# Transforming Tailings Management with Cambio: A Case Study on Enhancing Communication and Decision-Making at Red Chris Mine

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## Abstract

The safe management of a tailings facility necessitates the combined efforts of multidisciplinary teams and the clear communication of complex subjects to a diverse range of stakeholders. The Red Chris mine, operated by Newmont in British Columbia, Canada, has adopted innovative data solutions to support tailings dam construction and performance monitoring. This paper uses project examples to demonstrate how Cambio, a web-based software platform for data collection, monitoring, analysis, and reporting, has been leveraged to enhance communication, track construction activities, and improve decision-making at Red Chris.

Cambio can ingest and display a variety of data sets as well as interact with other software platforms. Users can visualize data in plan or 3D views or in profile by creating sections through topography, design surfaces, drill hole stratigraphy, and instrumentation data. At Red Chris, Cambio is used by the Owner and the Engineer of Record teams for day-to-day communication. This includes reviewing historical data, such as as-built information and tailings deposition locations, projecting future tailings facility configurations at various design stages, and planning site investigation and instrumentation installation programs. During annual dam construction, Cambio serves as a supplemental tool to track weekly fill placement volumes, and the automated change detection tool process is a visual aid used to check construction progress. In the field, the Cambio mobile application is used by construction CQA/CQC teams to log testing and sample data, which is then summarized in a dashboard to track compliance with the design specifications. The Owner and Engineer of Record teams use Cambio to monitor and review dam performance using the instrumentation module. Instrument data calculations, plotting, and alarming are automated with the added

benefit of viewing the instrument behaviour in context with key site information such as aerial surveys, drill hole stratigraphy, and latest construction activity.

The successful development of a robust and user-friendly data management platform has been driven by close collaboration among the Owner, Engineer of Record, and software developer teams. This collaboration transforms raw data into actionable knowledge, which is used to make informed decisions and simplify communication.

**Disclaimer:** The data and figures presented in this paper are for illustrative purposes only.

## Introduction

Throughout a mine's lifecycle, large volumes of data are generated by a range of stakeholders, including engineers, owners, and contractors. The design, construction, and operational phases of a tailings facility can span decades, while the closure phases, including transition, active care, and passive care, extend even longer (CDA, 2019). As data acquisition becomes more accessible through technological advancements, the challenge shifts toward ensuring effective and efficient data management. Without proper systems in place, critical data may remain underutilized.

Industry guidelines for tailings management emphasize the need for an integrated, interdisciplinary knowledge base (e.g., GISTM, 2020). Traditional methods of data collection and reporting, often reliant on static documents, geographic information systems (GIS) platforms, and disconnected databases, pose challenges in terms of data accessibility, interpretation, and integration. Recent advancements in geospatial digital knowledge bases offer a transformative solution for managing project data by integrating multiple data sources, including instrumentation data, site investigation data, imagery, design lines, construction monitoring data, and dam inspections and observations, into a dynamic, near-real-time system. By leveraging a geospatially integrated platform, engineering teams can dynamically analyze observed changes in condition alongside supporting datasets and historical records, leading to improved understanding of the underlying conditions that may be contributing to the changes observed at the site. Centralized access to site data can also provide an enhanced ability to work collaboratively to solve complex problems.

This paper presents the application of the Cambio™ (Cambio, v3.4.99) software platform as a geospatial digital knowledge base at the Red Chris mine (Red Chris), operated by Newmont. A case study is presented to demonstrate how Cambio has enabled a transition to an integrated digital workflow that enhances visualization and streamlined communication between the Engineer of Record (EoR) team from BGC Engineering and the Owner.

# Background

## Site Overview

Red Chris is an open-pit copper-gold mine located in northwestern British Columbia within the traditional territory of the Tahltan Nation. Key infrastructure comprises: an open pit area, a processing plant (mill), a rock storage area, low-grade ore stockpiles, water management infrastructure, and a Tailings Impoundment Area (TIA). The TIA is located at the eastern extent of the mine site, in a north-south trending valley with a northeast tributary. Tailings containment is provided by a single impoundment bounded by natural topography and three tailings dams: the North Dam, the South Dam, and eventually the Northeast Dam (Fig. 1).

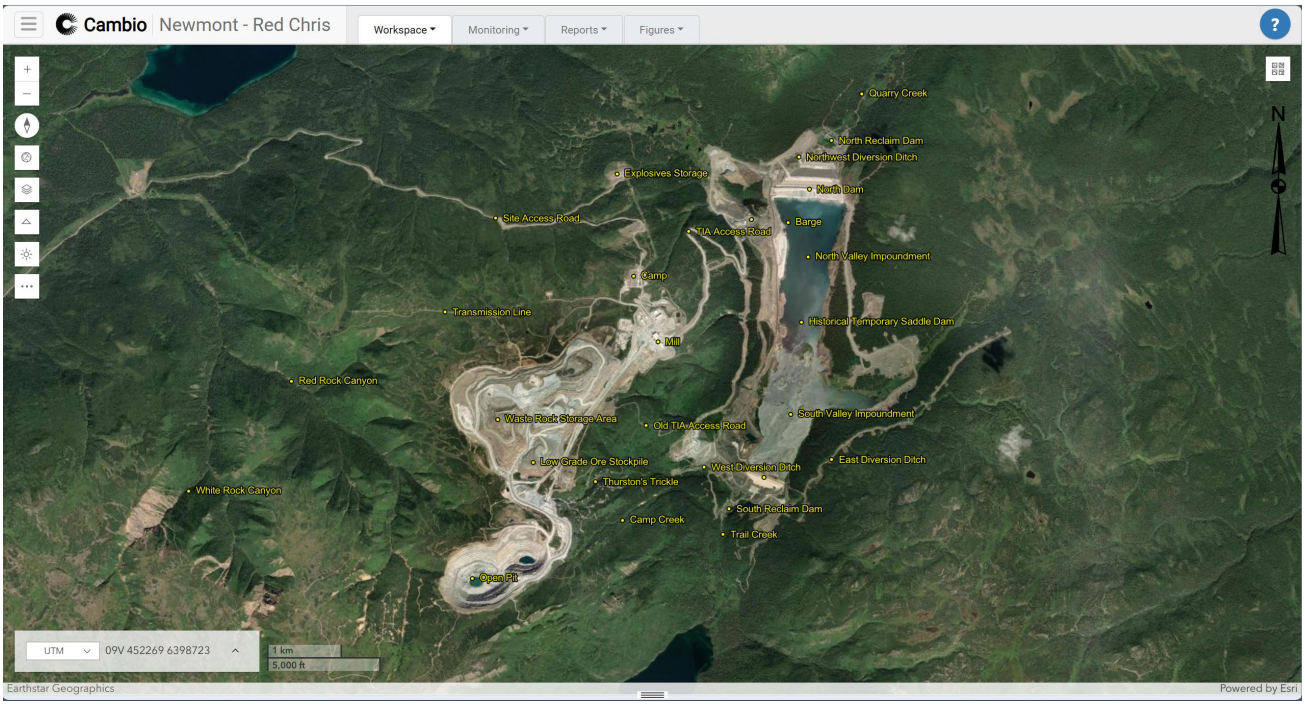


**Figure 1: Project location and site overview displayed in Cambio**

The permitted mine plan is based on a mill throughput of 30,000 tonnes per day and a 28-year mine life for a total of approximately 300 Mt of tailings produced. The ultimate elevation of the tailings dams is 1180 m, corresponding to the maximum height of the North, South, and Northeast Dams of 110 m, 85 m, and 12 m, respectively. Construction of the TIA began in 2013, and tailings were first deposited in the TIA in early 2015. Annual raises of the North Dam and South Dam have been completed since 2016 and 2017, respectively, and the Northeast Dam is expected to be constructed in 2034. Construction progress in the TIA area from 2010 (predevelopment) to 2024 is shown in Figure 2.

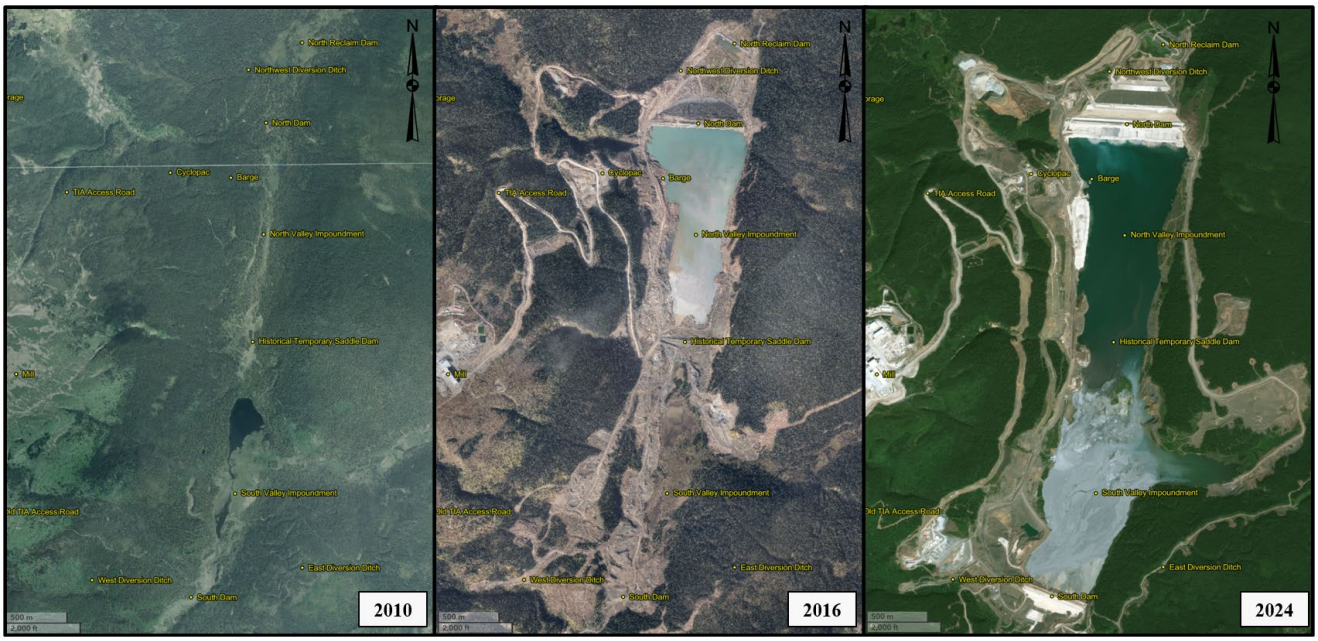


**Figure 2: Red Chris site development between 2010 and 2024 (Cambio, v3.4.99)**

## Development of a Geospatial Digital Knowledge Base with Cambio

Safe tailings facility management depends on the coordinated efforts of multidisciplinary teams and the effective communication of complex technical subjects across a wide range of stakeholders, each with varying levels of technical expertise. Due to the volume, sensitivity, diversity, and processing requirements of the data involved, project information is often stored in separate locations tailored to the needs of individual stakeholders of a given project.

Historically, data management has relied on static reports, drawings, and fragmented GIS platforms. While important for documentation and regulatory compliance, these formats can create information silos, making it difficult to form a complete picture of on-site conditions. As a result, engineers and owners often need to consult multiple data sources and rely on presentations, emails, or conversations to gain a complete understanding of on-site activities and conditions. The development of a geospatial integrated knowledge base allows project teams to centralize access to data, which provides an enhanced ability to work collaboratively to solve complex problems and inform data-driven decisions.

Developing a geospatial digital knowledge base involves building a platform to organize, view, and interpret site data. The knowledge base should include a document library and integrate technical, social, environmental, and economic datasets while providing tools to identify, monitor, and manage project-related risks and actions. The Cambio platform has been adopted as a geospatial digital knowledge base at Red Chris.

Cambio is an advanced monitoring and geospatial data management platform developed through a partnership between BGC and Cambio Earth. Founded in 2024 as part of the BGC group of companies, Cambio Earth now fully develops and manages Cambio. Cambio integrates diverse data sources—including design files, instrumentation data, construction records, and field forms—into a centralized, interactive map-based interface that is accessible via both web and mobile platforms, including offline functionality for fieldwork. Users can visualize construction progress, monitor instrumentation in real time, log field activities, and track compliance with design requirements. Its dashboards and reporting tools enhance communication across multidisciplinary teams, streamline construction CQA/CQC workflows, and support timely and informed decision-making. These capabilities make Cambio a powerful tool for managing tailings facilities, as demonstrated in the following case study.

## Red Chris Case Study

The sections below describe how Cambio has been implemented as a geospatial digital knowledge at the Red Chris TIA to support CQA/CQC tasks and dam performance monitoring. Examples of how the knowledge base is used at Red Chris include review of historical imagery and topography, consolidating site data, site investigation data review, construction monitoring, and instrumentation performance monitoring. The platform also simplifies onboarding by giving new team members access to critical project information in one place, eliminating the need to search across multiple sources. The mobile application allows for field data input via custom-developed forms and cached offline access to key site information (e.g., design files, instrument locations, borehole data, previous forms or photos), leading to more informed field data collection and better understanding of spatial and historical context. When used together, the web and mobile applications create a geospatial construction record repository that delivers value throughout the project lifecycle.

### Initial Development

The initial development of the knowledge base involved creating a centralized hub to manage, visualize, and analyze data. The following datasets are some examples of data added to the Cambio web platform:

- site layout including base imagery;
- permit boundaries and key infrastructure;
- site characterization data, including surficial mapping, drill hole, and test pit logs;
- instrumentation data, including instrument type, location, and real-time measurements;
- design and construction as-built data;
- imagery and topography, including aerial photos, drone photogrammetry orthophotos, and digital elevation models (DEMs);

- hydrology data, including local watersheds, water bodies, and stream networks;
- engineering reports.

The successful development and deployment of a geospatial digital knowledge base relies on collaboration between the Owner, the EOR team, and the software development team. Because there is no one-size-fits-all solution, engagement, trust, and time investment by all parties are essential. The product manager played a key role in the stewardship of operational change through on-site engagement, observation of day-to-day workflows, and ongoing training and support. This level of engagement was particularly impactful in shaping Cambio for the facility's context and ensuring a smooth rollout amongst all parties.

### Construction Monitoring

Construction and operations management requires a holistic understanding of the project site and a detailed understanding of historical site conditions to troubleshoot challenges as they arise. Quick and effective decision-making is often required to react to conditions while maintaining quality and meeting schedule targets.

At Red Chris, Cambio is used to support construction teams by integrating a variety of key layers, including design lines, borrow area polygons, and the latest ortho-imagery, along with Cambio's construction monitoring compliance functionality. An example of 2024 design lines overlain on imagery from before and after construction is presented in Figure 3. The integration of commonly collected field datasets, such as survey and imagery data, with design layers, in conjunction with various map tools, such as the image compare tool (shown in Fig. 3), is used to support communication of construction progress and challenges.

As part of Cambio's construction monitoring functionality, quality control data and tracking compliance to the Issued-for-Construction (IFC) technical specifications is managed and stored in one central location. The mobile app enables field teams to efficiently collect data using tailored forms for material sampling, compaction testing, and foundation approvals. Automated compliance workflows allow immediate comparison of field test results against the IFC specifications, accelerating quality workflows. The field data is then synced to interactive dashboards which provide real-time insights into testing coverage and compliance status across materials and structures. These dashboards also support the tracking of weekly fill volumes, creating an easy visual progress tracking tool for those off site.


**Figure 3: 2024 design lines overlain on imagery from before and after construction**

Tracking construction-related data from one season to the next establishes a dynamic, geospatially referenced construction record repository. This living construction record integrated within the broader digital knowledge base allows for the review of construction data alongside design files, geological information, site investigation results, current imagery, topography, and instrumentation data to drive informed project decisions, as described further in Section 3.5.

## Field Observations

Cambio is used to assist in visualization and communication between onsite and offsite staff throughout construction campaigns by combining photographs captured in the field with recent imagery and topography data. Photographs are collected during regular field activities and are stored in a spatially referenced format in Cambio. Figure 4 shows an example of drone imagery of the South Dam overlain with photograph locations and highlighting a select overview photograph from the 2024 Dam Safety Inspection. These photographs are reviewed along with other relevant datasets to better understand field observations, such as seepage rates at the toe of a dam to compare them to expected conditions. Photographs may also be reviewed to track the progress of construction action items assigned by the quality team.


**Figure 4: Site photograph locations in Cambio overlain on drone imagery**

## Site Investigation Data Review

Red Chris's site geologic model and conceptual hydrogeologic model are built based on site investigation and instrumentation data. These models directly support geotechnical and hydrogeological design decisions and inform various other aspects of tailings facility design and operation (e.g., facility monitoring plans, surface water management).

Site characterization studies for the TIA began in the 1990s during the prefeasibility design stage, with periodic drilling campaigns continuing until 2010. Since 2013, annual drilling programs have been conducted. These investigations have included the installation of nested vibrating wire piezometers (VWPs), monitoring wells, slope inclinometers, and ShapeArrays (SAAs) to monitor groundwater levels, water quality, and dam foundation behaviour.

Cambio connects to site investigation data stored in Openground (v10.0.1.1732), allowing users to visualize drill hole locations and metadata on an interactive map. Elevation data can be displayed on user-defined cross sections, which may also include DEMs, design surfaces, drillhole and instrument locations, and their associated depths, offsets, and real-time reading values.

A series of topographic surveys from photogrammetry datasets, design surface, borehole logs and real-time piezometer data from the North Dam are shown in plan and section in Figure 5. By plotting existing site investigation data along with topographic surveys and real-time instrumentation data, users can quickly appreciate current site conditions. These tools are used together with an understanding of

geologic and hydrogeologic models to allow multidisciplinary teams to effectively communicate design considerations and for the ongoing incorporation of new data into existing design bases.


**Figure 5: User-generated plan and section views of the North Dam showing borehole locations, instrument installation depth, latest readings, and stratigraphic stick-logs**

## Dam Performance Monitoring

Tailings facilities typically rely on a diverse and extensive network of instruments installed throughout the mine's lifecycle. Instrumentation installed in the TIA is a key component of progressing toward performance-based design and managing the risk of the facility.

At Red Chris, critical sensors such as VWPs and SAAs collect readings automatically at scheduled intervals. Cambio automates the ingestion, processing, and visualization of instrumentation data in real time. Users can generate custom time-series plots and configure alarms to compare readings against predefined thresholds and associated trigger action response plans. Overlaying instrument data on high-resolution site imagery and topography improves interpretation by enabling users to correlate sensor responses with site activities and dam foundation conditions.

For example, data from a slope inclinometer installed at the South Dam was analysed in Cambio to gain insights into its behaviour following the detection of minor deformations. By comparing the timing of these movements with aerial imagery and topographic data, the team quickly confirmed that the deformation did not align with fill placement or tailings deposition in the area. Based on the shape of the deformation plot, the timing and rate of deformation, foundation conditions encountered in the observed zone of movement, installation as-built information, and data from other sensors installed in the same structure, the observed movement was interpreted to be due to an installation issue with the instrument itself, rather than actual foundation soil deformation. Accordingly, the EOR team concluded that no intervention was required and construction activities were allowed to continue without delay.

Figure 6 displays instrumentation locations and alarm status at the North Dam over drone imagery collected during construction and a pop-up slope inclinometer data plot.

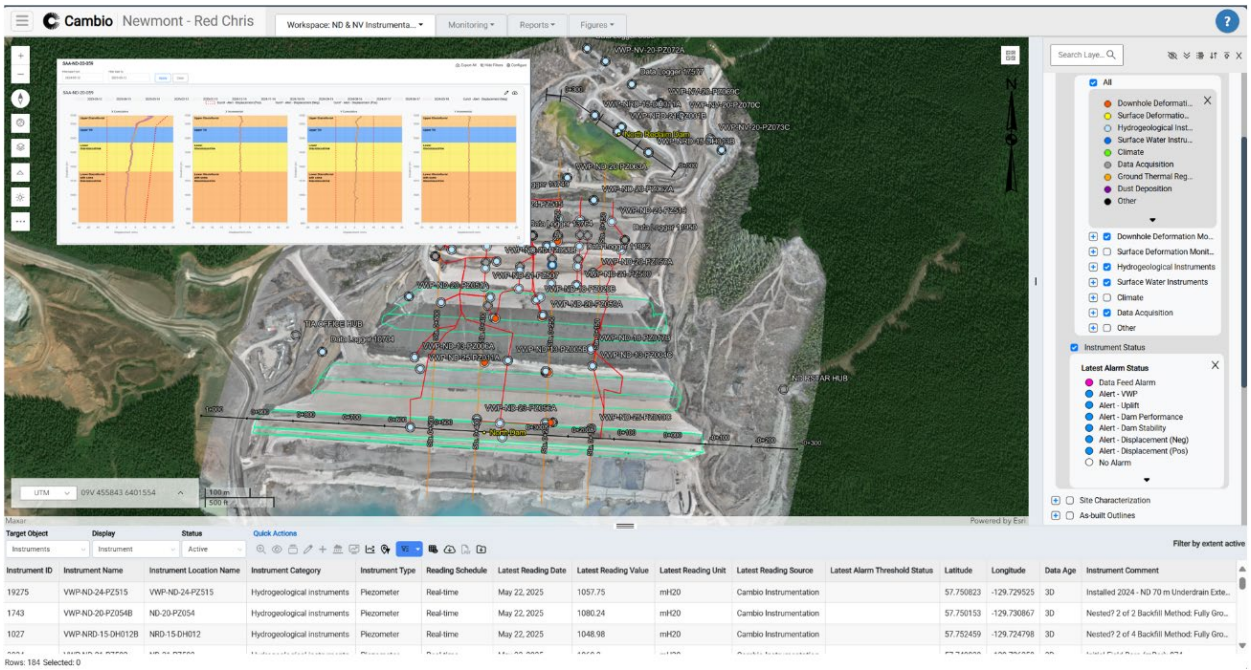


**Figure 6: Instrument locations and SI data plot**

## Conclusion

Safe tailings facility management involves the collection, organization, and analysis of large quantities of data and effective communication between a range of stakeholders. The Cambio implementation at Red Chris has brought notable benefits to the tailings project, including improved communication between the Owner and the EOR teams, efficiency gains in CQA/CQC data collection and tracking, and improved understanding of available real-time data. The ability to track construction performance metrics, such as design specification requirements, provides greater transparency and accountability across the project. A major advantage has been the integration of the monitoring program, combining drone data (imagery and topography) and instrumentation data into a single platform, allowing for real-time, holistic review alongside the broader body of project information. This comprehensive view supports more data-driven decision-making.

A key lesson learned has been the importance of close collaboration between project and software development teams, with ongoing user feedback playing a vital role in evolving and refining the platform to meet operational needs. While establishing the system required significant upfront investment, the time savings and workflow improvements have been substantial after only a short period of use. The process highlighted the necessity of good data management practices and that even the most advanced tools rely on accurate, up-to-date inputs to function effectively.

As the mining industry continues to implement digital solutions, the Red Chris case study demonstrates that technology alone is not the solution; it is the integration of people, processes, and the platform that drives real change. Looking ahead, geospatial knowledge bases like Cambio have the potential to redefine how we manage complex tailings facilities by turning data into actionable insights and fostering a culture of proactive mine management over the lifespan of the project.

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