TRAIL MAGIC

A climate-neutral, positive-energy home in which body, mind, and spirit flourish and our lifestyle of simplicity and interdependent self-reliance find expression as we live, work, and prosper among a community of kindred spirits.

SITE

1. Less than one mile from downtown Oberlin with easy access to a host of in-town amenities, as well as city water and sewer.
2. Four acres: mixed woods and field.
3. House located to orient long wall to true south for passive and active solar and close to road to preserve majority of site.
4. Self-maintaining landscape with any needed water from cistern and pond.
5. A walk-out, south-side patio is sun exposed and wind protected, thereby extending the season of outdoor activity and plant growth.
6. Pond dug to provide fill for house site, geothermal heat source/sink, and fish for food.
7. Quarter-acre garden and acre field for mulch.
8. Two derelict houses removed with 150 tons recycled (59%).
9. Existing gravel driveway extended to conserve resources.

HOUSE

Two-and-a-half stories with lower floor earth-bermed on three sides; 2,494 square feet.

Ground Floor: Two bedrooms, full bath, family room, kitchenette, mechanical room, workroom, under-deck storage area. This floor was designed to accommodate guests.

First Floor: Living/dining room, kitchen, pantry, half bath, master bedroom, walk-in closet, full bath, deck.

Half Floor: North side study and library-loft area overlooking master bedroom.

Stairwell: Ventilation windows at high and low points along with stairway are designed as a wind tower to ventilate house in warm months. The lower floor is a summer refuge, naturally cooler due to thermal mass and earth berming. Adjustable shades passively prevent overheating during the day and heat loss at night.

Detached Barn: Space for truck, car, and tractor with large, multi-purpose, second floor room.

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COST: The cost for house alone was $146 per square foot.

WATER HEATING AND CONSERVATION

1. Hot water from evacuated-tube, solar, hot-water heater and 80-gallon storage tank with feed to on-demand electric tankless hot water heater with capacity of 2 gallons per minute. About 50% of the energy for hot water is supplied by the sun.
2. Low-flow shower heads (1.5 gpm), low-flow bathroom faucet aerators (0.5 gpm), and low-flow toilets (dual flush, 1.6 and 0.8 g per flush) substantially reduce water use and the amount of hot water needed.
3. 1,875 gallon cistern filled from roof runoff for watering garden and plants with overflow to pond.

HEATING AND COOLING

1. Pond geothermal heat exchange – 2 ton unit with 3 ton loop (4:1 efficiency ratio—4 BTUs of heating/cooling for each BTU used). If wood stove is not used, then annual energy for heating and cooling with geothermal heat pump is ~1,900 kWh.
2. ERV (energy recovery ventilation) unit.
3. Passive solar gain is determined by proper orientation, size, and shading of windows.
4. Windows and stairwell placed for passive cooling and ventilation, the predominant cooling mode.
5. Airtight wood stove fueled by wood from site trees provides heat on cold, cloudy days.

Note: Trail Magic has a “Cadillac” heating/cooling system that is not only highly efficient but also provides for superior indoor air quality, mold elimination, and occupant comfort and health. Design strategy also allows owners to heat and cool house passively and with wood stove, using mechanical systems only as needed.

INDOOR AIR QUALITY

1. Energy Recovery Ventilation (ERV) unit for fresh air is integrated with heat-pump and air circulation that is controlled by a programmable timer. Air can be circulated within house, or with outside air, with and without heating/cooling provided by heat pump. The ERV allows for the incoming fresh air to be heated or cooled by exiting air.
2. Exhaust fans in bathrooms remove excessive moisture.
3. High quality filters on geothermal heat pump and ERV clean air.

ELECTRICAL

1. Electricity is from a 3.12 kW system with an annual production of 3,250 kWh. In the first year, annual use was 2,400 kWh with 850 kWh fed to grid. Oberlin Municipal Light and Power System has net metering that allows Trail Magic to feed excess electricity onto the grid and to take electricity from grid when needed. At this time Trail Magic does not have a battery backup system. If the grid goes down, the PV system shuts down and does not supply power to the house.
2. Energy Star appliances throughout and icebox in kitchenette.
3. Compact fluorescent and LED lighting.
4. Day-lighting from window placement replaces the need for electric lighting in daylight hours.

Above: South and western façades show most windows on south façade. PV panels are on west side of south roof and evacuated-tubes of hot-water system are on east side. Deck faces west and in foreground, out of sight, is the below-grade, south-facing sun patio.
ENERGY USE
SUMMARY
Trail Magic annually uses 60 million BTU. One-hun-
dred percent of this energy is provided on site by sun:
daylighting and passive solar gain from the winter
sun, 32 million BTU; wood stove, 15 million BTU; PV
panels, 11 million BTU; and solar hot-water heater,
2 million BTU.

Note: Over half of this en-
ergy results from
passive solar design. The
cost of passive solar features—window place-
ment and envelope—was
$16,000, or less than 5
percent of construction
cost when compared to
conventional construction
and with a payback of 5 to
10 years.

ENERGY COST
In 2005 the average, sin-
gle-family home in the
U.S. purchased annually
107 million BTUs for
~$2,100 (DOE). Energy
cost for Trail Magic’s first
year was zero. It runs on
its own sunshine.

Design and layout: Kelly
Viancourt, photos: Joseph
Ferut and Carl McDaniel, text:
Carl McDaniel, Donald
Watson, Joseph Ferut, Mike
Strakle

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CONSTRUCTION

1. Ground Floor: Reddi-Wall insulated con-
crete forms with additional 2.5 inches of wet-
spray cellulose insulation (half below ground,
walls 13 inches thick, R = 35.5) and 4 inches
rigid insulation under cement floor (R = 20).
2. First Floor: Double, 2 x 4 wall with 1 inch
spray foam air barrier and 10 inches wet-
spray cellulose insulation (R = 47.5). Double
wall construction reduces “thermal bridging”
(the movement of heat through wall), thereby
increasing effective R-value.
3. Siding: Prefinished fiber-cement “Hardi-
board” siding and trim, used for its durability,
fire resistance, and low maintenance.
4. Roof: TJI rafters with 1 inch spray foam air
barrier and 15 inches wet-spray cellulose
insulation (R-value = 62.5); 24-gauge,
standing-seam, steel roof with light color that
meets Energy Star requirements for high heat
reflectance.
5. Windows: Loewen high performance
windows—double- and triple-pane
low-E argon with warm edge spacers.
South windows tuned for solar gain.
6. Finishes: Low volatile organic chemical
paints; recycled ceramic tile; wood stove
hearth made from reused granite cobble-
stones; local and on-site trees lumbered
for flooring, shelving, pantry countertop, inte-
rior and exterior beams.
7. Framing Strategies: Engineered rafters
and joints are used in lieu of large-dimen-
sional lumber, which comes from old growth
forests. Nothing larger than a 2 x 6 is used in
construction. Advanced framing techniques
are used which minimize amount of lumber
needed without sacrificing structural integrity.
8. Airtight construction: Use of spray foam air
barrier, caulk and seal package, high quality
windows, and results from a blower door test
substantially reduced air infiltration, which is a
significant factor in heating and cooling loads.

CONSTRUCTION WASTE: 95% reused or recycled

1. 10,475 pounds of waste generated:
Wood: 4,271 lbs. [wood scraps reused as
wood stove kindling or for children’s play
blocks, OSB and TJI recycled off site as
ground mulch.
Sheetrock and plaster: 3,910 lbs. [all recy-
cled on site by rototilling into soil]
Hardboard: 780 lbs. [crushed and used
as base for driveway]
Cardboard: 756 lbs. [recycled]
Metal: 181 lbs. [recycled]
Plastic: 66 lbs. [recycled]
2. Landfill: 511 lbs. [soiled paper and rags,
paints; recycled ceramic tile; wood stove
non-recycl-
able plastic]
3. Reused and Recycled: 9,964 lbs.

CHALLENGES
AND CHOICES
We employed systems thinking and holistic design
decisions to resolve con-
licts that arose from the individual perspectives of
architecture, beauty and
aesthetics, building stan-
dards and codes, econom-
ics, energy and resource
use, and environmentally-
appropriate construction.

Design and material deci-
sions rarely have one
optimal choice but rather a
preferred choice within the
context of the particular
project. Our overriding
metric, however, was the
lifecycle cost measured
environmentally and eco-
nomically.

Our behaviors were, and
continue to be, critical in
making Trail Magic a
climate-neutral (production of operating energy results
in no net-release of heat-
trapping gasses), energy-
positive (more energy
comes from on-site pro-
duction than used) home.
We strive with varying de-
grees of success to use
energy and resources only
as required for the task at
hand.

(Photos, clockwise, from upper left) 1. Bookcases on stairway wall going to second-floor study and
loft. Wood for bookcases from on-site ash, black walnut, maple, and red oak trees. 2. Daylighting
through open rears on stairway from first floor to second floor and wood bin behind stove in living-
dining room on winter day. 3. Solar heating and daylighting in living-dining room on winter day. 4.
Kitchen, kitchen beam from on site ash tree, and one of two sunset windows on summer day.

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