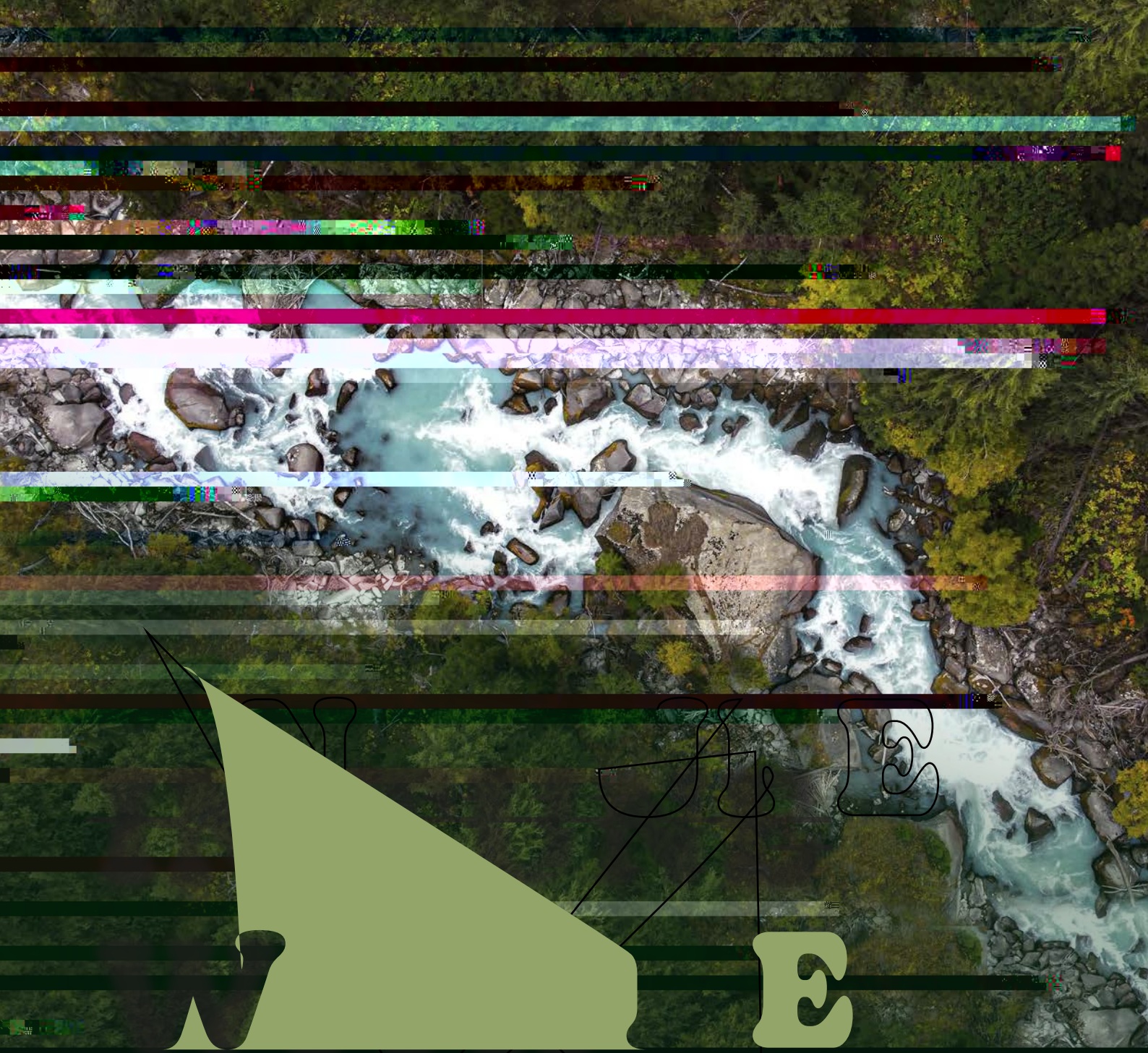

NATURE

Paul Kos and Chris Jaros, Stantec, USA, consider the advantages of implementing nature-based stream restoration methods in mine closure.

The mining industry can show sustainable water management by restoring streams, wetlands, and woodlands to natural ecosystems. Restoring a natural water system using Nature-based Solutions (NbS) provides a critical habitat for creatures living on land and in the water. It also supports the United Nations Sustainable Development Goals.

Reclamation promotes biodiversity, and helps mining companies get regulatory and social approval.

Historically, in the US, mine closure and water management regulations prioritised preventing erosion. Because of this, many mine water management methods included waterways made of hard armouring. The hard armour would be riprap or gabion baskets (a layered rock wall held together with metal wiring). Thankfully, today's policies allow some erosion in stream restoration projects. This is a positive development, because erosion is a key principle of natural stream behaviour. Now, a more modern approach to mine closure and water management means restoring waterways to mimic the surrounding undisturbed areas.

Components of a restored stream

Stream restoration does not require a major effort beyond reclamation and monitoring. The initial water treatment and grading is the same for both nature-based and traditional methods. The main difference lies in recreating a more natural ecosystem using the six components outlined below.

Low-flow channel

A low-flow channel is key to concentrate seasonal flow fluctuations, providing a continuous water path. This channel usually meanders through the floodplain to limit channel gradient.

Riffle-pool sequence

Riffle-pool sequences create varied aquatic habitats. They have riffles on straight segments of the stream and allow for pools at the bends. Both habitat types are necessary for fish and insects to propagate. Riffle-pool sequences are also important from a structural perspective – as they provide gradient control on slopes up to 5%.

Floodplains

When there is more water than the stream can hold, it entnanT and insodplains

reduced sediment loading and a stabilised channel. This restoration project also helped recharge groundwater nearby and safeguard natural infrastructure. The Alamosa River Restoration was good for the environment, promoted healthier communities, and achieved regulatory compliance, improving the larger watershed beyond the Alamosa River.

Another example in Colorado is Four Mile Creek. It supplies water to a few small towns near Boulder, and the watershed had been impacted by previous mining activity.

When Stantec's team started work here, the amount of arsenic in the water was over the drinking water standard. Stantec environmental engineers tested waste rock piles to determine what metals were present and removed waste rock from the channel. The channels were restored using the principles discussed above, and the design included a low-flow channel, rifle-pool sequences, boulder walls, vegetated soil lifts, and floodplain areas. The team also capped remaining waste rock with an evapotranspiration cover to reduce leaching. Finally, they planted vegetation consistent with the surrounding forest and native stream channel.

After the restoration of the main channel and side tributaries, water quality in the area has greatly improved. Now, arsenic levels are below detection limits, and the surrounding landscape is regrowing.

Beyond environmental benefits – social acceptance and carbon

Support and buy-in is a very real component of today's mining landscape. A mining company that has shown attention, care, and funding focused on environmental remediation is more attractive in the eyes of investors and the public. Plus, a proven record of responsible mining and environmental care promotes trust in communities who are often quick to oppose nearby mining activity. Changes in both legislation and reporting capabilities mean independent reviews can verify environmental stewardship successes.

Another benefit that is getting a lot of attention lately is the potential for riparian and wetland areas to sequester carbon. Large swathes of land – especially forested riparian ecosystems – can become carbon sinks as part of a carbon offset programme. This is evident in many industrial site closure plans.[2] It is anticipated that carbon sequestration opportunities will gain popularity, as more companies look to secure carbon credits and carbon offsets.

Cost of nature-based stream restoration

Regardless of the channel type, water management is typically a small percentage of the total reclamation costs at a mine. The greatest costs are usually slope grading, topsoiling, and vegetation. This means that adjusting the channel construction costs from hard armour to a natural system has a small impact on the final cost.

When restoring a stream, Stantec uses geometry and vegetation for erosion protection. As such, any additional excavation and vegetation may cost less than buying and placing rocks. Maintenance costs are also generally less. This is because a natural stream is a resilient ecosystem. It maintains balance through erosion and sediment deposition. Flooding is mitigated by building a grassy marsh area rather than riprap armouring.

In both the US and Canada, many mining projects may qualify for state and federal tax incentives and low-interest loans to support restoration work.[3] This is especially true for historic or abandoned mine sites that do not have an active supply of funding.

A duty to care for land and water

Nature-based water management can be part of every future mine closure plan. It is encouraging to see so many successful projects that have restored landscapes that were damaged due to mining impacts. Choosing to (tion may c)21 (oed)5 3DC 1.8Tmn-Gn8 0 1 k) [(tha)1m1 k thathas