

**enable**

Your home for today,  
and tomorrow

## Water Narrative D8 Submission

August 10, 2017

**HOUSE**

by Northwestern

Northwestern University

U.S. Department of Energy  
Solar Decathlon 2017



**enable**

Your home for today,  
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**water  
narrative**

*Enable* by House by Northwestern is Northwestern University's first entry in the Department of Energy Solar Decathlon. Designed for active Baby Boomers living in Chicago's North Shore, who are looking to downsize and buy their home for life, *Enable* delivers an **EN**ergized (energy-efficient and active lifestyle) and Adapt**ABLE** (the house meets residents' changing needs) experience for its target users. *Enable* is more than a house. It's a home for today, and tomorrow.

#### **AGING-IN-PLACE & UNMET HOUSING NEEDS FOR BABY BOOMERS**

Baby Boomers, born between 1946 and 1964, are important to the U.S. housing industry given their sheer numbers. From 2016 to 2060, the population of individuals 65 and older is projected to more than double—from 46 to more than 98 million—which represents an increase from 15 to nearly 24 percent of the total population.<sup>1</sup>

In the city of Evanston, IL, home to Northwestern University and part of Chicago's North Shore, 20 percent of the population is projected to be 65 and older by 2020.<sup>2</sup> A community that takes pride in its age-friendliness, Evanston is one of 284 cities in the world and 45 cities in the United States approved to enter the World Health Organization (WHO) Network of Age-Friendly Cities.<sup>3</sup> Being a part of this network requires that a city adapt its structure and services—including housing—"to be accessible to and inclusive of older people with varying needs and capacities."<sup>4</sup>

Recent Boomer homebuyers aged between 52-61 project they will live in their homes for at least 20 years<sup>5</sup> and approximately 90 percent of those over age 65 report wanting to stay in their homes as long as possible.<sup>6</sup> This desire to age-

in-place means that Boomers' houses will become important places for long-term care as they deal with disabilities and other aging-related health challenges. However, the Joint Center for Housing Studies of Harvard University estimates that only 1 percent of the current housing stock contains the key features required to support **aging-in-place**, such as zero-step entrances, single-floor living, wide hallways and doorways, wheelchair-accessible light switches, and lever-style door handles and faucets.<sup>7</sup>

It is with this housing shortage and Evanston's interest in improving its current structures and services to create a culture of age-friendliness in mind that the Solar Decathlon team at Northwestern University set about designing a highly energy-efficient, yet fully-accessible home for a rapidly aging Baby Boomer demographic.

#### **ENABLE: A USER-CENTRIC DESIGN APPROACH**

The House by Northwestern (HBN) team took a user-centric approach to the design of *Enable*. In other words, community members weighed in at every step of the design process about how *Enable* could best meet their needs. The buyer personas of "Michael and Lisa", which are referenced frequently in our materials, encompass HBN market research data and represent that common voice of the active Baby Boomer living in Chicago's North Shore.

Based on primary research from HBN User and Market Research Teams,<sup>8</sup> our target market ranked the following housing features in order of importance to them: **comfort and livability, high-performance with functionality, easy home maintenance, sustainability, and affordability**. The crux of HBN's design efforts was to create a home that balances the needs of the market with our team's desire to create a sustainable, environmentally-friendly home. By packaging energy efficient and sustainable features into a comfortable, beautiful, accessible, and easy-to-maintain home, *Enable* offers sustainability without compromise.

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#### **WATER IN THE UPPER MIDWEST**

The U.S. has a long and complicated history with water. Some of its most pressing and recurring issues involve shortages,

flooding and contamination. And as the implications of climate change become more and more evident, water issues too will need to be more and more urgently addressed. Current estimates predict that ocean levels will rise four to 10 feet by the end of the century<sup>9</sup>, which will put many Americans in direct danger and many others at increased risk of flooding. On the opposite side of the spectrum, the US is presently at risk of experiencing a “megadrought” that would strike the Central Plains and Southwest sometime between 2050 and 2099 and last for decades. If climate change continues at its current pace, the likelihood of this drought occurring is 80%<sup>10</sup>.

Many people in the Midwest don’t feel it’s as urgent to conserve water as it is in other parts of the country, such as California or Nevada. This unconcerned segment includes Chicago’s North Shore, which borders Lake Michigan. Despite the fact that the Great Lakes and their tributaries contain roughly 18% of the world’s surface freshwater<sup>11</sup>, their resources are finite. Water levels in Lake Michigan have been steadily falling, as have groundwater levels in the Chicagoland area. At the same time, the population of the Chicago-Milwaukee area is expected to increase by 20% in the next 20 years, which will result in a regional increase in water demand. When coupled with a decreasing supply, this increasing demand creates pressure on local freshwater resources and industries<sup>12</sup>.

Climate change increases chances of flooding due to severe storms in the Chicagoland area. These floods can overwhelm the municipal sewer system, discharging wastewater and stormwater into the Chicago River and Lake Michigan. By reducing the residential wastewater load on our sewer system, we can lessen the frequency and intensity of these combined sewer overflow events<sup>13</sup>.

The costs of water usage are not only environmental. An annual survey by Circle of Blue, an international coalition of journalists and scientists committed to increasing awareness about the global freshwater crisis, found that from 2007 to 2010 the cost of water in Chicago increased by 50%<sup>14</sup>. *Enable*’s integrated water conservation features will help its occupants save money and reduce strain on the local watershed.

In keeping with its historically progressive roots, Evanston named “sustainability” as one of the three guiding values in its City Strategic Plan in 2007<sup>15</sup>. A recent survey of its residents shows that though 70% of respondents think Evanston is safe from water shortages, nearly all believe that water conservation is important<sup>16</sup>. This responsible thinking is in line with Evanston’s Climate Action Plan, which aims to “implement policies and practices that treat rainwater as a precious resource and make use of it where it falls” and “optimize the use of native plants throughout Evanston”<sup>17</sup>. The county-wide planning agency also has recommended residents use efficient appliances to further conserve water<sup>18</sup>.

Given these Evanstonian values and the priorities of our target audience, we challenged ourselves to design a home that enables and encourages its occupants to conserve more water than the average house. To do so, we asked ourselves: ***How might we design a house that uses water efficiently while minimizing needs for water-related maintenance?***

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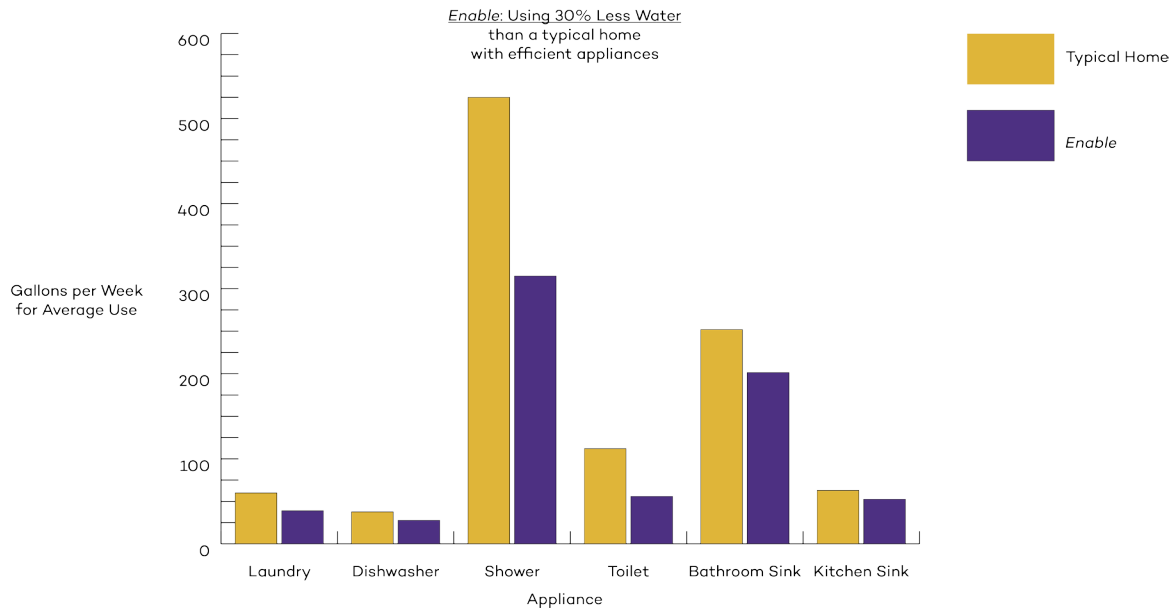
## APPLIANCES & MATERIALS: REDUCE

### APPLIANCES

More than 50% of respondents to a recent Evanston survey expressed a desire to learn how to replace their old toilets and showerheads with more water-efficient ones. *Enable* responds to this interest by outfitting its residents with highly-efficient appliances that make water conservation a seamless part of home life. **Collectively, its accessible appliances use ~30% less water than those in a standard, code-compliant house<sup>19</sup>, making it both a functional home for Baby Boomers and educational model for the community (Figure 1; Table1).**

### FURNISHINGS AND BUILDING MATERIALS

*Enable*’s furnishings and building materials are also sourced from environmentally-conscious companies. In addition to prioritizing energy-saving fabrication processes and seeking out recycled content, many of these firms have adopted practices that limit their manufacturing water-usage. A few of the most water-responsible ones include Crossville<sup>20</sup>, which reuses over 99.8% of water in its tile manufacturing, Sunbrella<sup>21</sup>, which also uses a unique water-saving process



**Figure 1. Amount of water used per week compared with popular conventional appliances and our carefully-selected, more efficient models.**

APPLIANCE	FEATURES	CERTIFICATIONS	WATER SAVINGS
<b>BEKO® 24" FRONT LOAD WASHER (WMY10148C0)</b>	<ul style="list-style-type: none"> <li>Automatic water adjustment system to sense how much water each specific load of laundry needs</li> </ul>	<ul style="list-style-type: none"> <li>ENERGY STAR certified</li> </ul>	<ul style="list-style-type: none"> <li>Uses 45% less water than a conventional washer<sup>19</sup></li> </ul>
<b>BEKO® 24" PRO-STYLE FULLY INTEGRATED DISHWASHER (DDN25400 SERIES)</b>	<ul style="list-style-type: none"> <li>Thorough dishwashing eliminates need for pre-rinsing</li> <li>A variety of options allow you to choose water-efficient cycles</li> </ul>	<ul style="list-style-type: none"> <li>ENERGY STAR certified</li> </ul>	<ul style="list-style-type: none"> <li>Uses 35% less water than a conventional dishwasher</li> </ul>
<b>NIAGARA SAVA SPA™ FIXED MOUNT SHOWERHEADS</b>	<ul style="list-style-type: none"> <li>Showerhead flow rate of 1.5 GPM</li> </ul>	<ul style="list-style-type: none"> <li>WaterSense® labeled</li> </ul>	<ul style="list-style-type: none"> <li>Uses 40% less water than a conventional showerhead</li> </ul>
<b>NIAGARA THE ORIGINAL STEALTH® - 0.5/0.95 GPF DUAL FLUSH TOILETS</b>	<ul style="list-style-type: none"> <li>One flush thoroughly evacuates the bowl every time, eliminating double flushing</li> <li>No flapper to cause leakage</li> </ul>	<ul style="list-style-type: none"> <li>A UHET™ product</li> <li>WaterSense® labeled</li> <li>MaP PREMIUM rated</li> </ul>	<ul style="list-style-type: none"> <li>Uses up to 69% less water than a conventional 1.6 GPM toilet</li> </ul>
<b>KOHLER® PURIST™ WIDESPREAD BATHROOM SINK FAUCET + NIAGARA WATER AERATOR</b>	<ul style="list-style-type: none"> <li>Maximum flow rate of 1.2 GPM at 60 PSI</li> <li>0.5 GPM with Niagara Water Aerator</li> </ul>	<ul style="list-style-type: none"> <li>WaterSense® labeled</li> </ul>	<ul style="list-style-type: none"> <li>Uses 77% less water than a conventional 2.2 GPM faucet</li> </ul>
<b>KOHLER® TOURNANT™ SEMI-PROFESSIONAL KITCHEN SINK FAUCET + NIAGARA WATER AERATOR</b>	<ul style="list-style-type: none"> <li>Maximum flow rate of 1.5 GPM at 60 PSI</li> <li>1 GPM with Niagara Water Aerator</li> </ul>	<ul style="list-style-type: none"> <li>Meets water savings requirements for California Energy Commission (CEC), CALGreen, and Colorado SB 14-103</li> </ul>	<ul style="list-style-type: none"> <li>Uses 60% less water than a conventional 2.5 GPM faucet</li> </ul>
<b>CHILTRIX® CHILLER WITH PSYCHROLOGIX™ CONTROLLER (DYNAMIC HUMIDITY CONTROLLER (DHC) IN HVAC SYSTEM)</b>	<ul style="list-style-type: none"> <li>Dehumidifies only as much as is needed to maintain a comfortable interior environment during the summer</li> </ul>	<ul style="list-style-type: none"> <li>Comparable to geothermal cooling systems, but far less costly</li> <li>Exceeds the efficiency (EER) requirements needed for a variable speed geothermal unit to earn an Energy Star label</li> </ul>	<ul style="list-style-type: none"> <li>Depends on the moisture content of the environment</li> </ul>
<b>ZEHNDER® COMFOAIR 200™ (ENERGY RECOVERY VENTILATION SYSTEM)</b>	<ul style="list-style-type: none"> <li>Recovers humidity from exhaust air, removing or eliminating the need for humidification in the winter</li> </ul>	<ul style="list-style-type: none"> <li>Certified Passive House Component</li> </ul>	<ul style="list-style-type: none"> <li>Recovers up to 65% of moisture in the air while removing odors and bacteria</li> </ul>

**Table 1. Water-Saving Appliances selected for Enable. Usage comparisons from independent research of usage by popular conventional models.**

in its fabric manufacturing, and Huber<sup>22</sup>, whose ZIPsystems panels create a tightly-sealed building envelope that decrease the need for both winter humidification and summer dehumidification systems. Together with *Enable's* many other energy-efficient features, the home's water-savvy appliances, furnishings, and building materials demonstrate intuitive conservation strategies for the community. These sustainable products also lower the home's operating cost.

## RAINWATER CATCHMENT SYSTEM: RECLAIM

Over half of surveyed Evanston residents believe that water-conserving yards look as good as or better than traditional lawns, and they expressed interest in learning how to install rain barrels and landscape with native plants that require less water<sup>23</sup>. Since the Illinois Plumbing Code prohibits indoor use of collected rainwater or any greywater systems, capitalizing on Evanstonians' eagerness to adopt xeriscapic landscaping practices is key to city-wide conservation goals<sup>24</sup>.

As a model of sustainable gardening for the community, *Enable's* rainwater catchment system is designed to focus on landscaping irrigation. It is compliant with local codes and will be ready-to-use once *Enable* is installed in its permanent location.

*Enable's* roof is pitched at a 23.5° slope, which both maximizes the amount of solar energy captured by its roof-integrated photovoltaic panels and funnels rainwater into the single gutter that runs along the south side of the roof. The gutter releases water via two downspouts: one on its far west side and the other on its far east side respectively. Each of these downspouts funnels water into a rain barrels that sits below them (Figure 2).

Because *Enable's* roof is 63.5' wide and 22' deep, a 1" rainfall event produces 871 gallons of water. Thus, a mere 1/8" of rain will fill our two main rain barrels. As our plants have been selected for their drought tolerance, small and infrequent precipitation events will provide enough water to keep them healthy. Additionally, the simple nature of *Enable's* two-point collection system makes it easy for future occupants to expand their collection-potential once *Enable* is located on its permanent site.

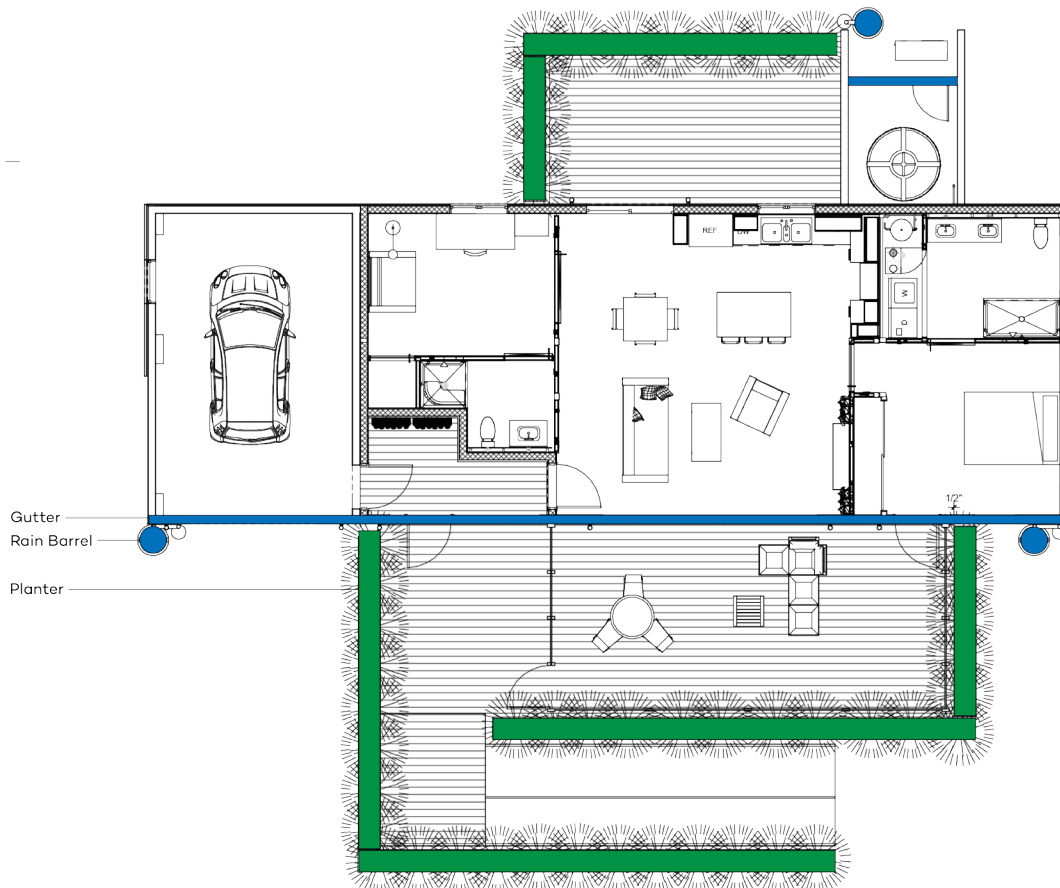


Figure 2. Rainwater catchment system plan

## LANDSCAPING: REUSE

### PLANTERS

Insights from HBN's User Research Team<sup>25</sup> tell us that our target demographic both enjoys gardening and values privacy, so we custom-designed and built *Enable's* 201 square feet of planter beds to meet both of these needs. Using a decision matrix, we also weighed sustainability, functionality, aesthetics, maintenance and cost in our process. Many of these considerations were related, as tall planters both increased privacy and were easier to maintain, as they do not require occupants to kneel while weeding.

The result: six verdant boxes ranging from 10' to 33' long that line *Enable's* north deck, south deck and entrance ramp. Each of these wooden planters is 33" tall and 18.5" wide, and each of them contains a simple yet effective self-watering system. Though their sides extend to the ground, their bases are situated 22" above that, roughly halfway up the planters and even with the deck (Figure 3). This design saves unnecessary material waste by cutting the amount of dirt and gravel needed to fill them by more than half while maintaining the solid aesthetic standards that *Enable's* future residents value. Purchasing lumber from a local provider ensured that our planters would be made of high-quality material, and building them by hand guaranteed a custom fit.

Landscaping felt lines the planters' bases. 3" of gravel sit atop this felt, providing drainage in the event of excessive rain (Figure 2). More landscaping felt sits atop this gravel, separating it from the soil above to prevent plants' roots from rotting in the drainage cavity. 8" of soil sit above this second layer of felt, providing space and nutrients for the plants to grow.



## LANDSCAPING: REUSE

### PLANTS (DENVER)

We chose *Enable's* plants using a decision matrix that weighed privacy, ease of maintenance, sustainability, functionality, aesthetics, and cost. We sought native plants because they require less water, are low-maintenance, and promote local biodiversity as well as enhance the situational beauty of our site. As a result, *Enable's* combination of drought-tolerant plants and water-conserving practices comprises system that demonstrates smart-scaping across climates (Table 2).

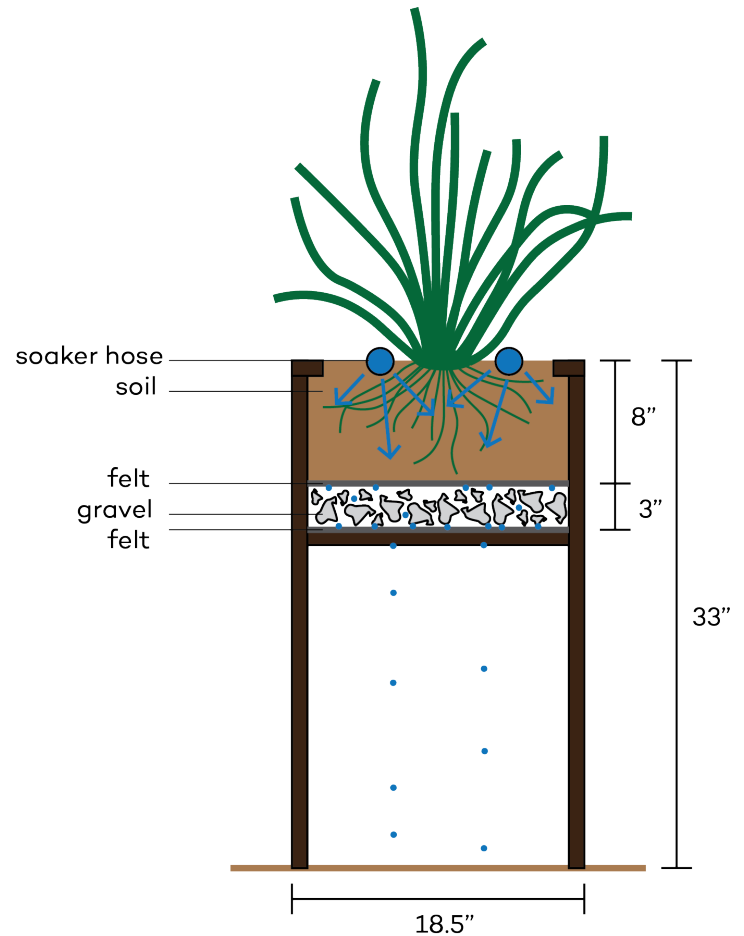


Figure 3. Diagram of self-watering planter.

Denver is located in Climate Zone 5b<sup>26</sup>, which defines the weather and growing conditions of the Great Plains. Within this designation, rainfall averages around 10 in. per year, and evaporation due to sun, wind and humidity exceeds precipitation. Precipitation rates are greatest during the months of April through August. Plants in this region often have water-saving adaptations, such as waxy cuticles<sup>27</sup> and minimized stomata<sup>28</sup>. In Denver, temperatures can get as high as the 103F and as low as -23F<sup>29</sup>.

*Enable's* plants have been selected for their drought-tolerance and suitability for Denver's climate. Their sun tolerance ranges according to their on-site location, and the color and timing of their blooms differs as well. This bloom variation ensures that *Enable* boasts a dynamic range of specimen plants throughout the full growing season each year.

PLANTS	LOCATION	FUNCTION	GROWTH REQUIREMENTS
TALL GRASSES	<ul style="list-style-type: none"> <li>In planters that line the North deck, South deck, and entrance ramp</li> </ul>	<ul style="list-style-type: none"> <li>Provide privacy</li> <li>Aesthetically pleasing</li> </ul>	<ul style="list-style-type: none"> <li>Drought-tolerant</li> <li>Partial to full sun</li> </ul>
FLOWERS	<ul style="list-style-type: none"> <li>In urns and pots around the house and on the decks</li> </ul>	<ul style="list-style-type: none"> <li>Aesthetically pleasing</li> </ul>	<ul style="list-style-type: none"> <li>Drought-tolerant</li> <li>On deck: partial to full sun</li> <li>Inside: partial sun to full shade</li> </ul>
FRUITS & VEGETABLES	<ul style="list-style-type: none"> <li>In urns and pots around the house and on the decks</li> </ul>	<ul style="list-style-type: none"> <li>Enable users to eat organic, locally-grown produce during warmer months</li> <li>Aesthetically pleasing</li> </ul>	<ul style="list-style-type: none"> <li>Drought-tolerant</li> <li>On deck: partial to full sun</li> <li>Inside: partial sun to full shade</li> </ul>
SUCCULENTS & AIR PLANTS	<ul style="list-style-type: none"> <li>On the DIRTT Breathe Wall</li> </ul>	<ul style="list-style-type: none"> <li>Air filtering</li> <li>Aesthetically pleasing</li> </ul>	<ul style="list-style-type: none"> <li>Drought-tolerant</li> <li>Partial sun to full shade</li> </ul>

**Table 2. Plant types selected for Enable; locations; functions; growth requirements. Specific species will be selected based on local availability.**

## PLANTS (EVANSTON)

Like Denver, Evanston is in Climate Zone 5b<sup>30</sup>. It borders Chicago’s Climate Zone of 6a, however, which indicates that it is far more humid than Denver<sup>31</sup>. Its highs and lows are similar to those of Denver, with temperatures reaching as high as the 105F and as low as -27F<sup>32</sup>.

When *Enable* returns to Evanston, our general landscaping strategy will remain the same: by using a combination of native plants and water-conserving practices, *Enable’s* garden system will be a smart-scaping model for the community. The City of Evanston is currently working to become certified as a Wildlife Habitat with the Natural Wildlife Federation. Citizens’ Greener Evanston, which is a non-profit formed in 2011 to “reduce greenhouse gas emissions and enhance community sustainability”, leads this initiative<sup>33</sup>. In order to support this community initiative, *Enable’s* permanent landscaping will include habitat space that birds and pollinators need to thrive. It will also continue to be maintained without the use of harmful pesticides and chemical fertilizers.

Some of the plants featured in and around *Enable’s* permanent site will be similar to or the same as the ones exhibited in Denver, and others that are uniquely native to the Upper Midwest will be planted as well. Depending on location and orientation, trees, shrubs and groundcover will be planted permanently by the house. This larger vegetation will offer shade, block wind and provide a visual and audial barrier as needed.

As we are still working to identify a permanent location for *Enable* post-competition, we have not yet selected specific plants or created a final landscaping plan. We are in discussions with the Chicago Botanic Garden to partner with

them by offering *Enable’s* permanent location as a site for their high school sustainable horticulture internship program.

## LANDSCAPING: REUSE

### HARDSCAPING

*Deck.* Cedar decking allows water to soak into the earth beneath it. Environmental benefits include reducing runoff, which reduces the strain on local sewer system and benefits the neighboring ecosystem.

*Driveway.* At *Enable’s* permanent location, its driveway will be constructed with permeable pavers to reduce runoff (Image A4).

## CONCLUSION

HBN began the Solar Decathlon 2017 by asking ourselves: How might we design a home for Chicago’s North Shore that uses water efficiently while minimizing needs for water-related maintenance? Our answer: *Enable*.

As an adaptable, energy-efficient home that allows its residents to safely enjoy seasonal indoor and outdoor activities, *Enable* offers a design-solution to the shortage of housing for Baby Boomers who wish to age-in-place on Chicago’s North Shore. Its water-efficient appliances and tightly-sealed building envelope make water conservation a seamless part of home life, and its rainwater catchment and self-watering planter systems ensure efficient water use and ease of maintenance as well. Designed with our target market’s priorities in mind, *Enable* inspires and delights, empowering its residents to live their lives to the fullest.



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# APPENDIX

## APPENDIX A. RENDERINGS



Image A1. Overhead exterior view from the southeast, Summer



Image A2. Exterior view from the southeast, Winter



Image A3. Exterior view from the southeast.



Image A4. Exterior view from the southwest.



Image A5. Interior view from front door, looking into the living room, dining room, and kitchen.



Image A6. Interior view from door to the convertible room, looking into the living room and out to the sunroom.



Image A7. Interior view of the master bedroom; door to the right exits to the sunroom.



Image A8. Interior view of the master bathroom.



Image A9. Interior view of the convertible room, looking out to the dining room and kitchen.

## APPENDIX B. USER RESEARCH DATA

View the video we made about our user research process here: [https://www.facebook.com/pg/HouseByNorthwestern/videos/?ref=page\\_internal](https://www.facebook.com/pg/HouseByNorthwestern/videos/?ref=page_internal)

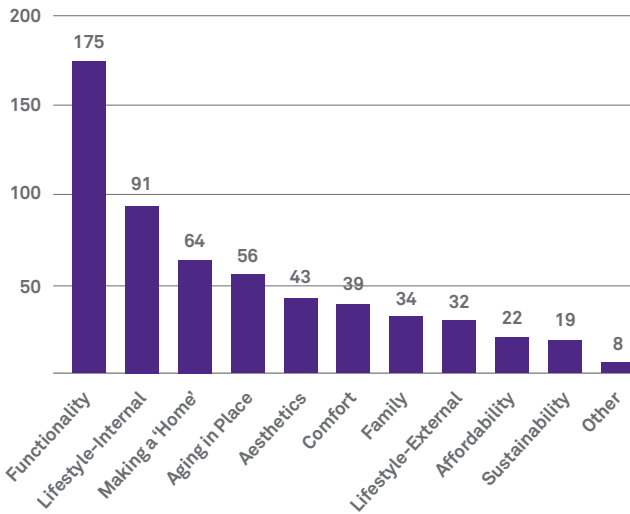


Figure B1. Target demographic housing priorities (ranked in order of importance). Source: House by Northwestern User Research Team ([bit.ly/2hgkw1k](https://www.facebook.com/pg/HouseByNorthwestern/videos/?ref=page_internal))

Requirements (Counter Stool)	Folio Top-Grain	Lowe Smoke C	Rouka Grey Up	Phoenix Ivory 2	Curran Crema Counter Stool
	\$499	\$279	\$349	\$149	\$369
Has a back for support, can grab on when getting in and out	1	1	1	1	1
Footrest to step on and off stool	1	1	1	1	1
No armrests so users can slide in and out	1	1	0	1	1
Feels sturdy, wide footprint by feet	1	1	1	1	1
Skinny enough to fit two in center island	1	1	1	1	1
User appeal (material, quality, design)	1	1	1	1	1
Comfortable to sit in (curve, upholstered)	1	1	1	2	1
Does not swivel	1	1	1	1	1
Design matches our aesthetic (grey=0.5, not grey = 1)	0.5	0.5	0.5	1	0.5
Price (ranked)	-1	2	1	3	0
<b>TOTAL:</b>	<b>8.5</b>	<b>8.5</b>	<b>7.5</b>	<b>10</b>	<b>8.5</b>

Requirements (Dining Chair)	Lowe Smoke Le	Curran Quilted	Sava Dining Ch	Monterey Charcoal Dining Chair
	\$199	\$349	\$249	\$199
Comfort	1	1	1	2
Customer reviews (durability, ease of cleaning)	-1	1	1	1
Aesthetic	1	1	1	2
Price	2	0	1	2
Lead time				
Seat depth no deeper than 17"	1	1		1
Width no larger than 19"	1	0		1
Seat height (29"-12") = 17"	0	0.5		1
<b>TOTAL:</b>	<b>5</b>	<b>4.5</b>	<b>4</b>	<b>10</b>

Figure B2. User Research Team design matrix used to determine most suitable counter stools and dining chairs. Requirements gathered from interviews, home observations, and focus groups with target demographic.

Requirements	Loveseat + swivel	2-seat sofa + armchair	Armless loveseat + swivel	L-shape	Right-arm + swivel
Can see 55" TV	2	-1		2	2
Looks out sunroom	-1	1		-1	-1
Comfortable armrests for lying down	1	1		-1	1
Easy to get in and out of	1	1		-1	-1
Correct firmness	1	1		1	1
Correct height	1	1		1	1
Sturdy	1	1		1	1
User appeal	1	1		0	1
ADA compliance + four route	1	1		1	-1
<b>Total:</b>	<b>8</b>	<b>7</b>		<b>3</b>	<b>6</b>

Armchair Requirements:	Elyse Swivel	Elyse Swivel Glider
Arms match sofa	1	1
Swivels to face conversation or outside	1	1
Does not rock to allow users to get up	1	0
Proper seat dimensions	1	1
Fits in space	1	1
<b>Total:</b>	<b>5</b>	<b>4</b>

Fabric Requirements:	Duet - Natural	Diamond - Flax
Interesting read	1	1
Nice hand	1	1
Matches color scheme	1	1
Easy to clean	1	1
Wrinkle resistant	0	1
<b>Total:</b>	<b>4</b>	<b>6</b>

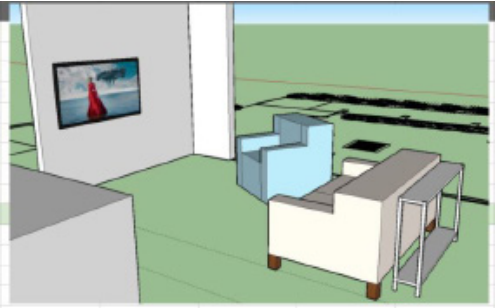


Figure B3. User Research Team design matrix used to determine most suitable living room layout. Requirements gathered from interviews, home observations, and focus groups with target demographic.