LEED for HOMES

The First Optimum Performance Home™

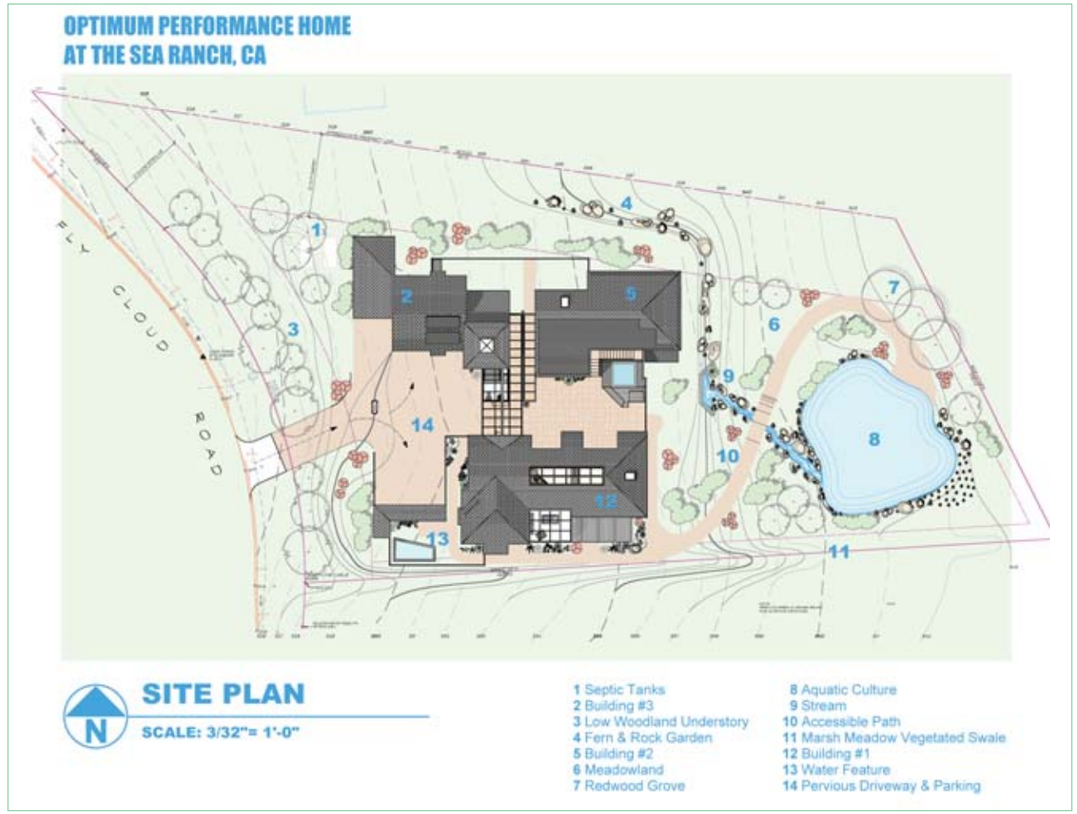
site planning part II

Gary Reber

Introduction

This is the second article in the series documenting the design and construction of the first Optimum Performance Home™. The project has been selected by the U.S. Green Building Council (USGBC) for inclusion in the national Leadership In Energy And Environmental Design (LEED®) for Homes pilot program, their new green build certification initiative. The home will be built at The Sea Ranch, located in Sonoma County along the Northern California coastline of the Pacific Ocean. The showcase project is exemplary of the "Ultimate Home Design™" concept, which integrates universal design with the best sustainable building practices while exerting minimal impact on the environment. A building science systems approach to home building is the cornerstone of the project with emphasis on the relationships between the home's components and the envelope they create. Also paramount is good stewardship—proper regard and respect for the rights of neighboring homeowners, resource efficiency, and the surrounding natural setting. The goal is to optimize occupant health, comfort, and safety; maximize energy efficiency and structural durability; and minimize environmental impact. In addition, the aim is toward providing a nurturing home environment to support independent living and sustainable lifestyles.

The home design integrates all of the concepts advocated in Ultimate Home Design™. I conceived the "Optimum Performance Home" and "Ultimate Home Design" concepts, and had a vested interest as this would not only be my home but my office as well. My goal was to demonstrate how today's products and building methods can make life safer, more comfortable, and more enjoyable. The science of optimum performance homes is about building structures that use less energy, are quieter and more comfortable, have fewer problems with materials degradation, provide clean air and water, and do less damage to the environment. As an integrated holistic design, the house will serve as a home for many people and serve in many phases in one's life.



The site plan for the Optimum Performance Home at The Sea Ranch showing the relationship of the three-building compound to the site

A Case Study

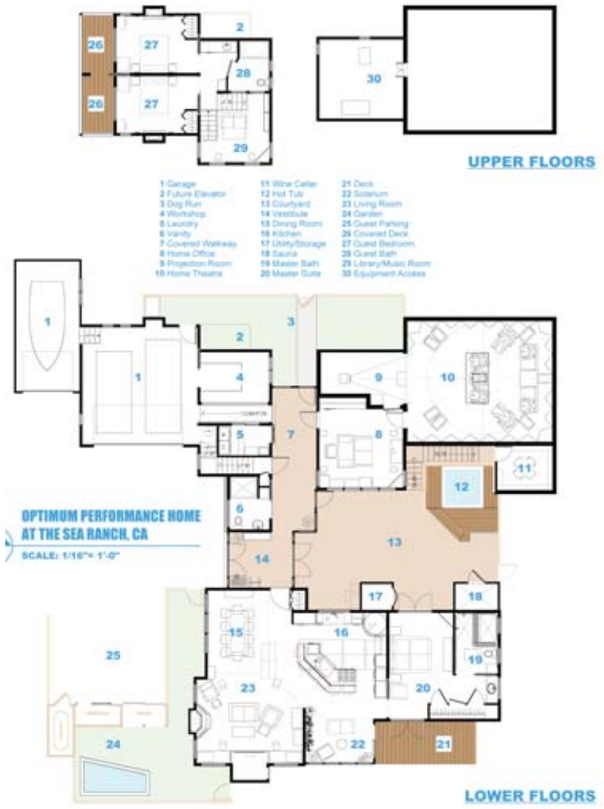
The approach I am taking with this series of articles on designing and building the Optimum Performance Home at The Sea Ranch is to present a case study, which details every phase in the design and building of this home project.

For our readers who have not personally experienced such a process, I believe that this serialized documentation will be enlightening and beneficial to approaching your own home design and building project (see "The Architect's Role As Designer And Implementer"). Of course, this is our

"The single most important element in the design and construction of a home is the actual site, as the natural environmental factors dictate how your home should be designed and built, and how it should be situated."

Synopsis

- *Site-specific design and construction lay at the very heart of sustainability.*
- *Sustainable site design is an approach to the land, beginning with an understanding of the important natural resources of a site, the impacts of the proposed project, and a philosophy that seeks to first reduce impacts and then to mitigate impacts through better design.*



The floor plan of the Optimum Performance Home delineating the three-building compound arrangement and covered walkways

experience and not all aspects of our approach will apply to your project. Nonetheless, there will be aspects of our approach that will be educational and useful. I hope that, as a result, you will be rewarded with a better appreciation of the extent of commitment necessary to successfully design and build a new home.

Please understand that this is a real-life project scenario and that to date we have yet to break ground and lay the foundations. Therefore, expect that some issues of *Ultimate Home Design* will have more coverage of this project than others, depending on the construction stage we are in at any given time over the course of the next year.

Space Design

In designing the Optimum Performance Home at The Sea Ranch, we had to analyze the activities that my wife Marlene and I engage in. Both Marlene and I are active in our companies and our home needs to reflect our personal needs and requirements, as does yours.

Accordingly, a good home design may include inside and outside spaces, big and small spaces, and shared and individual spaces. It will also incorporate a transition, hopefully smooth, from more public space, like entries and foyers, to semi-public space, like living rooms, to private space, like bedrooms. The bottom line is that home design is really all about spaces and how they are integrated together. The quality of your activities, and thus, really, your life, are affected by the qualities of the spaces in which they occur. Defining spaces includes analyzing the size of the home, orientation, and degree of privacy.

There is always an area or size of space that works and feels best, both functionally and psychologically. This is where personal needs and requirements play a major factor in the design of a home. What works for one person may not necessarily be optimized for someone else.

Design Committee Oversight

At The Sea Ranch, a Design Committee, appointed by the elected Board of Directors of The Sea Ranch Association, a Common Interest Development, has, in essence, the "authority" to regulate house size and bulk. As it turns out, this issue was central to the numerous denials that we encountered throughout the design review process for this project.

The early designs attempted to organize the interior spaces within a single structure to reduce cost of construction. However, as such, the size of those early designs appeared to the Design Committee to be out of character with the size of existing homes in the "neighborhood" designated by the Design Committee. Therefore, the Design Committee required that a neighborhood bulk study be prepared for preliminary design review in order to identify the challenges that most likely exist in making the home we desired an "appropriate fit" to the neighborhood.

Along with the submittal of a neighborhood plot plan indicating the approximate location of any improvement on neighboring lots and the relation to our lot to undeveloped lots, we concluded that our proposed home would be screened from the frontage road and from view of the four existing homes within the 300-foot perimeter of our property in our designated neighborhood. The requested neighborhood bulk study indicated that two of the houses in the "neighborhood" are of virtually the same gross building area or bulk as our proposed home project.

In order to further reduce apparent visible size and bulk, we adopted the Design Committee's recommendation to organize the desired spaces into a compound concept. This approach pleased the Design Committee because the overall mass of the proposal was now broken up into components and grouped around a central vestibule and courtyard. The downside to this more spread out arrangement is that this resulted in a significant increase in square footage, with the footprint appearing much larger than the neighboring homes.

While the larger compound mass also would require the removal of most of the existing trees on the property and removing some of the natural screening that might shield the home from view, in actual fact the non-indigenous pine trees on our lot were already in a diseased state and susceptible to wind-throw damage and fire. When The Sea Ranch was first chartered in the 1960s, it was planted over by the developer with stands of non-native Bishop Pine (*Pinus muricata*) and Grand Fir (*Abies grandis*), as well as Douglas Fir and Redwood, which are native and suitably adaptive.

As it turned out, the Grand Fir and Bishop Pines were particularly susceptible to wind-throw. Already senescent and damaged by beetles, most of the large pines on the site had been toppled by winds that exceeded 70 mph in November of 2003, leaving a helter-skelter pile of logs up to three-feet high in diameter and great tangles of slash. The remaining few were hazardously off-camber and in bad shape and had in fact been marked by our arborist consultant for removal. Opening up the grounds thus became the first step in stewardship and restoration, to be followed later by a vigorous planting of native species. The slash from the tree removal has been chipped on site and stockpiled for use both in erosion and silt control during construction and as protective landscape mulch during the regeneration of the native landscape to come.

The compound approach confirmed for us that added "perceived" building mass would result, in large part due to the necessity of roofed passageways and glass-enclosed walkways to interconnect the garages, home office/home theatre, and living spaces. This would also substantially increase the cost of construction. However, the implementation of using linked interior spaces allowed us to create a desired courtyard defined by the three-building compound and other outdoor spaces that enhance the aesthetics of the setting.

At this point in the process, after three denials, the Design Committee further required that we prepare a bulk analysis of the existing homes in the designated neighborhood before proceeding with further design development. The study would be necessary to determine the appropriate maximum size for the home to appear that it "fits" into the "neighborhood." This recommendation was alarming since it appeared on the surface to suggest that the size of the home would be limited by the biggest house size in the neighborhood. This was the first indication to us that we could be limited in the size of our home regardless of our personal needs and requirements. This was somewhat disheartening, given that we had no indication that this type of limitation existed when we purchased the property and began the process of designing our home. At the time of purchase, no documentation was provided, nor was a representation made by the previous owner and his real estate agent that in any way suggested the possibility of such a limitation. Moreover, this was NOT communicated to us in the previous denial letters from the Design Committee, and certainly should have been. Furthermore to a certain extent, it contradicted the original comments from the Design Committee, stated in writing in the initial review of the conceptual submittal, specifically: "This is a large house due, primarily, to the inclusion of the [home] theatre facility. This in itself is not a problem, but the formal quality of the plan and the three-dimensional form combine to give an impression of a very massive building." All told, we stumbled through the design review process and could have benefited from some clear guidance, especially from the start.

To further address the reduction of apparent size and bulk we explored methods to reduce both numerical square footage and visual bulk, which included tightening up interior spaces to be functional, not excessive. As a result, we were able to reduce the total building bulk from 5,046 to 4,304 square feet or a reduction in bulk size of 742 square feet or 14.7 percent. Overall, the lot coverage total building footprint was significantly reduced from 15.2 to 13.5 percent with total lot coverage reduced from 24.2 to 18.8 percent (well within stated Sonoma County guidelines in which the total lot coverage is not to exceed 35 percent). We also revised the roof plan to significantly reduce apparent bulk.

In the final approved design, after a three-year-plus design review period, there is no way to determine that this is a large home by simply viewing the screened southwest and northwest exterior from the frontage road, which is to the west. The

home's primary living spaces are oriented to the east, west, and south, and benefit from the penetration of the sun into and around the three-building compound. Our solution provides privacy and an inward oriented, sunny environment, with distant views of the Pacific Ocean from selective interior and exterior perspectives. The site-specific design and structures are integrated to the land and its natural context and, in terms of its relationship to existing residences, the home is so situated that the other homes in the "neighborhood" are, in fact, more exposed from the road than our proposed home, even though ours is larger.

Prior and throughout the design review process, we had assumed that the community would foster maximum individual flexibility and freedom of individual expression while maintaining the architectural quality of The Sea Ranch community and thereby uphold property values. As we understood it, that was a central premise of The Sea Ranch. As such, the Optimum Performance Home represents a different approach than that used in the design and building of other homes on The Sea Ranch. Part of this relative departure is the comprehensive inclusion of all of the techniques of sustainability and green building that have more recently been developed, especially through the impetus of the USGBC's LEED program.

Then too, our proposed green build home at The Sea Ranch has always been looked upon as a family heirloom to be passed on to younger family members. Ours would be an owner-built home and a family building project designed with the intent to serve as both a nurturing habitat and an inspiring environment for at-home creative and productive work.

Natural Environmental Factors

The single most important element in the design and construction of a home is the actual site, as the natural environmental factors dictate how your home should be designed and built and how it should be situated. In particular, the climate conditions at the site and the home's thermal response to these conditions play a critical part in the home's overall level of comfort.

Site plans are as important as home plans, especially at The Sea Ranch, which seeks to preserve the natural coastal environment. At The Sea Ranch, communing with nature is as important as community. The plans for the Optimum Performance Home embrace the desire to minimize the impact of building on the site.

Site-specific design and construction lay at the very heart of sustainability. Sustainable site design is an approach to the land, beginning with an understanding of the important natural resources of a site, the impacts of the proposed project, and a philosophy that seeks to first reduce impacts and then to mitigate impacts through better design.

The design factored in the site-specific characteristics of the nearly one-acre lot. The home is designed to optimize its relationship to the natural environment and climate, and to collect just enough passive solar radiation emanating from the southern exposures to heat the home through a cool clear winter day—yet not overheat it. The site has an approximate eight-degree western slope with a mixed woodland shelterbelt to the east, north, and west. The morning sun will warm the waking home from the east—from sunrise until late morning. As the sun moves southerly at higher midday angles, it will fully activate the solar system on the south-facing roof of the home office/home theatre portion of the home. The southern sun also will provide an infusion of bright, natural light through the solarium into the kitchen area, as will the roof-ridge skylights. And when the mid-to-late afternoon sun tries to beat on the west wall of the dining and living room, the vegetation to be planted to the west to screen the home from the road will intercept it. The effect of interaction between the microclimate and the regenerative native landscaping will be to cool the home with shade and ventilation. In addition, the design of the buildings and their orientation on the site is intended to make use of the prevailing afternoon breezes coming off the nearby Pacific Ocean.

Home Positioning

Orientation relates to the optimum positioning of the home to passively provide the natural environmental conditions necessary for daylight activities. The master bedroom suite will have French doors that will allow light in from the east as the sun rises. Another set of French doors on the west side of the suite will enable cross ventilation when both sets of doors are open. But, with the exception of a few days per year, the overall net building requirement will be for heating rather than cooling. During the day, the southern sun will provide solar gain and ambient light to the home office, kitchen, and solarium. The south-facing glazing will be incorporated specifically to reduce the home's annual heating bill. Insulated low-E glass, selective coatings, and a rigorous attention to insulation and the mass of various building materials will optimize passive solar heating and overnight thermal retention and stability.

Though part of a well-planned community, the home is also designed for privacy—from the road and from neighbors. Carrying this through to the overall design, the interior spaces are also organized to provide personal privacy when so desired.

Placing the home to optimize privacy from the road, and yet provide the safest entrance and exit route and meet fire codes, is an important consideration. But equally important is providing for the contribution that impervious pavement makes to watershed degradation. To address this, the pervious surfacing of the driveway and garage entrance and guest parking areas, as well as the walkways around the home and grounds, are designed using pervious surfacing methods to retain all potential runoff in the immediate watershed.

During excavation, the very fertile layer of topsoil that makes up the upper foot of the soil profile will be preserved and then used for landscaping with native plants, thus preserving some of the very valuable natural capital of the land. Natural buffers in the form of native fire-adaptive redwoods, riparian uplands plants, and understory or meadow habitat bushes, flowering plants, ferns, bulbs, and trees will provide privacy and acclimatizing influences, while making use of the opportunity to flourish due to the unique hydrology of the site. A watershed management plan (See "Site Treatment") will be implemented to preserve this aspect of this particular site while protecting the actual building itself from the negative effects of too much moisture.

The landscape plan is designed to take advantage of sun, shade, and wind to make the home more comfortable, reduce heating and cooling loads, and stabilize indoor temperatures. The home's solar-integrated roof faces south to optimize electrical energy generation and complement the passive solar heating/cooling benefits derived from the home's orientation.

DESIGN
optimum performance home

Site Preparation

When Marlene and I first considered the purchase of this particular vacant lot at The Sea Ranch, it appeared to be a dense, dark, overgrown lot, with evidence of large and damaged trees and thick brush. The potential was, however, quite different with the result being a sunny meadow landscape, once the invasive overgrowth was removed. The lot also favored three levels of views—controlled, local, and expansive. Controlled views look into a courtyard or a prepared place on the property, which we will maintain. Local views look out onto nearby land we either don't own or won't attempt to maintain such as adjoining properties and commons, which are maintained by The Sea Ranch Association. Expansive views go out to infinity and include the Pacific Ocean and "big sky" views. The lot is beautifully situated on the western slope of the forested coastal foothills of the coast range, with distant views of the Pacific Ocean. This potential and the otherwise favorable view perspective and gentle slope and even topography of the lot were the deciding factors in our decision to purchase the lot.

The Sea Ranch design review process entails four stages. The first is a site visit and evaluation with the property owners by a staff representative in the Department of Design Review & Environmental Management serving the Design Committee. This is followed by a review by the Design Committee of the conceptual plans, which define the character, size and bulk, and the specific relationship of the home to the site and to the other homes in the designated "neighborhood." The determining stage is the review of preliminary design, which details all of the elements approved by the Design Committee in the conceptual stage. Once the preliminary plan has been approved, the final stage is the construction plan review and approval. This stage details how the home will be constructed in accordance with the approved preliminary plan. Following Design Committee approval, the set of construction plans must be approved by the Sonoma County building department before a permit to build will be issued.

Over the course of a two-and-one-half-year period we had six denials before our preliminary plan was approved in June 2005. Our construction plans were approved by the Design Committee in January 2006 with the stipulation of certain design modifications and approved landscaping. We are now in the plan check and approval phase required by Sonoma County, prior to the issuance of a building permit. We expect to break ground in March with the installation of the French drain system and grading of the building pad to accommodate the foundations.

During the fourth conceptual plan review submittal prior to the preliminary review submittal, the Design Committee required us to retain an arborist, a professional tree and forestry expert. We retained arborist Ed Tunheim, who prepared a full report on the status and health of the trees on our lot. The report confirmed our earliest assessment of the deteriorating condition of the trees at the site—virtually all of the trees were diseased or hazardous and required removal, including those that otherwise would have to be cleared to accommodate our project.

At this same time, the Design Committee expanded the geographical size of the declared wind-throw danger area that abutted our property to formally include our lot. A wind-throw danger area is an area in which shallow-rooted trees, such as pines, are subjected to

The series of images depict the various stages of site preparation from the raw state at the time of purchase to the initial felling of trees.

severe wind damage, including toppling and are recognized as a potential hazard to surrounding improvements and people, and a fuel to spread fire.

While our arborist's report identified numerous diseased and hazardous trees to be removed, including trees endangering the regional power lines occupying an easement on the north side of our property, no immediate action granting hazardous tree removal was taken by the Design Committee. Unfortunately, in late December 2004, one of our trees took out the power lines, resulting in a power failure on much of The Sea Ranch and south coast over an 11-hour period. As a result, the power company took action and felled several marked trees that remained a hazard to their lines. A month later the Design Committee granted our application for hazardous tree removal, which was previously denied on the basis that arborist reports are typically reviewed in concert with the preliminary stage building stakeout and permission to remove issued at the time of a secured construction permit.

At this point, we retained John Eaton, a general engineering contractor based in the area, to fell the remaining tagged trees and dense brush identified in the arborist's report. A few trees remained that were tagged but we have decided to fell them nearer the time the lot would be graded and prepared for putting in the foundations. Several native myrtles and madrone were carefully preserved during the tree and brush removals.

As our lot is now officially part of The Sea Ranch declared wind-throw danger area, we have become subject to a neighborhood revegetation program. We have complied with the recommendations for planting indigenous plants native to our "zone" as prescribed in the Neighborhood Landscape Management Plan and will commence planting soon.

A requirement of building a new home is an analysis of the soil conditions that will impact the type of foundation necessary, determine the presence or absence of ground water, and, if there is no sewer connection to the property, the site's suitability for a septic system.

In the case of our lot, the soils analysis performed by Dimensions 4 Engineering, based in Santa Rosa, California, indicated that, while we had suitable soil structure, the presence of perched ground water five to six feet below grade would not support an on-site septic system. Thus, The Sea Ranch Department of Compliance &

Following the felling of trees and cutting of brush, the debris was then burned and the senescent and damaged pines that were cleared were stockpiled at the site to be chipped, so no bare ground will be left exposed after construction.

Environmental Management granted us a reservation for the use of a portion of The Sea Ranch commons for the location of our proposed off-site septic system's leach field. This would mean that the home itself would be served by a water-tight septic tank to remove solids and digest them over an extended period of time, but that the clarified effluent instead of flowing to an adjacent leach field, would have to be pumped offsite to a site on The Sea Ranch commons.

Next, we retained BACE Geotechnical, based in Windsor, California, to perform the soils analysis and geotechnical engineering services to determine the soil's structural capabilities, and determined that the soil could support standard concrete slab foundations. This information was also used to prepare the site grading and water management plans.

Bill Wilson, who is a principal Environmental Planning & Design, LLC, based in Mill Valley, California was retained as our site development and water management planner. UHD

The Author

Gary Reber is the President of Ultimate Home Design, Inc. and the founding Editor-In-Chief and Publisher of *Ultimate Home Design* magazine. His diverse background in several fields includes an undergraduate, graduate, and postgraduate university education in architecture, community planning, and economic development planning. For years he was a consultant on community and economic development planning. For the past 15 years he has been an editor and publisher of magazines in the consumer electronics field. Gary can be reached at 951 676 4914 or gary@ultimatehomedesign.com.

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Ed Rose is a residential architectural designer. His company is Rosebud Studios, based in Monte Rio, California. Ed provided all of the images of the site plan, floor plans, elevations, and isometric perspectives. Ed can be reached at 707 865 1146 or rosebud@thegrid.net.

Ed Tunheim is a arborist and consulting forester, based in Cazadero, California. Ed can be reached at 707 847 3761 or 707 847 3114, or tunheim@mcn.org.

John Eaton is a general engineering contractor, based in Point Arena, California. John can be reached at 707 367 1894 or johneaton@saber.net.

Architectural Illustration & Photo Credits

Ronald Devesa is an architectural illustrator, based in Santa Rosa, California. He specializes in architectural rendering and CAD drafting using AutoCAD, Autodesk VIZ-Maxwell, and Photoshop. He is a member of the American Society of Architectural Illustrators. Samples of his work can be viewed at www.geocities.com/rldevesa. Ronald can be reached at 707 849 3500 or rldevesa@sbcglobal.net.

Scott is a pilot and aerial photographer. His company is West Of One, based in Gualala, California. Scott resides at The Sea Ranch and provided the aerial photos depicted in this article. Samples of his work can be viewed at www.westofone.com. Scott can be reached at 707 785 9445 or scott@westofone.com.

The First Optimum Performance Home™
site treatment

Bill Wilson

Synopsis

- ***The hyrologic plan intercepts the water that moves across the site, transfers it around the house, and returns it, through infiltration chambers, to the natural hydrology in front of the house, using a pond as a stabilization feature on the whole system.***

The site for the Ultimate Performance Home at The Sea Ranch is a gently sloping property with an open west and southwest exposure. At the time that the roads were put in by the original developers of The Sea Ranch in the 1960s, shallow-rooted non-native pines were inappropriately planted over major areas, including over this site. Over the ensuing 40 years, the trees have matured and become quite large. Then, during November of 2003, unusually heavy winds, with gusts over 90 miles per hour, swept through and knocked down hundreds of trees, including ones on this site. The site is now part of a declared wind-throw danger area, which encompasses several adjoining properties, all impacted.

As a result, many major trees at the site were marked by the regional arborist and taken out, and the underbrush was cleared in the process. The following rainy season began with above average levels of precipitation in October of 2004, and followed up with over 45 inches of rain, with consistent events stretching into June of 2005. Because of this, field observations and geotechnical borings were able to develop a good picture of the site's hydrology.

Particularly poignant was the large root crater left when a three-foot diameter pine toppled over. (Even though it was not raining at the time, the hole filed with water, and remained full until the tree was cleared and the "divot" filled.)

In addition to the shallow groundwater that was indicated by the tree crater, there was also sheet flow taking place along the southern property line, an open, well-vegetated meadow at the edge of a thicket of willows that backed up the property. The sheet flow of infiltrating water originates on the property adjacent to the project property to the south, and crosses onto the project property.

The environmental and geological investigation confirmed that a thin sheet of groundwater was present at the interface boundary between the terrace soils and the bedrock siltstone underlying the site, about five feet below grade across the planned home site. A curtain drain was recommended to intercept the groundwater and pipe it around the location of the home.

Instead, an analysis of the grading plan for the house pad and of the hydrology of the entire site was made, and a plan evolved that will protect the actual building site and foundations but maintain the unique watershed characteristics of the seasonally marshy meadow.

A hyrologic plan has been developed to intercept the water that moves across the site, transfer it around the house, and return it, through infiltration chambers, to the natural hydrology in front of the house, using a pond as a stabilization feature on the whole system. This should effectively address the movement of water from the neighboring property across the site, providing a dry pad, while at the same time maintaining the existing natural hydrology.

Following the environmental assessment of the lot and surrounding area, and the geological investigation, and in concurrence with the project geologist, it was decided that due to the hydrological regime of the site it would be extremely challenging to construct an earth-banked building and insure that it would remain dry and sound over time.

Instead, a sloped bank to the rear of the house will not be retained or faced in any sort of formal way, but will rather be incorporated into the landscape plan and intermittently spotted with natural boulders. Native ferns, rhododendrons, and bulbs will be planted in between the "randomly" placed rocks. Because of the moisture in the area, this should produce a lush natural transition from the house pad to the natural landscape behind the house.

The grading and drainage plan is integrated with the landscaping plan to take advantage of the site's lush potential

DESIGN
optimum performance home

to serve as a repository for plants that thrive with more moisture, and to enhance habitat values. An excavated pond was also designed to intercept and manage the sheet flow and possible spring that crosses onto the back of the property from the neighboring lot.

Some of the features of the integrated site plan include:

• **There will be an excavated pond at the rear of the property, with a volume of approximately 50,000 gallons.** The pond can be constructed completely by excavation and does not require a berm or constructed dam. The four- to six-foot deep 45-foot basin will be over-excavated by about a foot, and sealed by Seepage Control. The Seepage Control system utilizes a vegetable-derived polymer mixed with a foot of soil to seal the pond. This is more effective than a liner in many applications. Thus, the polymer will be mixed with the native soil and compacted to form a foot-thick natural impermeable soil liner. The pond will then be filled and landscaped with important and interesting native plants, including rushes and reeds, bulbs, and aquatic plants.

• **A horizontal drain made up of strips of a unique drainage product, Smart Drain will be installed above the pond to wick the sheet flow from the adjacent lots into the pond.** Smart Drain is a versatile product consisting of thin strips of plastic pipettes that create capillary draw and remove excess moisture, while leaving non-saturated soils with the moisture needed to support plant life and soil ecology. The horizontal drain will act as a virtual spring box to recharge the pond.

• **A level control adjustable weir device will allow excess water coming into the pond to overflow.** The water being discharged will actually be drawn through a bank of infiltration chambers buried in gravel on the bottom of the pond. This design keeps aquatic life from being discharged, and tends to pull oxygen down through the water column. The excess water will be conveyed by a buried pipe to a chamber in front of the home, dubbed the "water handler," which will manage excess flows from the foundation drains and from the roof catchment cistern as well as from the pond.

• **All drainage systems require an overland flow route in case installed drains and pipes become blocked, and a shallow vegetated bioswale already exists along the southern property line.** The only problem with it is that it veers into the actual area that will contain the house pad as it approaches the lower front of the property. To correct this, an existing vegetated swale is to be adapted to continue down the sideline and fan out along the frontage. This will require no changes or grading on the neighboring property to the south of the project property.

• **A gravel beach is a feature of the southern side of the pond, adjacent to the swale.** This will serve as an overflow filter and spillway for the pond should the level control slider box become blocked for any reason. By depressing the gravel beach a few inches below the lip of the pond, and carrying it out to the swale shoulder, excess water will actually bypass the pond when it is full, should the weir become blocked.

To reforest the site and replace the downed pines, a semicircle of redwoods is planned for the northeast corner of the lot. Redwoods are the appropriate native overstory, as they are deep-rooted and fire-adapted. In addition, they can take up significant amounts of excess soil water and act as a sort of curtain drain above the pond, helping to mitigate the perched groundwater. Additional screening trees and bushes are planned for the area along the power line right-of-way to the north of the house site.

• **Because it is anticipated that the pond will actually receive a surplus of water from the various inputs, the pond will also serve as a reservoir for the landscaping around the finished home.** A one-foot draw down of the pond will yield approximately 12,000 gallons, or about enough water to irrigate a quarter of an acre of turf for a week. The native landscape planned for the project will require significantly less.

• **The pond will also serve as an emergency water source in the event of a fire.** A draw down pipe will connect the pond water to a front-of-house connection for a pump to provide pond water to a fire hose.

• **An analysis of the elevation of the bedrock (and hence the perched groundwater) showed that the grade cut for the house pad would actually intersect with the bedrock at the rear of the structure.** Aside from greatly reducing the cost of the rear footing, this meant that the deep curtain drain anticipated by the geotechnical report could be substituted with a shallow French drain and foundation drains.

• **The French drain is designed to be cut a minimum of one foot into the bedrock and to wrap around the rear of the house pad.** A slotted drain pipe is to be placed low in the drain trench and will pick up any groundwater that is migrating along the bedrock boundary. The slotted drain pipe will continue into a solid drain pipe and terminate in the "water handler" basin in front of the home.

• **Roof runoff will be harvested by rain gutters over most of the eaves and valleys, and directed into a cistern placed beneath the central courtyard.** After passing through sorbent filters to remove any sediment and impurities, the clear rainwater will be

stored to provide natural soft water to the outdoor showers, heated by a demand-type tankless water heater. Overflow from the cistern will also go to the "water handler," via a drainage pipe.

• **Instead of constructing retaining walls to accommodate the grade changes brought on by the pad cut, a sloping side cut returning up to the natural grade was chosen.** The side-cut will be landscaped with boulders and rock in a naturalistic layout and densely planted with ferns, begonias, and rhododendrons, with a variety of the more moisture-loving natives and bulbs.

• **The "water handler" is designed for the front of the property to act as a distribution basin for all of the various inputs of excess site water, and to reintegrate it back to the native hydrology.** The "water handler" consists of a 30-inch diameter ribbed section of PVC storm pipe, with a sealed bottom and a bolted, gasketed lid, buried vertically and plumbed with influent lines from the pond level control weir, the French drain, and the overflow from the cistern. A pump and control system will send drainage water from the French drain up to the pond to replenish the pond water level during dry periods, as necessary, and to top up the water features at the front and back of the home. The water handler also includes an overflow line that leads to a band of infiltration chambers that will be buried across the entire frontage of the property.

• **A line of infiltration chambers is designed for the lot's frontage.** The infiltration band is designed as a trench with half-domed StormTech chambers buried in gravel and a foot of native soil. The trench bottom will be dead level, across the front of the property, with the intention that even large amounts of wet season runoff and groundwater that have been interrupted by the insertion of a house can be returned to the groundwater once past the house.

• **In case the volume capacity of the infiltration band is exceeded, a second set of chambers is designed for the lowermost corner of the lot (the northwest), several feet lower in elevation than the main infiltration belt.** This shorter set, though installed the same way as the upper band, will receive any excess water via an overflow pipe and either infiltrate it or, if no further capacity exists, exfiltrate it along the topography line, where it will sheet-flow through mulch and groundcovers and rejoin the natural drainage.

Permaculture Regenerative Planting

Other integrated elements of the drainage and landscaping system include a permaculture regenerative planting of the property, featuring an overstory of redwoods on the northeast side of the lot, a middle story with screens of madrone, wax myrtle, dogwood, and California bay laurel, an understory of rhododendrons, azaleas, ferns, and flowering shrubs that support birds and butterflies, and groundcovers of mimulus and pennyroyal.

The senescent and damaged pines that were cleared were stockpiled at the site to be chipped, so no bare ground will be left exposed after construction, and the mulch can also be used as a temporary site control during construction to prevent the discharge of sediment. Native grasses and groundcovers, as well as at least four varieties of ferns found at the site, are being collected and propagated for reintroduction after construction.

To minimize the use of increasingly valuable potable water, no landscape will be irrigated with imported water. The plumbing system and fixtures planned for the home are being carefully selected, and it is anticipated that water consumption will be reduced by at least 40 percent, compared to comparable fixture selections that comply with the benchmark EPACT '92 designations for toilets, showers, and baths.

Septic System

The Sea Ranch, for the most part, uses individual septic systems to handle wastewater. Though frequently maligned as a primitive and even polluting wastewater treatment method, a properly designed and installed septic system is actually an effective method for treating sewage if certain parameters are met. The tank itself must be absolutely water-tight, though in actuality few tanks installed more than a few years ago actually were, and all too many currently being installed either leak or take in groundwater. The tank must also be an effective size and shape—generally, length is important, since travel distance from inlet to outlet has the greatest effect on effluent quality. The effluent pipe should also be equipped with a device known as an effluent filter, which blocks fine particles from leaving the tank. And finally, the tank should have accessible access ports to the surface that are also water-tight, to allow for inspection and maintenance.

If these basic design criteria are met, it is possible to get a clear water effluent from a septic tank that approaches the discharge quality of many municipal wastewater treatment facilities. This water is then conveyed to the leach field, where soil and soil organisms complete the polishing of the effluent and return it to the environment. Under the best of circumstances, the water is available to trees and plant root systems.

Since this lot has shallow groundwater, the septic tank effluent will have to be pumped to a commons and the leach field installed there. This allows for the installation of a programmable timer on the pump controls and the gradual draw-down of a day's effluent in small doses. By intermittently dosing the leach field in this manner, small volumes of effluent can be sent to the leach field and be allowed to dissipate by capillary action, with resting periods between doses. This method optimizes the ability of soil systems to polish septic tank effluent.

Gray Water System

Because of the shallow groundwater, and the seeming availability of sufficient site water to maintain the landscape, a gray water system may be superfluous. Nonetheless, the home will be plumbed for gray water, bringing the waste lines from the laundry, sinks, showers, and baths to the building perimeter in parallel with the waste line from the toilets and kitchen. Once outside the building foundation, the two waste lines can be tied together and directed into the septic tank. Should gray water be needed for additional landscape irrigation, such as during a severe drought, it will be accessible.

Invisible Structures GravelPave2

As discussed earlier, using pervious paving as a substitute for runoff-producing concrete and asphalt is one of the ways to limit the hydrological footprint of a project. To provide a stable and load-rated entry drive, Invisible Structures GravelPave2 was selected. It will also be used to reinforce the paths around the home and grounds to support wheelchairs, in keeping with the attention to accessibility that is a focus of the overall design.

Invisible Structures ring-grid system of geotechnical reinforcement is capable of supporting loads much greater than those anticipated for the entry drive, and once installed over open void drain rock, will allow rainfall to pass through without restriction. Other than the roof, there will essentially be no hydrologically effective surface area over the rest of the project, although technically a full pond would have to be considered as an "impervious surface."

Summary

To summarize, the challenge in designing a construction project on this particular site has been to accommodate the requirements of the building plan, while maintaining the unique environmental quality of what can be, due to a number of offsite influences and a fairly wet slope. It is hoped that the resulting design will allow a very special home to be seamlessly inserted onto the site. Though necessarily interrupting the flow of water as it has existed prior to development, and using the pond as a "flywheel" for excess flow across the site, the intercepted drainage can actually be guided around the planned home and returned to the natural watershed. No additional runoff will be generated. In this way, the advent of a dwelling on the site will bring with it both a low impact and an added element of stewardship and enhanced habitat values. UHD

The Author

Bill Wilson, is a principal in Environmental Planning & Design, LLC, based in Mill Valley, California. He is the Editorial Director of the Environmental Design Department of *Ultimate Home Design*. Bill can be reached at 415 389 9922 or on his mobile phone at 805 689 7639 or by e-mail at billwilsonwater@earthlink. net.