Shoreline, Waterway and Retention Pond Protection

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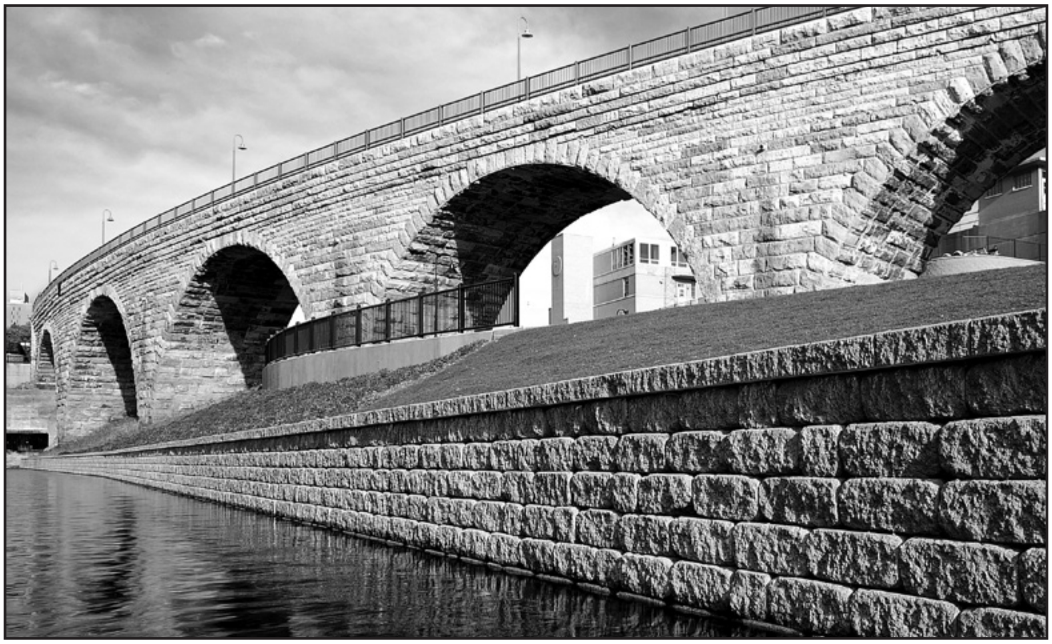
VERSA-LOK® Retaining Wall Systems have earned engineering approval for use on a growing number of diverse shoreline and waterway installations. This bulletin features basic design and installation guidelines for VERSA-LOK segmental retaining walls (SRWs) as used in retention ponds, lake and stream shorelines, channels and other waterway applications. These guidelines are not intended for use on any particular installation, as site conditions and specific design parameters will vary.



ADVANTAGES OF VERSA-LOK SYSTEMS IN WATER APPLICATIONS

There are several advantages to using the VERSA-LOK system for water management, shoreline and stream bank erosion control, and open channel applications:

- The system is free draining. Because no mortar is used between units, the VERSA-LOK wall allows water to weep through joints in the wall. This helps to minimize buildup of hydrostatic pressure behind the wall.
- The unique VERSA-LOK dry-stack system is a relatively flexible structure that is founded on an aggregate leveling pad foundation. This allows minor movement and settlement of the system without visual distress. VERSA-LOK units move and adjust relative to each other without loss of function.
- VERSA-LOK systems utilize solid, durable, high-strength concrete SRW units. These characteristics make the system highly resistant to rapid water flow velocities, face spalling and destructive impact from floating debris.
- VERSA-LOK systems are generally easier and faster to construct than systems requiring formwork or poured, reinforced footings. SRW units can be installed manually without the need for heavy equipment.

TECHNICAL BULLETIN

This Technical Bulletin is the first in a series of informational papers that provide specific application ideas and installation tips for VERSA-LOK® Retaining Wall Systems. Additional information is available in our *Design & Installation Guidelines.*

The information, including technical and engineering data, figures, tables, designs, drawings, details, suggested procedures and suggested specifications, presented in this publication is for general information only. While every effort has been made to ensure its accuracy, this information should not be used or relied upon for any application without verification of accuracy, suitability and applicability for the use contemplated, which is the sole responsibility of the user. A final, project-specific design should be prepared by a qualified, licensed, professional engineer based on actual site conditions. VERSA-LOK Retaining Wall Systems disclaims any and all express or implied warranties of merchantability fitness for any general or particular purpose, trademark or copyright in regard to information or products contained or referred to herein.

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TECHNICAL AND INSTALLATION ISSUES

Whenever an SRW is permanently or periodically in water, certain concerns must be addressed during project development. These concerns include: foundation, hydrostatic pressure, internal drainage, rapid draw down, surface water control, scour, ice forces and backfill materials. Designs will vary with type of water application (as seen in Figures 1-4). A project-specific design should be prepared by a qualified professional engineer (P.E.).

FOUNDATION

A competent foundation is essential to the structural integrity of any SRW, especially those located in water environments. Often, suitable conditions for a foundation do not exist at a shoreline site. All loose or soft soils should be excavated and replaced with properly compacted backfill. Foundation soils must be stiff, firm, and have sufficient capacity to support wall weight.

Water is often encountered where the base will be constructed. Contractors can dewater the foundation area by sealing it off with sand bags or sheet piles and removing water with pumps.

Rather than dewatering, sometimes a reinforced aggregate base can be placed in the wet area. This type of base may also improve the foundation over soft soils. A reinforced base can consist of open-graded, free-draining gravel (no fines) reinforced with geogrid and wrapped in geotextile fabric (Figure 2). The geotextile reduces the movement of fine particles into the granular base. The contractor may opt to place a poured concrete footing in the wet area, with the concrete displacing water during the pour. A concrete footing, however, must be placed below the seasonal frost depth.

For water applications, minimum wall embedment should be 1 foot (two VERSA-LOK Standard units). Additional embedment beyond this minimum will be needed depending on wall height, wave action and current conditions.

HYDROSTATIC PRESSURE

Adequate drainage of water in the retained soils must be provided to avoid buildup of hydrostatic pressure behind the wall. Standard designs assume no hydrostatic pressure on the wall. Also, typical designs usually do not account for the reduction in soil strengths and soil interaction caused by saturation.

It is important to remove accumulated water behind the wall quickly. In most cases, a properly engineered drainage system can be designed to efficiently remove excess water behind the wall.

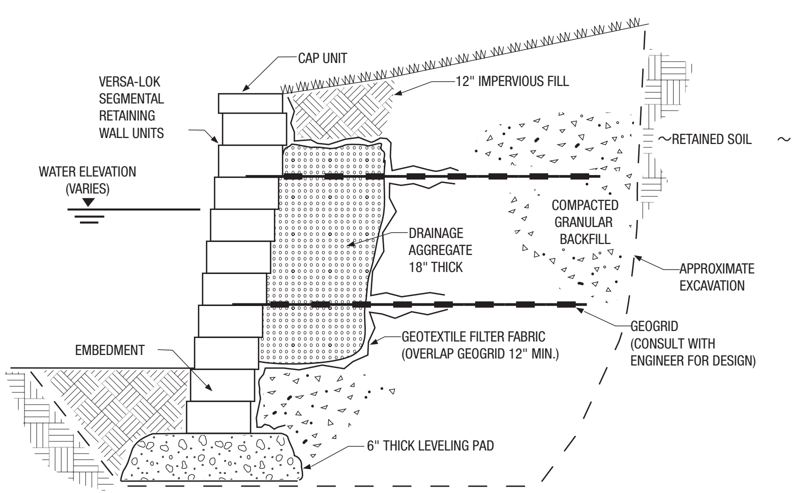


FIGURE 1 **Retention Pond — Typical Section**
(scale: none)

INTERNAL DRAINAGE

There are four possible components of a good internal drainage system that effectively reduce hydrostatic pressures in water applications.

Drainage aggregate

This material should be clean, open-graded 3/8 inch to 3/4 inch diameter, angular gravel, with no fines, to allow for the free flow of water through the system. A minimum of 18 inches of this aggregate should be placed immediately behind the wall face (Figure 1).

Drainage pipe

The drainage aggregate may need a perforated drainage pipe at the base to carry accumulated water away quickly. Drain pipes at intermediate levels may be needed for sustained high-water levels. All drainage pipes should have adequate flow capacity and positive slope to direct water away by gravity (Figure 2).

Drainage blanket and chimney

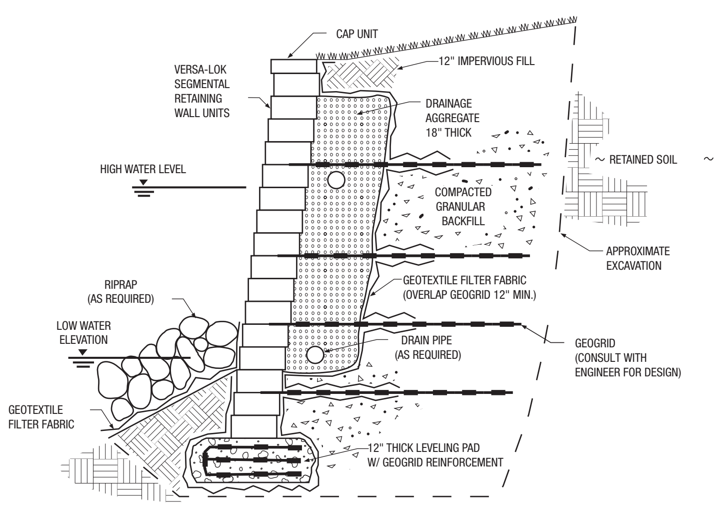
When groundwater rises seasonally into the compacted granular backfill and retained soil zones, a blanket drain may be necessary to remove water as it seeps into this soil mass (Figure 3A). The drainage aggregate layer is extended horizontally to form a blanket across the entire width of the reinforced wall and soil zone. A chimney drain can provide an additional drainage path to channel water from behind the wall (Figure 3B).

VERSA-LOK® Retaining Wall Systems have been used on many agency shoreline projects.

Geotextile filter fabric

In wall systems that have water moving through the backfill, fine soil particles can migrate into the internal drainage aggregate—eventually clogging. Geotextile filter fabrics allow water to pass through pores but restrict movement of fine soil particles. Selecting an appropriate geotextile (based on both the opening size in the fabric and the grain size of the fines in the surrounding soil) is important to prevent the fabric itself from clogging (Figure 1-4).

FIGURE 2 **Shore Protection — Typical Section**
(scale: none)



RAPID DRAWDOWN

Rapidly fluctuating water levels in front of a wall can cause large water loads on an SRW. As water in front of the wall recedes quickly, the soil behind the wall may not drain as rapidly, causing a temporary hydrostatic pressure on the wall. Rapid drawdown may occur after flooding in a channel, or when a detention pond quickly drains after a storm event.

Rapid drawdown pressures may be addressed in two ways. Depending on the severity, it may be possible to eliminate such pressures by improving the internal drainage with drainage blankets and chimney drains. If this is not sufficient or practical, the engineer may be able to design for the temporary water load by increasing the length and strength of the geogrid reinforcement.

SURFACE WATER CONTROL

Grading at the top of the wall should provide positive slopes away from the SRW. A 12-inch-thick layer of impervious fill should be placed at the top of the wall. In cases where a wall may be topped over with flood waters, special attention should be given to minimize erosion at the top and ends of the wall.

SCOUR

Scour (the erosive force of moving water) at the toe of an SRW is due to continuous wave action or fast-moving channel or river flow currents. If left unprotected, the foundation below an SRW may deteriorate from these erosive forces. Whenever possible, the SRW base should be embedded below scour depth.

In less-critical applications, riprap and a geotextile filter fabric can often alleviate scour forces. (Figure 2).

In highly turbulent water conditions, a qualified engineer will require specific knowledge about flow rates and other causes of scour—perhaps a complete hydraulic analysis—to adequately design an SRW system for these applications.

The design of the riprap is very site-specific. Generally, riprap protection should extend until the slope in front of the wall levels out. Riprap must be properly graded to function well and carefully placed so that large angular pieces do not puncture or displace the geotextile filter fabric.

FIGURE 3A **Drainage System — Wall Face and Blanket**
(scale: none)

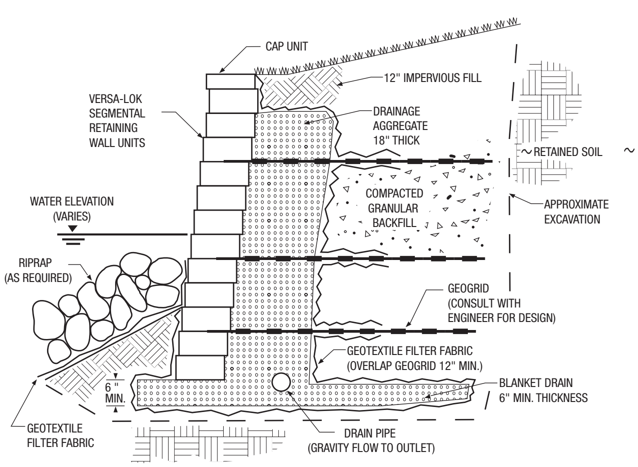
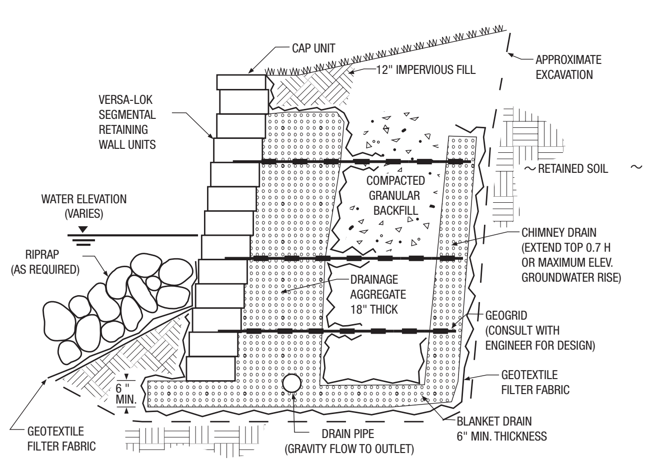


FIGURE 3B **Drainage System — Blanket & Chimney**
(scale: none)



ICE FORCES

In colder climates, ice forces can affect walls placed in water. Where ice forces are extreme, such as a seasonal occurrence of large, thick ice sheets, it may be impractical to design an SRW for these loads. Generally, there are three types of ice concerns that need to be considered: thermal expansion/ contraction, uplift and impacts. Temperature changes can create horizontal contraction or expansion loads when ice is confined. Changes in water level under ice sheets can exert uplift or downward forces. Possible impact forces of floating ice slabs in high-velocity streams or heavy wave action should also be considered. Although solid VERSA-LOK units provide superior durability, SRWs cannot be easily designed to resist large forces from the front of the wall. However, if a VERSA-LOK wall is pushed out of alignment by ice forces, the VERSA-LOK units can often be reused to rebuild the wall.

VERSA-LOK Systems increase retention pond capacity and maximize usage of surrounding land.

BACKFILL MATERIALS

For water applications, the preferred backfill material in the geogrid reinforced soil zone is well-graded, angular gravel (such as an aggregate road base material). This material provides relatively good drainage and maintains its properties well when saturated. Open-graded drainage gravel (no fines) is also used. However, this material can act as a "bathtub," collecting water quickly. This could overwhelm internal drainage systems and create hydrostatic pressures without proper design. Fine-grained soils, such as lean clays, may sometimes be used for reinforced backfill in less critical water applications, but the wall design must account for the effects of saturation on these finer soils.

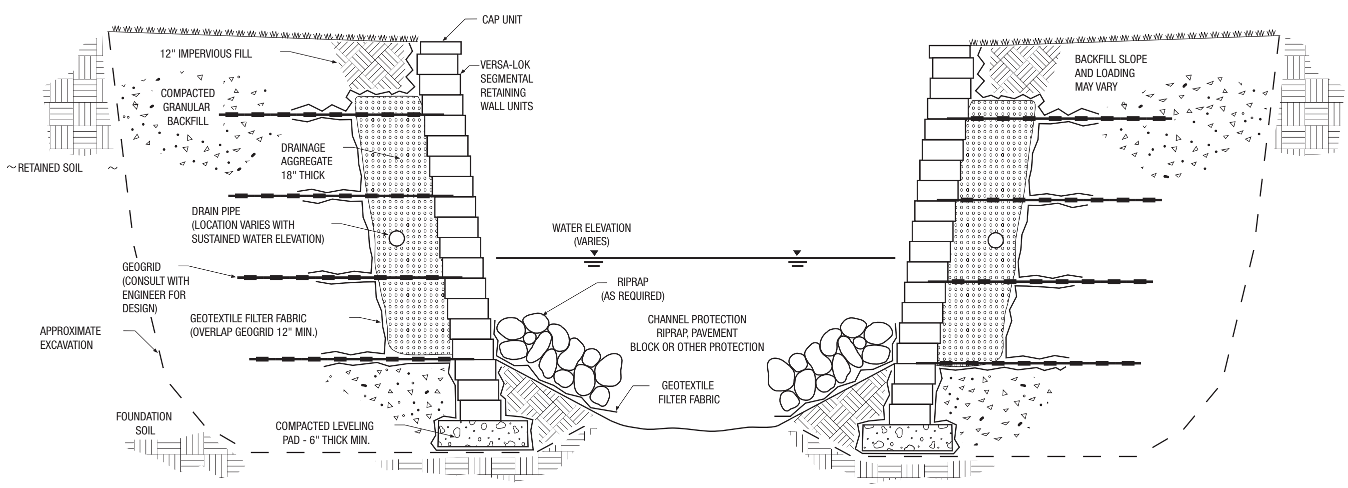


FIGURE 4 **Channel Wall — Typical Section**
(scale: none)

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TECHNICAL BULLETIN

For more detailed information regarding design and installation, please contact your local dealer or VERSA-LOK® Retaining Wall Systems.

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U.S. Patent D319,885,
U.S. Patent D321,060,
U.S. Patent D341,215,
U.S. Patent D346,667,
U.S. Patent D435,302,
U.S. Patent D439,678,
U.S. Patent D447,573,
U.S. Patent D452,332,
U.S. Patent D458,387,
U.S. Patent D537,533,
U.S. Patent D552,258,
U.S. Patent D555,810,
U.S. Patent D569,010,
U.S. Patent 6,488,448,
U.S. Patent 6,960,048,
U.S. Patent 7,229,235,
U.S. Patent 7,244,079
and other U.S. patents pending

Canadian Industrial Design Registration No. 63929, No. 71472, No. 73910, No. 73911, No. 73912, No. 91178, No. 115161, No. 123413, No. 123414 and No. 123415; Canadian Patent No. 2,313,061, No. 2,313,062 and No. 2,288,575; I.C.B.O. No. 4625

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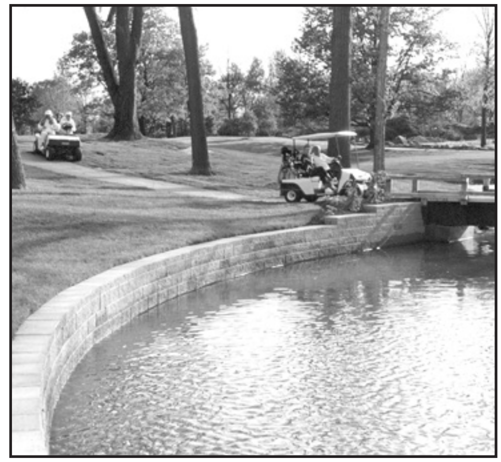
Solid, durable, interlocking VERSA-LOK® units are ideally suited for channel and flood control projects.



VERSA-LOK walls can provide an attractive and stable border around lakes and ponds.

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This bulletin presents only basic guidelines for the design and installation of VERSA-LOK retaining walls in water applications. Additional information covering the subject of SRW design and installation and hydraulic design criteria, both beyond the scope of this bulletin, is contained in the following reference documents:

Design Manual for Segmental Retaining Walls, Third Edition, National Concrete Masonry Association, 2009.

Highway Drainage Guidelines, Vol. VI, "Hydraulic Analysis and Design of Open Channels," American Association of State Highway and Transportation Officials, Inc., 1992.

Hydraulic Design of Flood Control Channels, U.S. Army Corps of Engineers, EM 1110-2-1601, 1 July 1991.

Design of Riprap Revetment, U.S. Federal Highway Administration Hydraulic Engineering Circular No. 11 (HEC-11), March 1989.

Hydraulic Design Criteria, U.S. Army Corps of Engineers loose-leaf data-book, available from the National Technical Information Service (NTIS), revised periodically.

Retaining and Flood Walls, U.S. Army Corps of Engineers Engineering manual EM 1110-2-2502.

Handbook of Hydraulics, Sixth Edition, Brater, E.F. and King, H.W., McGraw-Hill, 1976.