INTEGRATING LOCAL MINE GRIDS WITH REAL-WORLD COORDINATES AND FIELD VERIFICATION

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I want to thank my mentor, Barbara Carroll, for helping me develop my skills as a GIS professional and believing in me. I would also like to thank my partner, Chad Jennings, for his support during this time.

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LIST OF ABBREVIATIONS

Au	Gold
GIS	Geographic Information System
GPS	Global Positioning System
G/T	Grams per tonne
JORC	The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves
KG	Kilograms
LMG	Local Mine Grid
OPT	ounces per ton
SP	State Plane Coordinate System
UTM	Universal Transverse Mercator Coordinate System

ABSTRACT

In March 2021, an Australian publicly listed company agreed to acquire the Colosseum Gold Mine, a past-producing precious metal property in San Bernadino County, California.

GeoGRAFX Consulting LLC of Tucson, Arizona, was contracted to organize the existing data. The company received 122 boxes of files and maps for the Colosseum project. The data was generated from 1972 through 1993. The quality of the files and maps was degraded due to their age and storage conditions.

GeoGRAFX compiled a verified digital project database of all obtained land status, geology, topography, drill hole, assay, and lithology data used in the resource evaluation from the files provided for the Colosseum project. Previous companies for the Colosseum Mine created three local mine grids between the early 1970s and 1987. The challenge and purpose of this Master's Project was to use these three local mine grids to integrate with real-world coordinates, and field verify the results.

The data verification checks performed internally by GeoGRAFX staff and external and independent reviews have resulted in sufficient validation of the entire historic database at the Colosseum Project. The company used the data to model the geology and calculate a Mineral Resource.

Keywords: Colosseum Mine, Local Mine Grids, Drilling, Gold, Real World Coordinates

ETHICS STATEMENT

GIS is a fast-growing field that impacts people on a global scale. GIS can be used for various applications including decision making and emergency response. The project modeled the Urban and Regional Information Systems Association (URISA) GIS code of ethics. This code highlights four main principles: obligations to society, obligations to employers and funders, obligations to colleagues and the profession, and obligations to individuals in the community.

Obligations to society require a GIS professional to recognize the impact of work on society. This includes but is not limited to geographic or demographic minorities. The effect of work must realize the impact on future generations. The result should be socially, economically, and environmentally inclusive.

Obligations to employers and funders include the GIS professional delivering the products they were hired to complete. The GIS professional must be qualified and current in the related field. Documentation of work for others is another crucial obligation to employers. The professional must have a good working professional relationship with the clients and keep the information confidential unless instructed otherwise. Avoid conflicts of interest with other companies by not disclosing work about current clients. Help provide a secure backup, retention, and recovery system. The professional will be honest in their representation and list relevant qualifications.

The GIS professional will have obligations to colleagues and the profession. The individual will recognize the value of working in a community of professionals and will cite others' work when appropriate. Honor the software and data rights and realize they are the intellectual property of another. Respect the limitations of my knowledge and accept help and learn from others when possible. The individual should respect other

professionals regardless of religion, ethnicity, gender, or political beliefs. Engage with other professionals and offer support when asked.

As a GIS professional, I have an obligation to individuals in society. The individual will realize the impact on individual people and strive to avoid harm to these individuals. To prevent harm, the individual will provide privacy on a person's identity unless told they can disclose this information. The GIS professional will obtain all permissions from an individual if any personal data is used, including but not limited to names and pictures. The professional will avoid all intrusions into an individual's life unless authorized to be there. All individuals will be treated as equals, regardless of race, age, gender, and ethnicity. If information is published, the individual will be provided with information and a copy of the publication.

As a GIS professional for this project, I was objective and practiced integrity when completing the work. The data and findings were made public when appropriate. The data and conclusions are accurate based on the information collected.

CHAPTER 1
INTRODUCTION

Purpose

In March 2021, an Australian publicly listed company agreed to acquire the Colosseum Gold Mine, a past-producing precious metal property located in San Bernadino County, California. In January 2022, GeoGRAFX Consulting, LLC was engaged to produce a Mineral Resource Estimate and Technical Report based on the historic data for the Colosseum Project.

Since the early 1970s, numerous companies have held the property, including Draco Mines, Placer Amex, Amselco, Dallhold Resources, Bond Gold, and Lac Minerals. The Colosseum Mine, located in the Clark Mountain Mining District, was active from 1987 through 1992, producing over 340,000 ounces of gold.

The paper summarizes the results of the data compilation, integration, and verification of the historical data for the Colosseum Project that was used to compile a comprehensive database. The challenge and purpose of this Master's Project was to use these three local mine grids to integrate with real-world coordinates, and field verify the results. The work completed included a site visit and data gathering, data, and database compilation, review, and reporting. This data was used to create a current drilling program, resource estimate, and an independent technical report that meets JORC 2012 standards of disclosure.

History

In the 1860s, the Clark Mountain Mining District was established. The Colosseum Mine's gold mineralization was first identified in 1865, but no production was ever officially documented there until the 1930s. About 615 troy ounces (19 kg) of gold were

produced during that decade, along with a small amount of silver, copper, and lead (Hewett 1956). As a non-essential industry during World War II, the mine was shut down in 1942. After the War, the property underwent sporadic, insignificant exploration by a number of people and businesses (Mason and Arndt 1996).

Colosseum Mine Recent History

1970s – 1985: California Gold Properties held the Colosseum property for fifteen years, leasing some of the more established claims while discovering an additional 176 claims. The Colosseum property was the subject of several exploration projects by Draco Mines, Placer AMEX, and Amselco. Between 1982 and 1984, Amselco carried out extensive drilling and feasibility studies on the property after leasing it from Draco Mines (EPA 1992). Amselco started the necessary permit applications in 1983, and in July 1985 a Final EIR/EIS was approved.(Mason and Arndt 1996).

1986-1989: Midway through 1986, Dallhold Resources, Inc. purchased the property. Dallhold Resources eventually joined Bond International Gold, Inc. after this transaction. With mineable reserves estimated to be 10,539,000 tons with an average grade of 0.062 oz Au/ton, or 653,418 oz Au (20.32 metric tons), modern open-pit mining started in 1986.(Beatty 1989).

1989 -1993. The mine was operated by Colosseum Inc, which was a subsidiary of Lac Minerals Ltd company, until July 10, 1993, after the acquisition of the mine by Lac Minerals from Bond International Gold Inc. The Colosseum Mine stopped all operations, after four years on July 10, 1992.

In March 2021, Colosseum Rare Metals, Inc., a wholly-owned subsidiary of Dateline Resources, entered into an agreement with LAC Minerals (USA) LLC, a wholly-owned subsidiary of Barrick Gold Corporation, to acquire the Colosseum Gold Mine

(Dateline Resources Limited 2021). Since its acquisition of the Colosseum Gold Mine. GeoGRAFX has compiled the historic data into a document management system for Dateline, and conducted engineering and geochemical exploration programs, geologic mapping, and exploration drilling programs.

CHAPTER 2
METHODS & DATA

Historic Data Compilation/Indexing

GeoGRAFX Consulting LLC of Tucson, Arizona, was contracted to organize the existing data. The company received 122 boxes of files and maps for the Colosseum project, as shown in Figure 2-1.

Figure 2-1. Historic Colosseum Data

Due to the amount of data, and the need to convert files to a digital format to be indexed, searched, and shared in a secure environment with staff worldwide, the company elected to upload the data to a cloud-based document management system.

The company compiled a verified digital project database of all obtained land status, geology, surface topography, drill hole collar, assay, and lithology data used for the resource evaluation for the Colosseum project.

As of February 22, 2022, 6,105 documents and 3,289 maps have been scanned and indexed into the document management system. Approximately 50% of the documents received had been indexed, primarily focusing on documents that would aid in evaluating the historic and remaining resources. While the data obtained to date is extensive, the data found to date is incomplete and can only be used as it exists.

The compilation of historic data is ongoing as of the effective date of this paper, and further information will be added to the historical database. The current drill-hole databases were directly created by GeoGRAFX using drill log lithologies and cross-referencing against original digital records in the case of the collar and down-hole deviation tables, and original digital analytical certificates in the case of the assay tables. (Carroll 2022).

Data and Document Examination

The primary data contributions to the current Colosseum project database include Draco Mines, Placer Amex, Amselco, Bond Gold, and LAC Minerals. The existing data consists of files and maps from Administration, Corporate Development, Environmental, Exploration, Financial, Legal, and Operations departments dating from the early 1900s through 2012. The data was collected from 1972 through 1993. The quality of the files and maps has degraded due to their age and storage conditions.

DIGITAL DATA COMPILATION

GeoGRAFX compiled a verified digital project database of all obtained land status, geology, topography, drill hole, assay, and lithology data used in the resource evaluation from the files provided for the Colosseum project.

Working copies of collar coordinates, downhole survey information, assays, and lithology were converted into Excel templates for data verification. Verified data was loaded into a Project specific Microsoft Access® database. Claim boundaries provided by Barrick were supplied in ArcGIS format. Historic data from other companies were stored in the format provided. Data were converted to formats required for GIS, modeling, and resource estimation software.

Coordinate Systems

Historically, mining companies have relied on a simple non-Earth (meters or feet) coordinate system to display local mine grid data or data from grid sampling in the project area. While this allows the data to be displayed spatially, it cannot be integrated with other projection systems.

Local Mine Grid coordinate systems often depend on the equipment available to survey points. For surveying, Total Station technology replaced the theodolite in the 1970s as the survey instrument of choice. GPS technology was first developed for military use in the US in the 1970s and became fully operational in 1993.

Three local mine grids were created for Colosseum Mine between the early 1970s and 1987. The source and accuracy of the survey points mapped during this time must be considered when converting a local mine grid to real-world coordinates.

In the 1970s through the nineties, computer limitation for fixed format numeric fields was constrained to eight values, so coordinate systems needed to be modified to

accommodate this limitation. Also, most of the mine planning packages available during that time could not work in a geographic coordinate system, instead relying on x, and y coordinates.

Sharp Local Mine Grid

The 1972 Sharp Local Mine Grid (LMG) based its grid on California State Plane Zone V (1927). Notes from a 1980 survey did not define the 0,0 point. Sharp LMG elevations were obtained by subtracting 57.2 feet from state plane elevations shown in Figure 2-2 below, which is an example of a Sharp Local Mine Grid Map. The map shows the geology and current drill hole locations.

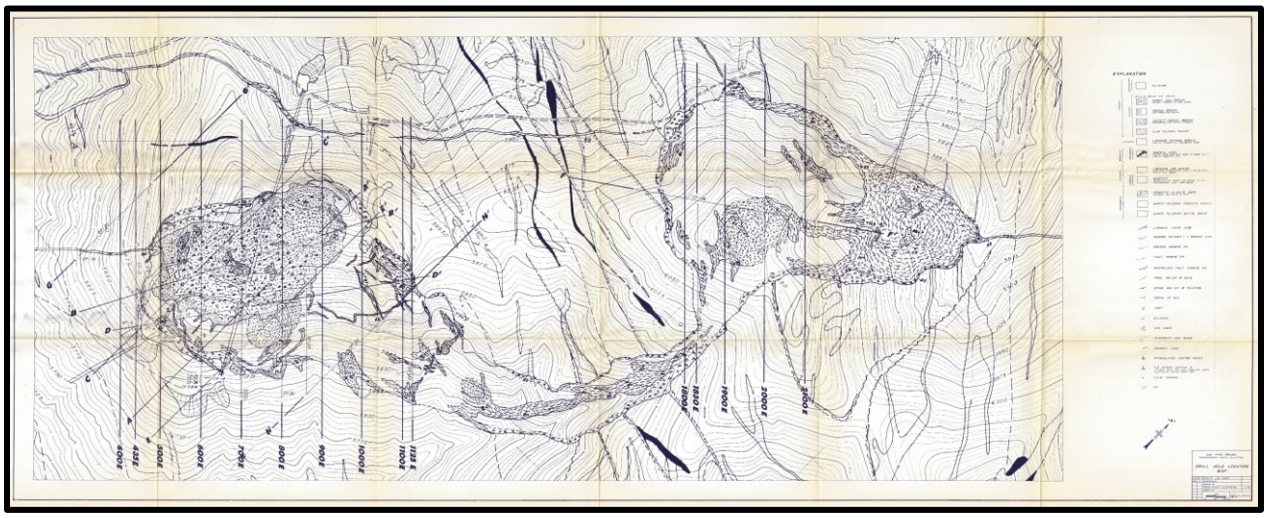

Figure 2-2. Example of the Sharp Local Mine Grid

Draco Local Mine Grid

The 1979 Draco LMG modified the California State Plane system by dropping the first two values in the easting and one value in the northing to conform with historic limitations for computer processing. Table 2-1 compares digitized drill holes from a map with the California State Plane Coordinate system, to the collar coordinates from the Draco Local Mine Grid.

Table 2-1 Computer Limitations on Coordinate Systems

Hole ID	California State Plane Zone V		Draco Local Mine Grid	
	Easting	Northing	Easting	Northing
CH-47	2,723,895.60	762,554.26	23,895.9	62,554.5
CH-39	2,724,219.14	762,664.59	24,218.9	62,664.4
CH-52	2,723,465.92	762,531.84	23,466.1	62,530.6
CH-29	2,724,097.66	762,192.04	24,097.2	62,191.3

Figure 2-3 in the Draco Local mine grid shows the regional geology with rock sample locations, claim outlines, and surface topography.

Figure 2-3. Example of the Draco Local Mine Grid

Amselco/Bond Local Mine Grid

This map from the Colosseum project shown in Figure 2-4 shows the geology of the deposit and the current drilling. The map shows the state plane coordinates grid at a 45-degree diagonal and the 1983 Amselco Bond local mine grid running north/south – east/west.

This map was used to convert the Amselco/Bond Local Mine Grid maps to the California State Plane real-world coordinate system.

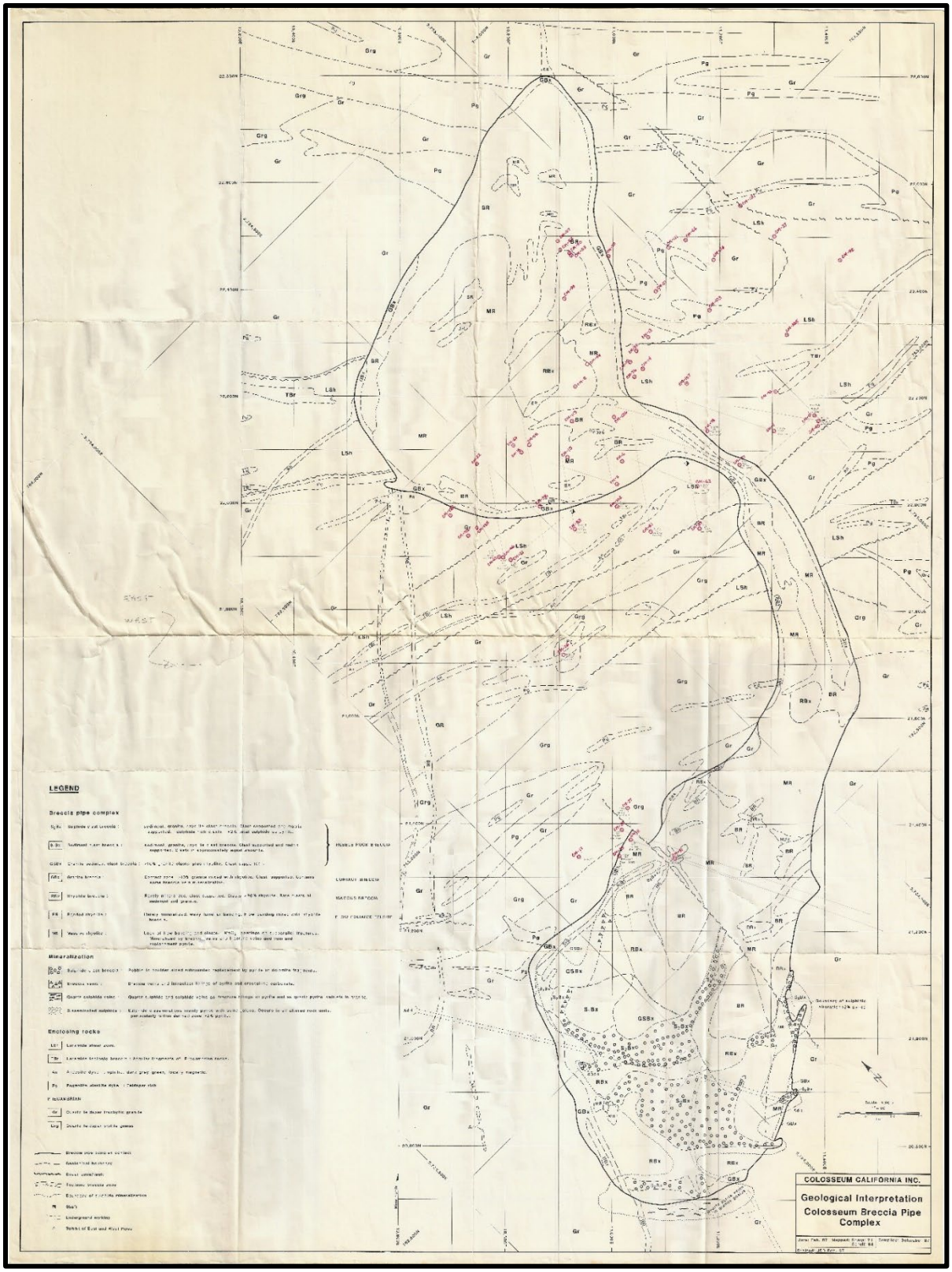

Figure 2-4. Example of Amselco/Bond Local Mine Grid

Note that in this example, the local mine grid is rotated 45 degrees from north to parallel the mineralization. The two prior mine grids for this project were north/south.

Table 2-2 below shows four different holes in their respective coordinate systems.

Table 2-2. Local Mine Grid Drill Hole Coordinate Comparison

Hole ID	California State Plane Zone 5		Sharp Local Mine Grid (LMG)		Draco LMG		Amselco/Bond LMG	
	Easting	Northing	Easting	Northing	Easting	Northing	Easting	Northing
CH-47	2,723,895.6	762,554.26	2,384.67	12,085.76	23,895.9	62,554.5	10,950	21,024
CH-39	2,724,219.14	762,664.59	2,709.19	12,193.18	24,218.9	62,664.4	11,100	21,329
CH-52	2,723,465.92	762,531.84	1,954.8	12,067.19	23,466.1	62,530.6	10,664	20,703
CH-29	2,724,097.66	762,192.04	2,583.48	11,721.73	24,097.2	62,191.3	11,350	20,913

Integrating Local Mine Grids with Real World Coordinates

In the Colosseum data set, the map shown in Figure 2-4 above contains the California State Plane Grid, and the Amselco/Bond grid, as well as drill hole locations. MapInfo/Discover software was used to create an algorithm that allowed the Amselco/Bond local mine grid to be integrated with geographic coordinate systems.

Figure 2-5 compares the Drill Hole collars in Local Mine Grid projection locations for the State Plane Projection for the Colosseum project.

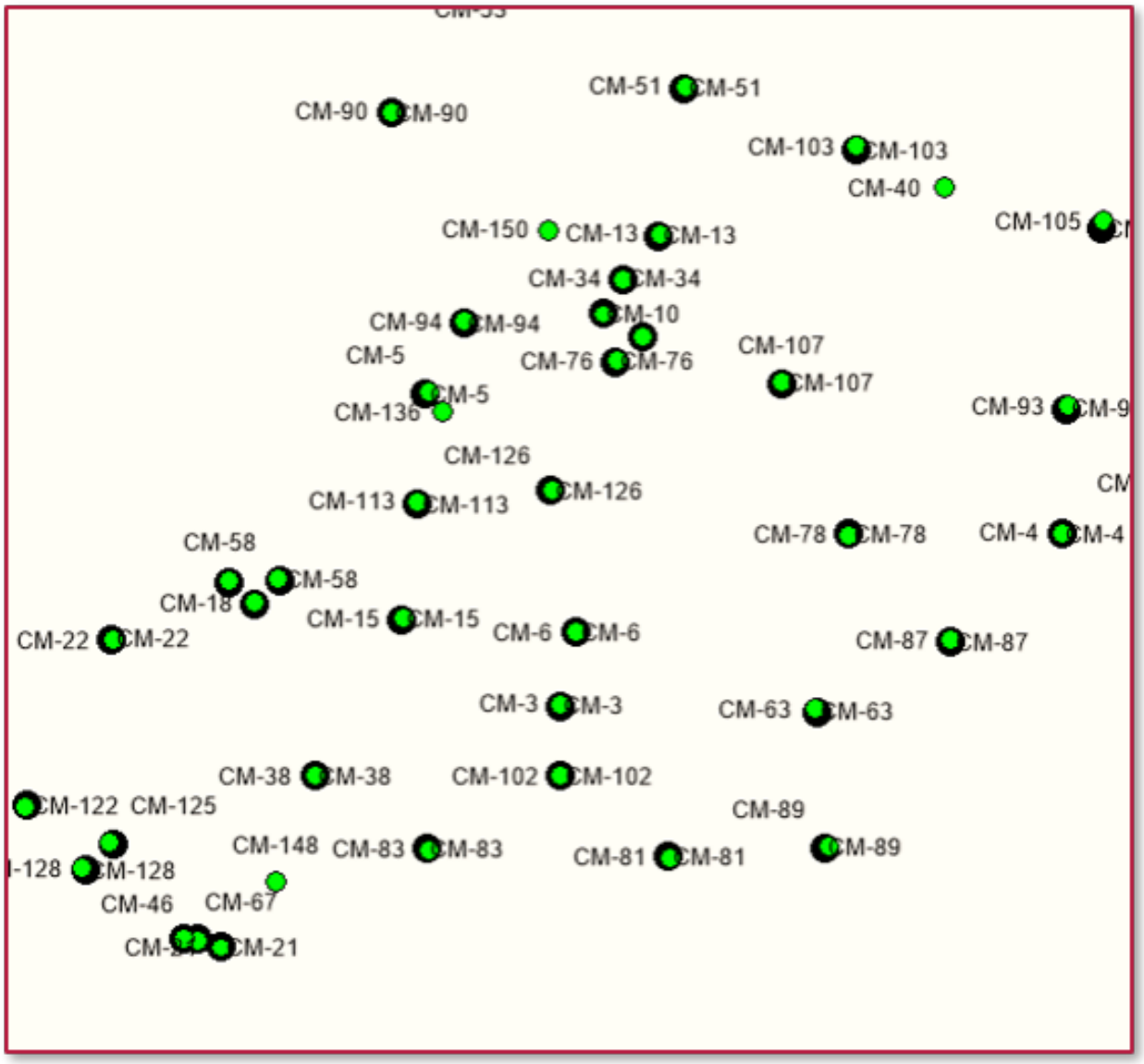

Figure 2-5 Comparison of Drill Holes shown in Local Mine Grid and Real-World Coordinates

There is good agreement between the data sets. The green dots are in the local mine grid projection. The black dots are the holes digitized from a map in state plane coordinates. Both data set units are in feet.

Surface Topography

Multiple surface topographic maps were created between 1980 and 1993 from aerial imagery. The project focuses on the 1984 surface topography, and the final

topography flown in 1992 before the mine shut down. The 1992 survey was used as the ground surface for the resource estimate.

The aerial survey used to create the 1984 surface topography was flown by McLain Aerial Mapping out of Tucson, Arizona, in 1983, prior to mining. The source for the digital topography for the Colosseum mine area was the Mine Planning map at a scale of 1” =100’ with five-foot contour lines created in August of 1984 in the 1927 California State Plane Coordinate Zone V system grid. The contour lines from this map were digitized using a raster-to-vector conversion program. Elevations were assigned by the software. Figure 2-6 shows the 1984 digitized topography overlaying the aerial survey.

Figure 2-6 1984 Surface Topography

The results were overlain on the original maps and checked for errors. A surface grid was created from the topo linework. Collar locations of holes drilled prior to the map were checked against the surface. No discrepancies were found.

The aerial survey used to create the 1992 surface topography was flown by Cooper Aerial out of Las Vegas, Nevada, on 2 Jan 1992. The source of the digital topography for the Colosseum mine area report was the survey directly over the pit and mine workings at a scale of 1”-100’ with five-foot contours. The grid was the Bond Local

Mine Grid. Survey control points for the vertical elevations were found and agreed with the generated topography. The contour lines from this map were digitized using a raster-to-vector conversion program. Elevations were assigned by the software. Figure 2-7 shows the 1992 digitized topography overlaying the aerial survey.

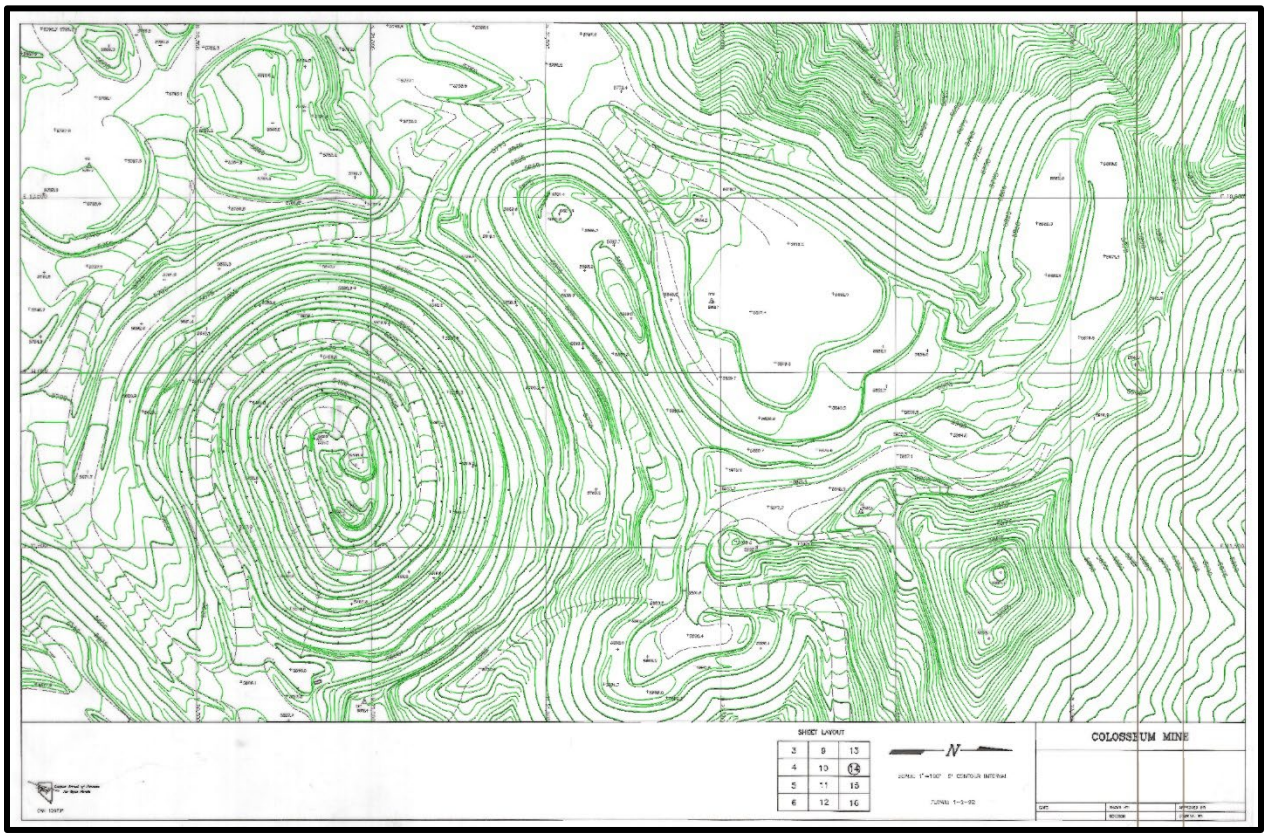

Figure 2-7 1992 Surface Topography

The results were overlain on the original maps and checked for errors. One line was not assigned an elevation and was removed from the dataset. A surface grid was created from the topo linework. Collar locations of holes drilled prior to the map were checked against the surface and when found, were in close agreement.

Since the 1992 survey, there has been additional ground disturbance due to surface recontouring to meet reclamation requirements (Carroll 2022).

Drill Hole Database

Drill holes with assay samples and lithology within the immediate project area were imported into a MapInfo/Discover database. The extracted 1972 through 1991 drill hole database contains 599 unique collar records and 36,286 assay records, and 3,206 lithology values within the Colosseum mine area to be used in the resource estimate (Carroll 2022). Drill holes for exploration targets were not included in the database.

Collar

Historic drill hole collar coordinates were measured using the local mine grid coordinate system that was in use at the time.

The data files containing the collar coordinate information for the Hole Series, C87, CH, CM, CP, WDDH, ATDH, C88, and EDDH in the Amselco/Bond local mine grid system contained computer printouts from 1990. Using an OCR text recognition system, the files were processed, the output was compared to the originals, and any errors were fixed. The corresponding survey files were compared to the hole series that the Amselco/Bond grid had generated. The remaining collars were entered from the survey files, and collar locations on plan maps were compared with the collar entries. There were inconsistencies in the Collar table.(Carroll 2022).

Figure 2-8 shows the drill hole collar location with hole traces used in the Project.

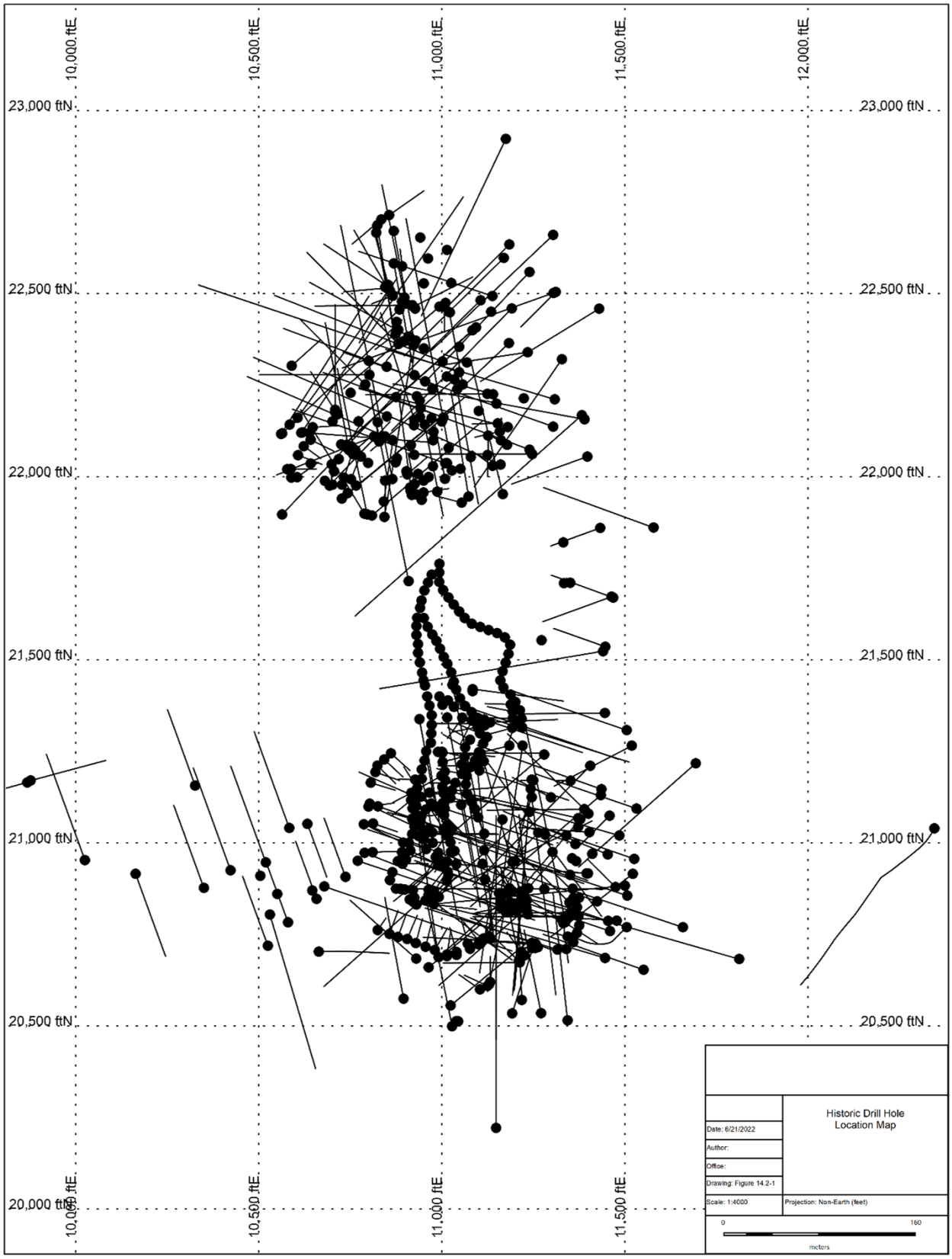

Figure 2-8. Drill Hole Location Map

Assay

The CP, CH, and CM series holes come with computer printouts and assay certificates. Directly from the Amselco lab in Denver, the computer database was loaded with the Amselco CM drill hole assays. A final database was created by segmenting the assay data into distinct drill hole intervals. To correct any errors, the original lab submittal sheets were compared to all assay data entered into the computer. An integrated database was created by combining the completed geological and assay data with drill hole collar and down the hole surveys. (Amselco 1984).

37,147 assays in total have been recorded in the historical database. As scanned copies of paper files in the PDF file format, the information for historically drilled holes was accessible. The data for assays ranges from scanned printouts from early digital assay databases up to 1985 to original assay certificates and submittal forms. The computer printouts were processed using OCR text recognition software. The outcomes were contrasted with the originals, and any errors were fixed. Any discrepancies between those results and the assay certificates were fixed. Later tests were checked by scanning the assay certificates. (Carroll 2022).

Lithology

Several different classification methods existed for logging and recording lithology over the course of the mine life. This is partly a reflection on the understanding of the lithology and limitations of mine planning software available at the time. Drill logs were also modified to reflect a further understanding of the variables necessary for mining the deposit. The original resource estimates used a numeric lithological classification with only three variables representing granite, felsic, and breccia units.

In 1987, the rock type designation was switched to a character classification based on lithology and percent of breccia fragment types (Carroll 2022).

Geologic information from the historic drill logs, cross sections, and printouts was entered by GeoGRAFX into the database to assist in the development of the geologic model. Of the 599 holes, 313 contained associated lithology. A total of 3206 lithology values were entered into the data set. There were fourteen distinct lithologic units, as shown in Figure 2-9, entered in the data set:

AN - Andesite Dike,
B, Unknown
bF – Banded Felsite,
F - Felsite,
FB – Felsite Breccia,
FGB – Felsite Granite Breccia,
FGSB – Felsite Granite Sediment Clast Breccia,
FSB – Felsite Sediment Clast Breccia,
G - Granite,
GB – Granite Breccia,
GFB – Granite Felsite Clast Breccia,
GSB – Granite Sediment Clast Breccia,
NS – No Sample,
SB – Sediment Clast Breccia

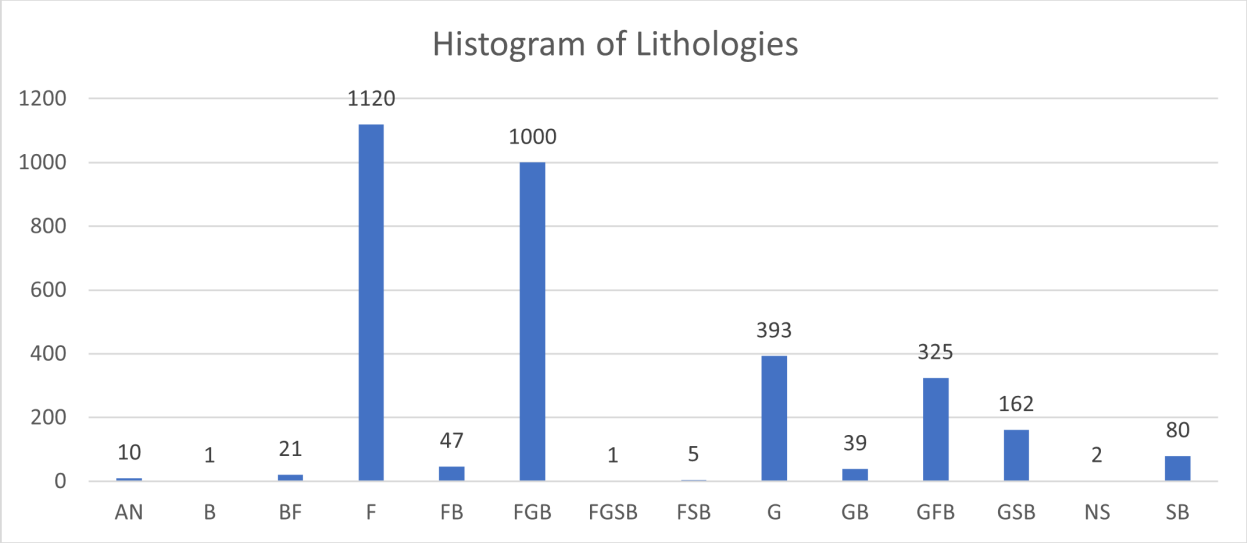

Figure 2-9. Histogram of Lithologies

Verification of Drillholes

The database was subjected to industry-standard validation checks, and where necessary, minor corrections were made. Inconsistencies in naming conventions or analytical units, duplicate entries, interval, length, or distance values less than or equal to zero, blank or zero-value assay results, out-of-sequence intervals, intervals, or distances longer than the reported drill hole length, incorrect collar locations, and missing interval and coordinate fields were all checked for in the database (Carroll 2022). There were no obvious differences with the data.

Drill Hole Database Audit

The verification process involved the following steps. First, to compare collar data to survey, assay, and geology data for incorrect depths, Azimuths, and dip values. Second, to check survey, assay, and geology data for length overruns (survey depth greater than TD (Total Depth of Hole)) and overlapping intervals (Carroll 2022). The third step was randomly checking drill-hole geologic, survey, and assay data against

logs and hardcopy data. The last step in the audit was to plot cross sections and check for obvious errors in hole trace orientations and potential missing assay data (no data present) (Carroll 2022).

Gold values greater than or equal to 0.08 opt (2.74 g/t) were extracted from the assay database to check for discrepancies. There were sixteen errors in the 216 assays that were checked. Only 7% of the total number of assays were checked. Seven of the sixteen means that 3% of the database could be materially affected. Four of the errors were assay values that could not be verified with assay certificated and four were assay values that were inconsistent with the primary assay of the database. Three of the entries that do not affect the resource estimates were not included. The last three errors include a typographic error, one unknown error and a duplicate error. The duplicate error caused and out of sequence error. The errors were then corrected in the database (Carroll 2022).

FIELD VERIFICATION

A field examination of the project area was conducted on April 4, 2022. The visit included a field review of the current drilling locations and confirmation of the location of several historic drill holes.

The historic Colosseum drill hole database was queried for collars within five feet of the 1992 surface topography. Those drill hole locations were imported into a Garmin Montana 750i DGPS, and the points were checked against drill hole locations found on the ground using the Montana with an accuracy of 8ft -10ft (2.4m – 3m). The holes were also imported into the Android Tablet for use with Discover Mobile as the larger screen made location in the field much more straightforward.

CHAPTER 3
RESULTS

Drill holes near the Colosseum Mine pit areas were difficult to locate due to degradation by subsequent mining activity, post-mining reclamation, and other ground disturbance. Time has taken its toll on the drill hole location information, as hole information was weathered beyond recognition on the located stakes. The hand-held GPS unit helped to verify that the location of the drillholes on the ground corresponds to the location in the database. The GPS unit does not have survey level accuracy, but for this project the unit was accurate enough to help locate the drill holes. All four holes were within 6-7 feet (1.8-2.1 meters) of the historic collar locations. Drill holes located during the site visit are shown in Figure 3-1 below. Black dots show located drillholes.

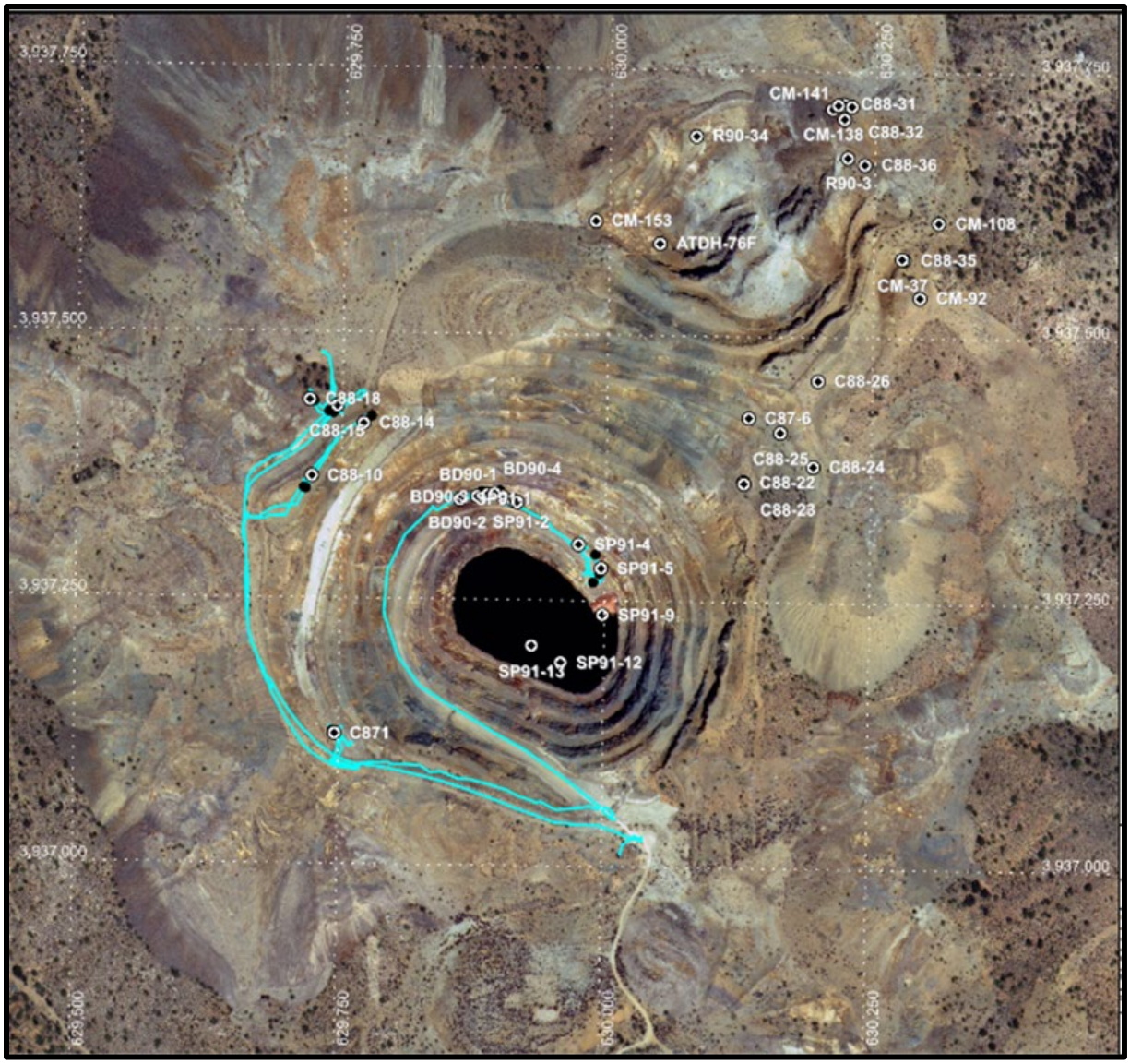

Figure 3-1. Drill Collar Location Check

Table 3-1 below details the historic drill hole collars located during the site visit. Details include an image of the GPS waypoint number, drill hole id, UTM coordinates, and notes on the site location.

Table 3-1. Drill Collar Location Details

Waypoint	C871
Drill Hole	C871
Easting UTM	629,746.27
Northing UTM	3,937,122.47
Notes	Disturbed ground, no drill hole found

Waypoint	C88-101
Drill Hole	C88-10
Easting UTM	629,721.82
Northing UTM	3,937,364.29
Notes	Drill Hole found. Survey point

Waypoint	C88-141
Drill Hole	C88-14
Easting UTM	629,770.18
Northing UTM	3,937,414.05
Notes	Drill Hole found

Waypoint	C88-151
Drill Hole	C88-15
Easting UTM	629,744.97
Northing UTM	3,937,430.41
Notes	Drill Hole found

Waypoint	C88-181
Drill Hole	C88-18
Easting UTM	629,718.96
Northing UTM	3,937,436.09
Notes	Drill Hole found

Waypoint	BD90-3
Drill Hole	CM22-01
Easting UTM	629,882.89
Northing UTM	3,937,349.67
Notes	CM22-01

Waypoint	BD90-2
Drill Hole	CM22-02
Easting UTM	629,898.72
Northing UTM	3,937,352.23
Notes	CM22-02

Waypoint	SP91-4 SP91-5 SP91-2 SP91-1 BD90-2 BD90-3 BD90-1 BD90-4 BD90-5 BD90-6
Drill Hole	
Easting UTM	
Northing UTM	
Notes	No drill holes are visible. Disturbed ground.

CHAPTER 4
CONCLUSIONS

Drillhole collar locations of the four holes located on the ground fell within the 1.8-3m error of the handheld GPS unit when compared to the drill hole locations recorded in the database. This confirms the integration of the local mine grids with real-world coordinate system. Figure 4-1 displays a 3D model of the Colosseum mine site created from the World Imagery draped over 1992 surface topography and the historic drill holes.

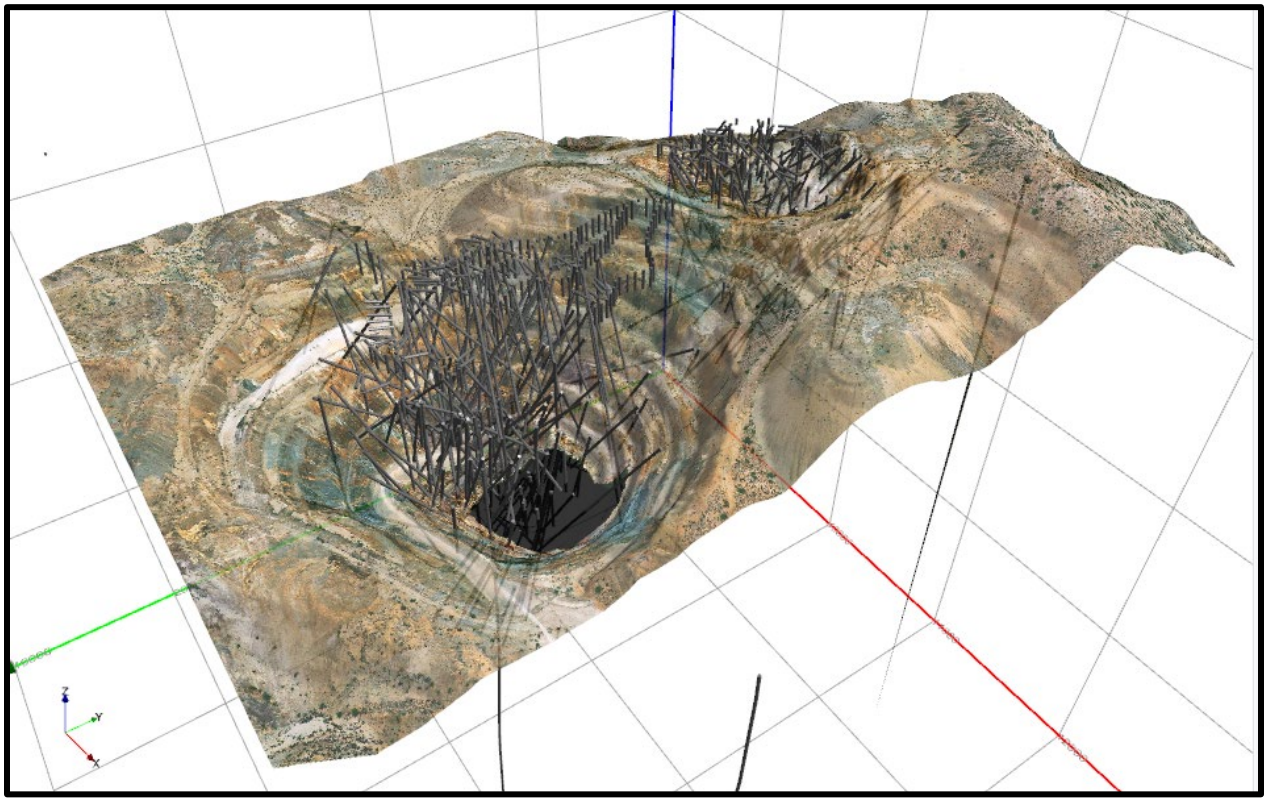

Figure 4-1. 3D Model of the Colosseum Project

The data verification checks performed internally by GeoGRAFX staff, in combination with external and independent checks, have resulted in sufficient validation of the entire drilling database at the Colosseum Project, and the data used in the modeling of the geology and calculation of the Mineral Resources is satisfactory.

This historic data compilation allowed the company to complete a resource estimate, define a 2022 drilling program, and produce an independent technical report meeting JORC 2012 standards of disclosure.

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