U.S. Department of Energy
Energy Efficiency and Renewable Energy

High Performance Schools in Temperate and Humid Climates: A Design Overview

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A PROFESSIONAL CORPORATION

Why “High Performance” Schools?

- Improve Student Performance
- Increase Average Daily Attendance
- Increase Staff Retention
- Reduced Operating Cost
- Reduced Liability
- Reduced Environmental Impact
- Use of the School as a Teaching Tool

- ✓ Improve Student Performance

  Lighting and indoor air quality - California, Washington, Colorado, North Carolina, studies show that students progress 20-26% faster on reading and math test over course of one year
- ✓ Increase Average Daily Attendance

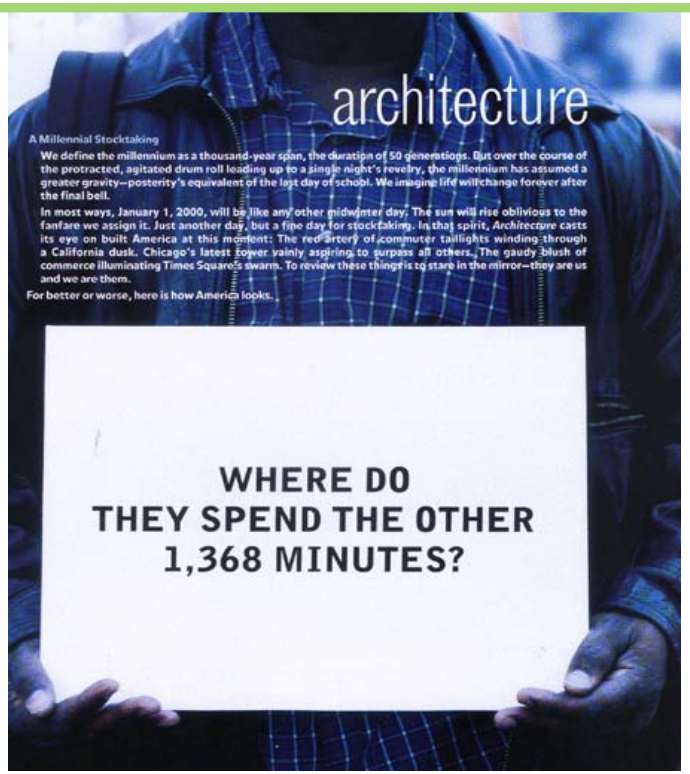
  Charles Young ES renovation resulted in an increase in attendance from 89% to 93%
- ✓ Increase Staff Retention

  Number of teachers in this Country are declining
- ✓ Reduced Operating Cost

  $6 billion dollars per year spent on K-12 schools (more than computers and textbooks) Many high performance schools are realizing energy savings of 40% or more

- ✓ Reduced Liability
  - Continued increase in health related lawsuits
- ✓ Reduced Environmental Impact
  - Energy and water efficiency
  - Nontoxic materials that are high in recycled content that can be recycled again.
  - Protection of wetlands
  - Minimizing impact on our landfills
- ✓ Using the School as a Teaching Tool
  - Science programs
  - Funding Sources

Approximately 91,000 K-12 schools in the US house 47 million students



- Schools in the U.S. spend roughly $6 billion per year on energy
  - 42% on heating
  - 22% on water heating
  - 20% on lighting
  - 8% on cooling and ventilating
  - 3% on cooking and refrigeration
- EPA reports that nearly 55 million people spend their days in school buildings

What a tremendous opportunity we have to improve these places of learning

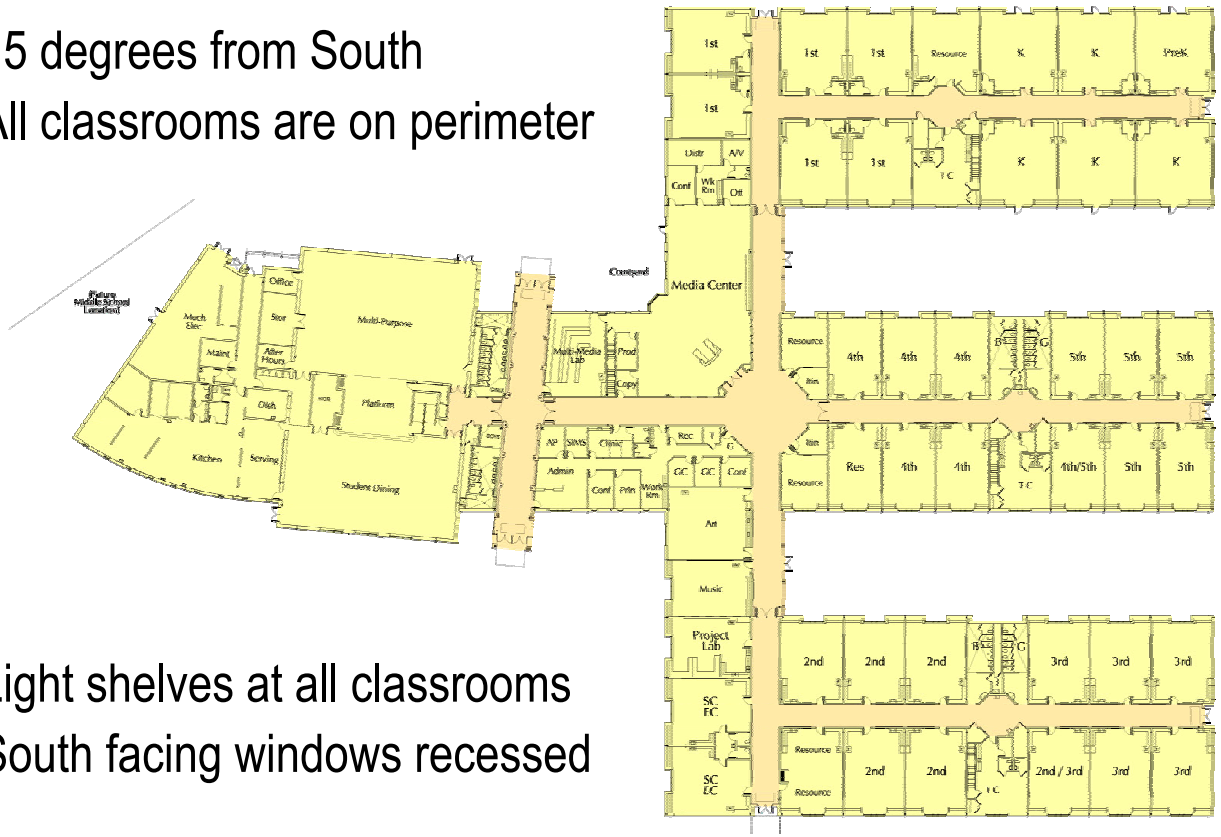
Case Study Schools

Third Creek Elementary School

TC Williams High School

Site Selection

- 15 degrees from South
- All classrooms are on perimeter



- Light shelves at all classrooms
- South facing windows recessed

Site Selection

Reuse of existing school site

EnergyStar compliant roof surfaces

Structured parking saves land and reduces heat island effect

Sharing facilities with Parks & Rec Department

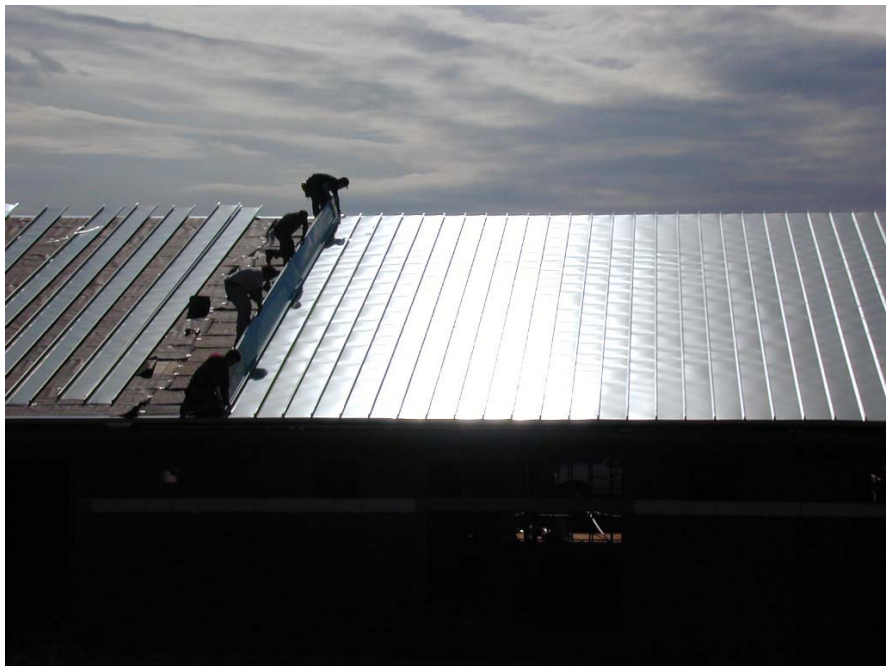
Rain Garden to cleanse surface runoff

Vegegated roof to slow and cleanse stormwater

Buried cistern to store stormwater for later use

Reducing Urban Heat Islands

- Landscaping designed to shade 30% of non-roof surfaces within five years.
- Energy Star compliant roofing materials



Water Efficiency

DESIGN CASE

FIXTURE	MALE USES	FEMALE USES	DURATION		WATER VOLUME PER USE GAL.	TOTAL WATER USE GAL
WC(FV); 1.6 gal/flush	1	3	1	FLUSH	1.6	6.4
UR waterless	2	0	1	FLUSH	0.0	0.0
LAV 0.25 gal/cycle; metering fauc	3	3	1	CYCLE	0.25	1.5
SK 0.5 gpm	1	1	30	SEC.	0.25	0.5
HANDSINK 0.5 gpm	0.011	0.011	30	SEC.	0.25	0.00556
SHOWERHEAD 2.0 gpm; low flow	0.013	0.013	5	MIN.	10	0.3

total per occupant (gal.)	8.67
Occupants	900
Gross Daily volume (gal)	7805
Work days	180
Total volume (gal)	**1,404,900**

BASELINE CASE

FIXTURE	MALE USES	FEMALE USES	DURATION		WATER VOLUME PER USE GAL.	TOTAL WATER USE GAL
WC(FV); 1.6 gal/flush	1	3	1	FLUSH	1.6	6.4
UR; 1 gal/flush	2	0	1	FLUSH	1.0	2.0
LAV 0.25 gal/cycle; metering fauc	3	3	1	CYCLE	0.25	1.5
SK 2.5 gpm	1	1	30	SEC.	1.25	2.5
HANDSINK 2.5 gpm	0.011	0.011	30	SEC.	1.25	0.0278
SHOWERHEAD 2.5 gpm	0.013	0.013	5	MIN.	12.5	0.3333

total per occupant (gal.)	12.76
Occupants	900
Daily volume (gal)	11485
Work days	180
Total volume (gal)	**2,067,300**

Water Use Reduction
Estimated at 32%
Estimated at 664,200 gallons per year

Third Creek Elementary School

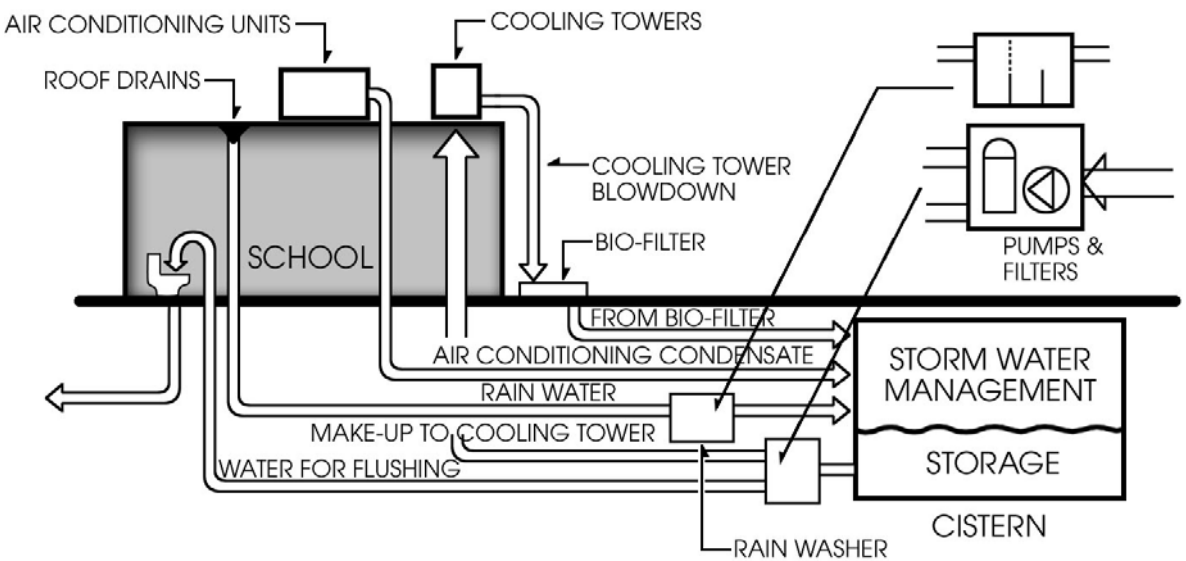
Water Efficiency

Third Creek Elementary School (700 students)
June 2002-March 2003
115,900 gallons
Less than $2,000 spent on water since school opened!

Comparison:
ADR and Wayside Schools (550 students)
July 2001 – June 2002
146,000 gallons
More than $4,000 spent on water

East Iredell Elementary School (620 students)
July 2001 – June 2002
1,020,100 gallons
More than $2,600 spent on water

Water Efficiency



TC Williams High School

Cistern system still under design

Water Efficiency

Roy Lee Walker Elementary School – McKinney, TX

The addition of a cistern for stormwater management or for water supply for irrigation and/or building uses can also offer educational opportunities in the classroom.

Energy Efficiency

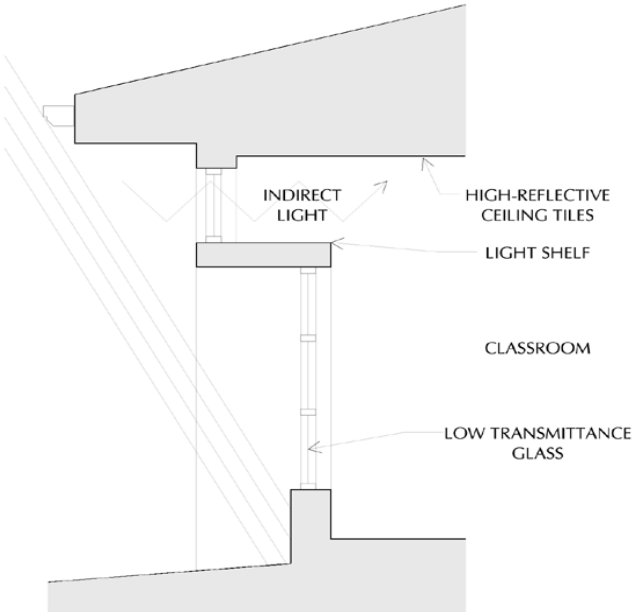
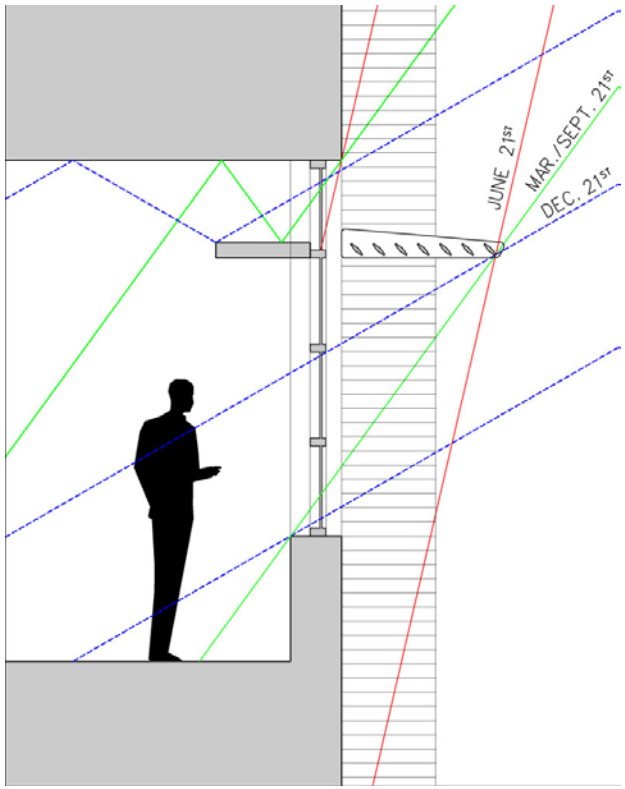
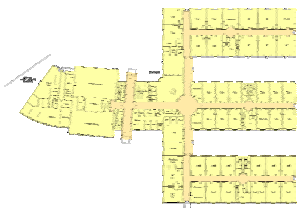
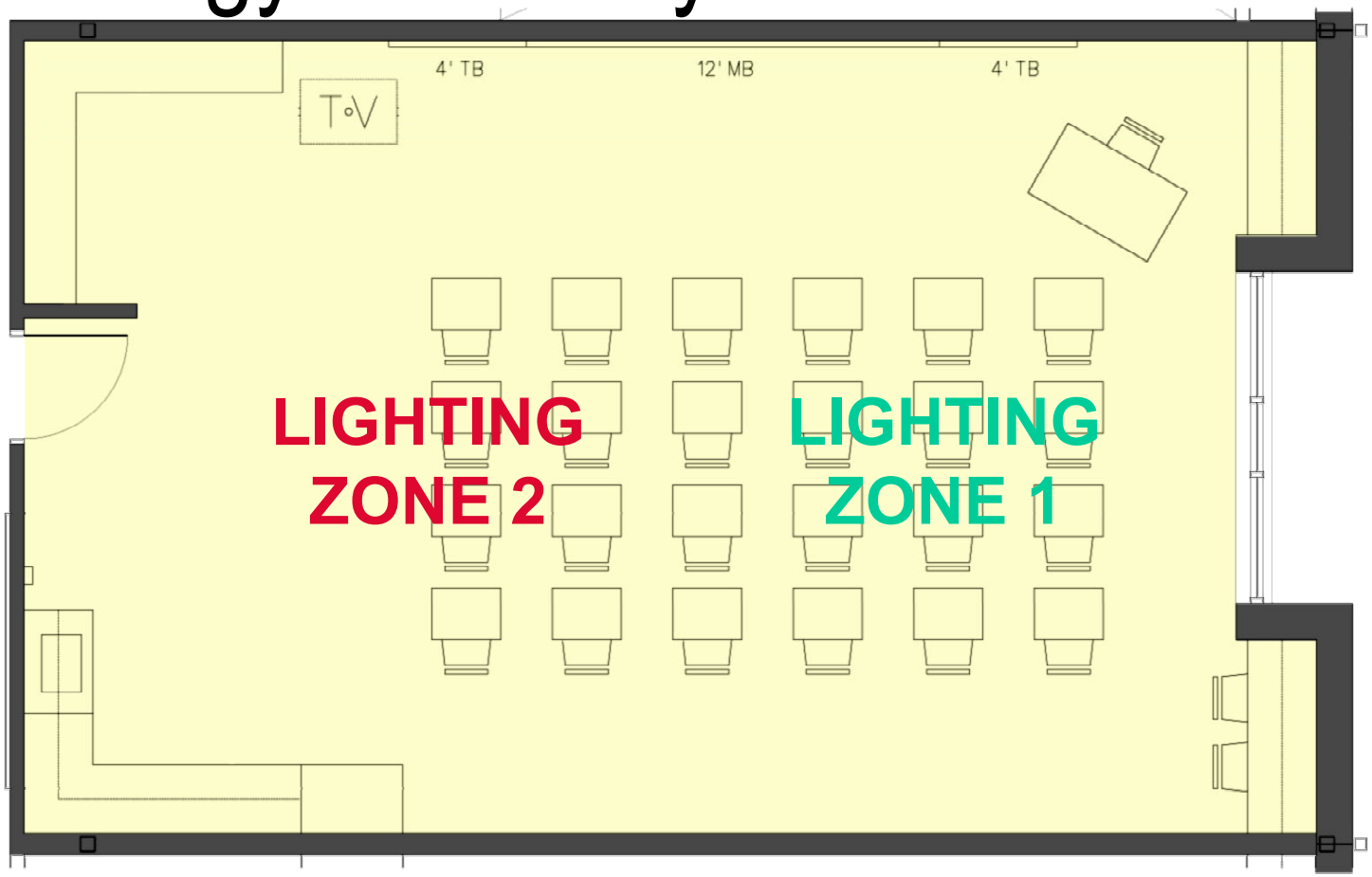


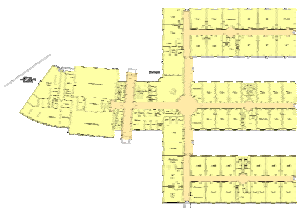
Image: Light Shelf





Energy Efficiency





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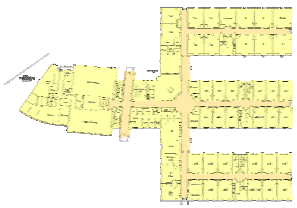

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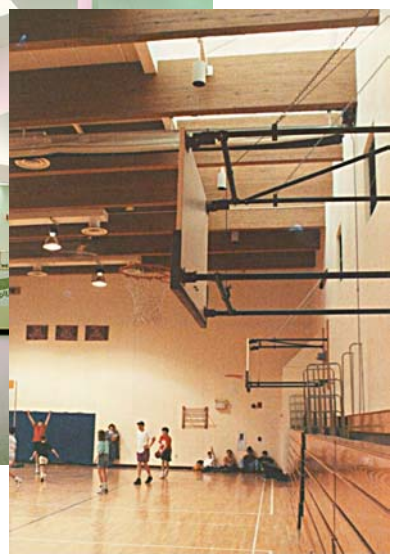
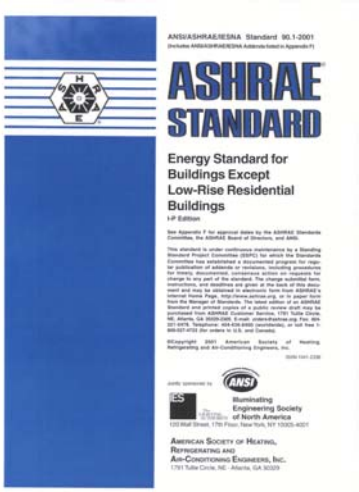


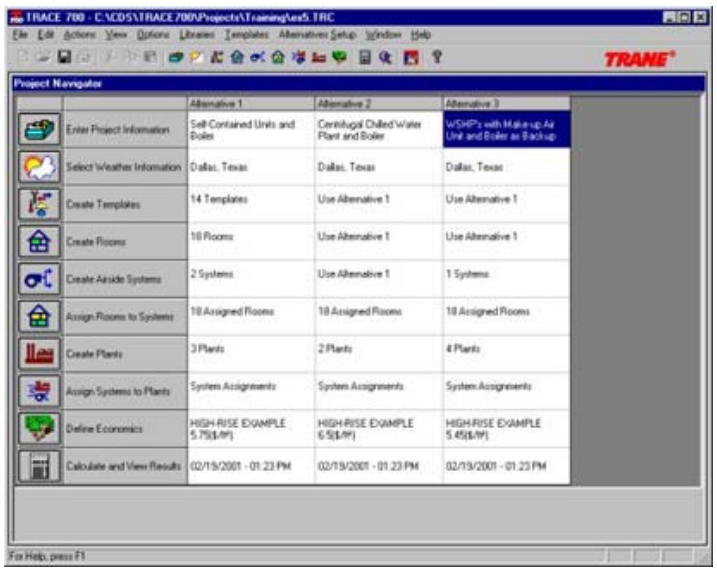
Energy Efficiency

Use ASHRAE 90.1-1999 or later as the baseline

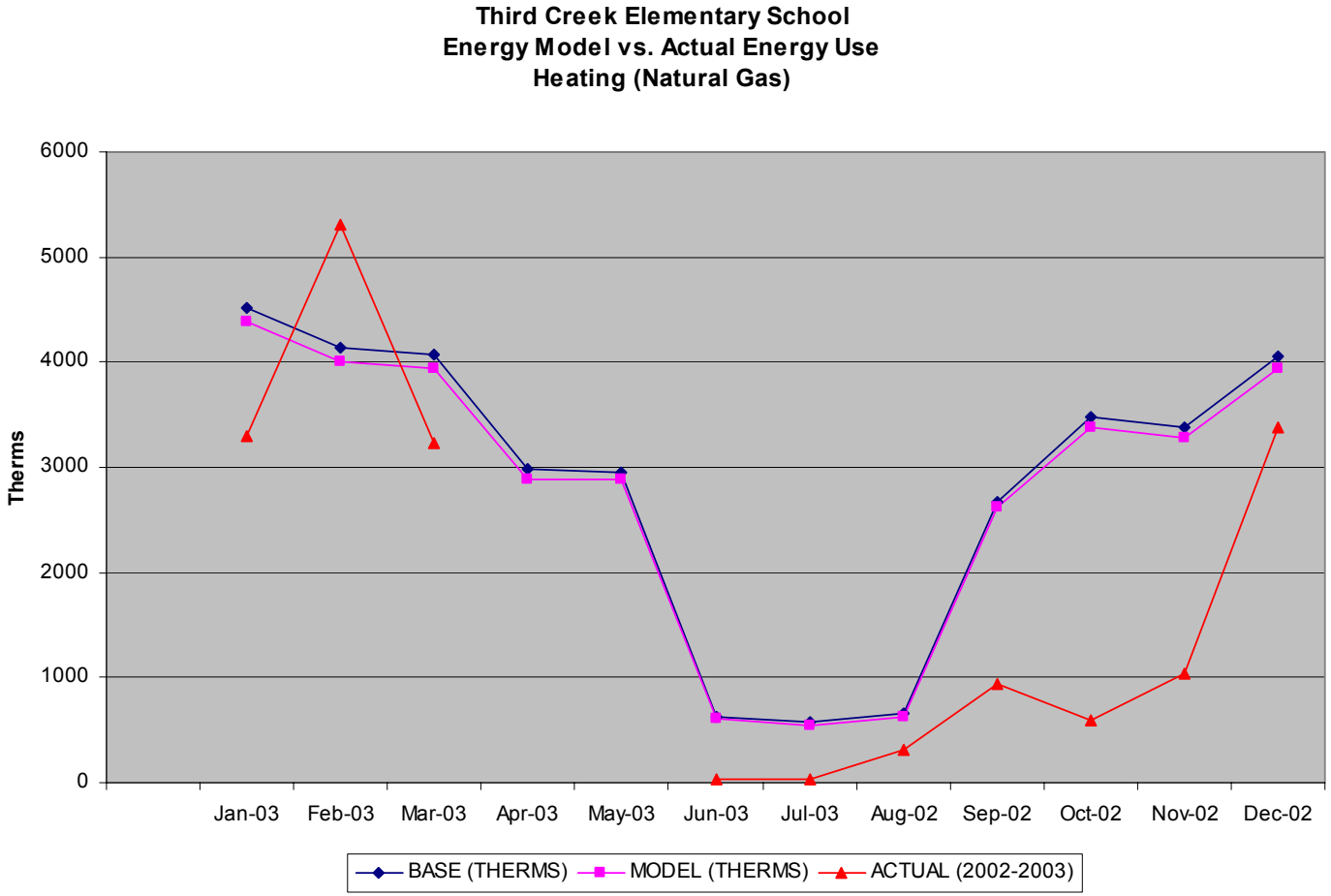
Use a modeling tool

At Third Creek, we anticipated a 24% improvement in our designed building over ASHRAE 90.1-1999





Measurement & Verification



Construction Waste Management

"Tipping fees are lower for sorted waste than unsorted waste at the landfill… also the disposal of many recyclable materials is free".
-Victor McBryde,
Brooks General Contractors

Landfill Table

Material	Weight [tons]
Construction and Demolition Waste	168.0
Subtotal	**168.0**

Recycle / Salvage Table

Material	Weight [tons]
Concrete	133.0
Land Clearing Debris	
Wood	
Gypsum Wallboard	
Masonry	24.4
Cardboard	1.5
Steel	70.0
Furniture	0.0
Brick	2.0
Subtotal	**230.9**

Landfill Subtotal	**168.0**
Recycle / Salvage Subtotal	**230.9**
Total Waste, Recycle, Salvage	**398.9**

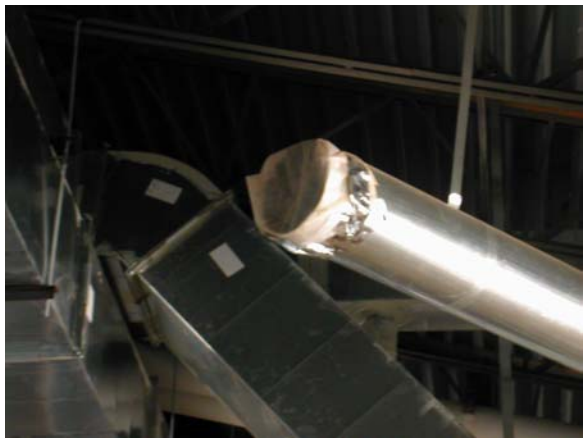
Percentage of Recycle / Salvage 58%

Materials

Traditional wood harvesting methods

FSC certified forest after selective harvest

Construction IAQ Management



1. Material Protection
2. Source Control
3. Physical Separation
4. Housekeeping
5. Scheduling
6. Flushout/<u>Testing</u>

2.2 MATERIALS:

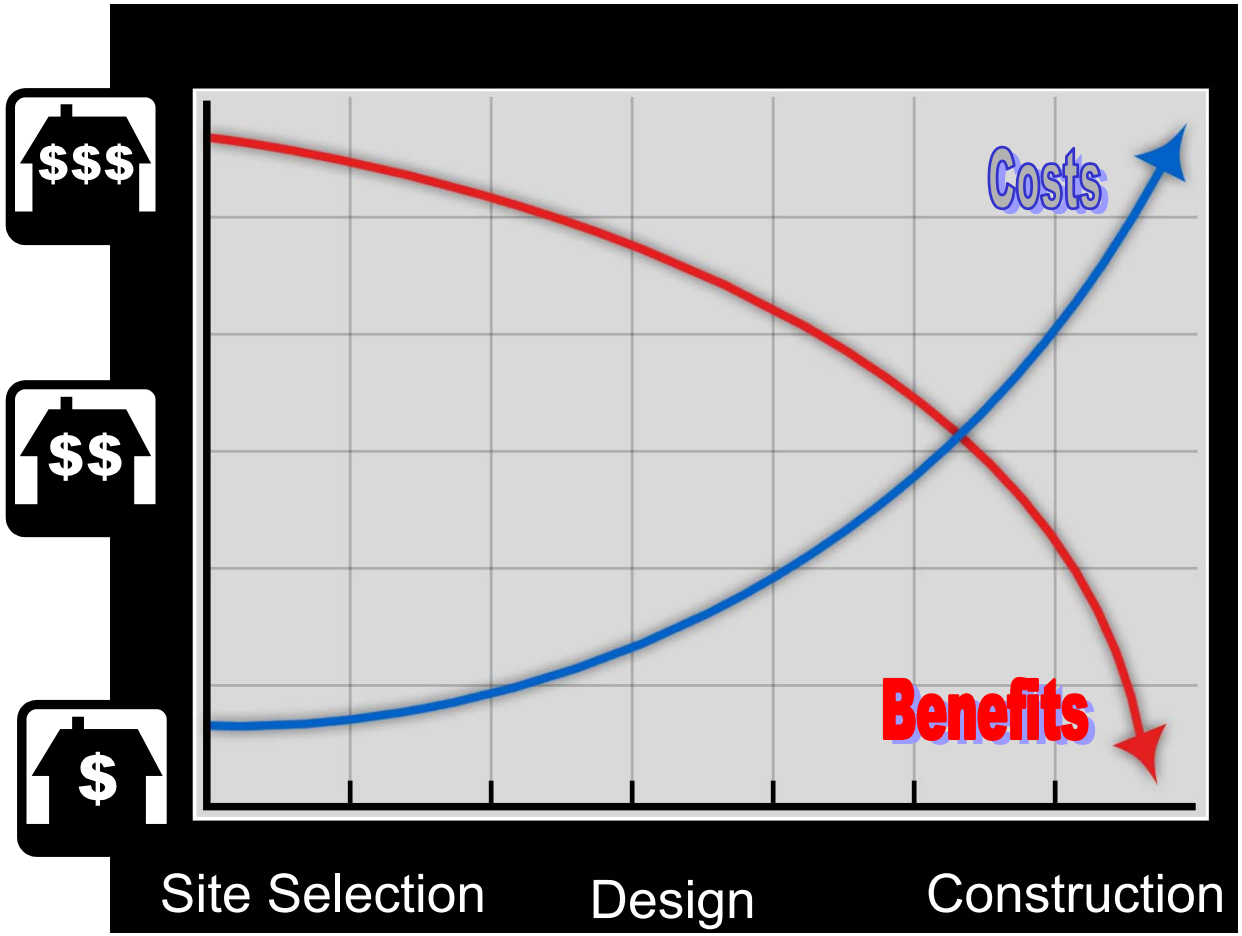
A. <u>GreenSeal Requirements</u>: All paints used must meet GreenSeal requirements for VOC and chemical component limits, which are as follows:

1. The VOC concentrations (in grams per liter) of the product shall not exceed those listed below as determined by the US Environmental Protection Agency (EPA) Reference Test Method 24. The calculation of VOC shall exclude water and tinting color added at the point of sale.
   a. Interior Coatings; Non Flat: 150 g/l
   b. Interior Coatings; Flat: 50 g/l
   c. Exterior Coatings; Non Flat: 200 g/l
   d. Exterior Coatings; Flat: 100 g/l
   e. All Anti-corrosive Coatings; 250 g/l
2. Chemical Component Limitations – Aromatic Compounds: the product must contain no more than 1.0% by weight of the sum total of aromatic compounds. Testing for the concentration of these compounds will be performed if they are determined to be present in the product during a materials audit.
3. Chemical Component Limitations – Other Chemicals: the manufacturer shall demonstrate that the following chemical compounds are not used as ingredients in the manufacture of the product:
   a. Halomethanes: methylene chloride
   b. Chlorinated ethanes: 1,1,1-trichloroethane
   c. Aromatic solvents: benzene, toluene (methylbenzene), ethylbenzene
   d. Chlorinated ethylenes: vinyl chloride
   e. Polynuclear aromatics: naphthalene
   f. Chlorobenzenes: 1,2-dichlorobenzene
   g. Phthalate esters: di (2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate
   h. Miscellaneous semi-volatile organics: isophorone
   i. Metals and their compounds: antimony, cadmium, hexavalent chromium (chromium VI), lead, mercury
   j. Preservatives (anti-fouling agents): formaldehyde
   k. Ketones: methyl ethyl ketone, methyl isobutyl ketone
   l. Miscellaneous volatile organics: acrolein, acrylonitrile

Construction IAQ Testing

Carbon Monoxide	Not to exceed 9 ppm
Carbon Dioxide	Not to exceed 800 ppm
Airborne Mold/Mildew	Indoor readings not to exceed outdoor readings
Formaldehyde	<20 micrograms/m^3
TVOC	< 200 micrograms/m^3
4-phenylcyclohexene	<3 micrograms/m^3
Total Particulates	<20 micrograms/m^3

What about cost?



Make it fun, and share it all with the kids!