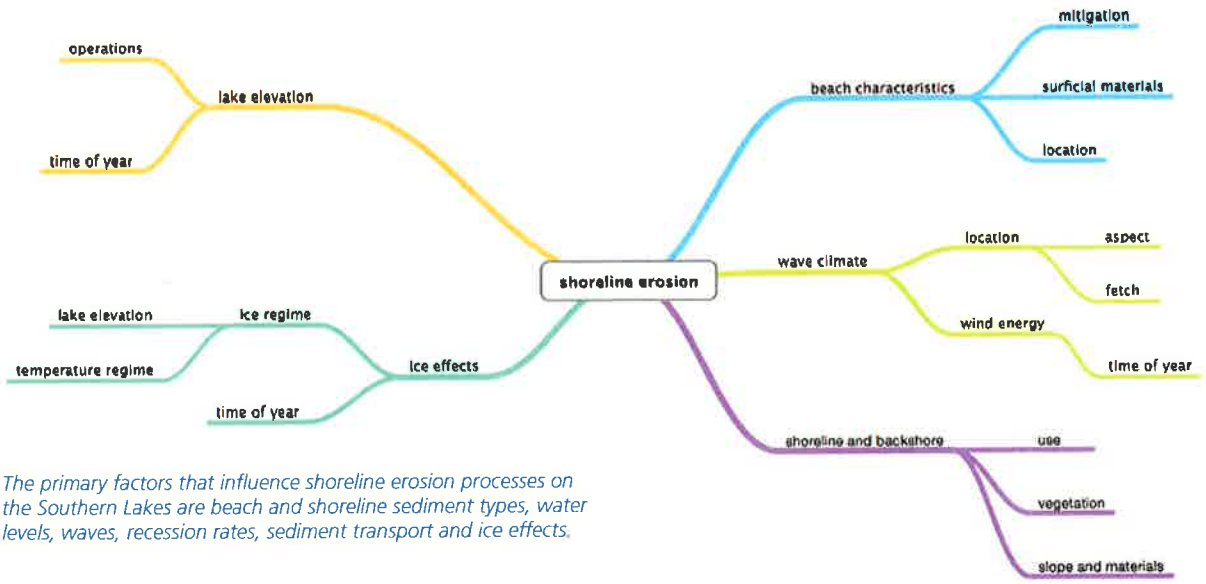
Erosion Program

SOUTHERN LAKES ENHANCED STORAGE CONCEPT • EROSION



The primary factors that influence shoreline erosion processes on the Southern Lakes are beach and shoreline sediment types, water levels, waves, recession rates, sediment transport and ice effects.

Introduction

Over the last several years, Yukon Energy has engaged regularly with Yukoners and done significant research on the idea of increased water storage in the lakes south of Whitehorse. The Corporation has worked hard to understand the potential environmental and socio-economic impacts that could occur as a result of the concept.

Over the next few months, this research will be reviewed and used to decide whether to move the concept forward to the YESAA environmental and socio-economic assessment phase.

Wave-induced currents along the shoreline transport beach sediment in and out of, or along the shoreline causing sand deposits and erosion.

Summary of the Concept

Electricity demand in Yukon is highest during the cold, dark winter months, which is also the time of year when water levels in our lakes and rivers are naturally low. In order for Yukon Energy to produce enough hydroelectricity for Yukoners during the winter the Corporation must hold back (or store) water in Marsh, Tagish and Bennett Lakes during the fall, when water levels are higher.

Right now, the amount of water Yukon Energy is allowed to store (Full Supply Level) is not always enough to meet energy demands in winter, so fossil fuels are burned to make up the difference.

The Southern Lakes Enhanced Storage Concept would involve changing Yukon Energy's water license so the Corporation could store up to 30 centimeters more water in the fall and early winter and use up to an additional 10 cm of water below the current level in the spring.

This water would be available for winter energy production when it's needed the most, and would provide cost-effective and environmentally responsible energy. The concept would not increase naturally-occurring high water levels that occur in the Southern Lakes and the additional water storage would not be carried over year-to-year.

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Potential Impacts to Properties Related to Erosion

There are already naturally-occurring erosion issues in some areas of the Southern Lakes. The Corporation's previous erosion studies identified six shoreline areas containing multiple properties that are currently experiencing erosion and may experience additional erosion as a result of the concept.

The proposed increase to the Full Supply Level will result in additional shoreline areas of up to 30 vertical centimeters being inundated for a longer period of time each year. This additional period of higher lake levels may result in additional shoreline erosion due to wave action. It is important to note that the proposed increase is well below the natural high water level that occurs each year in late summer. Shoreline erosion along the Southern Lakes is site-specific and depends on the location and aspect of the property, as well as the characteristics of the shoreline. Such natural characteristics include the slope of the foreshore and bluffs, and the type of material in these areas such as sand and gravel. The presence of vegetation also affects the rate of erosion.

Initial Meeting (one-on-one)
- Discuss shoreline erosion on property
- Discuss YEC shoreline erosion mitigations
- Get your feedback

Design a preliminary shoreline-unit specific erosion mitigation plan

Follow-up meeting (one-on-one or groups)
- Review prepared preliminary shoreline-unit specific erosion mitigation plan
- Incorporate comments and feedback for final design

Final mitigation plans and landowner feedback are reported to Yukon Energy and used in decision making on whether to proceed with a project assessment and permitting

Landowner Engagement Process

An important part of this next step is engaging with landowners who may experience erosion on their properties as a result of the concept.

Yukon Energy will use your input as well as the input of your neighbours to help develop one consistent erosion mitigation plan for your shoreline unit. If implemented, this plan would combat existing erosion as well as any potential concept-related erosion and would provide a long-term benefit should the concept move forward.

Please note that it is not necessary for you to support the Southern Lakes Enhanced Storage Concept to participate in this engagement process. This process allows us to fully understand the issues and costs related to potential mitigation of shoreline erosion, which will provide Yukon Energy with a more accurate estimate of the costs and benefits of the project for the assessment process and Yukon ratepayers.

RipRap

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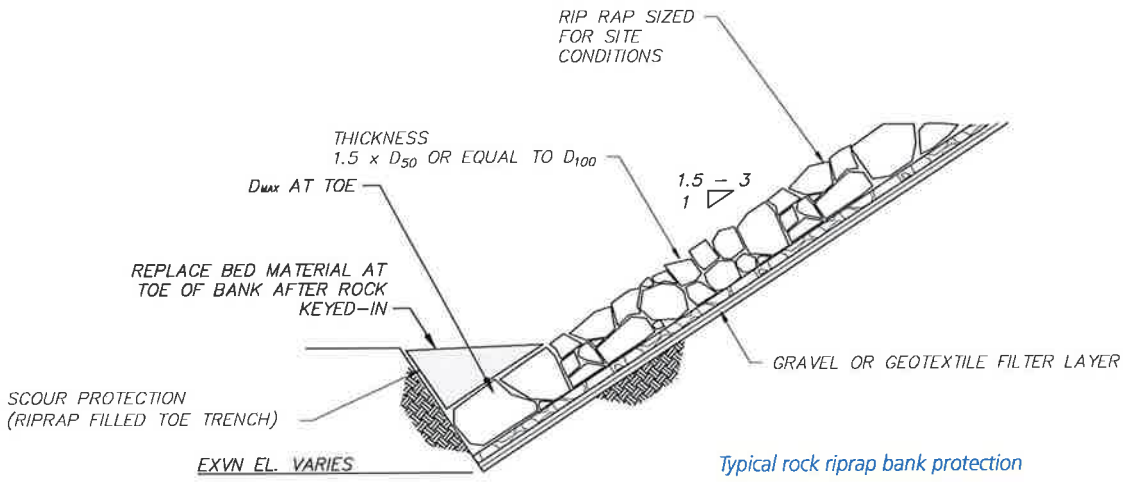


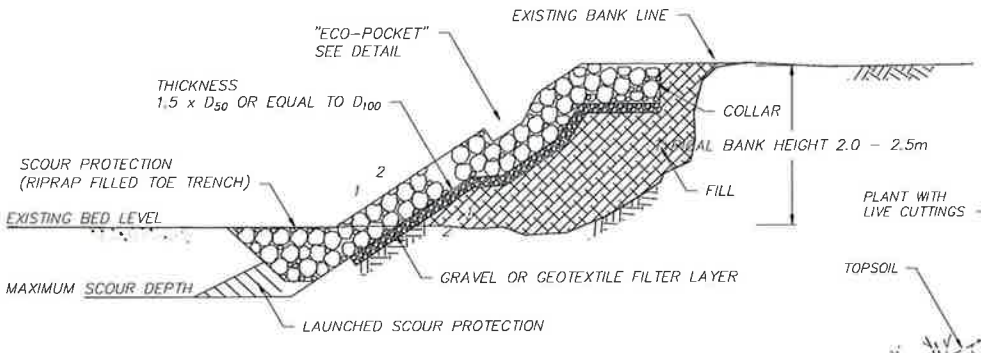
Typical rock riprap bank protection

Typical riprap involves using quarried angular rock to protect eroding slopes. The size of the rock and the thickness of the armour layer depend on the extent of the erosive forces on the slope. An underlayer is used between the rock and eroding slope to keep fine sediments from eroding away between the spaces in the rocks. The toe of the riprap can either be excavated into the bottom of the slope or an apron can be constructed to avoid excavation. Riprap is typically used where erosion is extensive or in proximity to infrastructure, and construction requires access for large and heavy machinery (e.g., excavators and dump trucks). In order to make this option feasible a good source of quality rock needs to be available in reasonable proximity to the site.

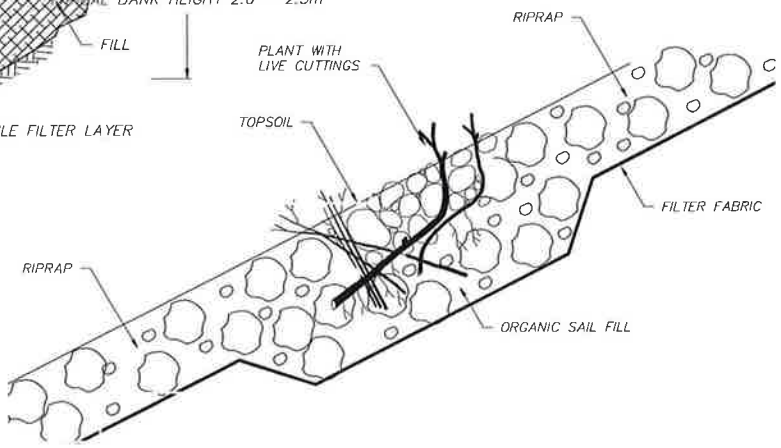
Advantages	Disadvantages
Highly effective protection	Artificial and unnatural appearance
Very low maintenance	Not environmentally friendly
Effective on high and steep slopes with significant erosion	Access required for large and heavy equipment
Requires minimal manual labour	

Vegetated RipRap

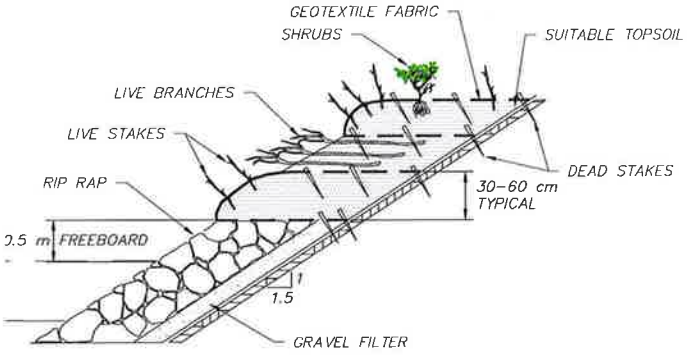
SOUTHERN LAKES ENHANCED STORAGE CONCEPT • EROSION 2



Typical riprap with vegetated ecopocket



Vegetated riprap is the same as typical riprap with the addition of vegetation within and or above the riprap slope. Vegetation can be in the form of "eco-pockets" which are small pockets of soil and vegetation in various locations on the surface of the rock slope. The planting of stakes or live cuttings in the spaces between the rocks are also an effective planting option. The top of the riprap slope can be planted with grass seed, brush, stakes or live cuttings or trees.



Typical riprap with vegetated soil wrap

Advantages	Disadvantage
Highly effective protection	Somewhat artificial and unnatural appearance
Low maintenance	Access required for large and heavy equipment
Effective on high and steep slopes with significant erosion	Requires more manual labour than typical riprap
More natural appearance and environmentally friendly than typical riprap	Some maintenance required for vegetation

Gabion Baskets (Standard And Vegetated)

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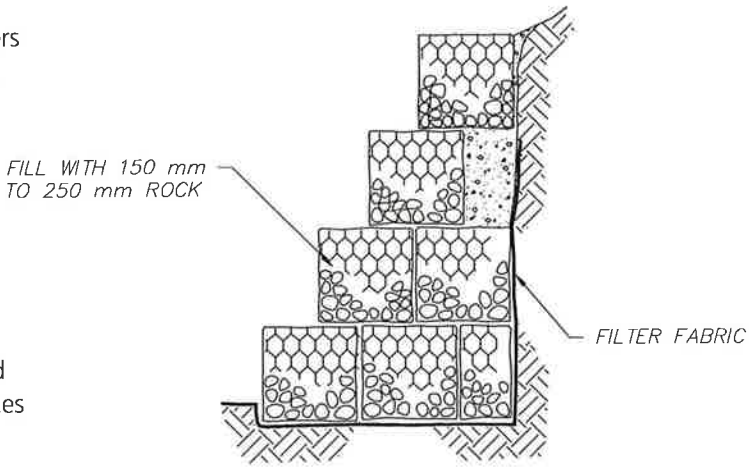
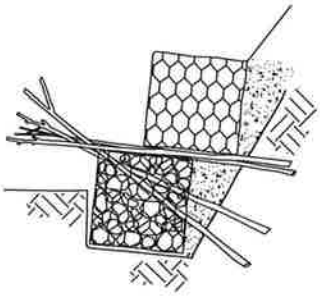
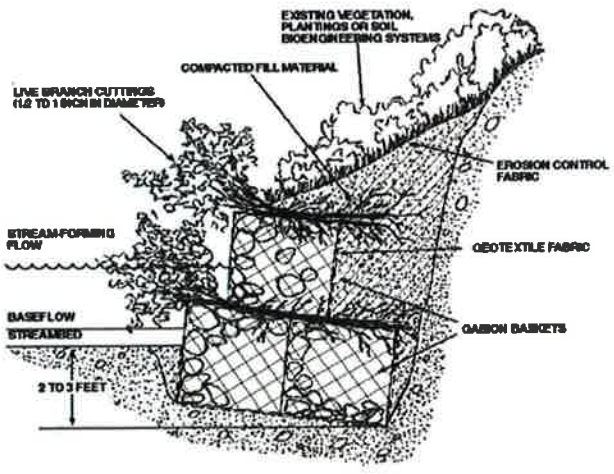
Gabion baskets are box shaped wire mesh containers that are filled with rock and stacked on top of each other to a desired height to provide protection on steep slopes. The baskets arrive from the manufacturer flattened and are assembled on site using manual labour. Small or medium sized machinery is used to fill each basket with rocks approximately 15 cm in diameter. Quarried angular rock is preferred but rounded rock can be used. The bottom row of baskets are buried into the toe of the slope and the baskets can be stacked numerous rows high. For the vegetated option stakes or live cuttings are placed between or within the baskets. Gabion baskets are typically used in areas where a high level of protection is needed but where large quality rock is not available for riprap.



Typical gabion bank protection

Advantages	Disadvantages
Highly effective protection	Gabion wire will corrode over time
Low maintenance on non-vegetated option	Artificial and unnatural appearance (non-vegetated option)
Effective on high and steep slopes with significant erosion	Not environmentally friendly (non-vegetated option)
Good option where large rock is not available	Requires machinery
Large and heavy equipment not required	Requires manual labour, especially for vegetated option





Typical vegetated gabion bank protection

Groynes

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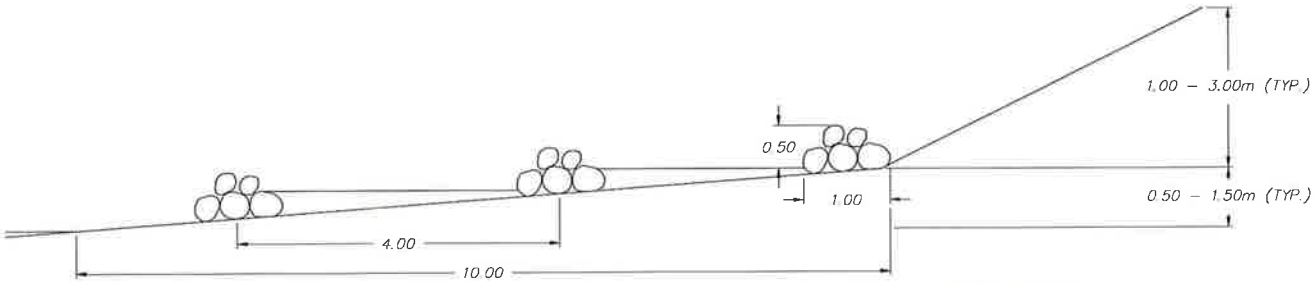


Parallel groynes

Groynes are structures that extend into the water to protect the shoreline from erosion by disrupting the flow of water, wave action or longshore transport of sediment. Groynes can be walls made of timber or logs but are typically made of large rock similar to that used for riprap. Groynes are only effective where beaches or bluffs are degrading due to waves and currents running parallel or near parallel to the shoreline resulting in longshore transport of sediment.

Advantages

Highly effective protection under longshore transport scenarios

Very low maintenance

Requires minimal manual labour

Disadvantages

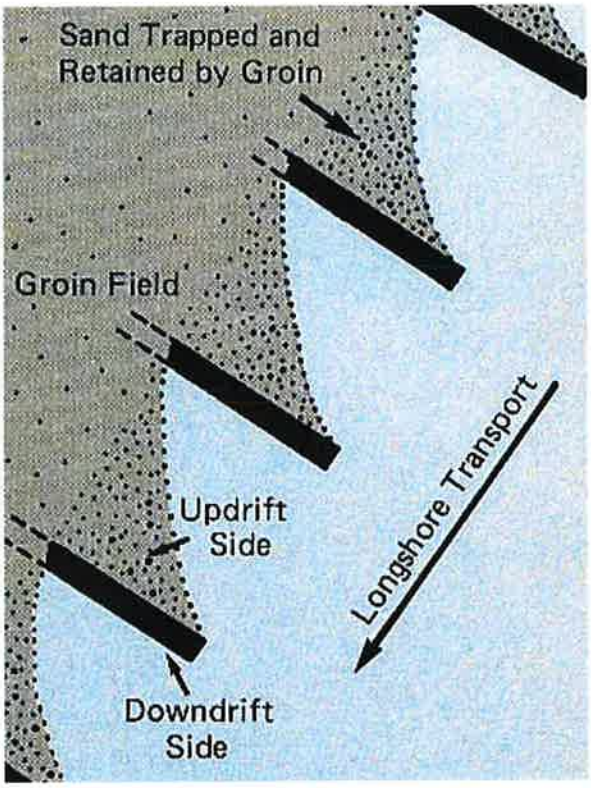
Only effective under longshore transport scenarios

High initial cost

Artificial and unnatural appearance

Not environmentally friendly

Access required for large and heavy equipment



Perched Beach

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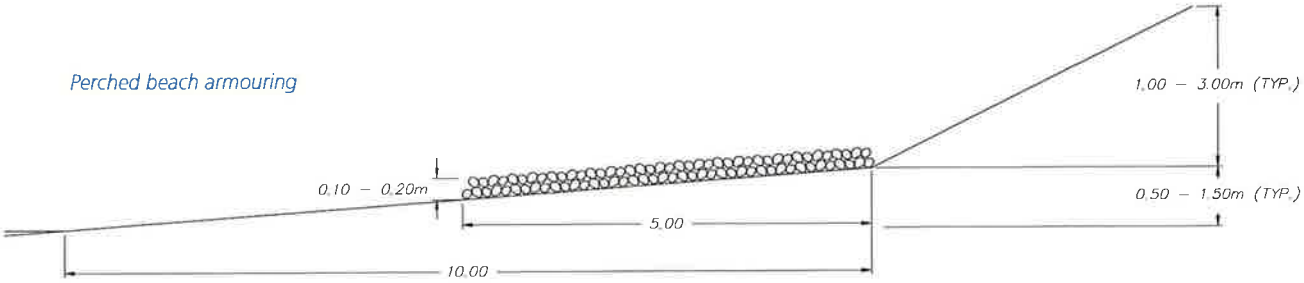
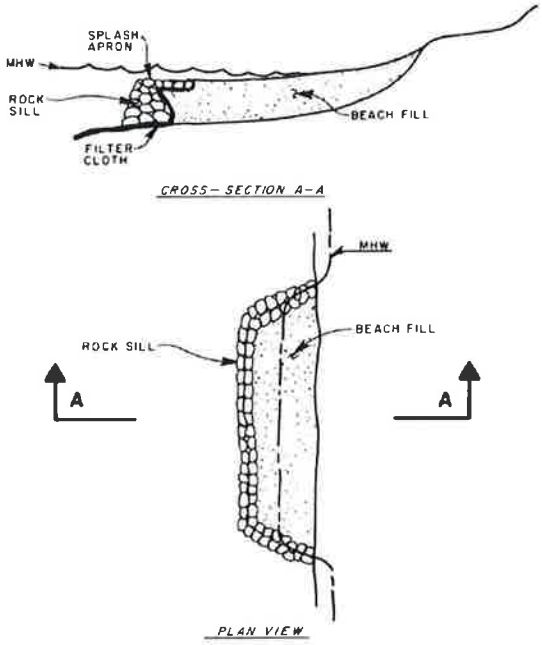
Perched beach armouring



A perched beach involves protecting an eroding beach by armouring the shoreline with beach fill on the landward side of the armour. An alternate method involves laying a thin layer of armour protection on the surface of the beach to prevent additional degradation from occurring. With the beach fill option an armoured berm is constructed with large rock and the beach fill can either be backfilled beach material or left empty to gradually fill with natural beach material. With the alternate method the entire beach or portions of the beach along the shoreline can be covered with rock.



Advantages

Reduces wave effects

Installed on existing foreshore

Does not impact backshore slopes

Highly effective protection under longshore or onshore/ offshore transport scenarios

Low maintenance

Requires minimal manual labour

Disadvantages

Impacts existing beach and foreshore area

Does not directly protect backshore slopes

Somewhat artificial and unnatural appearance

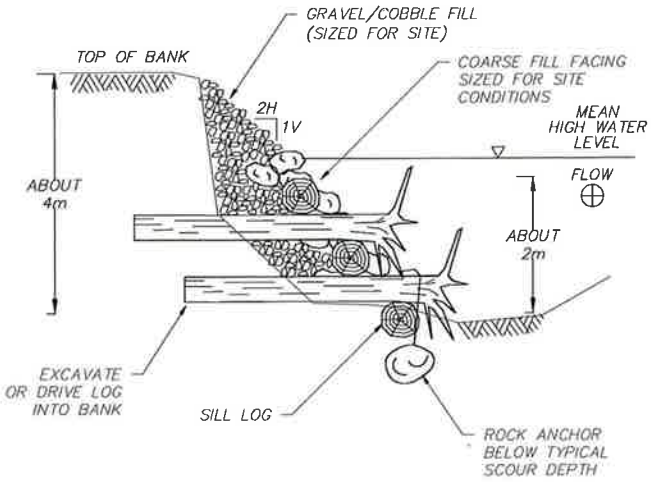
Somewhat not environmentally friendly

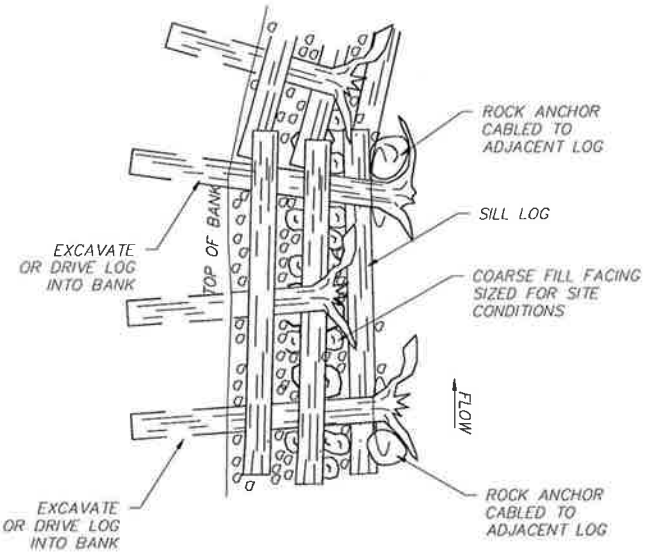
Access required for large and heavy equipment

Cribwall

A cribwall is a wall made of logs or timber to protect a vertical or near vertical eroding slope. For a high level of protection the wall can be built vertically with alternating logs parallel and perpendicular to the slope and backfilled with rock. See drawings below for an example of this method. The toe of the wall can be buried into the ground for additional protection. For a less engineered option a series of logs can be laid beside each other or stacked to provide a moderate level of protection as shown in the photo below. The logs can also be cabled together or anchored into the ground to provide more durable protection.

Advantages	Disadvantages
Good for poor or limited machine access	Not ideal option if available logs are small and deciduous
Environmentally friendly	Moderate level of protection
Can be built with manual labour	





Typical crib wall

Vegetated Cribwall

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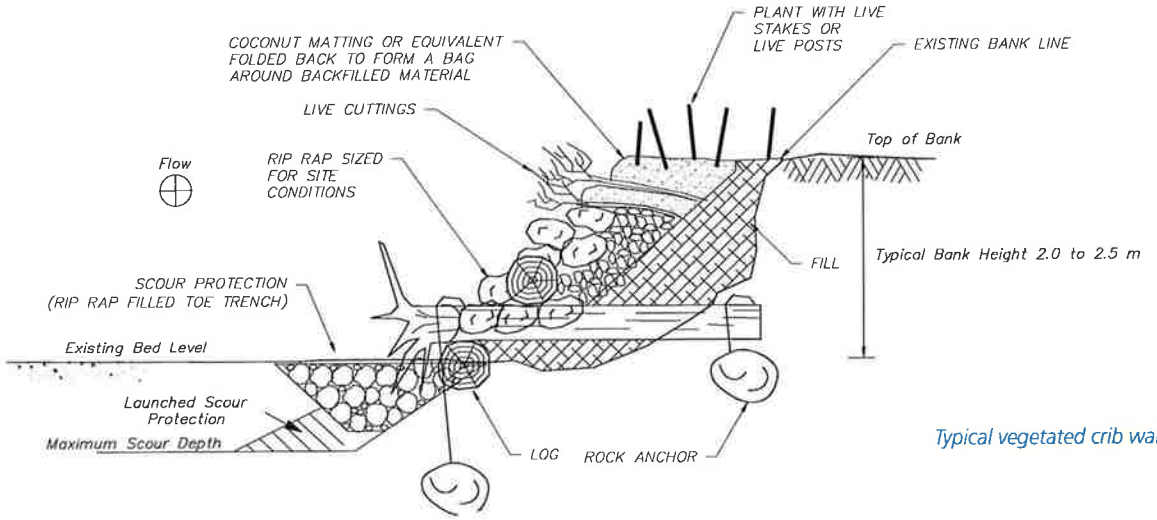
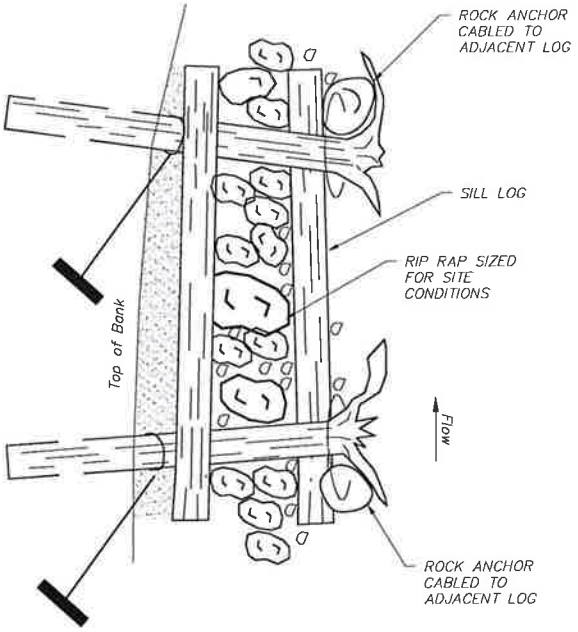


Typical vegetated crib wall

Vegetated cribwalls are similar to standard cribwalls but with the addition of vegetation incorporated into the wall. The vegetation can be stakes or live cuttings incorporated into the spaces between the logs. The top of the cribwall can be planted with grass seed, brush, stakes or live cuttings or trees. If not naturally occurring, a growing medium (soil or bags filled with soil) would need to be added for the planting at the top of the cribwall.



Advantages

Good for poor or limited machine access

Environmentally friendly

Can be built with manual labour

Uses natural materials

Ideal for log-based foreshores

Effective slope protection

Effective on high and steep slopes with significant erosion

More natural appearance and environmentally friendly than typical cribwalls

Disadvantages

Not ideal option if available logs are small and deciduous

Moderate level of protection

Limited design life in harsh environments

Limited structure strength

Requires excavation to embed/fill/build

Will require maintenance to replace vegetation that does not survive

Requires more manual labour than typical cribwalls

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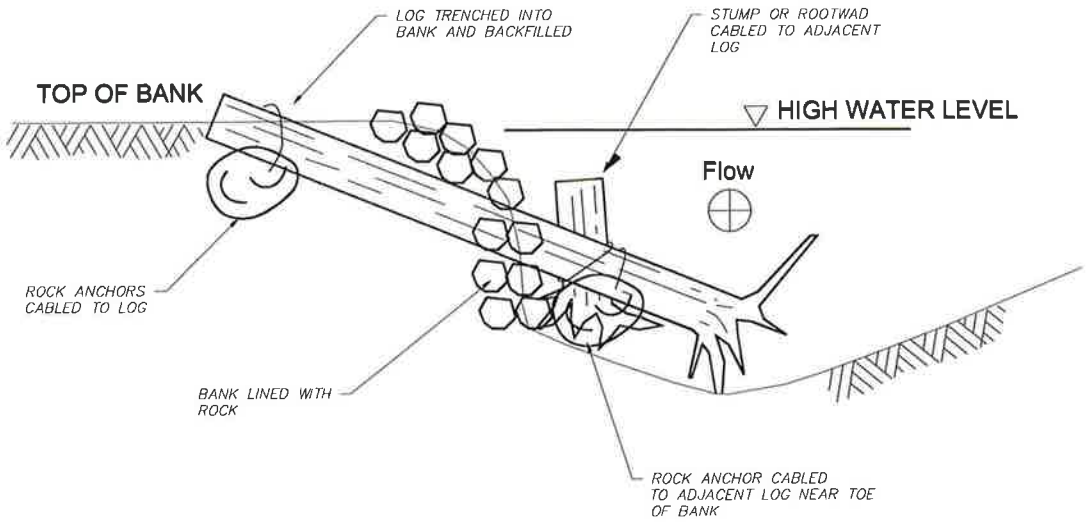
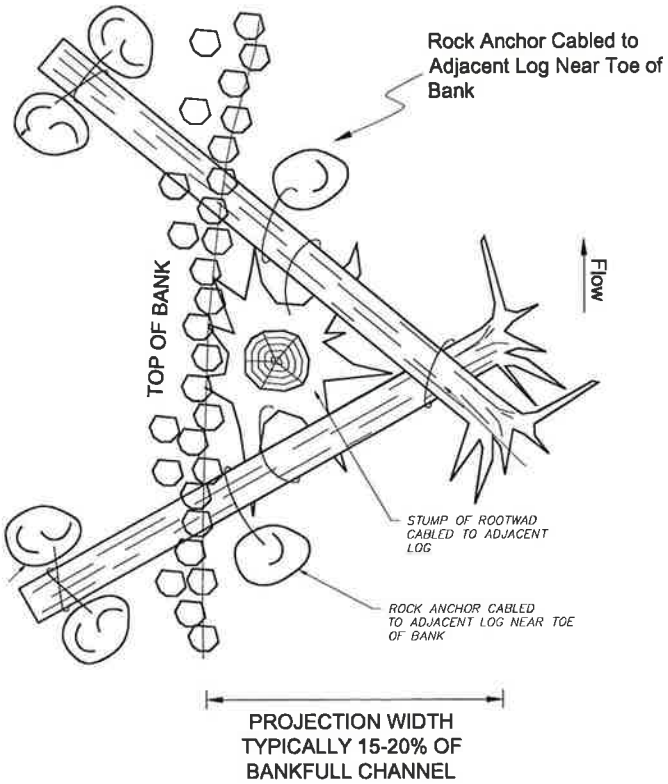
Large Woody Debris Structures

SOUTHERN LAKES ENHANCED STORAGE CONCEPT • EROSION 8

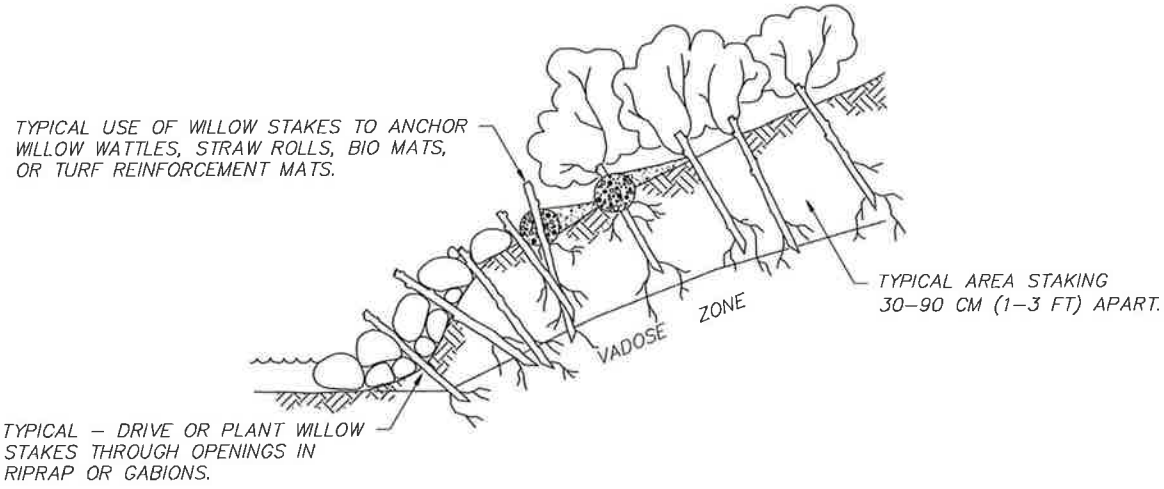


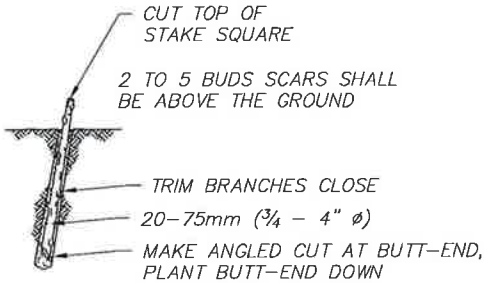
Large Woody Debris (LWD) structures are a collection of logs that are clustered together to provide protection for eroding slopes. The logs may have the root wad attached and they are typically cabled together and or anchored into the slope or anchored to large boulders. They can be quite natural in appearance and are environmentally friendly as they provide habitat for fish and wildlife. They do not provide a high level of protection but are inexpensive to construct and are low maintenance. This option is not appropriate when the eroding slope is high and steep or the erosive forces are significant.



Advantages	Disadvantages
Good for poor or limited machine access	Not ideal option if available logs are small and deciduous
Natural appearance and environmentally friendly	Minimal level of protection

Live Staking





Live Staking involves cutting vegetation from a nearby source and planting the cuttings on the eroding slope or beach to decrease the rate of erosion. This method is only effective where the extent of erosion is not significant. Ideal growing conditions are required for this option. The stakes are only effective after they have established which can take several years depending on the growing conditions. This option is very natural looking when the stakes are established and can be constructed with manual labour. This option is ideal where access is difficult for large and heavy machinery.

Advantages	Disadvantages
Provides additional protection over time as vegetation establishes	High failure rate in initial years
High ecological value	Limited installation period
Low cost	High initial maintenance for replanting
No large or heavy machinery required	Requires suitable soil for growing
Natural appearance and environmentally friendly	Requires moisture in the soil for growing

Brush Layering

Brush layering involves cutting vegetation from a nearby source and planting the brush cuttings in dense layers on the eroding slope and then backfilling with soil. This method is only effective where the extent of erosion is not significant. Ideal growing conditions are required for this option. The brush layers are only effective after they have established which can take several years depending on the growing conditions. This option is very natural looking when the brush layers are established and can be constructed manually. This option is ideal where access is difficult for large and heavy machinery.

Advantages

Provides additional protection over time as vegetation establishes

High ecological value

Low cost

No large or heavy machinery required

Natural appearance and environmentally friendly

Disadvantages

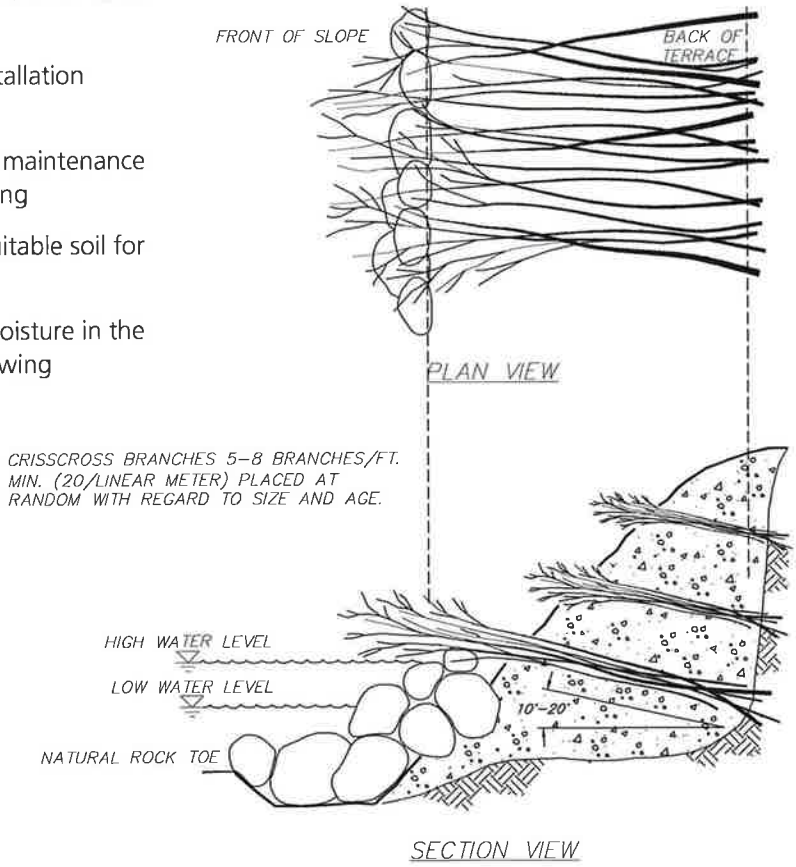
High failure rate in initial years

Limited installation period

High initial maintenance for replanting

Requires suitable soil for growing

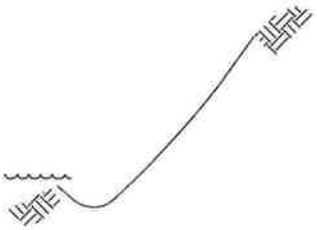
Requires moisture in the soil for growing



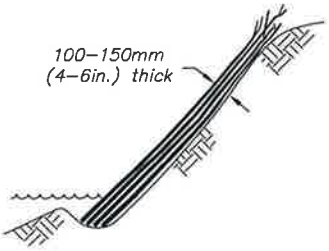
Brush Matting

Brush matting involves cutting vegetation from a nearby source and planting the brush cuttings in dense layers on the eroding slope. The cuttings are densely placed side by side and secured together with twine or rope to create a mattress like structure. This method is only effective where the extent of erosion is not significant. Ideal growing conditions are required for this option. The brush matting is only effective after the vegetation has established which can take several years depending on the growing conditions. This option is very natural looking when the brush matting is established and can be constructed with manual labour. This option is ideal where access is difficult for large and heavy machinery.

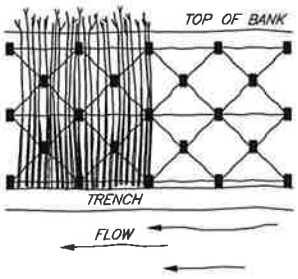
Advantages	Disadvantages
Provides additional protection over time as vegetation establishes	High failure rate in initial years
High ecological value	Limited installation period
Low cost	High initial maintenance for replanting
No large or heavy machinery required	Requires suitable soil for growing
Natural appearance and environmentally friendly	Requires moisture in the soil for growing



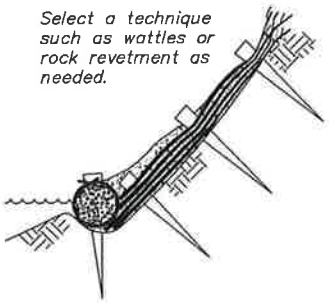
Step 1: Excavate trench and grade bank.



Step 2: Place willow branches making sure that the butt ends reach the bottom.



Step 3: Place stake (notched) on 1.0m (3ft.) centers and secure the mattress with twine, rope or wire.



Step 4: Drive the stakes deeply into the bank to tightly compress the branches against the soil. Cover and partially bury the mattress to encourage rooting.