KEYSTONE® RETAINING WALL SYSTEMS
A CONTECH COMPANY

Retaining Excellence™

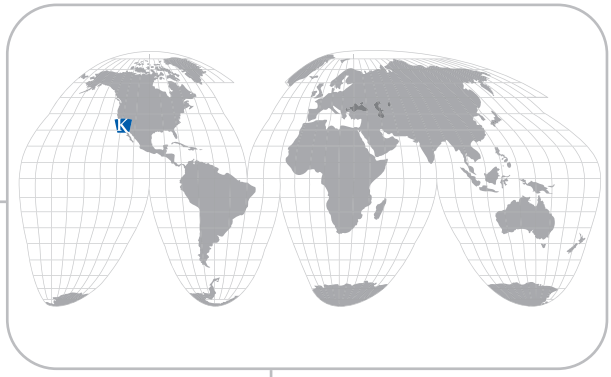
Norris Canyon Estates

San Ramon, California

The Norris Canyon Estates of San Ramon, California are gaining a local presence not merely for luxury homes, but also for the approximately half million square feet of multiple-tiered Keystone walls built throughout a challenging terrain.

A location with 1:1 slope ratios and expansive clay soils required a major transformation to make the area suitable for development. A local jurisdiction stating that walls on the project could not be taller than five feet further complicated matters. Multiple-tiered walls were designed to blend with the natural settings and also accommodate the wall height restriction. With some walls up to 10 terraces deep and reaching 30' in total height, global stability became a major concern.

For the project's entirety, more than 10 years, the Keystone Standard Unit has provided the perfect solution to overcome the extreme land challenges and create beautiful and structurally sound walls.



Project:	*Norris Canyon Estates*
Location:	*San Ramon, California*
Developer:	*Toll Brothers*
Licensed Manufacturer:	*Basalite Concrete Products*
Product Used:	*Keystone Standard Units* *Tensar Uniaxial Grid, Stratagrid*
Wall Area:	*400,000 square feet*
Architect:	*Malant & Associates*
Engineer:	*ENGEO, Inc.*
Contractor:	*B.C. McCosker Construction*
Keystone Supplier:	*ATCO Construction Products*

CASE STUDY

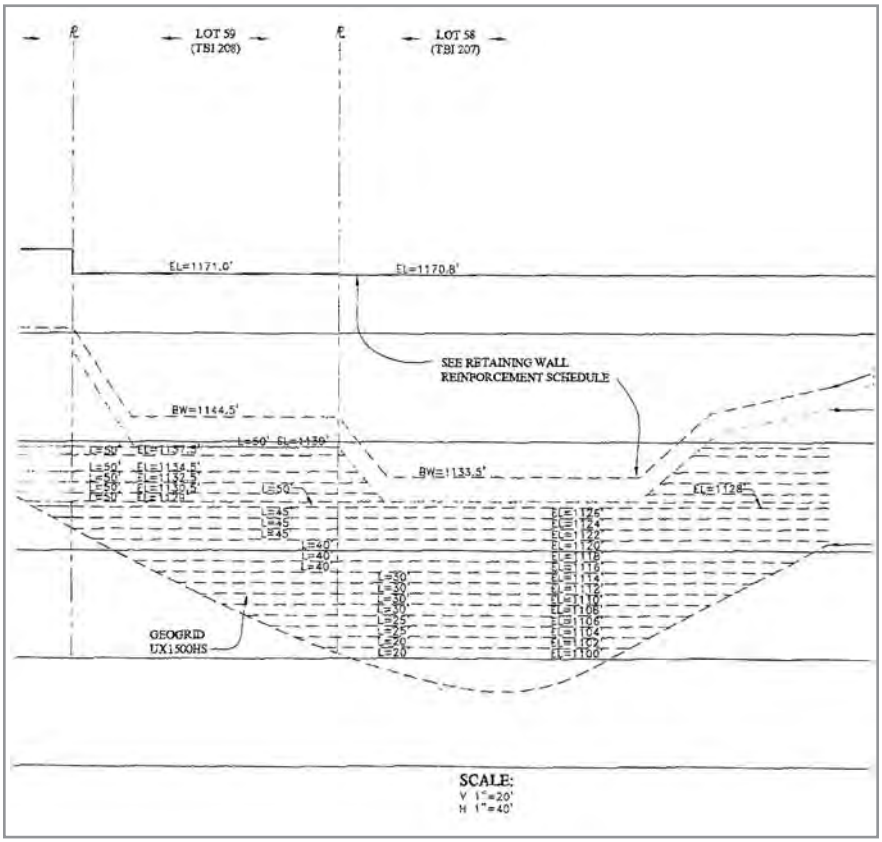
The Walls: A Look Below and Behind

The Norris Canyon Estates project walls vary from two to ten tiers with some requiring grid reinforcement at every course with grids up to 50' in length. Major over excavation, which included placing a minimum 8" thick leveling base of compacted crushed stone or Class 2 aggregate, prepared the land for wall and grid installation.

"To make it work and be able to build a design with so many walls on these land characteristics, a high amount of geogrid had to be used below the walls. It is quite amazing how it all came together," said Project Engineer Macy Tong, ENGEO Inc.

Looking below and behind an eight-tiered wall illustrates the design's complexity (see diagram). The soil strength, measured at a 28° phi angle, had to be reinforced by fifteen layers of Tensar Uniaxial (UX) 1500 geogrid placed underneath the wall. The underneath grid ranges in lengths from 30' to 50'. The wall is reinforced by eight feet of rock backfill and 50' of Tensar UX 1600 geogrid placed at every course.

Tensar UX geogrid was used for the majority of the project. Tensar UX Geogrids are manufactured using select grades of high-density polyethylene (HDPE) resins that resist elongation when subjected to high loads for long periods of time. The eight-tiered wall required only using one strength grid, however some walls are reinforced with up to three different grid strengths. Adapting to the different land conditions required varying grid strengths.



"You can't tell from the outside in, but it is a very complex design. As a wall contractor, it seemed inefficient to have so many 5 foot terraced walls instead of one continuous wall, because we could have saved the developer both time and money, but the County of Jurisdiction required no walls greater than 5 feet in height. The end result, however, is very impressive," said contractor, Stuart Campbell of B.C. McCosker Construction.

Campbell and his crew have built nearly all the development's walls. For this complex installation, they worked from the bottom up and into the upper slopes as they progressed. The complex drainage pipework was tied to the bottom outlet and flowed to a central vertical pipe. A common drainboard was used throughout the project.

Upon completion in mid 2007, the Norris Canyon Estates project will have a remarkable half million square feet of Keystone walls built on seemingly unusable land. The Keystone Standard Unit, with its structural stability, made it possible to build upon this challenging terrain.

For more information on the Keystone Standard Unit or other innovative Keystone products, please visit **www.keystonewalls.com** or call 800-747-8971. Keystone Retaining Wall Systems, Inc. is a subsidiary of CONTECH Earth Stabilization Solutions (ESS), Inc. CONTECH ESS also represents Tensar® Biaxial and Uniaxial geogrids. For more information on the CONTECH ESS family of erosion control products, visit **www.contechess.com**.

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