EXPERT REPORT OF Dr. SUSAN E. KOENIG

IN THE SUPREME COURT OF JUDICATURE OF JAMAICA

IN THE CIVIL DIVISION

CLAIM NO. SU2021CV00187

BETWEEN	SOUTHERN TRELAWNY ENVIRONMENTAL AGENCY	1ST CLAIMANT
AND	CLIFTON BARRETT	2ND CLAIMANT
AND	ATTORNEY GENERAL OF JAMAICA	1ST DEFENDANT
AND	NORANDA JAMAICA BAUXITE PARTNERS II	2ND DEFENDENT
AND	NEW DAY ALUMINUM (JAMAICA) LIMITED	3RD DEFENDENT

I, SUSAN E. KOENIG have been appointed as an expert witness to Claim No. SU2021CV00187 between the Southern Trelawny Environmental Agency (1st Claimant) and Clifton Barrett (2nd Claimant) and the Attorney General of Jamaica (1st Defendant) and Noranda Jamaica Bauxite Partners II (2nd Defendant) and New Day Aluminum (Jamaica) Limited (3rd Defendant).

<u>My expertise and relevant experience</u>

1. For the purposes of this report my address is Susan Koenig, Windsor House, Sherwood Content P.O, Trelawny, Jamaica. I am an expert in wildlife ecology.

2. Windsor House (aka Windsor Pen Great House) is located deep within Cockpit Country. It was built ca. 1795 on the grounds of a British military base, of which building ruins and a perimeter wall remain standing. The base was positioned approximately 500 meters from the headwaters of the Martha Brae, in what was part of the British strategy to control river risings (and assured access to freshwater supplies) during conflicts with the Maroons. I have lived permanently in Windsor House since 1999, and such prolonged residency has afforded me a unique opportunity to observe the daily, monthly, and seasonal dynamics of plants and animals which inhabit a cockpit karst limestone landscape. Most notable are observational records in how living organisms are influenced by and respond to abiotic (non-living) factors, such as the timing and intensity of rainfall events and how rainwater drains vertically and quickly from the land surface into sub-surface strata but can also rise upwards through the soil via capillary action to cause "rising damp" in the foundation cut-stones of the house. Since 2002, I have been responsible for recording daily rainfall amounts in Windsor, the record log of which commenced in 1996 by the previous owner of Windsor House, Mr. Michael Schwartz (d. 2018).

3. I received a Doctorate in Forestry and Environmental Studies from Yale University, New Haven, Connecticut, USA in 1999. The topic of my dissertation research was the breeding biology and conservation implications of Jamaica's endemic Black-billed Parrot (*Amazona agilis*) in Cockpit Country. In 1999 I moved from the USA to Jamaica, to my reported address. In 2002 I was a founding director of Windsor Research Centre (WRC), which operates out of Windsor House (aka

Windsor Pen Great House). Since 2002 I have been serving as WRC's Director of Research and I have been the Principal Investigator on a range of research projects, including studies of birds, bats, and the endemic Jamaican Boa (*Chilabothrus subflavus*). Since 2018 I also have been a Managing Director of WRC.

4. I attach a copy of my *Curriculum Vitae* (CV) marked **SEK-1**.

5. As presented on WRC's website <http://cockpitcountry.com/WRC%20Mission.html> (for which I have been fully responsible for maintaining since 2018), WRC's Mission is to promote research in the Natural Sciences, with particular reference to the conservation of Cockpit Country; to act as a repository; to disseminate information to ensure the best-possible protection and management of Cockpit Country

6. In 2000, I prepared a report entitled "Cockpit Country Conservation Project: Biodiversity Assessment" for the Natural Resources Conservation Authority (NRCA) and the World Bank Global Environment Facility. In consultation with Dr. Ann Haynes-Sutton (ornithologist), Dr. George Proctor (botanist), and Dr. Peter Vogel (herpetologist), I consolidated published and grey literature (e.g., technical reports) of Cockpit Country and created maps which, while intended to highlight plant and animal distributions, instead revealed the pattern of researcher movements along the most accessible roads and paths. That is, I was able to identify data gaps and potential sources of bias when plant and animal distributions known at the time were used to define Cockpit Country. Also for the report, and in collaboration with the World Bank's Biodiversity Specialist, Dr. Tony Whitten, we delineated a buffer zone boundary around the Cockpit Country Forest Reserve. Using Government of Jamaica Survey Department's 1991 series of 1:50,000 topographic maps, we traced the existing road network which encircles this Forest Reserve so that citizens and visitors would have an easy visual reference, to know that they were on the periphery of a buffer zone intended to protect the largest Forest Reserve in the Cockpit Country. We called this buffer delineation the "Ring Road", which should not be confused with a boundary mapped by Barker and Miller (1995), which they labeled "Proposed boundary of Buffer Zone" and encircles more Cockpit Country features, such as British-Maroon military heritage, than the "Ring Road" included. I present these mapped boundaries in Figure 1, on page 6 of this report.

~~7.~~ Of relevance to this case, I have conducted field workshops in Windsor for international and local and participants (including from GOJ agencies and practitioners of Environmental Impact Assessments (EIAs) in: (a) map reading and orienteering in cockpit karst topography; (b) bird banding, which involves the safe capture, handling, and application of a metal or plastic identification band (aka ring) to a bird's leg – this enables unique identification of individual birds for long-term monitoring of their site fidelity, survival, and reproductive performance; (c) radio-tracking of wildlife in cockpit karst topography; and (d) survey techniques of bats, including species identification from direct physical examination and through the analysis of ultrasonic vocalisations, which bats produce so they can fly and find food in the dark.

8. Also of relevance to this case, I have given technical seminars for EIA professionals and natural resource managers, where I outlined the need for appropriate animal survey techniques, the need for cumulative impact assessments, and the need for proof that proposed mitigation actions are, indeed, valid in their claims of protecting biodiversity. All of these topics are necessary for EIA Terms of Reference (ToR) to be fulfilled. Marked as **SEK-2**, I have attached a pdf of a presentation entitled "Protecting Biodiversity (aka Jamaica's Life-Support System): Is the EIA Process Working?",

which I first presented at the Jamaica Institute of Environmental Professionals' Speaker's Forum, October 29th 2009 and subsequently presented in other fora to NEPA and other stakeholders involved in landscape spatial planning.

9. I have more than 25 years of experience using Geographic Information System (GIS) software and since 2018 I have created all maps for WRC, including those which I have uploaded to WRC's website or which were requested by external entities.

10. In 2006 I was a member of a small team of Cockpit Country stakeholders which consolidated historical written accounts, maps, reports, peer-reviewed publications, and other data sets which were available for the region of central-western Jamaica, which since at least the signing of the Peace Treaty between the British and the Maroons [on the Julian Calendar, civil year date of March 1st 1738-39 (i.e. March 12th 1739 under the present-day Gregorian Calendar)] and into the late 1890s was called the "Cockpits" (alternate form "Cock-Pits"). Then around the turn of the century (1895 – 1905), the name transitioned on maps and in written texts to its currently-recognised proper noun form "Cockpit Country". Working in collaboration with WRC's Mr. Michael Schwartz, he and I integrated all maps and geo-referenced data into a GIS database. We then viewed the GIS data layers of geology, morphology (aka topography or surface landform), hydrology (e.g., such as where rivers sink and where they emerge), plant and animal occurrence distributions, and British-Maroon heritage locations. We then drew a boundary which included all of these "Cockpit Country" defining features. To the best of my knowledge, this was the first time all known defining features were used, at the same time, to delineate Cockpit Country. The result, finalized on November 29th 2006, is what is known as the Cockpit Country Stakeholders Group (CCSG) Boundary. WRC is the repository for the CCSG Boundary GIS shapefile and I provide electronic copies on-request.

Background knowledge regarding the claim

11. My knowledge of the issues pertaining to the positions of the Claimants and the Defendants was obtained from studying documents submitted to the Court by the parties. These included affidavits and the exhibited documents relied on by the parties, including Special Mining Lease No. 173, registered on Aug 28 2018 to the 3rd Defendant, and the Final Environmental Impact Assessment dated August 3 2021, the Corrigenda and Addendum prepared by Conrad Douglas & Associates Limited (CDA).

12. I am aware that on February 7th 2022 the NRCA / NEPA (National Environment and Planning Agency) issued two environmental permits to the 2nd Defendant. I downloaded both permits, (Nos. 2018-06017-EP00196 and 2018-06017-EP00197) from NEPA's website: https://www.nepa.gov.jm/environmental-impact-assessments . I also am aware that Jamaica Environment Trust (JET), 123 Constant Spring Road, Kingston 8 submitted a review of these permits to NEPA on March 8th 2022, a copy of JET's review I attach, marked **SEK-3.** Referring to page 3 of **SEK-3**, I advise that I provided JET the information that, contrary to what is written in the permits for the boundary delineation and shown on their appended maps, the coordinate information specified for location points P6 and P7 are located within Trelawny Parish, not on the St Ann / Trelawny parish border. I confirmed this positioning using the National Spatial Planning Information Technology Platform of Jamaica (NSPIT): https://nspit.licj.org.jm/#lat=18.115179&lon=-77.279207&zoom=9.396465393242421

13. With regards to the preceding paragraph 12, I believe NEPA's error in claiming that location points P6 and P7 are positioned on the St Ann / Trelawny parish border is associated with NEPA's usage of GoogleEarth for their mapping efforts. The agency's usage of GoogleEarth was evidenced in PowerPoint slides presented by Mr. Peter Knight, CEO during a "Stakeholders' Briefing on NRCA Decision on SML 173" transmitted via Zoom on January 3rd 2022; this presentation is attached and marked **SEK-4**. As an experienced GIS user, I am aware that GoogleEarth's mapping of Jamaica's parish borders does not align correctly with GOJ's designated borders. For example, in exhibit marked **SEK-4** of the CEO's presentation, note the positioning of the western (left-hand side) border of the "Approved area for release (1,324 h)" (sic) on "Slide 5 of 6" or "Slide 6 of 6". But when mapping of the P6 and P7 permit coordinates is done either on the NSPIT online platform or using GOJ's 1:50,000 topographic maps, P6 and P7 are visibly inside Trelawny Parish. Please see my Figure 2 on page 7 below and Figure 3 on page 8, which shows close-up detail.

14. I am aware that on March 17th 2022 Prime Minister, the Most Honourable Andrew Holness, ON, PC, MP announced during the Budget Debate 2022 that the boundary for a Cockpit Country Protected Area (CCPA) was completed, that the CCPA would encompass 78,024 hectares, and that 841 hectares were "clawed back" from SML 173 and allocated to the CCPA. I have read The Jamaica Gazette Supplement, Vol CXLV, Friday, March 18, 2022, No. 21, which presents The Natural Resources Conservation (Cockpit Country Protected Area) Order, 2022, a narrative description of the boundary, and a low resolution map of the CCPA prepared by the Forestry Department, all of which were "Dated this 17th day of March, 2022" and signed by Andrew Holness, Minister of Economic Growth and Job Creation. I also have read The Jamaica Gazette Supplement, Vol. CXLV, Friday, March 18, 2022, No. 19A, whereby the CCPA is closed to prospecting and mining under The Mining (Prohibition) (Cockpit Country Protected Area) Notice, 2022, "Dated this 16th day of March, 2022" and signed by Audley Shaw, Minister of Transport and Mining. Thus, for this report, I am aware that the area of SML 173 has been reduced by 841 hectares, but at the time of writing I have not seen an amended version of SML 173 which presents this change.

15. During the preparation of this report I relied upon the information in the documents noted in Paragraph 11, information from published literature and web content, my expertise, and my direct experiences: (a) driving a segment of the northern boundary of SML 173, which adheres to the B11 road from approximately 2.4 kilometers northwest of Stewart Town, through Stewart Town, and then bisecting the districts of Enfield and Lyndale before it deviates and turns to the south approximately 1 kilometer west of the Brown's Town Post Office; (b) within the area of SML 173, notably along the unpaved road from Stewart Town through to Gibraltar via Belmont district; (c) within SML 165, which is adjacent to SML 173 and mined by NJBP II (and its antecedents); and (d) other areas of Cockpit Country, including but not restricted to the area south of SML 173, which is a part of the CCPA and includes the Litchfield Mountain-Matheson's Run Forest Reserve. References to literature and web content will be mentioned in this narrative, and all sources are listed in attachment marked **SEK-5**.

16. The geographical area of interest to this report is shown on pages 6, 7, and 8 in: (a) Figure 1, a map I created using a GIS shapefile provided by Forestry Department (FD) of the area which had been ground-truthed for the protected area by the end of March 31st 2021, and with the 841-hectare "Clawed Back Add-On" as was presented for the gazetted CCPA (2022); and (b) Figures 2 and 3, which I created in GIS by adhering to the spatial coordinate information presented in SML 173 (registered on August 28th 2018) and in the Environmental Permits issued on February 7th 2022. I note that NEPA advised me to refer to the Environmental Permits, to the detailed descriptions of the

area released for mining, as the Agency communicated to me via email on March 23rd 2022 that GIS shapefiles I requested under an Access To Information (ATI) application "are not available." I have attached a copy of the email communications between NEPA and myself, marked as **SEK-6**. In previous ATI requests related to Special Mining Leases, Mines and Geology Division (MGD) of the Ministry of Transport and Mining (MTM) advised it "does not request data to define the boundaries of mining leases in the format of shape files." Consequently, I had to create the GIS shapefiles to map the SMLs and the area released in the Environmental Permits, as presented in Figure 2.

17. I was guided as to the issues to consider in this report by instructions from Mr. B. St. Michael Hylton, O.J., Q.C. of Hylton Powell, 11A Oxford Road, Kingston 5. The instructions are attached as **SEK-7-instructions**. Those instructions outlined two issues: (1) was SML 173 issued in an area traditionally considered to be a part of Cockpit Country, which is ecologically rich and sensitive; and (2) will bauxite mining activities cause damage which constitutes environmental abuse and causes degradation of ecological heritage (i.e., will mining breach the Claimants' constitutional rights). I was asked to address the impacts of bauxite mining on forests, flora and fauna, assist the court in examining scientific data, and to evaluate / analyze the Environmental Impact Assessment (EIA). To facilitate this process, I shall refer to two documents I previously prepared and submitted to NEPA: (a) my review (Koenig 2020) of the draft EIA, which was dated November 6th 2020; and (b) my review (Koenig 2021) of the final EIA (dated August 3rd 2021) and an associated public meeting held on November 16th 2021. These documents are referenced in **SEK-5**.

18. With reference to CHAPTER III, CHARTER OF FUNDAMENTAL RIGHTS AND FREEDOMS, section 13. subsection (3) (l) the right to enjoy a healthy and productive environment free from the threat of injury or damage from environmental abuse and degradation of the ecological heritage: owing to the fact that the phrase "ecological heritage" is not explicitly defined, for the purposes of this report I define it as:

    Ecological heritage refers to the natural features and physical formations that provide habitat for naturally occurring species, particularly those which are endemic to (occur only in) a given region or are threatened or endangered, and includes the complex relationships between organisms and their surroundings. The term is generally understood to include natural areas of great scientific or conservation value, as well as sites of outstanding natural beauty.

19. In this report I have highlighted in ***bold italics*** my major conclusions.

Figure 1: Map of geographical area of interest showing boundaries of Cockpit Country referenced in this report and Cockpit Country heritage points identified by the Jamaica National Heritage Trust (JNHT).

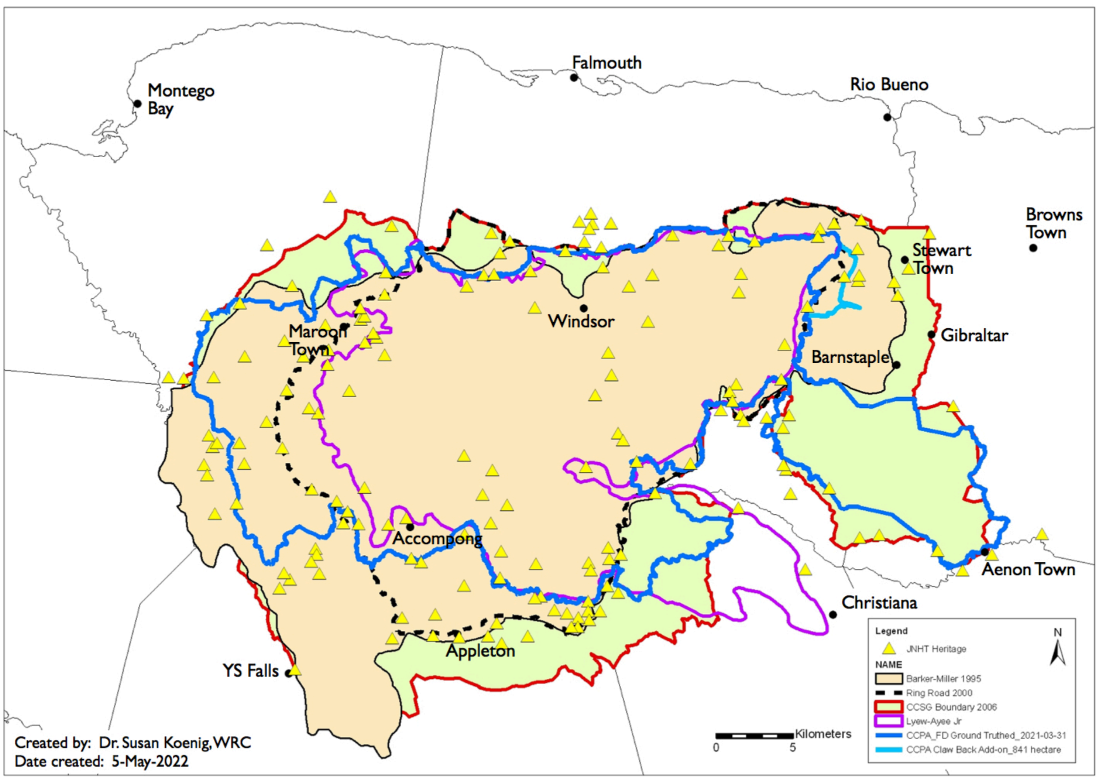


Figure 2: Map of geographical area of interest showing Special Mining Leases (SMLs) in relation to the Cockpit Country Protected Area and Cockpit Country Stakeholders Group boundaries. The points to delineate the boundary of the 1,333 hectares permitted by NRCA / NEPA are from the coordinate data presented in the Environmental Permits. The faint red dashed-line which underlies the western (left-hand) side of the 1,333 hectare area is the border of St. Ann / Trelawny; this feature is printed directly on the 1:50,000 topographic base map.

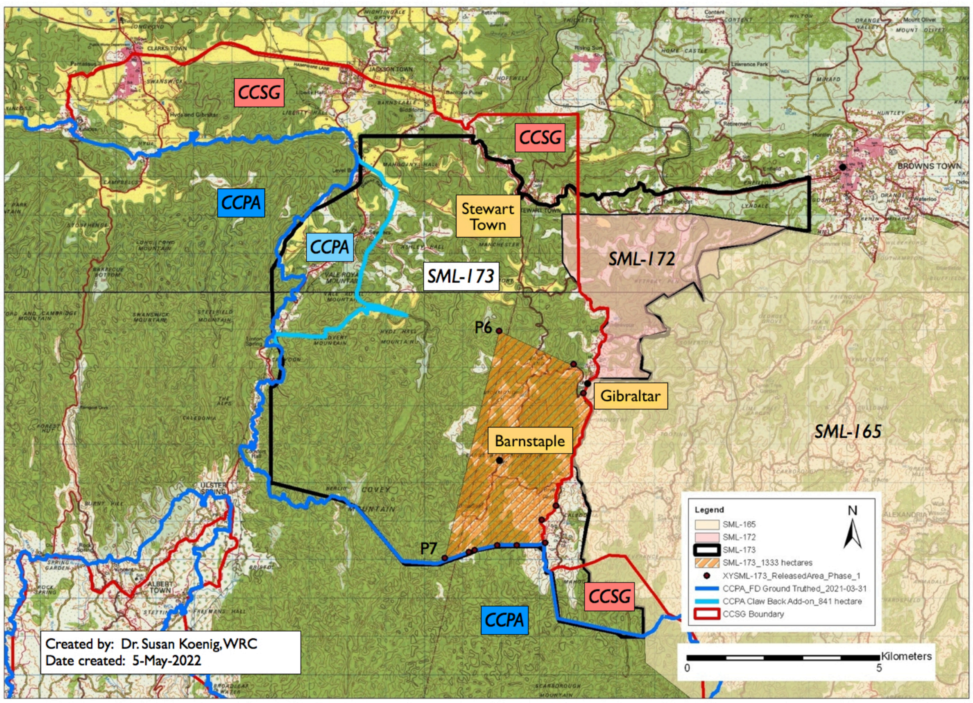
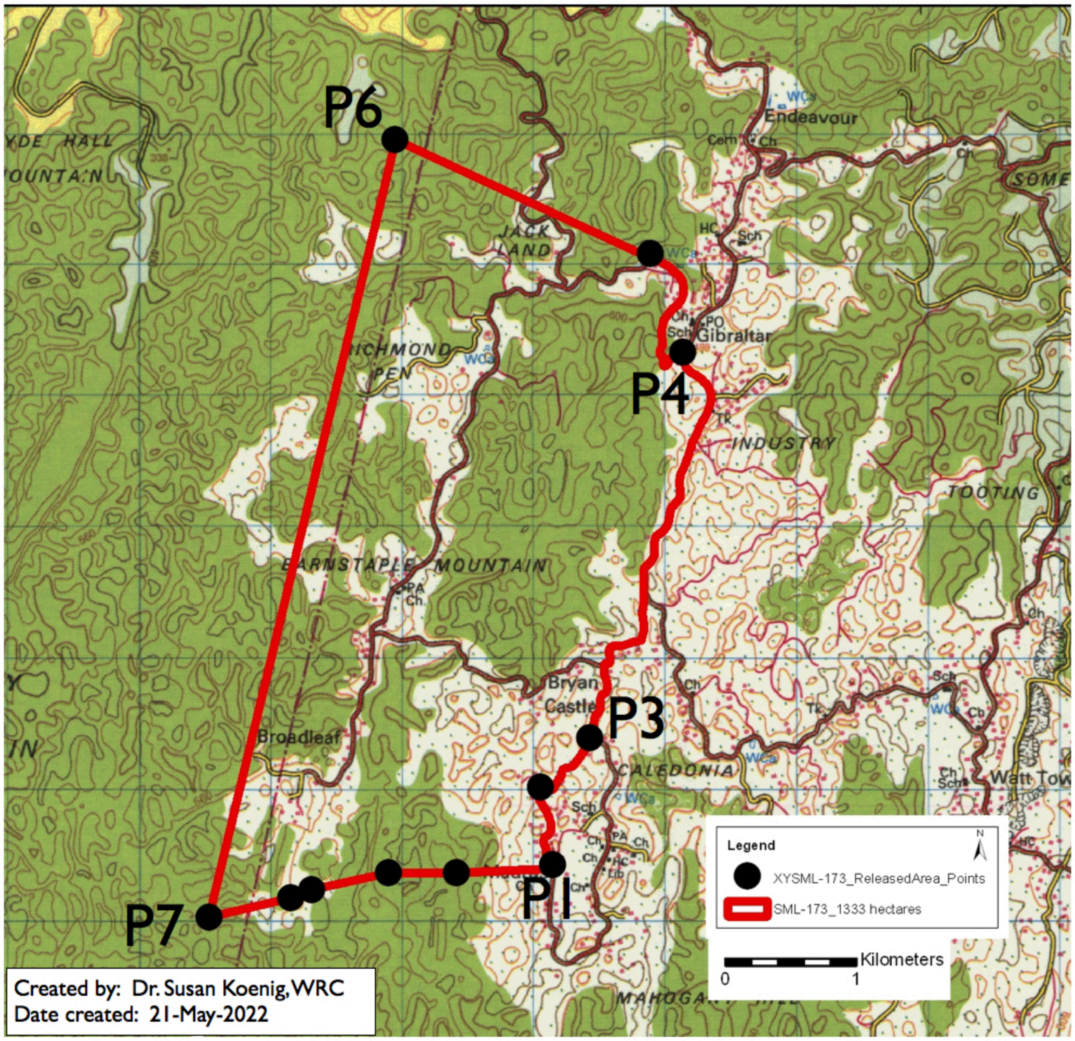


Figure 3. Close-up of the 1,333 hectares permitted by NRCA / NEPA, revealing how location points P6 and P7 fall within Trelawny Parish and not directly on the border dividing line (red dashed-line on the base map) with St. Ann.



Errors in the written lease, SML-173

20. When SML 173 was registered on August 28th 2018, the lease contained two major mapping errors.

20.1. As was written in the lease and presented by Dr. Oral Rainford in paragraph 11 of his affidavit filed on April 16th 2021, the lease area was noted to encompass "approximately One Hundred and Twenty square kilometers". Mathematically this converts to 12,000 hectares. However, when I created a GIS layer by adhering to the geo-spatial data presented for "*DELINEATION OF THE AREA"* and verified my work by geo-referencing the map included on page 11 of the lease, the GIS software calculated the area to be only 9,514 hectares. Thus, SML 173, as registered, had internal inaccuracies.

20.2. The second error is that when SML 173 was registered, the delineated boundary included 1,179 hectares which already had been allocated to the 3rd Defendant, more than a year earlier on May 16th 2017 in SML 172. Consequently, the text of SML 173 should have noted that 8,335 hectares (or approximately 83 square kilometers) were to be granted for mining purposes. As per the Draft EIA dated November 6th 2020, I believe MGD must have been aware of this error, as the mathematically correct number of 8,335 hectares was presented in the EIA. As an experienced GIS user, I consider this to be the more serious of the two errors: if MGD is keeping track of and monitoring areas that have been assigned to mining leases, I do not understand how their GIS geo-database allowed for the same area to be assigned to two leases.

SML 173: issued over an area traditionally considered to be a part of Cockpit Country

21. I created Table 1 to present the evolution of the name, from the "Cockpits" and "Cock-pits", to a "Cockpit country", and finally to "Cockpit Country" over a span of approximately 150 years. In reading the historic literature, one has to pay careful attention to the usage of capital vs. lower case letters and what that denotes in terms of proper nouns. I have highlighted in bold font the direct usage of "cockpit" (and its variations) in historic accounts.

Table 1. Evolution of the name "Cockpit Country"

Year	Source / Title	Quote / Description / Comment
1739 (Civil year 1738/39)	Peace Treaty with the Accompong Maroons	"That they shall enjoy and possess, and their posterity forever, all the lands situated and lying between Trelawny Town and the **Cockpits**, to the amount of fifteen hundred acres, bearing north-west from the said Trelawny Town." (NB: Trelawny Town was at present-day Flagstaff, approximately 1.5 kilometers east / southeast of Maroon Town, St. James.)

1803	Map by James Robertson Title: A Map of the Interior part of Jamaica, called the **COCK-PITS**, which was the Seat of THE MAROON WAR in 1795 and 1796.	This map presents the names and positions of settlements (British and Maroon), military establishments, two Maroon paths and main travel routes across the southern regions of St. James and Trelawny and northern St. Elizabeth. It includes a stylized representation of cockpit morphology, but it is clear from how Robertson truncated his cockpit sketching at the border of St. Elizabeth and Trelawny and elsewhere that this should not be interpreted as a complete rendering of the **COCK-PITS.** This is supported by his subsequent all-island map of 1804, where his stylized depiction of cockpit morphology extended far into St. Ann. One of the features of this 1803 map relevant for SML 173 is a depicted path which originates at a camp at the Hectors River near Troy and is labeled "Maroon Path to Mahogany Hall". Unfortunately, the eastern border of the map stops just to the east of Quashies River Sink, so we don't know the route to Mahogany Hall after a village called Dohertys. (NB, Quashies River Sink is one of three proven directional flows of underground water which re-emerges aboveground at Dornoch Head Rising and Dornoch Spring, the headwaters of the Rio Bueno. This is of MAJOR importance when discussing SML 173 as mining will alter water infiltration characteristics under the northern region of the aquifer associated with the proven Quashies River Sink flow (along with the Lowe River Sink and Cave River Sink proven underground flows to Rio Bueno). After this table, I present Figure 4, a map depicting the proven directions of underground flows, with SML 173 superimposed.)
1803	Book by R. C. Dallas. Short title: THE HISTORY OF THE MAROONS, FROM THEIR ORIGIN TO THE ESTABLISHMENT OF THE CHIEF TRIBE IN SIERRA LEONE.	This book is focused on the 2nd Maroon War. Dallas repeatedly uses the lower-case hyphenated form: cock-pit(s) Examples: Pg 2: "The whole range of **cock-pits** was open to the enemy: if annoyed in one they chose another, and the contest had all the appearance of being an

		endless evil . . . " Pg 130: " . .. and the General from his own station had driven them into the remote **cock-pits**, where, from the setting in of the dry weather, the scarcity of water must have been already felt. " Pp 142-3: "It is a circumstance hardly known, that he meant, on the junction of the whole Maroon force, if he had found no opportunity of treating, or in negotiating had failed, to have crossed the island, and on the south of the **cock-pits**, through Cave River, to have made a descent on the estates in the mountains of Clarendon, where he expected to find a more favourable disposition in the negroes than to the northward and westward; for in these parts, besides the great military force to awe the slaves, the majority of them were actually the determined enemies of the Maroons: whereas in Clarendon, whence the Maroons originally came, a degree of family connexion was still acknowledged among them, and emissaries have been deployed to ascertain their inclination." (NB: Cave River is highly relevant to SML 173 as it has a proven underground flow of water which re-emerges aboveground at Dornoch Head Rising and Dornoch Spring, the headwaters of the Rio Bueno. See Figure 4 after this table. Also to the west of Cave River Sink is the topographic feature "Cuffie Ridge.") Dallas also includes multiple descriptions about how the Maroons climbed upslope of saddle-corridors which connect the **cock-pits** (i.e., the hillsides) to each other, waited for the soldiers to hike through single-file, and then rolled boulders down onto them. He also includes details about the impacts of the lack of surface water, how during the dry season the military guides were instructed to examine wild-pine (aka tank bromeliads), withes, and the roots of cotton-trees for water. Pg 162: "the soldiers were so parched they were ready to drink their urine."

1823	Book by J. Stewart. Short title: A VIEW OF THE PAST AND PRESENT STATE OF THE ISLAND OF JAMAICA.	Pg 25: "There is no island in the West Indies so diversified in its surface as Jamaica. Its mountains, its precipitous rocks, its countless hills, valley, and glades – its lofty, rugged, and abrupt ascents – its deep ravines, caverns and ***cockpits**** - its thick-planted majestic woods- its numerous rivers, cascades, and mountain streams, dashing through this wilderness of nature- give to the interior a diversity and grandeur of appearance not to be found, perhaps, in any other island of similar extent." " *A level spot, surrounded and confined by lofty and abrupt mountains, into which a narrow defile leads."
1847	Book by Phillip H. Gosse. Title: THE BIRDS OF JAMAICA	Gosse doesn't record "cockpit", but his usage of the noun "country" is insightful for the standard dictionary usage -- an area or region with regards to its physical features -- in the mid-1800s: Pg 262: "A mountain district very remote, between Trelawny and St. Ann's . . .a peculiar **country** called the *Black grounds* . . ." (NB, He was referring to an area of the Central Inlier; the adjective Black refers to the soils, which are derived from the igneous bedrock and distinguished from the *terra rossa* aluminum-bearing red dirts.)
1869	Book by James G. Sawkins. Short title: REPORTS ON THE GEOLOGY OF JAMAICA.	The geologist Sawkins is generally recognized as being the first person to link the words "Cockpit" and "country". But it cannot be emphasized enough, he never presented them as a proper noun (i.e., as "Cockpit Country"). His first description is on page 216, as he was approaching the headwaters of the Martha Brae river: "This valley is more undulating than that of Fontabelle, descending from the north by four distinct depressions before reaching the river in front of Windsor Pen Great House. It is here the

		Cockpit country commences; and from the difficulties presented by the uneven surfaces . . .” Again, notice how he used a lower case “c” for country. On page 220, Sawkins’ language shifted: “All that portion of this parish south of Windsor Pen as far as the line of St. Elizabeth and Westmoreland is considered as the western **Cockpit land**, that is, a rough uncultivated track of **country** covered by fragmentary limestone, with pointed hills on narrow ridges, with deep precipitous hollows like inverted cones, or deep narrow troughs on which the forest trees of the **country** thrive to the greatest perfection.” And in the next paragraph, also on page 220, Sawkins continues: “The **windward Cockpits** are those which occupy that section of the parish lying between the Alps and the line of parish dividing this from St. Ann.” (NB – Sawkins’ limitation to the parish boundaries on page 220 relates to the fact that he was writing about the features of Trelawny Parish (i.e., he presented his descriptions parish by parish). ***But to be clear: what James Sawkins recognized as the “*****windward Cockpits*****” has been assigned to SML 173.***) For the St Ann description of Rio Bueno to Dry Harbour, Sawkins wrote on page 202: “the greatest part of the surface consists of hard white limestone and red earth.” For St. James, he wrote on page 205: “the northern side of the Lacovia Mountain descends gradually . . . where it connects to the high lands of St James and Trelawny. This area is traversed by many deep and almost impassable valleys between steep rugged hills.”

		We also read on page 223: "The fragmentary condition of the white limestone in the **Cockpit district** furnishes the observer with an opportunity of estimating the denuding influences where the surface of the slopes are composed of accumulated talus, each fragment presenting a weathered and wasted surface, and the talus attaining a depth of many hundreds of feet at the base of the depression or pit." And on page 242: "The most extraordinary peculiarity consists in the numerous and deep depressions which occur in the white limestone, called by the natives **"Cockpits;"** they present the appearance of an inverted cone or tea cup of 100 to 500 feet deep, covered on every side by fragmentary limestone of all sizes, weathered and worn into every possible shape imaginable, and the edges or rim of these pits when extended on a map present a series of lines like net work or the edges of cellular tissue." Thus, it is clear that when Sawkins wrote "Cockpit country" on page 216, he was not using "country" as part of a proper noun but, instead, to discuss an area that could be defined with regards to its distinctive physical features – ***a country of Cockpits***. He presented the morphology in a sketch-diagram on page 243, entitled "PRESENT DEPRESSIONS AND **COCKPITS**. FIG. 5". (NB, After this table, see Figure 5, where I present Sawkins' sketch diagram, and Figure 6, where I present GIS-generated vertical profile examples of the cockpit morphology found within SML 173.)

1895	Pamphlet (93 pp). JAMAICA IN 1895, A HANDBOOK OF INFORMATION FOR INTENDING SETTLERS AND OTHERS.	Here we see the label of "**COCKPIT COUNTRY**" starting to be included on maps. At this time, the label is positioned in the southwestern corner of Trelawny, where it meets with St. James and St. Elizabeth, and just to the north of Accompong. The narrative text, however, continues to refer to "**Cockpit district**" (pg 2) and "the inaccessible **Cockpits**" (pg 3).
1901	Map by Edward Stanford. Title: JAMAICA	While the label positioning is similar to the afore-mentioned 1895 map, Stanford assigned the name "**WILD COCKPIT LAND**" to the area north of Accompong.
1902	Map, compiled by E.V. d'Invilliers (Geologist and Mining Engineer). Title: TOURIST MAP OF THE ISLAND OF JAMAICA, B.W.I.	Label positioning is as on the 1895 and 1901 maps, with the name "**Cockpit Country**" positioned north of Accompong. Here we see that cartographers are beginning to carve-in-stone the proper noun Cockpit Country.
1905	Title: MAP OF THE ISLAND OF JAMAICA, PREPARED FOR "JAMAICA IN 1905"	Label positioning of "**COCKPIT COUNTRY**" as with 1895 onwards, but this map also included delineations for Crown Lands. (NB, all subsequent maps I have seen used the name Cockpit Country.)

22. ***Based on historic references from the 18th, 19th, and early 20th centuries, there can be no doubt that SML 173 has been issued in the "country of Cockpits," which since the late 1890s / early 1900s has been called Cockpit Country.***

Figure 4. Proven directions* of underground water flows supplying Dornoch Head Rising, the source of the Rio Bueno.
*See also paragraph 23 below for details.

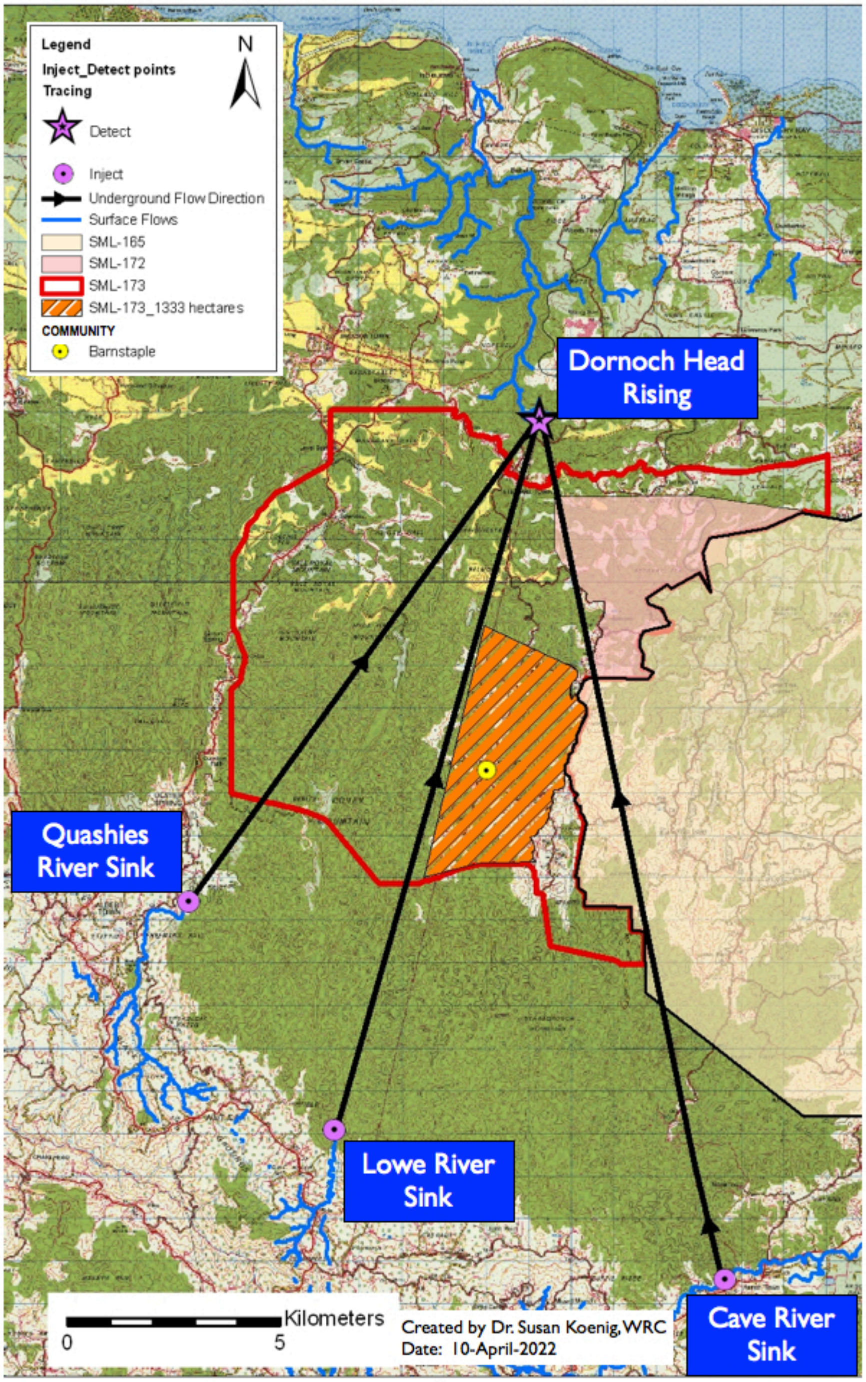
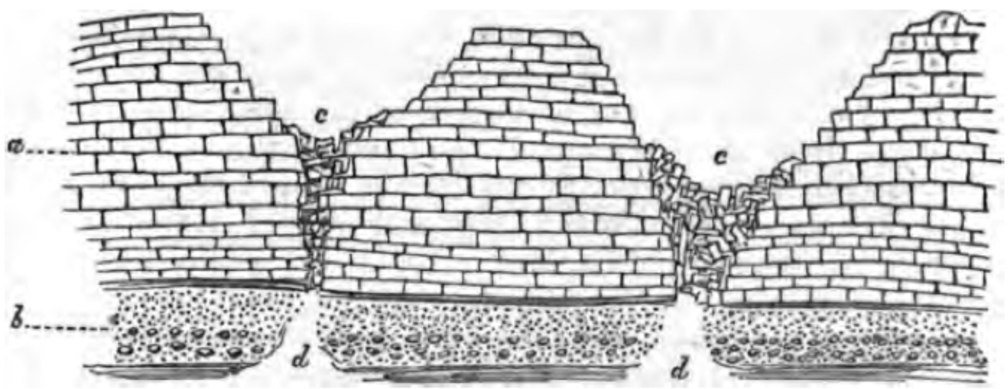


Figure 5. Sketch diagram of Cockpit morphology, as presented by James Sawkins (1869).

PARISH OF ST. JAMES. **243**

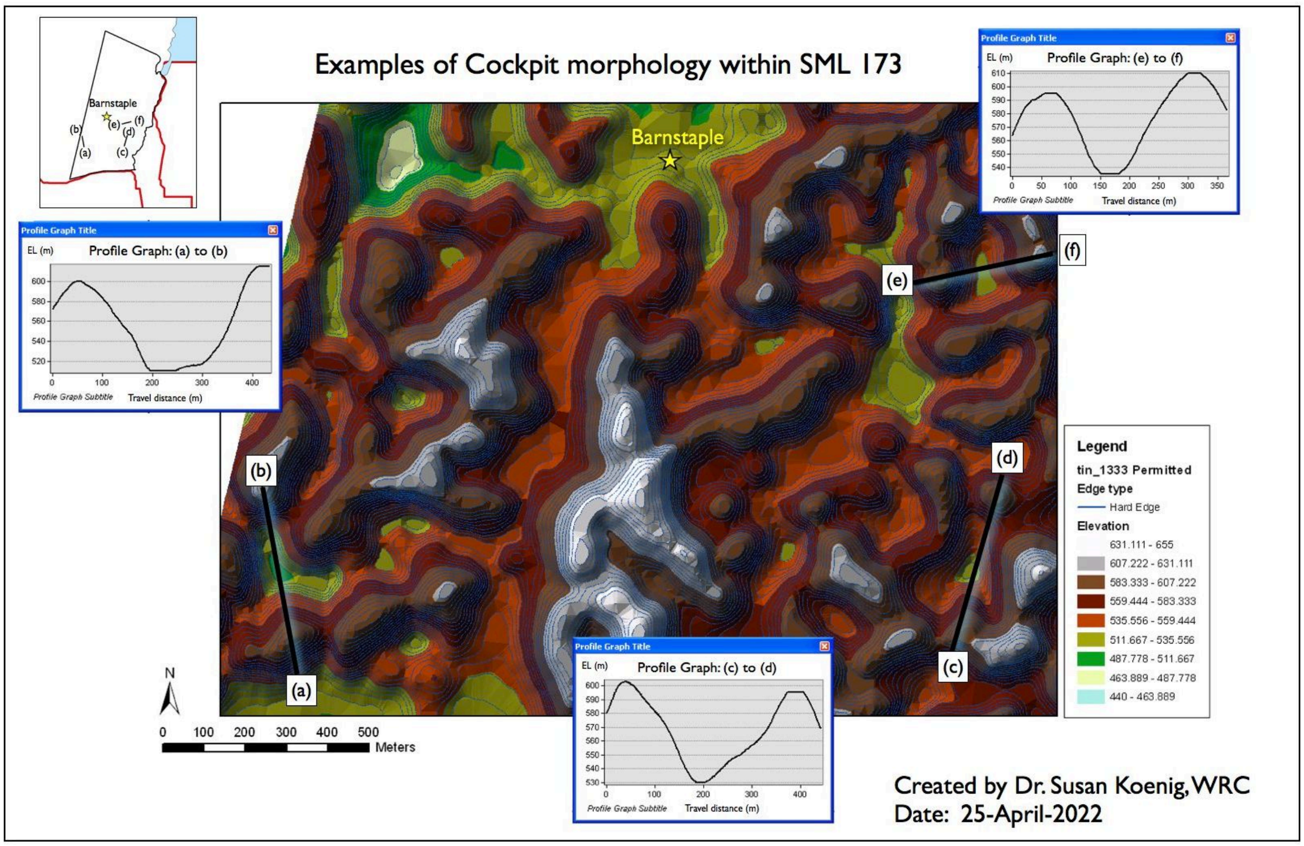
PRESENT DEPRESSIONS AND COCKPITS.

Fig 5..



a. Limestone. *b.* Trappean series.
c. Bottom of cockpit. *d.* Subterranean channel.

Figure 6. Examples* of how the Cockpit morphology can be indentified and quantitatively measured using GIS software, in the area of the 1,333 hectares released for mining within SML-173. * There are many other examples of Cockpit morphology which can be profiled in this figure.



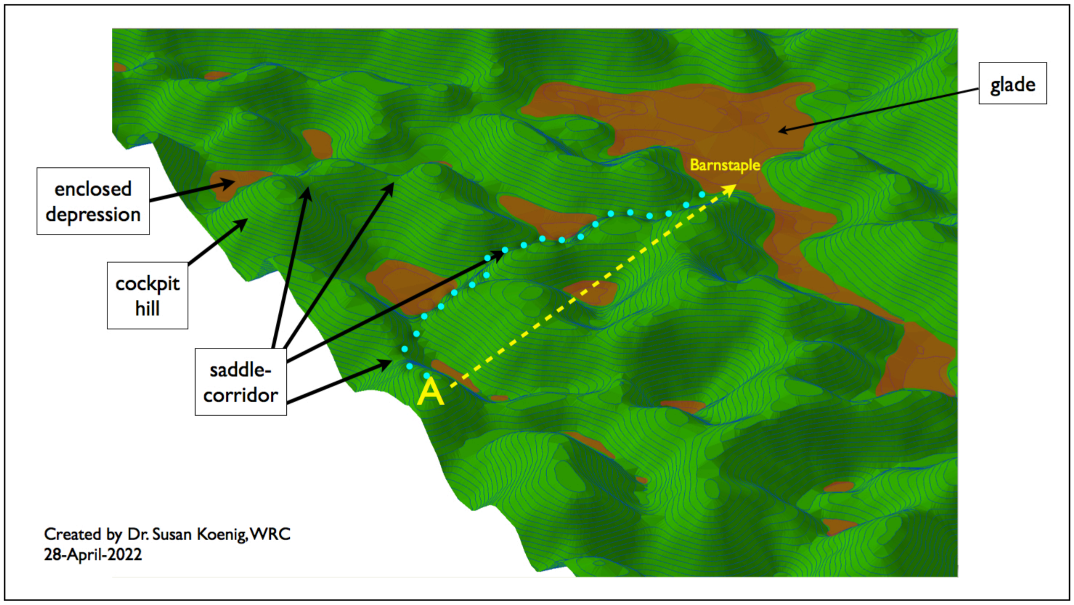
23. With regards to Figure 4 and of relevance to the final EIA, dye tracer studies were undertaken by Water Resources Authority (WRA) in 2017 / 18 which re-confirmed the flow connection between the Quashie River and the Rio Bueno and confirmed a connection between the Lowe River and the Rio Bueno. In WRA's 2018 report, Chief Hydrologist Geoffrey Marshall wrote:

> "The use of isotope hydrology would be ideal for further clarity in the dynamics between precipitation recharge, groundwater and surface water flow dynamics in the basin. Dye Trace methods are limited to surface water and conduit flow connections, but stable isotope analysis of ^{2}H and ^{18}O could be used for a more precise analysis, guided by the results of dye trace exercises. The WRA intends to commence an isotope hydrological study of the Rio Bueno sub-WMU in 2020 as guided by these studies."

24. As presented on April 11th 2022 in a webinar, entitled "Multi-disciplinary Evaluation of Karst Aquifer Recharge Patterns and Vulnerability," WRA currently is collaborating with the International Atomic Energy Agency (IAEA) on an isotope project to track the movement of water – rainfall, infiltration and drainage -- for the Rio Bueno sub-Watershed Management Unit (WMU). I have attached the Project Proposal Form (marked **SEK-8**), which I received from Mr. Marshall on April 22nd 2022. During the webinar, preliminary information was presented to highlight how sinks, springs, and the Rio Bueno responded during the period of August 25-28th 2021 after the passage of Tropical Storm Grace on August 17th 2021. It also was noted by Dr. Aurel Persoui that response signals were not detected within deeper wells (i.e., it remains unknowns whether response time of water infiltration in wells is greater than one week, or one month, or if there is mixing in the epikarst [surface and soil]). Data collection for the project will continue through March 2023. At the time of this report, the 4-part webinar series had not yet been uploaded to youtube.com, but Mr. Marshall noted during the webinar that it would be "in future". In the absence of a video record of the webinar, I have attached a copy of my hand-written notes I recorded during the webinar; these are marked **SEK-9**.

25. In 1958, Dr. Marjorie Sweeting created the morpho-geological term "Cockpit Karst" to define this uniquely-recognizable pattern of polygonal karst. For the layperson, the morphology is typically described as an upside down egg carton, with steep, rounded-top hills which are connected to each other via saddle-corridors. This hillside connectivity results in irregularly-shaped, enclosed depressions where deep soils accumulate. (For a primer on Cockpit Karst morphology, see Figure 7 below, which I created in ArcScene GIS software from a geo-database GIS file of 5-meter elevation contour lines of Jamaica; WRC received this GIS file from Forestry Department more than 10 years ago.) Attempting to differentiate between the cockpit hillsides and enclosed depressions is essentially meaningless because they are functionally interconnected components of the "cockpit" morphology – you don't have one without the other. While Cockpit Karst morphology has formed in other tropical karst limestone regions, ***Cockpit Country is the type locality***, so that all other areas around the world are compared to Jamaica.

Figure 7. Primer of Cockpit Karst morphology: cockpit hills, saddle-corridors which connect hilltops, and the associated enclosed bottomland depressions where soils accumulate, as presented for a section of the 1,333 hectares permitted by NEPA. A glade is an elongated enclosed depression, where individual cockpits extend along lines of jointing and faulting.
If I had to hike from hilltop A to the Barnstaple glade, hiking in a direct straight line, scrambling downhill-uphill-downhill-uphill, would be extremely arduous because of the steepness of the hills. Instead, I would hike down from the hilltop to a saddle-corridor and then traverse along the sides of the hills following a level elevation contour line, doing a "serpentine weave" through the saddle corridors. Knowing that the British soldiers would take such a logical "path of least resistance," the Maroons waited on hilltops to ambush them with boulders.



26. Delineated by Sweeting (1958), the majority of SML 173 is "Cockpit Karst", as shown in Figure 8.

27. If Dr. Sweeting had access to present-day GIS software, she would have recognized quantitatively that her delineated "Degraded Cockpit Karst" extended too far west. That is, that the area of the 1,333 hectares released to mining is "Cockpit Karst" morphology, as rendered visible with GIS 3D presentation of contour-elevation data and shown in Figure 9 and Figure 10. Simply put, the area of the 1,333 hectares looks cockpit-y because it is full of cockpits, like elsewhere in SML 173.

28. As a further note, when Dr. Sweeting attempted a redefinition for the entire Cockpit Country, she ignored Sawkins' description of the "windward Cockpits"; indeed, she also ignored her mapping of Cockpit Karst. Instead, she chose to adhere to a conspicuously faulted area along the Alps road, a fault which also serves as the western border of SML 173.. Unfortunately, when (Dr.) Parris Lyew-Ayee Jr undertook his digital topographic analyses of the morpho-geology of the Cockpit Country Region, because he adhered to Sweeting's restricted definition he, too, excluded the "windward Cockpits" from Cockpit Country. This is an important technical flaw in the Lyew-Ayee Jr. boundary (not to mention the fact that his definition also excludes Accompong from Cockpit Country).

Figure 8. Sweeting's 1958 geomorphological map of north-central Jamaica, with SMLs and the 1,333-hectare area permitted for mining. The yellow line is the Lyew-Ayee Jr. boundary which, like Sweeting, attempted a redefinition of the entire Cockpit Country by adhering to the conspicuous Alps fault (which is also the western border of SML 173). The consequence was the he excluded the entire eastern flank of Cockpit Country from his morpho-geological assessment.

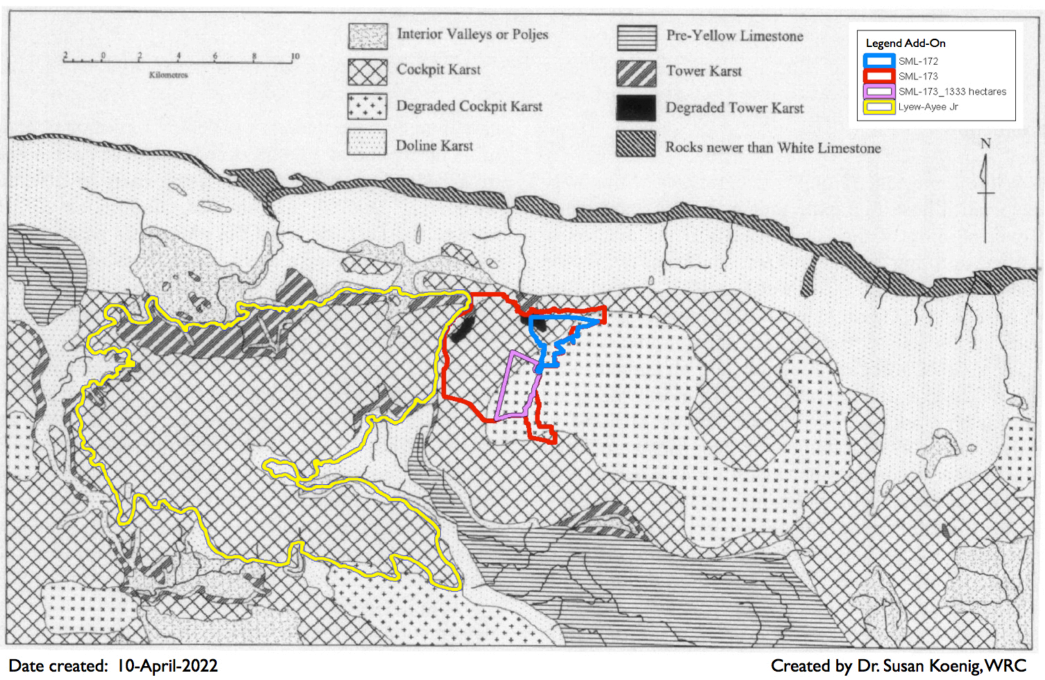


Figure 9. Morphology of SML 173, including the 1,333 hectares released for mining.

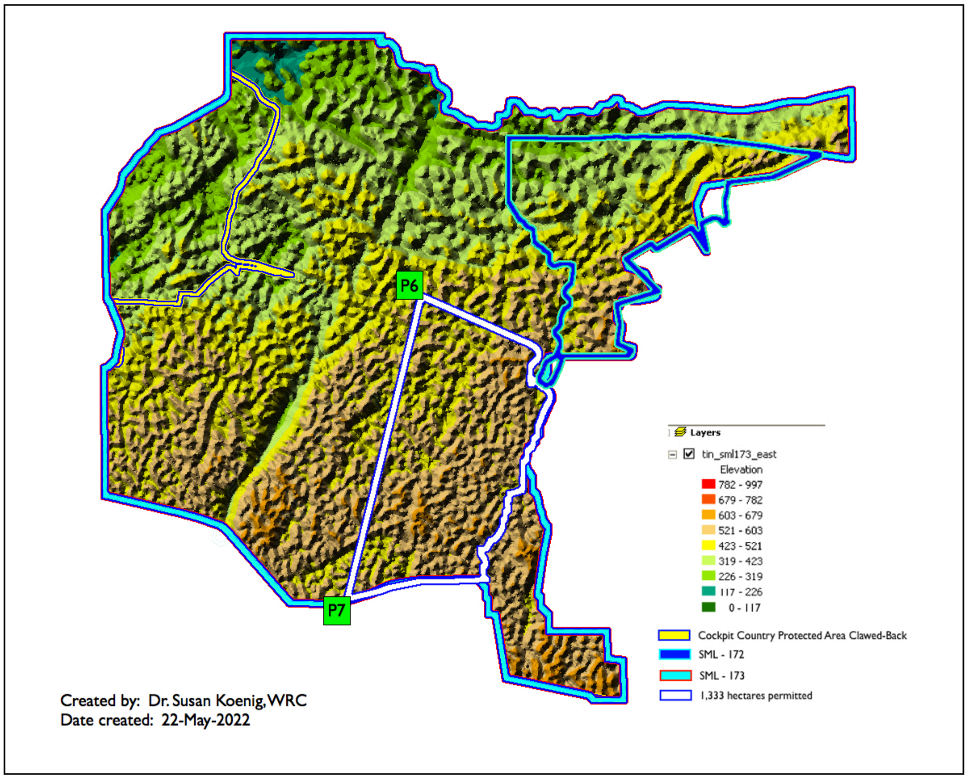
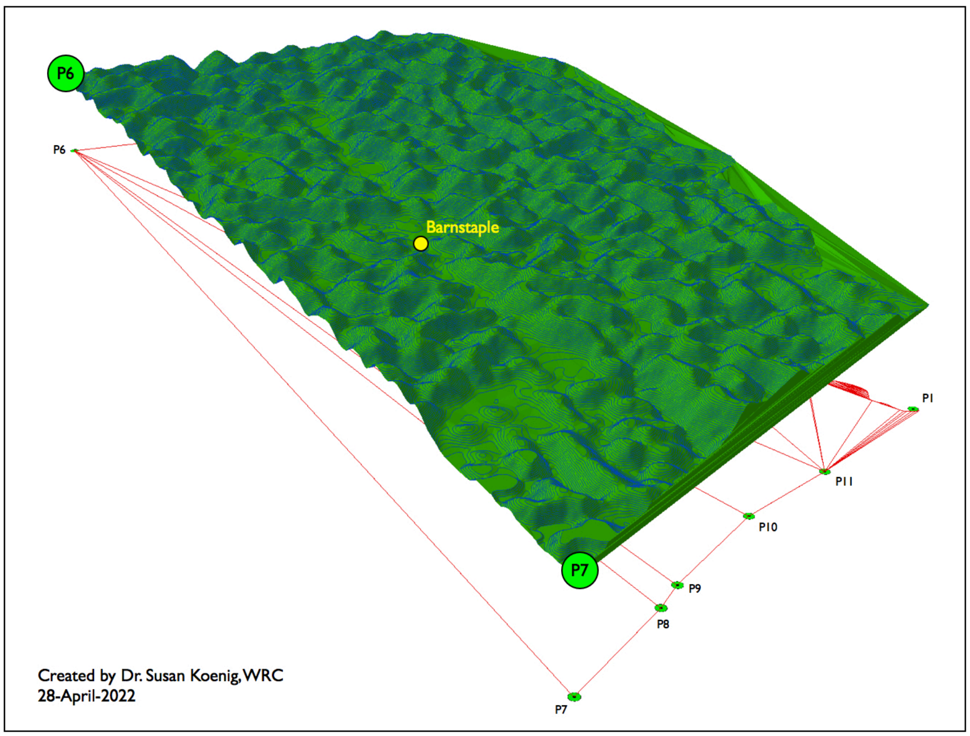


Figure 10. 3-D rendering of the 1,333 hectare-area released for mining within SML 173.
The red, triangle-creating lines on the layer showing the locator points of the environmental permits are related to the 3D processing in ArcScene software. To facilitate orientation to other 2-D maps in this report, I added P6, P7 and Barnstaple to the 3-D rendering.



<u>Failings of the EIA to correctly describe abiotic features (geomorphology and hydrology) of SML 173, with consequences for not understanding the impacts that bauxite mining can have on forests, flora and fauna.</u>

<u>Topography</u>

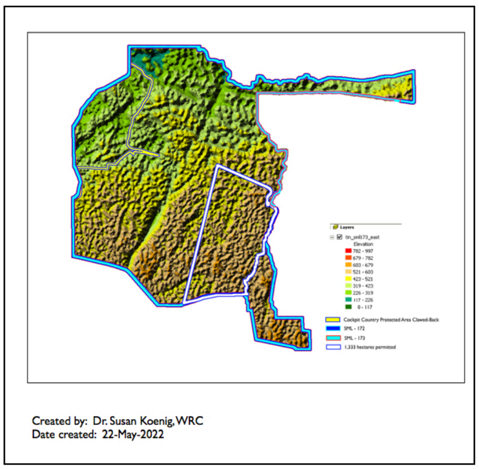
29. In the final EIA, in section **5.1.2. Topography** on page 5-3, CDA wrote: "The topographical features of the SML 173 area comprises gentle rolling knolls, hillocks and valleys and are generally characteristic of limestone that has undergone karstification." Notably missing from this section of the EIA is the quantifiable fact that the area is composed of cockpit hillsides, saddle-corridors, and the associated enclosed depressions, the latter of which is where bauxitic soils are accumulated. That is, the area of SML 173 is quantifiably Cockpit Karst morpho-geology.

30. Based on **Figure 5-2: Topography Map of SML 173** (page 5-4) in the EIA, I believe that CDA had a GIS data file of 5-meter elevation contour lines to create the digital surface model they presented in Figure 5-2. I believe this to be true because I can create a comparable representation of SML 173 using a 5-meter elevation contour Digital Surface Model (DSM) GIS data file which WRC received from Forestry Department more than 10 years ago. See Figure 11 for my comparison to the EIA's Figure 5-2.

31. ***In my opinion, when NEPA accepted the final EIA, the Agency: (a) failed to understand the topography (morphology) that Figure 5-2 was presenting; and (b) failed to require a quantitative, accurate technical description of the morphology of SML 173. Had NEPA done so, the morphology would have been described quantitatively and correctly as "Cockpit Karst".***

32. An objective, quantitative assessment of SML 173's morphology in the EIA would have included the number and spatial positioning of: (a) enclosed depressions and glades; (b) circular hilltops; and (c) cockpit saddle and ridgeline corridors. I believe these parameters to be relevant to the 2nd Defendant for creating the first 5-year plan of haul roads (as was presented in Figure 4-2 of the EIA) so as to determine the configurations and costings of the haul road network. Although NEPA was unable to provide GIS files of ore bodies and haul roads [files which the Agency would have used to create a map presented by the CEO Mr. Peter Knight to the public on January 3rd, 2022 (see **SEK – 6**)], I extracted Figure 4-2 from the EIA, spatially aligned the image to WRC's geo-database, hand-traced all ore body polygons and haul roads, and verified positions by cross-checking with WRC's DSM file. Based on this work, ***I count that there may be at least 38 limestone corridors which will be irreversibly destroyed for the creation of haul roads in order to gain access to ore bodies within the 1,333 hectares permitted.*** See my Figure 12.

Figure 11. Topography of the 1,333-hectare permitted area, as created by Dr. Koenig using WRC's GIS 5-meter elevation contour shapefile and CDA's digital elevation colour scheme, with comparison to **Figure 5-2: Topography Map of SML 173** extracted from the final EIA.



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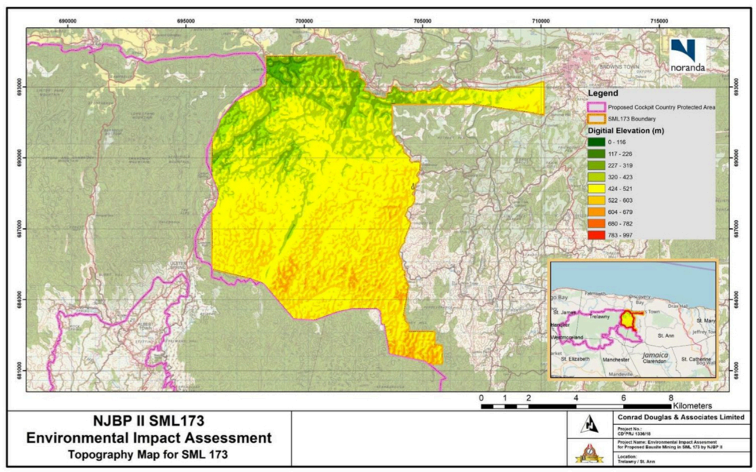

Figure 5-2:Topography Map of SML 173

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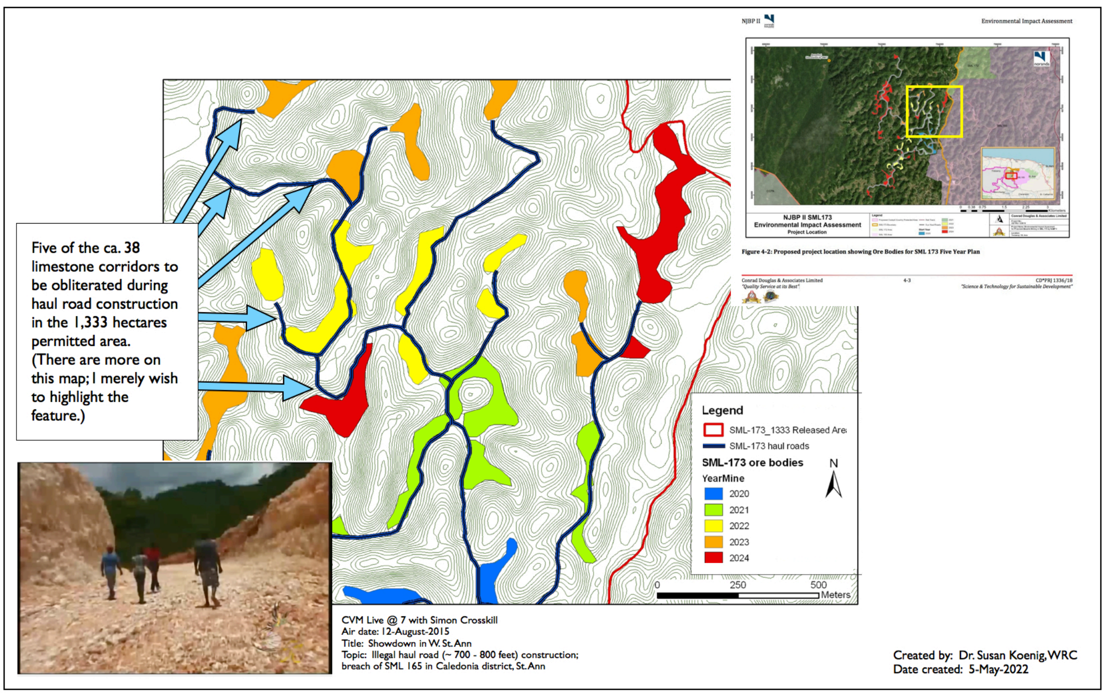
Figure 12: A few examples of where the construction of haul roads will irreversibly destroy the limestone corridors which connect cockpit hillsides. These limestone saddle-corridors are a part of the functional definition of "Cockpit Karst" morphology.
In the legend, "YearMine" is as was presented in the final EIA. The inset photograph on the lower left is in the district of Caledonia, St. Ann, where in 2015 "Noranda" constructed a haul road outside of its permitted area of SML 165 into what is now SML 173. During a televised interview with Simon Crosskill on August 12th 2015, Mr. David Wong Ken, Director of Property & Legal Department at Noranda Aluminum Holding Corporation verbally confirmed this breach.



33. Contrary to assertions in the EIA that the creation of haul roads is a Minor and Reversible change to a karst limestone environment (reference **Table 7.1. Impacts to Physical Resources** in the EIA), the obliteration with dynamite or bulldozers of cockpit corridors, with a specific purpose to create a gap between cockpit hillsides in order to access ore bodies in depressions, is an irreversible change. ***It is physically impossible to recreate the morphology and its myriad fissures and cracks in the limestone landform. Because this irreversible change will occur in a part of what is the*** **type locality** ***of Cockpit Karst, haul road construction is, in my opinion, a Major and Irreversible change to a site of global scientific importance.*** I discuss the impacts on forests, flora, and fauna in greater detail below.

<u>Hydrology</u>

34. As presented in paragraph 23 and Figure 4 above, dye tracer studies have identified subterranean water flows between: (a) Quashies River Sink – Dornoch Head Rising; (b) Lowe River Sink – Dornoch Head Rising; and (c) Cave River Sink – Dornoch Head Rising. In the draft EIA dated November 6th 2020, in **Figure 5-15: WRA Dye Trace Study (Source: *WRA*)** on page 5-25, CDA failed to include the direction-of-flow line for (c) Cave River Sink – Dornoch Head Rising. Given that this connectivity has been known since at least the early 1970s (Brown and Ford 1973), I considered this to be a gross omission of information when I reviewed the draft EIA (ref paragraph 16 in Koenig 2020). But in the final EIA, not only did CDA not include this 3rd proven flow, instead they replaced the map with an entirely different map of fault lines, with not a single underground-direction-of flow line, while retaining the same Figure title. See my Figure 13a and Figure 13b. NEPA officers who reviewed the final EIA before presenting it to the public clearly failed to detect this error. As an expert, this leads me to ask a question: why was the Cave River Sink – Dornoch Head Rising relationship not presented in Figure 5-15 of the draft EIA?

35. On page 2-3 the EIA notes that "The moisture content of naturally occurring bauxite ranges from about 20% to 25%. . . .it is sticky and difficult to handle when wet as it bridges across the components of mining equipment." At 26% moisture-by-weight, the soils become saturated and thereafter the water will percolate vertically downwards into the underlying limestone.

36. The EIA presents that there are "approximately 150 million tonnes of bauxite in the SML 173 area" (page 2-2), for mining "for a period of about twenty-five (25) years" (EIA page 1-1). As a back-of-envelope mathematical calculation, this would work out to mining approximately 6 million (dry metric) tonnes (MDMT) per year (ref also EIA page 1-4). Similarly, given that the area of SML 173 (excluding the area also allocated to SML 172) is 8,335 hectares, that would mean mining in parcels covering 333 hectares per year (8,335 divided by 25) . As I wrote previously in paragraph 14, 841 hectares have been "clawed back" from SML 173: this represents a reduction of approximately 2.5 years of mining (841 divided by 333) and the reduction of total available reserves from approximately 150 MDMT to approximately 135 MDMT. I would look forward to receiving more accurate MDMT estimations if available.

Figure 13a: The dye trace figure presented in the draft EIA dated November 6th 2020 was missing the third proven underground flow from Cave River Sink to Dornoch Head Rising. (For reference, see my Figure 4 on page 16.)

2

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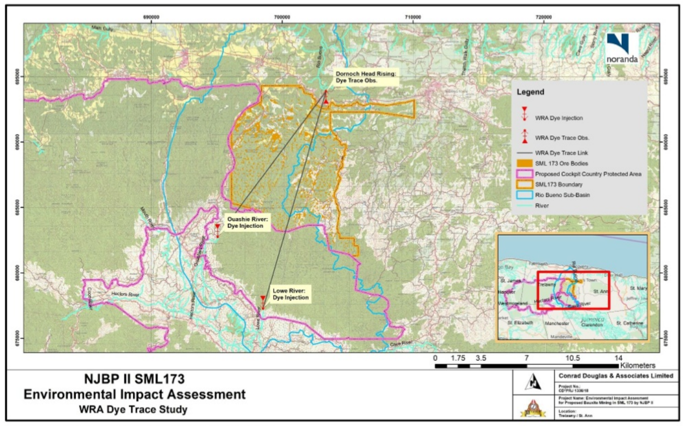

Figure 5-15: WRA Dye Trace Study (Source: *WRA*)

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Figure 13b: Although labeled "**Figure 5-15: WRA Dye Trace Study (Source WRA)**", the figure in the final EIA dated August 3rd 2021 not only failed to include the third proven flow direction line, but it replaced the underground hydrology with a map of fault lines, not the dye tracer studies.

NJBP II noranda bauxite Environmental Impact Assessment

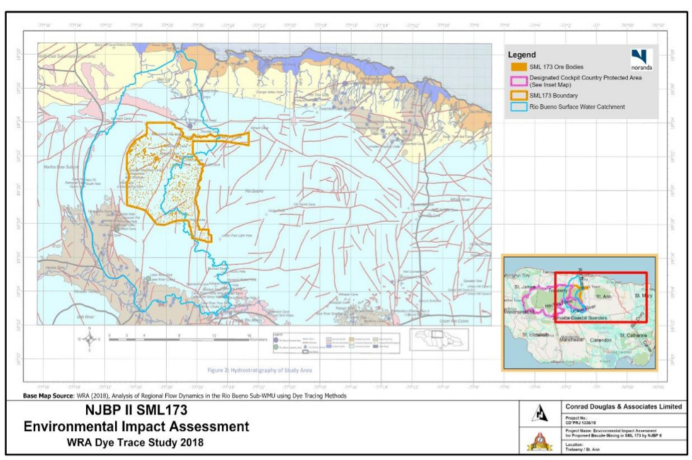

Figure 5-15: WRA Dye Trace Study (Source: *WRA*)

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37. “Dry metric tonnes” represents the weight of the bauxite after it has been dried so that it retains only approximately 13% moisture by weight. With an *in situ* capacity to hold 25% moisture-by-weight, 135 MDMT means that 151.2 million metric tonnes of bauxitic soils would be extracted, of which 117.9 million metric tonnes would be solid material and 33.3 million metric tonnes would be water. Given that one tonne of water equals 1,000 liters of water, ***if the area outlined by SML 173 (minus the “clawed back”) were mined, 33,264,000,000 liters of water-holding capacity of the bauxitic soils will be irreversibly lost from the area, the Rio Bueno sub-WMU.***

38. For the 5-year, 1,333 hectare permitted area, I calculate that 7,392,000,000 liters of water-holding capacity of the bauxitic soils will be irreversibly lost from the Rio Bueno sub-WMU.

39. The EIA presented no data or models to predict how removing the moisture-holding bauxitic soils from SML 173 will impact the water cycle, including but not restricted to the speed at which rainwater will reach the underlying limestone in the absence of buffer-mediation by the very deep soils. I consider this to be a MAJOR flaw in both the EIA and of NEPA’s acceptance of the EIA.

40. I note here that in the April 11th 2022 WRA webinar (reference paragraph 24 above), Dr. Christos Pennos communicated that “thickness of soil”, as it relates to rain water infiltration, is one of the parameters that is needed for the EPIK modeling of the Rio Bueno sub-WMU (see **SEK-9**).

Impacts that bauxite mining will likely have on forests, flora and fauna

41. Before addressing the impacts of bauxite mining activities – haul road construction, extraction of ore bodies and transport -- , I must correct a false assertion which the EIA and other mining proponents on Jamaica, such as the Jamaica Bauxite Institute (JBI), have presented multiple times. On page 5-17, the EIA asserts, “there is a general misconception that bauxite occurs under forested areas” and on page 1-1 it asserts that grassland is “its natural state”.

    41.1. As Professor Simon F. Mitchell (Department of Geography and Geology, UWI-Mona) presented in his (undated) review of the draft EIA, in his paragraph 11: “Bauxite does NOT naturally give rise to grassland. Originally all areas would have been forested. It is the glades where bauxite occurs that have been substantially cleared for agriculture. (The same is true of the alluvial plains, which were cleared for the production of sugar.)”

    41.2. Professor Mitchell was drawing attention to what is a substantial body of peer-reviewed literature on the relationships between geo-morphology, elevational topography, and the composition, diversity and physical structure of forests in tropical limestone ecosystems. These natural relationships, in turn, explain the patterns of why humans convert forest to agriculture in bottomlands, valleys, and in enclosed depressions such as glades, dolines, and poljes (i.e., those topographic areas where soils accumulate) while leaving hillsides and hilltops (which are almost entirely devoid of soils) with forest cover. In as simple an explanation as possible, forest trees become shorter in stature as one travels upwards in elevation, from bottomlands to hilltops. There are at least three reasons for this: (a) trees growing in bottomlands may have direct access to groundwater (e.g., roots may reach water-filled conduits in the limestone component of the aquifer); (b) moisture-holding soils accumulate to their greatest depths in bottomlands and, consequently, trees have access to 'soil water' when 'rain water' does not fall for prolonged periods of time; and (c) trees on hilltops may have greater exposure to desiccating winds during the dry season. In presenting his descriptions of the forest structure on Jamaica's Cockpit Karst, Aub (1969) also reported that, because more dew condenses overnight and drips from the dense forest trees in the depressions, the bottomlands of cockpits receive at least 14% more water than their surrounding hilltops; the trees, thus, create a positive feedback mechanism for moisture retention. See Brewer *et al.* 2003 and references therein for a more comprehensive discussion of this well-documented phenomenon of topography, patterns of soil accumulations, and tropical limestone forest structure.

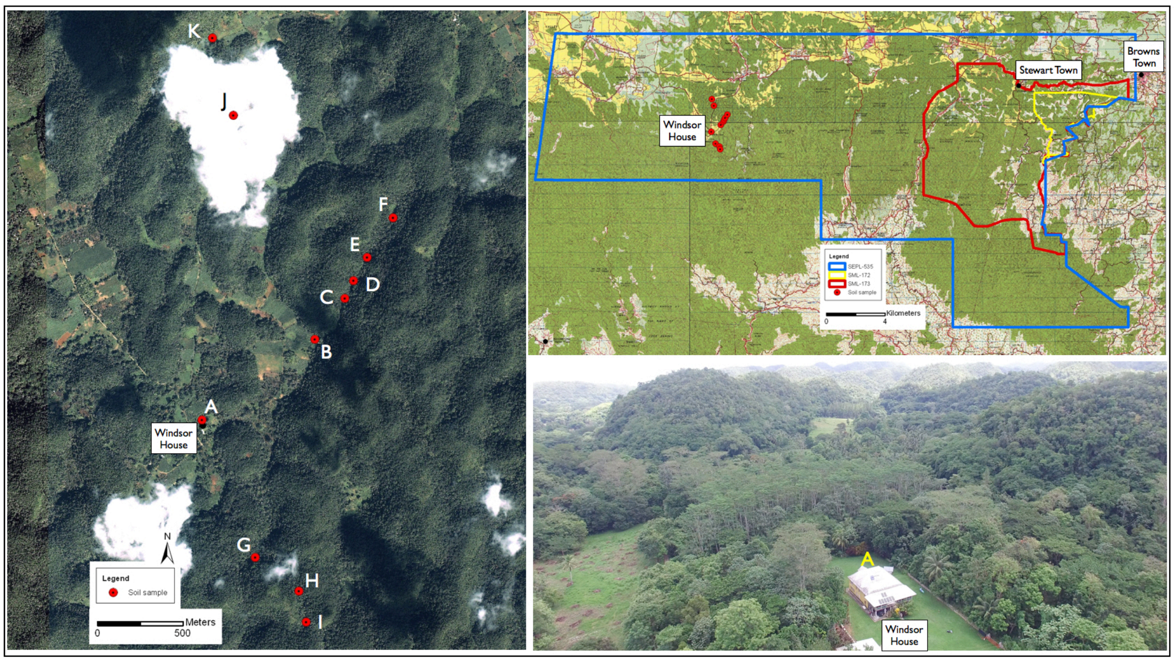
41.3. I submit that CDA were, in fact, aware of the documented relationships between topography, bauxitic soils, forest structure, and clearing of forest for agriculture when they prepared the EIA. I created Table 2 with text extracted from the EIA.

Table 2. Extracted text from the EIA. Asprey and Robbins (1953) refers to:
Asprey, G. F. & Robbins, R. G. (1953). Vegetation of Jamaica. *Ecological Monographs 23*(4), 359-412. https://www.jstor.org/stable/1948625

EIA page	EIA text
5-127	Figure 5-85 shows the distinction that is obvious from the aerial images of SML 173. The vegetation within the bauxite bearing depressions is sparse in comparison to the heavily vegetated hillocks.
5-127 & 5-128	Asprey *et al* (sic) postulated that the difference in vegetation between the hillocks and the depressions in SML 173 are due to anthropogenic activities over the history of Jamaica. The depressions were cleared for farming and other activities, hence all the depressions are classified as secondary vegetation. There are also several sections of the elevated areas of hillocks which show similar characteristics of anthropogenic activities. (NB, clearance of "elevated areas" will be at saddle corridors, where soils also accumulate due to the level terrain.)
5-130	Asprey and Robbins (1953) defined the areas of the Cockpit Country (and by extension, similar surrounding areas including the study area) as comprising "*limestone hillocks surrounding circular depressions (dolinas) filled with bauxitic soils with accumulated humus from the surrounding rim of the limestone rock".*
5-133	At the time of their description, Asprey and Robbins described the lowlands or 'cockpits' (sic: cockpits are the hills) as being dominated by the tree types *Terminalia latifolia* and *Cedrela odorata.* This is not currently the case. The presence of deep pockets of soil have resulted in most of the lowlands or 'cockpits' (sic) being defoliated of their forest vegetation to facilitate subsistence agriculture and pasture land usage.

41.4. Because CDA provided no empirical data to support their assertion that forest trees do not grow in bauxitic soil, I collected soil samples from enclosed depressions and glades in Windsor District, Trelawny and had the percentage aluminum concentrations analyzed by the International Centre for Environmental and Nuclear Science (ICENS) at the University of the West Indies, Mona. Data collection and analyses adhered to the methodology of Lalor (1996). My sample sites were all located within the boundary of an old, expired Special Exclusive Prospecting License (SEPL) 535, which had been issued to Alcoa Minerals of Jamaica LLC & C.A.P. on May 18th 2004. As shown in Figure 14, SEPL 535 included in its northeastern region the area now covered by SML 173.

Figure 14. Locations of Windsor District soil samples analyzed for their percentage aluminum concentrations.



41.5. At the time of submitting this report, ICENS had provided a preliminary report for percentage aluminum concentrations, as presented in Table 3. They are preparing a final report which will include results of other heavy metals, including cadmium, arsenic, and lead.

Table 3: Percentage aluminum concentrations in soils from Windsor District, Trelawny.

ID	Latitude	Longitude	Land Cover at Sampling Point	%- Aluminum
A	18^0 21’ 24”	77^0 38’ 49”	Grass lawn	16.01
B	18^0 21’ 39”	77^0 38’ 27”	Cattle pasture	10.75

C	18^0 21' 47"	77^0 38'20"	Closed-canopy forest	15.78
D	18^0 21' 50"	77^0 38' 19"	Blown-over forest tree; sample collected from exposed roots	16.82
E	18^0 21' 55"	77^0 38' 16"	Closed-canopy forest on saddle-corridor	18.98
F	18^0 22' 02"	77^0 38' 11"	Closed-canopy forest; historic stone wall	18.74
G	18^0 20' 57"	77^0 38' 38"	Closed-canopy forest, regenerating since farmer died in 2003	17.82
H	18^0 20' 52"	77^0 38' 30"	Closed-canopy forest on saddle-corridor	20.44
I	18^0 20' 46"	77^0 38' 28"	Regenerating forest; historic building foundation stones	19.51
J	18^0 22' 22"	77^0 38' 43"	Small plot of yams at roadside forest hedgerow	19.35
K	18^0 22' 37"	77^0 38' 47"	Yam farm; area was sampled by Lalor (1996)	19.02

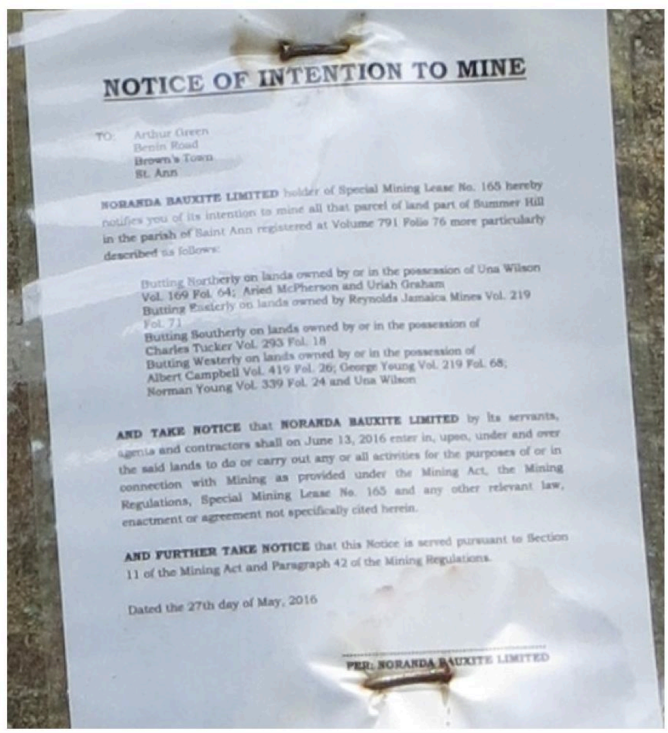
41.6 CDA's assertion that "there is a general misconception that bauxite occurs under forested areas" is demonstrably false: forests do grow in soils with percentage aluminum concentrations $\geq$ 17%, what Lalor (1996) classified as "bauxitic soil." I do not understand why NEPA accepted CDA's assertion when the EIA, itself, provided information which countered its assertion.

41.7. I also believe that the mining industry is aware that trees do, indeed, grow in bauxitic soils. See my Figure 15 on page 33.

<u>Why do trees (any plant, actually) grow larger in soils compared to growing on limestone hillsides?</u>

42. All plants require carbon dioxide ($C0_2$) and water for survival and growth. Without both of these, photosynthesis – the process whereby plants use sunlight to synthesize food (a simple sugar molecule) and release a "waste product" of oxygen (O_2) – cannot take place. Photosynthesis occurs when stomata on leaf surfaces (akin to pores) are open. A problem for plants, however, is that when stomata are open, the leaf also releases water vapour from the plant's tissues into the surrounding air, a process called transpiration. Thus, plants always need an input source of water to balance water losses associated with photosynthesis and transpiration.

Figure 15. Noranda Bauxite Limited sign stapled to tree on Mr. Arthur Green's farm property, notifying of intention to mine in SML 165. Photograph taken by WRC's late director, Mr. Michael Schwartz (d. 2018), on July 11th 2016. Vehicle mileage log verifies his trip.



43. During a rainy season, plant transpiration water loss is balanced by leaves intercepting 'rain water.' During a dry season plants either will have to have a non-rainfall source of water or prevent water loss by keeping leaf stomata closed (which, of course, means that photosynthesis cannot occur and the plant will not produce sugar-food to continue growing). Other adaptive mechanisms to prevent water loss include shedding leaves during a drought (again, this means no photosynthesis for growth) or having smaller leaves (reducing photosynthesis performance). However, when plants are rooted in soils which have the capacity to retain water, their root network can access 'soil water', particularly deeply-stored water molecules, which can move upwards when certain physical properties of soil grains align correctly. We know from other research that tropical trees can extract 'soil water' to depths of at least 11 – 18 meters (Davidson *et al.* 2011 and references therein). Most importantly, deep 'soil water' allows tropical trees to maintain their baseline functional processes, such that transpiration losses are fully balanced by deep-water soil gains during periods of drought and primary productivity (growth) is maintained (Wagner *et al.* 2012).

44. Because understanding the moisture-holding functional role of bauxitic soils is absolutely critical for understanding both the natural gradient of forest structure we see in un-mined limestone ecosystems (i.e., why trees are stunted on hillsides but can grow to much larger sizes in bottomlands) and for understanding the irreversible impacts bauxite mining will have on all subsequent floral communities, including agricultural flora, I have extracted Box 3 from a chapter I wrote, which appeared in the book *RED DIRT Inheritance or Commodity? A Multidisciplinary Review of the Bauxite-Alumina Industry in Jamaica*. This chapter is referenced as Koenig, S. 2021 in **SEK-5.**

BOX 3. WATER MOVEMENT IN TROPICAL BAUXITE SOILS: DOWNWARDS DURING THE RAINY SEASON AND UPWARDS DURING THE DRY SEASON

Perhaps the singularly most important structural characteristic of bauxite with regards to the survival and growth of trees is the extremely fine, yet variable sizes of particles. Grains vary from less than 1 micron (i.e. one thousandth of a millimetre) to 40 microns (Stahl, 1971; Madourie, 2013). How the grains align determines the space between them (porosity); that space, in turn, determines not only how much air or water can occur within the soil (porosity volume) but also the ease with which water can move through the pore spaces (hydraulic conductivity).

Transmission Pores:

- When pore size exceeds > 75 microns, water drains freely downwards by the force of gravity – water is not stored. Such macro-pores will be created when, for example, tiny fragments of limestone get mixed-in with bauxitic soils;

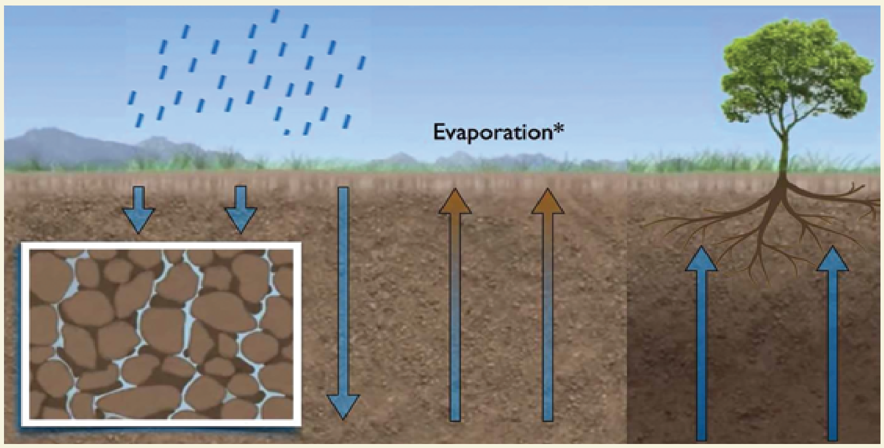
Storage Pores:

- Meso-pores (30–75 microns) have the ability to store water; if a tree root reaches into a mesopore, the root can draw up the water via capillary action, but a water molecule, itself, cannot overcome the force of gravity "keeping it down";
- Micro-pores (5–30 microns; e.g. the porosity of "coarse" bauxite): at this size, not only do adhesion forces between the water molecules and the grains of bauxite particles hold the water in place, but the downward force of gravity is overcome by capillary (upwards) action – the same "wicking" process that enables a paper towel to absorb water from a countertop; and
- Ultramicro-pores (0.1–30 microns; e.g. "fine" bauxite): these pores not only are large enough to hold molecules of water, but the voluminous space is inhabited by microbial bacteria and fungi which can keep the pore open.

Residual Pores:

- Crypto-pores (< 0.1 microns): these pores are too small for most microorganisms but they can still hold water.

During the rainy season, precipitation intercepted by plants balances the water losses they experience during photosynthesis and transpiration (or what humans and other biodiversity value: the production of oxygen and sequestering of carbon dioxide). During a dry season, moisture held deep in bauxite is accessible via a network of deep, fine roots and/or is moved upwards towards shallower roots via capillary action; this enables year-round forest growth (Grant & Koch 2007, Davidson et al., 2011). Without capillary water, roots cannot survive drought.



*Evaporation rates of soil increase with surface temperature. Shade cast by trees decreases surface temperature, with a resultant decrease in soil evaporation.

45. While the presence of forest cover on cockpit limestone hillsides is proof that a functional forest of drought-adapted, stunted flora could be **rehabilitated** on a mined-out ore body, ***the elimination of bauxitic soils means that the potential to restore a forest of the largest-possible sizes of native trees*** **or r*ehabilitate*** ***with non-drought-adapted species (as applies to most cultivated fruit trees) will be irreversibly lost with bauxite mining. This also means that the greatest potential for*** CO_x ***absorption and climate change mitigation*** (e.g., Lawrence *et al*. 2022) ***will be irreversibly reduced as trees will never reach their full potential size when they are not rooted in deep, moisture-holding bauxitic soils. Failure of the EIA to address how irreversible changes in abiotic conditions will forever compromise vegetation growth (and, consequently, the quality of all ecosystem services which large forests provide) was, in my opinion, a MAJOR flaw of the EIA. The environmental permits issued by NEPA make no reference to a Soil Management Plan to meet the specific requirements for reforestation, to rehabilitate the full growth potential of tree species.***

46. Mining industry experts will recognise my precise terminology: because of changes to geo-chemistry and morphology, it is physically impossible to **restore** – return to its original state – an area which has been subjected to surface mining. The correct terms are **reclamation** and **rehabilitation**.

47. Following extraction of the bauxitic soils, the next stage is **reclamation** – the mechanical process of reshaping the mined-out area using bulldozers and which is described in the final EIA on pages 8-10

and 8-11 . By cutting material "from higher areas to fill depressions and to reduce steep gradients" (EIA page 8-10), reclamation causes irreversible changes to the morphology of the associated limestone hillside, most notably creating very distinctive vertical cliff scars (Figure 16a and Figure 16b).

Figure 16a. Examples of vertical scars on hillsides from mining and reclamation, as presented in Koenig (2021). The yellow star is my position (18^{0} 19' 15.6" N, 77^{0} 22' 45.4" W; approximately 3 kilometers northwest of Alexandria, St. Ann), looking northeast for the inset photograph taken on October 17th 2006 at 12:44 pm, within SML 165.

Figure 15: *Vertical Scars on Hillsides from Mining and Reclamation*

Figure 16b. On page 8-20 in the final EIA, CDA presented an example of a vertical cliff face formed at a mined area. This shows that only a small percentage of vegetation established on the cliff and that the unpaved road remains uncolonised by any vegetation.

Figure 8-12: Vertical Cliff Face Formed at Mined Area

48. The process of reclamation causes the final surface area of the mined-out area to increase in size by at least 40% or more. I defer to the Defendants to present the percentage increase in area associated with reclamation "swell" of either SML 165 or SML 172 as records of MGD's rehabilitation certifications I have in my possession from ATI requests are incomplete.

49. If marl (crushed limestone) deposited during reclamation is sourced and quarried from any cockpit hill within SML 173, this will be another irreversible change to cockpit morphology.

50. ***In SML 173, the process of reclaiming mined-out pits will cause irreversible changes to the morphology of what is part of the type locality of Cockpit Karst* i.*e., Cockpit Country. The EIA failed to evaluate this aspect in its* Table 7.1. Impacts to Physical Resources.**

51. After surfacing the backfill with marl, the overburden topsoil that was removed prior to mining is returned. As has been reported in the peer-reviewed literature, the physical characteristics of the reconstructed topsoils in Jamaica are so visibly different in their physical characteristics – notably the inclusion of limestone rock fragments – compared to un-mined soils, that a caret (^) symbol is added when presenting the name of the post-mined soil horizon. The symbol specifically indicates soil horizons formed from human transported material (Greenberg and Wilding 2007; see also Harris and Omoregie 2008).

52. The inclusion of limestone rock fragments in post-mining reconstructed soils has a direct, negative relationship to water-holding capacity: because the fragments are physically bulkier and have larger pore-spaces ***reconstructed soils in Jamaica, even after 20 years post-mining, do not retain water as well as un-mined soils*** (Greenberg and Wilding 2007). ***The consequence for any flora (e.g. forest trees, fruit trees, trees for bio-fuel production, any agriculture plant) rooted in such "bulky", highly porous soils, as already presented above, is that plant growth will be stunted unless a year-round supply of water (e.g. rainfall, irrigation) is provided. Given that climate change models are predicting prolonged drought cycles for Jamaica, keeping moisture-holding soils is situ will become increasingly more important for forest- and food security. How would one irrigate forest in all of the mined-out depressions of SML 173?*** Because it is so important, I must reiterate what I presented in paragraph 42: photosynthesis can only occur when water is available to plants.

53. For many countries, **increasing** an area's groundwater storage potential is one important mitigation for improving climate resilience; for Jamaica, groundwater recharge is a strategy accepted by WRA. But removing bauxite soils can only **decrease** water storage capacity, with direct consequences for vegetation productivity. This is governed by the laws of physics, as it relates to the downward and upward movement of water in soils via capillary action.

54. The problem of reduced water-holding capacity in post-mined, reconstructed soils is not unique to Jamaica. In Australia, for example, seedlings of even native drought-adapted species display signs of water-stress during experimental plantings in reconstructed soil substrates from the Pilbara bauxite mining region in Western Australia (Bateman *et al.* 2016).

55. I must take this opportunity to explain that comparisons to bauxite mining and rehabilitation efforts in Australia must be conducted very cautiously and judiciously because of the major differences in underlying geologies -- granite in Australia and limestone in Jamaica – and the significantly different depths of ore bodies, which will influence natural infiltration rates of rainwater. As I submitted to NEPA on March 29th 2022, in my review of another SEPL (Koenig 2022) (which although not prepared by CDA nor associated with the Defendants, is in my opinion, relevant to this case), I wrote:

> " With regards to hydrological responses to mining, if NEPA is going to allow the EIA to attempt to draw comparisons to Australia, the agency must require a proper technical description, with an explanation as to why the consultants believe comparison is valid to lateritic soils derived from a granite bedrock, with blanket-type 'bauxite' deposits typically only 5-8 m in depth (see Szota 2009 and references therein). I submit that comparison of hydrological responses in Australia is neither appropriate nor valid for Jamaica' deep ore bodies overlain on limestone." (Koenig 2022, item #7 on page 6).

56. Expanding on the previous paragraph 55: In Western Australia, for example, where bauxite deposits are particularly shallow (3-5 meters in depth), post-mining rehabilitation is directed towards establishing ecologically-functional forests using only native species. With this land use, **shallow** groundwater discharge rates can return to pre-mining levels after 10+ years (Grigg 2017). But as noted in the final EIA (page 5-28) for SML 173, in relation to SML 165 and the flow of the Rio Bueno:

> "The trend line indicates a slight increase in flow despite the diversion of the Cave River and the mining of bauxite within the Rio Bueno Sub Basin by Kaiser Bauxite, and successive companies over the past 50 years. "

57. As evidenced by WRA's collaborative project with the IAEA (ref paragraph 24 above), I submit that the water recharge dynamics of the Rio Bueno sub-WMU remain poorly understood and, consequently, this precludes WRA's abilities to detect any changes that may be caused by mining in SML 173. Assertions that there is "no risk to the flow rates and water quality" of the Rio Bueno (verbally, Dr. Conrad Douglas during a public meeting on December 8th 2020) were not supported by any modeling or data-based evidence. ***In my opinion, failure to undertake modeling of Karst Aquifer Recharge Patterns and Vulnerability of the Rio Bueno sub-WMU represents a MAJOR failing of the EIA, particularly as this also has direct relationships to terrestrial floral communities***.

58. Returning to the soils reconstructed post-mining (ref paragraph 51), although CDA conducted a flora and fauna transect survey at one "rehabilitated mine that had been disused in excess of 17 years" (page 8-17 in the final EIA) in Tobolski, St. Ann, the EIA provided no quantitative data for the condition of the soil. Based on the wording in the EIA, it was intimated that this one site is representative of rehabilitation efforts in SML 165.

59. In the absence of any published literature on the physical properties of reconstructed soils in St. Ann mining areas, I refer to a project funded by JAMALCO / ALCOA in 2007 – 2008 (Lewis *et al.*

2010, 2012). This project assessed soil microbial communities, soil function, and soil fertility in rehabilitated pits with a chronosequence of: (a) within-year rehabilitation (2007), (b) 10 years post-rehabilitation (1997), and (c) 20 years post rehabilitation (1987). Compared to un-mined soils, the authors identified that levels of carbon and nitrogen and the diversity and abundances of bacteria – all indicators of soil quality – were reduced. Critically, they found that these differences persisted at the 10-year and 20-year post-rehabilitated sites. Indeed, the oldest site was the least improved of all sites examined. They particularly noted the absence of nutrient-rich plant material (i.e., an indicator of low plant productivity) and the dominance of bacterial rather than fungal biomass, an indicator that vegetative successional processes were not occurring (Harris 2009). ***As presented by the peer-reviewed literature, soil function and soil fertility are not being rehabilitated in Jamaica to un-mined conditions***.

60. I note in Environmental Permit 2018-06017-EP00196, paragraph 67 under the heading **RESTORATION** (sic) that the 2nd Defendant is required to "develop and submit a Restoration (sic) Plan for the approval of the Mines and Geology Division" and that a copy of this plan shall be submitted to NEPA.

61. I note in Environmental Permit 2018-06017-EP00197, paragraph 22 under the heading **FAUNA AND FLORA** that the 2nd Defendant is required to "develop and submit a plan to the Forestry Department to reforest land commensurate in size with hectares of forest to be lost due to the Permitted Activity. The reforestation plan must include details on the activities to be executive by the Permittee to guarantee the establishment of forest cover on the identified site(s) which includes but is not limited to the identification and acquisition of appropriate species; . . .This plan must be approved by the Forestry Department . . . at least one (1) month prior to the commencement of mining / quarrying operations. "

62. At no point do the Environmental Permits specify that mined-out ore bodies or haul roads, themselves, need to be rehabilitated with forest. ***In my opinion, the permits are designed for a "no net loss of forest" policy and do not explicitly address the fragmentation of the forests on the limestone corridors, which will be destroyed during haul road construction***.

63. The final EIA presents on page 8-16: "To date NJBP II has not attempted to use natural growth as a certification land cover alternative." I interpret this sentence to mean that the 2nd Defendant has not attempted to use native plant species to rehabilitate a self-sustaining, ecologically functional forest of native flora and fauna. ***In my opinion, Cockpit Country should not be the location where the 2nd Defendant should (experimentally) attempt to rehabilitate native forest in mined-out areas***.

<u>**How does the structure of plant communities impact fauna? Or more correctly: What are the documented impacts of bauxite mining on fauna in Jamaica?**</u>

64. I present a paragraph I wrote in my review of the draft EIA (ref paragraph 29 in Koenig 2020):

"The EIA reports on two floral and faunal transects, one undertaken in a mined-out ore body which was reclaimed and rehabilitated 17 years ago in Tobolski, St Ann and one which is actively being mined in Gibraltar, St. Ann. Only 4 bird species were detected in the rehabilitated site, and a set of 4 different bird species was detected in the active-mining site (Table 8-3). Given these results and in comparison to the un-mined areas surveyed in SML-173, how does the EIA defend its assertion that birds are not impacted by mining, both by short-term impacts and long-term effects? That is, why was the Risk Assessment not driven by the field data?"

65. With regards to bird surveys conducted in un-mined areas (i.e., in SML 173), I wrote this in my review of the draft EIA (ref item no. 25 in Koenig 2020):

"The EIA detected 46 bird species. Checklists from eBird (www.ebird.org) for this same area report 86 species. Thus, the EIA, with its inadequate temporal sampling effort, recorded just barely more than half of the bird species which are known to occur in the area, and, by extension, failed to account for their contributions to ecosystem services. Of particular concern is the EIA's failure to detect the following IUCN Red Listed Near-Threatened (NT) and Vulnerable (VU) species, which are on eBird checklists:

Ring-tailed Pigeon (*Patagioenas caribaea*) VU
Plain Pigeon (*Patagioenas inornata*) NT
Crested Quail-Dove (*Geotrygon versicolor*) NT
Black-billed Parrot (*Amazona agilis*) VU
Blue Mountain Vireo (*Vireo osburni*) NT"

66. Marked as **SEK-10**, I attach the eBird checklist of birds for the Stewart Town area of SML 173, which I downloaded from the internet on December 10th 2020 for my review of the draft EIA. In addition to the 86 species reported for this area, I draw attention to Mr. Ricardo Miller's sightings over multiple months from 2016 – 2020. Mr. Miller is Environmental Coordinator of Fauna in the Ecosystems Branch at NEPA. I know him personally and can attest to his skill in bird identification.

67. Even accepting the EIA's lower detection record of 46 bird species in SML 173, with only 4 bird species detected along the Tobolski transect of a mined-out ore body reclaimed and rehabilitated 17 years ago (within SML 165) and only 4 birds species detected in an area actively being mined in Gibraltar (SML 172), I can reach only one conclusion: ***bauxite mining has MAJOR impacts on bird diversity, as measured by the number of species, in the parish of St. Ann.***

68. Unfortunately, because CDA's sample sizes (i.e., the number of transects) of mined and rehabilitated areas are so low, it is impossible to conduct a quantitative statistical analysis for the information presented in the EIA to support my qualitative conclusion of "***MAJOR impacts***".

69. Fortunately, statistically-robust avian field research was conducted by Kennedy *et al* (2010) in mining-impacted areas of Manchester and just across the parish border into Clarendon. They were interested in understanding whether bird communities in limestone forest patches differed if the forest patches were embedded in one of three different human-dominated land use matrices

(agriculture, peri-urban, and bauxite mining) or if the forest patch was embedded in continuous forest (i.e., a natural "matrix"). Relative to the natural forest matrix:

- The agriculture matrix was not statistically different from the forest matrix, both in terms of the number of species (richness) and community composition (the ecological types of different species, such as fruit- vs. insect-feeding birds);

- The agriculture matrix had seemingly little effect even on forest-restricted species, and species associated with open habitats actually increased in abundances (the number of individuals);

- Peri-urban and mined landscapes both had significantly lower bird diversity (numbers of species) compared to the forest / agriculture matrices and their communities were strikingly different from those in forest landscapes, in that many insectivores and frugivores were absent or less abundant; more than one-third (36%) of species had lower abundances when forest fragments were embedded in peri-urban and bauxite mining matrices compared to the "natural forest" matrix.

70. Continuing with the results of Kennedy *et al*. (2010), from a suite of 11 traits which can describe birds (e.g., body mass, whether they prefer to feed low to the ground or remain high in the crown of a tree), the variables of Diet Guild, Nest Height, and Habitat Association (specialists vs. generalist) best-explained the field observations. A slightly different way of understanding this is to ask: what feed, nesting, and roosting resources were available in each of the land use matrices and were birds able to avoid native and / or introduced predators? As Kennedy *et al.* (2010) noted, in comparison to bauxite mining lands, the matrices of peri-urban, agriculture and forest contained greater vegetation cover and complexity.

71. Comparing to the final EIA, Kennedy *et al*'s (2010) descriptions that bauxite mining lands have less vegetation cover and structural complexity, lower numbers of bird species, and less-complex avian community assemblages correspond to CDA results for the site being actively mined in Gibraltar and the 17-years-since-rehabilitated Tobolski site. To quote from page 8-18 for Tobolski, "The area was void of any true tree species." As a reminder, CDA detected only 4 bird species at Tobolski during their surveys.

72. I submit that CDA's own field data and the peer-reviewed literature clearly demonstrate that bauxite mining in Jamaica has both immediate impacts and long-term effects on bird communities and the plant communities / habitats upon which the birds depend.

<u>Predictable impacts of bauxite mining on bat communities in-and-around SML 173</u>

73. Bats (scientific order Chiroptera, colloquially known as "ratbats") are another dominant faunal assemblage which will be impacted by mining in SML 173. In the draft and final EIAs, CDA attempted to describe the ultrasonic sound (pressure) waves which bats vocally produce, which enable them to function in complete darkness, to locate and / or avoid any object in their flight path as the sound wave is deflected back to the bats' ears (i.e., the echo bounced back from an

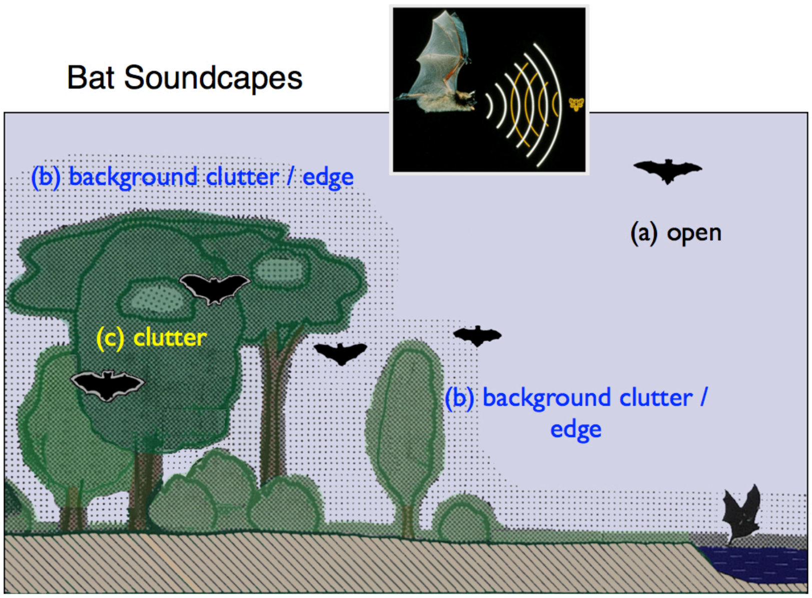
object is what enables the bat to locate the object, whether it be an insect prey item, a fruit hanging on a tree, another bat, the ceiling in their roosting cave, etc.). Because CDA confused concepts related to the frequencies of bats' ultrasonic vocalisations, and because they mis-used software designed to auto-classify bat species by their vocalisations, and their written answers to public review comments reinforced my opinion that they have not received adequate training in the basics of bat ecologies, echolocation and auto-classification software, and because NEPA, by accepting the flawed presentation of information in the EIA demonstrated that its officers who review EIAs are not adequately trained in using computer software to identify bats, I will explain several key characteristics about bats which must be understood in order for EIA consultants, including CDA, to fulfill their Terms of Reference, which required details of "niche specificity" for nocturnal species.

74. As with birds, bats can be identified by their feeding niche. In Jamaica there are 14 species of bats which feed on insects (insectivores), four species which feed primarily on nectar but can also consume fruits and any insects they opportunistically encounter at the nectar-flowers (nectari-omnivores), two species which feed on fruits (frugivores), and one species which feeds on fish (piscivore). How does a bat catch a fish? When a fish is swimming near the surface of a pond or slow-flowing river, if its dorsal fin breaches the surface, an echolocating Fishing Bat (*Noctilio leporinus*) will detect what is the equivalent diameter of a human hair and scoop-up the fish by dragging its feet just below the surface of the water.

75. The hunting example of the Fishing Bat is what bat researchers call the "soundscape." For every bat species which echolocates (some Old World bats use only vision and smell), we describe their "soundscape niche" by its physical structure: (a) uncluttered, open space; (b) cluttered in the background, edge open space; and (c) highly-cluttered, forest space. I created a schematic diagram, presented in Figure 17 on page 43.

76. On WRC's website, there is a webpage I created in 2015 for a bat workshop for EIA practitioners, which explains in more detail the fundamentals of sound and echolocation: http://www.cockpitcountry.com/batsSound101.html . For this report, it is only necessary to understand that bats which have evolved to travel and feed in highly-cluttered spaces, such as dense forest canopy and understory, produce ultrasonic vocalizations that will transmit only very short distances (e.g., often less than one meter). This is because the returning echo from leaves, branches, or tree trunks must reach the bat's ear before the bat actually collides with the clutter, as it flies at speeds of 8-10 meters per second. The consequence of having such a highly tuned acoustic system for avoiding dense clutter is that, if the bat finds itself in an open space, where objects are e.g., more than 5 meters away, the ultra-high frequency sound wave dissipates before it reaches any objects to echo-back (imagine how waves propagate, then dissipate after a pebble is tossed into a pond). A cluttered-space bat is acoustically deaf in wide open spaces; consequently this presents a acoustic barrier which they will actively avoid.

Figure 17. Acoustic soundscapes**:** the co-evolution of a bat's echolocation system with the physical environment (or how to find food, avoid collisions, and navigate between a cave roost and a feeding area in total darkness).



77. Because most of the vocalisations which bats produce are higher in frequency (aka pitch) than what our human hearing can detect, we have to use special microphones which can detect their calls. With computer software, we can then convert the ultrasonic audio recordings into visual images (sonograms) of the sounds being produced, as shown in Figure 18 on page 44.

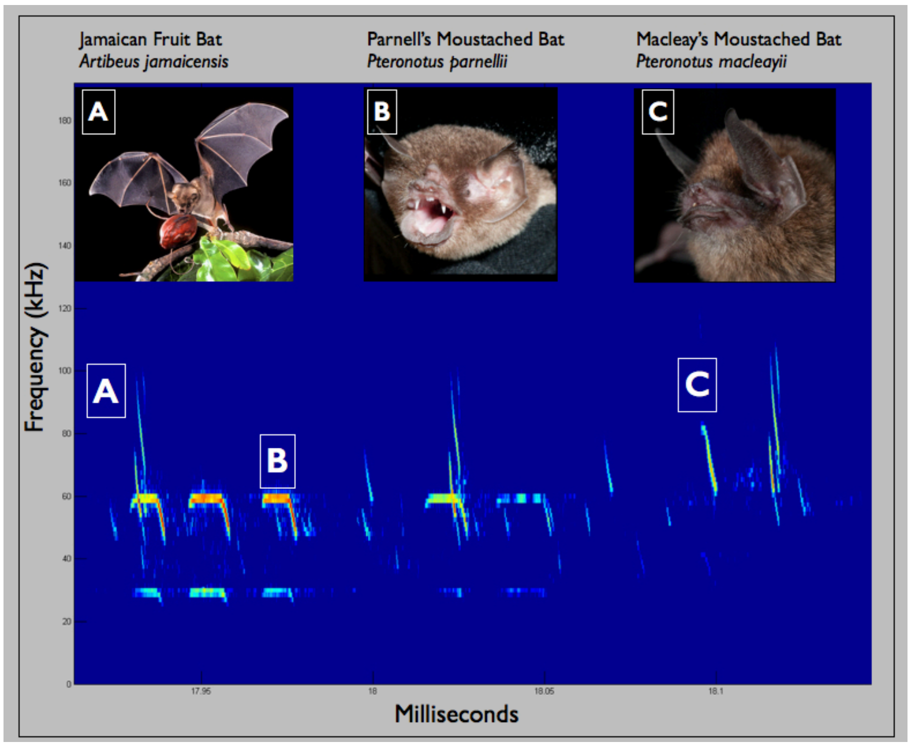
78. Ecological soundscape niches are known for 7 of Jamaica's 21 bat species (Emrich *et al*. 2013).

79. Prior to the EIA, it was already known that one of Jamaica's most forest-dependent bat species, Parnell's Moustached Bat (*Pteronotus parnellii*) (ref Emrich *et al.* 2013; see also de Oleviera *et al.* 2015) roosted in Drip (aka Belmont) Cave, located approximately 2.5 km south of Stewart Town, within SML 173.

80. On July 17th 2019, I confirmed the presence of *Pteronotus parnellii* flying in the closed canopy forest of SML 173, where tree crowns connect over the unpaved road between Stewart Town and Endeavour. I submitted report to NEPA on June 27th 2019 (see Koenig 2019 in **SEK-5**).

Figure 18. Sonograms of three bat species which occur in the forest of SML 173*. These three species produce uniquely-recognizable calls. The Jamaican Fruit Bat's soundscape is "generalist, can navigate in open and cluttered environments"; Parnell's Moustached Bat is restricted entirely to "cluttered forest"; and Macleay's Moustached Bat prefers "background cluttered / edge".

*The EIA failed to detect / identify the Jamaican Fruit Bat, but I detected it within SML 173 on June 17th 2019 (see Koenig 2019 and paragraph 79 below).



81. From Emrich *et al.* 2013 and my direct observations of *Pteronotus parnellii* in Windsor Great Cave and the wider Windsor environs, we know two important facts about this species: (1) when they leave their daytime roosting cave at dusk to go hunting and when they return to their cave at sunrise, they do so in highly-coordinated "flightlines" of thousands of individuals – imagine a narrow-but-high-volume stream of bats staying cohesive for more than 5 kilometers through a densely-cluttered forest as they travel en masse to other forested feeding areas; and (2) this species will not tolerate flying across gaps in the forest crown which are wider than 4-5 meters -- they prefer the forest canopy to be completely connected (see Figure 19). For this species, a gap of 4-5 meters is significantly less than the standard 11 meter width proposed for haul roads in SML 173. When the construction of haul roads obliterates the forest-covered limestone corridors connecting one cockpit to another, a gap will be created which *Pteronotus parnellii* acoustically will be unable to traverse. This species can't just "temporarily migrate" as CDA asserts fauna will do.

Figure 19. Example of the "soundscape" requirement of *Pteronotus parnellii,* where tree crowns must be in contact for the species to fly across understory gaps, such as those created by roads. This photograph, taken in Windsor, Trelawny (18^0 21' 46.0"N; 77^0 38' 51.0") is the location of one of three known crossings, where a coordinated "streaming" flight-line of this species crosses the road from Windsor to Sherwood Content, which is approximately 10 kilometers north of Windsor. These are permanent bat crossings: I have known all of them since the late 1990s and one was described in the field notebook of a visiting researcher from the American Museum of Natural History in 1920.

82. While the EIA reported detecting *Pteronotus parnellii* within Drip / Belmont Cave, CDA conducted no terrestrial surveys within SML 173 to identify the cluttered-space forested corridors through which this species will travel and in which they will hunt for insects.

83. CDA failed to conduct any terrestrial bat surveys at the ore body which was actively being mined in Gibraltar or at the site in Tobolski, of the rehabilitated mine that had been disused in excess of 17

years. Assertions in the EIA that haul roads will not impact bats (e.g., such as *Pteronotus parnellii*) are not grounded in any data nor are they grounded in the documented ecological soundscape (acoustic niche) requirements of this species. ***In my opinion, obliteration of limestone saddle-corridors and the cumulative network of haul roads will irreversibly damage the soundscape of bats in SML 173.*** I know from direct experience that the haul road gaps shown in Figure 12 and Figure 16b will be actively avoided by *Pteronotus parnellii*.

84. A bat species like *Pteronotus parnellii* matters to the ecosystem because it is known to consume and potentially control a minimum of 229 insect species (Emrich *et al*. 2013). Had CDA attempted to estimate the size of the roosting population within Drip / Belmont Cave, they would have been able to estimate the tonnes of insects the colony would be capable of consuming per annum. This is because insect-feeding bats will consume 30 - 100% of their body weight in insects every night (Kolkert *et al* 2019 and references therein). In addition to an ecosystem service of "insect pest control", the presence of *Pteronotus parnellii* serves as a biological indicator to us that functional forest connectivity is being maintained across a landscape. ***The disappearance of Pteronotus parnellii would serve as a warning indicator that functional forest connectivity has been compromised or lost.***

85. For this report, I will not address the soundscapes of other bat species that were reported in Table 5-30 of the final EIA. Instead, I re-print section 10. of Koenig (2022), my review of SEPL 541 (Outer Valley) which I submitted to NEPA. For that review, I independently verified that the auto-classification software (Wildlife Acoustics' Kaleidoscope Pro) used by CDA to identify bat species in SML 173 is wholly unreliable for Jamaica and output results cannot be trusted either for establishing baseline conditions or for monitoring impacts of mining activities.

RE-PRINT OF SECTION 10 from Koenig, 2022.

10. With regards to the identification of bat species by their ultrasonic calls, because this is now the fourth time I have had to address this in my EIA reviews, I now direct my comments to NEPA.

    Wildlife Acoustics' Kaleidoscope Pro software is not reliable in its auto-identification of Jamaican bat species and NEPA must reject all species lists created using this software program. Ignoring the fact that it does not include any species of Phyllostomidae, the files within its call library lead to misidentification of Jamaican bats. Results of Kaleidoscope Pro analyses must be rejected, and NEPA should only accept species lists (including those which will be presented for monitoring efforts required by Environmental Permits) which involve the manual review of all recordings by persons who can demonstrate knowledge of the fundamentals of echolocation, ultrasonic bat detectors, and the limitations of auto-identification software.

    Examples of Kaleidoscope Pro errors and problems which I have independently identified include:

    - Software misclassifies calls as *Noctilio leporinus* (a piscivore), when, as is clearly visible on sonograms, the calls belong to *Pteronotus macleayii* (an insectivore).

- Calls produced by *Molossus milleri* (formerly *M. molossus*) are misidentified by Kaleidoscope Pro as *Eptesicus fuscus.* I identified this Kaleidoscope Pro error by allowing the software to process recordings of what were confirmed *M. milleri* recordings archived in WRC's Jamaican Bat Call Library[1]]
- Calls produced by *Artibeus jamaicensis*, (a frugivore), as archived in WRC's Jamaican Bat Call Library, are misidentified by Kaleidoscope Pro as *Pteronotus quadridens* (an insectivore).
- High-quality recordings of *Nyctinomops macrotus* in Cuba are classified as "Noise" by Kaleidoscope Pro; this makes all Kaleidoscope Pro reported identifications of this species highly suspect, esp. given the absence of Jamaican examples from any reference libraries.
- Insect noises not only classified as "bat" but they are identified as belonging to the insectivorous *Tadarida brasiliensis*.
- Classifying calls recorded over water bodies as *Noctilio leporinus* when, owing to functional convergence, the calls could also have been emitted by multiple species of Molossidae coming to the water surface for drinking or foraging. The phenomenon of functional convergence of acoustics is well-documented in the literature.

The EIA reported that 5 species were classified using the Auto-ID from Kaleidoscope Pro (page 155). Based on my assessment of Kaleidoscope Pro for this current review, I do not consider the classifications of *Nytcinomops macrotus*, *Eumops glaucinus* and *Noctilio leporinus* to be reliable.

NEPA must stop accepting results from all auto-identification software packages which do not yield reliable results and the Agency must explain to EIA practitioners why auto-identification results cannot be accepted. I also would urge NEPA to review: (a) Dr. Brock Fenton's review of SML-173, which he submitted in December 2020; (b) the extensive peer-reviewed literature on the limitations of auto-identification software packages; and (c) Sonobat's detailed explanation about false-positive rates in bat identification software packages, as presented in the FAQ sub-heading SPECIES IDENTIFICATION: https://sonobat.com/faq/

Furthermore, usage of any auto-identification software must not be allowed for monitoring the impacts of mining under Environmental Permits, until a software program is demonstrated to be valid for Jamaica. Given the acoustic characteristics of tropical bat species, it is highly unlikely that any auto-identification software will ever be reliable enough.

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[1] WRC's Jamaican Bat Call Library was created by recording individual bats in-hand, tethered to a zipline, flying in an enclosed space, flying as they departed the enclosed space or when they were hand-released. That is, all library calls are recordings where species identity was confirmed in-hand.

86. With reference to the preceding Section 10 re-print, I include Dr. Brock Fenton's review of the EIA for SML 173 along with his CV, marked **SEK-11**.

Nuisance Dust: Will exposure concentrations and impacts to forests, flora, and fauna (and public health) be meaningfully measured? Will unsafe exposure concentrations be prevented?

87. While the EIA's reporting of air quality conditions as an average over a 24-hour cycle for TSP (Total Suspended Particulates) and PM10 (Particulate Matter $\leq$ 10 micrometers in diameter) represents compliance with the Fourteenth Schedule of The Natural Resources Conservation Authority (Air Quality) Regulations, 2006 (but not, I note, represent compliance with the Fifteenth Schedule, which specifies 4-hour averaging time for PM10), a 24-hour averaging interval does not allow one to conclude that plants, animals, or members of the public are not being exposed to harmful levels of air-borne pollution during the sampling cycle.

88. "Averaging" vs. "frequency of exposure" are two critical mathematical concepts to understand when measuring exposure to dust during mining activities, which as the EIA noted will be undertaken only during daylight hours. With dust-generating activities restricted to diurnal hours, any high-concentration pulse events will be masked by averaging with nighttime data. I shall use an example of the famous "Canary in the Coal Mine", where birds were used as bio-sentinels because, compared to humans, birds die from lower concentrations of carbon monoxide poisoning. If someone reported that the **average** concentration of carbon monoxide in a coal mine was 50 parts per million (ppm) for a 24-hour period, does that mean it was 50 ppm for every single hour of the 24-hour period? Or does that mean there were 23 hours with no carbon monoxide and one hour of an exposure concentration of 1,200 ppm? Exposure to 50 ppm of carbon monoxide every hour for 24 hours will leave a human feeling woozy and nauseous; a pulse of 1,200 ppm will kill you. Thus, the appropriate temporal reporting for air quality must be **frequency** based: how many minutes or hours in any given 24-hour cycle do particulate concentrations exceed safe levels?

89. Even the 4-hour averaging time for PM10 specified by the Fifteenth Schedule (ref paragraph 87) may not be adequate for detecting unsafe levels of this particulate size class. As experts are aware, daytime dust movements are influenced by relative humidity which in turn is dictated by air temperature (i.e., natural ambient dust suppression will be greater in early morning hours compared to mid-day; members of the public certainly are aware of this phenomenon even if they don't understand the scientific reasons which underpin it).

90. On July 22nd 2021, while observing pit reclamation in SML-172 near the Gibraltar All-Age School, I deployed an air quality monitor (Dylos Corporation, model DC1700-PM), which detects and sizes microscopic particles as they pass through an internal laser. Data are recorded minute-by-minute. The count and size data is used to calculate both the number of particles per volume of air (particle concentration). Using an internal conversion algorithm, the device also can estimate the mass of particles per volume of air (mass concentration). The device measures PM10 and smaller particles of PM2.5 which are created during combustion, such as the burning of diesel fuel.

91. In Figure 20, I present three slides from a PowerPoint presentation I created which explains how, when averaging PM10 over the 88-minute sampling period, the dust concentration (144.4 µg / m^3) would be reported as "safe", just below the regulatory cut-off level of 150 µg / m^3. But as the data reveal, for 22 minutes (25% of the time), PM10 concentrations exceeded safe levels.

Figure 20. Air quality monitoring at the Gibraltar All-Age School on July 22nd 2021. Classes were not in session but adults were present, including the Principal. Later in the afternoon there was a community meeting, which was attended by Councillor Cardel Wickham.

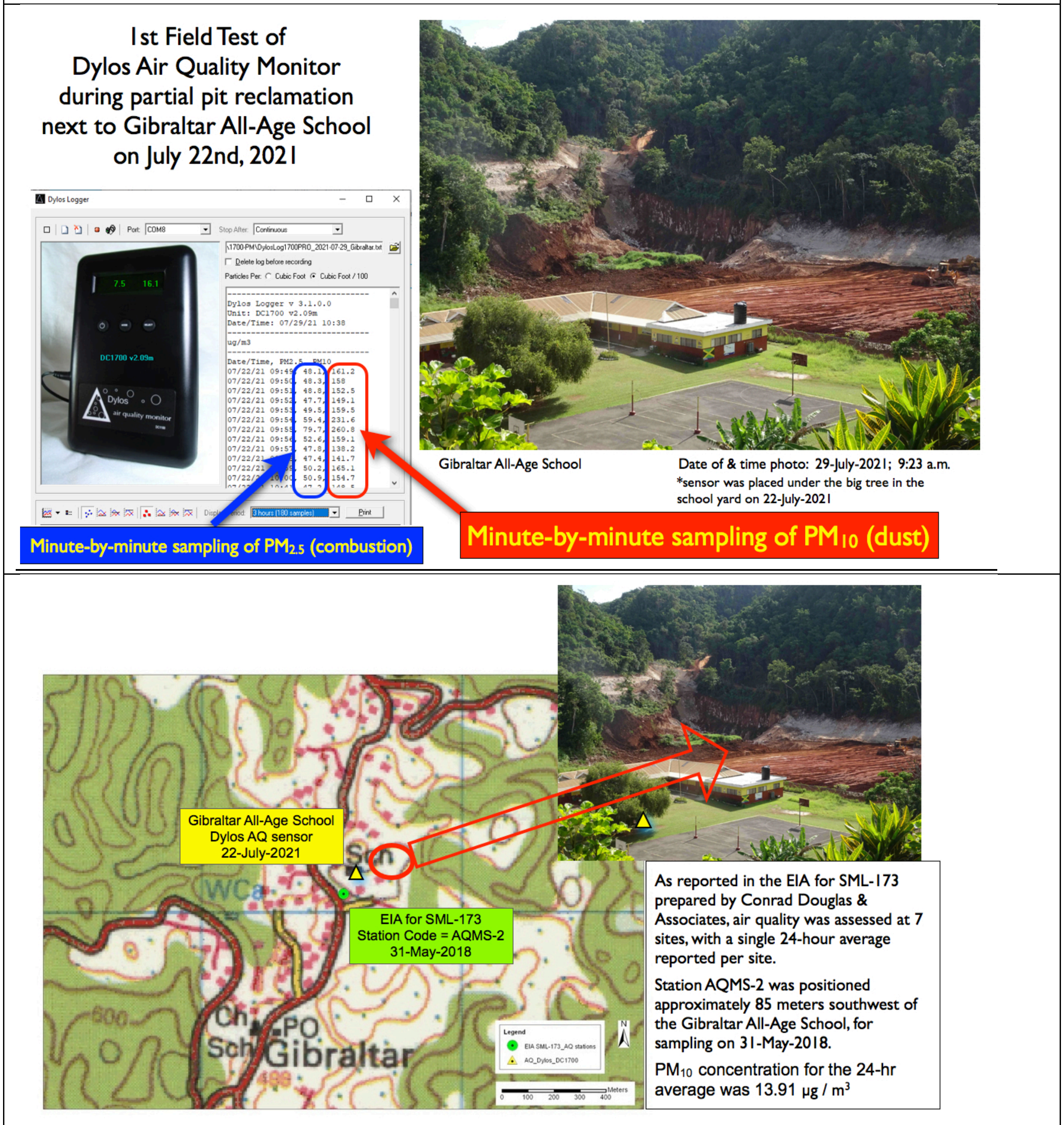
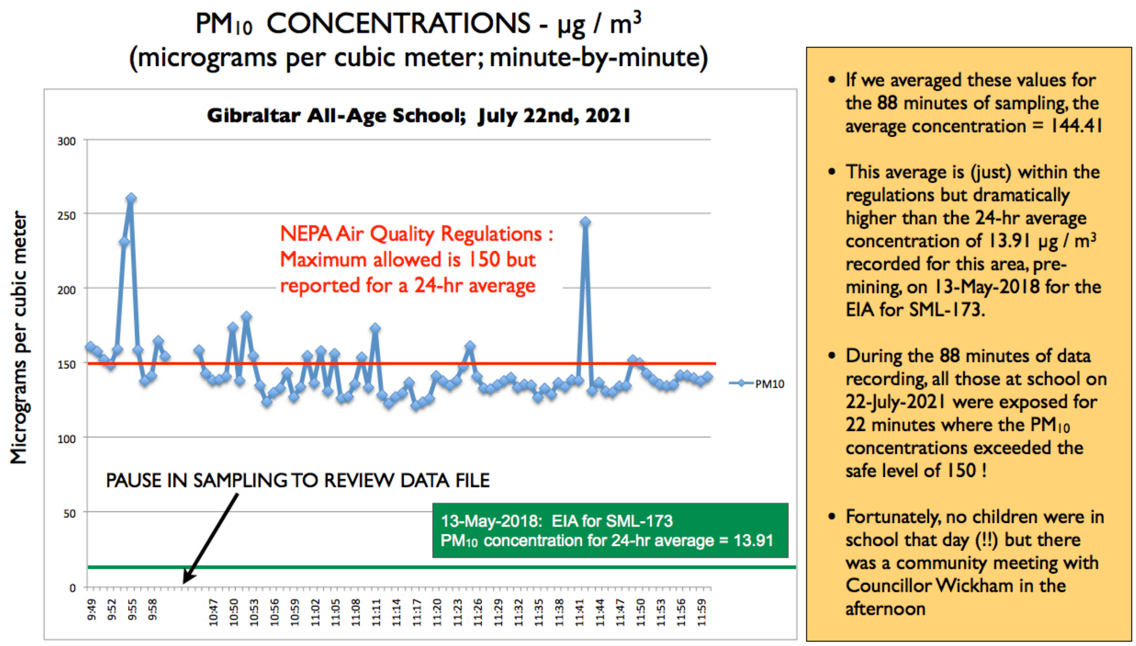


Figure 20 (cont).



92. Although my Dylos laser air quality monitor measures PM2.5, I note that currently on Jamaica there are no regulations which require monitoring of this particulate size class. The World Health Organization (WHO) standard for 24-hour exposure is 35 µg / m^3. During my 88-minute sampling at the Gibraltar All-Age School, the average PM2.5 concentration was 47.06 µg / m^3, with a range of 43.1 to 63.4. That is, at no time during my sampling where PM2.5 concentrations within safe levels.

93. I add that, while air quality dispersion models presented in the EIA may predict that localized high concentrations for TSP and PM10 should decline by at least 80% within 100 meters of an active ore body, data from my Dylos AQ monitored revealed that unsafe concentrations of PM10 will disperse at least 500 meters from an ore body.

94. Based on data I collected at the Gibraltar All-Age School on July 22nd 2021, I do not consider The Natural Resources Conservation Authority (Air Quality) Regulations, 2006 to be adequate for protecting the environment and public health from air-borne pollution due to the fact that: (a) reporting of averages enables the masking of high-concentration pulse events; and (b) monitoring of PM2.5 particles, which are produced from combustion (e.g, burning of fossil fuels), is not required.

Summary

95. Based on historic references from the 18th – 20th centuries, and despite the fact that the area was excluded from the 2022 gazetted Cockpit Country Protected Area, there can be no doubt that SML 173 has been issued in an area traditionally considered to be a part of Cockpit Country, which prior to the early 1900s was called the Cockpits.

96. My objective (but by no means comprehensive) GIS analyses confirm that the landform in SML 173 is "Cockpit Karst" morpho-geology, as first presented by Sawkins (1869) and described in further detail by Sweeting (1958) when she created the term "Cockpit Karst" for this recognizable form of polygonal karst.

97. Cockpit Country is the ***type locality*** for Cockpit Karst: all other global occurrences of this morpho-geology are compared to this iconic natural landscape in Jamaica.

98. Mining activities, including the elimination of saddle-corridors during haul road construction and the scraping-down of cockpits (the hillsides) during reclamation, irreversibly destroy and damage the very features which functionally define Cockpit Karst morphology.

99. Because the extraction of bauxite ore bodies changes geo-chemistry and morphology, it is physically impossible to **restore** – return to its original state – any area which has been subjected to surface mining. At best, one can aim for viable **rehabilitation**, recognizing that abiotic conditions can never be identical to the pre-mined state .

100. Unless equivalent amounts of soils which are capable of holding 25% moisture-by-weight (and be of appropriate chemical properties, esp. pH so as to not be caustic) are returned, the extraction of bauxite ore bodies irreversibly reduces the volumetric capacity of the rainfall catchment area to retain moisture *in situ*.

101. Without access to "soil water" or human-provided irrigation during prolonged periods of drought, plants cannot maximize their photosynthesis potential and their growth will be stunted; if droughts are prolonged, plants will die.

102. Peer-reviewed literature for Jamaica reveals that, when compared to un-mined soils, soils reconstructed during the reclamation process have reduced water-holding capacity owing to the presence of limestone fragments. This is a result from both the mechanical process of removing topsoil and the mechanical process of reclamation.

103. Peer-reviewed literature and bird survey data presented in the final EIA for a 17+ year old rehabilitated site and a currently-being-mined site reveal that vis a vis changes to the vertical structure of the vegetative landcover, bauxite mining directly impacts the numbers (species richness) and ecological types (community composition) of bird species.

104. As a direct result of haul road construction, the elimination of saddle-corridors and their associated contiguous forest cover will alter the physical “soundscape” of bats. Until it can be demonstrated that forest canopy connectivity can be rehabilitated across haul roads, I hold the opinion that the elimination of cockpit saddle-corridors irreversibly damages the habitat of all “cluttered space” forest-dependent species – with bats serving as the bio-indicators for ALL other forest-dependent fauna.

105. Exposure to unsafe concentrations of PM2.5 and PM10 is recognized by global health experts as being damaging to respiratory, cardio-vascular and cognitive health. My pilot data call into question whether the environment and public health are being correctly monitored so as to ensure protection from air-borne pollution caused by mining activities.

106. Based on the above summary paragraphs 95 - 105, in my expert opinion I believe that mining activities in SML 173 will cause irreversible physical damage to ecological heritage and that the damage from the environmental abuse will breach the Claimants’ constitutional rights.

Assertions of the Expert Witness

1. In preparing this report, I examined documents provided by Hylton Powell and which I downloaded directly from NEPA’s website. Based on information gleaned from the documents, reference to scientific literature and my knowledge and experience both with the area of SML 173 and other areas of Cockpit Country, I arrived at my conclusion as to the validity of the Claimants’ claim. I believe that this approach complied with instructions given in Part 32 “Experts and Assessors,” of Jamaica’s Civil Procedure Rules and in particular Section 32.3 “Expert witness’s overriding Duty to the Court”, and section 32.4 “Way in which expert witness’s duty to the court is to be carried out”.

2. I was also aware of my right to apply to the court for directions (section 32.5), my need to address my report to the court and not any other person (section 32.12) and the details of the required contents of my report (section 23.13).

3. I believe I have included all matters within the realm of my knowledge that are relevant to the issues and that I have made clear where I feel that uncertainties in my opinions or in the opinions of others exists.

Susan E. Koenig

SUSAN E. KOENIG DATE: 24th MAY 2022