



PHOTO: AUGUSTA QUIRK

URBAN GREENING: A RESIDENTIAL LEARNING LAB

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Abstract

Working locally can transform a street, a neighborhood, and even a whole city. Architect Isabelle Duvivier was inspired to push the limits by creating Los Angeles County’s “greenest home” when she transformed a dilapidated 100-year-old house. The house resides in a long-established, low-income neighborhood on Brooks Avenue in Venice, California. Her solution was holistic. Every part of the house from building materials to energy and water use was examined for maximum efficiency. What resulted was a Leadership in Energy and Environmental Design (LEED) Platinum house and a 2012 Outstanding Home Award from the United States Green Building Council (USGBC). Experimental opportunities such as greywater applications, 95% native plants, collection cisterns for irrigation, net-zero energy, and material reuse were investigated and used. One hundred percent of storm water was collected on site, including runoff from an adjacent property. One of the project’s most notable achievements was controlling how and where water was distributed and reused. The gardens were designed to create

a haven for local wildlife, a spot for orchards, farming, and a distribution center to provide produce to neighbors. The heat island effect was reduced through landscaping and minimizing the hardscape. The house and garden acts as a laboratory for “sustainable” gardening. Duvivier even boosts educational signage about green building throughout the property. Looking into the future, Duvivier is designing a sustainable neighborhood plan by reimagining the streets and alleyways as part of a broader green infrastructure network that will include permeable paving, street trees, and play areas.

Introduction

Sustainable Goals

Isabelle Duvivier, a local California architect wanted to make a big difference in environmental practices in her community when she purchased a dilapidated house on Brooks Avenue in Venice in a low-income neighborhood. She went about renovating the 100-year-old house from top to bottom, inside and out with experimental and scientific fervor. The goal was to reduce the impact of the house



FIG. 1A. The original 100-year-old house before the transformation.



FIG. 1B. The original home was remodeled and the second story addition includes the master suite.

and garden on the environment through intelligent design choices related to water, energy, and material use. To achieve this goal, every part of the Brooks residence, a 1,700 square foot remodel and addition to a 1912 Craftsman Cottage, was examined and designed to be as green and energy efficient as possible using the most current technologies and experimental opportunities available. The natural environment was also incorporated by creating a habitat for birds, bees, and butterflies, along with educational opportunities for friends, clients, and neighbors. The result was a Leadership in Energy and Environmental Design (LEED) Platinum dwelling that was recently honored by the United States Green Building Council (USGBC) with a 2012 Outstanding Home Award. The award recognizes innovative multi- and single-family projects that have demonstrated leadership in the residential green building marketplace. The house has also become a personal learning laboratory and a means to experiment with new technologies.

Adaptive Reuse in a Historical Neighborhood

Rather than tear down the 100-year-old house in which generations have lived (Fig. 1a), Duvivier remodeled and modernized her craftsman house, keeping the integrity of the bungalow streetscape (Fig. 1b). Integration into this high-density, low-income neighborhood was important. The sailing form of the new second story harmoniously blends with the existing house while respecting the architectural history and scale of this traditional beach neighborhood. A vegetable garden was created in the south-facing front yard to encourage casual discussion around the sharing of food. Giving food to neighbors became a common practice. Whenever possible, Duvivier hired local workers to decrease commutes and infuse revenue and jobs into the local economy.

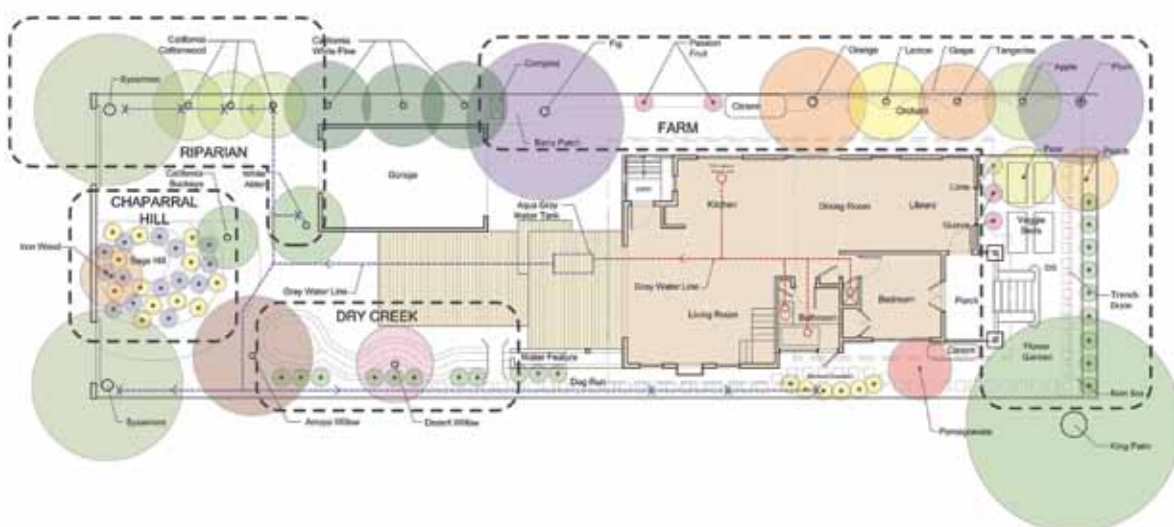


FIG. 2. Site plan showing zoning for water use and associated plant communities' locations.

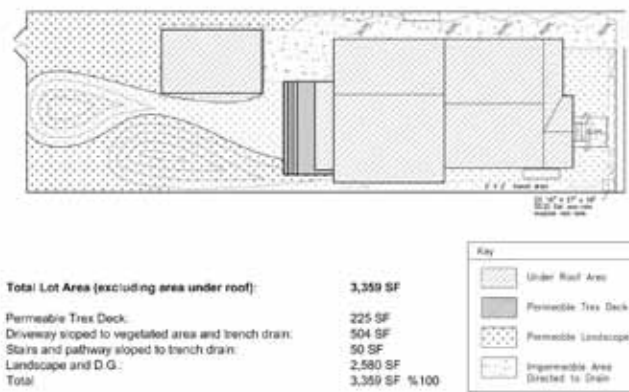


FIG. 3. Site plan for permeable surfaces and runoff flow direction. Measures were taken to infiltrate onsite and offsite runoff, such as the installation of trench drains, EcoRain boxes, and swales, the removal of concrete, and the use of Trex decking.

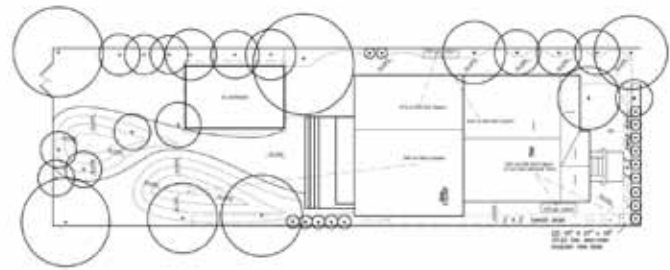


FIG. 4. Site plan for roof runoff collection. All roof runoff is directed either to a cistern or to the rain garden.

Water Management and Conservation

An overall site plan was developed early on, zoning the garden into different types of habitats, water requirements, roof runoff opportunities, and indoor water availability (Fig. 2). The entire site is designed to either allow water to permeate into the ground naturally (Fig. 3) or to be collected for reuse later (Fig. 4). The goal was to increase the efficiency of storm water/greywater reuse, introduce elements of beauty into water delivery systems, and provide habitat diversity without the need for imported water. The principals of low impact development (LID) were used even though at the time of the permitting of this project, these City of LA requirements were not yet in place.

Offsite water sources

Water sources include seasonal offsite runoff from an adjacent neighbor and the rear alley that drains four immediately adjacent, impermeable, high-density housing projects. Another water source includes all project seasonal roof runoff. Finally, the last water source is the frequently flowing greywater from the ultra-low flow interior bathroom fixtures.

Infiltration devices installed on site

Due to the site topography and the compacted soils, in the past, rainfall would be directed toward the house, and due to the elevation change, would end up collecting under the house. To eliminate this problem, the site was modestly re-graded to direct water away from the house (Fig. 5a). It should be noted that although the site was re-graded, no soil left the site in order to reduce the waste impacts. Instead, a small hill was created, specifically a landscape feature later



FIG. 5A. The site needed to be modestly re-graded to move runoff away from the house. No soil left the site. The excess soil was used to create a berm, which later became Sage Hill.

FIG. 5B. Sage Hill in the back yard is a main feature of the landscaping and was created from excess soil after re-grading the site for better surface water management.



FIG. 6A. Percolation trench during construction showing filter fabric and gravel.

FIG. 6B. Percolation trench during a rain event before it was filled with gravel and landscaped.



FIG. 7. The original driveway was retained for bike riding and skating but 4' of it was removed for better infiltration and to plant the fruit trees and perennials.

coined Sage Hill (Fig. 5b). A gravel-filled trench drain and several Eco-Rain boxes were installed along the west and front property lines to direct water away from the house toward the front of the property where it could be infiltrated (Fig. 6a and b). On the rear east side of the property, a swale was created and planted with trees. On the front east side, the concrete from the original driveway was cut out and vegetated with fruit trees and perennial herbs. (Fig. 7) These measures were taking to infiltrate onsite and offsite surface runoff.

In order to infiltrate runoff from a portion of the building, an 850-gallon rain garden was installed in the rear yard to collect runoff from 34% of the roof area. This rain garden is landscaped with California native plants, which enjoy seasonal drenching (Fig. 8a–d). There is also a lovely waterwheel sculpture and fountain that slows the water down and makes an artful statement before the water disappears into the garden (Fig. 13a and b). Trex decking and decomposed granite (DG) were used to allow for infiltration on outdoor walking and entertaining surfaces.

Water collections—Cisterns, first-flush diverter

Two cisterns were installed that together collect 800 gallons of rainwater. These cisterns collect the 66% of the roof runoff that the rain garden does not infiltrate. One cistern waters the fruit orchard using a manually operated gravity-feed drip irrigation system (Fig. 9). The other serves as a seasonal fish habitat and a flower garden. Both cisterns and their accessories (first-flush diverter, rain chains, and downspouts) are artful and positioned for functionality and visibility.

A first-flush diverter was created that would be prominently displayed and oversized (Fig. 10). This device is placed on the downspout to divert the first several gallons of rainwater away from the collection container, to overflow into the adjacent vegetation. The initial water is dirty from roof pollution, bird droppings, and other loose matter. The design works in such a way that heavier material will drop straight down into the diverter instead of the cistern. The standard ones available are uninteresting and often made of vinyl. A beautiful custom-built device was created that is integrated into the downspout and cistern collection area. It is highly visible so as to be used as an educational example, showing how it works to all who visit the site.

The second cistern collects less water, only 300 gal., than the other but it is a living laboratory for the little people who live in the house (Fig. 11a). While it is used to water a small flower garden at the front west corner of the property, it provides learning opportunities and requires much on-going experimentation (Fig. 11b). It is an open-air cistern that provides habitat for fish, plants, and insects.

Making water visible—Rain chains and waterwheel

One of the goals of this project was to make water visible by creating and displaying artfully made beautiful water accessories, such as custom-made ornamental rain chains (Fig. 12a and b) and a waterwheel (Fig. 13a and b), in addition to the cisterns. This was seen as an important part of the site design to promote dialogue and an understanding of hydrology and watershed management.

Greywater

A greywater recycling system is connected to most fixtures in the house except the kitchen sink, dishwasher, and toilets. The water flows into a Hydotech Aqua2use tank that instantly pumps the water in a 1" pipe into the garden (Fig. 14a and b). Water flows out directly into the garden and is never stored in the tank. There is an overflow to the sewer in case of a malfunction, as well as a valve that can turn the whole greywater system off.

As previously stated, the site is organized by location of water sources, both rainwater and greywater. It is not a good green building practice to introduce water close to the house. Irrigation and moisture near the base of a house will encourage mold, rotten wood, and termites, and has the potential to undermine the foundation. Deciding where to use greywater requires careful consideration. Not only do you want the plants to be away from the house, but you need to choose plants that like the appropriate water regimen.

There are approximately seven native riparian trees that are regularly irrigated by the greywater system (Fig. 15a). Each tree is surrounded by a 1' deep by 3' mulch field and has an adjustable valve to adjust water levels (Fig. 15b). The tree species include the following: *Populus fremontii* (cottonwoods), *Alnus rhombifolia* (white alder), *Platanus racemosa* (California sycamore), and *Salix lasiolepis* (arroyo willow), plus five nonnative varieties of banana located in the banana crescent at the end of the greywater line.

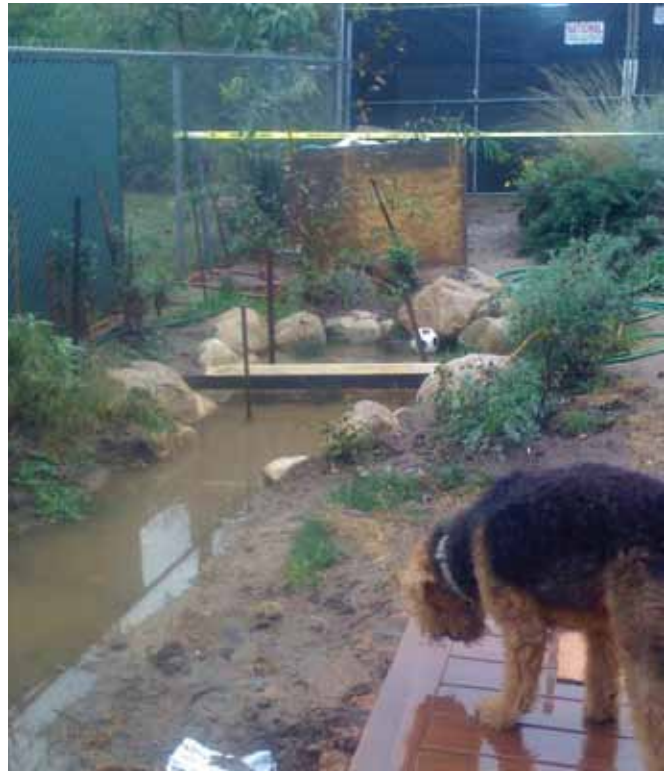


FIG. 8A. Rain garden under construction.

FIG. 8B. Rain garden under construction after a big rain event with some preliminary landscaping.

FIG. 8C. Rain garden, first winter.

FIG. 8D. Rain garden, first summer.



FIG. 9. A 500 gal. stainless steel cistern and overflow diverter positioned in a prominent location on the site to encourage discussion.



FIG. 10. The first-flush diverter collects the first rain and heavy matter to reduce pollutants in the cistern.



FIG. 11A. A 300 gal. open cistern and decorative downspout collect water for irrigation and outdoor play.

FIG. 11B. The open cistern is used to water the small flower garden, which is under an enormous, beautiful palm toward the front of the property.



FIG. 12A. An important part of the site design was to create beautiful water features to start dialogues and foster awareness about local water opportunities and constraints.

FIG. 12B. Rain chains were custom made by a sheet metal subcontractor that had a flare for the ornate.



FIG. 13A. The waterwheel is part of the storm runoff system, but also an artistic device used to draw attention to the rain and fog drip alike.

FIG. 13B. In the backyard, roof runoff from rain passes over a waterwheel into a fountain and overflows into a vegetated swale, which collects up to 850 gallons.



A Potential Water Reuse of 38,000 gallons annually for an average family of four



Aqua2use SWS2 Dimensions

Line	Dimensions (Imperial Units)	Dimensions (Metric Units)
1	18.0	457.2
2	18.0	457.2
3	18.0	457.2
4	18.0	457.2
5	18.0	457.2
6	18.0	457.2
7	18.0	457.2
8	18.0	457.2
9	18.0	457.2
10	18.0	457.2
11	18.0	457.2
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100	18.0	457.2

Aqua2use SWS2 US Dimensions

Aqua2use SWS2 Pump Performance Curve

Aqua2use SWS2 Pump Specifications

Line	Dimensions (Imperial Units)	Dimensions (Metric Units)
1	18.0	457.2
2	18.0	457.2
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100	18.0	457.2

The Answer for Graywater Reuse

Matala® 3D Progressive Filtration Technology Proved in more than 40 countries



FIG. 14A. The Hydrotech Aqua2use system instantly pumps greywater into the garden.

FIG. 14B. The greywater tank before hookup to the sewage system.



FIG. 15A. Twenty-three trees have been planted on site for erosion control, to reduce the heat island effect, and to provide habitat and food for the residents and critters. Seven of the trees are irrigated several times daily by the greywater system.

FIG. 15B. The greywater valve at each tree is very wide to allow particles to flow without clogging the pipe.



FIG. 16A. The vegetable garden is located in the front yard for easy access, to promote dialogue with neighbors, and for the sharing of food.
FIG. 16B. The veggie garden is the only garden that requires regular hand watering.



FIG. 17. A tree house made with recycled wood lath and pallets, next to a young fig tree and the berry patch.

Habitat

Plant communities found on the property are native chaparral, riparian shrubs/trees, a fruit orchard, a berry patch, a banana crescent, and a vegetable garden. The backyard is a formalized version of the natural world where native plants are aesthetically pleasing and serve a function—conserving water and providing sustenance for native organisms. One cistern collects rainwater used to irrigate the fruit orchard and the other is an open-air cistern with a habitat for fish that subsequently irrigates the cut-flower garden. There is a vegetable garden in the front yard that encourages discussions with neighbors about growing organic food while building community spirit and sharing food (Fig. 16a and b) At the top of the driveway, next to the garage, concrete was removed to build a tree house (more like a lifeguard tower; see Fig. 17). Next to the tree house, a fig tree was planted with berry vines under it, so one day the tree house might actually have a tree in and/or near it. In the backyard is a rain garden that fills seasonally with over 850 gallons of rainwater (Fig. 8c-d). Ninety-one percent of the plants on the entire property are native plants that are drought tolerant and thus rarely need to be watered. These plants also provide a critical habitat for native fauna and insects that exotic plants do not (Fig. 18a and b).

There are approximately 106 species of butterflies in Los Angeles. Eighty-five of those species require native plants to survive, based on centuries of co-existence and species interactions. The same is true for birds and insects. To attract these native organisms, a wide variety of native species was planted. These include five types of *Salvia* and *Ceanothus*; three varieties of *Ribes*; several types of *Dudleyas*, *Heucheras*, *Mimulus*; and shrubs and trees such as *Lyonothamnus floribundus*, *Prunus ilicifolia*, *Carpenteria californica*, and wild flowers.



FIG. 18A AND B. All the vegetation in the backyard is California native. The plants attract native critters, are low maintenance, and require little water once established.



FIG. 19. Repurposed stair treads, book shelves and hand rail—wood is from the interior studs of the house.

FIG. 20. Recycled concrete countertops and repurposed Douglas fir cabinets.

Special species that were planted include *Comarostaphylis diversifolia* and *Aristolochia californica*.

Nonnative species planted for food and source food for the bees are housed in an onsite top-bar beehive. These plants include apple, plum, peach, and citrus fruit trees, borage, rosemary, many perennial herbs, and vegetables.

Team collaboration between many subcontractors was essential to the creation of an efficient water distribution system inside and outside of the home. The plumber, in tandem with the greywater engineer, contractor, and landscaper, developed an intelligent greywater distribution and overflow system, which was fine-tuned to accommodate overall landscape and specific plant requirements and flow rates.

A sheet metal subcontractor and artist collaborated with the cistern company, landscaper, and drip irrigation professional to develop a water delivery system for many different water sources. Through collaboration, the team managed to tap the expertise of each

individual, resulting in a better project and educating all the team members as the work progressed.

The Building

Energy Performance

To improve energy performance, this passive solar house has a lot of natural lighting, carefully placed windows, solar tubes, and skylights, as well as natural ventilation so that there is no need for air conditioning. Combined with high-efficiency appliances and Energy Star lighting (95% LED lights), the result is a home that is 53% more efficient than Title 24, the State of California's Energy Requirements. There is a 4 kW solar array that produces a power surplus ten months of the year.

One of the most important aspects of the green design is called QII or Quality Insulation Installation, which is a technique of properly insulating a home, thereby improving overall energy performance. This technique was used on the house, and is a requirement of all LEED-certified building, as well as Energy Star homes. It is a very

House Areas	Material	Low Emissions	Local Production
Exterior siding	Recycled content fiber cement		
Wood floor	Reused existing Doug Fir floors	X	X
Wood floor	New floor from locally demoed house	X	X
Framing	Reused existing on 80% of house		
Cement	30% fly ash		X
Interior paint	Low/no VOC		
Patio	Trex - made from recycled durable material		
Counter	Recycled concrete		X
Door jam	Made from existing 2 x 4s		X
Sealant		X	
Roofing	Asphalt shingles made locally		X
Insulation	Recycled content	X	
Shelving	Reused existing	X	
Cabinets	Made from old Doug fir	X	X
Tiles	Recycled content		
Aggregate	Local source		X

TABLE 1. List of materials used for the interior of the house

effective way to reduce leakage by avoiding the loss of air space within the fiber or smashing insulation around pipes and electrical conduits. As a result, the insulative quality of the insulation is increased. It is easy to do by a trained professional and needs to be verified by an accredited third-party green building expert known as a HERZ rater.

Materials for the Interior of the House

Materials were used in an ultra-efficient manner to reduce the need for source material and minimize waste. The stair treads, doorjamb, and bookshelves are made from laminated 100-year-old 2x4's reclaimed wood from the few walls that were removed (Table 1 and Fig. 19). The existing Douglas fir floors were restored. In order to reduce material sent off to a landfill, the old cellulose insulation was composted on site and no soil was removed from the property. In the backyard, re-grading the site to divert water away from the house created Sage Hill (Fig. 5b). High recycled-content products were selected, including the exterior siding, bathroom tiles, concrete countertops (Fig. 20), insulation, and the foundation. In total, 76 percent of construction waste was reused instead of going to the landfill.

Observations

After two years, we made the following observations.

Overall

- No rainwater has left the site since the BMPs were implemented. Additionally, runoff from the neighbor's property and some runoff from the alley and sidewalk are also absorbed.

- Grading has successfully eliminated water from collecting at the base of the house or under the house.
- Native vegetation has attracted a wide diversity of bird and butterfly species and created a great habitat for the bee population on site.

Rain garden

- The vegetated swale/rain garden has absorbed 100% of all its share of the runoff.
- Storm events that produce more than 1 ½ inches of precipitation or multiple events over the course of a couple of days create a small pond that persists for one to two days before being absorbed into the soil.

Cisterns

- While the two cisterns often overflow (into the infiltration trench drain) after the third consecutive storm event, the large rainwater cistern is empty by mid-summer when used bi-weekly to irrigate the fruit trees. The site could have used bigger cisterns, but due to space constraints, a larger above grade one was not possible. To install an underground cistern, it would have been necessary to install a pump, which due to maintenance and longevity was less desirable. The current gravity-fed irrigation system works well.

Greywater

- There is much more irrigation water available due to the greywater system than was first expected and planted for. Sycamore, willows, cottonwoods, and alders were planted at about 3–4 feet tall and after two years, they have grown to 18 to 23 feet tall due to the constant irrigation from the greywater.



FIG. 21. The plan calls for creating a street tree network to absorb air pollutants and provide shade; paving changes to increase permeability and slow traffic; and widening sidewalks to accommodate pedestrian-oriented activities.

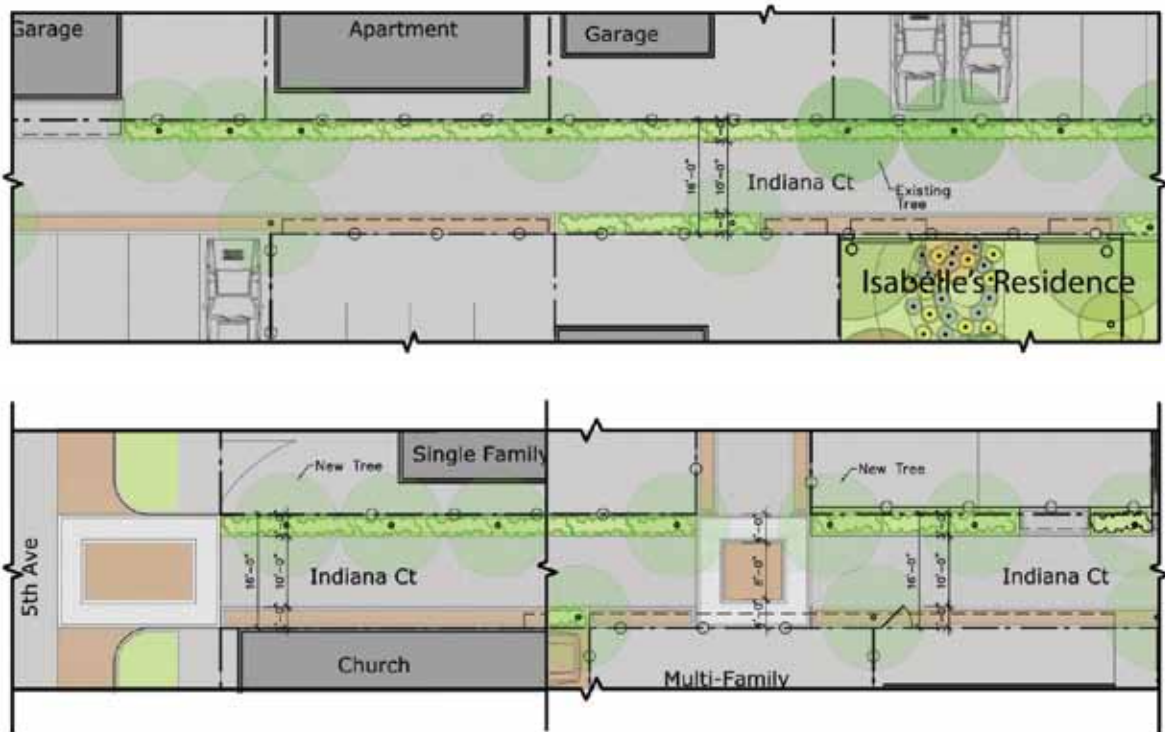


FIG. 22. The plan includes improvements such as landscaping, tree planting, permeable paving, and creating places for basketball playing, cycling, and other outdoor, kid-friendly activities.

- Additional riparian plants and the banana crescent were added to the system to use up some of the abundant water.
- Several of the finest filters from the greywater tank were removed to allow passage of coarser material.

Next Steps

With the house and garden now complete, Duvivier is looking beyond this site toward the entire neighborhood. With a group of neighbors, she plans to grow green infrastructure into the surrounding neighborhood, alleys, and street networks. She has drawn up preliminary plans to start a conversation about this with the neighbors and policymakers. This predominantly multi-family, low-income, mixed-race neighborhood is extremely park poor. There are many neighborhood children who have neither front nor backyards, and consequently a lot of activities, such as soccer, basketball, and bike riding take place in the alleys. Most apartment buildings have no views, little landscaping, and are completely impermeable, creating a river of water in the alleys during rain events. To make matters much worse, this neighborhood is under the Santa Monica Airport's flight path, dumping pollutants from the planes onto the community.

Duvivier's long-term plan is to obtain funding to create a network of green alleys that will be designed for permeability, capturing storm water, landscaping, trees, and play spaces for the community. Along Brooks Avenue, the plan calls for creating a street tree network to absorb air pollutants and provide shade; paving changes to increase permeability and slow traffic; and widening sidewalks to accommodate this pedestrian-oriented neighborhood (Fig. 21). In the alleyways, the plan includes improvements such as landscaping, tree planting, permeable paving, and creating places for basketball playing, cycling and other outdoor, kid-friendly activities (Fig. 22).

LEED Platinum—Leadership in the Built Environment

The Leadership in Energy and Environmental Design (LEED) rating consists of a suite of rating systems for the design, construction, and operation of high-performance green buildings, homes, and neighborhoods. The Brooks Residence received the highest rating, which is a Platinum LEED. A total of 109 points ranks this home within the top ten LEED-rated homes in California and the top twenty-five LEED-rated homes in the US. Both on the inside and the outside of the Brooks Residence, the architect Isabelle Duvivier demonstrates leadership by expanding the conversation on green building techniques and water reuse.

Team

Architect/Project Manager: Isabelle Duvivier, AIA, LEED AP, Duvivier Architects

Project Team: Loren Perry, Tina Hovsepian

Green Rater: Walker Wells, Director, Green Urbanism Program for Global Green USA

General Contractor: Rick Arreola, Arreola Construction

Plumbing: Best Buy Plumbing, Inc.

Cisterns: California Water Storage/California Rainwater Tanks

Gutters, Rain Chain, Waterwheel: Larry Strickland from Sheet Metal Specialists

Greywater: Scott Hey Tank LA

Cabinets: Clark Davis

Counters: Aggregate Art

Structural Engineer: David Lau

QII Insulation: Allied Insulation

Tiles: Epoxy Green

HVAC: Patrick Modugno

Solar Panels: Martifer Solar

Plant specialist: Jettscap

Tree House Builder: Karl Braunz

Deck Builder: Richard Draut

Windows: Marvin Integrity

Photography: Augusta Quirk, Isabelle Duvivier

Isabelle Duvivier is a licensed and LEED-certified architect in the state of California. She received her master's degree in Architecture from the University of California at Berkeley in 1992.

Linda Jassim received her Master's Degree in Landscape Architecture from the University of Southern California in 2005. She works as a designer and writer in the architecture and landscape architecture fields.