RECOMMENDATION
THAT Council receive Report OPS 20-02 Old Vienna Road Slope Improvements;

AND THAT recommended Option 4 be selected as the preferred remediation of the slope along Old Vienna Road;

AND FURTHER THAT a slope monitoring program be implemented in 2021.

BACKGROUND
Old Vienna Road is a municipal road immediately adjacent to Big Otter Creek. The municipal infrastructure under Old Vienna Road consists of a 400mm dia. ductile iron watermain, a 450mm dia. concrete/CSP storm sewer and a 600mm CSP outlet pipe. All of which are at risk of failure from advanced slope failure due to toe erosion from the turbidity within Big Otter Creek. This slope instability has placed the integrity of the underground infrastructure along Old Vienna Road at a high risk of failure which would have significant impacts on the services provided to the adjacent Forest Hill Industrial area. The site in question is illustrated in Figure 1.

DST Consulting Engineers Inc., a Division of Englobe (“DST”) was retained by the Town in 2019 to complete an environmental and geotechnical investigation to quantify the current state of slope instability and develop alternative solutions to improve any identified instability while protecting nearby municipal infrastructure.

DISCUSSION
Based on the current site condition characterized by the environmental and geotechnical investigations the slope along Old Vienna Road is in need of remedial work to reduce risk and the impact to adjacent underground and above ground municipal infrastructure. With this in mind the Consultant developed four (4) conceptual design options to improve the slope stability as provided in Attachment 1.
Cross sections of the four (4) alternative options considered are provided in Attachment 2 and are further described below:

- Do nothing;
- Partial slope reconstruction;
- Soil nails with toe armouring; and
- Granular shear key / shear piles with toe armouring

Option 1: Do Nothing

The primary consideration in the “Do Nothing” option is the temporary deferral of the costs associated with a full remediation of the existing slope along Old Vienna Road. Given the advanced state of slope instability an ongoing monitoring program, at a minimum, is required at this time estimated at approximately $42,000 to implement and $7,500 on an annual basis thereafter. If the existing slope is left to continue to fail, creep and degrade it is expected that the potential slope movements at some point will necessitate unnecessary emergency spending to repair the adjacent roadway and underground infrastructure. These repair costs will depend on the extent, timing and severity of the damages sustained at the time of slope failure, not to mention the potential service disruptions to the Forest Hill Industrial area.

From an environmental perspective, doing nothing will not have an immediate impact on the existing terrestrial and aquatic habitat at the site. However, the continual ground loss being exhibited along the crest and toe of the slope can be expected to hinder the establishment of any substantial long-term habitat.
The existing failed condition and creep movement of the slope has the potential to damage existing infrastructure along Old Vienna Road at the crest of the slope. From an aesthetics point of view the current situation is considered generally as displeasing by most. Considering the direct impacts that the instability of the slope is displaying on the existing infrastructure, the remaining serviceable life of the road asset is estimated to be within the order of 5 to 10 years.

Note that the possibility of a drastic slope failure under adverse conditions cannot be ruled out and with continued removal of remaining resisting material at the toe of the slope by the erosive undercutting action of Big Otter Creek will not permit the slope to re-establish any form of permanent (long-term) stable geometry, unless the river changes course. Considering current conditions, the risk to public safety and potential service interruptions to the Forest Hill Industrial area, the “Do Nothing” option is outweighed by overall risk.

**Option 2: Partial Slope Reconstruction**

This option will achieve a slope with the required minimum slope stability by partially reconstructing the slopes directly behind 27 Old Vienna Road (owned by the Town) and immediately adjacent to Old Vienna Road with benched retaining walls and toe armouring.

The slope behind 27 Old Vienna Road, features a design with one mid-level bench (i.e., a three-tiered slope: upper, middle, and lower levels) was found to be viable. The middle and lower levels would each be supported locally by a gravity retaining wall with free-draining granular backfill and subdrains to prevent the build-up of water behind the walls. A sloped upper bank would be established next to the river, supported by riprap toe armouring. Each terrace would then be revegetated to mitigate surface erosion from flood and rain events. For the slope below Old Vienna Road retaining wall tie-back anchors would be necessary to ensure an adequate degree of stability.

The primary benefit of Option 2 is the creation of a benched geometry which can be useful both during construction and throughout the life of the structure. During construction, the benches can be used as work platforms for staging the work and accessing different parts of the slope. Once constructed, the benches can be transformed into recreational space or revegetated, bearing in mind that access should be maintained for regular maintenance and inspection work. A reasonably nice-looking retaining wall cladding, and brand-new recreational space could be expected to have great aesthetic appeal.

A moderately long service life can be considered for permanent retaining walls, assuming regular maintenance and repairs as needed. This is, however, shorter than the other contemplated options.

From a safety and reliability perspective, this option allows for on-going verification of ground conditions during the excavation, since the excavated ground will be exposed. The ability to inspect and verify the actual ground conditions in a
continuous manner helps reduce uncertainty and increases the adaptability of this option. However, any tie-back anchors used to increase the stability of the retaining walls should not be installed where future excavations are anticipated, such as the above any underground infrastructure assets. These future excavations could jeopardize the stability of the wall if the anchor is influenced by the excavation.

With the installation of retaining walls behind 27 Old Vienna Road and sections of property behind Van Street working in conjunction with the tie-back anchors along Old Vienna Road both the residential properties and Town road allowance would be protected from erosion.

The main disadvantage of Option 2 is the associated estimated cost of this design being relatively high compared to other options. This is primarily due to the relatively large amount of earthworks involved to reconstruct the entire slope. This option would also require a substantial amount of dewatering compared to the other contemplated options and the removal of all existing vegetation across the slope since the slope would need to be sub-excavated. The potential influx of sediment into the creek during construction activities could disrupt aquatic life if sediment and erosion control measures are not well executed. Thus, the environmental impact of this option is also expected to be elevated.

The high level cost estimate of Option 2 is approximately $3,055,000.

**Option 3: Soil Nails with Toe Armouring**

Option 3 primarily makes use of soil nails and toe armouring similar to Option 2 in order to achieve the minimum slope required to be stable.

For the slope behind 27 Old Vienna Road the design consists of three levels of soil nailing set at different lengths into the current soil sub-structure. For the slope between Old Vienna Road and Big Otter Creek the design includes four rows of soil nails distributed equally across the existing slope.

Soil nailing can be completed with minimal impact to an existing slope face. However, the failed gabion basket retaining wall would need to be removed and regraded to ensure the possibility of localized failures is mitigated. As such, the existing vegetation would likely have to be removed and replaced with the installation of a surface facing material. The surface facing material would cover the entire exposed face of the reinforced slope, protecting it from surficial erosion until the slope is fully revegetated.

While this method is expected to adequately address the stability of the slopes to their existing geometries, the application of toe armouring would also be required to address the on-going erosion at the toe of the slopes. The toe armouring will involve the placement of heavy-duty riprap capable of withstanding the water levels and forces of flow generated from Big Otter Creek.
As with Option 2 this method would require clear cutting of the existing vegetation in order to install the soil nails and toe armouring, however the area would re-vegetate over time. The underground infrastructure assets would also have to be relocated such that the soil nails would not rupture the storm sewers or watermain.

The high level cost estimate of Option 3 is approximately $2,525,000.

**Option 4: Granular Shear Key / Shear Piles with Toe Armouring**

A fourth slope stabilization option is a combined approach method involving the construction of a granular shear key in the toe region of the existing slope near 27 Old Vienna Road and the installation of shear piles along the toe region of the slope bordering Old Vienna Road.

For the slope behind 27 Old Vienna the Granular shear key installation would involve native soils being removed and replaced with a granular backfill material constructed perpendicular to the direction of sliding. This type of structure is generally quick to construct and possesses a relatively small footprint. The backfill material is typically angular, high-strength gravel sourced from a material that is resistive to physical and chemical degradation. This material is also typically free-draining, which can potentially result in the shear key acting as a cut-off trench lowering the site water table. Although this potential drainage improvement would further improve slope stability it is not considered reliable long-term due to the possibility of the sub-drains clogging and was therefore excluded from the overall slope stability analysis.

The main advantage of Option 4 is that it is anticipated to have a comparatively low cost, whether a granular shear key or a structural shear pile wall is selected, is anticipated to have a relatively long service life, and a low per annum maintenance cost compared to the other options considered.

Additional benefits of this option are the relatively limited impact to the upper portion of the slope, although surface grubbing and revegetation is suggested to mitigate the risk of localized failures. The limited footprint of this option is considered a benefit by allowing for a more natural aesthetic. The aesthetic could be further enhanced if a toe berm were integrated into the final design, which could double as a new riverside recreational area for pedestrians. The environmental impact of this option is considered variable. If a granular shear key is utilized, large quantities of excavated and generally inexpensive fill material would be involved using common place equipment, compared to the built structural elements of the other options considered.

Unfortunately the need to construct this option relatively close to the river could create challenges with water; particularly the need to dewater the excavation if opting for a granular shear key. Furthermore, a sequenced excavation would be a critical requirement to allow for the construction of a granular shear key due to the temporary destabilizing effect that trench excavation would have on the upper portion of the slope. This does present a temporary safety risk during construction. However, once constructed, granular shear keys are relatively unaffected by
changes in water levels, thereby making them very resilient to climate change and seasonal fluctuations in water levels or rainfall. Furthermore unlike the other options the underground infrastructure assets would not have to be relocated to facilitate construction.

The high level cost estimate of Option 4 is approximately $1,545,000.

**Options Evaluation**

In order to assess the various slope remediation options and determine which of the four (4) options represents the highest overall net benefit to the Town, an evaluation matrix was developed based on major and minor criteria including:

1. Safety
   a. Encroachment on Existing Road During and After Construction
   b. Long-Term Resilience under Normal Conditions
   c. Long-Term Resilience due to Flooding or Seismicity Activity

2. Environmental Impact
   a. Long-Term Impact to Terrestrial Habitat
   b. Long-Term Impact to Aquatic Habitat
   c. Likelihood of Increased Surface Water Run-off

3. Cost & Lifespan
   a. Long-Term Cost Effectiveness
   b. Ease of Inspection and Normal Maintenance
   c. Estimated Service Life of Overall System

4. Aesthetics
   a. Aesthetic of Natural Environment
   b. Aesthetic of Infrastructure

Each criterion was assigned an importance factor, as identified within the evaluation matrix, based on the overall project objectives. The range of importance factors is summarized in Table 1.

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<td>High Importance</td>
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<tr>
<td>No Importance</td>
<td>0</td>
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Each criterion was then scored against the site specific considerations/impact associated with each option. The impact level and corresponding score are noted in Table 2.

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<th>Impact Level</th>
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The individual minor criterion scores for each considered option were taken as the product of the importance score and the relative impact score. The final score for each considered option was then calculated as the sum of the individual scores for each of the considered minor criteria, with a maximum total score of 108 points. The option with the highest total score was taken to reflect the most desirable of the considered remediation options based on the above noted weighted criteria.

A high-level summary of the individual evaluations and associated assigned scores for each of the alternative solutions is present in the Evaluation Matrix of Attachment 3.

Next Steps

Based on the Evaluation Matrix it is staff’s recommendation that Option 4 – Granular Shear Key / Shear Piles with Toe Armouring be selected as the preferred slope rehabilitation method. As part of the RFP scope of work the Consultant will complete the detailed design of the recommended option including a detailed cost estimate for future budgeting purposes.

Until the construction of a permanent solution, staff also recommend that a monitoring program as identified in Option 1 be commissioned next year to collect and analyze pertinent slope movement information on an ongoing basis that will help to ensure infrastructure investment is completed at the right time.

CONSULTATION

Town staff have worked collaboratively with DST to reach this important project milestone and will continue to do so throughout the design stage. The Long Point Region Conservation Authority has also been consulted and will be circulated for additional comments during the design stage.
FINANCIAL IMPACT/FUNDING SOURCE
It is recommended that a reserve contribution in the amount of $200,000 for the rehabilitation of Old Vienna Road Slope be incorporated in future budgets to mitigate the financial burden of this project on a single budget year and to help minimize the financial impact should slope failure occur in the meantime. In addition, the $42,000 cost associated with implementing a monitoring system and the ongoing annual cost of $7,500 will be introduced as part of the 2021 budget deliberations.

COMMUNITY STRATEGIC PLAN (CSP) LINKAGE
1. Excellence in Local Government
   - □ Demonstrate strong leadership in Town initiatives
   - □ Streamline communication and effectively collaborate within local government
   - ☒ Demonstrate accountability

2. Economic Sustainability
   - □ Support new and existing businesses and provide a variety of employment opportunities
   - □ Provide diverse retail services in the downtown core
   - □ Provide appropriate education and training opportunities in line with Tillsonburg’s economy

3. Demographic Balance
   - ☒ Make Tillsonburg an attractive place to live for youth and young professionals
   - □ Provide opportunities for families to thrive
   - □ Support the aging population and an active senior citizenship

4. Culture and Community
   - □ Promote Tillsonburg as a unique and welcoming community
   - □ Provide a variety of leisure and cultural opportunities to suit all interests
   - ☒ Improve mobility and promote environmentally sustainable living

Attachments:
Appendix 1 – DST Conceptual Design Report to Improve Old Vienna Road Slope Stability
Appendix 2 – Cross Sections
Appendix 3 – Evaluation Matrix
## Report Approval Details

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<td>- OPS 20-02 Attachment 2 - Cross Sections.pdf</td>
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<td>- OPS 20-02 Attachment 3 - Evaluation Matrix.pdf</td>
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This report and all of its attachments were approved and signed as outlined below:

- **Dave Rushton** - Jan 22, 2020 - 8:47 AM
- **Kyle Pratt** - Jan 23, 2020 - 6:30 AM
- **Donna Wilson** - Jan 23, 2020 - 8:27 AM