CIVIL AVIATION SENSITIVITY VERIFICATION REPORT FOR THE PROPOSED NEW SOLAR PV FACILITY ON FARM PORTION 271 KIPLING RE NEAR HOTAZEL, NORTHERN CAPE, FOR ASSMANG (PTY) LIMITED

PRESENTED BY

GWI Aviation Advisory

FINAL DRAFT

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GLOSSARY OF TERMS AND ACRONYMS

This report makes frequent use of acronyms and terminology unique to the aviation industry and consistent with standard definitions applied by the International Civil Aviation Organisation and the SA Civil Aviation Authority. A glossary of such terminology and definitions is presented below.

TERM	ACRONYM	DEFINITION
Aircraft Classification Number	ACN	An indication of runway pavement strength requirements of aircraft, which must match the corresponding Pavement Classification Number (PCN) of the runway.
Aerodrome Directory	AD	A standard publication issued from time to time by the South African Civil Aviation Authority recording the known technical status of aerodromes registered but not necessarily licensed by the Authority.
Airfield Ground Lighting	AGL	Lighting systems on runways, taxiways and aprons.
Aeronautical Information Publication	AIP	A standard Publication issued by the South African Civil Aviation Authority (latest update 21st October 2021) in which the classification status and technical data of aerodromes licensed by the SACAA (and unlicensed) is recorded.
Above Mean Sea Level	AMSL	Elevation of a particular topographical feature, referenced to mean sea level.
Air Traffic and Navigational Services Corporation	ATNS	A statutory body (State Owned Enterprise) formed in terms of an Act of Parliament to provide air traffic and navigational service oversight to major airports and airspace management within the Republic of South Africa.
Black Rock Mine	BRM	Black Rock Mine, owned and operated by Assmang (Pty) Limited.
Civil Aviation Regulations	CARS	Regulations published by the South African Civil Aviation Authority in accordance with international standards and recommended practices set by the International Civil Aviation Organisation (ICAO).
Civil Aviation Sensitivity Study	CASS	A Civil Aviation Sensitivity Study required on proposed development sites if the preliminary assessment of the site using the DFFE screening tool indicates a medium or higher sensitivity.
Fire and Rescue classification category	CAT	The minimum fire-fighting and rescue facility requirements at an aerodrome, in terms of ICAO Annex 14, based generally on aircraft length and passenger cabin diameter.
Civil Aviation Technical Standards	CATS	Technical compliance standards applied by the SACAA, generally in parallel with ICAO Annex 14 requirements but in some cases adapted to local conditions.
Code	CODE	An alpha-numeric code e.g. 2B designating the classification of an aircraft by ICAO based on runway length (numeric code) required at mean sea level at standard temperature conditions for safe operations, and wingspan (alpha code).

TERM	ACRONYM	DEFINITION
Conical Surface	CS	An ICAO-defined Obstacle Limitation Surface that (for Code 2 aerodromes) commences at the outer edge of the Inner Horizontal Surface and slopes upwards at a grade of 5 % until a maximum elevation of 55m above the Inner Horizontal Surface.
Development	Development	The proposed development by Assmang (Pty) Limited of the proposed new pit.
Department	DFFE	The Department of Forestry, Fisheries and the Environment.
EScience Associates (Pty) Limited	EScience	A specialist consultancy offering environmental impact assessment and sustainability advisory services.
Federal Aviation Authority	FAA	Regulatory Authority for Civil Aviation in the USA – equivalent of the SA Civil Aviation Authority in South Africa.
Black Rock Airfield	FABP	SACAA acronym/reference for Black Rock Airfield
Hotazel Airfield	FAHZ	SACAA acronym/reference for Hotazel Airfield
General Aviation	GA	Private, recreational, pilot training and non-scheduled air services.
Global Navigational Satellite System	GNSS	Satellite based aircraft navigational systems relying on GPS technology, regarded by the SACAA as 'non-precision' instrument approaches.
Gloria Mine	GM	Gloria Mine, owned and operated by Assmang (Pty) Limited.
GWI Aviation Advisory	GWI	A specialist division of GWI Africa (Pty) Limited, a consultancy specialising in project and development management of infrastructure and built-environment projects.
International Civil Aviation Organisation	ICAO	The International Civil Aviation Organization, a specialized technical agency of the United Nations. It regulates international civil aviation and air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth.
International Air Transport Association	IATA	The International Air Transport Association, a trade association of the world's airlines. Consisting of 290 airlines, primarily major carriers, representing 117 countries, IATA's member airlines account for approximately 82% of total available seat miles air traffic.
Inner Horizontal Surface	his	An ICAO defined Obstacle Limitation Surface that extends (for a Code 2 aerodrome) for a horizontal distance of 2 500m from any point on the runway, at a height of 45m above the maximum ground elevation of the runway.
Non-directional Beacon	NDB	Radio beacon that broadcasts a one-way radio signal allowing aircraft to determine their position relative to the beacon, but without distance measuring or directional capability.
Notice to Airmen	NOTAM	*Ad hoc* notices or publications issued from time to time by the SACAA, describing temporary conditions or situations at aerodromes that are likely to affect the safety of the operation of aircraft or the operational status of such aerodromes.
Obstacle Limitation Surface	OLS	An imaginary surface in the air that defines, in terms of ICAO standards, a boundary beyond which any land-based obstacles may not 'penetrate', to preserve the safety of aircraft. For different categories of aerodromes and aircraft ICAO document 'Annex 14' defines the requirements for various types of OLS.
Passengers	PAX	Number of passengers.

TERM	ACRONYM	DEFINITION
Performance Based Navigation	PBN	ICAO recommended methodology to improve air traffic management through increased reliance on satellite-based navigation systems and customised flight paths matched to aircraft performance capability, designed to reduce aircraft-based carbon footprint through reduction in approach and 'hold' times of arriving aircraft and reduce reliance on ground-based navigational infrastructure.
Protocol	Protocol	The Protocol (see Appendix B) published by the Department of Forestry, Fisheries and the Environment in Government Notice 320 of March 2020, requiring Environmental Practitioners to undertake a Civil Aviation Sensitivity Study to determine or verify the site sensitivity of proposed developments that might adversely impact civil aviation infrastructure, particularly radar installations, located close by.
Reference Field Length	RFL	The runway length required for the safe arrival and departure of a fully-loaded 'critical aircraft' for which a runway is designed, referenced to sea level altitude and standard atmospheric and calm conditions.
Remote Navigation	RNAV	Satellite based navigation systems, substantially equivalent to GNSS.
Runway	RWY	A runway as defined by ICAO is a rectangular area of an aerodrome intended for the take-off and landing of aircraft. RWY's are designated according to their reciprocal approach headings at either threshold. Thus, for RWY 07/25, 07 refers to an approach heading of 70 and 25 to a heading of 250 degrees i.e. the reciprocal of 70 degrees.
South African Civil Aviation Authority	SACAA	The South African Civil Aviation Authority, the South African aviation regulating authority, established by an Act of Parliament to oversee civil aviation activities, licensing of aircraft and pilots and to conduct investigations into aviation accidents and incidents.
Standards and Recommended Practices	SARP's	Technical aviation and compliance standards and recommended practices, as set out by ICAO in various documents and publications, in particular Annex 14.
Safety Health and Environment	SHE	Safety Health and Environment
Uncontrolled Airspace	UA	A class of air space as defined by ICAO (generally Class F or G) and implemented by ATNS in which no air traffic management or guidance services are offered and no radar monitoring capability is provided by ATNS.
Visual Flight Rules	VFR	Visual flight rules are regulations under which a pilot operates an aircraft in weather conditions generally clear enough to allow visual navigation, within prescribed parameters.
Very-high frequency omnidirectional radio antenna	VOR/DME	Radio antenna that provides position and directional vectoring capability to aircraft. DME is the acronym for 'distance measuring equipment'.
Visual Meteorological Conditions	VMC	Meteorological conditions under which sight distances (per SACAA rules) allow flight operations to proceed under visual flight rules (VFR), without the necessity to resort to instrument procedures (IFR) under Instrument Meteorological Conditions (IMC).

1. EXECUTIVE SUMMARY

Appointment of GWI Aviation Advisory

In March 2020, the Department of Forestry, Fisheries and the Environment (DFFE) published a Protocol that requires Environmental Assessment Practitioners (EAP's) to assess the environmental impact of proposed developments on nearby civil aviation facilities. While the South African Civil Aviation Authority (SACAA) is primarily concerned with civil aviation safety and security, the DFFE is mandated to ensure the overall environmental compliance of aviation infrastructure and the impact of proposed new developments on existing infrastructure, particularly radar, within distance limits set out in the Protocol. To this end, it has developed a screening tool (Screening Tool) to allow EAP's to undertake a preliminary assessment of the potential sensitivity of proposed development sites. If the results of this assessment indicate medium or higher sensitivity, then a specialist Civil Aviation Sensitivity Study (CASS) is necessary to verify or revise the assigned sensitivity level. Should the CASS assess the sensitivity of a proposed development as medium or higher, a Civil Aviation Compliance Statement to the satisfaction of the SACAA is then required.

Assmang (Pty) Limited (Assmang) is proposing to develop a solar PV (photovoltaic) power generation facility on the farm portion Kipling 271 RE to service their mining operations in the Northern Cape Province, near Hotazel. While the distance from the proposed Development to the nearby Black Rock (FABP) aerodrome is greater than the 8km minimum distance set out in the Protocol, Hotazel (FAHZ) is only just over 2,5 km away, and thus triggers a CASS.

Using the Screening Tool, a preliminary assessment conducted by EScience indicated a high sensitivity. GWI Aviation Advisory (GWI) were thus appointed by EScience to undertake a CASS to verify or revise the EScience sensitivity assessment and to determine whether a Civil Aviation Compliance Statement is required. The scope of the GWI appointment is restricted to the CASS and associated recommendations. Should the CASS conclude that the site sensitivity is indeed medium or higher, it may be necessary to extend GWI's appointment to include the preparation and approval by the SACAA of a Civil Aviation Compliance Statement.

Analysis Scope and Methodology

The analysis conducted by GWI was based on the requirements of the Protocol, but also included an assessment of potential safety impacts of the proposed Development on FABP and FAHZ. For this purpose, the analysis included the determination of the Obstacle Limitation and Approach Surfaces (OLS) of the airfields and risk assessment, in accordance with the standards and recommended practices (SARP's) of the International Civil Aviation Organisation (ICAO), Annex 14. ICAO is represented in South Africa by the SACAA, who also publish their own Civil Aviation Regulations and Technical Standards (CARS and CATS).

In addition to the above rational approach, since no widely used precedents are available in South Africa, the analysis also considered methodologies recommended by the US Federal Aviation Authority (FAA) (Appendix C) for the risk assessment of solar PV facilities developed close to airports.

Findings

The findings of the CASS are summarized as follows:

- **Radar Installations**:
  There is no evidence of any ground-based civil radar installations closer than 15km or within the 15-35km distance limits of the proposed Development, as set out in the Screening Tool.

- **Navigational Infrastructure**:
  There is no evidence of any land-based navigational infrastructure within the same distance limits of the proposed Development site; FABP has no land-based navigational infrastructure and FAHZ is equipped with an NBD whose use (in terms of the SACAA AIP) is restricted to en-route navigational purposes only. However, indications are that the aerodrome is closed.

- **Aerodromes**
  There are no major civilian airports within 35km of the proposed development site; however FAHZ (Figure 2) falls within the 8km distance limit specified in the Screening Tool, at 2,57km away.

- **Upper-level Air Corridors and Routes**:
  The closest upper-level air corridor or major air service navigation route is some 40km to the south of the proposed Development (Figure 3), which falls outside the 35km distance limit imposed by the Protocol. In any event, the risk imposed by any PV infrastructure on site has been assessed as low in terms of the FAA guideline distance of 500ft.

- **Obstacle Limitation Surfaces**:
  - **Approach and Take-off/Climb surfaces**
    The proposed Development falls outside the approach and take-off/climb surfaces of FAHZ (Figure 5) and the Development is therefore expected to contribute minimal additional risk to safe operations at the aerodrome.

  - **Inner Horizontal Surface (IHS)**
    The proposed Development falls outside the IHS footprint of FAHZ. In any event, since the natural ground level of the proposed site is 1 053m amsl and the critical IHS height limit is 1 101m amsl (Figure 5), the available 'buffer' for any structures is 48m. The proposed Development therefore complies with the provisions of the ICAO SARP's.

  - **Conical Surface (CS)**
    The CS of FAHZ is located overhead the proposed Development footprint, but at a minimum height of 45m, after accounting for topographical differences. This is substantially greater than that of any proposed structures and the CS is therefore not penetrated by any proposed structures.

  - **Existing Obstacles**
    No existing obstacles are evident and the proposed Development, being outside the IHS and below 48m in any event, is not expected to constitute a new obstacle.

- **'Glint and Glare' Risk per FAA Guidelines**
  The proposed facility is located at bearings of between 326^{o} and 42^{o} relative to the FAHZ runway threshold, 2,57km away, with the proposed site of the PV arrays lying both east and west of the extended centreline of the runway (Figure 5). However, as mentioned, the OLS is at an altitude of at least 48 m

above natural ground level at the closest point of the site to the runway threshold. On the assumption that the runway may at some future stage be re-opened, two risk scenarios arise, being:

Approaches to and departures from RWY 02 (i.e. from south to north)
In this scenario, the 'glint and glare' risk would be when an aircraft is adversely positioned relative to the sun (either directly or reflected) and the proposed facility. Given the location of the facility some 2,5km north of the northern runway threshold, this can only happen when the sun is at a low azimuth (altitude) in the northern sky while the aircraft is departing or approaching. The critical time at this for latitude (S27^0 12$'$ 32$''$)is at the winter solstice, when the sun's azimuth is 39,4^o. This is too high to constitute a glint risk since the PV panels themselves will also be inclined 30^o north. The potential impact on aircraft on 'short final' approaches to the southern threshold is lower, since (a) the aircraft are some 1,6km further away and (b) the aircraft will only briefly cross the reflected image of the sun in relatively few PV panels, as it approaches the runway threshold. While the image of the sun would be directly ahead, the relatively high solar altitude will not interfere with the pilot's view of the runway. A pilot in the right seat will be less affected because of the horizontal angle, and risk to aircraft operations is thus low. This would be the case for both potential types of possible PV panel mountings, being fixed-inclination or sun-tracking, although in the latter case the risk would be even lower since the panel itself would be more closely orientated towards the sun, thus reducing the risk of reflection.

Approaches to and departures from RWY 20 (i.e. from north to south)
In this scenario, a potential reflection would only occur when the sun is at a 'critical reflection angle' in the sky relative to the facility and an affected aircraft. However, this would not be possible at this latitude since at all times of the year sun will either be behind the aircraft at 'critical' times or offset far to the east or west (early morning or late afternoon). No glint reflections can thus occur.

- **Radio and Communications Interference per FAA Guidelines**
  The guideline minimum distances prescribed by the FAA for the siting of PV facilities from radar, navigational and other communications devices they could potentially impact, range from 250ft to 500ft (Appendix C). These minima are well below the distance (2,57km) of the proposed facility from any communications infrastructure (VOR/DME and other radio equipment) at FAHZ. Risk of such interference is thus low.

Recommendations

It is recommended that the sensitivity level of the proposed Development be amended to 'low', in which case no Civil Aviation Compliance Statement will be required.

2. INTRODUCTION

2.1 BACKGROUND

EScience was appointed by Assmang (Pty) Limited to undertake a basic assessment for the proposed new PV facility on the farm Kipling 271RE near Hotazel in the Northern Cape Province, which it owns. The mines extract various metal ores.

The proposed development is approximately 2,57km north of the Hotazel airfield (FAHZ), and will comprise arrays of solar PV panels located at ground level on frames, optimally oriented at approximately 30 deg towards the sun as it traverses the sky throughout the year, plus control infrastructure and transmission cables to distribute power into local grid networks. The Black Rock airstrip (FABP) is another 8,9km northwest of the development and is thus not affected.

The proposed Development is intended to supplement the capacity of the mine, in pursuit of Assmang's strategic business objectives to reduce carbon footprint and promote renewable energy sources. The proposed Development site is within the Mining Rights Area of Black Rock, on property owned by Assmang.

The proposed Development will also include access roads, security infrastructure and associated service infrastructure.

Figures 1 and 2 outline the regional location of the proposed Development and its location relative to FAHZ and the airfield at FABP, also owned by the mine.

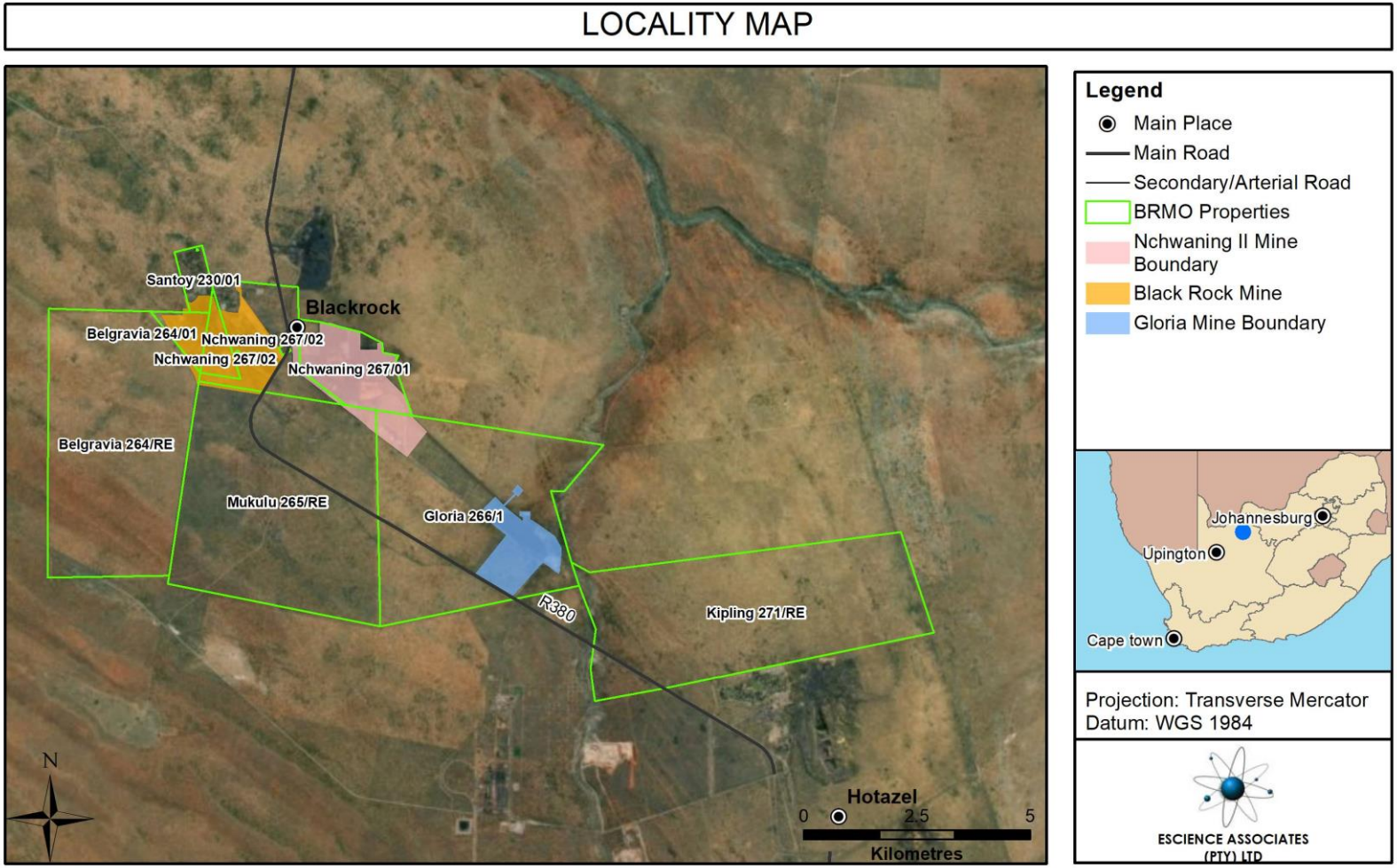

Figure 1:Locality of the Farm Portion Kipling 271RE relative to Hotazel

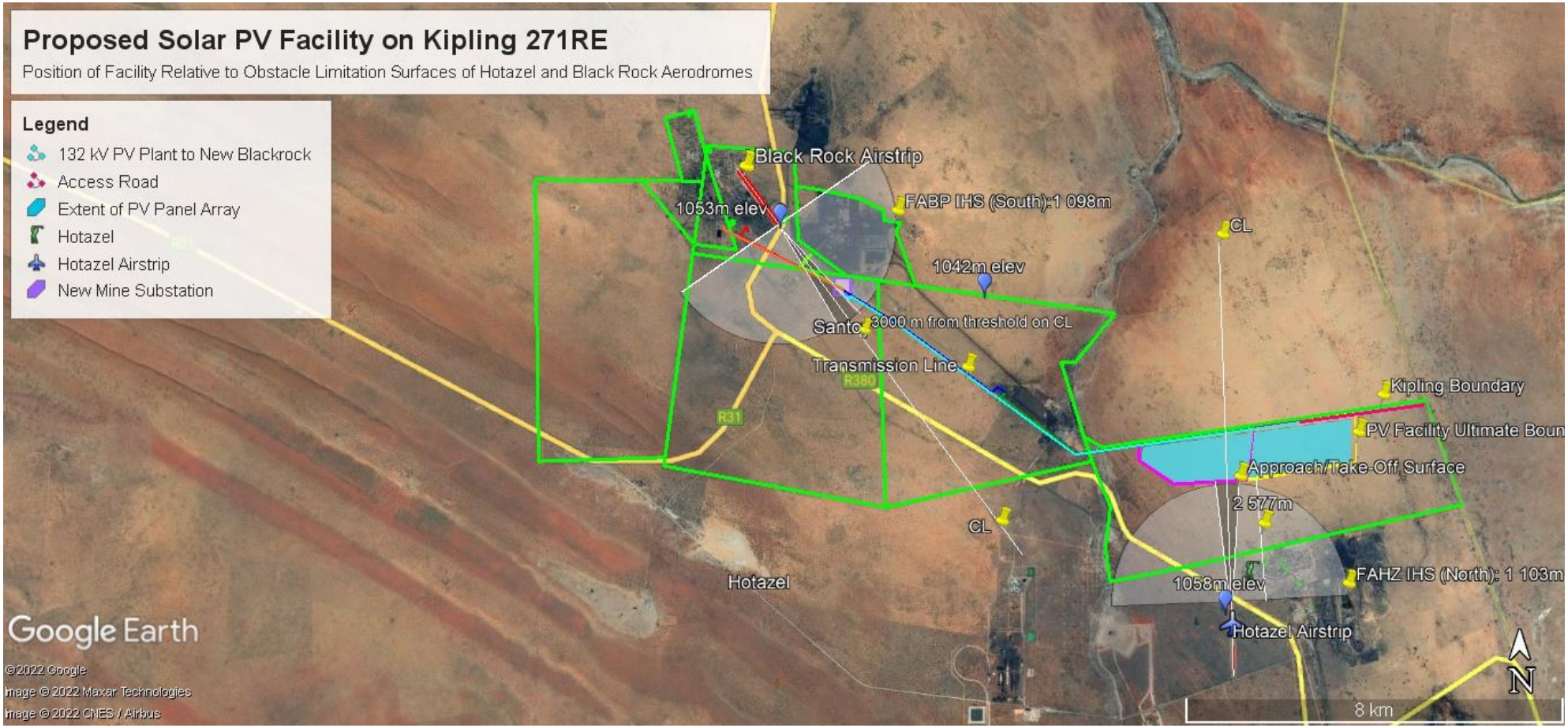

Figure 2: Location of Proposed New Solar PV Facility relative to Hotazel and Black Rock Airfields

2.2 ENVIRONMENTAL REQUIREMENTS

An Environmental Authorisation application is required in terms of the Environmental Impact Assessment Regulations (EIA Regulations, 2014) published in Government Notice (GN) No. 982 of 4 December 2014 (as amended by GN No. 571 of June 2021), in terms of Chapter 5 of the National Environmental Management Act, 1998 (NEMA, No. 108 of 1998), and in terms of Section 102 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA, No. 28 of 2002) for an EMPr amendment.

The EIA Regulations, 2014 provide for control over certain listed activities. These listed activities are detailed in Listing Notice 1 (LN1), Listing Notice 2 (LN2) and Listing Notice 3 (LN3), as amended by GN No. 517 of June 2021). The undertaking of activities specified in the Listing Notices is prohibited until Environmental Authorisation has been obtained from the competent authority. The listed activities triggered by the project are summarised below:

Listing Notice 1 - Activity No. 11(i): The development of facilities or infrastructure for the transmission and distribution of electricity –

(i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275kV or more.

Listing Notice 1 - Activity No. 14: The development and related operation of facilities and infrastructure, for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 cubic metres or more but not exceeding 500 cubic metres.

Listing Notice 1 - Activity No. 24(ii): The development of a road –

(ii) with a reserve wider than 13.5m, or where no reserve exists where the road is wider than 8m.

Listing Notice 1 - Activity No. 56(ii): The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre (ii) where no reserve exists, where the existing road is wider than 8 metres.

Listing Notice 2 - Activity No. 1: The development of facilities or infrastructure for the generation of electricity from a renewable resource where the electricity output is 20 megawatts or more, excluding where such development of facilities or infrastructure is for photovoltaic installations and occurs:

(a) within an urban area; or

(b) on existing infrastructure.

Listing Notice 2 - Activity No. 15: The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for—

(i) the undertaking of a linear activity; or
(ii) maintenance purposes undertaken in accordance with a maintenance management plan.

3. CIVIL AVIATION SPECIALIST STUDY REQUIREMENTS

3.1 DFFE PROTOCOL OF MARCH 2020

A '*Protocol for the specialist assessment and minimum report content requirements for environmental impacts on civil aviation installations*' was gazetted by the DFFE as GN No.320 in the Government Gazette 43110 on 20th March 2020. The Protocol is attached as Appendix B.

In terms of the Protocol, the EAP is required to undertake an initial review of the subject site, utilizing the Screening Tool developed by the DFFE, to assess the potential impact of the proposed development on adjoining civil aviation installations.

The Screening Tool uses distance as an indicator of sensitivity. If the proposed site is:

1. Between 15 and 35km from a civil aviation radar, or
2. Between 15 and 35km from a major civil aviation aerodrome, or
3. Between 8 and 15km of other civil aviation aerodrome (sic)

then a sensitivity rating of medium or high is assigned, which triggers a CASS.

In terms of the Protocol:

- ***If the outcome of (the Specialist's) site sensitivity verification justifies a sensitivity of medium or higher, then a Civil Aviation Compliance Statement is required***
- ***If the outcome of (the Specialist's) site sensitivity verification indicates low sensitivity then there are no further requirements.***

3.2 INITIAL ASSESSMENT

The proposed development site was assessed by EScience using the Screening Tool and a high sensitivity assigned on account of its proximity to FABP and FAHZ, which are respectively 8,9 and 2,57 km away at the closest points.

Based on this preliminary sensitivity rating, GWI was appointed by EScience to undertake a CASS to verify or adjust the rating. The credentials of GWI and relevant CV's of resources deployed on the study are attached to this report as Appendix A.

If the CASS determines that a Compliance Statement is required, the mandate of GWI may need to be extended to prepare the Compliance Statement and engage with the SACAA to obtain their comments on and approval of the document.

The CASS comprised the following elements:

3.3 AIRSPACE ANALYSIS

Using the SACAA AD and the current Aeronautical Information Publication (AIP) information on aerodromes and their license status, airspace classification sourced from the Air Traffic and Navigational Services Corporation (ATNS) and existing topographical data, the proposed development site was overlaid on the airspace classification map of the environs and risks posed to overflying or approaching civilian aircraft assessed.

3.4 RADAR INSTALLATION ASSESSMENT

Using information available from the SACAA and ATNS, the location of civil aviation radar installations within the guideline distances (per the Protocol) from the proposed Development was determined and the risk posed to the operation of these installations by the proposed Development assessed.

3.5 OBSTACLE ASSESSMENT

Using the ICAO SARP's, the relevant OLS's were reviewed and any additional risk to these surfaces presented by the proposed Development and associated infrastructure (transmission lines, for example) assessed.

3.6 OTHER POTENTIAL IMPACTS

Other potential impacts, for example risks to pilot visibility on approaches to the aerodrome arising from potential 'glint and glare' occurrences, were assessed using standard guidelines published by the FAA in the US (Appendix C).

Based on the above studies, the sensitivity status of the proposed PV Development was determined and amended.

4. SPECIALIST STUDY OUTPUTS

4.1 AIRSPACE ANALYSIS AND RADAR ASSESSMENT

Based on the SACAA AIP, neither FABP nor FAHZ are licenced aerodromes, although both are noted in the SACAA Aerodrome Directory as being 'private'. Key relevant factors are:

- While FABP has no navigational infrastructure, FAHZ has an NDB, designated 'HZ', which is primarily used for en-route navigation as defined in the AIP. However, it is evident that the NDB is no longer functional.
- It should also be noted that, based on observed runway markings, FAHZ is currently closed. It is not known how long this situation will endure.
- Apart from NDB 'HZ', neither airfield has any ground-based navigational aids, radar, runway or airfield lighting to assist approaching aircraft.
- The aerodromes are approximately 50km north of Sishen Airport (FASS), which although also a privately owned airport, provides an alternative landing option when visibility is restricted.
- The aerodromes operate under Visual Flight Rules (VFR) and all approaches are initiated in uncontrolled (Class F or G) air space (see Glossary), as defined by ATNS.
- Their runways are between 1 400m and 1 600m long and would technically be classified as ICAO 'Code 2' in terms of the SARP's, since the Reference Field Lengths (RFL - see the Glossary) in both cases are between 800 and 1 200m. However, both runway widths are less than ICAO SARP's, which limits the largest allowable aircraft to types operated under Part 91 or 135 of the Civil Aviation Regulations (CARS), which delegates to pilots-in-charge the discretion to determine whether the runway meets the performance criteria of their aircraft. For the purposes of this study an ICAO Code 2B classification was assumed.
- The airspace classification in the environs of the proposed Development is indicated in Figure 3.

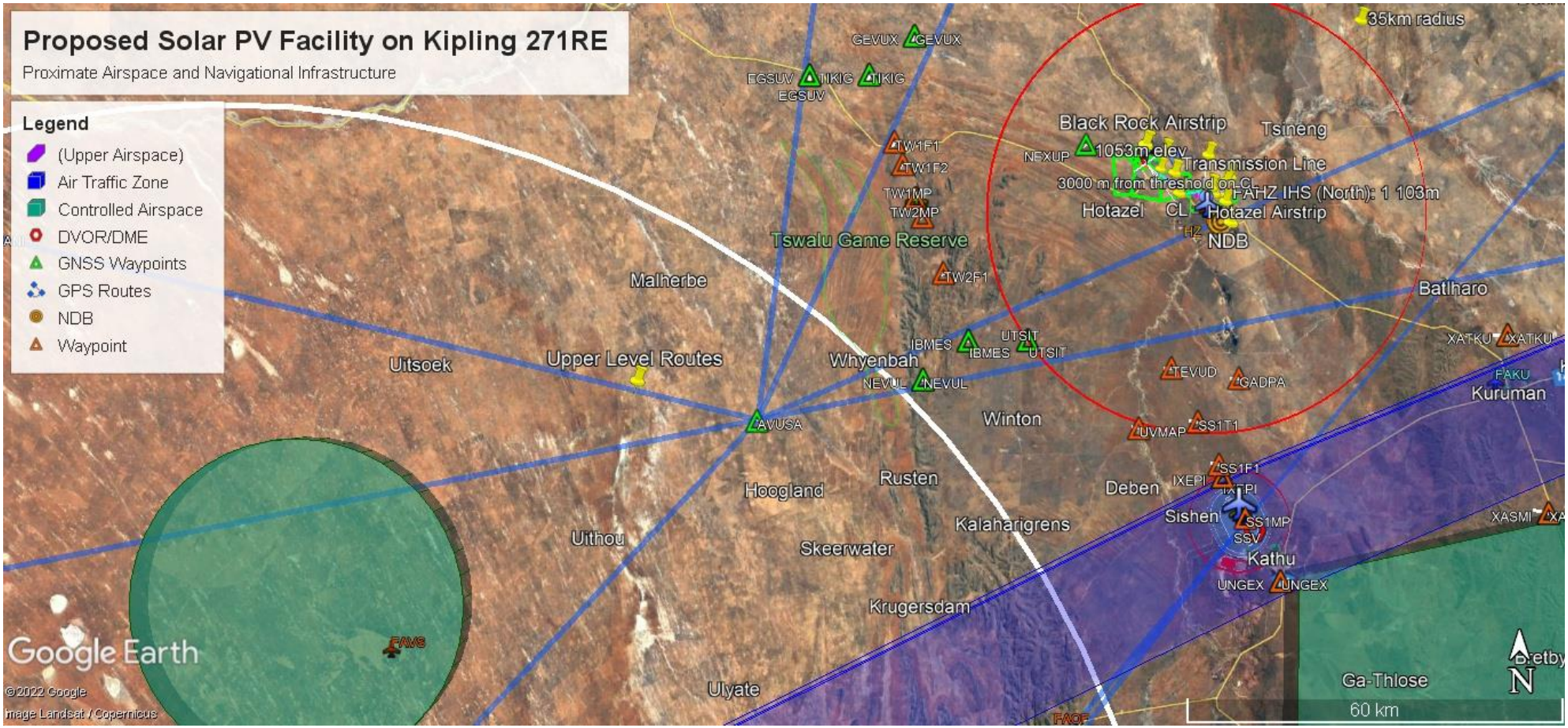

Figure 3: Airspace Classification, Air Corridors and Proximate Navigational Infrastructure

From Figure 3, it was determined that:

- The airspace around both airfields is uncontrolled.
- The closest defined air corridor is an upper-level corridor further than 35km south of the proposed Development, which therefore falls outside the scope of the Protocol.
- 2 satellite-based navigation (RNAV) routes for aircraft at high altitude traverse the 35km limitation zone, but since these are not reliant on ground-based radar or other navigational infrastructure are also beyond the remit of the CASS and will not be affected by the proposed Development.
- There are no nearby civil aviation radar sites that are likely to be affected by the proposed Development.
- The closest ground-based navigational equipment is the out-of-commission NDB 'HZ' located close to FAHZ, just over 2,57 km south of the proposed Development.
- The next-closest aerodrome is Sishen (FASS), some 50km to the south.

4.2 OBSTACLE LIMITATION SURFACES

For a full assessment of the proposed Development in relation to the nearby aerodromes, the ICAO SARP's require the following types of OLS (see Figure 4) to be determined:

- Conical surface
- Inner horizontal surface
- Approach and take-off/climb surfaces
- Transitional surfaces

While this analysis is mainly concerned with the potential impact, in terms of the 2020 Protocol, of the proposed Development on operations at the nearby airfields and/or on existing aviation infrastructure in the area, it is nonetheless similar in scope to an Aviation Safety Study and is thus based on the OLS's indicated in Figure 4 (extracted from ICAO Annex 14), as also ICAO Annex 14 - Table 4.1 and Figure 5.

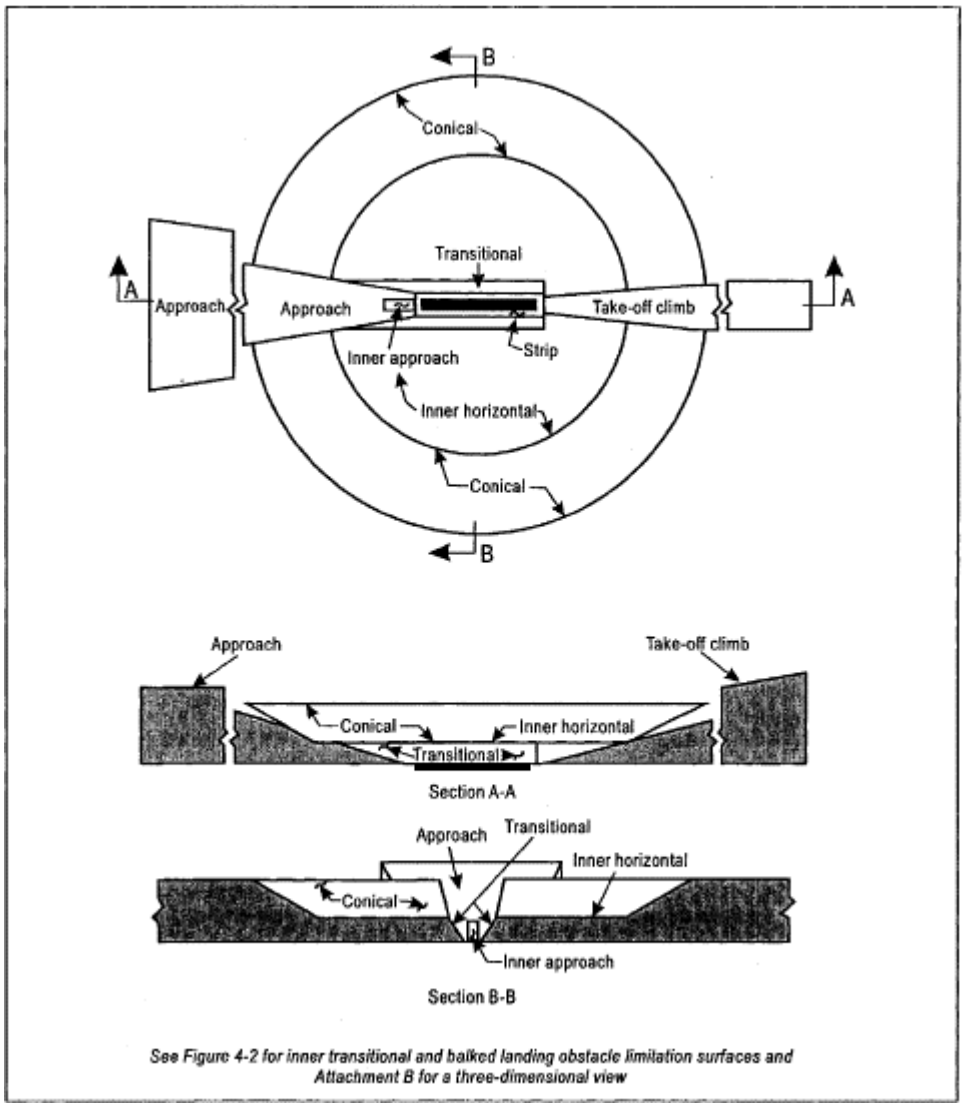

Figure 4: ICAO Annex 14 Obstacle Limitation Surfaces

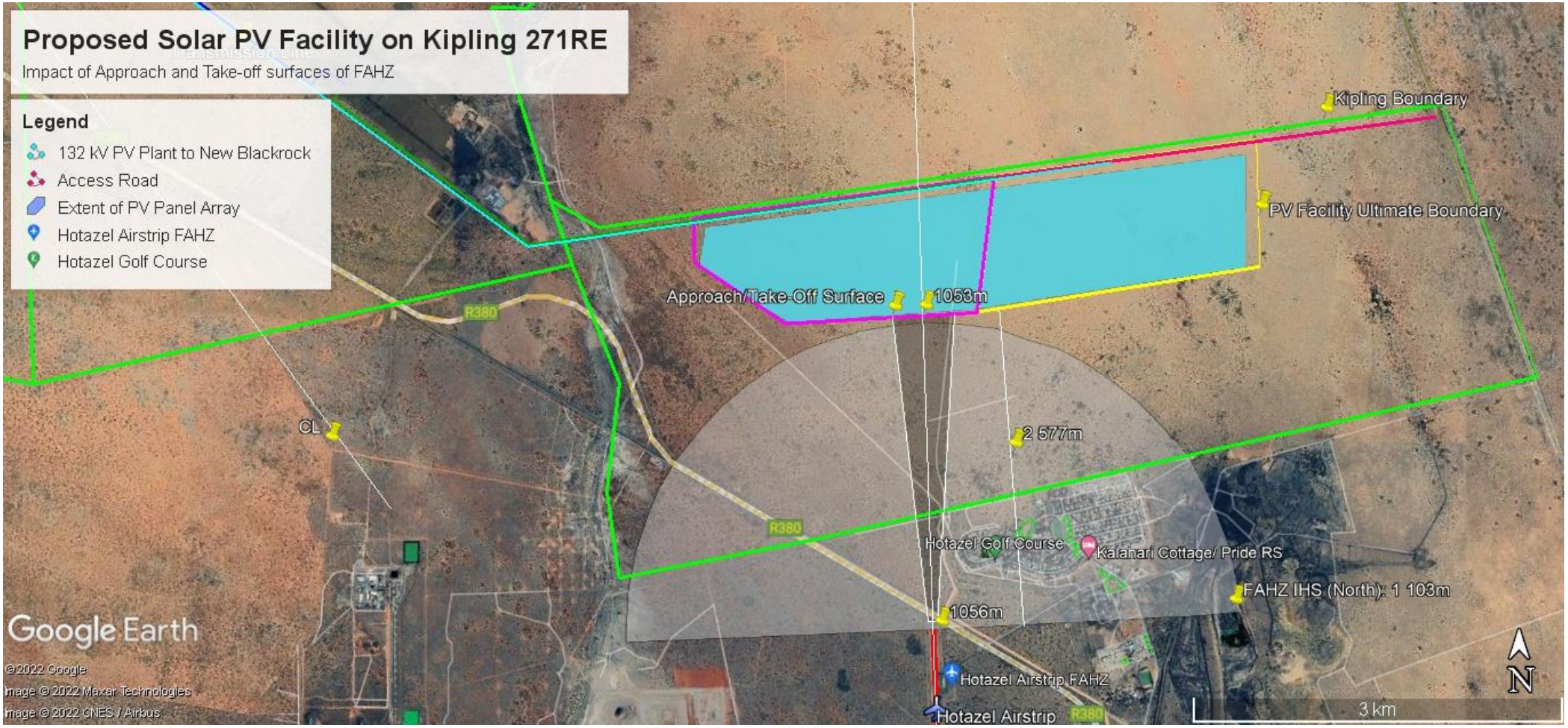

Figure 5: Partial ICAO Code 2B Obstacle Limitation Surfaces for Hotazel Aerodrome

4.3 INNER HORIZONTAL SURFACE

The ICAO SARP's require an IHS that extends horizontally 2 500m from any point on the runway, for a Code 2B aerodrome. The extent of the relevant portions of the IHS for FAHZ is indicated in Figure 5.

- Referenced to the SACAA recorded runway elevations of 1 056m AMSL, the lowest elevation of the IHS (45m above the runway, per the SARP's) is thus 1056+45=1 101m AMSL.
- The proposed Development does not fall inside the IHS footprint and thus does not affect it. Even if so, the limiting height of new structures in the Development would be 1 101 AMSL or 48m (1 101 – 1 053m) above natural ground level, which represents the maximum allowable height of any proposed structures.
- No penetrations of any structures (PV panels themselves or transmission lines) are thus anticipated, and therefore no new risks are likely to emerge.

4.4 CONICAL SURFACE

As discussed, the proposed Development is outside the IHS, but within the ICAO Conical Surface (CS), which extends a further 2 650m from the edge of the IHS for FAHZ (FABP is not affected) to beyond the northern limit of the proposed Development. However, the approach and take-off surfaces discussed in 4.5 may be more critical than the Conical Surface since they traverse the site.

No pre-existing obstacles are observed within the CS area.

The ICAO Transitional Surface for Code 2 aerodromes will always be above the Conical Surface at this distance from the runway and can therefore be ignored.

4.5 APPROACH SURFACES

The ICAO Annex 14 approach surfaces at FAHZ extend only 2 500m from the critical (northern) threshold at a slope of 4%, but terminate at the same point as the IHS, since the runway is classified as Code B. The height at the point the surface crosses the closest boundary of the Development is 4 % of 2 500m, or 100 m, which is higher than the IHS. There is thus no material affect from the proposed Development and the risk on aircraft operations posed by the Development is therefore low. As can be seen from Figure 5, while the proposed development is beyond the approach and take-off surfaces of the aerodrome, aircraft will likely manoeuvre over the site, but at altitudes of over 100m.

4.6 COMMUNICATIONS, GLINT AND GLARE

Airspace and Communications

The proposed facility is beyond the FAA recommended minimum distance of 500ft, so risk remains low.

Glint and Glare

On the assumption that the FAHZ runway may at some future stage be re-opened, two risk scenarios arise, being:

Approaches to and departures from RWY 02 (i.e. from south to north)
In this scenario, the 'glint and glare' risk would be when an aircraft is adversely positioned relative to the sun and the proposed facility. Given the location of the facility some 2,5km north of the northern runway threshold, this can only happen when the sun is at a low azimuth (altitude) in the northern sky while the aircraft is departing or approaching. The critical time for latitude S27^0 12$'$ 32$''$ is at the winter solstice when the sun's azimuth is 39,4^o. This is too high to constitute a glint risk since the PV panels themselves will also be inclined 30^o north. The potential impact on aircraft on 'short final' approaches to the southern threshold is lower, since (a) the aircraft are some 1,6km further away and (b) the aircraft will only briefly cross the reflected image of the sun in relatively few PV panels, as it approaches the runway threshold. While the image of the sun would be directly ahead, the relatively high solar altitude will not interfere with the pilot's view of the runway. A pilot in the right seat will be less affected because of the horizontal angle, and risk to aircraft operations is thus low. This would be the case for both potential types of possible PV panel mountings, being fixed-inclination or sun-tracking, although in the latter case the risk would be even lower since the panel itself would be more closely orientated towards the sun, thus reducing the risk of reflection.

Approaches to and departures from RWY 20 (i.e. from north to south)
In this scenario, a potential reflection would only occur when the sun is at a 'critical reflection angle' in the sky relative to the facility and an affected aircraft. However, this would not be possible at this latitude since at all times of the year sun will either be behind the aircraft at 'critical' times or offset far to the east or west (early morning or late afternoon). No glint reflections can thus occur.

Radio and Communications Interference per FAA Guidelines
The guideline minimum distances prescribed by the FAA for the siting of PV facilities from radar, navigational and other communications devices they could potentially impact, range from 250ft to 500ft (Appendix C). These minima are well below the distance (2,57km) of the proposed facility from any communications infrastructure (VOR/DME and other radio equipment) at FAHZ. Risk of such interference is thus low. In relation to communications equipment in aircraft themselves, it is possible that aircraft manoeuvring over the facility might come close to the FAA minimum recommended separation of 500 ft (altitude), but since VFR conditions apply, risk will be low.

4.7 OTHER POTENTIAL IMPACTS

Bulk ore mining in open pits and/or construction activities might result in airborne dust, which may affect the runway visibility for pilots-in-charge of approaching aircraft, when the wind direction or sun position is unfavourable. Since both proximate airfields operate under VFR conditions and in terms of Part 91 of the CARS, the discretion to reject landings under such circumstances, rests entirely with the PIC. Similarly, even though the proposed development is on the extended centreline of FAHZ, it will be easy for aircraft to maintain the recommended 'safety distance' of 5 000ft (1 524m), as recommended by the SACAA to mitigate the risk of entering airspace above activities subject to the use of explosives.

5. RECOMMENDATIONS

As specified in the DFFE Protocol, proposed development sites whose sensitivity is low do not require a Civil Aviation Compliance Statement. For sites whose sensitivity is medium or higher, then a Compliance Statement is required.

The analysis contained in this CASS has determined that the proposed Development and associated ground-based infrastructure would not materially impact radar or navigation infrastructure in the environs of either the Black Rock or Hotazel airfields, nor present any material additional risk to future operations at these airfields within the contemplation of the 2020 Protocol. On this basis, therefore, it is recommended that the Sensitivity Classification of the proposed Development be amended to 'low'.

Additional Recommendations

1. Based on the analysis of the OLS's at the affected airfields, it is further recommended that EScience's client be advised of the potential for dust generation during construction of the proposed Development and appropriate policies introduced to ensure that appropriate Notices to Airmen (NOTAM's) be issued where such risk arises from time to time. EScience's client should also be advised to ensure that any new obstacles are identified and appropriately marked in accordance with SACAA requirements.

2. Aircraft manoeuvring over the proposed site should maintain altitudes of at least 500ft.

APPENDICES

Appendix A: GWI Aviation Advisory – Capability and CVs

CURRICULUM VITAE: Jonathan Barry Clive Heeger

1. **Personal particulars:**

   a. **Name: Jonathan Barry Clive Heeger**
   b. **Date of birth: 2 May 1955**
   c. **Place of birth: Johannesburg**
   d. **Places of tertiary education and dates:**

Institution	Year of Graduation
University of the Witwatersrand: BSc (Eng) (Civ)	1977
University of the Witwatersrand: (GDE, Construction Mgt)	1985
University of the Witwatersrand: (MBA)	1985

2. **Qualifications:**

- MBA (1985); GDE (1985); BSc (Eng) (Civ), 1977
- Pr Eng (Reg 820365): 1982-2008
- MSAICE: 1982-1996

3. **Current position:**

- GWI Aviation Advisory: Principal Airport Precinct Advisor/Development Manager

4. **Employment history:**

Year	Organisation	Position
1978-1983	SA Railways and Harbours	Assistant Engineer
1983-1987	Retail Property Projects (Pty) Ltd	Development Manager
1988-1996	RMB Properties (Pty) Ltd	GM Property Development
1996-2000	Airports Company SA	Group Manager, Development and Planning
2000 – 2021	GWI Aviation Advisory	Aviation, Infrastructure and Commercial Property Specialist, Project Manager

Please refer to the next page for item 5

5. **Professional experience:** selected projects/experience relevant to the scope of work

Designation	Name	Employer, contact person & telephone number	Description of work (service)	Current Development Value of projects	Date completed
Aviation/Logistics Specialist	BDO Consortium	Mpumalanga Provincial Government	Development of Provincial Aviation Strategy	N/A	July 2019
Aviation/Commercial Specialist	SMEC Consortium	Kumba Mining Corp. Mr H Sifeni 076 6487185	Feasibility Study for new airport at Postmasburg, N Cape	R 500 mil	Ongoing
Infrastructural Expert	Grant Thornton Consortium	Ministry of Tourism, Republic of Kenya Cabinet Secretary (Tourism)	Infrastructural analysis and support for development of National Tourism Master Plan, Republic of Kenya	Multi-million US$	December 2017
Independent Consultant	GWI Africa	Mr P Serote	Master Planning and Concept Study for re-development of Grand Central AIrport, Midrand.	>R 10 bil	Ongoing
Development Expert	J Heeger (for GWI Project Managers)	KZN Treasury: Dr C Coetzee 082 796 4500	Institutional, Business and Technical advice – KZN Technohubs at Pietermaritzburg, Newcastle, Richards Bay and Port Shepstone – Infrastructure and Institutional arrangements within the structures of the MFMA and MSA.	R 500 mil	2018
Team Leader	Zululand District Municipality	Ms T Hadebi; Airport Manager	Commercial development planning and Feasibility Study for surplus property adjacent Ulundi Airport	>R 500 mil	2018
Commercial Advisor	ACSA	Mr L Tilana 082 3055855	Precinct commercialization and office development proposals for Port Elizabeth and East London Airport property precincts	>R 500 mil	July 2020
Commercial Advisor	PLD Developments/Matlosana Municipality	Mr AK Khuzwayo, Mr P Letlhage	Precinct commercialization and office/commercial development proposals for Matlosana Airport Precinct	>R 500 mil	Ongoing
Team Leader	Umhlathuse Municipality	Ms B Strachan strachanb@umhlathuse.gov.za	Pre-Feasibility Study for New Richards Bay Airport and Commercial Precinct	R 500mil	2018
Team Leader, Development Expert	J Heeger (for Royal HaskoningDHV)	City Manager: Mr S Sithole; Dr Mimi Ndokweni c/o: denny.thaver@durban.gov.za	Technical and Business analysis, Virginia Airport, Durban - redevelopment. Analysis of alternative sites for General Aviation airport to replace Virginia Airport and deal structure options compliant with the MFMA/MSA.	R 6 bil	May 2014
Development/Aviation Expert	J Heeger (for Grant Thornton)	ECSECC (Provincial Govt)	Mthatha Airport Strategy – providing technical and business support to ECSECC developing a	R 800 mil	August 2014

		Mr B Mhlaba 083 477 3372	comprehensive Development Strategy for Mthatha Airport Business Precinct		
Development Expert	J Heeger (for Treasury Crack Team)	Airport Exec: Mr D Gengan david.gengan@msundusi.gov.za	Strategic/ technical support to Umsunduzi Municipality in Master Planning, upgrading infrastructure and commercial precinct development at Pietermaritzburg airport. Options development for establishment of Municipal Entity in terms of MSA s 73-78	R 1 bil (est)	March 2014
Development/Aviation Expert	J Heeger (KZN Treasury Crack Team)	KZN Treasury: Dr C Coetzee 082 796 4500 Municipal Manager: Mr M Mbili maxwell.mbili@hcm.gov.za	Strategic and technical Master Plan support to the Margate Municipality - planning for upgraded airport precinct and Business models, negotiating the introduction of scheduled services and SLA for provision of a Municipal Service.	R 350 000 (fee)	Dec 2013
Development Expert	J Heeger (for Treasury Crack Team)	KZN Treasury: Mr T Madgwick	Technical and business support to Ladysmith Municipality in Master Planning and investigating airport precinct - infrastructure and Institutional arrangements.	R 40 000 (fee)	December 2013
Business Unit leader	EC Harris	Mafikeng IDZ Company	Condition Assessment and redevelopment strategy, proposed Mafikeng IDZ	R 2 mil (fee)	2004
Dept Head	J Heeger	ACSA GM Planning: Mr S Huckwell 082 572 0945	Chairman, Airport Steering Committee (Ministry of Transport). Feasibility study for La Mercy Airport (King Shaka)	R 8,7 bil	1996-1998
Dept Head – Commercial Development	J Heeger	ACSA CEO: Mr D Ackerman 083 326 1856	Capital budgeting, operational and business models for all ACSA airports, including retail and commercial project directorship and PM. Design of internal audit and revenue reconciliation systems.	R 5 bil	1996 – 2000
Development Expert	J Heeger (for Treasury Crack Team)	KZN Treasury: Mr T Madgwick	Audit of Concession models and assessment of sustainability. Investigating airport precinct infrastructure and Institutional arrangements.	R 50 000 (fee)	December 2013
Team Leader, Commercial/Aviation Expert	J Heeger (for NACO SSI Joint Venture)	Botswana Civil Aviation Authority Mr K Ayyar +267 (365) 5100; +267 71558983	Developing strategies for growing non-aeronautical income at Sir Seretse Khama Airport, preparation of Tender Documents for tenants/concessionaires and negotiation with successful bidders.	R 500 000	June 2010
Team Leader, Aviation Expert	J Heeger (for SSI Engineers)	Aeroporto du Mocambique Mr A Tuendue +258 82 327 0140	Design and construction supervision consultant for new Domestic and International Terminals at Maputo International Airport. Review of traffic forecast, design brief and design proposals. Compliance	R 1 bil +	2012

			assessment and business and commercialisation review.		
Commercial/Aviation Expert	J Heeger (for NACO SSI Joint Venture)	Botswana Civil Aviation Authority Mr K Ayyar +267 (365) 5100; +267 71558983	Design brief and concept for new terminal and landside precinct at Sir Seretse Khama Airport, Gaborone, including Master Planning, cost-benefit analysis and value engineering.	R 500 000 (fee)	2006-2008
GM Developments	RMB Properties	Warren Schultze, CEO 082 8000031	Responsibility for Group property developments including RMB Head Office and associated Merchant Place precinct developments and property due diligence and condition assessment surveys, West Rand Consolidated Mine village.	R 2 bill	October 1996

I, the undersigned, warrant that the contents of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed

Name: **JBC Heeger** Date: 23 November 2022

Position: Commercial/Aviation/Infrastructure Specialist

TO BE AFRICA'S PROFESSIONAL SERVICE PROVIDER OF CHOICE

SCHEDULE OF EXPERIENCE WITH AIRPORT RELATED PROJECTS

Project Name	Project location	Description of Project	Name of Client	Project Values	No. of profess. staff	Duration	Name of associated firm	Start Date	End Date	Staff involved and functions performed	Description of the services provided
CJWE Robinson Deep	Gauteng	Proposed development of an incinerator	EScience & Associates	TBC	2	6 Months	GWI	Nov 2020	May 2021	J Heeger - Aviation Advisor B Karstadt - Project Director	Specialist Aviation Study & Report
Black Mountain Mine - Aggeneys	Northern Cape	Proposed development of PV Plant	Uvuna Sustainability	TBC	2	6 Months	GWI	Dec 2020	Jun 2021	J Heeger - Aviation Advisor B Karstadt - Project Director	Specialist Aviation Study & Report
Eagle Creek	Gauteng	Proposed development of Green Energy Waste Facility	EScience & Associates	TBC	2	6 Months	GWI	Aug 2020	Feb 2021	J Heeger - Aviation Advisor B Karstadt - Project Director	Specialist Aviation Study & Report
ACSA Airports revitalization strategy	Port Elizabeth & East London	Evaluation and re-design of the landside precinct at these two airports. Proposal to advise on the utilization of the land with the airport precinct.	ACSA	TBC	4	30 Months	RHDHV & GWI	May 2018	Dec 2020	J Heeger - Aviation Advisor P Serote - Exec Director B Karstadt - Project Director A Martens - Urban Planner RHDHV Team	Commercial analysis, planning, design, evaluation and development proposals
Tommy's Airfield / Kolomela	Northern Cape	Planning & Design of a new airport	Anglo	TBC	2	30 Months	SMEC & GWI	Aug 2019	Jan 2022	J Heeger - Aviation Advisor B Karstadt - Project Director	Planning & Design of a new airport. Aviation compliance for the airport
Matlosana Airport Precinct Development	Klerksdorp	Master planning, evaluation and development proposals for the Matlosana airport precinct	Developer & Matlosana Municipality	TBC	3	Ongoing	GWI	Mar 2019	Ongoing	J Heeger - Aviation Advisor P Serote - Exec Director B Karstadt - Project Director	Development proposal options for the airport precinct
Grand Central Airport	Midrand	Airport Urbanism concept that will create a Transport Oriented Development (TOD) for the existing airport and surrounding area	Old Mutual	TBC	3	Ongoing	GWI / Ivora Capital / RHDHV	Oct 2017	Ongoing	J Heeger - Aviation Advisor P Serote - Exec Director B Karstadt - Project Director	Master planning and development proposal for a TOD with the integration of the Gautrain
Revitalization of the Prince Mangosuthu Buthelezi Airport	Ulundi	Review Prince Mangosuthu airport in Ulundi to introduce scheduled air services and development opportunities to sustain the operation of the airport	Zululand District Municipality	TBC	3	Ongoing	N/A	Jan 2018	Ongoing	B Karstadt - Project Director J Heeger - Aviation Advisor B Ndayi - Project Manager	Professional advice, guidance and support to the Municipality
KZN Regional Technology Hubs	Four (4) Techno Hubs in KZN, Port Shepstone Pietermaritzburg Newcastle Richards Bay	Development of 4 Technology Hubs at these locations. Project will attract investors with innovative and technology driven businesses	KZN Treasury and Department of Science and Technology	R120 Mil	19	36 Months	N/A	Mar 2015	Mar 2018	B Karstadt - Project Director R Best - Project Manager E Agnew - Project Manager J Heeger - Strategic Planner R Smorfitt - Business / Investment G le Roux - Architect A Adebayo - Architect / Urban Design V Davies - Electrical Engineer T Chetty - Civil / Structural Engineer M Sibeko - Supply Chain Management P Serote - Financial Services G Oldham - Economist	Project Management, Strategic Planning, Operations and Maintenance, Investment Advice, Professional Technical Services for the Built Environment Urban Design and Architectural Concepts

Appendix B: Government Notice No 320 of March 2020.

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CIVIL AVIATION

PROTOCOL FOR THE SPECIALIST ASSESSMENT AND MINIMUM REPORT CONTENT REQUIREMENTS FOR ENVIRONMENTAL IMPACTS ON CIVIL AVIATION INSTALLATIONS

1. SCOPE

This protocol provides the criteria for the specialist assessment and minimum report content requirements for impacts on civil aviation installations for activities requiring environmental authorisation. This protocol replaces the requirements of Appendix 6 of the Environmental Impact Assessment Regulations[1].

The assessment and reporting requirements of this protocol are associated with the level of sensitivity identified by the national web based environmental screening tool (screening tool).

The screening tool can be accessed at: https://screening.environment.gov.za/screeningtool.

2. SITE SENSITIVITY VERIFICATION AND MINIMUM REPORT CONTENT REQUIREMENTS

Prior to commencing with a specialist assessment, the current use of the land and the potential environmental sensitivity of the site under consideration as identified by the screening tool must be confirmed by undertaking a site sensitivity verification.

2.1. The site sensitivity verification must be undertaken by an environmental assessment practitioner or specialist with expertise in radar.

2.2. The site sensitivity verification must be undertaken through the use of:
(a) a desk top analysis, using satellite imagery;
(b) a preliminary on-site inspection; and
(c) any other available and relevant information.

2.3. The outcome of the site sensitivity verification must be recorded in the form of a report that:
(a) confirms or disputes the current use of the land and environmental sensitivity as identified by the screening tool, such as new developments or infrastructure etc.;
(b) contains a motivation and evidence (e.g. photographs) of either the verified or different use of the land and environmental sensitivity; and
(c) is submitted together with the relevant assessment report prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.

3. SPECIALIST ASSESSMENT AND MINIMUM REPORT CONTENT REQUIREMENTS

TABLE 1: ASSESSMENT AND REPORTING OF IMPACTS ON CIVIL AVIATION INSTALLATIONS
1. General Information 1.1. An applicant intending to undertake an activity identified in the scope of this protocol for which a specialist assessment has been identified on the screening tool: 1.1.1. on a site identified as being of:

[1] The Environmental Impact Assessment Regulations, as promulgated in terms of Section 24 (5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998).

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1.1.1.1. "very high", "high" or "medium" sensitivity for civil aviation, must submit a Civil Aviation Compliance Statement; or

1.1.1.2. "low" sensitivity, no further assessment requirements are identified.

1.1.2. on a site where the information gathered from the site sensitivity verification differs from the designation of "very high", "high" or "medium" sensitivity on the screening tool and it is found to be of a "low" sensitivity, no further assessment requirements are identified;

1.1.3. similarly, on a site where the information gathered from the initial site sensitivity verification differs from the designation of "low" sensitivity on the screening tool and it is found to be of a "very high", "high" or "medium" sensitivity, a Civil Aviation Compliance Statement must be submitted; and

1.1.4. If any part of the proposed development footprint falls within an area of "very high", "high" or "medium" sensitivity, the assessment and reporting requirements prescribed for the "very high", "high" and "medium" sensitivity apply to the entire footprint. In the context of this protocol, development footprint means the area on which the proposed development will take place and includes any area that will be disturbed.

VERY HIGH SENSITIVITY RATING - high likelihood for significant negative impacts on the civil aviation installation that cannot be mitigated. In-depth assessment of the potential impacts are likely to be required before development can be considered in these areas.	2. Civil Aviation Compliance Statement 2.1. The compliance statement must be prepared by an environmental assessment practitioner or a specialist with expertise in radar. 2.2. The compliance statement must: 2.2.1. be applicable to the preferred site and the proposed development footprint; 2.2.2. confirm the sensitivity rating for the site; and 2.2.3. indicate whether or not the proposed development will have an unacceptable impact on civil aviation installations. 2.3. The compliance statement must contain, as a minimum, the following information: 2.3.1. contact details of the environmental assessment practitioner or the specialist, their relevant qualifications and expertise in preparing the statement, and a curriculum vitae; 2.3.2. a signed statement of independence by the environmental assessment practitioner or specialist; 2.3.3. a map showing the proposed development footprint (including supporting infrastructure) overlaid on the civil aviation sensitivity map generated by the screening tool; 2.3.4. a comment, in writing, from the South African Civil Aviation Authority (SACAA), which may include inputs from the Obstacle Evaluation Committee (OEC), if appropriate, confirming no unacceptable impact on civil aviation installations; and 2.3.5. should the comment from the SACAA indicate the need for further assessment, a copy of the assessment report and mitigation measures is to be attached to the compliance statement and incorporated into the Basic Assessment Report or Environmental Impact Assessment Report with mitigation and monitoring measures identified included in the EMPr. The assessment must be in accordance with the requirements stipulated by the SACAA.
HIGH SENSITIVITY RATING – potential for negative impacts on the civil aviation installation that can potentially be mitigated. Further assessment may be required to investigate potential impacts and mitigation measures.	
MEDIUM SENSITIVITY RATING - low potential for negative impacts on the civil aviation installation, and if there are impacts there is a high likelihood of mitigation. Further assessment of the potential impacts may not be required.	

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	2.4. A signed copy of the compliance statement must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.
LOW SENSITIVITY RATING - No significant impacts on the civil aviation installation are expected in low sensitivity areas. It is unlikely for further assessment and mitigation measures to be required.	No requirement identified.

Appendix C: FAA Methodology for Risk Assessment of Solar PV Facilities close to Airports (summary).

For proposed projects off, but close to airport property, the methodology considers to three key questions:

Does the project height penetrate airspace ?

The FAA has certain criteria to determine this, but in the SA scenario we substitute ICAO Annex 14 and any additional provisions of the SACAA Regulations, where these are more onerous. This would typically involve a desktop analysis of the aerodrome or airfields closest to the project site – in this case only FASS. Airfields further than 8km away are generally not affected, unless approach or departure corridors pass directly over the site and there are precision navigation approaches in play, where aircraft have very 'flat' approach paths. (There might be military considerations here, too, but these in fact are excluded from the provisions of the DFFE Protocol).

Is the Project Design/Orientation likely to cause reflectivity concerns ?

For solar PV projects consideration is given to 'glint' and 'glare' issues that might cause 'flash blindness' arising from both specular and diffused reflections. Obviously this is important for solar PV projects, but for the other proposed facilities it may be necessary to consider any potential effects of construction materials (roof) and other potentially reflective components.

Depending on the proposed site layout, a geometric analysis based on the changing azimuth and bearing of the sun through the year, at key times during the day where air traffic is likely to be impacted, is sufficient for this purpose.

Is the Project likely to Interfere with Communications Systems, Operations and/or Flight Standards/Procedures

While the DFFE Protocol refers specifically to 'radar', the FAA precedent document also looks at potential interference on all types of communications equipment, which is prudent. Thus, consideration is given to, inter alia:

- Location of radar facilities
- Location of Control Tower(s)
- Location of (remaining) ground based NDB's (since these are being phased out)
- Location of VOR/DME installations

that could be affected by the potential of the project (or key components thereof) to generate EM radiation that could perhaps affect these. Based on FAA guidelines, these distances are generally quite small, and are not usually a cause for concern.

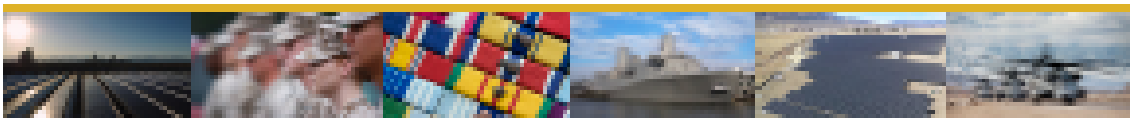
Finally, as part of the 'operational' aspect, a review would be undertaken of existing flight corridors, RNAV and VFR routes, approaches in the area and published airport/airfield procedures, circuits, etc., to assess the potential of the proposed project to negatively impact on any of these at a material risk level i.e.

more severe than 'low'. If so – and only in such case – would the matter need to be escalated to the SACAA for further analysis or review, in terms of the DFFE Protocol.

Reference Material on FAA Distance Guidelines for siting of PV Infrastructure

REPO

greenfleet.dodlive.mil/energy/repo



Electro-Magnetic Interference from Solar Photovoltaic Arrays

While the risk of electro-magnetic and/or radar interference from PV systems is very low, it does merit evaluation, if only to improve the confidence of site owners and other stakeholders.

Electro-Magnetic Interference

Electro-magnetic interference (EMI) is typically taken to mean radiofrequency (RF) emissions emanating from PV systems impacting nearby radio receivers, but can also include interference with communication devices, navigational aids, and explosives triggers.

The Federal Aviation Administration (FAA) has indicated that EMI from PV installations is low risk. PV systems equipment such as step-up transformers and electrical cables are not sources of electromagnetic interference because of their low-frequency (60 Hz) of operation and PV panels themselves do not emit EMI. The only component of a PV array that may be capable of emitting EMI is the inverter. Inverters, however, produce extremely low frequency EMI similar to electrical appliances and at a distance of 150 feet from the inverters the EMI field is at or below background levels. Also proper inverter enclosure grounding, filtering, and circuit layout further reduce EMI radiation.

Photovoltaic inverters are inherently low-frequency devices that are not prone to radiating EMI. No interference is expected above 1 MHz because of the inverters' low-frequency operation. In addition, interaction at lower frequencies (100 kHz to 1 MHz) is also very low risk because of the poor coupling of these extremely long wavelengths to free space, limiting propagation of the signal.

Additionally, the Code of Federal Regulations, Title 47, Part 15 regulates radio frequency (RF) emission from commercial products and many PV inverter manufacturers do qualify their residential or utility-scale equipment to this standard.

Radar Interference

Another concern is blocking or attenuation of nearby radar by the PV array, which are similar to other non-transmitting built structures like building or sheds in that they are constructed of metal and glass.

PV arrays have low profiles (i.e. height) relative to most built structures that may be found on or around airfields and in general airport radar systems (e.g., airport surveillance radar) are installed on elevated platforms or towers. The FAA has published a number of case studies that indicate that a setback of 200' to 600' between the leading edges of a PV array and existing radar equipment is sufficient to prevent blocking and/or signal reflection issues.

Siting Considerations

When considering sites for a PV array in close proximity to airfield navigational instruments or communications the tolerance of the equipment to EMI and susceptibility to radar signal blocking/attenuation should be considered. Fortunately, both of these concerns have been researched and vetted by the FAA and industry, and the following specifications should be applied:

1. PV system inverters should be sited at least 150' away from navigational and communications equipment that may be sensitive to EMI.
2. A minimum setback distance of 200' should be imposed between an airfields radar system and the leading edge of a PV array or any of its ancillary support equipment.

In the unlikely event that a PV array was to be built within the EMI setback distance, options are available to address interference if it were to occur. Inductor-capacitor (LC) filters can be installed to attenuate RF emissions at specific frequencies causing undesired interaction. Grounding of PV conduction either directly or via the inverter can also attenuate undesired RF emissions.

Additional Considerations

Where the FAA has identified interactions between PV systems and aircraft communication, this was often due to the prototype nature of the PV equipment in question. Some power electronics equipment operates at a higher frequency than we have discussed so far. This can be because the inverter uses advanced wide-bandgap semiconductors such as Silicon Carbide (SiC) or Gallium Nitride (GaN). Alternatively, the power electronics could be embedded within the PV module, which can enable or require a high switching frequency. In either case, these types of power conversion devices should be assessed for compliance with FCC emission limits, just as a conventional PV inverter would be.

As an illustration of the relatively low allowable FCC limits, we can compare the maximum emission allowed for a FCC class-A compliant inverter with a typical cell phone. The maximum expected field strength for this inverter at a distance of 100'is very low—comparable to the field strength of a cell phone a mile away, and unlikely to be distinguishable from background noise.

In conclusion, with diligent procurement and siting of PV system components, including specifications for FCC Part 15-compliant equipment and observation of minimum setbacks from potentially sensitive equipment, it is unlikely that a PV system will cause negative interactions with existing equipment or operations.

"Due to their low profiles, solar PV systems typically represent little risk of interfering with radar transmissions. In addition, solar panels do not emit electromagnetic waves over distances that could interfere with radar signal transmissions, and any electrical facilities that do carry concentrated current are buried beneath the ground and away from any signal transmission" – FAA Solar Guide.

"Prior research and field investigations of electromagnetic emission (EME) from Solar PV arrays concluded that they produce extremely low frequency EME similar to electrical appliances and wiring. ...At a distance of 150 feet from the inverters, these fields dropped back to very low levels of 0.5 mG or less, and in many cases to much less than background levels (<0.2 mG)" – Air Force Tiger Team Investigation.

Useful References

1. Air Force Civil Engineering Center, Planning and Integration Directorate, Regional Planning Development Branch. 2014. Solar PV Compatibility Project Tiger Team.
2. Federal Aviation Administration (FAA). 2010. Technical Guidance for Evaluating Selected Solar Technologies at Airports. FAA Office of Airports, Washington, DC. https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf.
3. Aranez, R, S. Lammens, M. Grassi, and S. Bertone, S. 2009."EMC issues in high-power grid-connected photovoltaic plants,"IEEE Transactions on Electromagnetic Compatibility, 51(3), 639-648.
4. Di Piazza, MC., G. Tine, C. Serporta, and G. Vitale. 2004. "Electromagnetic compatibility characterization of the DC side in a low power photovoltaic plant,"In Proc. IEEE Int. Conf. Ind Tech., pp. 670-6.

contact information
For more information, contact Chris Delme, Sr. Engineer, chris.delme@nrel.gov, 303-384-6356 or Steven Phillips, Project Manager, steven.j.phillips@navy.mil, 619-532-1096.

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