BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

YUKON GOVERMENT

GRUM SULPHIDE CELL COVER, FARO MINE

2014 REVIEW

FINAL

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March 11, 2015
Project No.: 0533-006

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Assessment and Abandoned Mines,
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Whitehorse, YT Y1A 2C6

Dear Dr. Rainey,

Re: 2014 Review – Grum Sulphide Cell Cover, Faro Mine

Attached is our report on the above captioned subject, following from our site visit in May 2014. We have attempted to focus on short term cover and water management issues but also considered some of the medium term water management aspects herein.

We thank you for the opportunity to provide service again at Faro Mine and we look forward to continuing our assessment work later this year.

Yours sincerely,

BGC ENGINEERING INC.
per:

ISSUED AS A DIGITAL DOCUMENT,
SIGNED HARDCOPY ON FILE WITH
BGC ENGINEERING INC.
AND RECEIVED BY CLIENT

James W. Cassie, M.Sc., P.Eng.
Principal Geotechnical Engineer

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1.0 INTRODUCTION

1.1. Background

As part of the early closure activities at Faro Mine in 2010, Yukon Government (YG) managed the design and construction (by third-party engineers and contractors) of a soil and geosynthetic liner cover and related perimeter ditches over the Grum Sulphide Cell (GSC). In May 2011, during spring run-off, significant erosion of the GSC cover occurred and non-compliant water from the GSC was discharged into Vangorda Creek. BGC Engineering Inc. (BGC) was retained in July 2011 to review the root causes of this discharge event and several remedial measures were constructed within the cover system, as documented in BGC (2012a).

It should be noted that, as part of the original design of the GSC, the run-off water from the cover was to be directly discharged to the environment at the toe of the Grum Dump. Based on the spring 2011 non-compliant discharge event, remedial measures were constructed in the fall 0f 2011. This included construction of a lined containment pond and an unlined contingency pond to capture surface water from the cover, coupled with an active pumping system to transfer contact water into the Vangorda Pit for later treatment. As such, YG accepted active water management from the cover versus the previously expected passive system.

Since that time, BGC has attended the site in 2012 and 2013 to assess the cover performance relative to freshet and spring thaw conditions in that year; BGC (2012b) and BGC (2013) document those results. BGC was again requested to attend and document the GSC cover conditions in May 2014, and this report documents the freshet conditions, related monitoring information, site observations and recommendations for consideration.

1.2. Scope of Work

BGC prepared a proposal dated May 5, 2014, that included the following main tasks:

1. Review of any existing run-off information collected by YG on volumes/rates and photos regarding cover system during 2014 spring freshet.
2. Brief site visit by BGC to review the condition of the GSC cover and related water management system.
3. BGC to prepare a condition report on the GSC cover and water management system, including a summary of pertinent observations, relevant photographs and recommendations (if any) for additional work and monitoring.

It was noted that the condition assessment and related recommendations are related to the short term performance of the cover and not towards the longer term issues that will also require assessment under separate scope.

This current report provides the condition report noted in Task 3. Authorization to proceed was provided under Engineering Agreement C00024032 between YG and BGC. Section 2 provides an overview of the GSC cover elements and freshet monitoring that occurred. Section 3 summarizes conditions observed during the BGC inspection, along with a review of site climatic conditions for context. Section 4 provides both short term and medium term recommendations.

2.0 BACKGROUND AND 2014 MONITORING

2.1. Cover Background and Elements

Background information on the as-builts for the GSC cover are provided in SRK (2011) for the original design and construction and BGC (2012a) for the cover upgrades constructed in 2011. Major components of the final design by list by SRK (2011) are as follows:

- Resloping of GSC dump slopes to 5H:1V (or flatter) and establishment of benches at horizontal intervals of 60 to 85 m.
- Construction of a Toe Berm (with clean waste rock) at the base of the GSC cover including geomembrane installation.
- Installation of textured (one side) 60 mil HDPE liner over the resloped GSC surface.
- Placement of 1 m of uncompacted till layer over the liner and Toe Berm.
- Placement of 1 m of waste rock and geotextile along GSC benches.
- Construction of access ramps and perimeter drainage ditches, including energy dissipation pools and water management structures, to direct surface runoff from the cover to Grum Creek.

As outlined in BGC (2012a), the cover run-off is directed into ponds for pumping to the Vangorda Pit. Photo 2-1 provides an aerial view of the GSC cover and associated elements.

Photo 2-1. Aerial view of the GSC cover, perimeter ditches and associated ponds, and water flow direction arrows, relative to overall Grum Dump. V15 and Grum Creek seep water collection located in right foreground at Y in the road. V15 monitoring station located at sump approximately 150 m west of Y in the road.

The GSC cover directs surface water horizontally from the 5 benches to the West and East Perimeter Ditches and around the Toe Berm to the Lined Pond (capacity of 8,000 m^3), located directly at the toe of the cover. Water from that pond is pumped by pipeline to the Vangorda Pit where it collected for treatment.

An unlined contingency storage pond, the Unlined Pond, was created within an existing depression on the waste dump level below the Lined Pond. This pond collects water from two sources; excess water from the Lined Pond/pumping system (if the inflow is greater than the pumping capacity and the storage is full), contact water from other dump runoff sources (unremediated) located southwest from the GSC cover and from the access road on the northeast toe of the dump. Water retained in the Unlined Pond is pumped to the Lined Pond.

At higher pond levels in the Unlined Pond, it is also possible that some seepage may occur down the south face of the waste dump as has occurred in previous years.

Seepage and runoff water from the Grum Dump not collected in the ponds is funneled down towards water quality/pumping station V15 as shown in Photo 2-2:

Photo 2-2. View of water collection and pumping elements at Pumping Station V15 at the confluence of V15 seep and Grum Creek seep (May 21, 2014). V15 water comes in from the southwest portion of the dump from the left channel. Grum Creek emerges from under the northeast corner of dump and flows over monitoring location GC Weir (white container marking channel at right-center of photo).

2.2. 2014 Freshet

YG (2014) provides a photographic summary of the GSC cover, ditches, and pond post-snow cover melting, including the following observations:

- The highest flow volume into the Lined Pond occurred at approximately 6:00 pm on May 6, 2014.
- By that time, the vast majority of the snow cover on the GSC cover had melted, except for some minor accumulations located on longitudinal bench drains, as shown on Photo 2-3:

Photo 2-3. Snow cover melted by freshet except for horizontal longitudinal benches, proximal to both perimeter ditches and the oblique accumulation on the west (left) side of the cover (May 6 or 7, 2014).

- Water appeared to be flowing under the snow cover in the East Drainage Ditch.
- Minor slumping noted in the toe berm slope.
- Standing water noted with snow accumulation of the toe berm bench as shown in Photo 2-4:

Photo 2-4. Melting snow cover and standing water on top of Toe Berm bench, looking west (May 6 or 7, 2014).

- West energy dissipation pond and toe berm ditch flowing properly with no signs of overflow or erosion.
- No erosion noted on the access road surface located adjacent to the West Drainage Ditch.
- Erosion noted on West Perimeter Ditch slope due to blockage (snow) on the adjacent bench.
- Some slope erosion noted on the western portion of the cover.
- Most longitudinal bench drainage was directed as intended.

No discharge of non-compliant water occurred this year, as occurred in 2011 and 2013.

2.3. Pond Levels Water Quality and Quantities

In considering the Grum Dump surface as an area for run-off generation, the dump is composed partially of the remediated GSC cover and partially of unremediated areas of waste rock and till. The objective in placing the GSC cover was to prevent contact between surface water and sulphidic waste, and hence, keep this contact water “clean”, whilst the waste rock contact water would likely be impacted, and generally not suitable for immediate discharge. To the first point, two aspects are important to consider on the cover material; cover design would be such to control cover erosion and if erosion occurred, the material needs to be clean. EDI (2011) indicates that the GSC till cover and the South Till Borrow area contains soils that contain elevated concentrations on zinc. These results suggest that the existing GSC cover material is a potential source of elevated zinc concentrations that would be liberated when the cover materials are eroded and become suspended in run-off water. As such, the prevention of any cover erosion is an important issue for water quality.

TEES (2014) provides a summary of 2014 pond levels and water quality monitoring results as summarized below, while Figure 2-1 provides total zinc concentrations for 2013 and 2014 for both ponds.

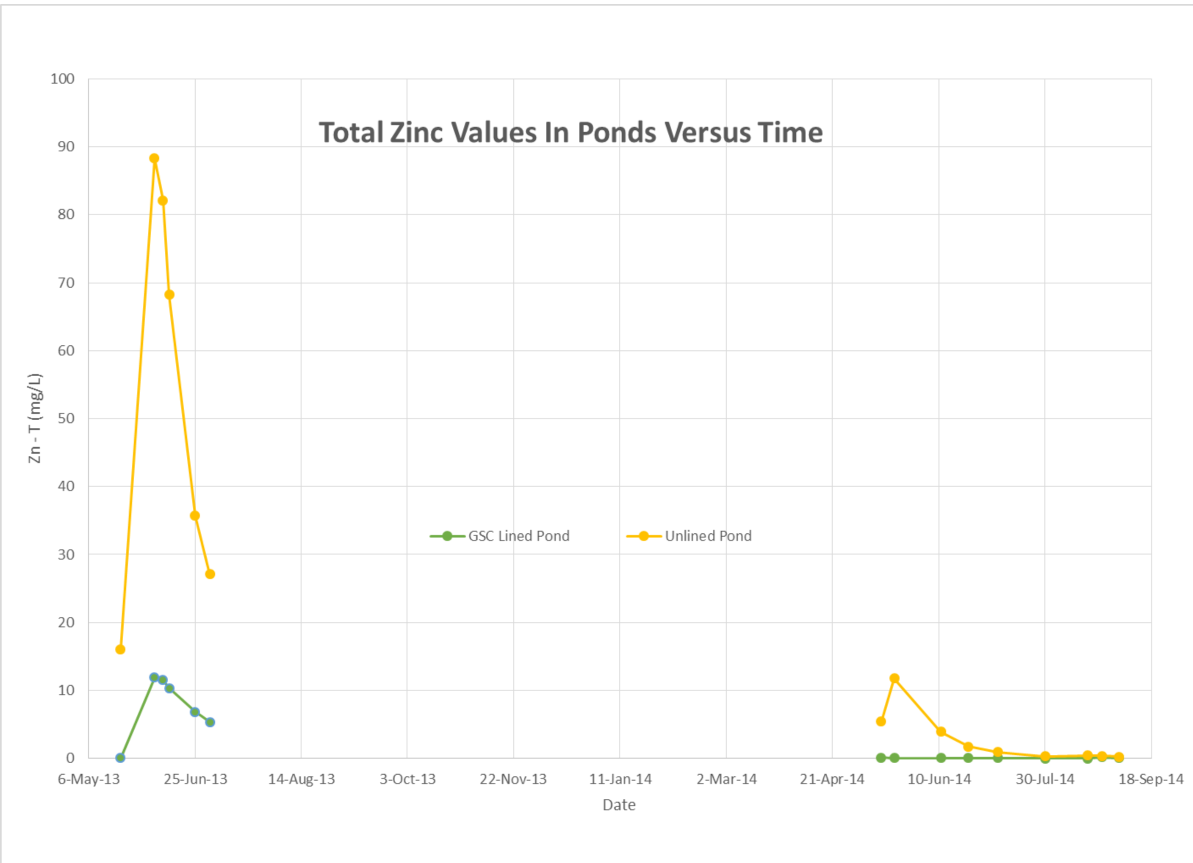

Figure 2-1. 2013 and 2014 Total Zinc Values for Both Ponds

- Table 2b (TEES 2014) indicated that pond levels were measured between May 14 and Oct. 28, 2014 and they varied from elevation 1189.634 m above sea level (asl) initially, up to 1189.785 m asl by May 20th (rise of 0.151 m), then oscilated around 1189.5 m asl until July 30th, followed by a decline to lowest elevation of 1187.947 m asl (decrease of 1.838 m since May 20th) on Oct. 21st.

- Table 2c provides the similar data for similar period for the Unlined Pond. It records that the pond elevation started initially at 1161.703 m asl on May 14th and then decreased until the lowest elevation of 1161.250 m asl on July 8th (pond level decrease of 0.453 m) which then rose slightly to 1166.547 m asl on Oct. 1st.
- Table 1a provides a summary of field and analytical results for water in the Lined Pond between May 14 and Sep. 3, 2014. Electrical conductivity and total suspended solids (TSS) values were elevated versus discharge criteria during the initial freshet period of May 14th to 20th; flow was estimated to be 2.05 L/s. Total zinc concentrations were all below 0.1 mg/L from May 14th until Aug. 19th with a slight increase to 0.198 mg/L (correlated with higher TSS value of 27 mg/L) on Aug. 26th. These analytical results imply that the water contained in the Lined Pond was compliant for discharge (assuming 0.5 mg/L concentration for zinc), based on the total zinc and TSS values (except for high values on May 14th and 20th). This compliant water would have been pumped to the pit for treatment.
- Table 1b provides a similar summary of results for the Unlined Pond for the same period. The electrical conductivity value was high on May 14th (7600 μs/cm) and then dropped and oscillated in the range of 1200 to 1800 μs/cm for the remainder of the period. Total zinc values were high in the range of 1.7 to 11.76 mg/L during the period of May 14th to June 24th, decreasing to 0.936 mg/L on July 8th and then less than 0.5 mg/L for the remaining monitoring period. TSS values were low except for two high values on July 30th and Aug. 26th. These analytical results imply the water in the Unlined Pond was not compliant for discharge between May 14th and July 8th but it was compliant for total zinc after that period, although TSS levels would have been too high on two of the noted days.

Comparing the total zinc values for the two ponds, the Lined Pond values were generally lower than 0.1 mg/L (compliant) while the Unlined Pond values ranged from greater than 5 mg/L (non-compliant) to a range of 0.23 to 0.4 mg/L (compliant). These zinc values demonstrate that the Lined Pond has lower concentrations and its run-off comes from the remediated (and cleaner) cover surface while the Unlined Pond water comes from the unremediated waste dump surfaces. For comparison sake to 2013, Table 3-2 within BGC (2013) provides similar summaries regarding analytical testing for the two ponds. The later season (post-freshet) total zinc values for the Lined Pond were 0.198 to 0.047 mg/L in 2014 but were 5.3 mg/L in 2013, so the values were much lower in 2014. For the Unlined Pond, later season total zinc values ranged from 0.23 to 0.4 mg/L for 2014 but they were >27 mg/L in 2013, indicating lower concentrations in 2014 again. The lower zinc concentrations in 2014 are both lower than 2013 and compliant for discharge (although not for TSS on occasion), likely driven by the smaller amount of cover erosion and vegetative cover taking hold, as discussed further in Section 3.1.

If the cover contact water was compliant for discharge for all discharge parameters (total zinc and TSS), it would make sense to discharge compliant water to the toe of the dump rather than mixing with non-compliant water in the pit for treatment.

BGC was not able to source, nor was provided with, any water quality information from the surface on the old rock quarry site, located to the southwest of the GSC cover (Photo 2-1). If water quality data exists for this quarry area and any dump areas southwest of the GSC cover, then it should be reviewed for compliance. Alternatively, if no water quality data exist, then it may be possible to take specific samples to address this data gap. If the surface water samples are compliant, then measures should be constructed to divert this dump water to the toe of the dump, rather than being collected with the GSC cover system or even the unlined pond.

Based on pumping data supplied by TEES, Figure 2-2 provides a monthly breakdown of the total water quantities (m^3) pumped from either the Lined Pond or the V15 Collection Station across to the Vangorda Pit:

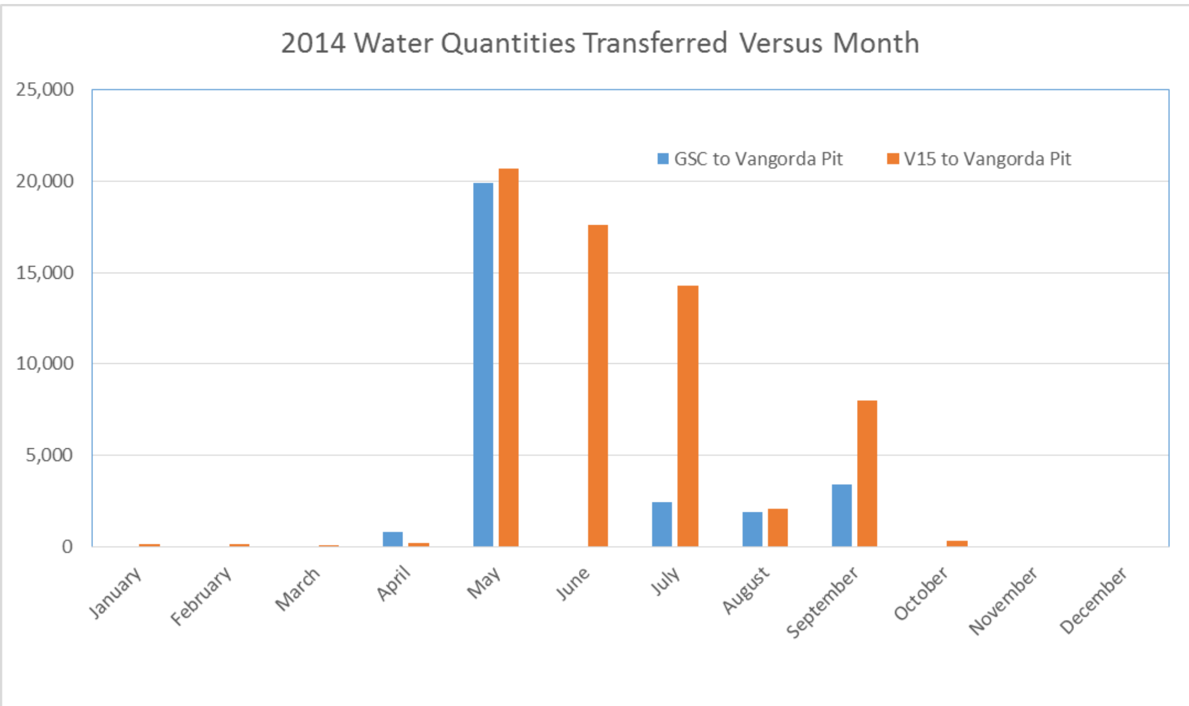

Figure 2-2. 2014 Water Quantities Transferred to Vangorda Pit

The main transfer quantities occur in May as expected, following the inflow of spring freshet. Minor transfer occur in other months from the Lined Pond (likely in response to rainfall events) while significant transfer occur in most of the summer months from the V15 collection stations (which collects both surface flow from other areas and seepage from the dump). Total yearly quantities for the Lined Pond and V15 were 28,526 and 63,571 m^3, respectively.

2.4. Revegetation Monitoring

As part of the mine closure planning process, revegetation activities and monitoring have been on-going relative to the specific GSC cover and to the Grum overburden revegetation trials, as summarized in EDI (2014a and 2014b). Specific to the GSC cover revegetation, EDI (2014a) notes the following:

- GSC was fertilized and hydro-seeded with nurse grass crop in 2011.
- In 2012, various revegetation activities were implemented, but prior to planting, soil surface was prepared with a dozer, creating 10 to 30 cm furrows in the cover surface.
- Approximately 14 out of 26 ha area of the GSC was planted with woody species.
- All arsenic and some zinc soil samples from 2012 and 2013 exceeded Canadian Council of Ministers of the Environment (CCME) guidelines for industrial land use.
- 2012 hydro-seeding resulted in herbaceous vegetative cover from 6% to 12.4%.
- Deeper furrows resulted in better seed germination and less erosion.
- Erosion rills developed where furrows were shallow. Water also followed dozer track depressions causing rills. Significant erosional gully on the west side of the cover shown in their Photo 6 (Aug. 13, 2013) correlates with gully shown in Figure 3-6 (May 21, 2014).
- Overall grass cover was not as high as expected due to relatively dry spring.
- Fertilizer application was recommended for 2014.

EDI's 2014 monitoring report for 2014 was not prepared at time of this report preparation but their initial field conclusions noted that woody species are naturally generating all over the GSC cover and that that cover appears stable with no new erosion.

EDI (2014b) provides some other learnings from the overburden dumps trials, as follows:

- Trial revegetation plots were established in 2009 to assess various study objectives and included the following aspects; grass seed mixes, woody plant treatments, fertilizer treatments, and soil surface treatments.
- Unfertilized plots had minimal growth.
- Planar and micro-rill treatment areas had erosion channels every 1 to 2 m, increasing in frequency and channel depth where vegetation coverage was less.
- No erosion was observed on the rough-and-loose plots.
- Site preparation methods are very important to prevent surface erosion.

3.0 2014 SITE VISIT

3.1. Observations

Mr. Jim Cassie, P.Eng., (BGC), undertook a site inspection of the GSC cover and associated dump areas on May 21, 2014, in the company of Dr. Dustin Rainey (YG). Below are some summary comments and observations, accompanied by select site photographs:

1. Generally, the GSC cover and water collection system has performed as intended, with run-off water contained within the two ponds, following the spring 2014 run-off. A general view of the cover is provided in Photo 3-1:

Photo 3-1. View of the lower portion of the GSC cover, with the Vangorda Access Road in the foreground. Olive brown vegetation cover now pronounced. Note the water retained in both the Lined and Unlined Ponds located at the toe of the cover (May 21, 2014).

2. Run-off water flowed into the Lined Pond, shown on Photo 3-2, but collected water did not flow out of the spillway.

Photo 3-2. View of the Lined Pond and staff gauge, looking west (May 21, 2014).

3. A small amount of run-off water collected within the Unlined Pond, as shown in Photo 3-3, resulting from dump run-off to the southwest of the GSC cover. No water was discharged from this pond to the environment.

Photo 3-3. View of the Unlined Pond and pump arrangement (May 21, 2014).

4. A new ditch was created on the uphill side of the access road running down to the Lined Pond. The ditch directs water into energy dissipation pond directly uphill from the Lined Pond.
5. Two small sloughs noted on the slopes directly above the Lined Pond area; first slough is 8 m wide on toe berm slope (~25 º to 27º slope), shown on Photo 3-4, and second slough (seen last year) is 12 to 14 m wide on slope above toe berm (~27 º to 30º slope). Third small slough also noted further west of the slope face.

Photo 3-4. View of the small slough on slope face above diversion ditch (May 21, 2014).

6. Minor erosional gullies continue to erode into the upper surface of the cover, even in fairly gentle slopes and in areas with vegetative bio-mass, as shown on Photo 3-5. Other erosional gullies noted on the cover; in some cases, carried minor sediment at the lower ends and partially blocked the longitudinal ditch on the bench faces.

Photo 3-5. View of two minor erosional gullies continuing to downcut into the cover, even on fairly gentle slopes (May 21, 2014).

7. In select locations, run-off water from various dump aspects located southwest from the GSC cover continue to erode significant gullies into dump faces southwest of the Unlined Pond. Some run-off water reports to the Unlined Pond and some flows farther downhill. These erosional gullies should be repaired to prevent any further erosion from occurring.
8. Another significant, but shallow erosion gully, is shown on Photo 3-6. Granular soils should be used to repair this gulley.

Photo 3-6. View of wide but approximately 0.5 m deep erosional gully that runs obliquely across the west side of the cover to West Drainage Ditch (May 21, 2014).

9. Overland flow and possible ditch blockage (due to snow and ice) lead to localized erosion gullies and sloughing of the cover till soil into the rip rap lined perimeter ditch at select locations as shown on Photos 3-7 and 3-8. These erosional gullies should be repaired to support cover and prevent any additional localized sloughing into the West Drainage Ditch.

Photo 3-7. View of two erosional gullies that run into the West Drainage Ditch (May 21, 2014).

Photo 3-8. View of more erosional gullies that run into the West Drainage Ditch (May 21, 2014), located at higher elevation than gullies seen in previous photo.

10. No significant erosion or flow channelization noted on the access road surface located directly proximal to the West Drainage Ditch.

Follow-up recommendations for short term maintenance are provided in Section 4.0 herein.

3.2. Climate Review

YG provided BGC with a summary of climate data from the Grum Weather Station (data has not been independently assessed or verified herein). The objective of the climate review was to look for atypical weather patterns or events that may have impacted performance of the GSC cover and drainage system, noting that there were non-compliant discharges in spring 2011 and 2013 but not in 2012 or 2014. Figures 3-1 and 3-2 display the plotted climate station data:

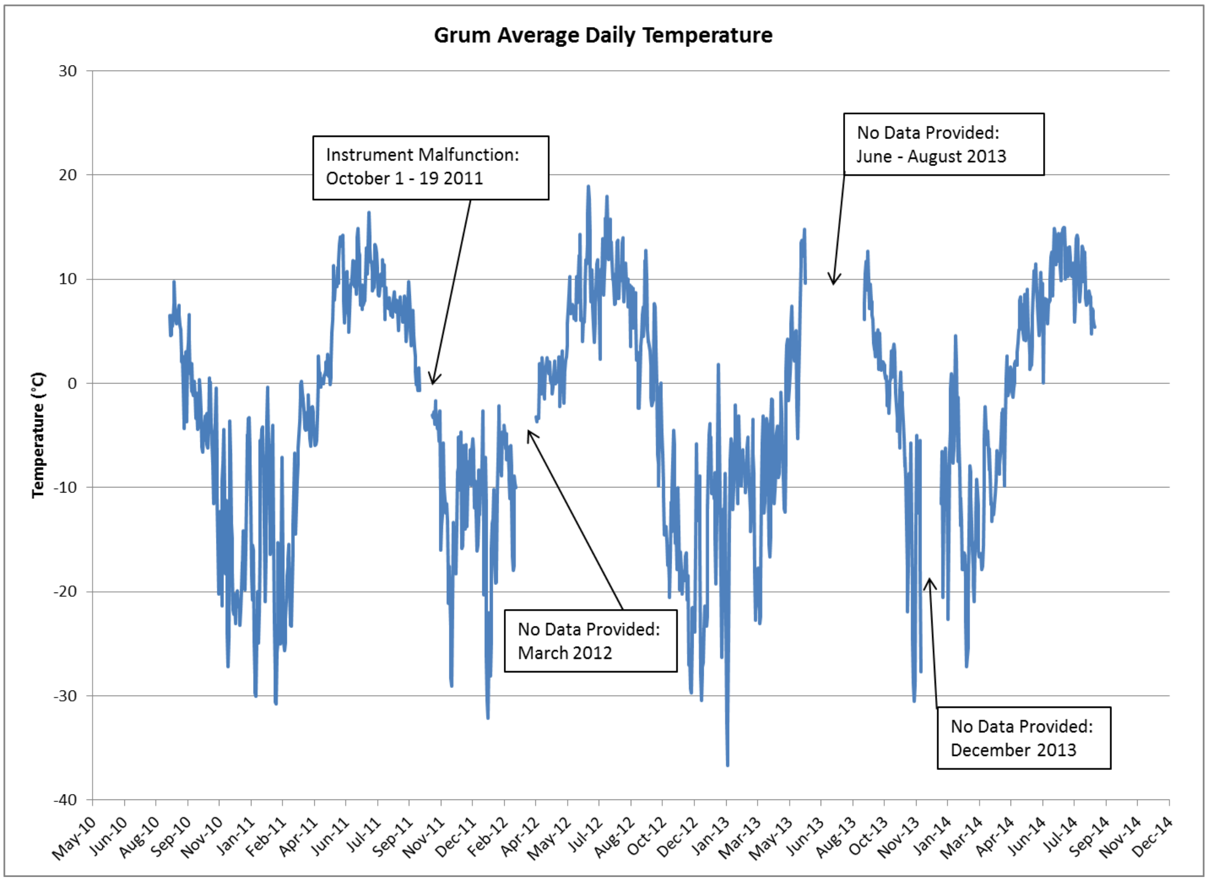

Figure 3-1. Grum Station Average Daily Temperatures

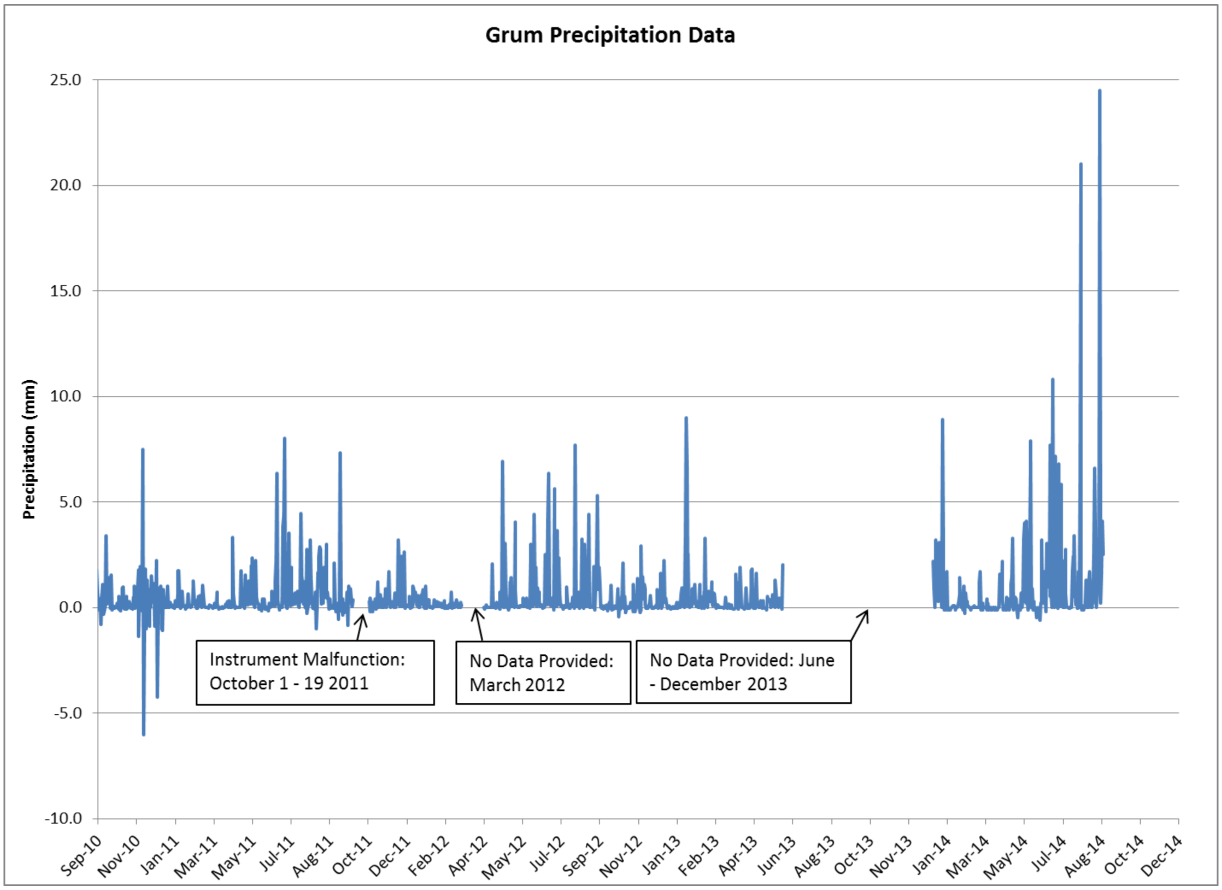

Figure 3-2. Grum Station Daily Precipitation Values[1]

Temperature ranges recorded in 2014 were generally in agreement with previous years, although summer 2014 appeared cooler than summer 2012 (incomplete data for summer 2013). Precipitation values in 2014 were similar to ranges from previous years with two specific comments; rainfall fell in January 2014 (also occurred in January 2013) and two significant rainfalls occurred in summer 2014. Unfortunately, specific snow pack depth and density measurements are not available for the cover for the various years. This data would be useful to understand the water equivalent quantity trapped in the late winter snowpack, but this data was not provided to BGC. The snowpack data would provide context for the quantity of run-off while the temperature data review provides context on its intensity.

Given the noted gaps and limitations in the Grum climate data, it is not possible to formulate either air freezing or thawing index (AFI and ATI) values or total rainfall and snowfall amounts from the current data. As a simple proxy for the former quantitative indices, the following

[1] Precipitation data from Grum Station was correlated with rainfall data from Faro AES station on select dates. Based on this correlation, the unit scale on Y-axis has been revised from previous years.

subzero and above zero temperature “seasons” were subjectively defined, as summarized in Table 3-1:

Table 3-1. Estimated Seasons Since 2010 (Based on Grum Data)

Season	Start Date	End Date	Length (days)
Subzero (2010-11)	11-Oct-10	28-Apr-11	199
Above Zero (2011)	29-Apr-11	29-Sep-11	153
Subzero (2011-12)	30-Sep-11	15-Apr-12	198
Above Zero (2012)	16-Apr-12	9-Oct-12	176
Subzero (2012-2013)*	10-Oct-12	30-Apr-13	202
Above Zero (2013)	1-May-13	20-Oct-13	172
Subzero (2013-2014)**	21-Oct-13	17-Apr-14	178

* above zero air temperature recorded on January 14, 2013.
** above zero air temperatures recorded on January 17, 18, 23, 24 and 25, 2014.

The subzero season of 2013-2014 was significantly shorter than the previous three subzero seasons.

In order to understand the freshet intensity between various years, Figure 3-3 presents a summary of spring air temperatures for the last 4 years.

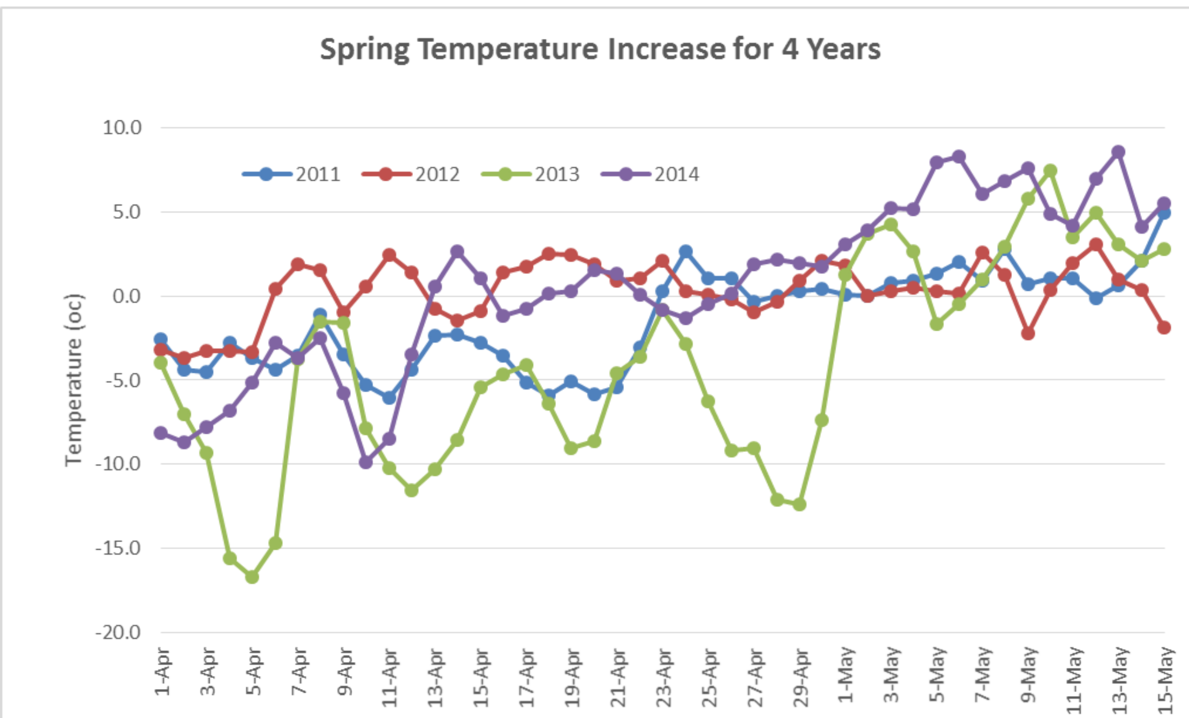

Figure 3-3. Spring Temperature Daily Values for Four Years

The plot shows that in the springs of both 2011 and 2013, the air temperature rise from subzero to above zero was rather rapid (on the order of four days for 2011 and 2013), resulting in a rapid melting of the snowpack. In spring 2012 though, the daily temperatures oscillate around zero for weeks (perhaps on the order of 30 days), which may have been partially responsible for a slower melt of the snowpack, releasing run-off at a slower rate. The warming trend in 2014 also showed an oscillating behavior (around 0^oC) over 13 days between April 13 and 26, warming above zero consistently thereafter. The slower warming of the snowpack appears to result in less erosion to the cover, although no assessment of the snowpack water equivalent has been made.

Based on BGC's experience on site, sloughs and slumping occurs in cut and slopes on the Faro site after either late fall or mid-winter rainfall events. This mechanism would certainly lead to increased surficial moisture levels and likely to increased saturation levels in slopes materials. Sloughs are indicative of near surface marginal stability and generally do not indicate overall slope instability (although additional problems may develop over time if no maintenance is undertaken).

4.0 SUMMARY AND RECOMMENDATIONS

4.1. General

BGC's specific scope of work on this project is generally focused on short term maintenance and monitoring issues, which are provided in Section 4.2. For completeness, BGC has also provided a summary of related and medium term issues and recommendations for consideration in Section 4.3.

4.2. Short Term Maintenance Items

The following short term maintenance items are recommended for the GSC covers and ditches:

- Repair and regrade any erosional gullies and associated slough material from the two occurrences in the West Drainage Ditch (as shown in Photos 3-7 and 3-8); granular material may be required for steep gullies. From the photo in YG (2014), it appears that one of these erosional occurrences may have been associated with a snow stockpile located uphill from this area. The grading and stockpiling of snow on the GSC cover should be undertaken with caution to ensure water blockages do not occur during freshet.
- Erosional rills and gullies on the GSC cover (as shown in Photos 3-5 and 3-6) should be repaired with granular material, regarded, and revegetated to prevent any further erosion.
- Repair and regrade the three sloughs on the slope above and below the toe berm bench, including any flatly graded surfaces above sloughs where water may accumulate. Repairs must be carefully done to ensure minimal disturbance to the remaining slope and prevent further any channelization of upslope run-off and associated erosion.
- Continue with all recommended activities to enhance revegetation growth and extent on the GSC cover.

In addition to the maintenance items on the GSC, the following maintenance items on the areas surrounding the GSC cover should be undertaken:

- Regrade and repair localized erosional gullies located on the dump faces to the southwest of the unlined pond area (example shown in Photo 3-4). These gullies are partially generated by run-off that comes down from the old "rock quarry" location higher up in the dump section.
- Review water quality sample results (if any available) from "old rock quarry" area located south of the GSC cover. If compliant for discharge, then construct appropriate surface measures to divert this surface water into the forest and dump toe, rather than letting water drain into the unlined pond area. When undertaking these measures, ensure water is not focused into narrow or singular discharge points where additional erosion and sedimentation could occur. This water diversion is a short term measure

only and surface water sampling should continue in parallel such that only compliant water is discharged.

4.3. Medium Terms Considerations

The water quality and the water management practices on the Grum Dump are evolving over time. Previously, surface water used to run off the dump faces into the informal seepage collection system at V15, then into the Moose Pond and into Vangorda Creek. After the low infiltration cover was constructed, some 26 ha of surface area had a higher run-off value than previously. This increases the water run-off from the surface component (likely decreasing the quantity of subsurface flow though). The remediation measures undertaken in the fall 2011 then changed the GSC run-off from a passive discharge system into an actively pumped system. In addition, the creation on the Unlined Pond, along with some changes to drainage paths on surface, meant that water from outside the GSC cover was also being formally captured and managed higher up on the dump surface, rather than reporting to the toe of the dump. As such, YG's focus on water quality has now changed from the narrow perspective of the GSC cover only, to the broader perspective of the entire dump surface. In addition, the vegetation cover is evolving and growing, leading to enhanced surface soil stability from erosion and to better/improving water quality.

Given this evolution and broadening perspective, BGC has prepared the following recommendations relative to the medium term (next year or two) operations of the GSC cover, Grum Dump, and associated water management system:

1. When freshet occurs, it appears that run-off water initially collected in the ponds will be non-compliant with respect to zinc concentrations or TSS. Once pond water is confirmed to meet discharge criteria, it should be pumped to any appropriate receiving environment rather than be pumped to the Vangorda Pit for mixing with contact water. By the same rationale, should surface water from the Grum Dump and rock quarry be confirmed to be compliant, these water should be diverted away from the Unlined Pond.
2. The pump at the Lined Pond should be ready to initiate drawdown as soon as run-off flows into that pond, without delay. Site staff need to ensure the pump is ready for use at the appropriate time. Discharge of water from the Lined pond overflow should only occur in extreme cases.
3. The existing GSC cover materials contain elevated levels of zinc, which is likely liberated during contact and erosion events. Zinc levels in the Lined Pond are dropping, likely in response to ongoing biomass establishment on the cover. Ongoing biomass growth and associated reduction in zinc entrainment by surface water should continue in the next few years, but continued monitoring would be required to prove that mechanism. It is likely not practical to excavate and replace portions of the cover that contain elevated zinc concentrations (e.g. hot spots), but this should be considered.

4. All yearly site climate data should be downloaded, plotted, and interpreted relative to mean and estimated ranges for various parameters, but mostly focused on temperatures, rainfall, and snowfall amounts (BGC was provided with raw hourly climate station data only). Yearly climate records provide context for the following year's performance of soil covers, slopes, vegetation success, and water management relative to design criteria, including climate change assumptions.
5. In order to prevent perimeter ditch water from discharging in spring freshet events, site staff should be prepared to clean out any snow and ice blockages before freshet occurs. Snow and ice stockpiles should be placed with caution to ensure no blockage or diversion of freshet runoff.
6. BGC provided an outline of monitoring plan recommendations for the GSC ponds and pumps (BGC 2012b) and these recommendations should be implemented to build an experience base on the actual performance of the cover and drainage system.
7. BGC is not currently involved with the assessment of the dump seepage water quality which is collected at the V15 Station. It would be useful to assess the placement of the GSC cover on the water quality from dump seepages in terms of understanding hydrogeochemical impacts from the cover placement.

In addition, BGC also provides the following three recommendations that tie into the longer term closure plan for the Grump Dump:

- Given that two non-compliant discharges occurred in 2011 and 2013, YG should consider a more formal seepage collection trench, pond, and pumping system along the entire length of the toe of the dump. Rather than focusing energy and resources to internal water management on the GSC cover, it may be more effective to align a water management approach that may be required for final closure anyways.
- The current GSC cover provides for an engineered solution for only a portion of the entire Grum Dump surface. Some preliminary plans regarding covers and landforms for the entire surface should be conceptualized so that potential water management aspects can be integrated as noted above.
- The GSC cover was designed to be a very low infiltration cover. No performance monitoring program of that design objective is currently underway. It would be useful for closure planning to initiate such a program so that baseline and evolving conditions can be measured and extrapolated to other proposed covers for final design.

5.0 CLOSURE

The comments and recommendations provided herein are based on assessment of third party data and observations, along with observations and data reviews undertaken by BGC. It is assumed these third party data and observations are accurate; they have been relied upon without independent verification.

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:

ISSUED AS A DIGITAL DOCUMENT,
SIGNED HARDCOPY ON FILE WITH
BGC ENGINEERING INC.
AND RECEIVED BY CLIENT

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