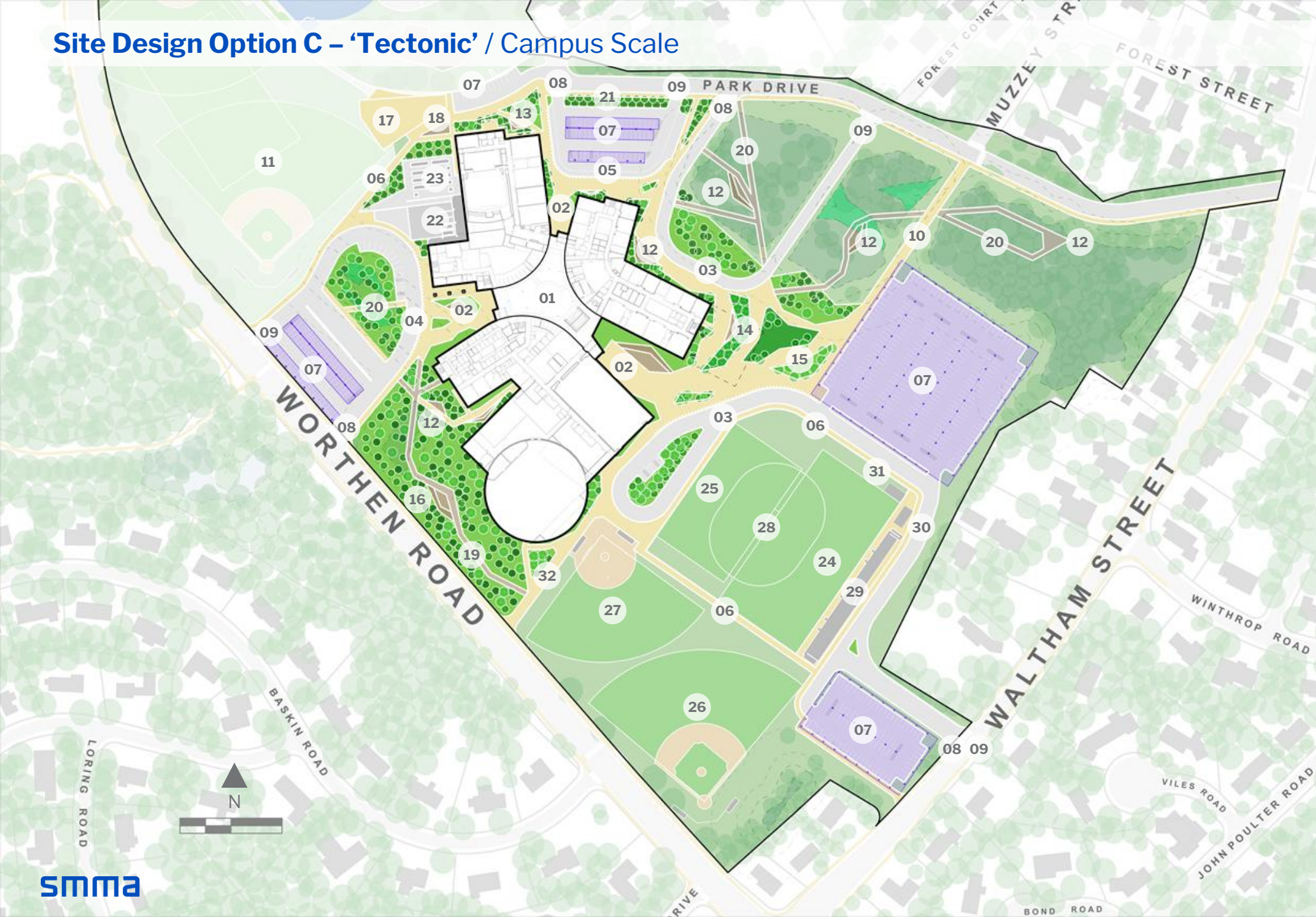
29 NEW 1,000 SEAT BLEACHERS
30 CONSESSION/RESTROOM
31 STORAGE
32 EMERGENCY ACCESS DRIVE

Site Design Option C – 'Tectonic' / Campus Scale



KEY

01 PROPOSED SCHOOL
02 ENTRANCE PLAZA
03 PARENT DROP-OFF
04 BUS DROP-OFF
05 LABBB DROP-OFF
06 10' SHARED USE PATH
07 PARKING
08 VEHICLE ACCESS
09 VEHICLE EGRESS
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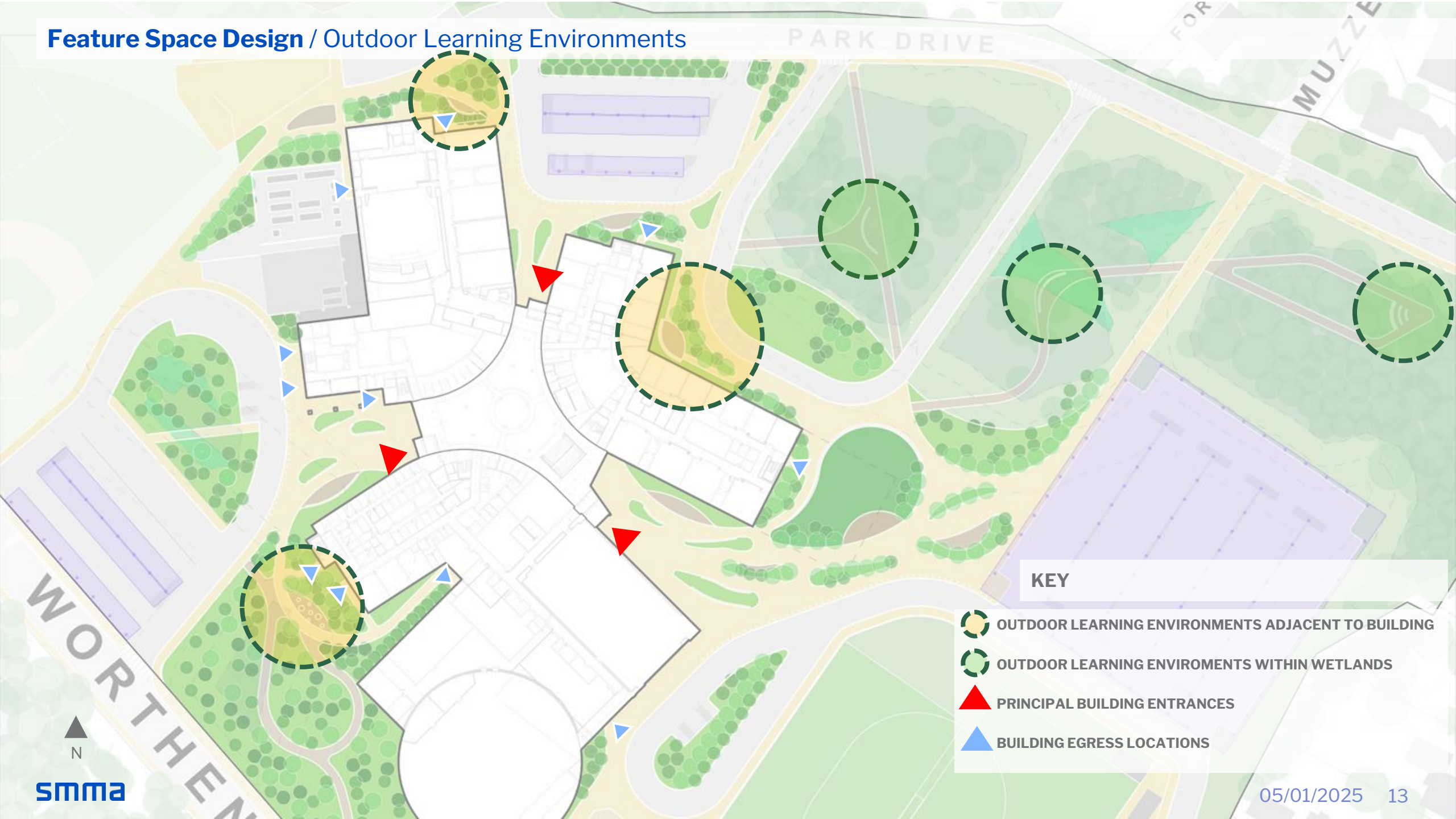
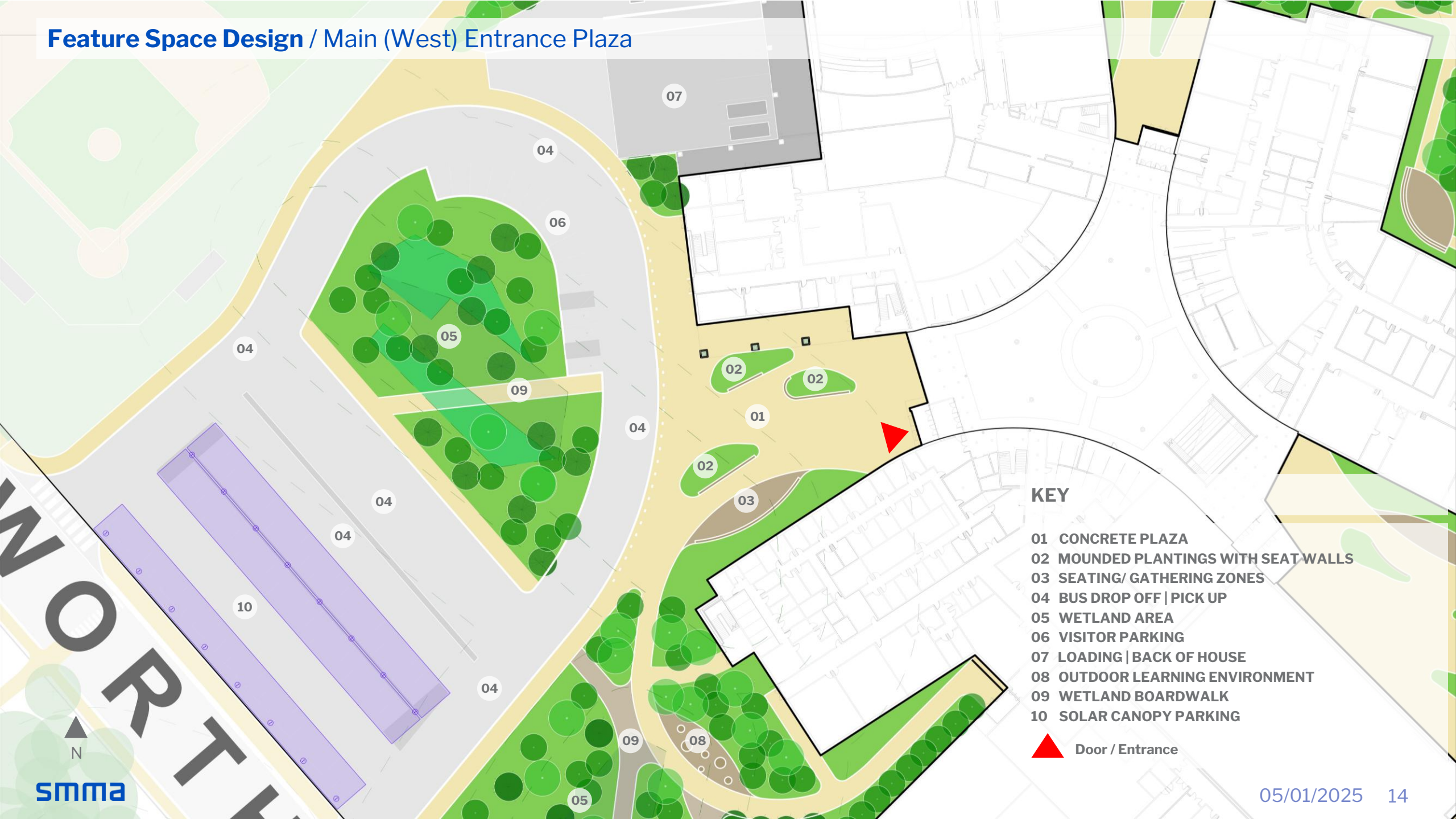
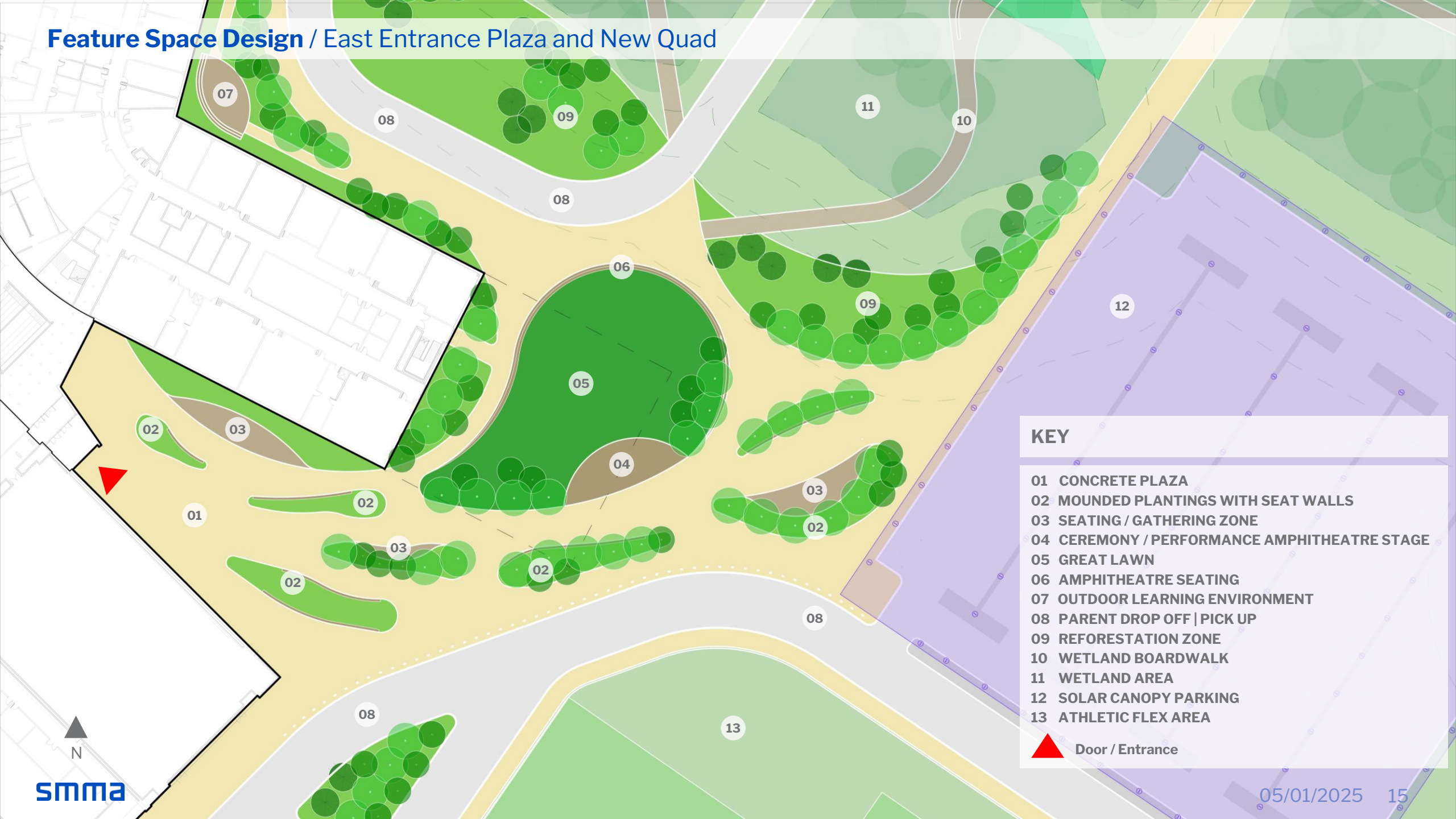
Feature Space Design / Outdoor Learning Environments



Feature Space Design / Main (West) Entrance Plaza



Feature Space Design / East Entrance Plaza and New Quad



KEY

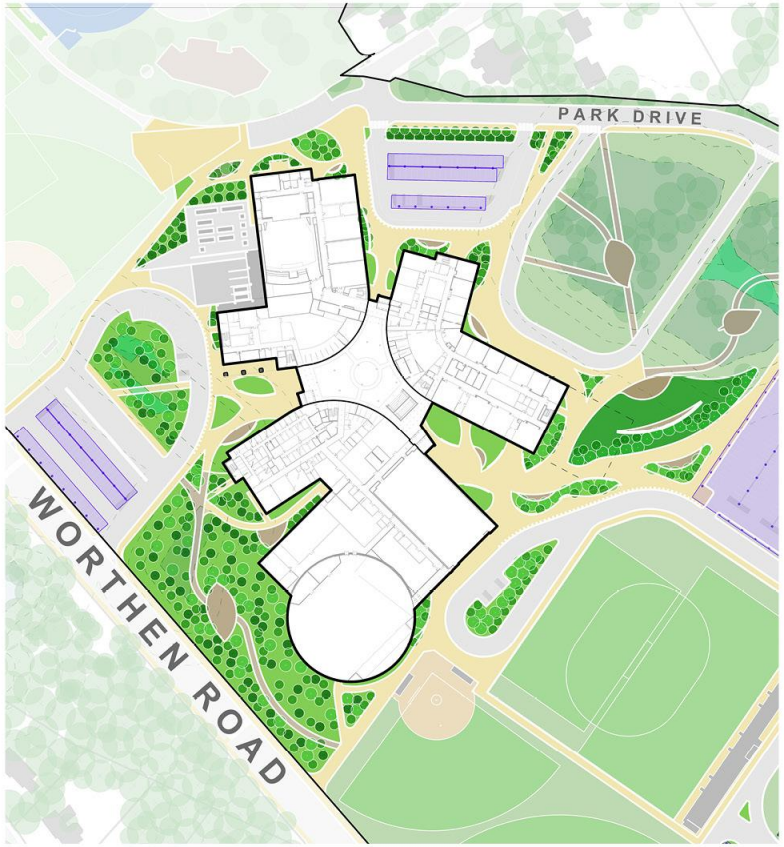
01 CONCRETE PLAZA
02 MOUNDED PLANTINGS WITH SEAT WALLS
03 SEATING / GATHERING ZONE
04 CEREMONY / PERFORMANCE AMPHITHEATRE STAGE
05 GREAT LAWN
06 AMPHITHEATRE SEATING
07 OUTDOOR LEARNING ENVIRONMENT
08 PARENT DROP OFF | PICK UP
09 REFORESTATION ZONE
10 WETLAND BOARDWALK
11 WETLAND AREA
12 SOLAR CANOPY PARKING
13 ATHLETIC FLEX AREA

Door / Entrance

smma

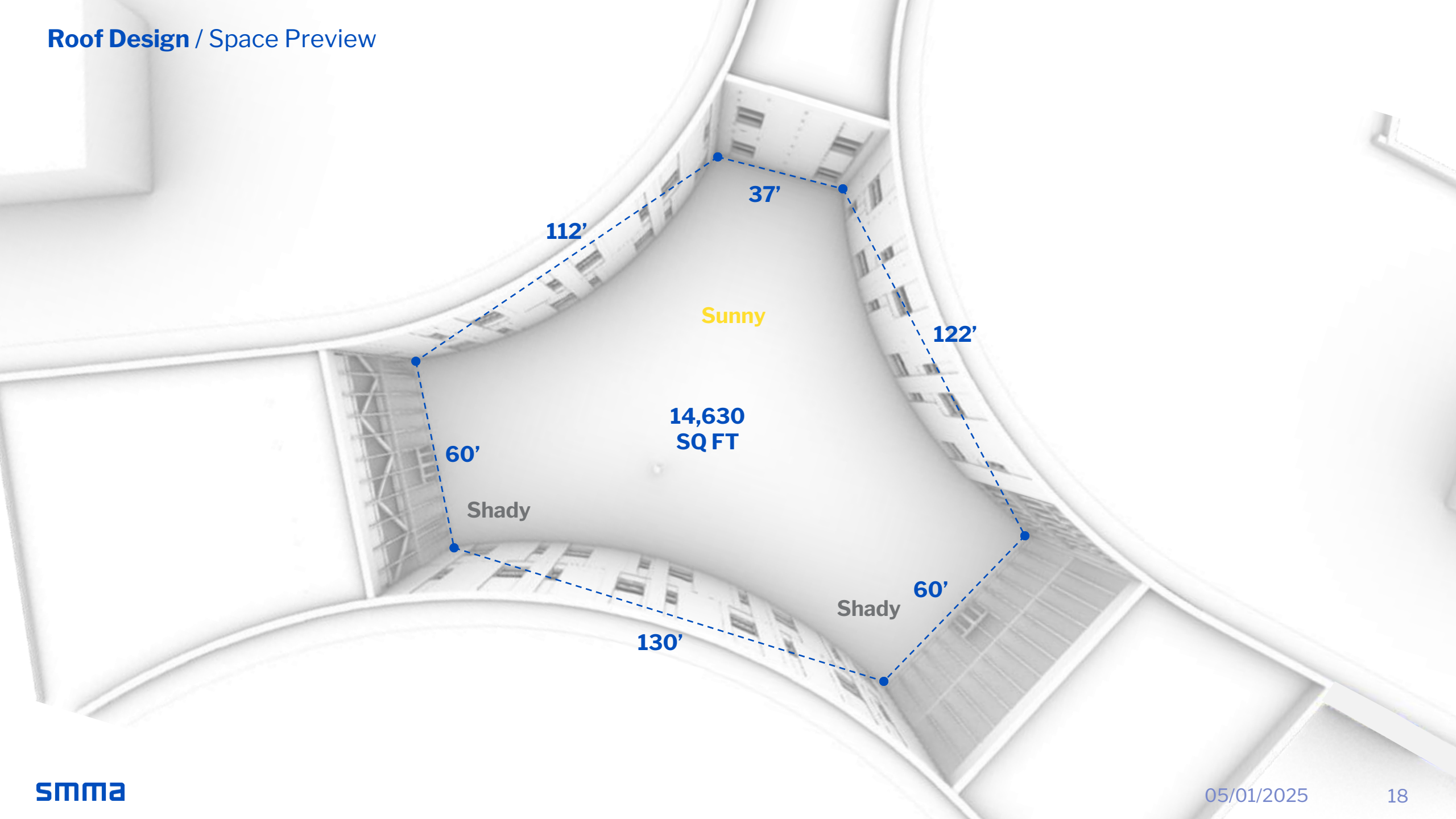
Fluid

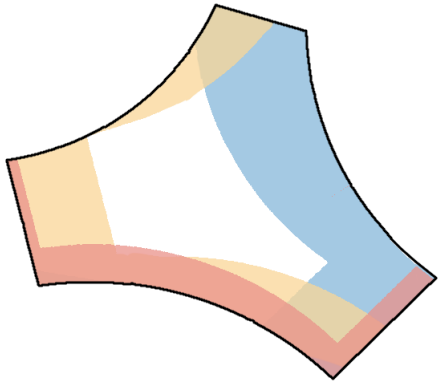
Understory



Tectonic

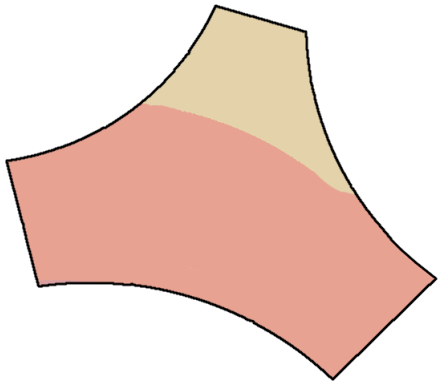
N


37’
112’
Sunny
122’
14,630
SQ FT
60’
Shady
60’
Shady
130’



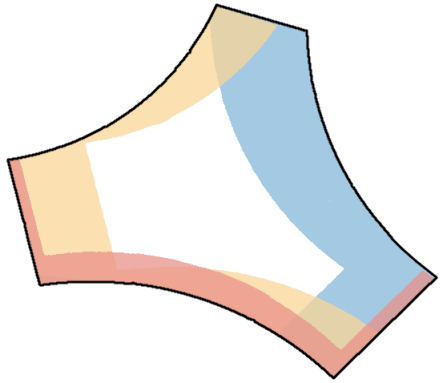
First Week of School

August



Winter Solstice

December



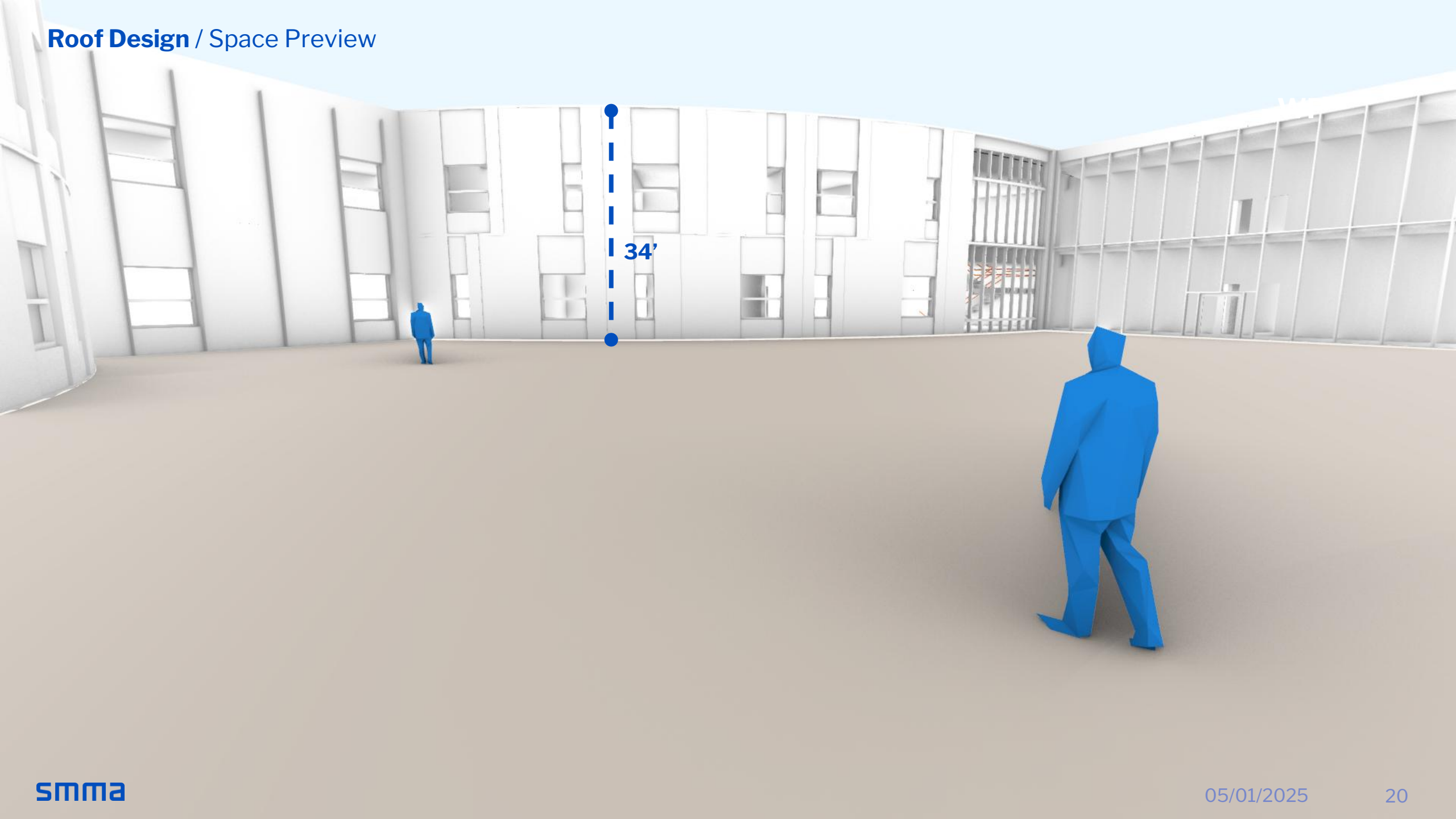
Last Week of School

May

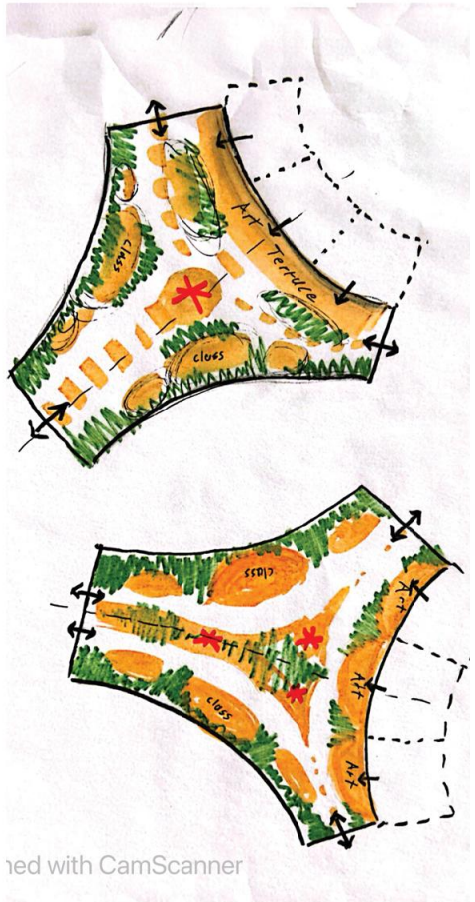
8am-12pm-3pm

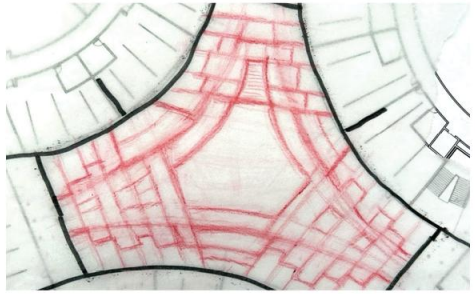
N

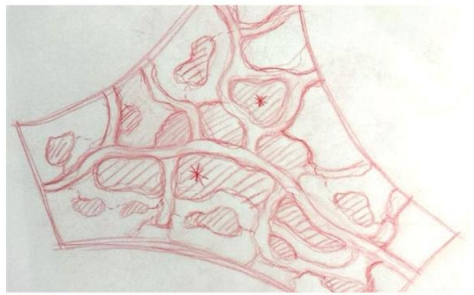
Roof Design / Space Preview

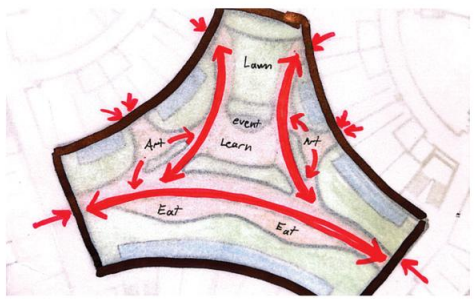


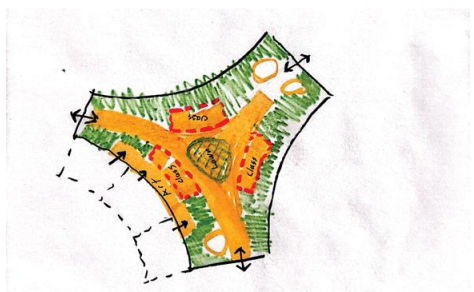
Roof Design / Design Process

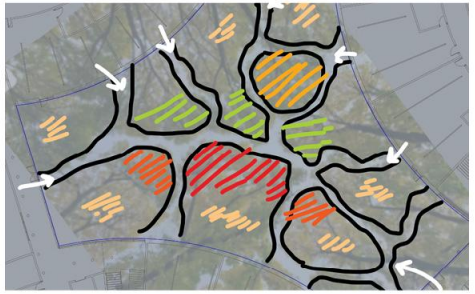


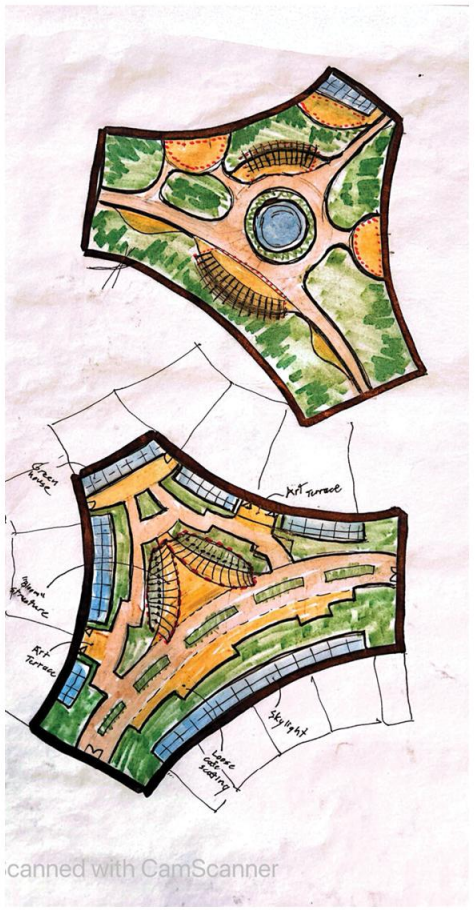


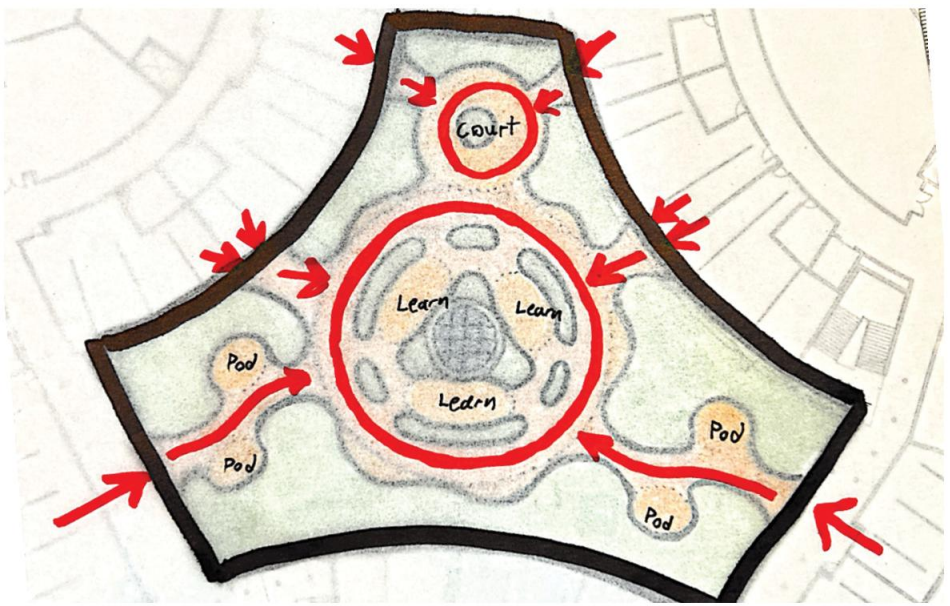






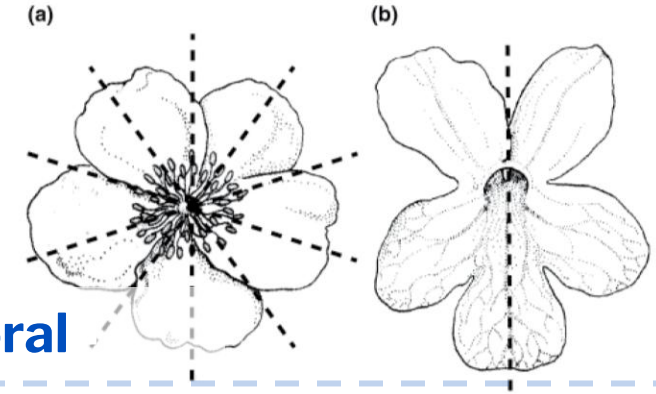


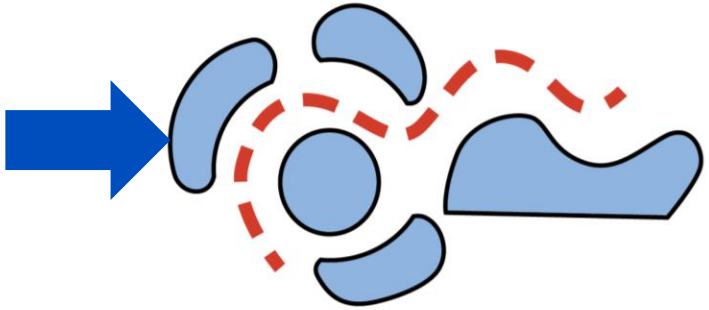




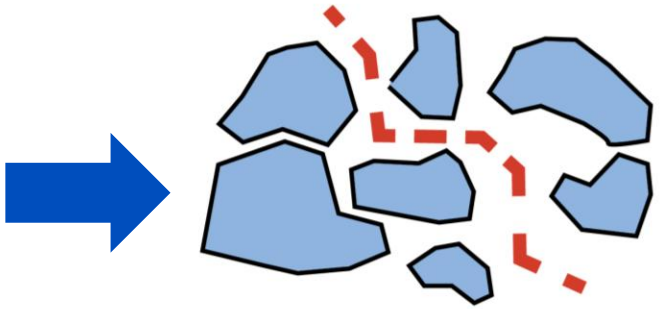
Overall Roof Design Concept / Design Concepts

Floral

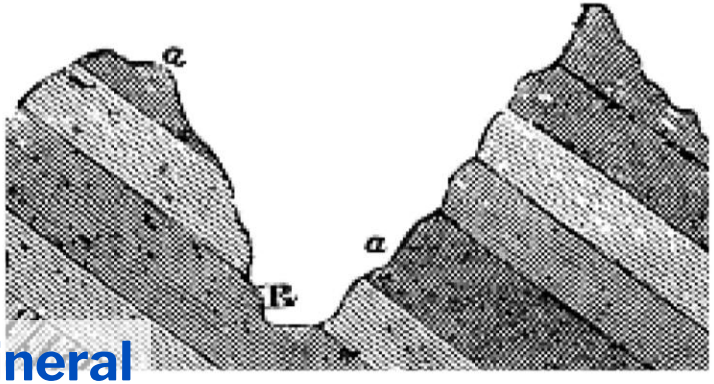


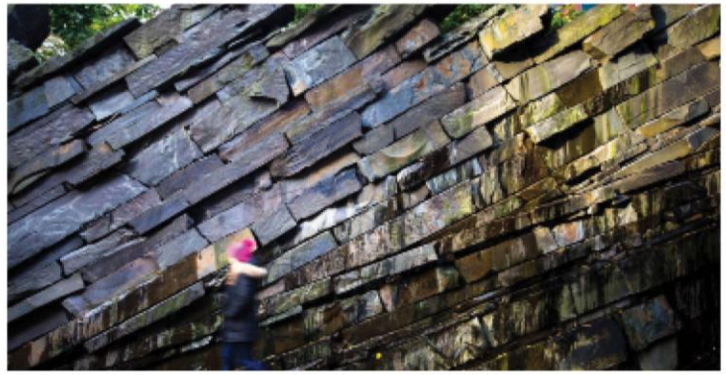


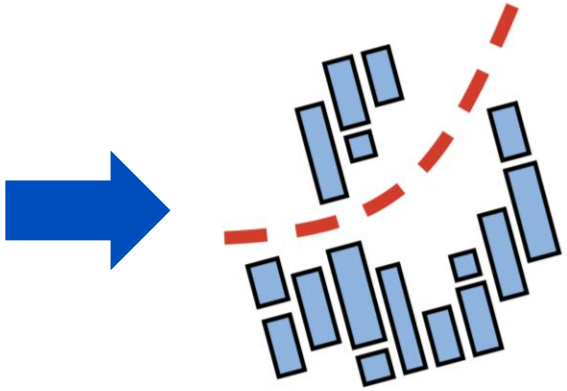
Overstory



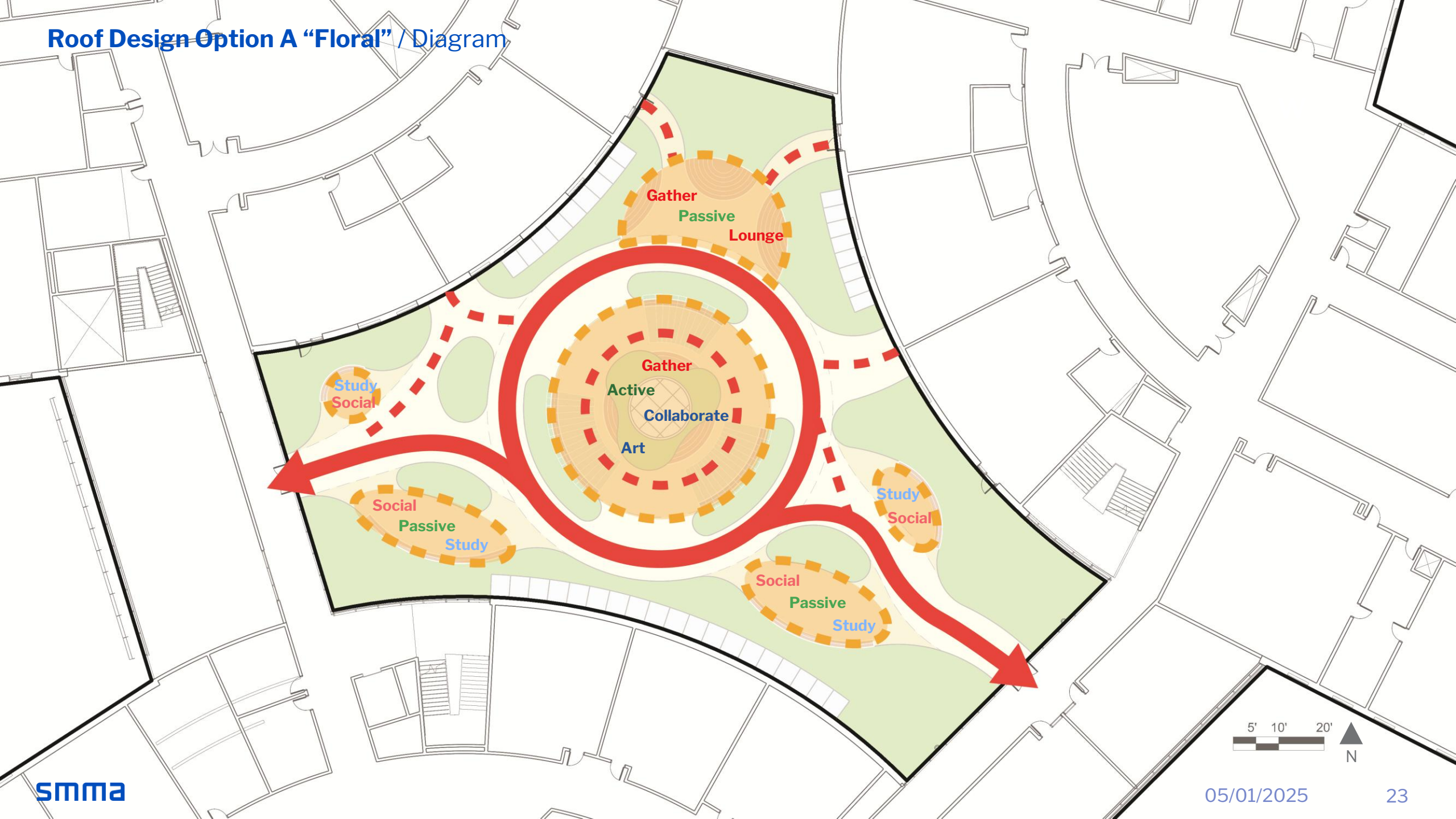
Mineral



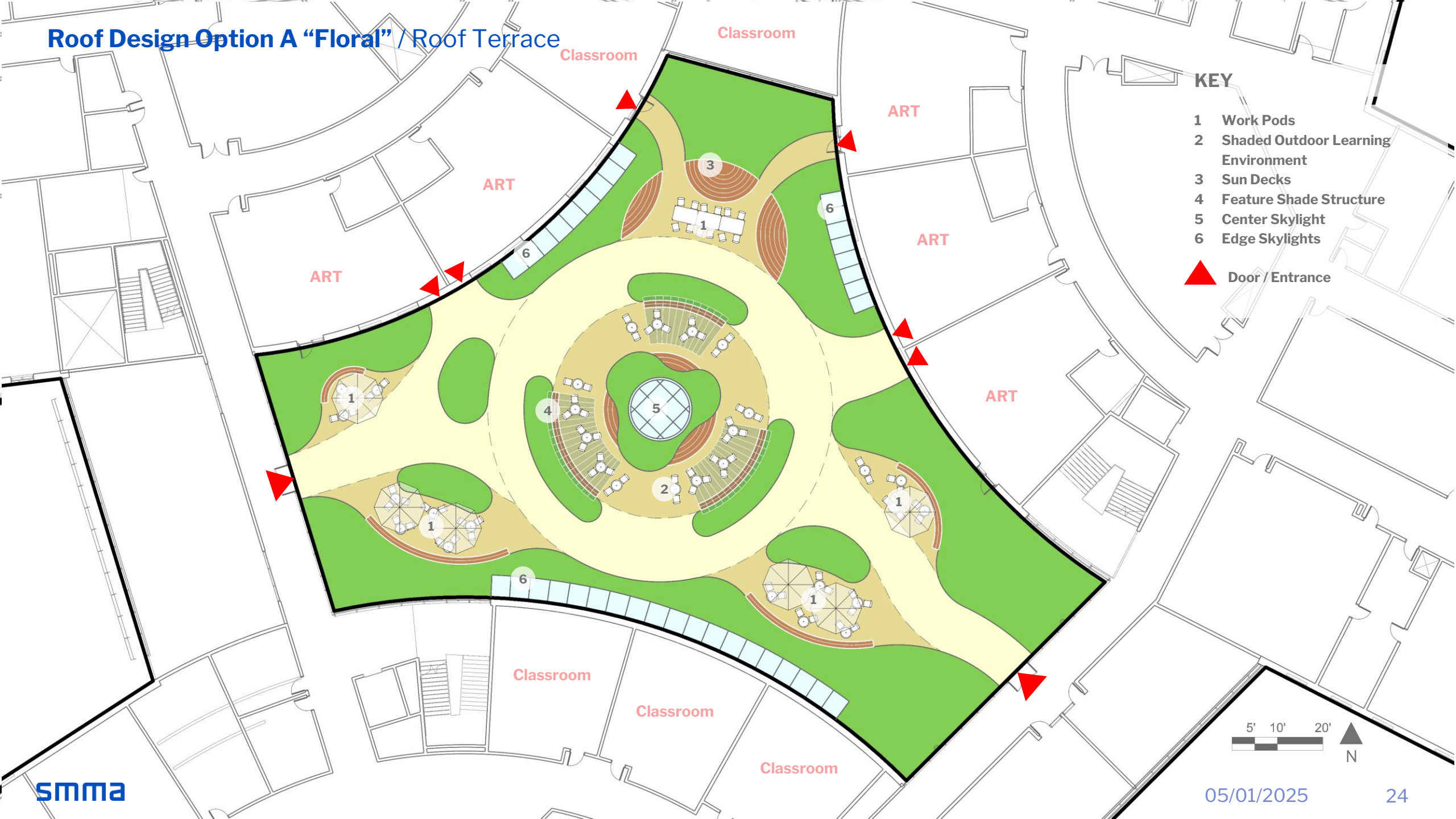




Roof Design Option A “Floral” / Diagram

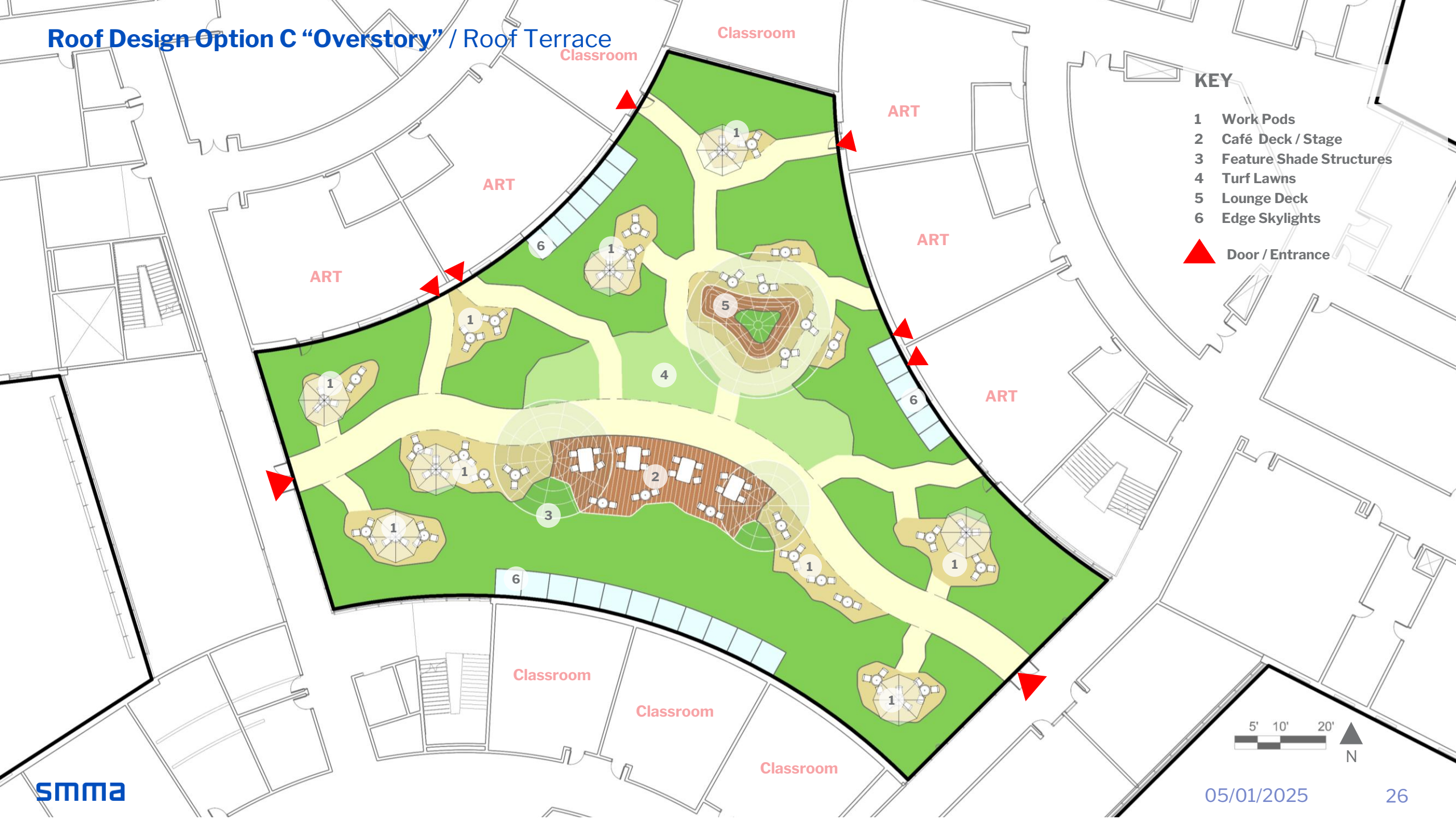


Roof Design Option A “Floral” / Roof Terrace



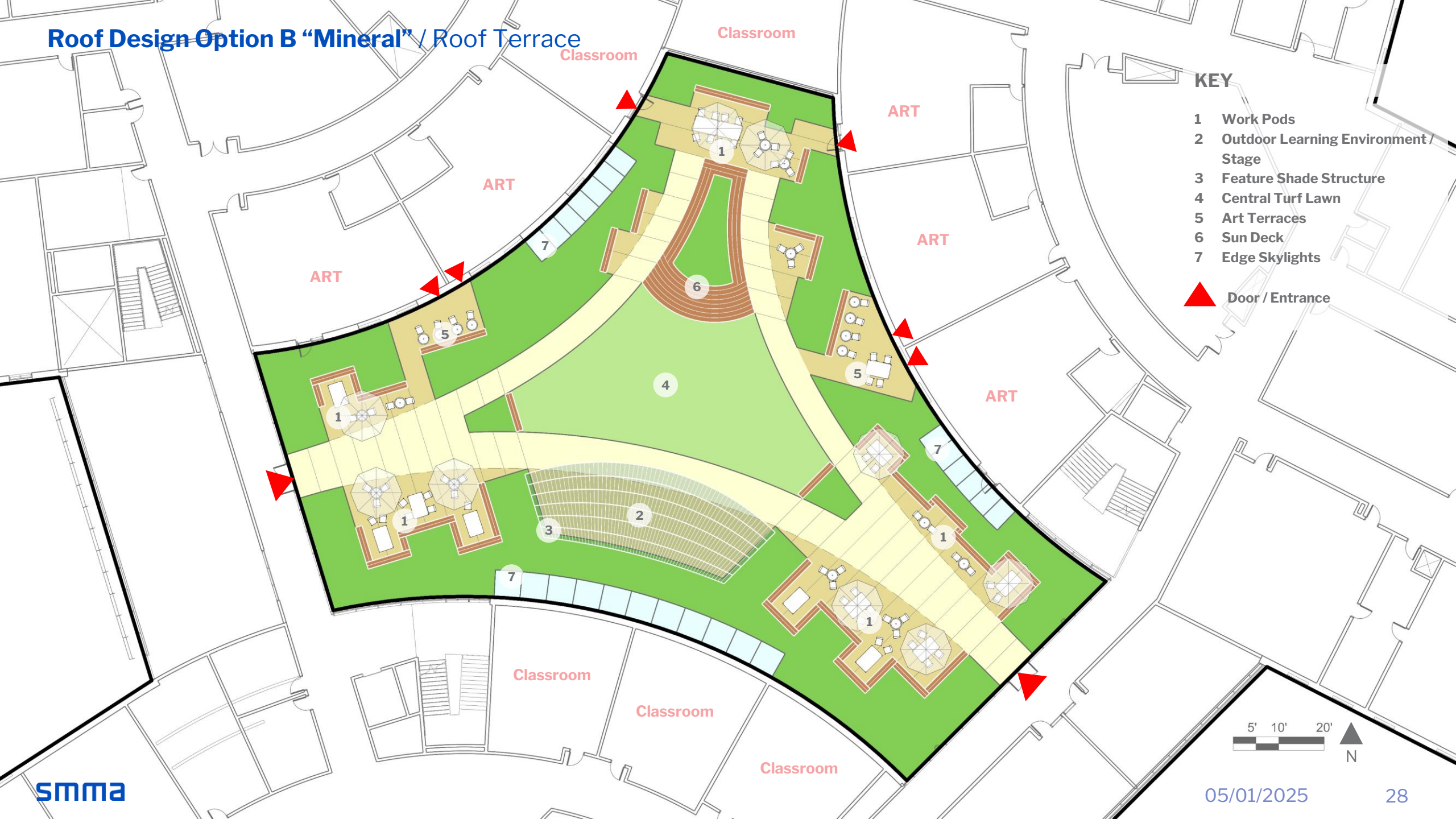
Roof Design Option C “Overstory” / Roof Terrace

Roof Design Option C “Overstory” / Roof Terrace



Roof Design Option B “Mineral” / Diagram

Roof Design Option B “Mineral” / Roof Terrace



Floral

Overstory

Mineral

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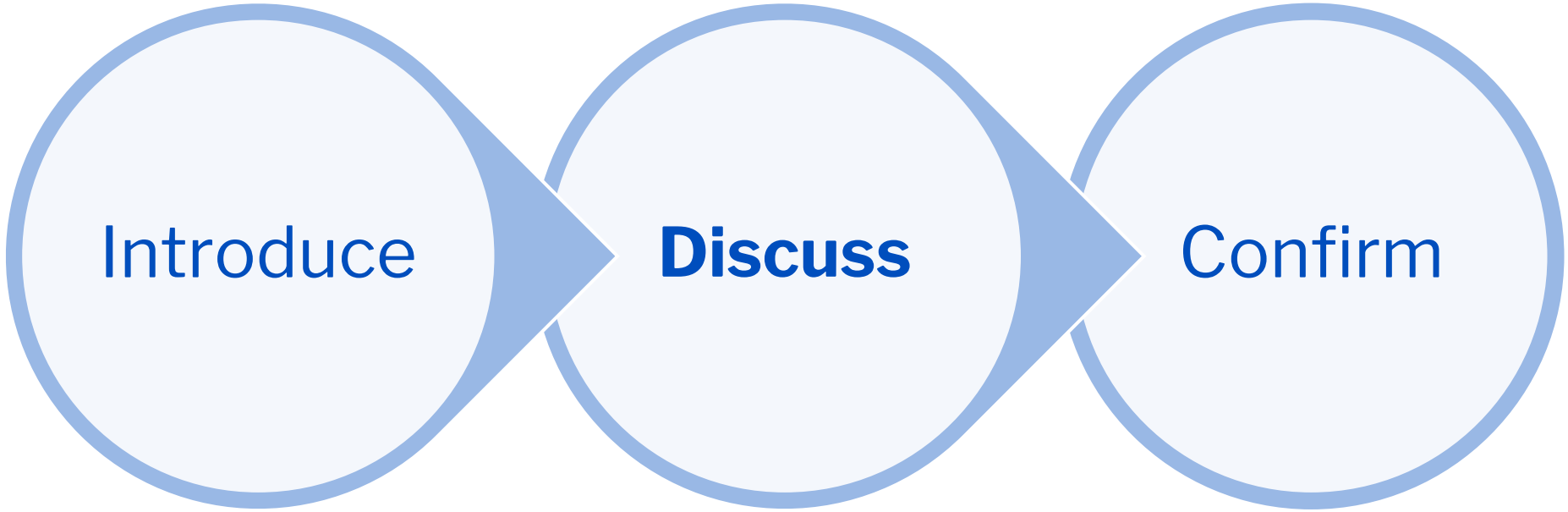
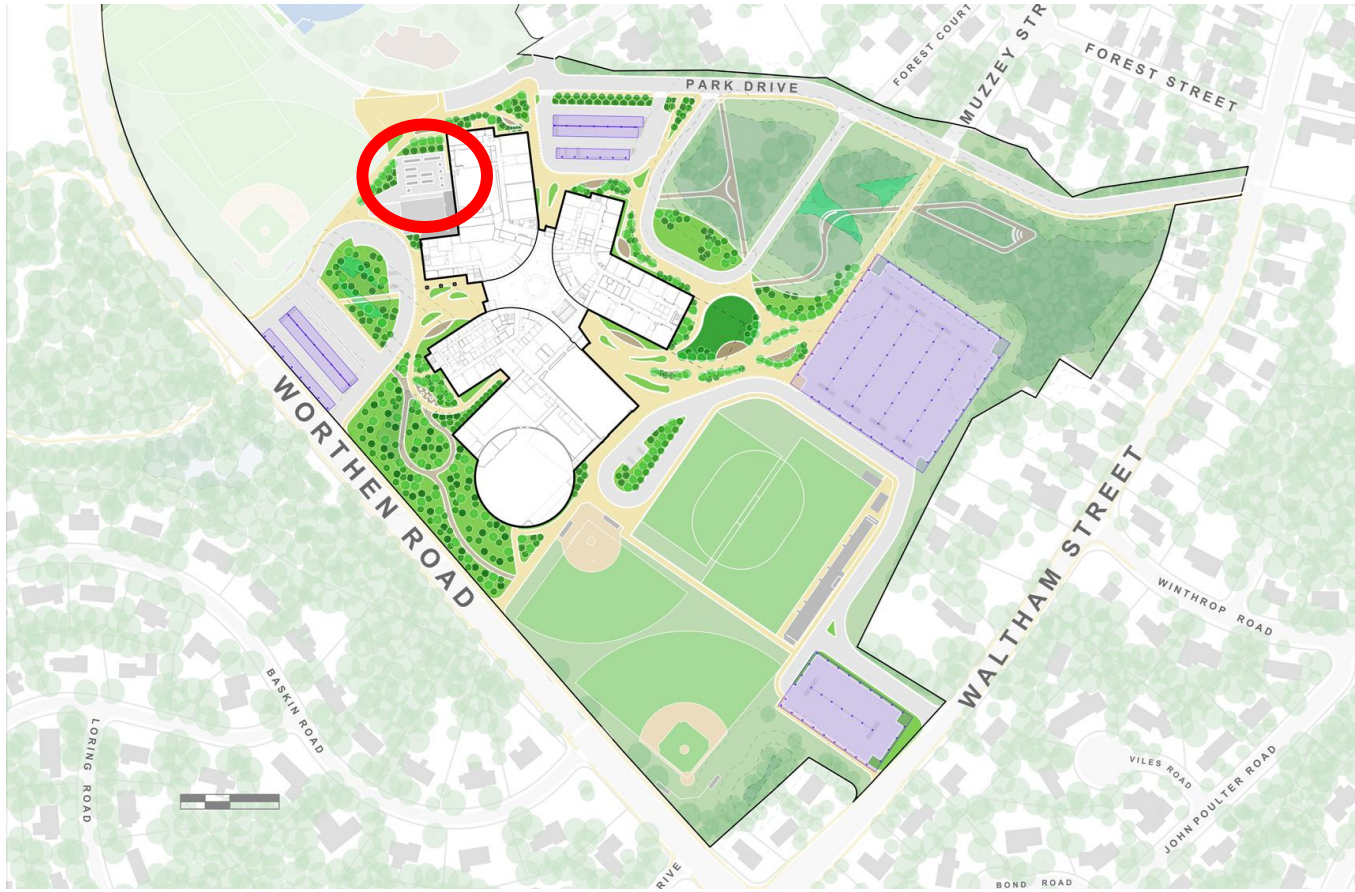

Introduce
Discuss
Confirm
February 27, 2025
May 1, 2025
May 8, 2025

List of Equipment

- Utility Interconnection Switchgear
- Battery and Solar Switchboard
- Two Diesel Generator
- Power Transformer
- Battery Energy Storage System



Renewable Energy/ EV Charging Station Quantity

Total Planned EV Spaces

- Total Spaces = 500
- Day 1 – 4% of the total off-street spaces = **20 spaces**
- Day X – 50% of the total off-street spaces (250-20 already installed) = **230 spaces**

Capacity Requirements (Lexington EV Bylaws)

- Day 1 – 20 spaces installed fully functional
- Day 1 – Conduits and space for transformers and switchboard for 230 spaces

% of Spots[1]	EV Spaces	EV Chargers[2]	Annual Energy Usage [3]	Solar Canopy Needed for Energy Offset
4%	**20**	**10**	**92,505 kWh**	**80 kW-dc**
10%	*50*	*25*	*231,264 kWh*	*201 kW-dc*
20%	*100*	*50*	*404,712 kWh*	*352 kW-dc*
30%	*150*	*75*	*520,344 kWh*	*452 kW-dc*
40%	*200*	*100*	*679,338 kWh*	*590 kW-dc*
50%	*250*	*125*	*838,332 kWh*	*729 kW-dc*

Notes:

1. The energy model is accounting for 4% EV charger usage.
2. Assumes all installed chargers will be Dual-port, level 2 chargers.
3. Estimated energy usage based on Lexington provided usage data. 11 Chargers downtown used 86,000 kwh in 2024. 2022 and 2023 data was as well to estimate a diminishing utilization rate, and scale for growth.
4. The additional PV is based on a Net Zero Site evaluation. Additional solar is reflected in parking canopy array production.

Site Design – Introduction & Discussion

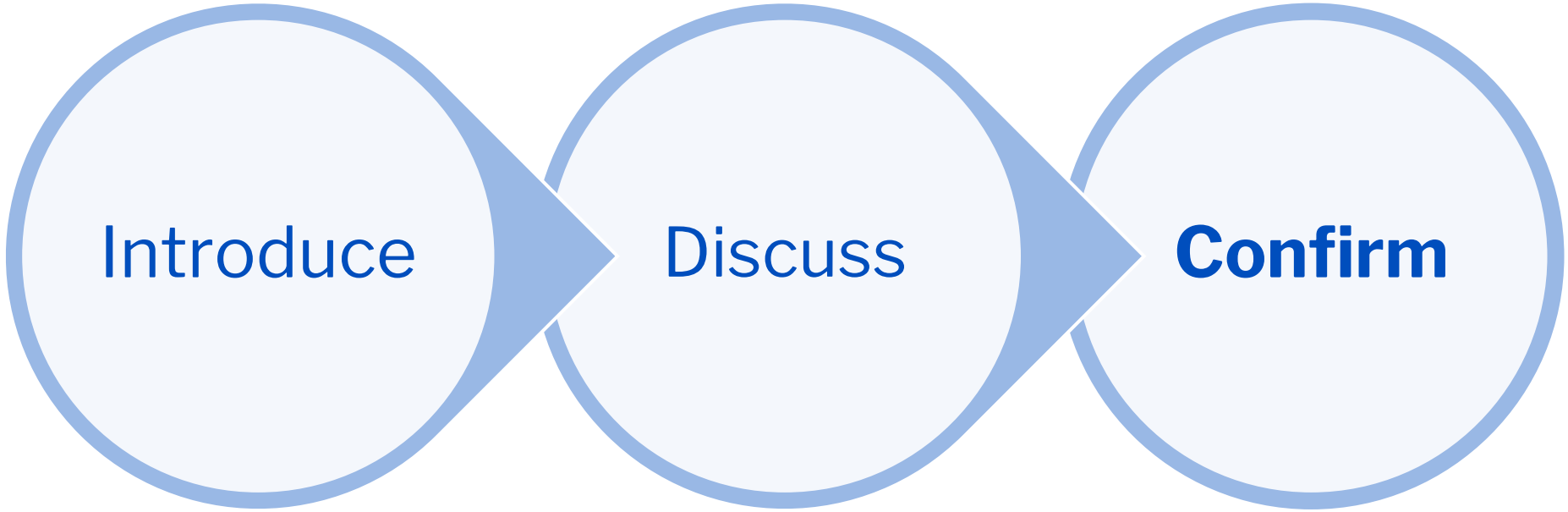
- ❑ Goals, Process, and Program
- ❑ Site Diagrams
- ❑ Site Design Options
- ❑ Feature Space Design: Outdoor Learning Environments, Entrance Plazas, Quad & Roof Terrace

Renewable Energy – Discussion

- ❑ Energy Storage Battery Location
- ❑ EV Charging Station Quantity

HVAC Design – Confirmation

- ❑ LCCA for HVAC Option
- ❑ Select Basis of Design HVAC Option


Introduce
Discuss
Confirm
March 13, 2025
March 27, 2025
May 1, 2025

GSHP = Ground Source Heat Pump
ASHP = Air Source Heat Pump
VRF = Variable Refrigerant Flow

Option 1	Option 2	Option 3	Option 4
Central GSHP	Central ASHP	Hybrid – Central GSHP & Central ASHP	ASHP VRF

Code Baseline: Natural Gas Boiler and water-cooled Chiller [ASHRAE System #7]

RECOMMEND

SMMA	SLC	Town/DPF	PBC
Option 3: Hybrid	**Option 3:** Hybrid	**Option 3:** Hybrid	

Reasons

- EUI 25 and NZE goal
- 30-year positive cash flow
- Equipment Low carbon life-cycle (vs. ASHP)
- Maintenance
- GSHP longer equipment life
- Resiliency: GHSP benefit during power outage
- GSHP Modular helps reliability
- Utility, O&M and peak load cost savings
- No refrigerants within the building interior spaces.

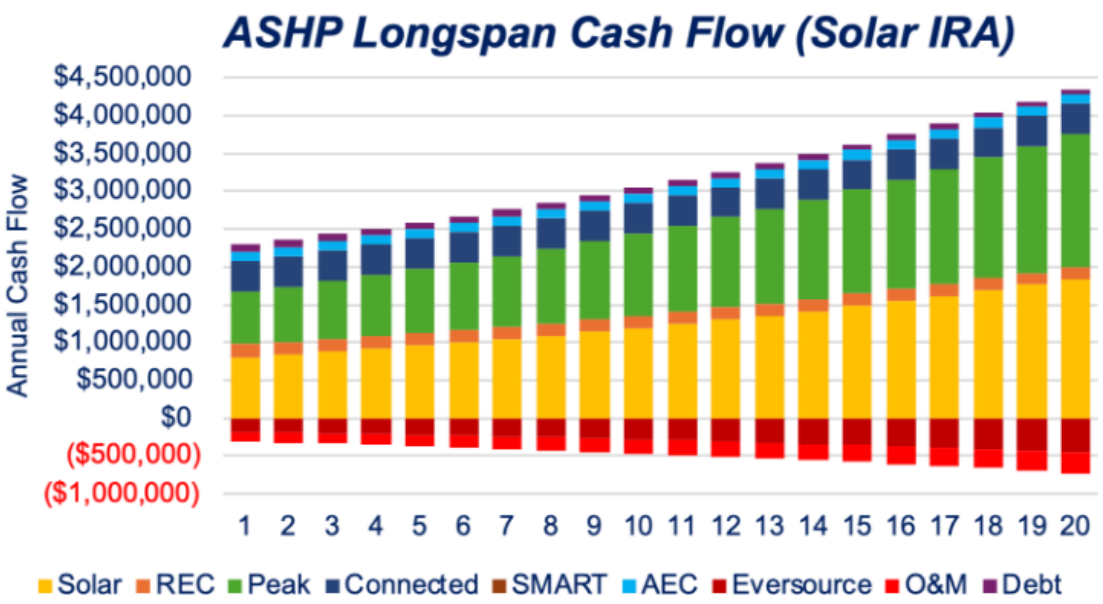
**Recommendations are based on analysis, review and discussion amongst the Department of Public Facilities, Sustainable Lexington Committee (SLC), Mark Sandeen, Dore & Whittier (OPM) and SMMA.

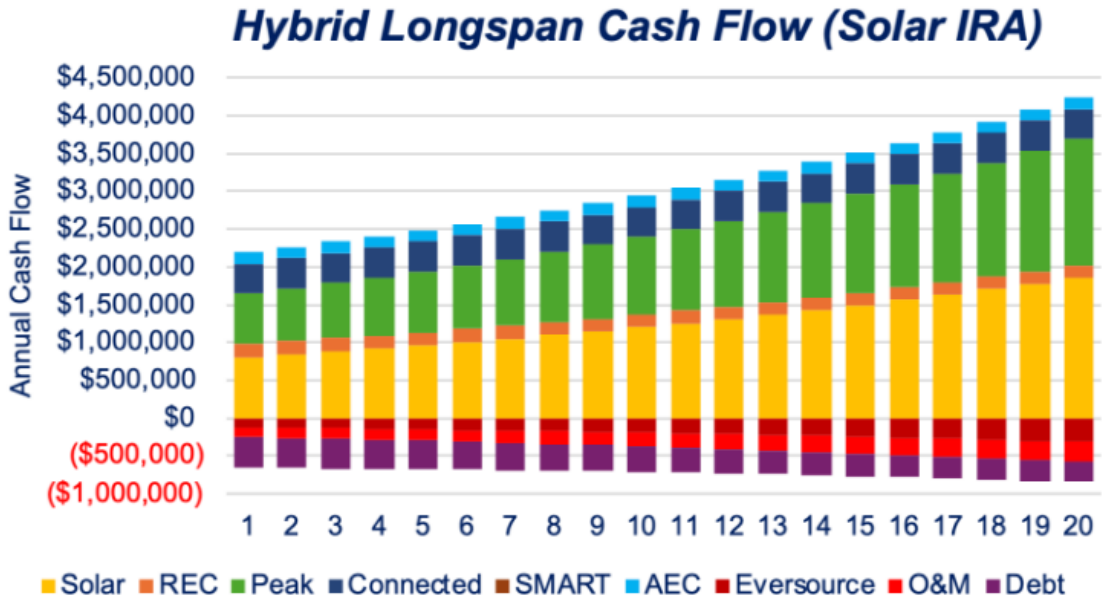
ASHP w/ Longspan Solar

- $85 to $170M positive cash flow
  - $99M expected cash flow
- $1.5M lower upfront cost
- $12M Eversource charges

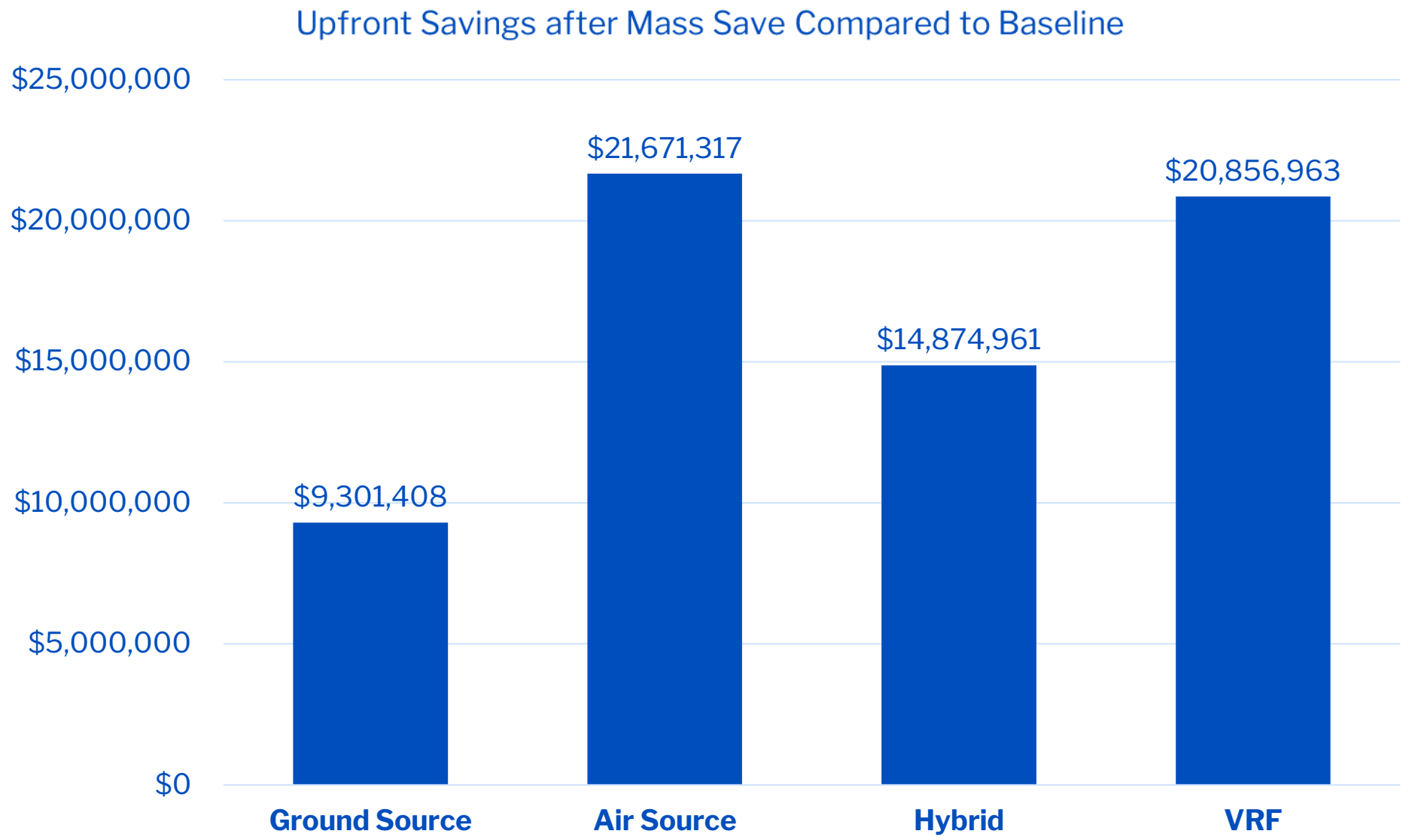
Hybrid w/ Longspan Solar

- $76 to $112M positive cash flow
  - $91M expected cash flow
- $5.2M additional upfront cost
- $8.3M Eversource charges





HVAC System Selection / HVAC Upfront Savings after Mass Save Compared to Baseline Gas/Chiller



	Option 1 Ground Source	Option 2 Air Source	Option 3 Hybrid	Option 4 VRF
Debt Service	$(603,828)	$80,946	$(279,350)	$169,253
Eversource	$(173,645)	$(400,628)	$(275,957)	$(1,233,707)
O&M	$(230,158)	$(238,654)	$(234,430)	$(303,309)
Solar	$1,652,586	$1,625,687	$1,639,970	$1,601,168
Peak Demand	$1,485,417	$1,542,455	$1,461,437	$1,723,665
ConnectedSolutions	$400,000	$400,000	$400,000	$397,400
RECs	$163,527	$160,865	$162,278	$158,439
SMART				
AECs	$172,911	$123,508	$148,210	$59,508
Annual Net Benefit	$2,866,811	$3,294,179	$3,022,159	$2,572,417
Total 30 Year Positive Cash Flow	**$86,004,330**	**$98,825,368**	**$90,664,762**	**$77,172,508**

HVAC System Selection / Pros & Cons

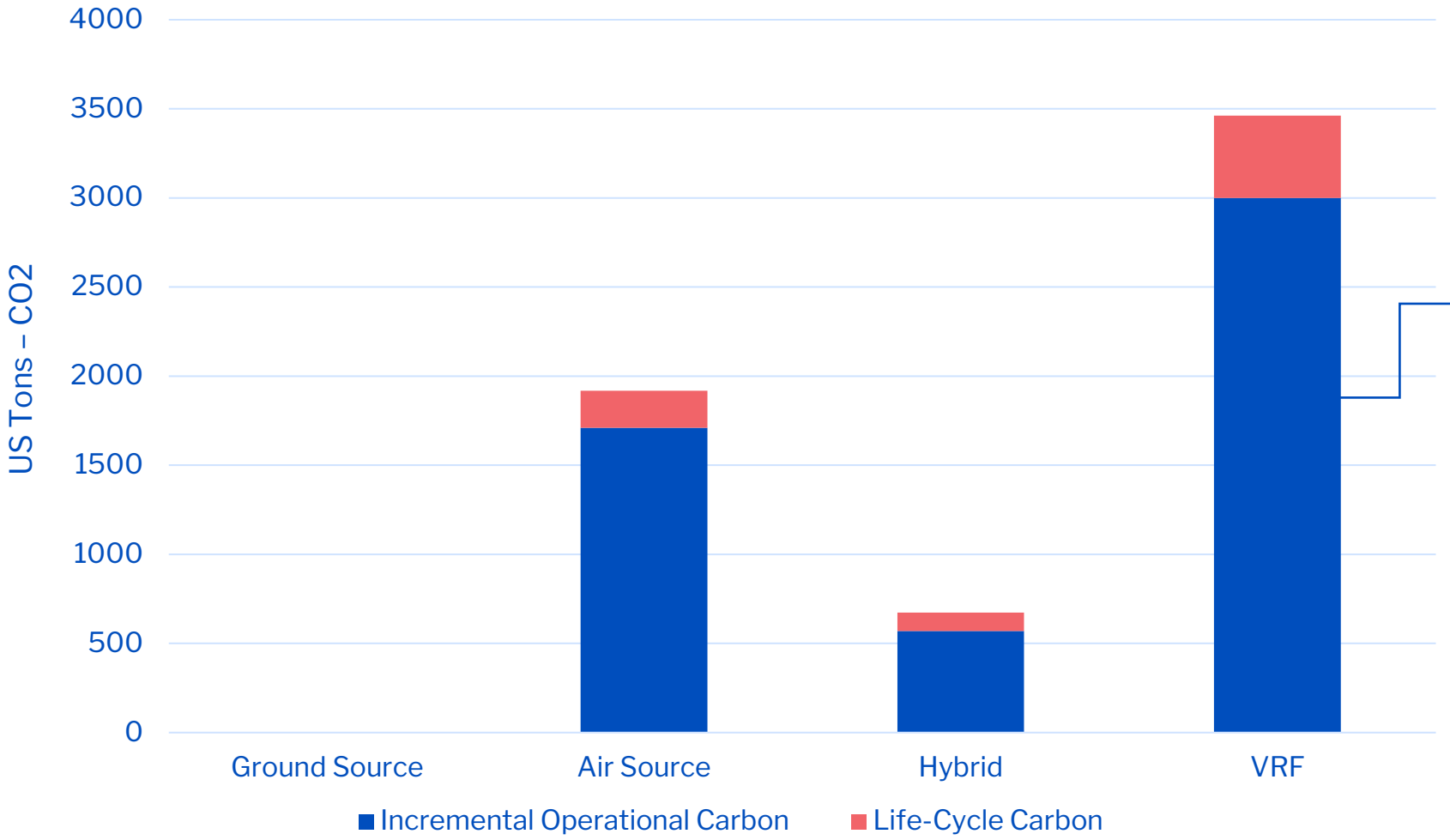
	Pros	Cons
Option 1 Ground Source	• Excellent energy efficiency • Flexible operation for heating and cooling needs • GSHP modular configuration enhances reliability • No defrost cycle to limit heating mode operation • ~20-year equipment life • IRA incentives may be available.	• Requires interior mechanical room (~2,500 sf) • Higher system installation (first) costs. • IRA incentives are not a certainty
Option 2 Air Source	• Flexible source for CHW and HW • Modular configuration helps reliability • Cost effective installation	• Does not meet 25 EUI goal • Energy efficiency is not as good as alternatives • Significant Utility, O&M and peak demand ($$$) • Defrost cycle disrupts heating function • Requires interior mechanical room (~1,400 sf) • Requires glycol for freeze protection • ~15-year equipment life
Option 3 Hybrid	• Excellent/very good energy efficiency • Geothermal field size is optimized for HVAC loads served • Modular GSHP configuration enhances reliability • IRA incentives may be available for GSHP • GSHP units: ~20-year equipment life	• Requires interior mechanical room (~2,000 sf) • Requires glycol for freeze protection of ASHP portion • IRA incentive not a certainty • ASHP units: ~15-year equipment life
Option 4 VRF	• Good energy efficiency • Cost effective installation • Satisfies simultaneous heating and cooling demands • No interior mechanical room space required	• Does not meet 25 EUI goal • Extensive refrigeration piping + New refrigerants are class A2L • High carbon emission (life cycle) due to refrigerants • Highest Utility, O&M and peak demand costs ($$$$) • VRF controls can be troublesome • ~15-year equipment life • VRF defrost cycles disrupt heating function

HVAC System Selection / Space Requirements, Efficiency & Carbon Comparison

System Type	Mech. Room Space	Efficiency	Incremental Operational Carbon (over Option 1 - GSHP)		Life-Cycle Carbon of Equipment[1] (Refrigerants)
			US Tons/Yr.	**US Tons** [15 yr. – Equip. life-cycle]	15 yr. –Equipment life-cycle
Option 1 Ground Source	2,500 SF	Excellent			**Very Low** *(to none)*
Option 2 Air Source	1,400 SF	Good	57	1,710	**Medium** 208 tons/yr. [0.45 lbs./CO2/SF/yr.]
Option 3 Hybrid	2,000 SF	Excellent	19	570	**Low** 104 tons/yr. [0.225 lbs./CO2/SF/yr.]
Option 4 VRF	0 SF (more space on roof)	Good	100	3000	**High** 462 tons/yr. [1.0 lbs./CO2/SF/yr.]

1: Source: Life Cycle Carbon - City of Seattle Refrigerant Emissions Leakage Analysis and Chartered Institution of Building Services Engineers (CIBSE) Journal

HVAC Equipment 30 –Year Life Cycle Incremental GHG Emissions



Note: When including the VRF defrost cycle electrical resistance energy usage, the operational carbon increases beyond 3500 US tons CO2.

Source: Life Cycle Carbon - City of Seattle Refrigerant Emissions Leakage Analysis and Chartered Institution of Building Services Engineers (CIBSE) Journal

Solar Hot Water System Selection/ Summary Incremental Costs and Paybacks **RECOMMEND**

Preliminary SD Incremental Cost & Payback Summary Relative to PSR DHW Systems Code Baseline Costs			
DHW System	***Incremental Costs***	***Estimated Annual Energy Costs Savings***	***Estimated Payback***
Code Baseline-Electric HW tanks			
DHW – Air Source HP (BOD)	***$401,000[3]***	**$21,102**	**19 yrs.**
DHW -Ground Source HP	$76,000	$28,136	3 yrs.
DHW- Solar HW System	$1,244,000	$40,094	31 yrs.

Notes:
1. Energy Savings: based on total annual kWh savings, using the average 2023-24 $0.24/kWh (utility bills).
2. Incremental Costs are based on the PSR and recent Turner's cost estimates and include materials and labors and are based on a per cost comparison to the analysis system baseline (BOD Air Source HP).
3. Air Source HP system costs (Incremental cost) already included into the PSR BOD estimate

Thank you.

Summary HVAC Systems Installation Costs, Incentives and Payback

	Option 1 Ground Source	Option 2 Air Source	Option 3 Hybrid	Option 4 VRF	Code Baseline
Estimated Installation Costs *(includes associated costs)*	**$70,989,000**	**$55,163,000**	**$63,057,000**	**$55,083,000**	**$72,509,000**
MassSave Incentives	($7,182,000)	($2,487,000)	($4,962,000)	($2,967,000)	
IRA incentives (GSHP)	($17,337,000)		($8,669,000)		
Estimated Payback					
with MassSave	**Instant payback over code baseline - first costs savings (see incremental costs above)**				
With MassSave + IRA					

Notes:

1. System Costs($) based on the PSR Cost Estimates (Turner Construction Updated Costs). Total system costs includes all HVAC equipment and associated costs (see next slide). GSHP System Costs includes bores/wells/casings for the GSHP system.
2. Code Baseline system: Natural gas boilers and chillers (VAV/water cooled) – ASHRAE App G system #7.
3. Incentives:
    - Preliminary load is estimated as 1,200 Ton based on proposed high school program, including AHUs and DOAS units.
    - GSHP using $4,500/ton. ASHP/VRF using $1,200/ton. AtWHP (central air source) using $800/ton. Eversource may apply custom [higher] incentives upon review/approval.
    - IRA Incentive up to 30% for GSHP requires compliance with Prevailing Wage and Apprenticeship criteria. Incentive can extend to cover complete system (borehole field and building systems) depending on compliance. Additional IRA Incentive for GSHP system possible through the use of domestic content (from 2 to 10%)

Summary HVAC System Associated Costs

	Option 1 Ground Source	Option 2 Air Source	Option 3 Hybrid	Option 4 VRF
Total HVAC System Cost	**$70,989,000**	**$55,163,000**	**$63,057,000**	**$55,583,000**
HVAC System Costs	$67,789,000	$53,185,000	$62,241,000	$51,423,000
Associated Costs				
Temporary Heating System	$3,200,000	--	--	--
Mechanical Space	Included in PSR	--	--	--
Additional PV (Energy gap to NZE/ additional equipment roof space)	Included in PSR (3.5 MW)	$1,978,000	$816,000	$4,160,000

Notes:

1. System Costs($) based on the PSR Cost Estimates (Turner Construction Updated Costs). Total system costs includes all HVAC equipment. GSHP System Costs includes bores/wells/casings for the GSHP system.
2. Associated Costs include:
    - Option 1 and 3: Temporary heating plant at $3,200,000 for option 1. Option 3 will not require temporary heating to the level of option 1, included in system costs. Please note that the existing site fields re-construction at $2,800,000 were removed as wells (bores) will be located at the existing school area.
    - Option 2, 3 and 4: Incremental parking solar PV canopy costs are included vs. GSHP EUI/ annual energy usage to BOD NZE.

Summary HVAC Systems Estimated Annual Energy Usage (MW)

	Option 1 Ground Source	Option 2 Air Source	Option 3 Hybrid	Option 4 VRF
EUI (kBtu/SF/yr)	**25.5**	**26.9**	**25.9**	**28.8**
Total Estimated Annual Energy Usage (MW)	**3.9**	**4.1**	**3.9**	**4.4**
Building + Heat trace+ Battery Storage	3.8	4.0	3.9	4.27
4% EVs	0.1	0.1	0.1	0.1

Notes:
1. System 1 and 3 are within the EUI 25 goal
2. System 2 and 4 are less efficient and further above the EUI 25 goal.

Preliminary SD LCCA Analysis Summary

Estimated 75-year LCCA Costs as Net Present Value

HVAC System	Total 75-year LCCA Costs	Total 75-year LCCA w/ Construction Incentives and Associated Costs	
		MassSave	IRA
Code Baseline	$169,939,000		
Option 1 – Ground Source	$119,203,000	**$112,022,000**	**$94,685,000**
Option 2 – Air Source	$108,371,000	**$105,884,000**	
Option 3 – Hybrid	$114,385,000	**$109,424,000**	**$100,756,000**
Option 4 – VRF	$109,503,000	**$106,536,000**	

Notes:

1. 75-year LCCA includes installation, replacement, maintenance and energy costs, brought forward as Net Present Value (NPV) costs.
   - Installation Costs are based on the PSR project cost estimates (Turner Construction updated costs).
   - Replacement costs are specific to each system, based on ASHRAE useful life data and using unit costs for equipment and labor.
   - Maintenance costs are estimated to include third-party service to systems, but not in-house routine maintenance.
   - Costs were review with Facilities Office.
   - Energy costs based on energy modeling analysis, using the 2023-24 Lexington utility bills' average [blended] annual $0.24/kWh (baseline $1.40/Therm), with a 3% cost escalation rate. The energy costs do not include peak load reductions expected from the project's Solar PV/Battery Storage systems. Peak demand costs are approximately 50% of Lexington's annual utility costs. The battery storage peak load reduction will bring utility energy costs benefits. The Total 75 yr. LCCA Cost is the sum of Installation, Replacement, Maintenance and Energy costs. Net Present Value modeled on a 75-year lifecycle cost, 3% cost depreciation.
2. Construction Incentives include MassSave NZE Path 1, Heat Pumps Incentives, POE incentives. and IRA (as applicable to the GSHP system). Post-occupancy annual incentives (revenues) are not included: Demand Response and peak load reduction utility incentive programs, and potential annual Renewable Energy Certificate (REC) for the GSHP.
3. Associated Costs: see presentation slides included above.