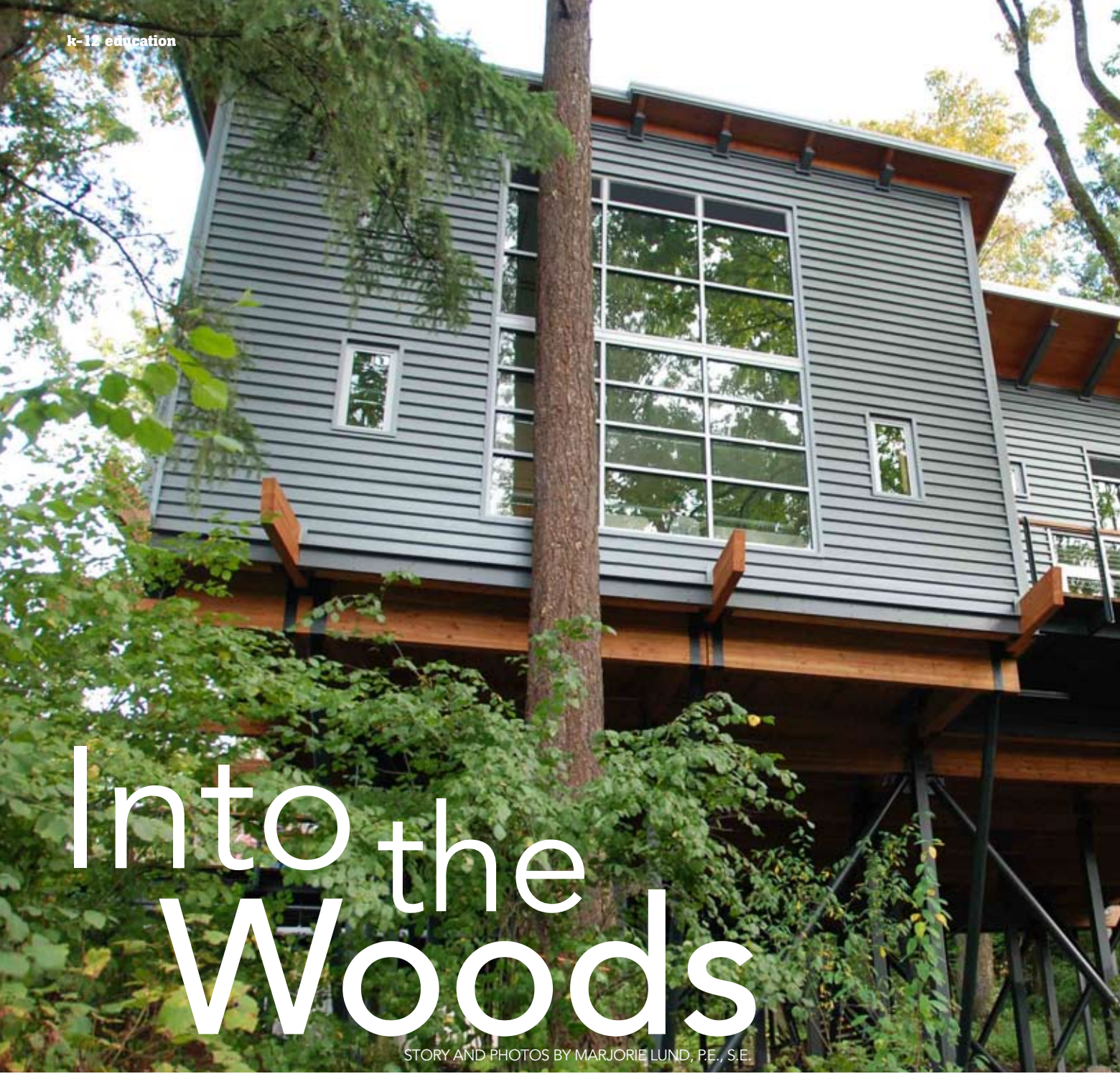

Into the Woods

STORY AND PHOTOS BY MARJORIE LUND, P.E., S.E.

Mercer Slough Environmental Education Center treads lightly but provides unique vantage points.

THE BELLEVUE, WASH., DEPARTMENT OF PARKS AND COMMUNITY SERVICES, in conjunction with the Pacific Science Center, has developed a remarkable project for hands-on wetlands education. Sited on a 40° slope overlooking the largest remaining urban wetlands in Washington, the Mercer Slough Environmental Education Center embraces the beauty of the natural environment while minimizing disruption to the sensitive forest floor. Seven individual structures are tied together with elevated walkways and grand viewing platforms to overlook the forest and wetlands. The initial phase of construction includes classrooms, visitor's center, restrooms, laboratory and administration, and totals 10,000 gross sq. ft.

The learning experience is enhanced by the lightness of the structures elevated into the tree canopy. Opportunities for exploration abound in the classrooms, tree house and on the boardwalks. Green roofs instruct on the benefits of insulating value and blending to the environs. A "wet lab" was built with the expectation that countless kids in muddy boots will be welcome there, viewing "pond dips," or slough samples, through microscopes.

The project anticipates a LEED® Gold certification, owing to its reuse of existing buildings, low-impact development, natural ventilation systems, certified wood, steel as a recycled material, and on-site stormwater management. The project is designed to

Exposed glulam beams are supported in custom saddles welded to the HSS substructure bracing.

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be light on the land through the use of a variety of low impact techniques. Steel piling and a steel substructure support the buildings, thus minimizing damage to tree roots and permitting unobstructed drainage. The use of exposed steel frames below the floors of the buildings and boardwalks minimize the disruption to the site and provides a unique lofty visual appearance.

Foundation System and Steel Substructure

The steep unstable slope required deep foundations but we needed to specify a foundation system that had the least construction area and weight of equipment because of the fragile forest soil surface. Clusters of helical anchors were augured into the soils by lightweight drilling equipment. The pile groups of mostly battered piles are capped with individual concrete pier caps supporting the steel framework. That approach minimized the placement of concrete onsite and disruption to the soil surface. A unique variation on grade beams was used to reduce damage to surface roots. The pile caps are connected with a series of galvanized pipes rather than reinforced concrete beams. This not only was less damaging to the site but also faster to construct.

The steel substructure splays upward in a manner architecturally echoing the tree branches above. This serves as lateral force resisting braced frames as well as allowing a cantilever system of floor beams that projects the buildings further into the trees and over the wetlands. The branching steel frame consists of HSS with slotted and welded gusset connections. Forces are transferred from the floor diaphragms to the braced frames by a grid of floor beams. The frames are designed as ordinary steel concentrically braced frames for seismic and for wind loads coming across the open ground in front of, and sweeping up the slope. The analysis of the

Far left: The use of steel framing for the substructures of the Mercer Slough Environmental Education Center minimized the project's impact on the sensitive forest floor and provides a light and airy feel to the entire complex.

Left: Elevated walkways, some three stories in the air, link the learning center's seven individual structures and provide viewing platforms overlooking the forest and wetlands.

three-dimensional steel and wood system was optimized by the use of RISA-3D software for gravity, wind and seismic forces. The structures are designed for Structural Occupancy Category II in Seismic Design Category D.

The floor diaphragms of the structures are structural insulating panels spanning between glulam beams. The beams, exposed from below, are supported in custom saddles welded to the steel braces. The saddles transfer the tension and compression components of the steel frames into the wood beams.

Walls above the floors are wood shear walls framed with engineered wood studs. The framing is enhanced with tubular steel frames to support out of plane wind loads in the 25-ft-tall window walls facing the slough. Steel roofing and siding were chosen for the project for their light weight, longevity, low maintenance, and recycled content.

Walls and Roof Framing

In keeping with the unusual combination of steel and wood framing, the roofs are constructed of open-web steel joists supporting structural insulated panels. The joists are exposed in the classrooms, continuing the architectural theme of lightness and openness. The joists provide the lightest roof support system with the benefit that the top chords extend out, providing graceful, slim eaves.

Again, the steel system was chosen for its ease and speed of installation and low impact on the site from weight and lack of heavy equipment. A simple connection was developed between the steel open-web joist and supporting glulam girders. The joists were pre-welded to bearing plates that were lag bolted to the tops of the girders.

A two-story "treehouse" anchors the end of the southern boardwalk. It is elevated by steel frames in a lovely compliment to the neighboring trees. On the west side an extended viewing platform, three stories above the trails, cantilevers 30 ft out toward the wetlands providing dramatic views of Mercer Slough and the city of Bellevue beyond. The beauty and airiness of this platform is enhanced with the lightness of the cantilevered steel frame.

Structural steel's exceptional light weight made erection on the difficult site less damaging to the soils and faster than conventional construction. The steel members were lifted from the street above into final positions with a mobile crane. No heavy equipment was needed on the slope for the erection. Keith Michel, project manager for contractor Berschauer Phillips Construction Co., said the project was a challenge due to the complex nature of the site. All equipment was chosen for its size, weight and maneuverability. The crew and all its equipment had to stay within five feet of the project's footprint. "This whole job was a little outside of the ordinary," Michel said. "We had to get creative in how we executed the work." That creativity led to a number of innovations to keep site impact to a minimum and reduce costs. MSC

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