

Online Community Conversation: Undermining Q & A

October 5, 2016

Are there any historical ruins on the site that can be maintained to help preserve the mining history of Canmore?

There are numerous artifacts scattered around the Town of Canmore, including rail cars and engines. Many of the mine entrances on TSMV, though sealed, are in the actual locations, but are generally recreated. There are some small artifacts found throughout the site (e.g. cables, wooden water pipes, small weirs, small machinery parts, timbers), but generally not historically significant objects. Many elements are removed during Golder's investigations for public safety if they are deemed hazardous.

One local group is working with the Canmore Museum and Geoscience Centre to restore the old lamp-house (near the former tipple site south of Three Sisters Parkway) as a historical resource, and Three Sisters is working with them to designate the site and create access easements as it is currently owned by Three Sisters.

What about the undermining in the area? I saw a video that showed that we don't truly know where the old mineshafts are. Aren't gasses and cave-ins inevitable?

As mentioned during the online conversation, we actually have quite excellent mine plans, and we have largely been able to 'truth' them through drilling where needed. So we actually have good mapping of where mines are, and also the condition they are in under and around development sites. Once undermining reports are completed, anyone can view the reports and diagrams in locations such as Town Hall, the library (collection incomplete, working to update) or by pulling a copy of an affected title and looking up the appropriate restrictive covenant.

On rare occasions, we encounter a situation where there was an old shaft leading to the surface, and we know pretty accurately where it is, but there can be challenges in re-opening the shaft due to backfilling work by the miners. In those instances, we have used drilling to locate to shaft where needed, or used conservative setbacks from building development to ensure no buildings are located over such features. At all times, public safety is the primary concern, and significant work is done so that in the event there is a future surface depression formed, the hazard is very small (perhaps a trip hazard at most) as a cautionary approach.

Are these mining plans as-built, or something else? How detailed was the geotechnical drilling?

Almost all of the mine plans prepared by the miners are as-builts. Rarely, we will find a plan that is largely accurate, but may identify—for example—a mine pillar as being present, but when we drill we discover that the pillar has been mined and the miners haven't bothered to update the plan. This is one of the reasons the undermining engineers undertake drilling programs—to verify mine plans. Undermining engineers verify that mining plans and the mining activity align, and that the miners did not take extra coal. Further, engineers assess the conditions of the mine and conditions of the pillars. They do enough drilling to confirm that the mine plan is an accurate representation of what is really

present. We have found that the previous miners kept excellent survey records of their work, a tribute to their diligence.

How many holes have been drilled in TSMV? At what depth are the mines?

There are hundreds of boreholes located throughout Three Sisters, with the location and number of boreholes per development site determined based on physical mine attributes, stratigraphy and anticipated depth to the shallowest mine. There are many areas in Three Sisters where two or more mines may be present below or near a site, however it is usually the shallowest mine that is concentrated on for drilling work, as shallower mines generally have a greater potential impact on development.

The depths of the mines vary. There are coal seams that come all the way to the surface, and were worked as pits dug down from the surface (like Grassi Lakes area, and a couple of locations in the unfinished golf course), and then there are mines that are over 100 – 200 meters below the surface.

Is the geologic stratigraphy of the overburden available for the public to view?

Most of the undermining reports are available at the Canmore Public Library, and the Town of Canmore has a complete collection as well. There was a period during the receivership when the library wasn't as updated as it could be, and we are currently working to update their files.

Finally, if you are a landowner affected by undermining within the Three Sisters regulated area, and your parcel was subdivided after 2005 or so, the entire report is registered against your land title. Previous ownerships of Three Sisters sometimes just registered a caveat which meets the provincial undermining regulations, but not the entire report on title. It also worth noting that parcels developed or subdivided before 1998/1999 or so like Peaks of Grassi, Mineside, Homesteads, etc. are not subject to provincial undermining regulations, and may not have a caveat on title due to different, less rigorous review procedures in place before the provincial regulations were enacted.

Aren't there coal mines in the eastern United States that have started to, and continue to, burn? What are the chances that these old coal mines might catch fire? What types of hazardous gasses are present here?

Yes, there have been examples of coal mines catching fire. Generally, that occurs in mines located in thermal coal seams, and not the higher grade of coal found in Canmore that was used for coking (bituminous to semi-anthracite). As for gasses, there is always a risk of carbon dioxide and methane gas coal in mines. There has been extensive methane gas testing conducted, and after years of testing, we have found that these mines are not releasing the concentrations of gas methane that would be considered a hazard. Further, many of the mines are flooded with groundwater, which precludes ignition of the Canmore coal seams below the water table.

Has the groundwater flow been mapped? How many groundwater monitoring wells are in the area? What kind of water pressures are in the area, given we are dealing with a shallow system?

That is a complicated question. Because we are in an extensively undermined area, the ground water flows have been heavily influenced by the mines. Due to the lateral extent of the mines and the interconnections between them, there is *very little opportunity for water pressure to build up*. The water can flow between and along mines easily, and the surface deposits are largely gravel, which is very well

drained. The mapping of groundwater flows would depend on the stream flows and inflows into the mines. We know, more or less, the water flows south to north towards the river, but *exactly* what happens underground is quite difficult to map here. However, the detailed mapping of groundwater flows is not considered to be an unusual factor for development of Three Sisters given the surficial gravels that provide a high level of drainage already even without the additional potential drainage conduits unintentionally possible through the mines.

Downtown Canmore has far more significant implications for development with respect to groundwater than Three Sisters does.

Which professional in this process would held responsible or liable in case of an oversight?

In general, it is the undermining engineer producing the report. The engineers work must be conducted to accepted professional standards; if they have been found *not* to have followed reasonable professional standards, they can be held liable.

For mines at significant (say more than seven (7) to ten (10) times the height of the mine tunnels) depths, is there any visible surface subsidence possible in the absence of a sink hole?

Over time, it is possible that the material that has gradually fallen into the void created by mining tunnels could be further compressed, but the changes due to compression are so subtle, one would not notice when walking over the surface, and buildings can be easily designed to accommodate such gradual and subtle changes if needed. Buildings are already designed for settlements around the world using typical geotechnical considerations, and are generally very well understood and accounted for.

Given the heterogeneity and complex structural geology of the area, how predictive can you be? Does the rock mass throughout the area deform and settle similarly enough that you can generalize?

There is actually a lot of consistency in the stratigraphy from a development and construction point of view; so, to a large extent, predictions can be undertaken with confidence. However, every development site is investigated and every situation is slightly different (e.g. depth of mine, extent of mining activity). Like every other engineering analysis for every other building built in North America under modern building codes, no one can be 100 per cent confident in every single variable considered for design. As for any analysis that must estimate the impacts of natural variability (e.g. earthquake magnitude potential, soil settlements, materials used, snow loads, live loads) the undermining engineers also apply some conservatism or safety factors to the analysis based on professional engineering assessment (i.e. buffers around potential hazards are larger than estimated impact area).

Mr. Beddoes mentioned extensive development has already been undertaken over abandoned mines in many countries. Is it not the case that there have been significant failures and damage to buildings in these areas? For example, in the UK and also in and around Edmonton.

Mr. Beddoes did note that there are plenty of places where development has previously taken place on mines, without awareness that the mines were there or proper engineering assessment of their location and condition which has provided an extensive amount of real world data on potential impacts. Under provincial regulations already in place, Canmore has much more robust methods for investigation and professional review than these past situations. Today for example, there are similar expectations in the UK around investigation and professional engineering assessments if development is going to occur

around mines as Canmore is already undertaking. These historical failures in other countries, however, have been of benefit to Canmore in that they can provide engineers with data they can use to increase their knowledge, test their predictions and ultimately increase their confidence.

How capable are you of predicting the location of future tension cracking? Do you think the ones that will form already have? Is crack formation post-development possible as mines settle over time?

Yes, future potential tension cracks are possible, and this is already something the undermining engineers consider. When they look at the current state of mining, they investigate and assess whether or not collapse has already taken place: often it has given the age and physical characteristics of the mines in Three Sisters area. In most cases, tension cracking evident at the surface has already taken place, but we cannot always be certain no others will occur in future. So during analysis, the undermining engineers look at the rubble that exists in collapsed areas, they look at voids, and they look at separations in the layers of rock near the surface. There is a process for predicting the compressibility of these features, so careful engineering assessments are made of those areas that may compress and settle in the future, and development recommendations already reflect those assessments. Some of the associated risks can be mitigated through building structural design if necessary, but more typically buildings are simply shifted to avoid potential areas of impact.

Can you speak to the sink holes that opened under Three Sisters Parkway about 10 years ago? What factors caused it? Was there more than one?

In that location under the Parkway, there was a known shaft and it had been mitigated. Unfortunately, it appears the alignment of the roadway had been shifted a little bit, and that new alignment was not relayed to the mitigating engineer. The issue was compounded by a water main that burst, forcing a lot of water into the soils under the roadway and removing some through erosion. Further, it was winter time, so the surface of the parkway was frozen and hid the lack of support caused by the soil erosion beneath the asphalt. These factors combined to create a sinkhole under the parkway. The parkway was shut down, the area was investigated, and the shaft was covered by a reinforced concrete cap to prevent further issues. After the reinforced concrete cap was constructed, the water main and the parkway was repaired. There have been no further issues since.

With slurry mitigations, how do you determine the volume to pump down, and do you evaluate how far the slurry migrates laterally through the mine workings?

The slurry consistency can change by design, and so it can be made to be quite fluid or less so. Often the undermining engineers create barriers so that the area they are pumping into becomes defined. One method we use is to drill boreholes where we can drop gravel to 'plug' either side of the cavity prior to pumping the slurry in. In other cases, we may be filling a flat tunnel, and we know the dimensions. In these situations, we will pump in substantially more than we believe we need to fill that void, and then we will drill additional boreholes to ensure the void is filled or watch the filling process through cameras dropped down through boreholes into the mines.

Does the slurry material impede groundwater flow? Will it result in a locally perched water table?

Certainly there are situations where it *could* impede ground water flow, but as mentioned earlier, we consider impeding flow in an area where flow used to take place. Nonetheless, given the relative small area of the features being filled with slurry material when compared to the watershed, it would be quite

difficult to create a perched water table, especially given the well-drained gravels that generally sit on top of the sedimentary rock.

If we already have two incidences of failures, Dyrgas Gate and Three Sisters Parkway, how many other vulnerabilities might there be in the new development?

Dyrgas Gate is not a failure of mitigation or investigation. In the case of Dyrgas Gate, Norwest (the undermining engineers before Golder) knew that there was an air shaft (known as B14) in the area, and several boreholes were drilled to find the exact location of the shaft. However, it had been backfilled to a significant depth by the miners, and so the exact location could not be determined physically. Knowing the shaft had been there, but unable to determine its exact location, Norwest laid a geogrid mesh over a large area, well beyond the mapped location of the shaft. Further, building development was separated from the potential air shaft on all sides, so there was no risk to structures or residents within the buildings. The intention of this approach was that if something *did* happen, the undermining engineers would know exactly where the shaft was, no-one would get hurt as they could not fall into the shaft, and no structures would be damaged. At that point, long term mitigation could be implemented. So, the investigation, engineering, and mitigation actually worked as intended. Unfortunately, the Dyrgas Gate sinkhole occurred during receivership, which has caused a delay in the repair, but this is not a failure of the engineering process or mitigation.

So at the Dyrgas Gate sinkhole, the geotextiles mitigated the risk to the public, but there is still the concern of cost in the future. Is the registration on title, and the placement of geotextiles just passing the buck to future owners? What is the structural integrity of buildings adjacent to the sinkhole?

All buildings were placed outside of the 'zone of influence' of both the undermined areas and the potential air shaft. There is and was no risk to the structures from the air shaft or the sinkhole. The buildings are very structurally sound, and conform to building codes. All buildings in this area have the undermining report registered against their title, and the airshaft and its mitigation was fully disclosed to the public through the registration on title. All public infrastructure like roads, waterlines, sewer lines, treatment plants, parks, sidewalks, pathways, fences, buildings and some types of undermining mitigation can require ongoing lifecycle maintenance.

What is the design lifespan for mitigation features, such as a concrete cap? What is the stability of the surrounding materials?

A concrete cap can be expected to last more than a hundred years. We do look at the stability of rocks and soils around the cap to ensure that they can support the fastening of a concrete cap. In many cases, we are adding a mitigation to a mine that has been closed for fifty or more years without incident; therefore, we would anticipate a very long life for the mitigation feature. Infrastructure does generally have a design life, such as 15 years for many roadways or 15-30 years for asphalt roofs or 50 years for many concrete structures exposed to weather.

What is the lifespan of mitigations below a building?

We would expect the forms of mitigation that would be used under a structure to last indefinitely for all practical considerations, and far exceed the 'lifespan' of the building constructed above. Should new buildings be built over mitigation works, they still require assessment before construction to ensure the mitigation undertaken works with the new building. Structural mitigations (to the buildings) are

expected to be the life of building as required by the Building Code with proper maintenance as required for any building.

What is the life span of a building (in years)?

The engineered lifespan is typically forty to fifty years. Buildings can last much longer, but require maintenance to extend the 'life' of the structure.

Building placement mitigates the safety risk to the public, but there is still the question of mitigation costs. Who is responsible for this? As I understand it, provincial and municipal tax payers are currently paying to control the size of the sink hole at Dyrigas Gate.

There is no work being done at Dyrigas Gate to control its size. In this case, there are two different regulations. One is the regulation defining the processes for mitigation. The other says the Town of Canmore is absolved of liability if they conform to proper mitigation processes. But there was an agreement with the Province that was signed by the Town that says, even though individual property owners and TSMV are protected from liability by the Province, if undermining related damage occurs on municipality-owned land (such as the park at Dyrigas Gate) the Town is not indemnified. The Town and Three Sisters are working together to talk to the Province about a potential new agreement with the Town, and this is ongoing. If you are an individual property owner, the Province protects you from liability after an occurrence, so long as you conform to the prescribed engineering standards and the undermining process. As with all public infrastructure initially installed by a developer (such as waterlines, sewer lines, roadways, and sidewalks) this infrastructure can require maintenance or repair by governments at some point. Most undermining mitigation doesn't require maintenance, but works that do are treated like any other piece of public infrastructure.

What percentage of Smith Creek and Resort Centre you are proposing to develop is undermined? How much of this area will require extensive mitigation prior to development?

The vast majority of the developable Smith Creek ASP area does not have undermining on it. Most of the mining that occurred in this area was to the south of TSMV property. Investigation of the property still occurs prior to development to ensure safety, but there was little to no undermining activity in the developable portion of Smith Creek. Approximately 70% of the Resort Centre is undermined, this is similar to the proportion of land undermined in Stewart Creek or Three Sisters Ridge areas. Other areas have less (Three Sisters Creek) and some have more (Cairns). The Resort Centre does have a small amount of vertical mine workings on the south edge of the ASP, however, it is less than 5% of the land area and these lands are simply avoided as they are not economic to mitigate through other means.

Is there any risk of earth quakes affecting the area? Do you consider this in analysis?

While the undermining engineers are specifically looking at undermining risks, the earthquake risk present in Alberta would not impact undermining assessments materially. Alberta is not a high earthquake risk area and mines also tend not to be significantly impacted by earthquakes. Structurally, earthquake mitigation is part of the Building Code of Alberta and is assessed by both geotechnical and structural engineers as part of the building permit process like every other structure in Canada.

You had mentioned that there is substantial undermining in Stewart Creek Phase 2. There are portions that are not undermined in that area, right?

Lands north of the parkway in Stewart Creek Phase 2 do not have very much undermining impact. There is some impact because the mines tend to terminate right along the parkway, which had to be analyzed. Stewart Creek Phase 1 had substantial undermining throughout it that had to be mitigated, through slurry fill and other approaches.

Is the potential for differential settlement an issue for the larger buildings associated with the higher densities that are proposed in the new development?

Differential settlements are definitely more of an issue with larger (longer) buildings. In these areas, there are mitigations such as adjustable or articulating foundations or walls to limit the impacts to cosmetics in the building, but there is negligible risk of significant damage to the structure. Differential settlements are also assessed as a part of building permit process by both geotechnical and structural engineers as required by the Building Code, the same as any other buildings throughout Canada.

In the event of an oversight or a failure of one of the mitigation measures, who is liable? Can home owners take out insurance against undermining if it is registered on their title? Who picks up the cost (owner, developer, municipal government, provincial government)?

In general, the engineer producing the report is liable—with conditions. The engineers work must be conducted to accepted professional standards; if they have been found *not* to have followed reasonable professional standards, they can be held liable. There is insurance from every professional engineer practicing in Alberta, but gross negligence related errors are very rare.

Regarding insurance, if an individual tried to take out insurance on their own home, they would have to ask their broker if undermining insurance is available and what the cost would be. That would be at the choice of the home owner, and it would be at their cost. You are already protected under [Alberta Regulation 114/97](#) as an individual land owner within the designated lands, so insurance obtained by homeowners would be over and above the regulation's protection should the homeowner wish to obtain it.

Will the developer voluntarily take out specific undermining insurance on any undermined land you plan to build on in order to take responsibility for the development, so taxpayers are not left footing the bill similar to what has happened on Dyrkas Gate Sinkhole?

This was investigated in detail several years ago. Undermining insurance of that type is simply not available. We went to some of the largest insurance companies in the world, who went to the re-insurers, and the Province examined the issue as well, and it was found that the insurance is unavailable. The option is being reinvestigated, but as of now—this is not an available option.

The previous provincial government failed to require developers to obtain insurance as required by Bylaw 114/1997, would the developer support the new provincial government if they decided to require insurance for structures on mitigated land?

As noted above, the previous government did not “fail” to require the developers to obtain insurance, nor did previous developers “fail” to provide it; it simply wasn't available. In fact, before the receivership, Three Sisters went through a very long and exhaustive process with Alberta New Home

Warranty and they agreed to provide their standard warranty coverage on undermined lands as they carefully assessed and evaluated the undermining investigation, assessment and review process and found no reason to deny coverage. (Note: Alberta New Home Warranty did not provide undermining specific insurance, but they wanted to assess if undermining presented unusual risks that were not being professionally address that would cause them to withhold warranty coverage). If Three Sisters were required to do so by the Provincial government, one would assume the insurance was available, and just like any other law-abiding business, we would comply and take out such insurance. However, as stated before, this issue has been examined previously and is being reviewed again.

Given the many bankruptcies in the past, and the difficult conditions of the newest proposal you are outlining to us right now, why should we trust that the developers have things under control this time around?

There are only two very small areas on the Resort Centre (less than 5% of the land area) where the conditions are difficult and these are the areas of vertical mine workings. We will be simply avoiding these areas as mitigating them is not economic to undertake. Otherwise, the conditions are similar to those that have already been successfully built upon in areas such as Hubman Landing, Three Sisters Ridge, Stewart Creek Phases 1 & 2, and others. Outside of the vertical workings (which only occupy less than 5% of the land area and are simply being avoided), the development of the Resort Centre is essentially typical of the remainder of Three Sisters, and is well understood.

It has been said that developers cannot obtain insurance for structures on mitigated land. If a detailed and accurate risk assessment and mitigation has been carried out, should it not be possible to obtain such insurance?

There has to be enough of a market for the insurance companies to offer insurance. We have previously investigated the availability of undermining insurance as noted above. As we are not insurance providers, we do not have a detailed response as to why it is not available.

Will development go ahead if insurance is not available?

Yes. If the development goes through the process described in this presentation (as prescribed by the province), then yes—development will proceed subject to all the usual municipal approvals and permitting processes.

What is the life-expectancy of the development? If the development proceeds, how long will it take for it to be completed?

The structures and infrastructure have identical life expectancies to the others in Alberta—there is nothing special about the life-expectancy of structures in TSMV.

The project will likely take 15 to 20 years to build out.

If the province isn't responsible, is the town responsible for undermining issues (liability) for Homesteads and Peaks of Grassi?

Yes, the Town could be exposed to liability for undermining risks in areas outside of the designated area, as they prescribed and participated in a very different undermining review process in parts of Canmore.

This of course would depend on the details and specifics of the issues should something arise, but it is possible.

Previous owners have gone bankrupt more than once. What special trust should we have in the current ownership incarnation being around 4 years from now?

We do not know of any written guarantee or special trust that any person, corporation or entity can make to say for certain that the entity will be around for a prescribed time in the future. But given the track record of the current ownership, as the only ownership that did not take the project into bankruptcy, we believe there is reasonable level of certainty and stability.

So the undermining sounds risky and expensive. The development negatively impacts the wildlife corridor. Many more people will live in the Bow Valley. How do you convince us that this is not a lose-lose-lose situation?

The decision to build TSMV was made in 1992 by the NRCB, and the decision regarding wildlife corridors (in terms of process) was also made in 1992. This is not an opportunity to re-visit or scrap the project, but rather to ensure we are using the proper techniques and engineering for undertaking the project. The Town's major infrastructure is already sized knowing the project is coming; so, if the project were to stop (for some reason), the taxpayers would be on the hook for oversize infrastructure.

Please review the [Wildlife Online Community Conversation](#) for a discussion on the impacts on the wildlife corridor.