creative LOGIC

TASHAKORI | DONNACHIE | PROGAR | WENTZ | HARDER | LANINGER

FEBRUARY 8, 2011

team

- **OWNER** – State College Area School District
  - **ARCHITECT** – Mahzad Tashakori
  - **LANDSCAPE ARCHITECT** – Laurie Beth Donnachie
  - **STRUCTURAL ENGINEER** – Josh Progar
  - **MECHANICAL ENGINEER** – Josh Wentz
  - **LIGHTING/ ELECTRICAL ENGINEER** – Asher Harder
  - **CONSTRUCTION MANAGER** – Patrick Laninger

vision

Simplified Presentation Structure
agenda at bottom

Client Focused
Touchstones = #1 Priority, along right

Integration at Core
discipline work divided between client needs

project

touchstones

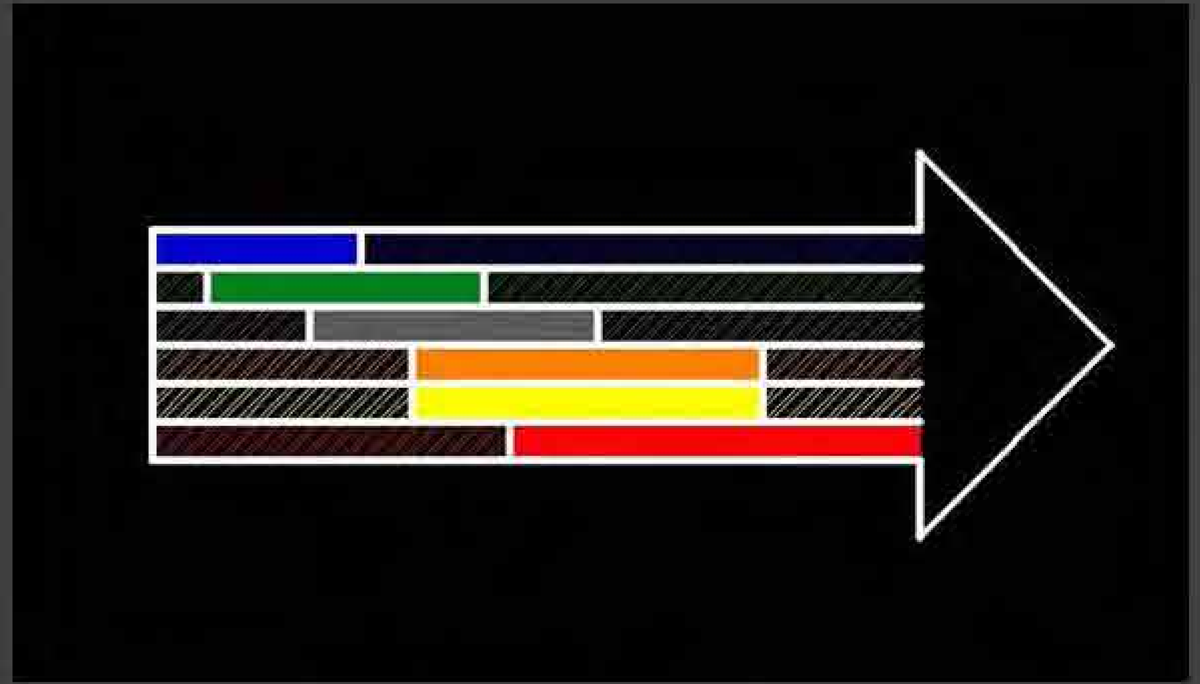
RANK	TOUCHSTONES
1	Supports learning program
2	Highly adaptable & flexible spaces
3	Energy efficiency
4	Daylighting
5	Adequate teacher space
6	Building & landscape
7	LEED Gold or Platinum
8	Adequate & appropriate storage/display
9	Thermal comfort
10	Indoor air quality & operable windows

– touchstone

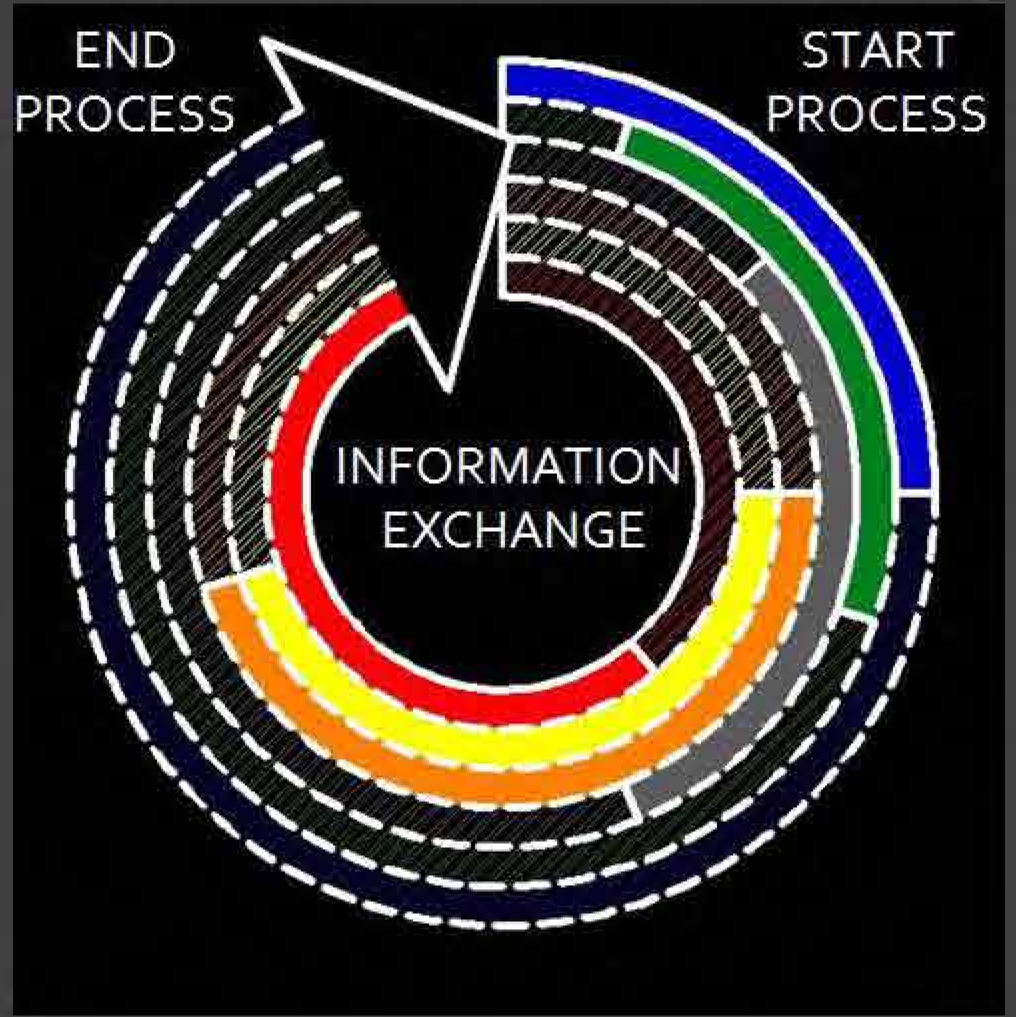
process

INFORMATION EXCHANGE PROCESS

- Key Elements:
  - Continuous input from all disciplines
  - Integrated multi-disciplinary leadership
  - Design authoring overlap
  - Rapid design iteration

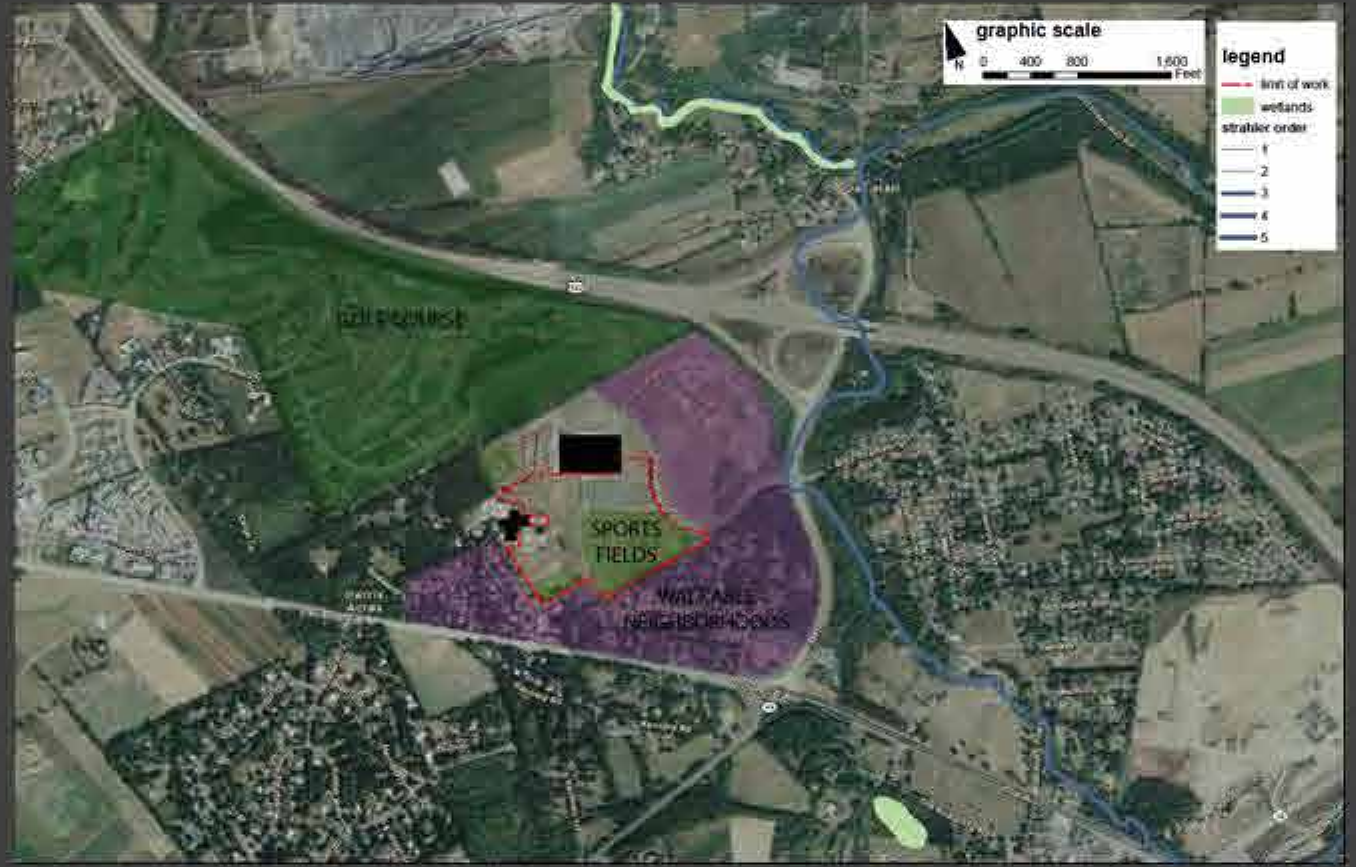


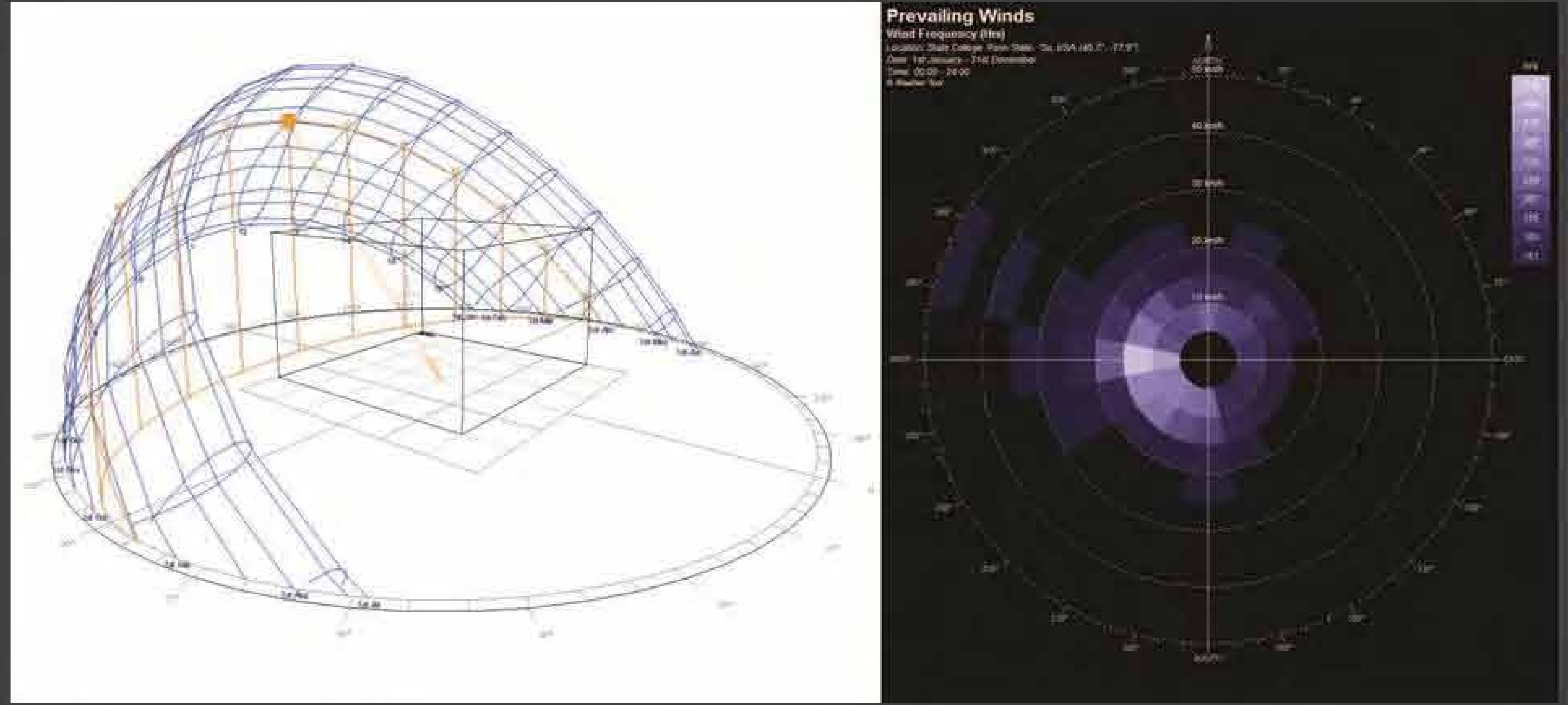
INFORMATION EXCHANGE



site

site analysis





geotechnical report

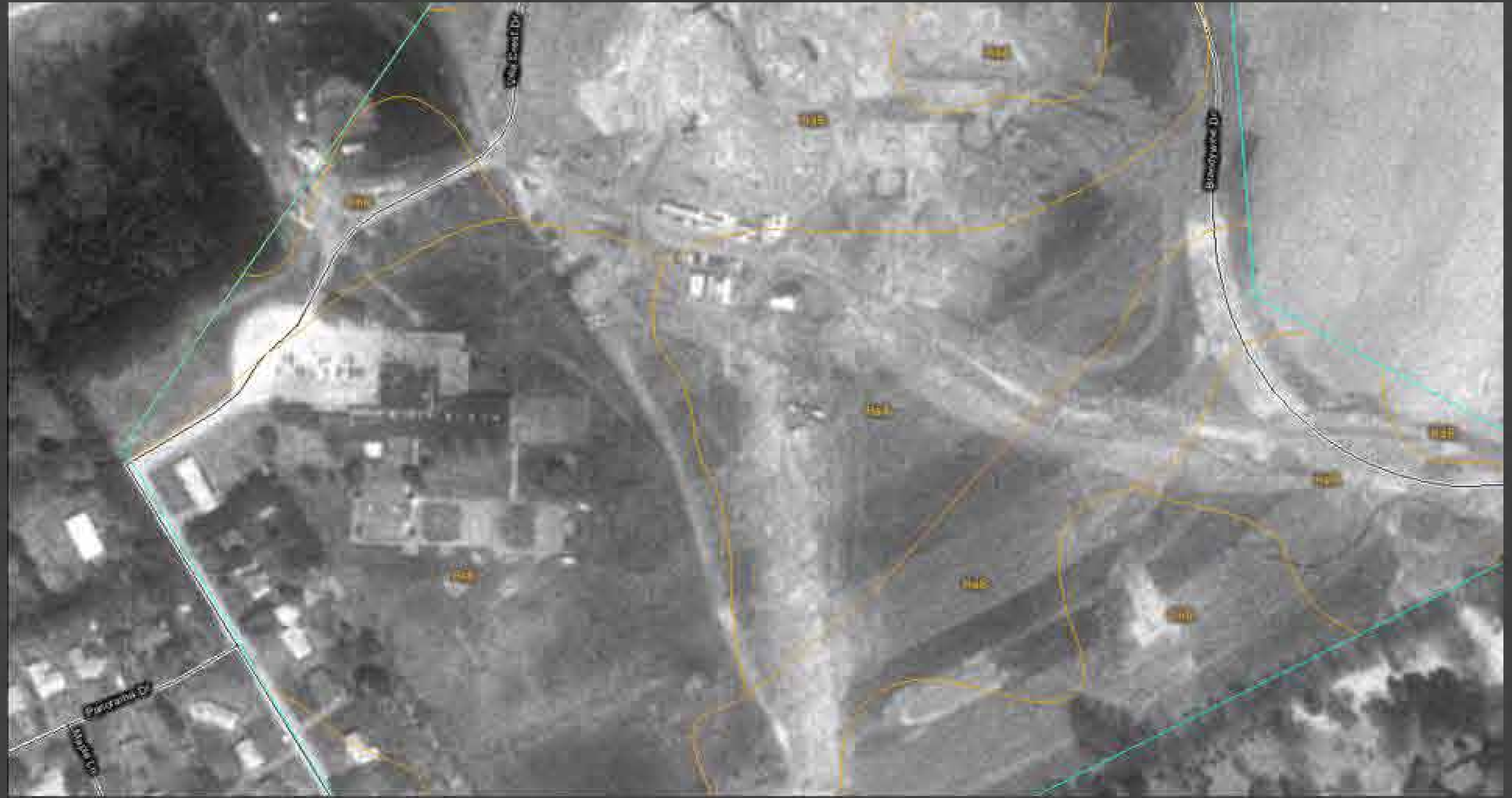
- Cohesive soil throughout site
    - Includes clay, silt and gravel
- Borings show bedrock 3′ – 50′ below grade
- Sinkhole potential

RECOMMENDED FOUNDATIONS:

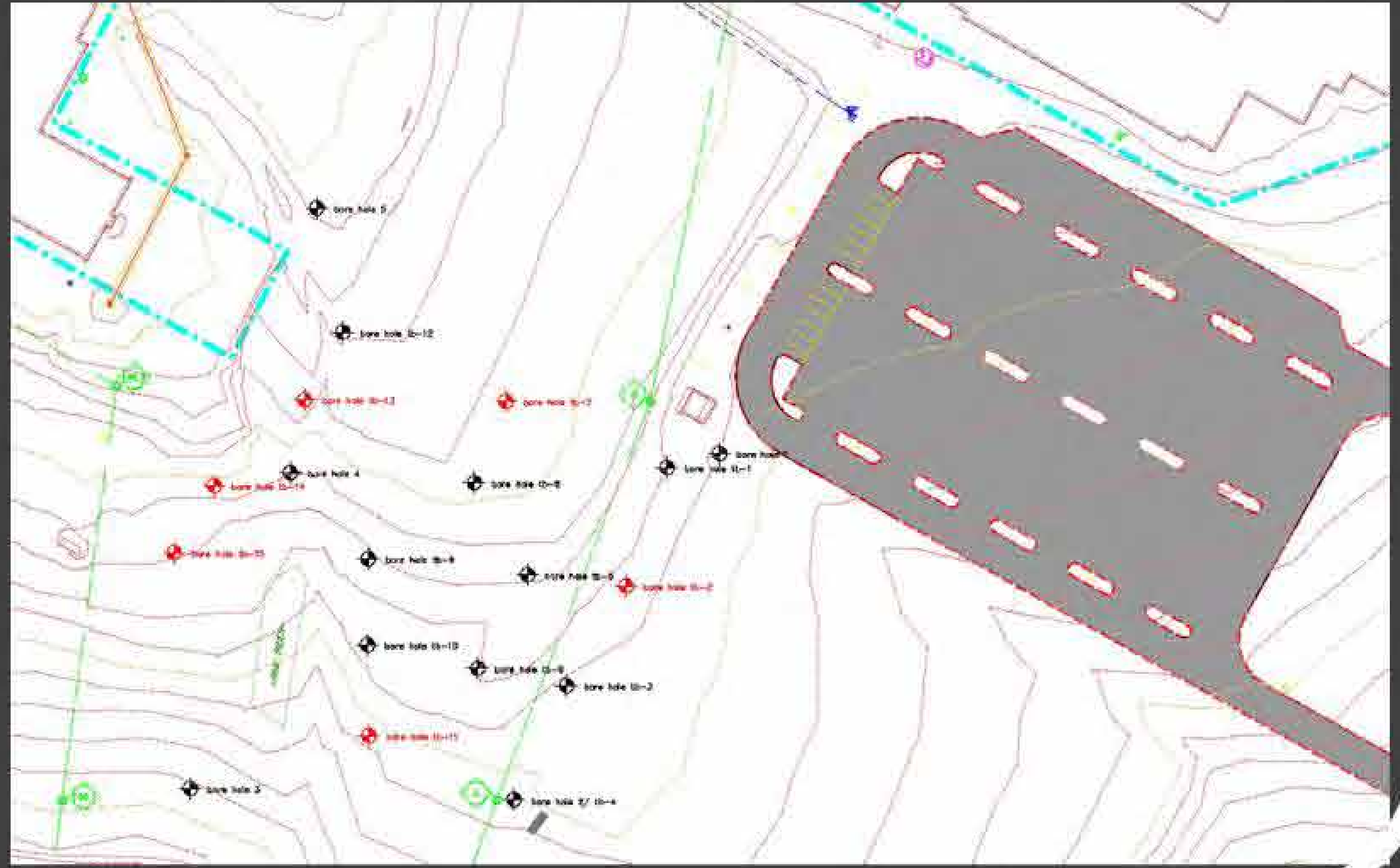
- Shallow continuous wall foundation
- Spread footings

Schematic design – spread footing foundations

soils



bedrock



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6 – building & landscape

analysis

- Drainage pit
  - silt fences
- Bioretention
  - Leave undisturbed
- Sport facilities
  - Re-construction
- Road access
  - Maintain access to middle school

UTILITY	COST(s)/UNIT
Purchased steam	9.85/1000lbm
Purchased chilled water	0.22/ton-hr
Electric consumption	0.07517/kWh
Electric on peak	1.09/kW
Water	3.32/1000 gallons

[Penn State OPP Website]

utility tie-ins

- Deliveries – 900′
- Sewage – 278′
- Electric – 440′
- Water – 770′
- Gas – 1050′

- Deliveries – 110′
- Sewage – 450′
- Electric – 110′
- Water – 1000′
- Gas – 110′

ideal location

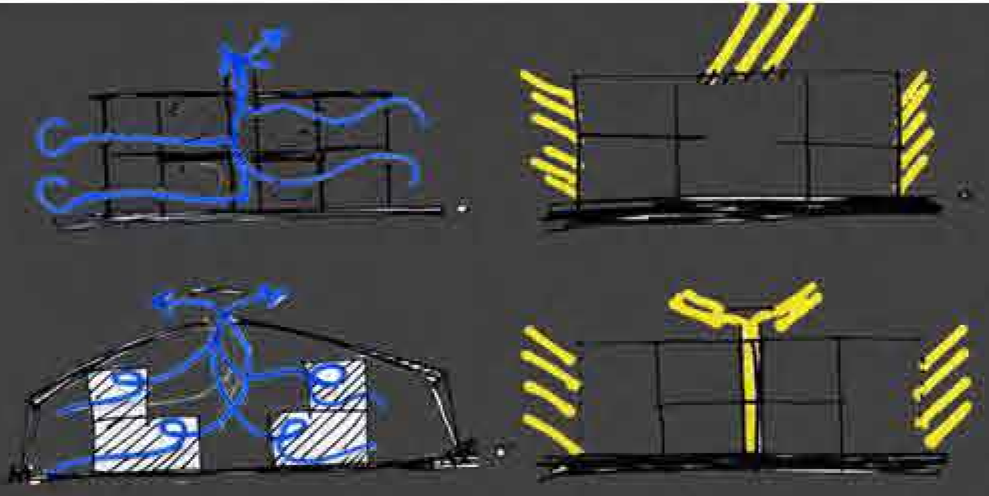
- Deliveries – 450′
- Sewage – 430′
- Electric – 450′
- Water – 950′
- Gas – 450′

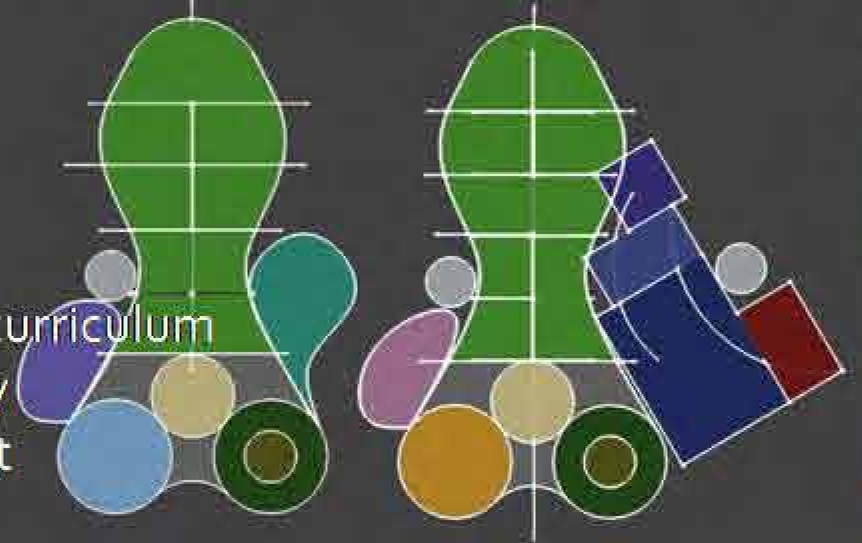
- Consolidate parking lots
- Consolidation of utility lines
- Ease of delivery
- Level site

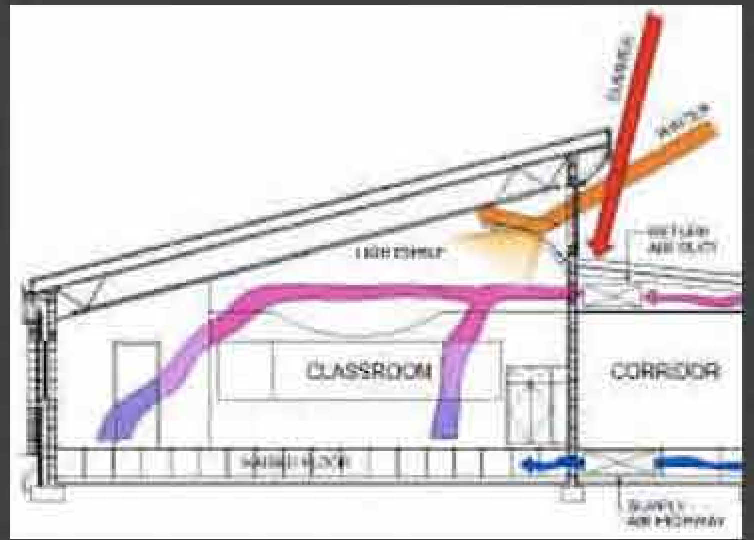
design

team precedence

North Guilford Middle School, North Carolina





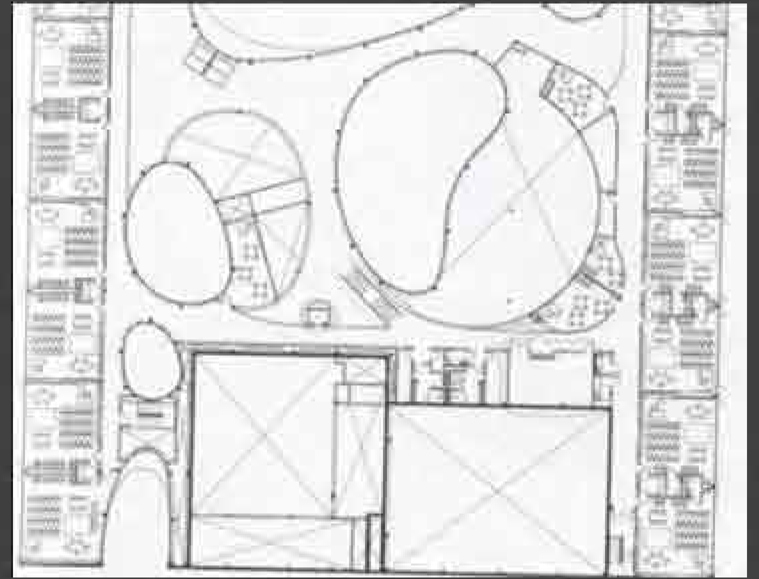


- Beyond its LEED Platinum award
- Green solutions strongly tied to the students' curriculum
- Day lighting with innovative clerestory strategy
- Educational Function of Light/Mechanical Shaft
- Water collection & filtration system

architecture precedence

- East-West orientation to maximize solar gain
- Wide, clear access areas with day light
- Indoor play & gathering areas

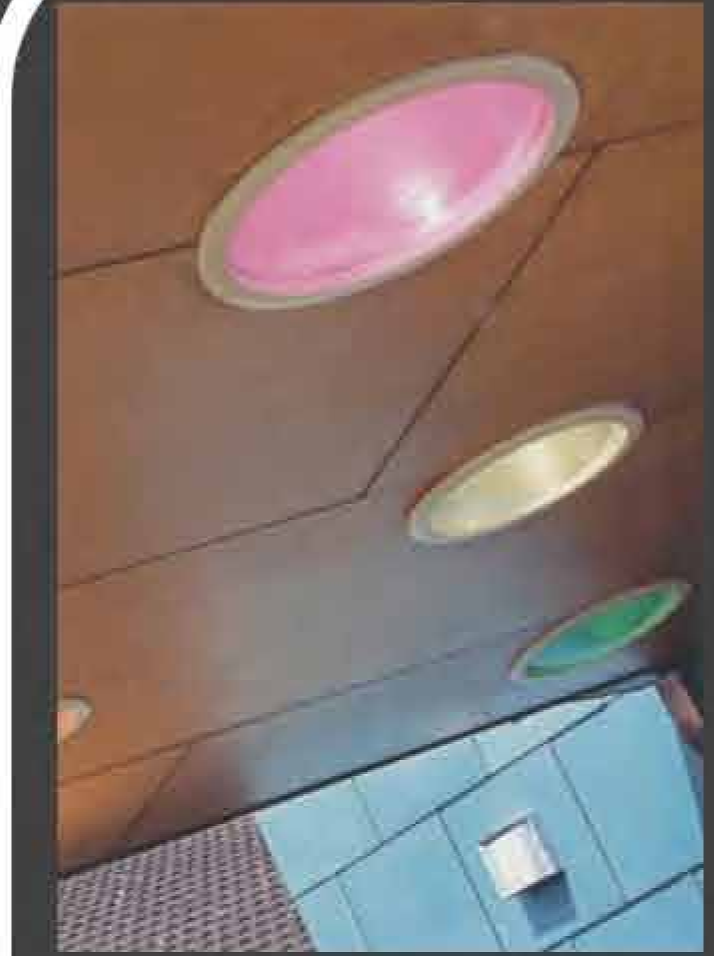
- Energy-efficient building shell, with radiant barriers & white reflective roofs
- 3-D experiential learning centers linking curriculum to sustainable design features

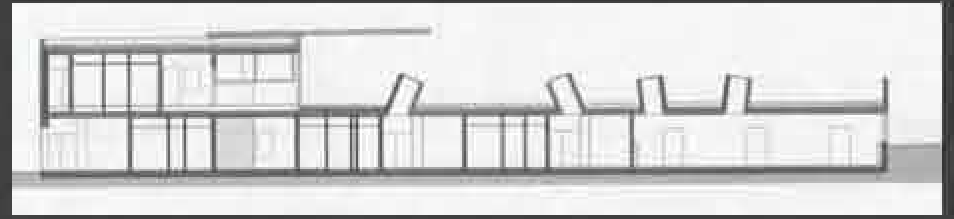


day lighting precedence

- Kinetic light illuminating the hallways
- Central light & mechanical shaft
- Daylight from the exterior hallways illuminating the classrooms
- Playful shapes & colors bring ambient daylight into the spaces

landscape architecture precedence











concept #1

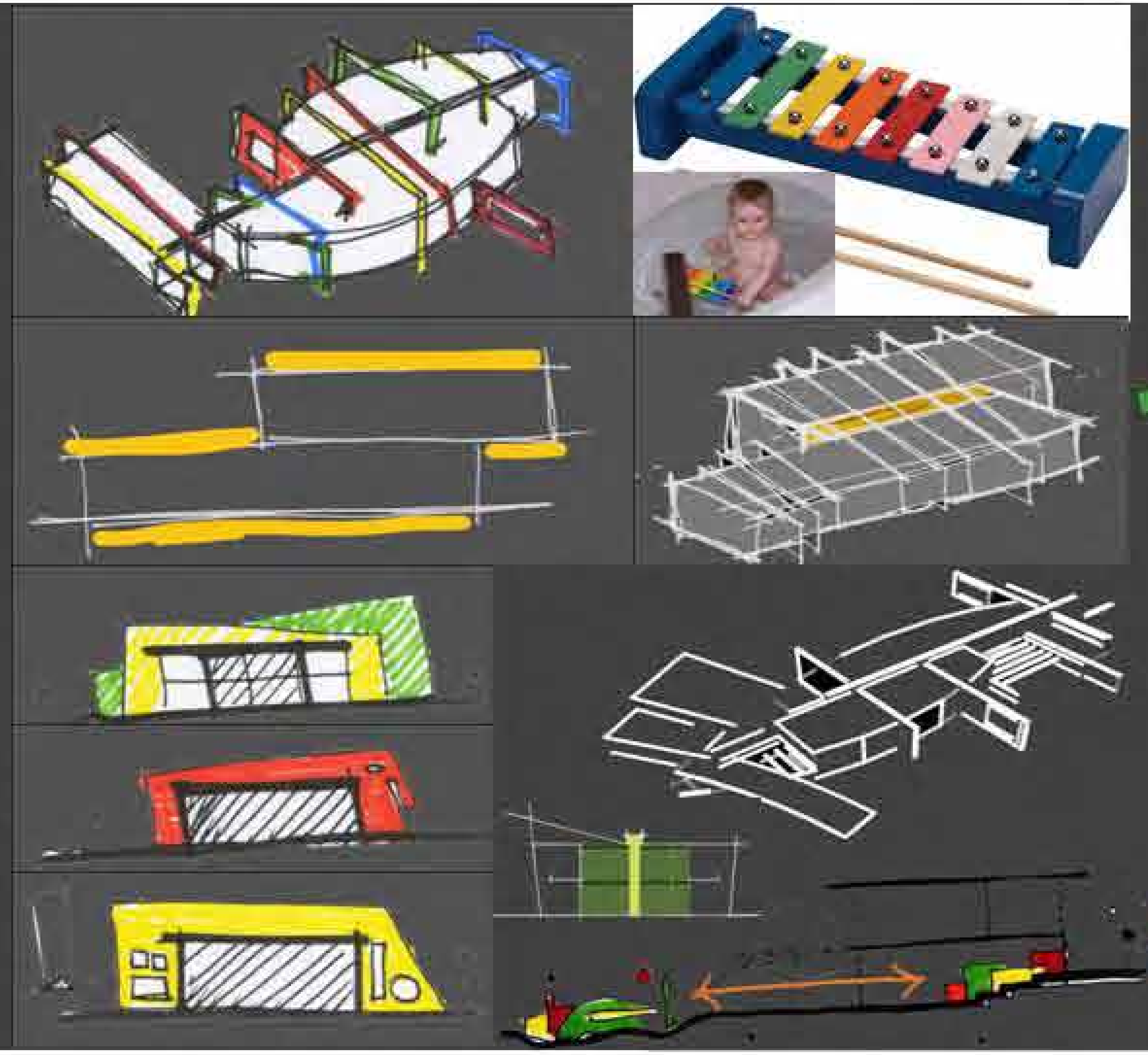
creative LOGIC

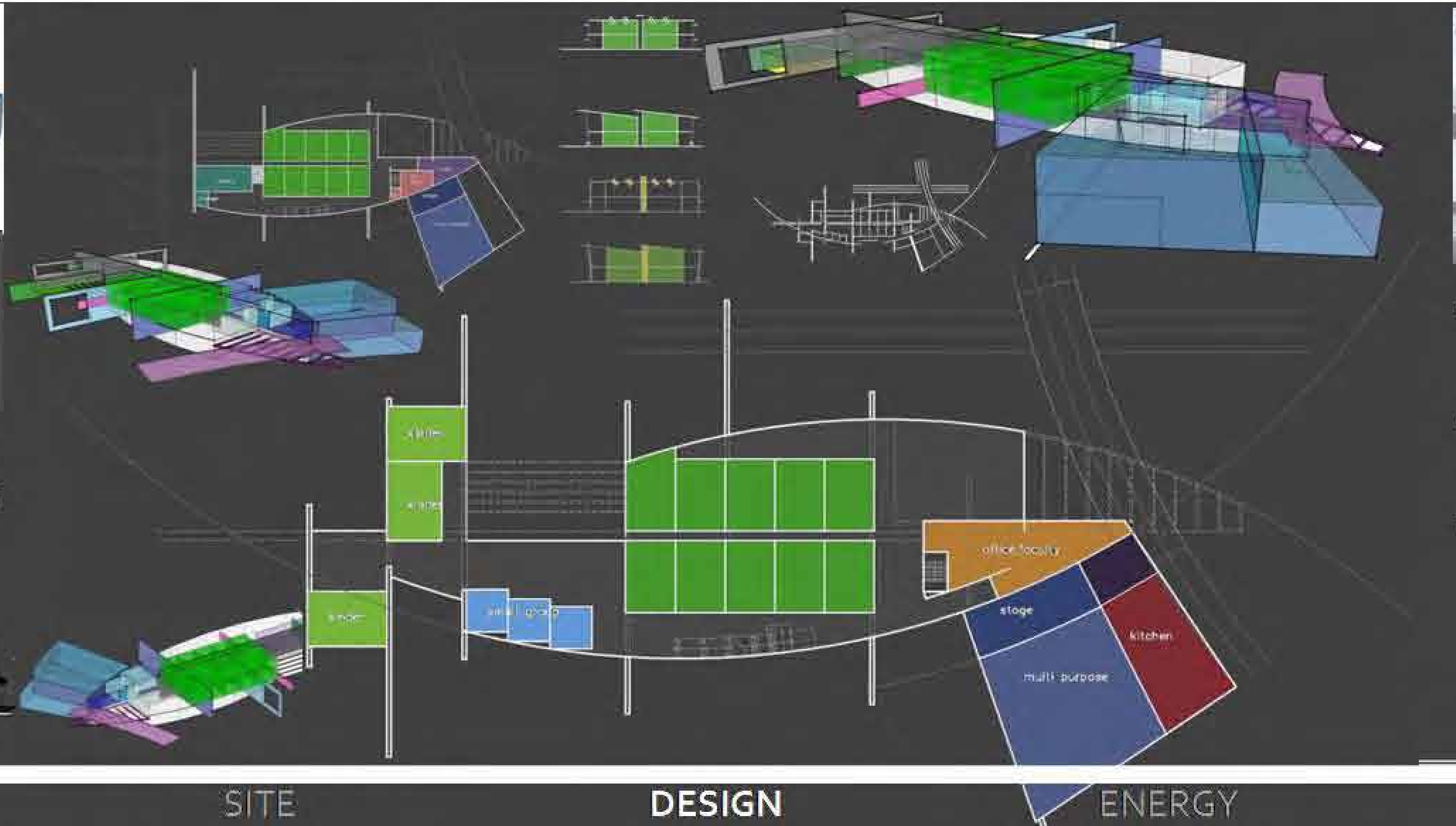
Idea- Xylophone

Layout - Linear

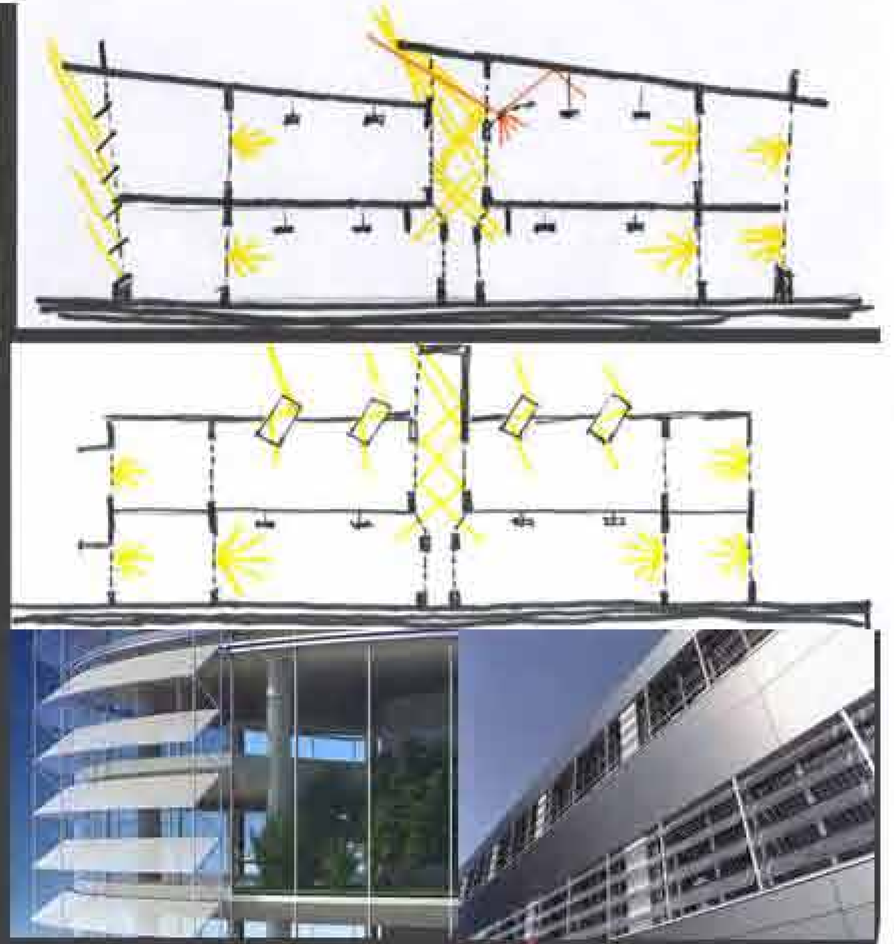
Form - Dynamic

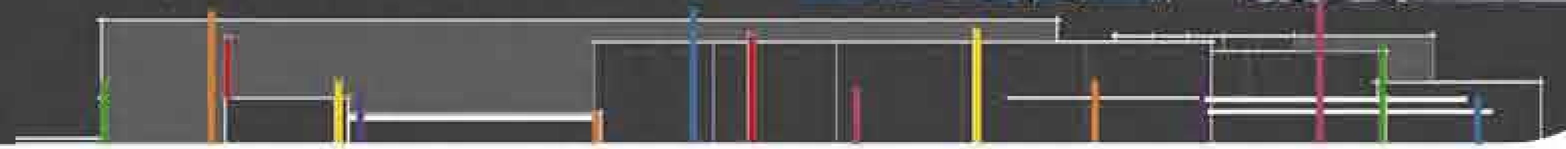
Sustainability through integrated systems





- Central, circular light well
- Innovative clerestory application
- Overhangs and possibility of photovoltaic shading





2 - highly adaptable & flexible spaces
4 – daylighting

site concept #1

Concept: to encourage learning through play

Program:

- Bioretention
- Grey/blackwater filtration
- Succesional forest
  - Classrooms
  - Play areas
- Themed gardens
  - Art
  - Music
  - Kitchen
- Sports fields:
  - Soccer
  - Baseball

2 – highly adaptable & flexible spaces
7 – LEED Gold or Platinum

concept #2

creative LOGIC

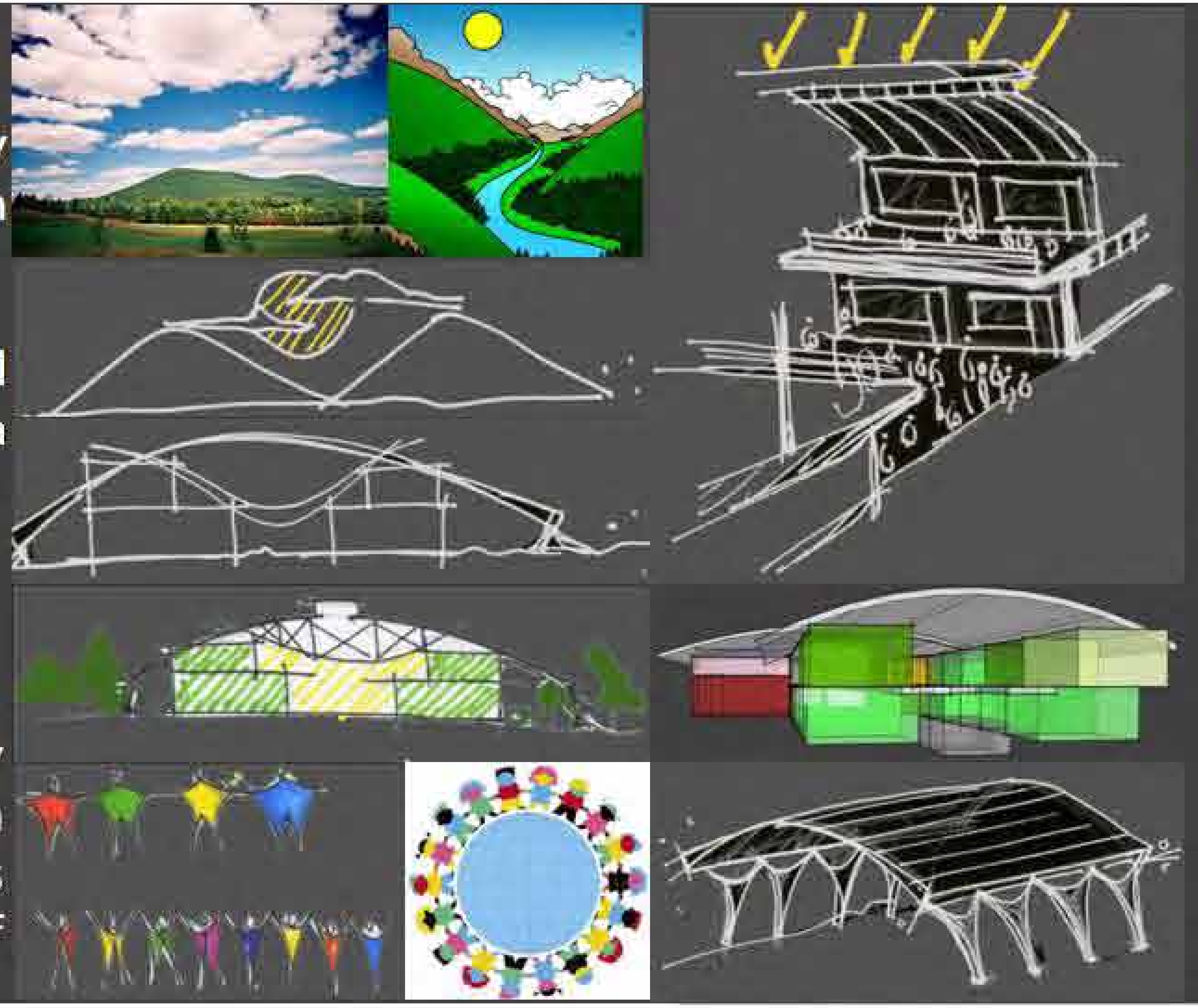
3 – energy efficiency
4 – daylighting

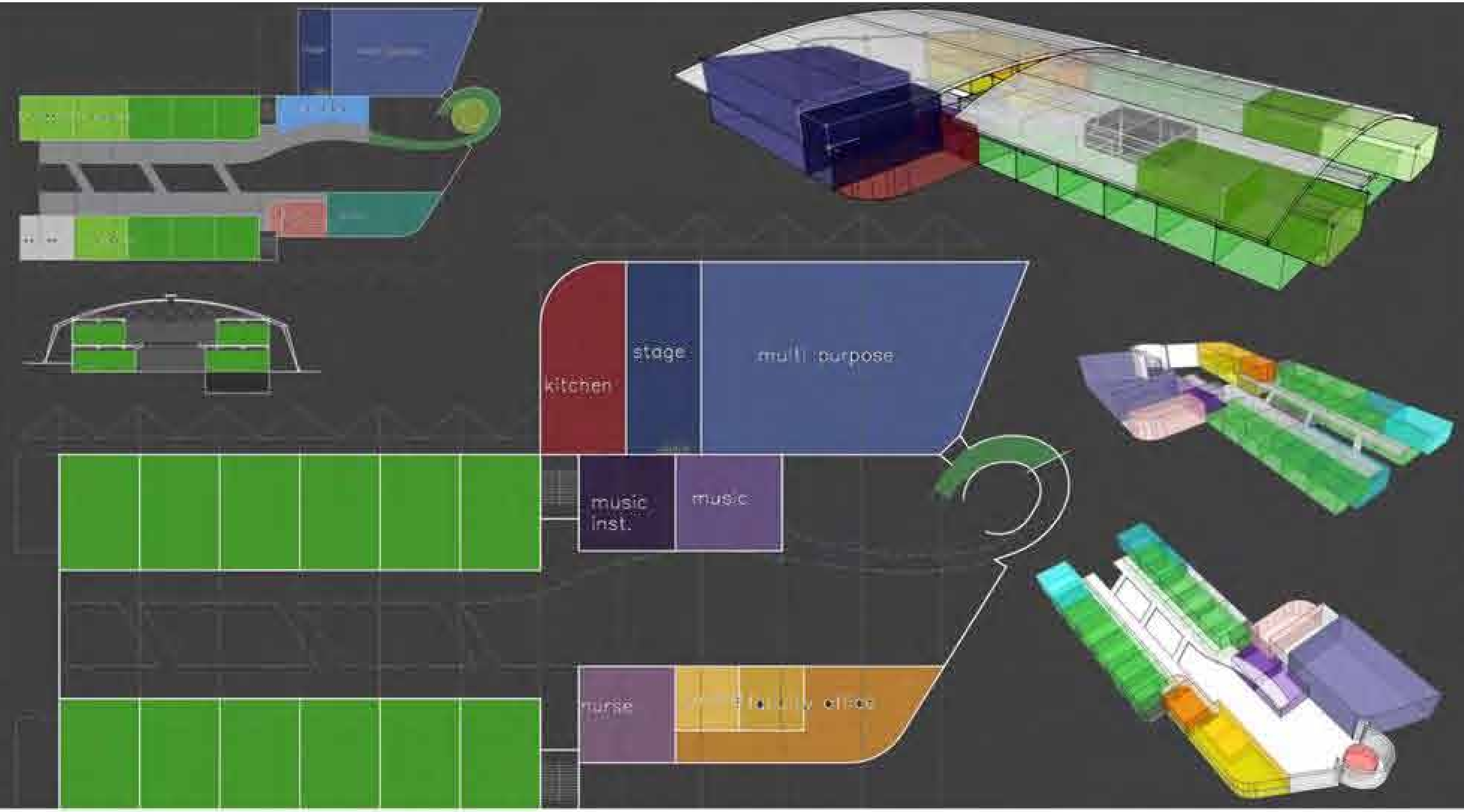
Idea- Happy Valley Children Chain

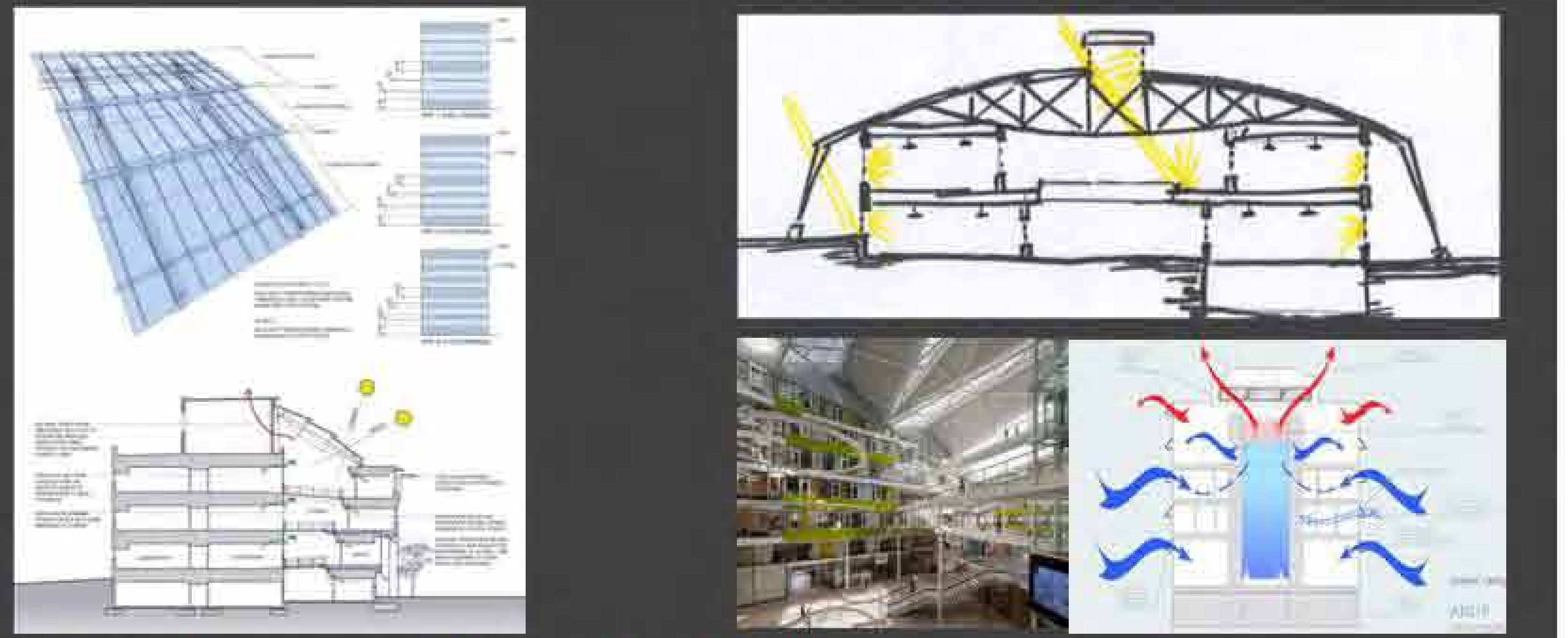
Layout- Central Indoor Area

Form - Introvert

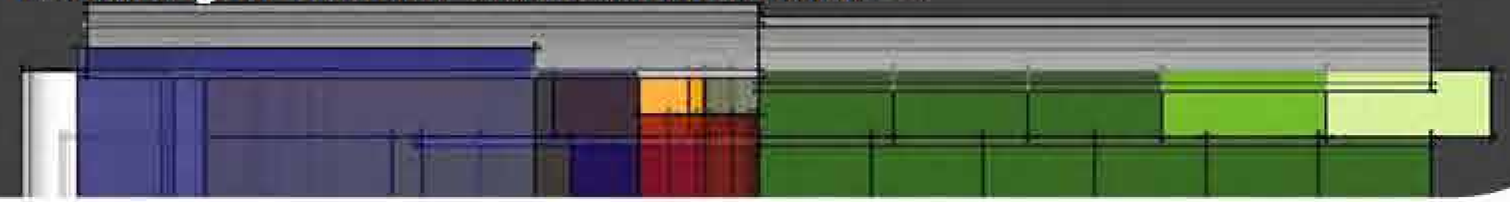
Sustainability through integrated systems single roof







- Central atrium providing ambient light
- Kinetic light in the central hallway
- Dimming of interior classroom luminaries

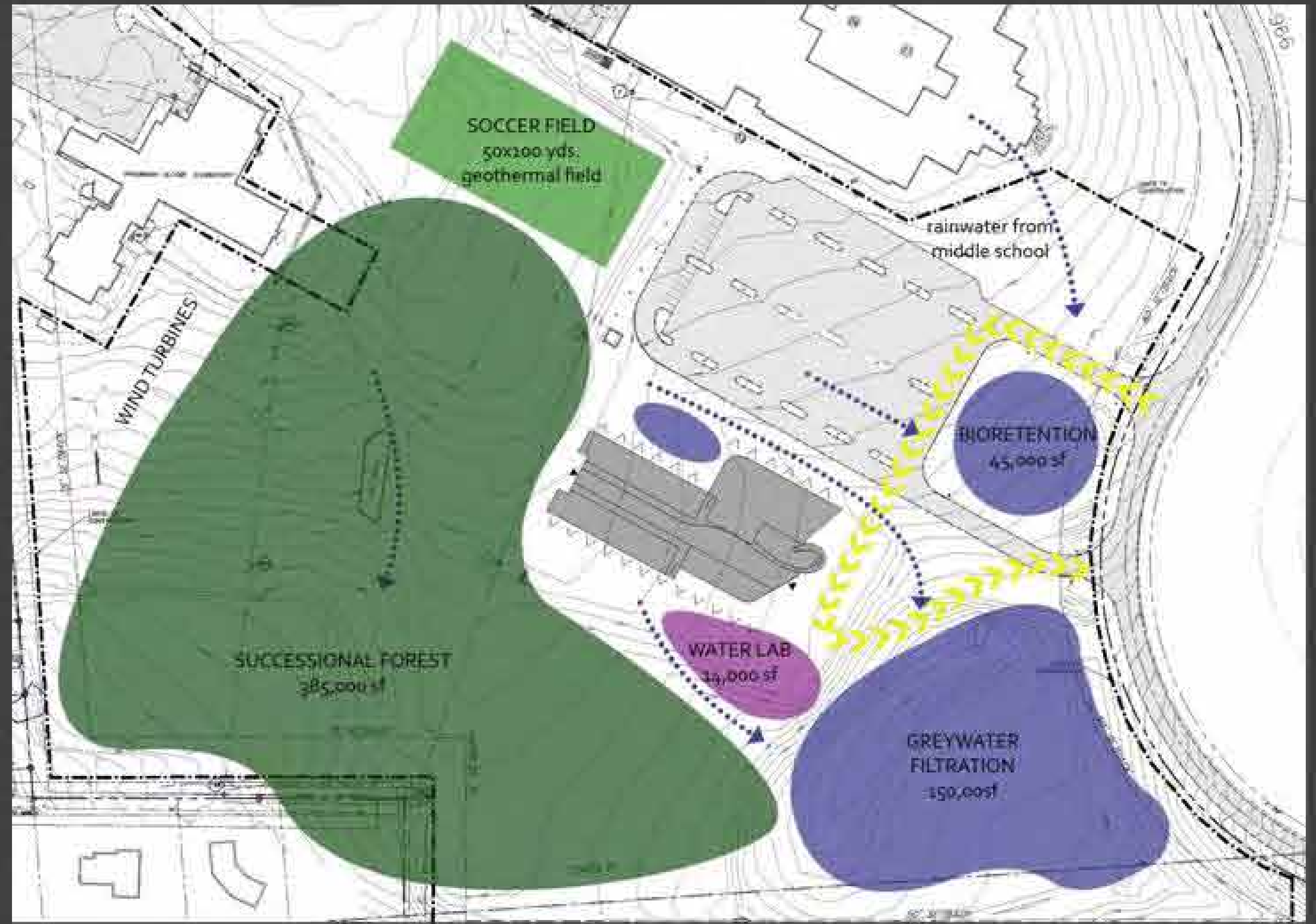


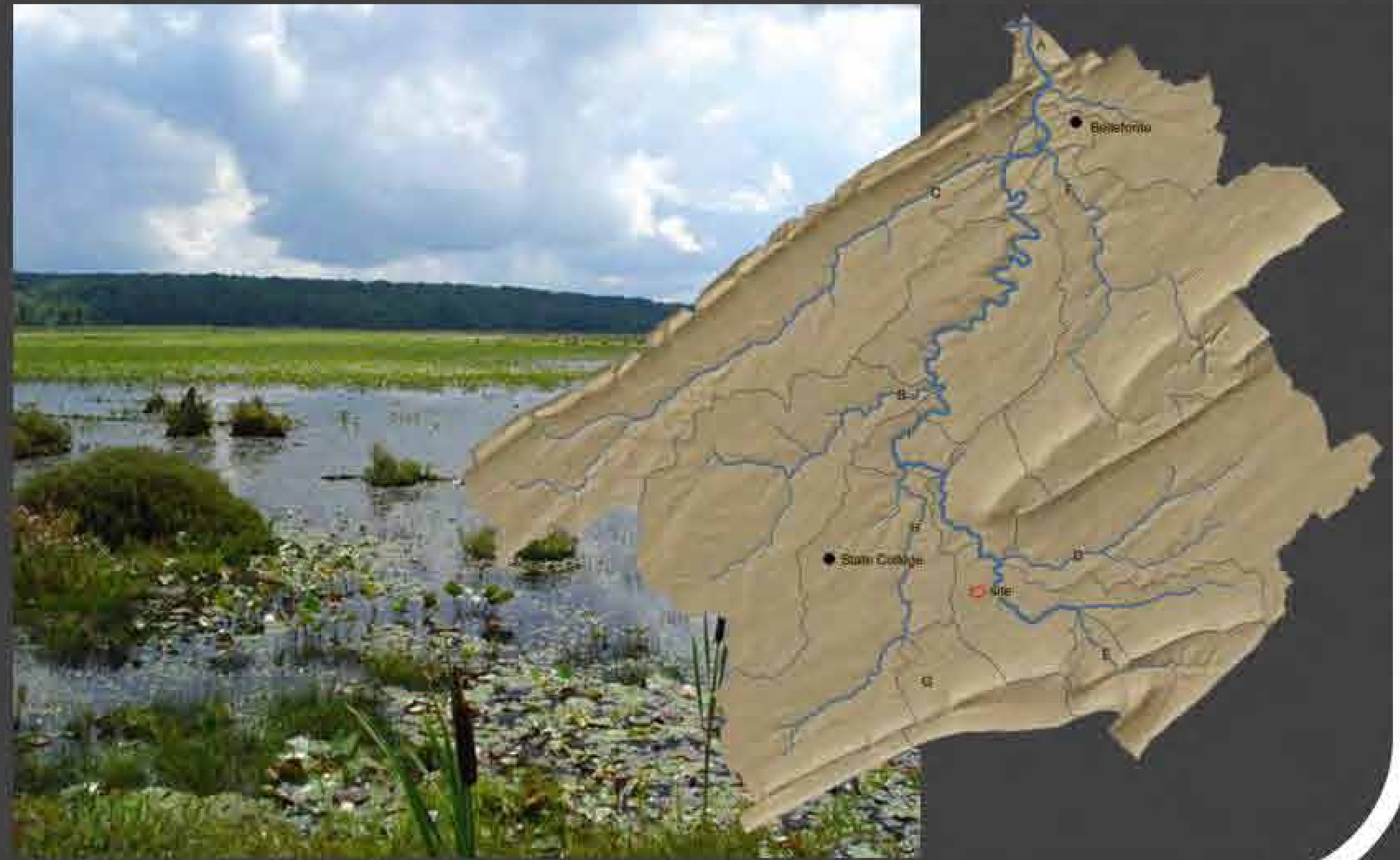
site concept #2

Concept: to promote understanding of human impacts on environment through the abstract representation of the Spring Creek Watershed

Program:

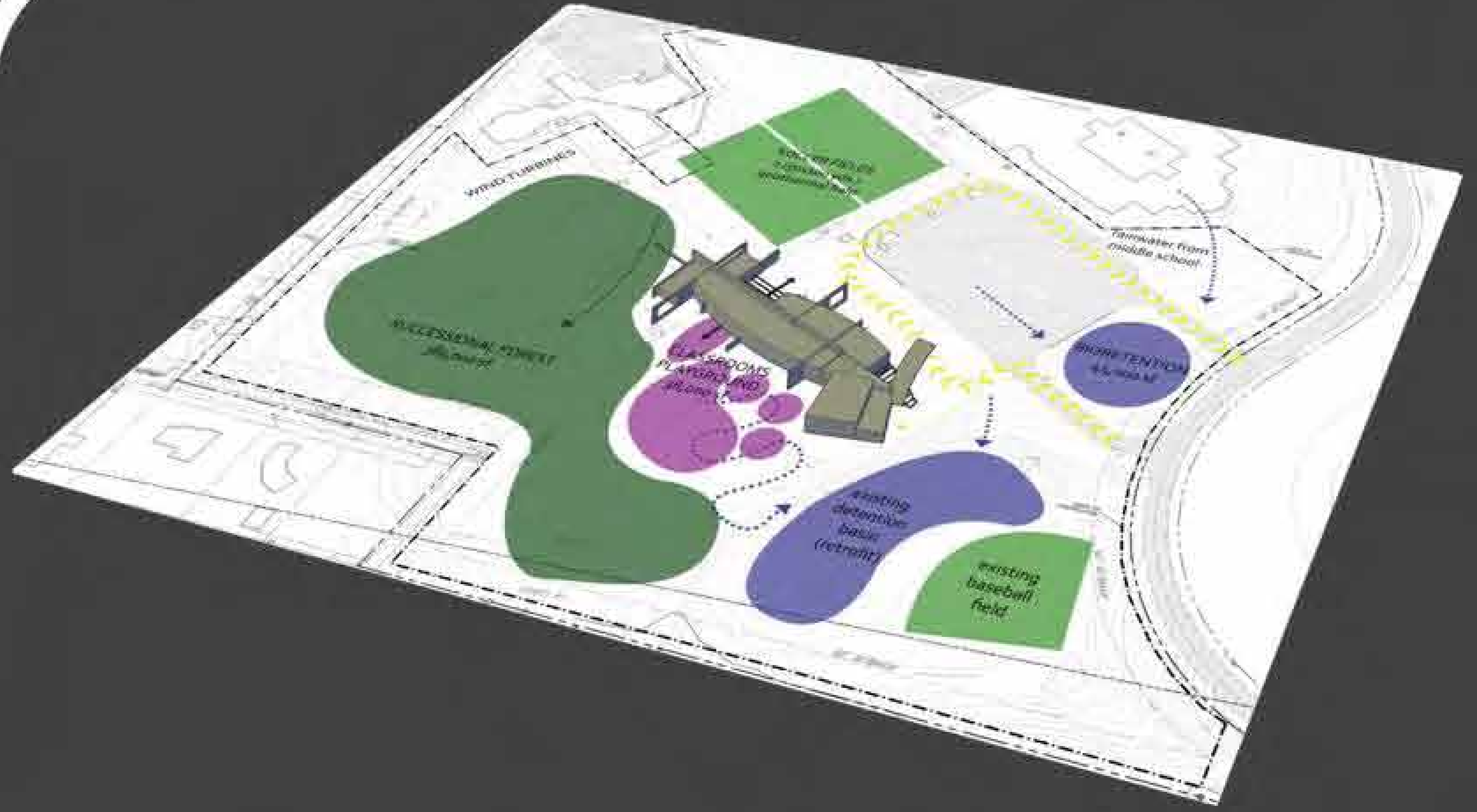
- Bioretention
- Grey/blackwater filtration
- Outdoor water lab
- Succesional forest
    - Classrooms
    - Play areas
- Soccer field



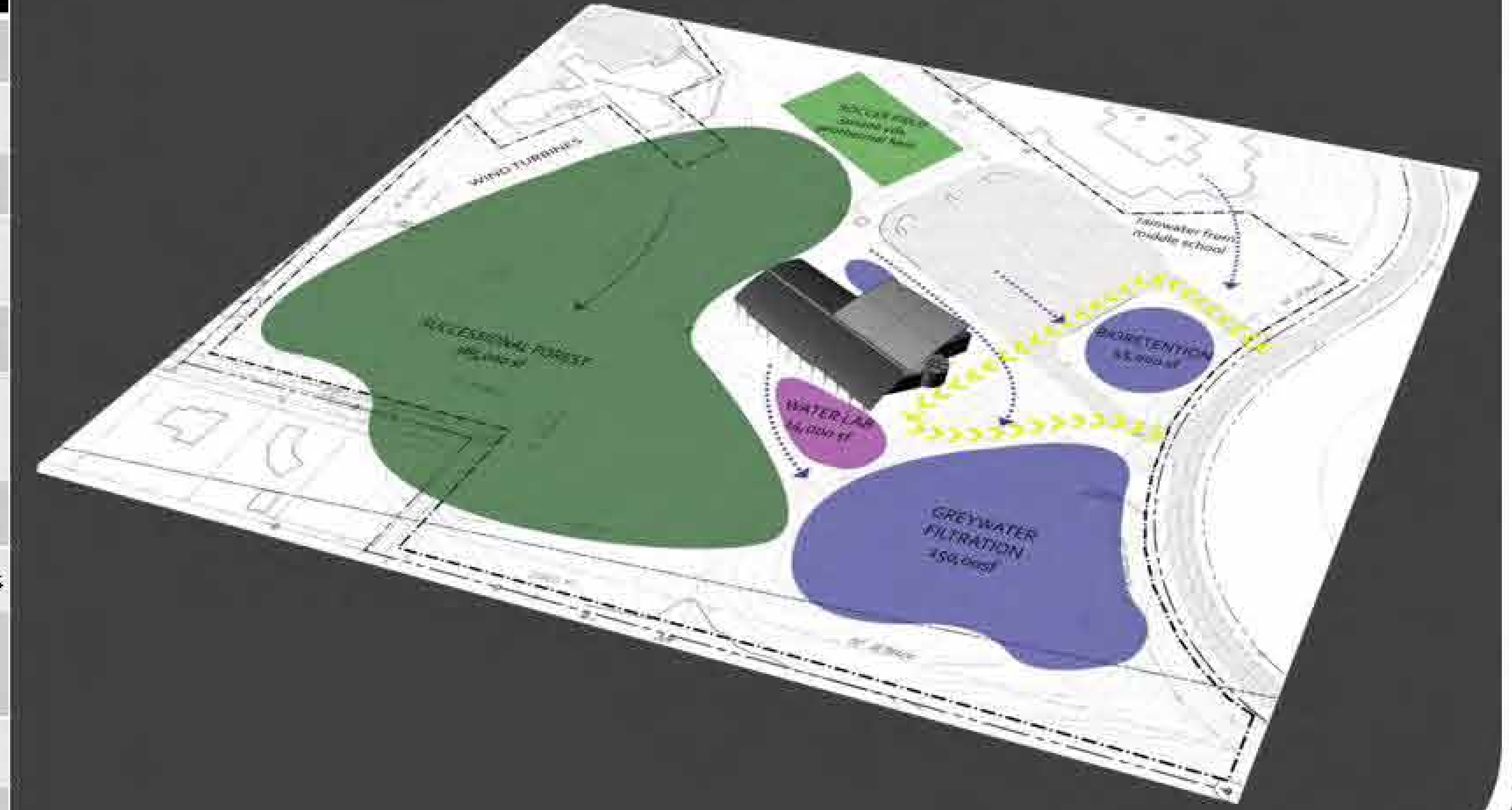


2 – highly adaptable & flexible spaces
7 – LEED Gold or Platinum

comparison



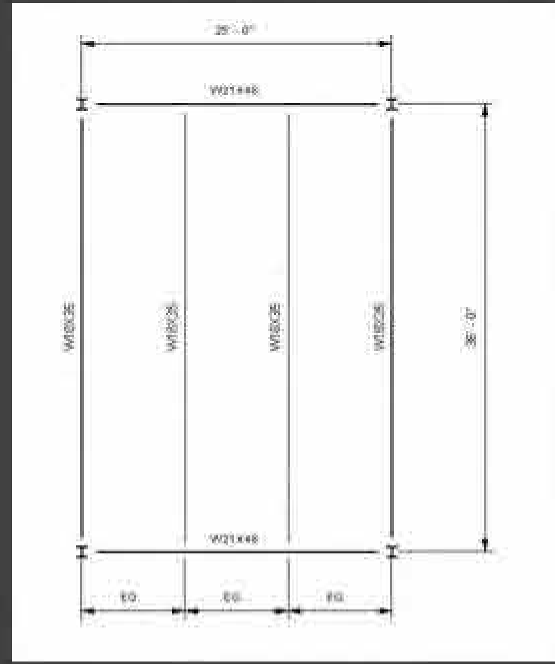
	Concept 1	Concept 2
Pros	Central energy shaft	Dense form
	Formal variety	One central indoor area
	Strong connection between inside & outside	Single structured roof
	Maintain existing site facilities	Decreased areas of low infiltration (pavement & sports fields)
	Creative & engaging outdoor educational spaces	Highly visible entrance
	Building as teaching tool through exposed mechanical systems	Ramp as main access for children
	Day lighting from corridor and central shaft	Exploit Topography change for Mechanical Room
Cons	More external surface area increases mechanical loads	Less connection between indoor and outdoor spaces
	Weak connection of music room, music garden & stage	Less dynamic form
	More sports fields and playgrounds	Less transparent
	Increased square footage of pavement	Complex structure



structural system options

- Four (4) main structural systems
  - Steel
  - Concrete
  - Masonry
  - Wood

classroom bay



- LRFD Analysis
- 25'-0" x 36'-0" bays
  - W 18's for equally spaced infill beams
  - W21's for girders
  - W10/W12's for columns
- Assumed 15'-0" floor to floor height

design loads

Occupancy of Use	Uniform LL (psf)
Lobbies	100
Gymnasiums	100
Classrooms	40
Corridors (1st Floor)	100
Corridors (Above)	80
Reading Rooms	60
Stack Rooms	150
Snow Load*	30

Lateral Force(s)	Location-Specific Data
Wind*	V= 90 mph
Seismic *	$S_{0.2}$ = 0.18g
Seismic *	$S_{1.0}$ = 0.06g
*State College, PA specific data	

creative LOGIC

energy

functions

CATEGORY	ROOMS BY PROGRAM	OCCUPANCY (sf/person)
Multipurpose Assembly	all-purpose room	10
Music/Theater/Dance	stage, full size music room, instrumental music room	29
Classrooms (age 5-8)	kindergarten rooms (3)	29
Classrooms (age 9+)	classrooms(18), small group instruction(3)	40
Libraries	library	50
Art Classroom	art room	50
Break Room	faculty lounge	50
Kitchen	full service kitchen	100
Restrooms	bathrooms (4)	200
Sickroom	nurse's suite	200
Office Space	administrative offices (1), faculty work	200
Mechanical	mechanical space	200
Corridors	hallways (not specified)	–

schedules

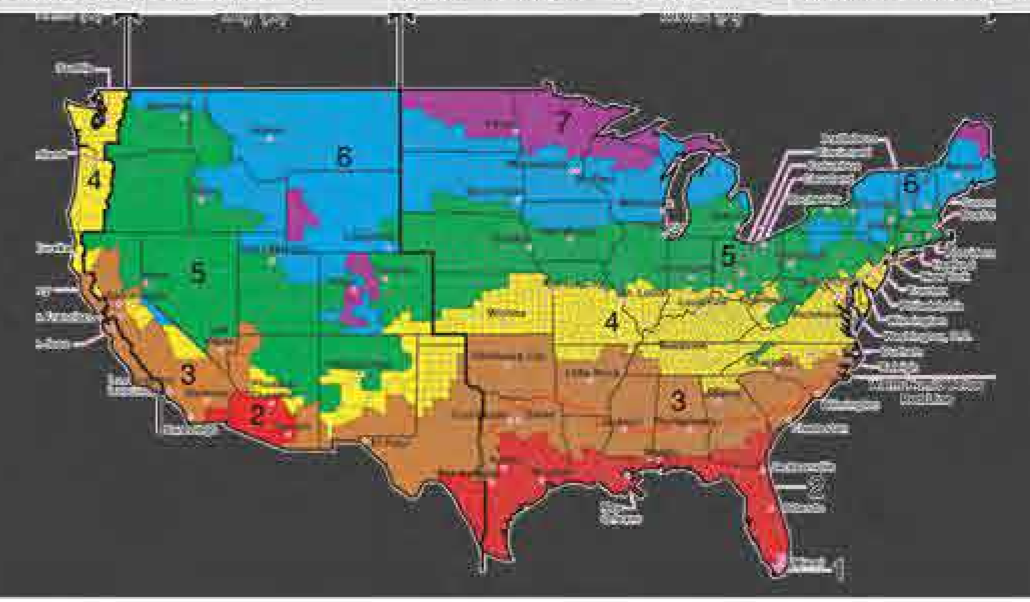
SCHEDULE	TIMES	PERCENT LOAD
School (Weekdays Year-Round)	6am-8am 8am-4pm 4pm-6pm	40 100 40

SET-POINT	HEAT AT	COOL AT
Occupied	70 °F	75 °F
Unoccupied	60 °F	85 °F
Holiday	50 °F	85 °F

[Ashrae 62.1-2007]

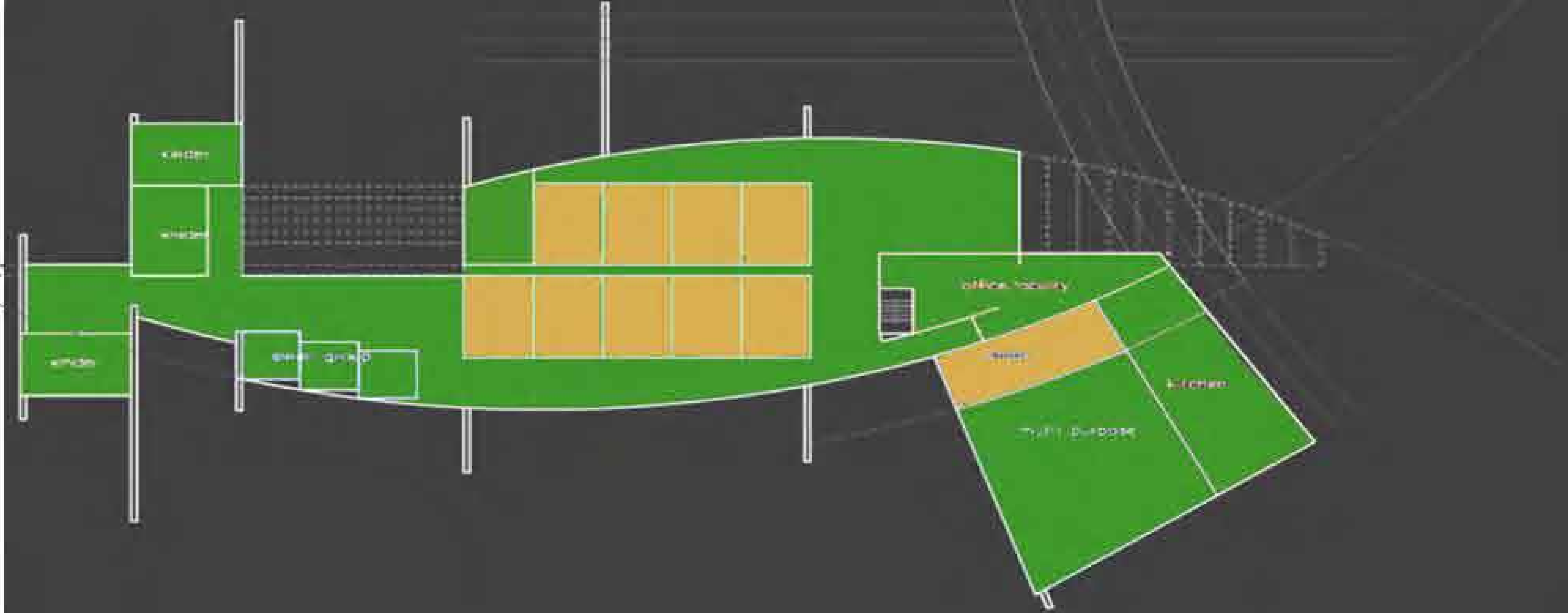
weather

ASHRAE Altoona, PA	Summer Design Condition Cooling 0.4%	Winter Design Condition Heating 99.6%
Outside Air Dry Bulb (°F)	88.5	4.7
Outside Air Wet Bulb (°F)	72.0	--
Indoor Comfort Area (°F)	75 DB, 50% RH	75 DB, 50% RH



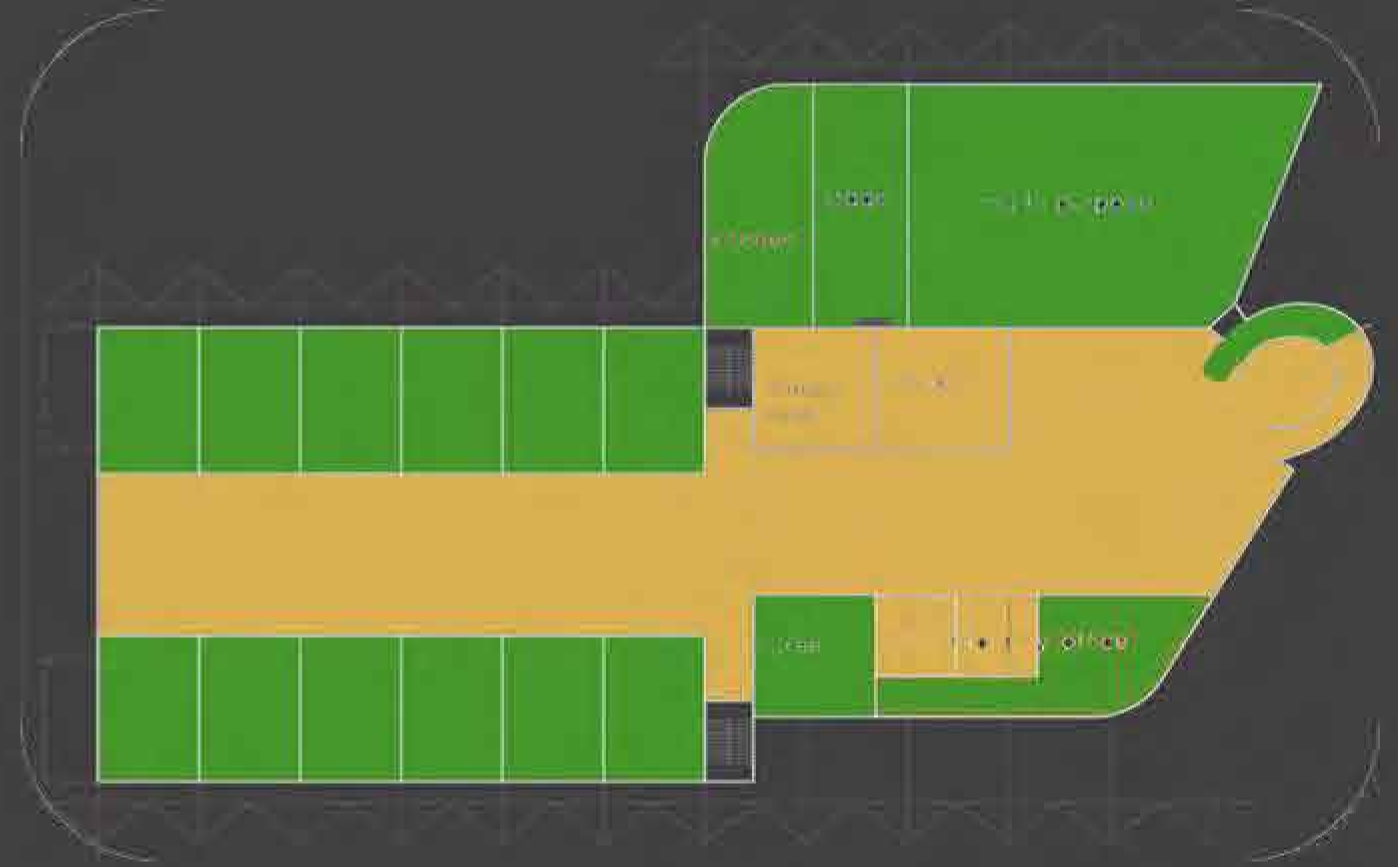
thermal zones

concept#1



	CONCEPT#1	CONCEPT#2	
EXTERNAL	Kindergarten, Small Group Study, Corridors, Office, Multipurpose, Kitchen	Classrooms, Kitchen, Stage, Multipurpose, Nurse, Office	EXTERNAL
INTERNAL	Classrooms, Stage	Corridors, Music, Faculty Lounge	INTERNAL

concept#2

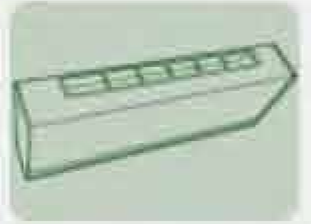


comfort

LOCAL	CENTRAL
+ Ability to respond quickly to individual rooms	+ Equipment contained within own space
+ Allows greater control over the room	+ Maintenance can be carried out without disrupting activities
+ Small foot print	
- Noise or by-products go right into room	- Breakdown paralyzes entire school
EX: unit ventilators	EX: heat pumps, fan/evaporator coils

RECOMMENDED FOR	RECOMMENDED FOR
Classrooms, Lounge	Corridors, Multi-purpose, Bathroom, Office, Library

mechanical systems

UNIT VENTILATORS	CHILLED BEAM	VARIABLE AIR VOLUME (VAV)
Uses a fan to blow air across a coil, thus conditioning the space which it is serving	Uses water to remove heat from room, chilled water closer to space	Fan capacity controls ventilation of multiple rooms from one area through ducts
+ Heats, cools & ventilates + Durable cabinet design + Cost-effective	+ Minimizes energy required by fans	+ Great reliablility + Flexible + Cost-effective
- Source of noise	- Level of humidity control required due to potential water damage - High cost	- Considerable space requirements (Up to 18" above ceiling)
		

health

- Passive low-energy approach to ventilation = windows (give building occupants control over outdoor air)
- Pollutant sources: odors, irritants, toxic, biological, radon

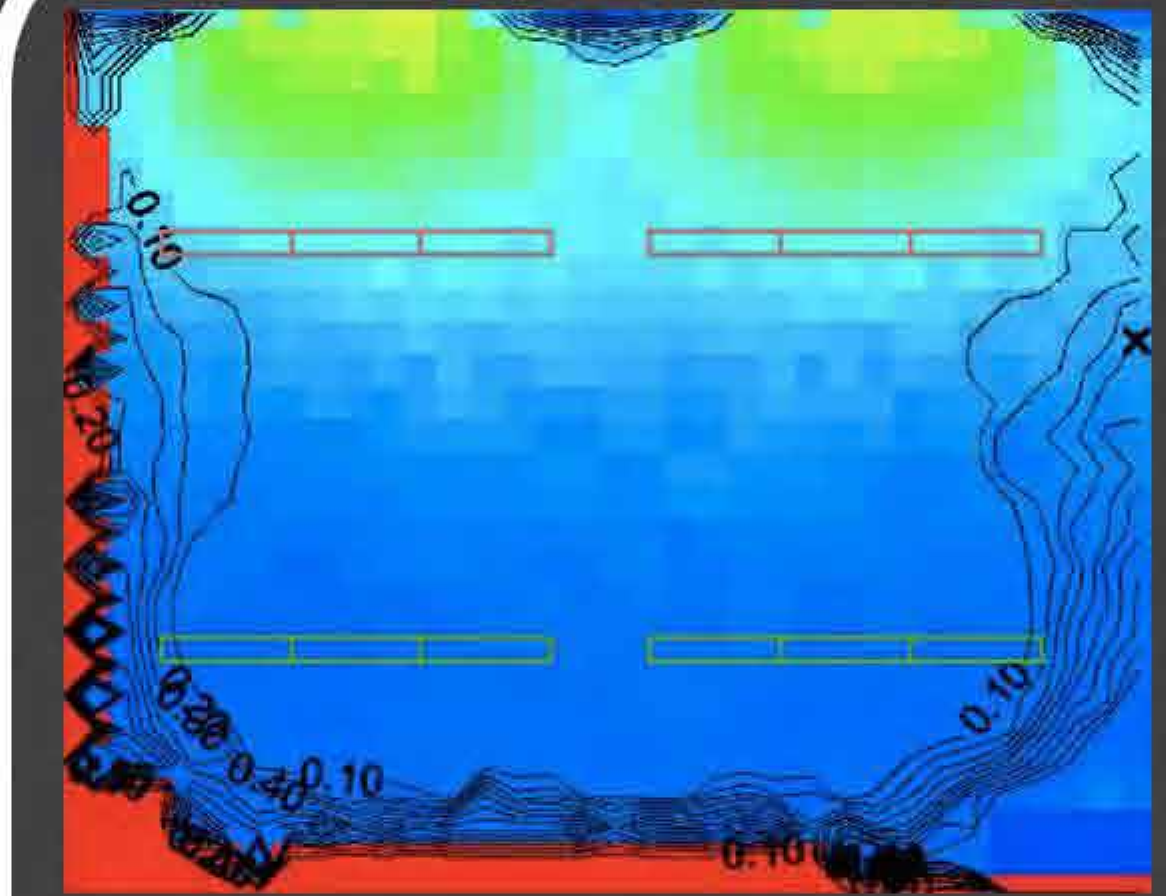
INDOOR AIR QUALITY RECOMMENDATIONS

1. Locate air intakes above pollution
2. Zone equipment such as copier near intakes
3. Dirty vs. clean areas: change pressure

AREAS OF CONCERN

Sickroom, Art Classroom, Kitchen

9 – thermal comfort
10 – indoor air quality



- Photosensors
- Occupancy sensors
- Timers

Strategies for reducing HVAC cooling load

- Selection of low emissivity, spectrally selective glass
- Window assemblies with low U-values
- Tinted or electrochromic windows

LIGHTING / ELECTRICAL
- Integration into the Architecture
- Cradle to Cradle
- Using low voltage switching (LEED)

MECHANICAL
- Duct covers for indoor air quality & LEED
- Local duct & pump manufacturers (Killingers / Armstrongs)

4 – daylighting
7 – LEED Gold or Platinum

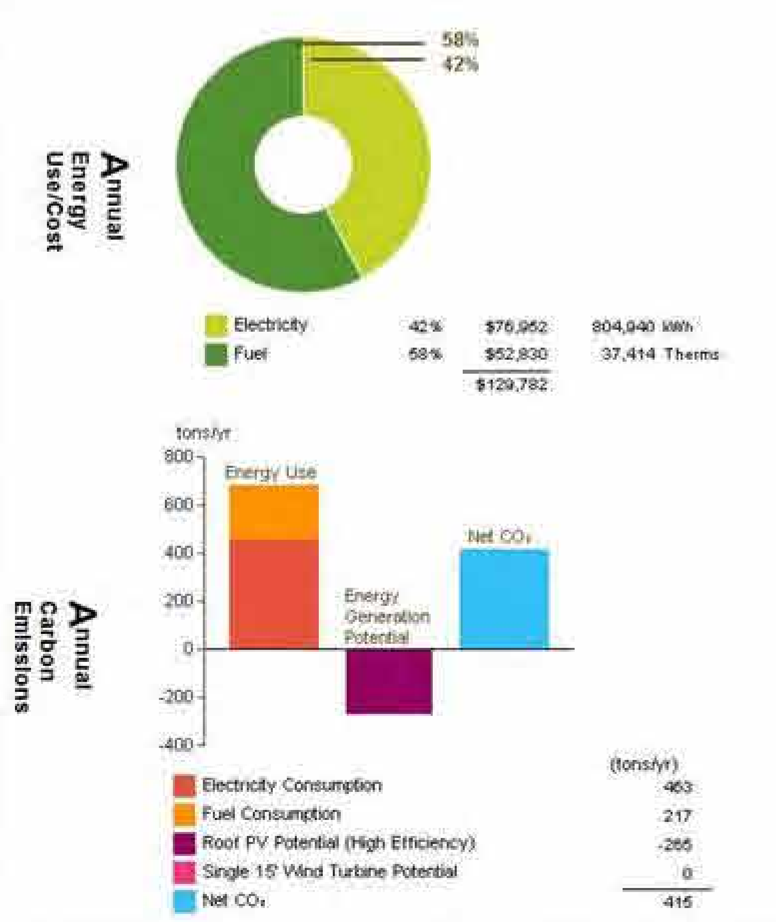
creative LOGIC

power densities

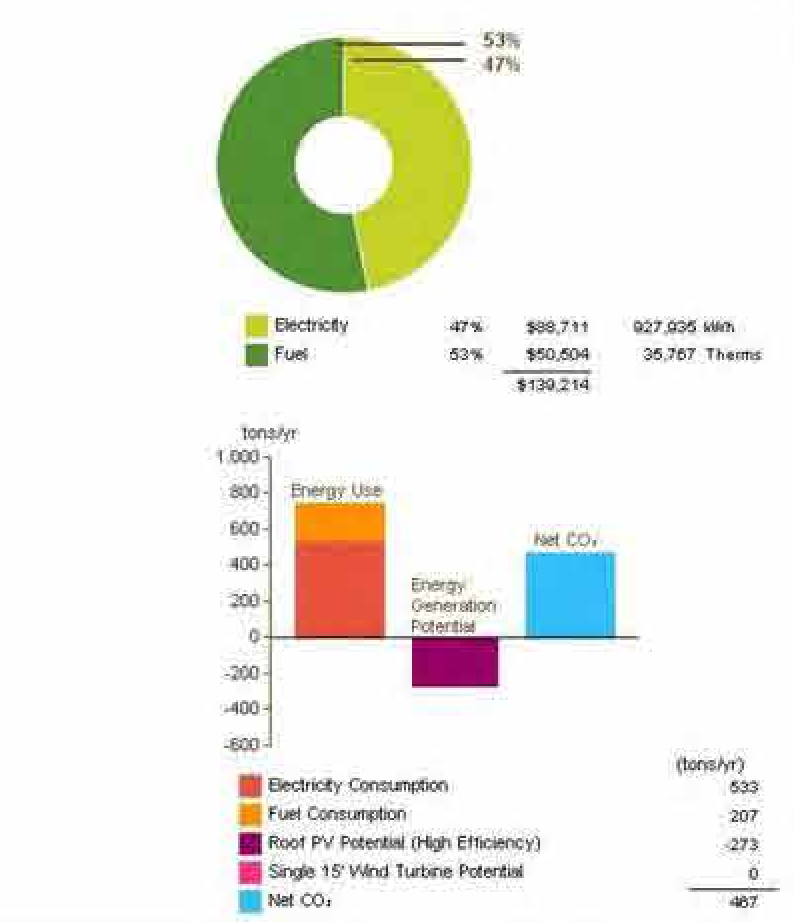
CATEGORY	LIGHTING PD (W/ft²)	EQUIPMENT PD (W/ft²)
Classrooms (age 9+)	1.4	1.0
Classrooms (age 5-8)	1.4	1.0
Music/Theater/Dance	1.3	1.0
Libraries	1.4	1.0
Art Classroom	1.4	1.0
Office Space	1.1	1.5
Sickroom	1.1	1.5
Restrooms	0.9	0.3
Break Room	1.2	0.5
Mechanical	1.5	0.3
Corridors	0.5	0.3
Kitchen	1.2	1.5
Multipurpose Assembly	1.3	1.0

[Ashrae 90.1-2007]

energy model



concept #1



concept #2

sustainability

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	24,148,209 kWh
Life Cycle Fuel Use:	1,122,441 Therms
Life Cycle Energy Cost:	$1,767,629

*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	154,027 kWh/yr
Roof Mounted PV System (Medium efficiency):	308,054 kWh/yr
Roof Mounted PV System (High efficiency):	462,081 kWh/yr
Single 15' Wind Turbine Potential:	1,220 kWh/yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

concept #1

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	27,838,065 kWh
Life Cycle Fuel Use:	1,073,025 Therms
Life Cycle Energy Cost:	$1,896,099

*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	158,653 kWh/yr
Roof Mounted PV System (Medium efficiency):	317,305 kWh/yr
Roof Mounted PV System (High efficiency):	475,958 kWh/yr
Single 15' Wind Turbine Potential:	1,220 kWh/yr

*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

concept #2

3 – energy efficiency
7 – LEED Gold or Platinum

construction

IPD

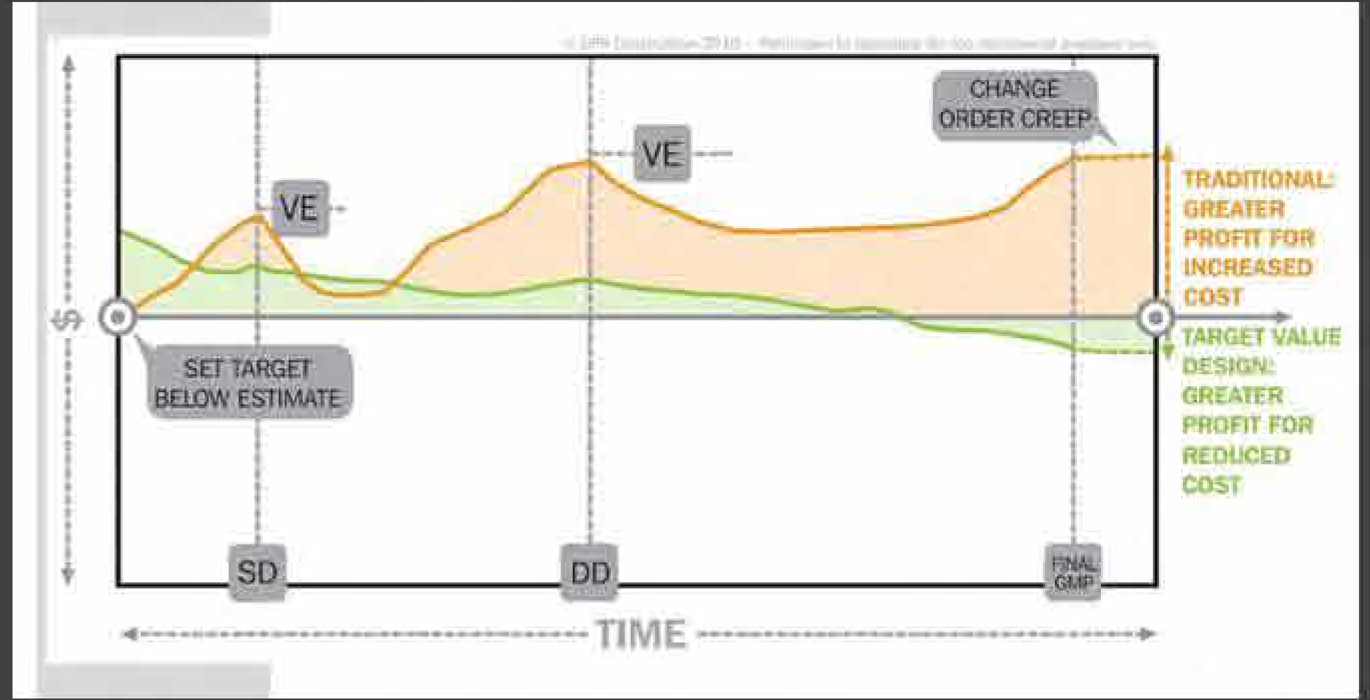
- **Avoids** redesign by considering **cost** early
- Saves **time** during design, estimating and coordination
- Ensures that **systems** work in **unison**, increasing project **value**
- **Refocuses** goals on **value**, rather than **direct costs**

key differences

CURRENT PRACTICES	INTEGRATION PRACTICES
Cost is an output of design.	Cost is an input to design.
Early commitment to design solutions.	Carry multiple solutions as long as possible.
Design, then calculate cost of design.	Provide cost feedback on concepts.
"Wait until I'm finished."	Share information early and often.
2-D light table coordination.	3-D model clash detection.
Time consuming manual take-offs.	Rapid, model-based estimating.
Optimize each piece.	Optimize the whole.

- Maximizes **collaboration**
- **Shortens** design **reiterations**
- Provides **instant** clash detection **feedback**
- **Focuses** on the **whole**, not the sum of its parts

incentive alignment



- Stresses **VALUE**, not **cost**
- **Aligns** involved parties

transfer to field

- No smoking indoors
- Water stations
- Waste ticket tracking
- Recycling plans
- Swift material unloading

construction materials

Material	Advantages	Disadvantages
Concrete	High Compressive Strength	Low Tensile Strength
	Fire Resistant	Formwork & Shoring
	Low Maintainence	Low Strength to Weight Ratio
	Lower Floor to Floor Height	Longer Time To Erect
Steel	High Strength-to-Weight Ratio	Corrosive Material
	Quick to Erect	Additional Fireprotection needed
	Good in Tension and Compression	Availability can be limited
	Reusable Material	
Masonry	High Compressive Strength	Low Tensile Strength
	Fire Resistant	Degradation of Material
	Passive Solar Applications	Low Strength to Weight Ratio
Wood	Cheap Construction Cost	Degradation of Material
	Low Embodied Energy	Lower Material Strength
	Fire Resistant	Non-uniform Stresses
	Reusable, Efficient Material	

Insulation	Thermal Resistance (R-Value)/ Inch Thickness	Compressive Strength (psi)
Wood fiber	2.78	80
Perlite	2.78	35
Polyisocyanurate	6.00	16-25
Expanded polystyrene*	3.80	12
Extruded polystyrene	5.00	15-100
Cellular glass	4.69**	100
Gypsum board	0.56***	500-1,250

unique documentation

MATERIAL	SUPPLIER	LOCATION	ROUND TRIP DISTANCE	METHOD	FUEL ECONOMY	TYPE OF FUEL	EMISSIONS	CARBON FOOTPRINT	# OF TRUCKS	TOTAL FOOTPRINT
Steel Deck	Vulcraft	Chemung, NY	280 MILES	Tractor Trailer	8 MPG	DIESEL	22.2 LBS/GAL	777 LBS		
Joists	Vulcraft	Chemung, NY	280 MILES	Tractor Trailer	8 MPG	DIESEL	22.2 LBS/GAL	777 LBS		

- Logs **carbon** footprint
- Documents **effect** of buying **locally**

materials sustainability

TRANSPORTATION

- **Shipping**
  - Trucks leave massive carbon footprints
    - Local Materials
- LEED needs revamping
  - Material tracking not required

CONSTRUCTION WASTE

- 10-15% of materials go to waste
- Most can be recycled

PRODUCTION & FABRICATION

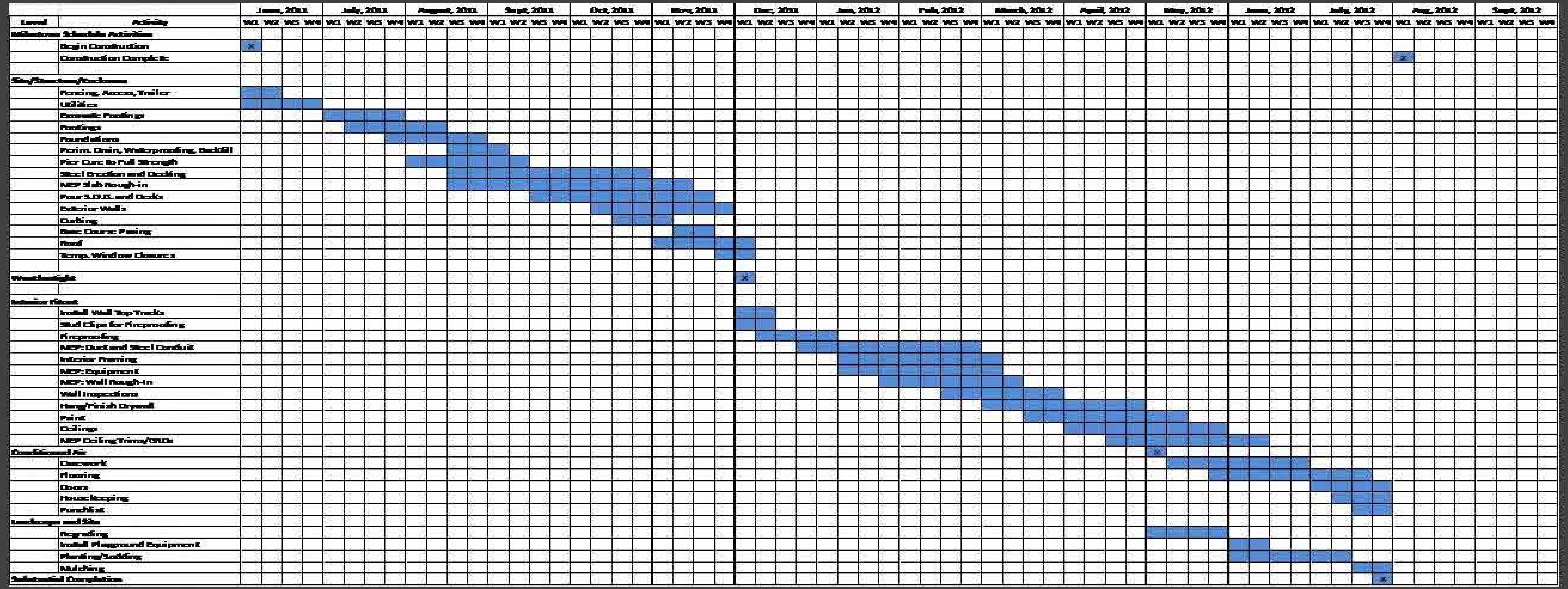
- **Embodied Energy**
  - Total primary energy consumed during the extraction, transportation, manufacturing and fabrication of construction materials
  - Structural systems account for 1/3 of total embodied energy
- **CO2 Emissions**
  - Roughly 10% of all manmade greenhouse gases are due to concrete/steel industries

Material	Embodied Energy	CO_2 emissions/lb.	Strength-to-Weight Ratio
Steel	High	1.50 lb/lb	1:10
Concrete	Med	1.00 lb/lb	1:40
Masonry	Med	~1.00 lb/lb	Low
Wood	Low	0.7 lb/lb	Low

- **Local Manufacturers**
  - Steel
  - Concrete
  - Masonry
  - Wood

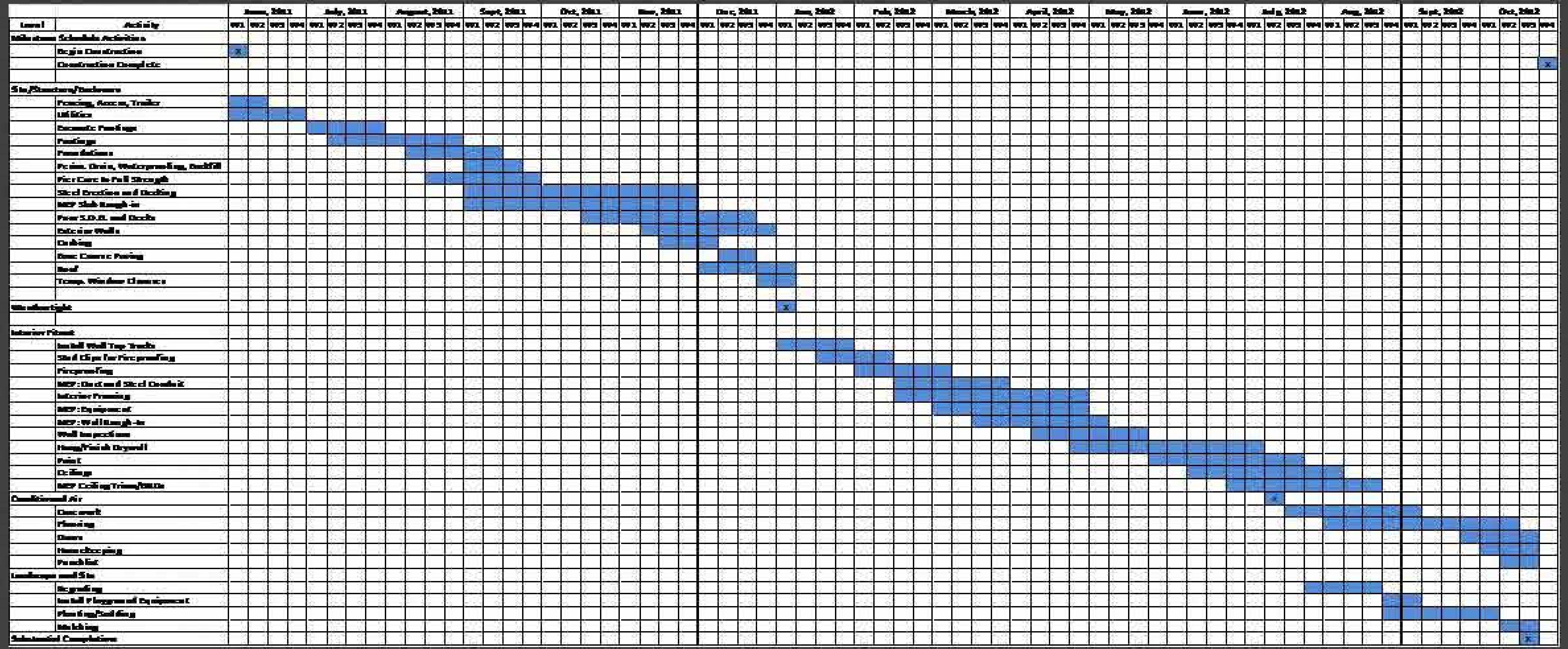
Multiple manufacturers within 50 miles

preliminary schedule – “happy valley” concept



- Modular design allows for:
  - Shortened foundation layout
  - Modular steel/deck erection techniques
  - Rapid exterior wall erection
  - Simple wall rough-ins
  - Elimination of complex drywall
  - Minimal custom floor cutting

preliminary schedule – “xylophone” concept



- Curvilinear design lengthens average durations for:
  - Foundations
  - Steel/deck erection
  - Exterior walls
  - Wall rough-ins
  - Hang drywall
  - Flooring

ROM estimate

Category	Complex Building	Modular Building
Net Area	36,920 SF	36,920 SF
Gross Area	58,333 SF	58,333 SF
R.S. Means Value for School	$7,291,625	$7,291,625
Size Multiplier	0.98	0.98
Location (Williamsport)	0.872	0.872
Complexity Markup	15%	0%
General Conditions Markup	10 Weeks - $25,000	$0.00
Total Price	$7,190,800	$6,231,132
Cost per Student	$17,977	$15,577
Schedule Duration	68 Weeks	57 Weeks

- R.S. Means S.F. Costs for 2011
- Median Price of $125/S.F.
- Complex Design
  - $18,000 per pupil
- Modular Design
  - $15,500 per pupil

constructability

- Building Locations
  - Existing bedrock spikes
  - Access to utilities
  - Minimize temporary roads
  - Zoning/Township lines
- Design
  - Curvilinear vs. Modular
- Long Term
  - Consolidate parking lots

future value engineering

- Simplified Designs
  - Minimize field cutting and custom work
- Centrally located MEP chases
- Integrate site logistics with future landscaping

integration

architect

Design Element	EFFECT ON OTHER DISCIPLINES	EFFECTED
Curvilinear Walls	Construction Time	
	Cost	
	Structural Layout	
Dense Form	Mechanical System Load	
	Day Light Infiltration	
Orientation	Energy saved and wasted	
	Artificial Lighting Requirement	
	Connection with Outdoor grounds	
Linear Layout	Iterative Grid	
	Most spaces have North or South light	
	Visual Connection with Landscape	
Mechanical Room Location	Amount of Plumbing and Energy Waste through Distribution	

landscape architect

DESIGN ELEMENTS	EFFECT ON OTHER DISCIPLINES
GREYWATER FILTRATION	Interior building systems connecting to exterior, installation by a qualified professional
LANDFORM	Extreme grade changes increase construction costs
BUILDING ORIENTATION	Energy efficiency of building
RENEWABLE E GENERATION	Impact needed energy loads & site utilization

structural

SYSTEM	EFFECT ON OTHER DISCIPLINES
STEEL	Lead times on steel fabrication
	Site Utilization - Staging Area
	Site Utilization - Crane Placement
	Floor to floor heights
	Larger bays/open design capabilities
CONCRETE	Cure time schedule delays
	Floor to floor heights
	MEP Penetrations through beams eliminated
MASONRY	Site Utilization - Staging Area
WOOD	Aesthetic opportunities
	MEP Penetrations through beams eliminated

creative LOGIC

mechanical

DESIGN ELEMENT	EFFECT ON OTHER DISCIPLINES
SPACE	Floor to floor heights to fit ductwork
AIR QUALITY	Covering ductwork during construction
ENERGY	Appropriate lighting & electrical loads in order to create model
COMFORT	Keep infiltration in mind when selecting materials
	Mindful of external spaces & additional thermal load

lighting

DESIGN ELEMENT	EFFECT ON OTHER DISCIPLINES	EFFECTED
SPACE	Integrated lighting techniques	
	Support locations for large scale multipurpose room lighting	
DAYLIGHT	Daylight penetration	
	Solar heat gain	
	Building orientation	

construction

DESIGN ELEMENT	EFFECT ON OTHER DISCIPLINES
SITE LAYOUT	Interference/Compatibility with Landscape
	Material Laydown and Storage Areas
MEANS/METHODS	Workforce Availability
	Equipment/Machinery Availability
LEED DOCUMENTATION	Larger bays/open design capabilities

NEXT STEP

- Proceed with an architectural concept
- Choose project-efficient structural, MEP systems
- Update BIM Ex plan
- Code validation
- Building systems analysis (energy, structural, etc.)

summary

OUTSIDE RESOURCES

BIM Project Execution Planning Guide - http://www.engr.psu.edu/ae/cic/bimex/index.aspx

IMAGES

www.yearout.com
www.continuingeducation.construction.com
www.tekla.com/international
wm2s.com/4.html
http://www.stacylevy.com/
http://www.bbg.org/discover/gardens/discovery_garden/
http://www.altavistagardens.org/html/music_garden.html

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thank you

questions?

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