




SUSTAINABLE SCHOOL DESIGN: THE NEXT TIME AROUND

Leo Bernabei LEED AP
Director Of Operations
Radnor Township School District
Wayne, Pennsylvania 19087



RADNOR TOWNSHIP SCHOOL DISTRICT
OUR INTRODUCTION TO GREEN BUILDINGS



RADNOR ELEMENTARY SCHOOL 2001



RADNOR ELEMENTARY SCHOOL 2001



RESEARCH

- Orientation of Building
- Windows and Doors
- Low/No VOC Products
- Flooring Systems
- Acoustical Considerations
- Stormwater Management
- Traffic Flow
- Indoor Air Quality
- Life Cycle Costing
- Luminaires & Lamps
- Construction Waste Recycling
- And More...



THE CONSTRUCTION PROCESS





PROTECTED OVER 100 TREES

RADNOR ELEMENTARY SCHOOL



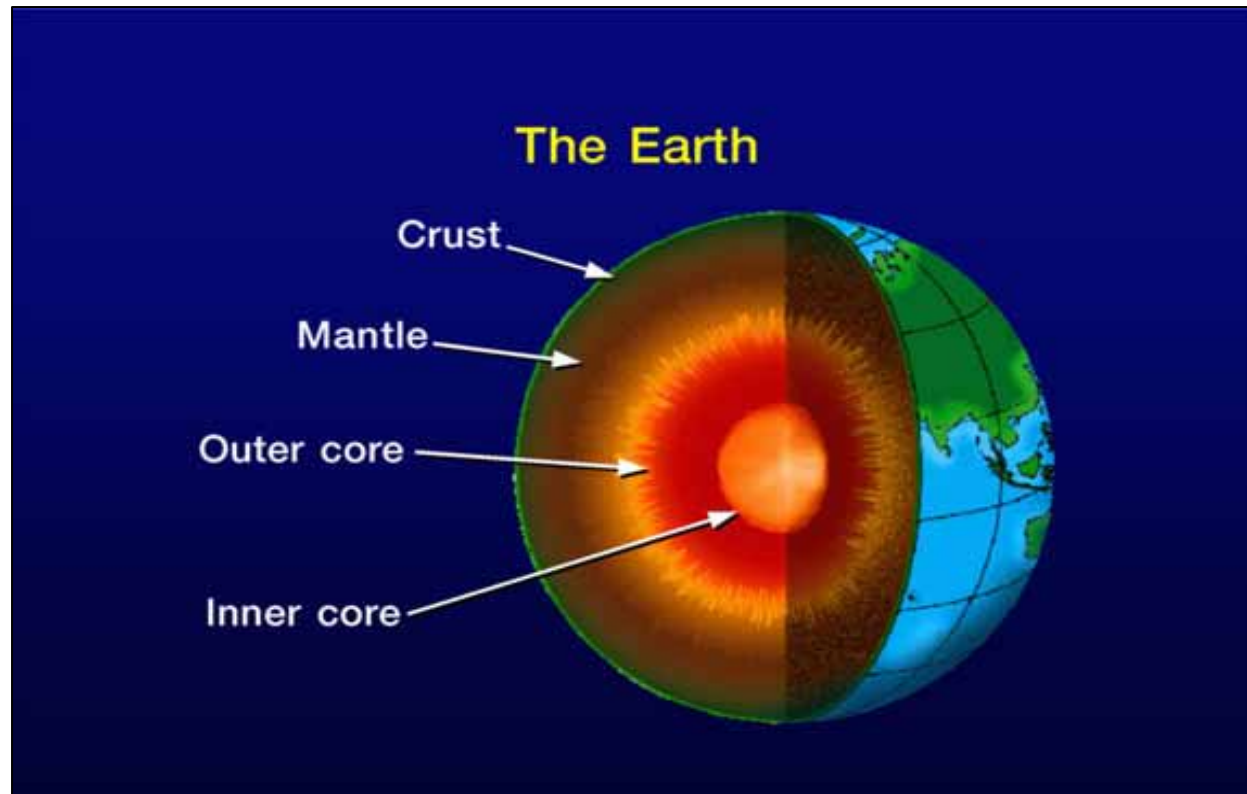
RECYCLING OF EXISTING HOME





Radnor Elementary School

Geothermal Heating and Cooling



Heat flows outward from Earth's interior. The crust insulates us from Earth's interior heat. The mantle is semi-molten, the outer core is liquid and the inner core is solid.



RADNOR ELEMENTARY SCHOOL SAVES
OVER 40,000 GALLONS OF OIL PER
YEAR

Radnor Elementary School Solar Photovoltaic System



56 Millennia MST-43MV Panels and
Xantrex STXR2500 Inverter – 2100 kWh/Year



RADNOR ELEMENTARY SCHOOL



BENEFITS OF GREEN

- Reduce Absenteeism
- Elimination of Staff Complaints
- Saving \$\$
- Reduce Environmental Impact
- Teach Children
- Improve Indoor Environment
- Gain Community Support





RADNOR MIDDLE SCHOOL

DESIGN CRITERIA: KIDS FIRST


THE BEST POSSIBLE EDUCATIONAL ENVIRONMENT

- High Performance Building
- Availability of Technology
- Researched Design Details

SECURITY

- Student Supervision
- Access Control
- Community Friendly

FLEXIBILITY

- Team Teaching Clusters
 - Modular Spaces
 - Relocatable Partitions
 - Systems Designed for Change
- 

LEED – BASED DESIGN

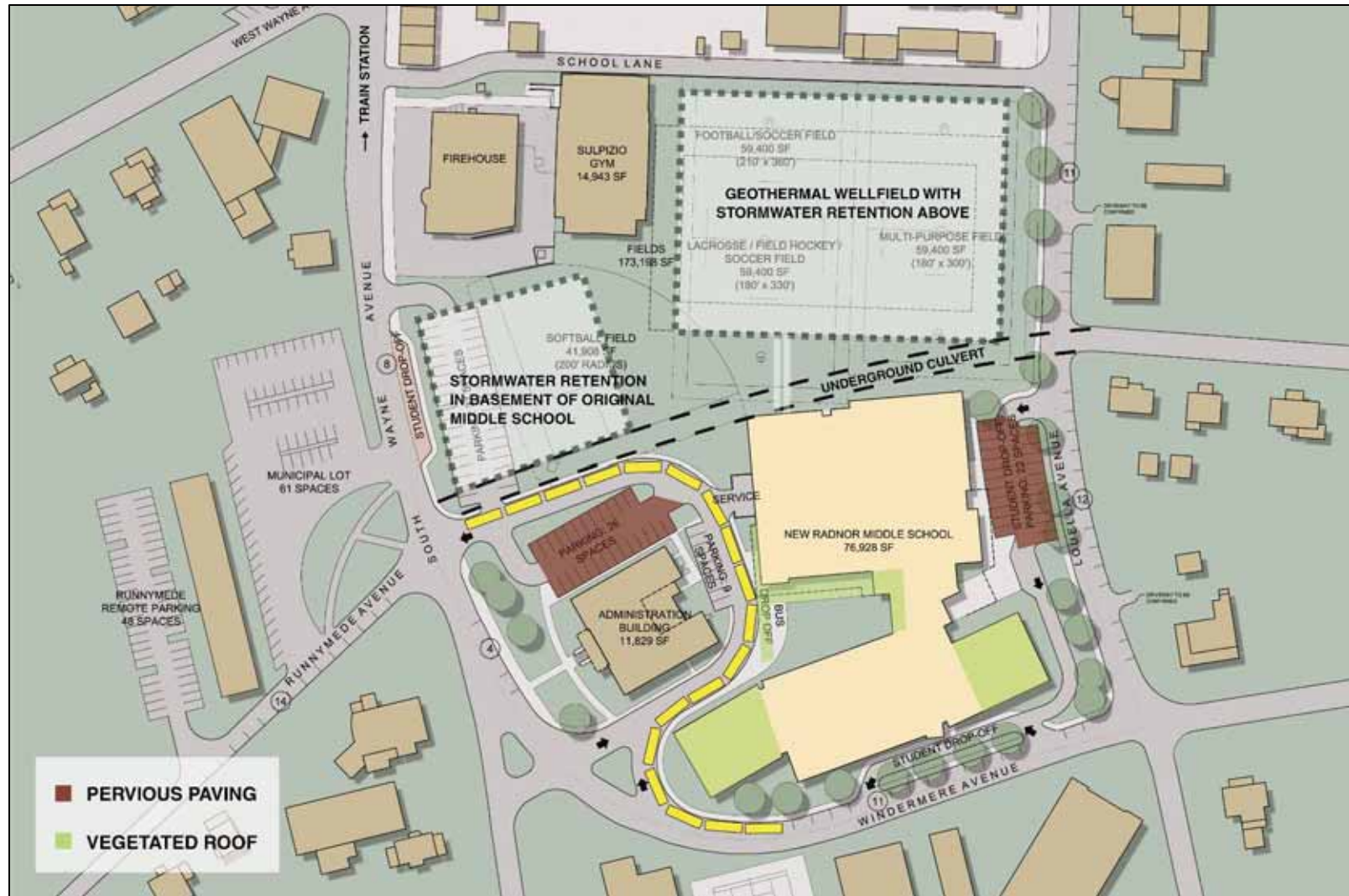


LEED: Leadership in Energy and Environmental Design

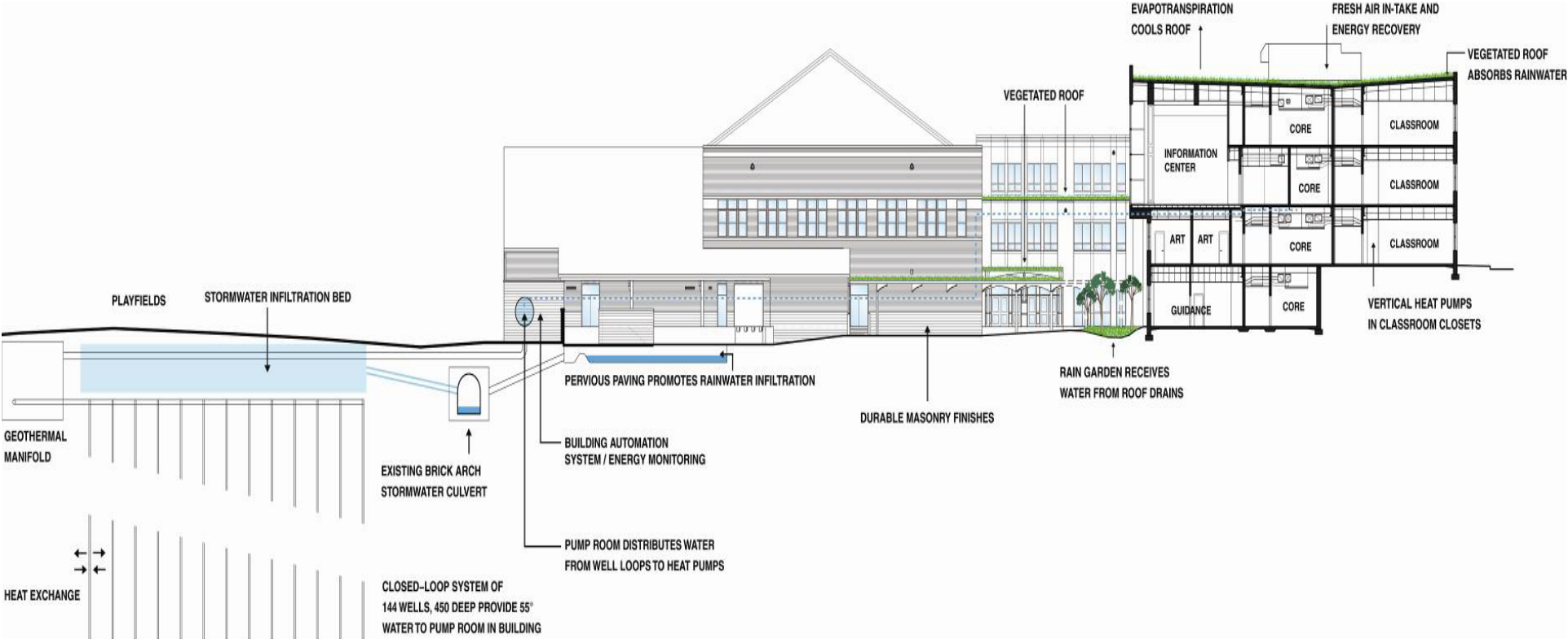
- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation & Design Process

<u>LEVEL</u>	<u>POINTS</u>
Certified	26-32
Silver	33-38
Gold	39-51
Platinum	52-69

SITE PLAN



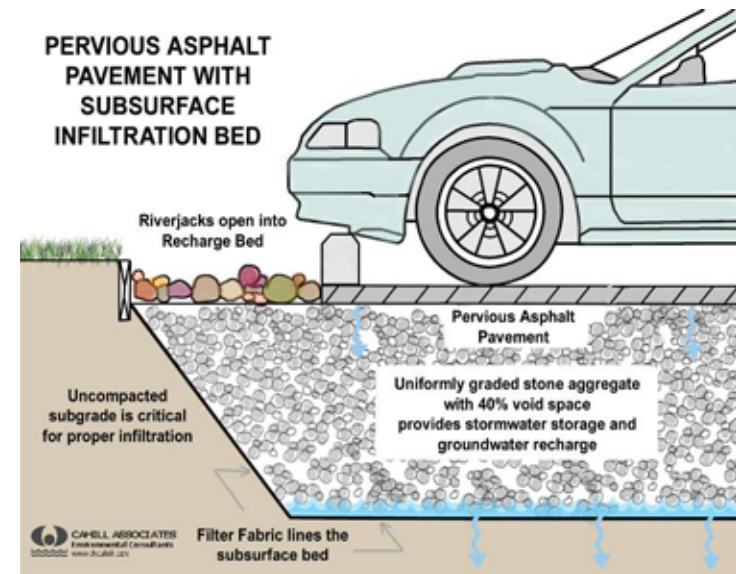
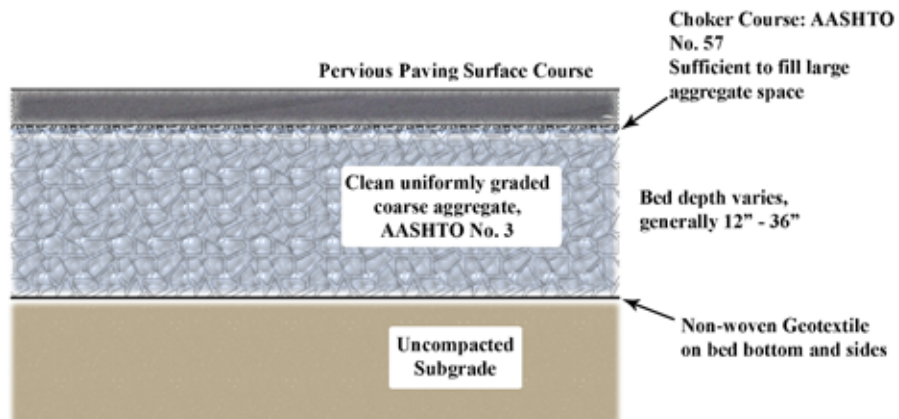
SITE SECTION



POROUS PAVING



POROUS PAVING



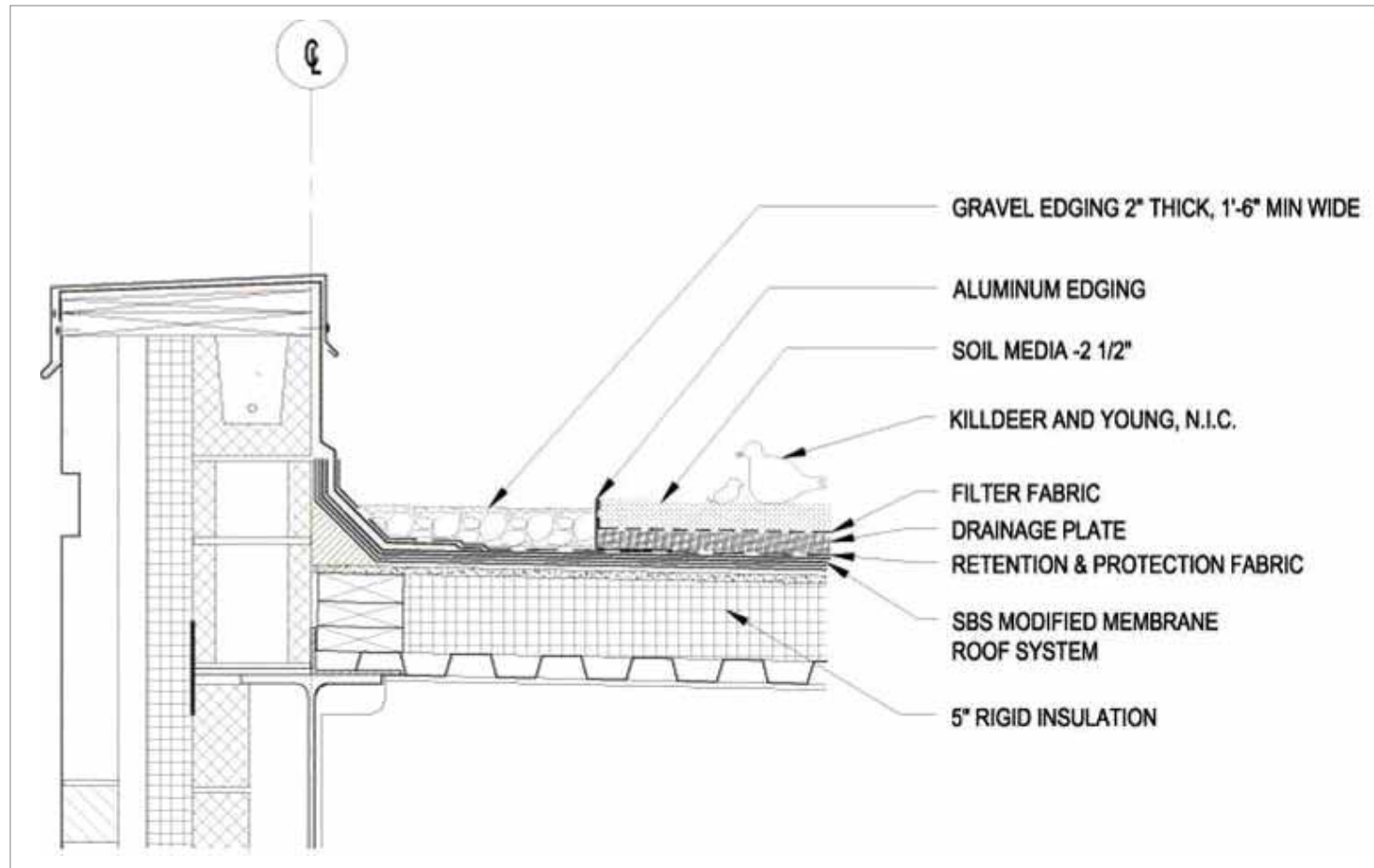
RADNOR ROOF PLAN

Area Percentages of Systems:

- High Emissivity Asphalt Shingles 34%
- Vegetated Roof 20%
- High Albedo 46%
- Total High Emissivity Roof 100%



VEGETATED ROOF



DETAIL

VEGETATED ROOF INSTALLATION



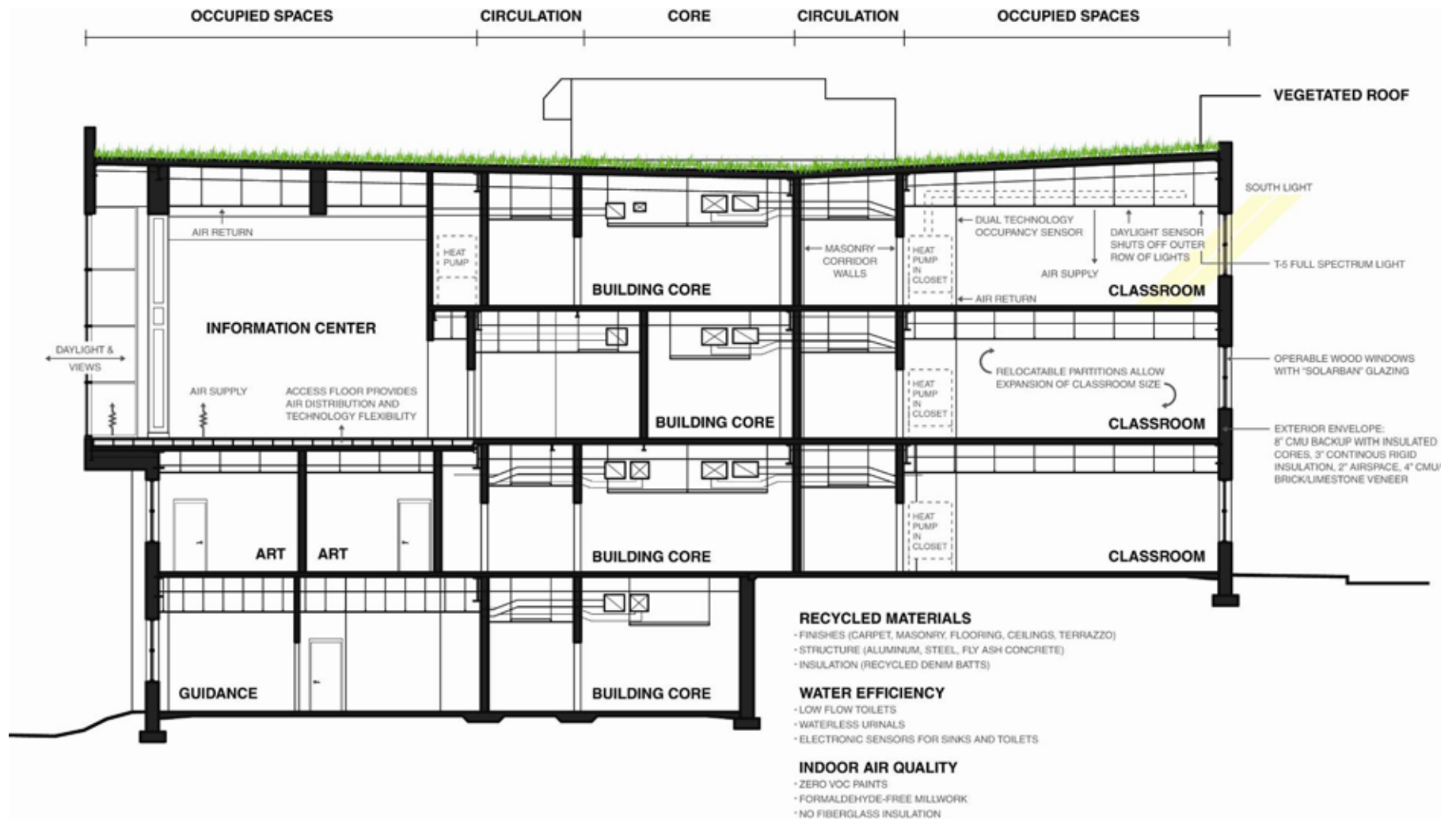
COMPLETED VEGETATED ROOF



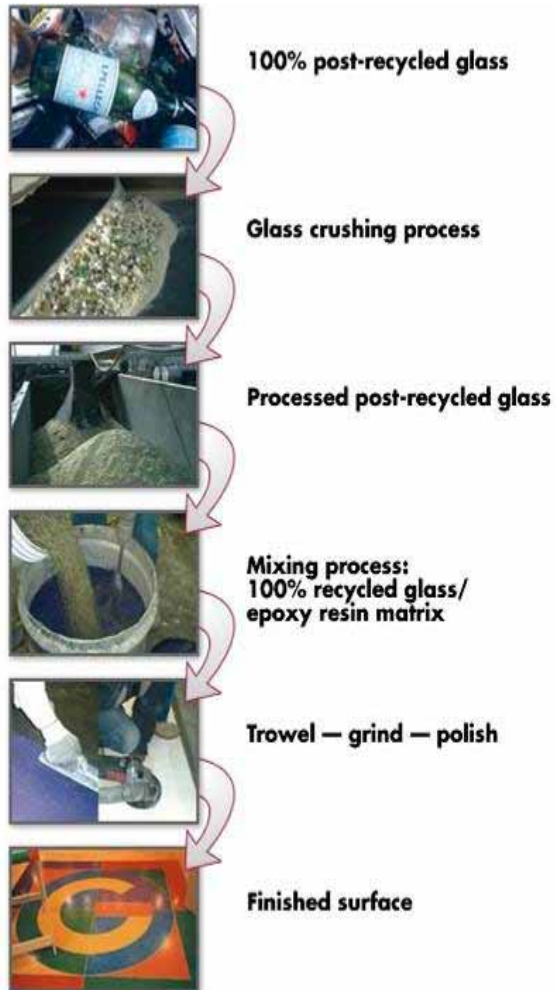
COMPLETED VEGETATED ROOF



SUSTAINABLE BUILDING COMPONENTS



MATERIALS



Terrazzo Floors with
Recycled Glass Aggregate



Agrifiber Board -
Rapidly Renewable Material

RECYCLED GLASS TERRAZZO FLOOR

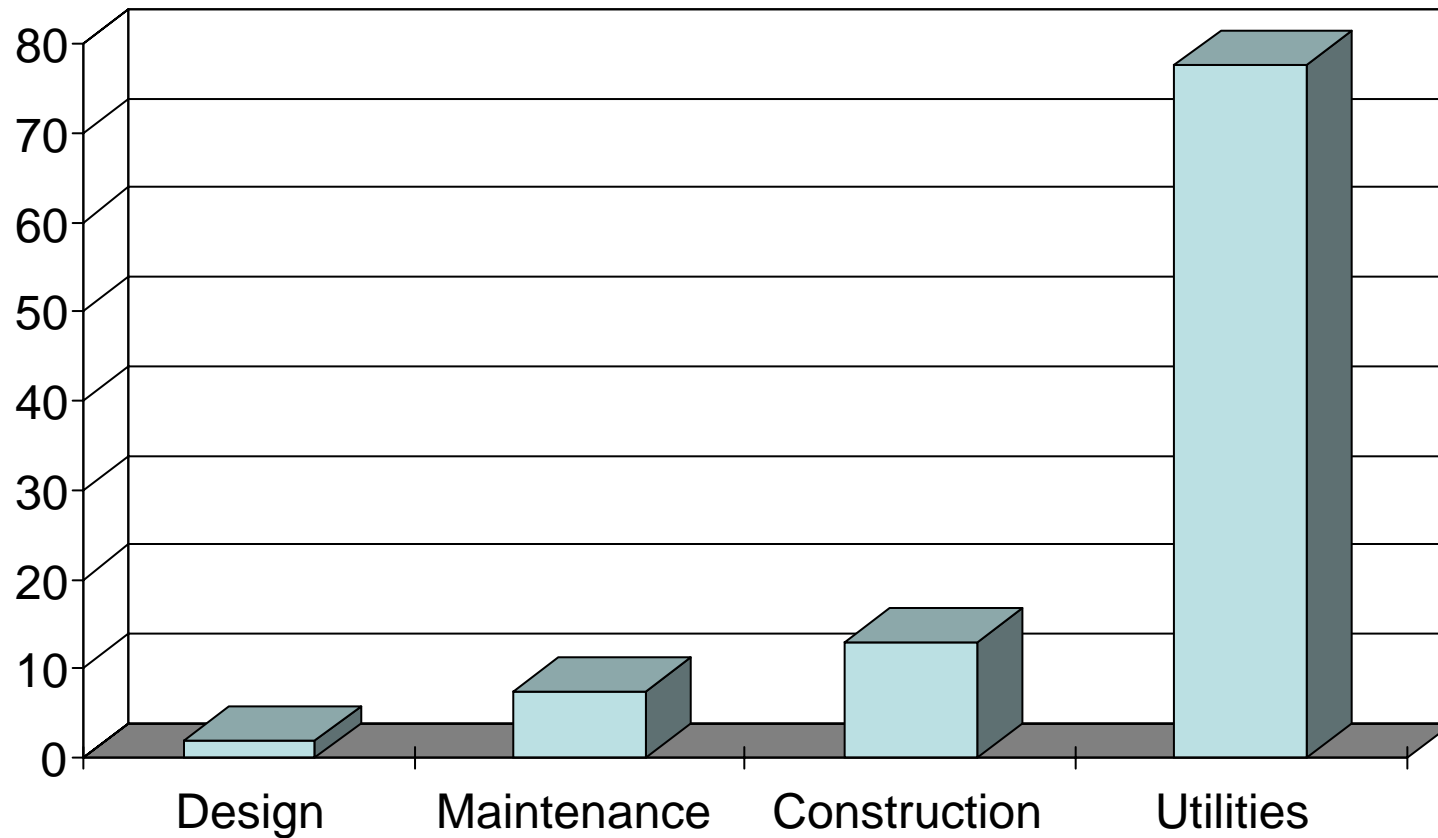


INDOOR AIR QUALITY AT RMS

- Indoor Air Quality Management Plans
 - Construction and Post-construction
- Thermal Comfort and Air Exchange
 - Exceed the ASHRAE 90.1-1999 Standard
- Low Volatile Organic Compounds (VOC's)
 - Reduce/Eliminate Off-gassing
- Increased Ventilation at Key Rooms
 - Copier Rooms, Computer Areas, etc.
- Individual Control of the Environment
 - Operable Windows and Thermostat Control
- Digital Systems Controls
 - Temperature Control
 - Security/Lighting Control
 - CO2 Monitoring
 - Automatic Ventilation Shut Down

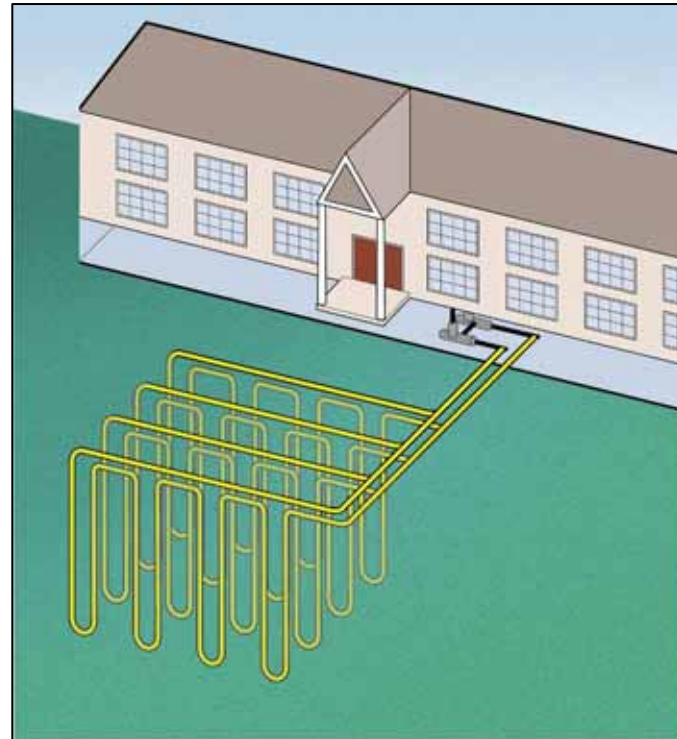


US DEPARTMENT OF ENERGY BUILDING LIFE CYCLE COSTING



HVAC SYSTEMS

- Geothermal Heat Pumps
- WSHP Boiler/Tower
- Chiller/Boiler/Tower (4pipe)
- Rooftop/DX/Gas Heat



LIFE CYCLE COMPARISON 30 YEARS

System New installations	Net Present Value Cost	First Cost	Energy Cost	Maint. Cost	Useful Life
Geothermal HP	Best	Highest	Lowest	Lowest	Best
WSHP Boiler/Tower	2 nd Best	2 nd lowest	2 nd Lowest	2 nd Lowest	3 rd Best
4 PIPE	3 rd Best	Highest	3 rd Lowest	Highest	2 nd Best
ROOFTOP DX/GAS HEAT	Worst	Lowest	Highest	3 rd Lowest	Worst

GEOHERMAL HVAC

- Lowest Life Cycle Cost
- Reduced Mechanical Room Space
- Reduction Of Fossil Fuel Use
- No Boiler Stack Emissions
- Elimination of Oil or Gas Components
- Possible Site Limitations



HEAT PUMP
ONE PER
CLASSROOM



Sound-Proof
Lining

“Old Design”
Unit Ventilator



ACOUSTICS AT RMS

- Acoustics at Radnor Elementary Independently Tested by Project Team
 - Acoustics at RMS to Meet or Exceed
- Comply with the American Disabilities Act
 - ANSI/ASA S1.60-2002 -35 dBA
- Classrooms Acoustically Modeled by Consultant
- Classroom Finishes Enhance Acoustics
 - Carpet, High NRC Ceiling Tile, Tack surfaces
- Minimize HVAC Noise
 - Heat Pump Closets Lined with Acoustical Insulation
- Pass Through Noise Between Rooms Minimal
 - Wall Materials have Superior NRC Ratings

LIGHTING DESIGN CONSIDERATIONS FOR CLASSROOMS

DIRECT / INDIRECT LIGHTING FIXTURES

Uses Ceiling as Reflector

Eliminates Glare

FULL-SPECTRUM LAMPING

MULTIPLE FIXTURE SWITCHING

Illumination Control by Teacher

OCCUPANCY SENSORS

Shuts Down Lighting in Unoccupied Spaces

DAYLIGHTING CONTROLS

Light Level Dimming

Building Orientation

Daylight Modeling

Sunshades

Efficient Window Glazing





EXPLORE THE POSSIBILITIES...


▫ HVAC

- Displacement Ventilation
- Raised Floor Distribution
- Thermal Mass Techniques
- Radiant Heating Technologies

▫ ELECTRICAL

- On-site Generation
- Combined Heat & Power
- Emergency Generation Peak Shaving
- Photovoltaic Technologies
- Wind Power

▫ PLUMBING

- Gray Water Recycling
 - PEX Piping
 - Solar Hot Water
 - Waterless / Low-Flow Technologies
- 

ADDITIONAL SUSTAINABLE PROCESSES

- **Construction Waste Management**
- **Green Cleaning Program**
- **Design for efficient maintenance**
 - Reduced Variety of Lamping
 - Anticipate Need for Facility Changes
 - Streamlined Receiving and Distribution
 - Anticipate Waste and Recycling Disposal
 - Concentrated Utility Distribution



WHY DESIGN TO GREEN BUILDING STANDARDS ?

- Utility Rebates for Energy Efficiency
- Improvement in Student Performance
- Reduced Operating Costs
- Healthier Buildings
- Better Daily Attendance
- Reduced Liability Exposure
- Enhanced Indoor/Outdoor Environmental Impact
- Incorporates Best Building Technologies



RECOMMENDATIONS

Full Commissioning

Independent Life Cycle Analysis

Thorough Operator Training

Ongoing Verification of Operability and Efficiency

Operations Data Sharing and Analysis

Avoid Proprietary Systems



QUESTIONS AND ANSWERS

Leo Bernabei, LEED AP
Director of Operations
Radnor Township School District
E-mail: leo.bernabei@rtsd.org
Tel: (610) 688-8100 Ext. 6103

