NORTH STAR GROUP, INC.

Value Engineering as a Design Discipline

Designing cost into repeatable housing, system by system

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Overview

Value engineering has two meanings, and they pull in opposite directions. In its common usage on a job site, it means cutting quality out of a building late in the process to meet a budget: a cheaper window, a thinner slab, a downgraded finish. The result is a worse building at a lower price. North Star Group uses the term in its original sense. Value engineering is the discipline of designing cost out of a building at the start, by choosing systems that deliver the same function for less money, before any drawing is fixed. The function is preserved. The cost is lower because the method is better, not because the building is worse.

The difference is timing and target. Cheapening happens at the end and lowers function. Design-stage value engineering happens at the beginning and holds function constant while lowering the cost of delivering it. A building is a set of systems, and each system can be specified in more than one way. Some specifications cost less to buy, install, and operate than others that perform the same job. The measures in this paper are those specifications, chosen for repeatable housing where the same decision is made many times.

This paper covers the design and specification side of cost. A companion paper covers the procurement side: owning the bill of materials, buying owner-direct, and contracting installation as a separate scope. The two work together. One lowers what a building costs to design and build. The other lowers what its parts cost to buy. This paper does not repeat the procurement argument. It assumes it.

Not every measure applies to every project. The method is to carry the ones a given model, site, and budget support, and to leave the rest.

How to read the measures

The measures below are not equal in how well they are proven, and honesty about that difference is what makes the rest of the paper usable. Some are established building practice, supported by published cost data and ordinary industry use. Others are engineered options that depend on a design choice, a code path, or a vendor confirmation not yet in hand. The paper marks which is which. An established measure can be relied on. An engineered option is carried as contingent upside, to be confirmed before it is counted, not as a booked saving.

This is the same discipline North Star applies to its own technical work. Where a number is an internal projection rather than a third-party result, the paper says so. Where a saving depends on a structural engineer's seal or a jurisdiction's rule, the paper says so. The measures are stronger for being sorted this way, because a reader can see exactly where the floor is.

The building envelope

The largest single cost in a house is the envelope: the floors, walls, and roof that enclose it. Conventional stick framing builds that envelope piece by piece on site, in the weather, with skilled labor. Structural insulated panels move most of that work into a factory. A panel is a foam core bonded between two structural facings, produced to size and delivered ready to set. The panel is the structure and the insulation at once, which removes a separate framing step and a separate insulating step.

The value-engineering case for panelized construction is labor and schedule. Setting panels takes fewer field hours than framing, the work is less weather-dependent, and the envelope closes faster, which shortens the financing period. Panelized envelopes are established construction practice in residential and light commercial work.

The cost advantage North Star records for its envelope is real in direction and illustrative in size. Internal comparisons place a standard panel envelope in the range of fifty to ninety-five dollars per square foot, against seventy-five to one hundred forty dollars per square foot for stick framing, depending on grade and market. Those figures come from North Star cost work, not from a third-party study, and they should be confirmed by bids on a specific model before they are underwritten. The method is established. The specific spread is illustrative.

One envelope item is an engineered option rather than an established saving. North Star holds a U.S. provisional patent on an embedded-joist panel, in which the floor or roof joists are built into the panel so that the subfloor and the

structural panel become one assembly rather than two. The intent is to remove an assembly step, performed in the factory rather than on site. The projected saving is on the order of two dollars per square foot. A conventional floor assembly of joists and subfloor sheathing runs roughly four to twelve dollars per square foot installed, so a two-dollar saving is a fraction of a step that already exists rather than a large claim. That figure is still an internal projection with no third-party performance data. The system would have to be engineered and sealed by a structural engineer, with the saving confirmed against real fabrication cost, before it is counted. It is carried here as upside contingent on that work, additive to the standard panel saving rather than a substitute for it.

Heating, cooling, and hot water

Ductless mini-split heat pumps heat and cool without ductwork. The cost saving is the duct system that is no longer built: the trunk, the runs, the registers, the chases framed around them, and the labor to install and balance them. Mini-splits also zone naturally, so unoccupied rooms are not conditioned, which lowers the operating cost. The equipment is established and widely available, and it suits the repeated small units this paper addresses.

Point-of-use and tankless electric water heating removes the standing tank and heats water on demand. The capital item is smaller, the footprint is smaller, and the standby loss of keeping a tank hot is gone. In a small unit the saving is modest but real, and it compounds with the electrical measure below, since a tankless unit's draw is part of what the electrical design has to plan for.

Electrical

Lighting and low-power devices do not need a 120-volt circuit. A low-voltage direct-current distribution, on the order of twenty-four volts, can carry lighting at a fraction of the wiring cost. The wire itself is the clearest saving. Low-voltage lighting wire runs in the range of forty to sixty cents per linear foot installed, against six to eight dollars per linear foot for a conventional 120-volt run with its conduit, boxes, and licensed labor. On the wire runs alone, the reduction is roughly ninety percent, and on a small unit it can reach one to two thousand dollars. The wire saving is well supported.

A larger saving is possible but conditional. If lighting and low-power loads move to low voltage, the conventional electrical service can in principle be smaller, because the coincident demand it carries is lower. Downsizing the service and the panel is where the larger dollars are. That saving is not automatic. It depends on an electrical design that limits coincident load, and on the code path for it, including the energy-management and load provisions of the National Electrical Code. The wire saving stands on its own. The building-level electrical saving is narrower than the wire-run figure, because the low-voltage system still needs transformers, drivers, power supplies, protection, an inspection path, and integration with the main service. Whether the service or panel capacity can actually be reduced is the open question, to be confirmed by the electrical design and the authority having jurisdiction.

Plumbing and bathroom assemblies

Plumbing carries two value-engineering moves, and both come from moving work off the site rather than from the pipe itself. The first is the manifold. A home-run manifold runs a dedicated PEX line from a central manifold to each fixture, which replaces rigid pipe and most of its joints. The material saving is PEX against copper, on the order of thirty to fifty percent. A home-run layout uses more tubing than a branched one, so built in the field the extra tubing can offset the gain. Built in a shop it does not, because the manifold and its runs are assembled in a controlled, repeatable setting at shop labor rates rather than fitted in place. A shop-built manifold is cheaper than the same manifold built in the field.

The second move extends the first to the whole room. A modular bathroom pod is a complete bathroom built in a factory, with plumbing, fixtures, finishes, and the manifold installed, delivered as a unit and connected to the building's utilities. A bathroom is the most trade-dense room in a building, requiring plumbers, electricians, and tile and finish trades in sequence. A pod does that work in parallel with the structure and sets in a day or two instead of weeks. Reported results put on-site bathroom labor down by roughly half and installation time down by roughly seventy percent against site building, while pod first cost typically runs eight to fifteen percent above conventional before those savings are counted. The saving is in labor, schedule, and waste, not in the unit's sticker, and it is largest where the same bathroom repeats many times.

Both moves depend on design. The saving appears only when the unit plan is standardized enough to fabricate in a shop and repeat. A one-off custom bathroom does not pod economically. A repeated unit does. The pod in particular should be evaluated only where the same bathroom repeats enough times to justify the shop setup, the freight, and the crane or forklift setting, which makes it a multi-unit measure rather than a single-house one.

The masonry option

Brick gives a building a durable, high-value face, but its installed cost is set mostly by the mason, not by the brick itself. Dry-stack, mortarless brick removes most of that skilled-labor cost, which is a low-cost way to capture brick's appearance. The approach is not novel to the industry. An established industry engineering group has already built interlocking brick that stacks dry into a sound wall, fired conventionally to full vitrification with no post-fire grinding required. North Star is pursuing an interlocking geometry of its own, covered by a U.S. provisional patent. The U.S. production path is not yet fixed. The most practical route may be to have an established brick manufacturer produce the units as a new line for resale, rather than operating a dedicated kiln. The open items are the production method, code acceptance, freeze-thaw and absorption performance, and builder adoption, so the measure is carried as a product-development path rather than a base-case cost measure. It is not included in base underwriting until the production route, code acceptance, and wall testing are in hand.

Site and water

Stormwater can be managed with built gray infrastructure, such as piping and detention structures, or with designed landscape features, such as rain gardens and bioswales that hold and filter runoff. Where the site and the jurisdiction allow it, the landscape approach can cost less to build and less to maintain over its life, and it can serve a second purpose as amenity. The saving is real where it applies and absent where it does not. It depends on the site's soils and grading, the local stormwater rule, and whether the jurisdiction credits the landscape feature against the drainage requirement. It is carried as a site-specific option, confirmed against the local rule before it is counted.

Shared infrastructure and program

At multi-unit scale, some costs fall when they are shared rather than repeated per unit. A single digital and utility backbone serving many units costs less than the same installation repeated in each one. Shared amenity and community space spreads a fixed cost across all the units rather than building it into each. These are programmatic savings, available when the project is large enough to spread the fixed cost, and they belong to the site plan rather than to the unit specification.

What this paper does not claim

A development can carry features that add value without lowering cost: integrated smart-home systems, low-power security and emergency networks, daylight and acoustic design, and resident-facing technology. These are real to a resident and to a rent roll, and they may be designed in at lower cost than they would be added later. They are not cost-reduction measures, and this paper does not count them as savings. Treating an amenity as a saving is the error that gives value engineering its bad name. They are noted here only to be set aside.

Status

The established measures in this paper rest on ordinary industry practice and published cost data. The illustrative figures, including the envelope spread and the per-unit wiring saving, come from North Star cost work and current market pricing, and they move to firm numbers when a specific model is priced against current quotes. The conditional measures, including the embedded-joist panel, the service downsizing, the dry-stack brick, and the stormwater credit, are carried as upside to be confirmed by the engineering, the vendor, or the jurisdiction named with each. The decisive version of the cost case runs a specific North Star model through the component database, prices its specification against current quotes, and counts only the measures that the model, the engineer, and the local rule support.

Measures at a glance

The table summarizes the measures, their evidence status, and what each requires before it is counted. It is a screening tool, not a savings total.

Measure	Status	Savings type	In base case?	Confirmation needed
Panelized envelope	Established direction; bid-specific spread	Labor, schedule, energy	Yes, after bid	Model-specific panel bid
Mini-split HVAC	Established	Duct deletion, efficiency	Yes	HVAC design
Tankless / point-of-use water heating	Established, modest	Footprint, standby loss	Maybe	Load calculation
24V lighting wire	Established for the wire run	Wiring	Partial	Electrical design / AHJ

Service downsizing	Conditional	Panel and service capacity	No until confirmed	NEC path / AHJ approval
Manifold and bathroom pods	Established at repetition	Labor, schedule	Maybe	Vendor quote / repetition count
Embedded-joist panel	Internal projection	Assembly labor	No	Engineer seal / fabrication quote
Dry-stack brick	Product-development option	Masonry labor	No	Testing, code, manufacturer
Green stormwater	Jurisdiction-dependent	Sitework, lifecycle	Maybe	Civil design / local credit
Shared backbone and amenity	Programmatic, at scale	Per-unit cost spread	Maybe	Project scale

The measures do not sum. Some overlap, some are alternatives, some require the same design condition, and some lower operating cost rather than capital cost, or lower labor while raising first cost. The base case counts only the measures the model, the engineer, the vendor, and the jurisdiction support, which is why several rows read no or maybe rather than yes.

Appendix: Claim sources and verification

This appendix sources each substantive claim in the paper. Each entry states the evidence and a status: *established* where published industry data supports it, *internal* where the figure is a North Star projection not independently verified, *primary* where the source is first-hand correspondence, and *jurisdiction-dependent* where the saving holds only under local rules. Figures from cost guides are market surveys, not quotations against a specific project. Where the research corrected a claim, the entry says so.

Panelized envelope — labor and schedule saving. Status: established in direction, internal in the specific spread. That panelized construction cuts framing labor is well supported. A study by the RS Means unit of Reed Construction Data, published by the Structural Insulated Panel Association, found residential builders can reduce framing labor by as much as 55 percent using panels rather than stick framing, in a side-by-side Habitat for Humanity build. Industry sources put panel material roughly 10 to 20 percent above stick framing, with total cost comparable or lower once labor, waste, and HVAC are counted (bhumi 2026; Premier SIPs; Offsite Builder 2025). Published material-only panel pricing runs about $7 to $18 per square foot, and a turnkey panel home about $150 to $220 per square foot (Lawnstarter 2026; bhumi 2026). The paper's envelope figure of $50 to $95 per square foot is a North Star shell figure, a different scope from material-only or turnkey, and is carried as illustrative pending bids on a specific model.

Embedded-joist panel — about $2 per square foot. Status: internal projection, bounded against a real cost basis. The two-dollar figure is a North Star internal projection, with no third-party performance data for the embedded-joist system itself. It can be bounded, though, against what the assembly it targets actually costs. A conventional floor assembly, meaning joists plus subfloor sheathing plus the labor to install both, runs roughly $4.50 to $12 per square foot installed: joist-and-subfloor installation is reported at about $4,500 to $12,000 for a 1,000-square-foot floor (JP Pro Painting 2025), plywood subfloor installed at $4.50 to $10 per square foot (Angi 2026), and subfloor sheathing material alone at $1.50 to $4 per square foot (Angi 2026; HomeAdvisor). Against that basis, a $2 per square foot saving from building the joists into the panel and removing the separate framing-and-sheathing step is roughly fifteen to forty percent of the assembly cost, a plausible fraction rather than an arbitrary number. The figure remains contingent. The system is the subject of a U.S. provisional patent and would require structural engineering and a sealed design before the saving is counted.

Mini-split HVAC — duct elimination and efficiency. Status: established. ENERGY STAR finds that 20 to 30 percent of conditioned air is lost to duct leakage and conduction in typical duct systems; ductless mini-splits avoid that loss and zone by design (Carrier; One Hour Heat & Air 2025; SoCal Climate Control 2025). Adding central air to a home without ducts runs about $8,000 to $22,000 and up, against $3,000 to $7,000 with existing ducts, so the duct system is a large share of the cost (Eco Temp HVAC 2025). Mini-splits are reported to use roughly 30 percent less energy than ducted central air (Eco Temp HVAC 2025).

Tankless and point-of-use electric water heating — standby loss and footprint. Status: established, with a caveat. Storage tanks carry standby heat loss accounting for about 10 to 15 percent of water-heating cost; on-demand units effectively eliminate it (4ABC 2026; U.S. Department of Energy). The Department of Energy puts tankless at 24 to 34 percent more efficient for homes using 41 gallons a day or less. The caveat: for whole-house electric tankless specifically, several sources report weak payback and element scaling, so the measure is strongest as point-of-use and small-unit application rather than a whole-house electric retrofit (Mother 2026; DOE notes about $44 a year electric

saving). The paper's "modest but real" framing matches the evidence.

24V DC lighting — wire-run saving. Status: established for the wire run, narrower all-in. HomeGuide's 2026 pricing puts low-voltage wiring at $0.40 to $0.62 per linear foot installed against $6 to $8 per linear foot for conventional electrical wiring, which is the roughly ninety-percent figure the paper cites for wire runs. The caveat, from electrician practice, is that the labor to pull low-voltage cable can be close to a 120-volt home run, so the all-in saving is narrower than the wire-only figure unless conduit, boxes, and licensed-electrician labor are also avoided (Mike Holt forum; Los Angeles Low Voltage Company). The paper's "on the wire runs alone" wording is the defensible scope.

24V service downsizing — code path. Status: established mechanism, conditional saving. The 2023 National Electrical Code, Section 220.70 with Article 750, allows an energy-management system's setpoint to be used in load calculations to limit current to a feeder or service, which permits right-sizing the service, feeders, and panel downward (Schneider Electric 2025; Eaton; Filipino Engineer 2025). The saving depends on installing the management system and on the authority having jurisdiction. In the 2026 code these provisions are renumbered: Article 220 becomes Article 120 and Article 750 becomes Article 130.

Plumbing and bathroom assemblies — prefabrication saving. Status: established, saving in labor and schedule. The value-engineering saving in plumbing comes from shop fabrication, not from the pipe. A home-run manifold uses more tubing than a branched system, so its field economics are mixed; the material saving in the measure is PEX against copper, about 30 to 50 percent (Plumbing Tips Today 2026; Fine Homebuilding). Built in a shop, the manifold avoids the field-labor penalty, the same logic that drives panelization. Extended to the whole room, a modular bathroom pod carries the larger saving: a 2024 Construction Analytics survey, reported by JMK Contractor, found on-site bathroom labor down about 54 percent and installation time down about 71 percent against site building, with pods setting in one to three days rather than weeks (JMK Contractor 2025; Projul 2026; Well Built Florida 2025). Pod first cost typically runs 8 to 15 percent above conventional, so the saving is in labor, schedule, and waste, and it is largest where the bathroom repeats many times (JMK Contractor 2025). The measure is design-dependent: a standardized, repeated unit pods economically; a one-off does not.

Dry-stack brick — mason cost and pedigree. Status: established cost share, primary prototype, demonstrated but not market-proven. That labor dominates a brick wall's cost is well supported: published guides put masonry labor at roughly 60 to 80 percent of a brick wall's total, citing the National Association of Home Builders (Coohom 2026; HomeAdvisor; Angi 2026), with mason labor at $7 to $17 per square foot against brick material of $2 to $8 per square foot. The pedigree is first-hand rather than theoretical: interlocking dry-stack brick has been fabricated and wall-tested as a working prototype by an established industry engineering group, fired conventionally with no post-fire grinding, and images were provided to North Star with permission to share them. The open items remain US code acceptance, freeze-thaw and absorption performance, and builder adoption, which is why the measure is conditional, and the group has noted the product has not been taken to market. The interlocking geometry North Star is pursuing is covered by a U.S. provisional patent.

Stormwater — green versus gray. Status: established direction, jurisdiction-dependent. An EPA study, summarized by Save The Bay, found green-infrastructure capital costs 15 to 80 percent lower than gray, with maintenance about 25 percent lower. Project examples bear this out: the Denver Housing Authority cut a site's stormwater cost from $850,000 for a vault to $350,000 for bioswales and permeable pavement (EPA Region 8), and a Richmond Fed account reports a $500,000 gray solution delivered green for $110,000. The saving is site- and rule-dependent, and some jurisdictions find green "less than or about the same" as gray (Florida DEP GSI). The paper carries it as a site-specific option confirmed against the local rule.

Shared backbone and amenity — programmatic saving. Status: structural. This is a scale argument rather than a sourced price. A single backbone or a shared amenity spreads a fixed cost across more units than a per-unit installation. It is offered as a programmatic observation, not a benchmarked figure, and the saving exists only where the project is large enough to spread the cost.

Prototype evidence — dry-stack masonry

BUILT AND WALL-TESTED PROTOTYPE

The dry-stack masonry path described in this paper is not a paper concept. The units shown are fired interlocking brick from an existing engineered prototype, stacked without mortar into a sound wall and tested by an established industry engineering group. They are included as evidence that the interlocking geometry has been manufactured and stands, not as a finished, market-ready product. Images used with permission.