



# Sustainable Development in Mining Communities: The Case of South Africa's West Wits Goldfield

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There is a significant role for the mining and minerals industry to play in achieving the Sustainable Development Goals (SDGs) at a global level, through supplying the raw materials needed for technological progress, human development and cleaner economic growth, and at a local level, through socio-economic development and support, environmental protection, and good governance. While mining companies support the SDGs at the corporate level, there is a lack of evidence to show whether they are being implemented at the mine site level. There is also a lack of clarity on who the mine host communities are and what happens to the SDGs commitments after mine closure. The aim of this study was to identify all the host communities in the West Wits goldfield in South Africa and measure a comprehensive set of local SDG indicators, to explore the local variations that are hidden at national and municipal level, and the implications for communities achieving the SDGs in the context of mine closure. The West Wits is home to over 300,000 people living in 47 diverse communities—towns, mine villages, townships, informal settlements, industrial areas and rural areas. While 23 local SDG indicators were selected, only 13 indicators across 8 SDGs could be measured using census data. The findings show significant inequality between communities and deprivation in many communities, particularly the informal settlements. There are low levels of education, internet access and employment across the communities, indicating high vulnerability to mine closure. Without major intervention the SDGs will not be met by 2030 and thousands of people in these communities will be left behind. This is even more concerning given the majority of mines are expected to close in the next 10–20 years and the local economy in the West Wits is largely reliant on mining. Achieving the SDGs will require collaboration between multiple mining companies, local government authorities, civil society and communities, and significant urgent interventions on education and skills development, internet access and employment creation beyond the mining industry.

**Keywords:** Sustainable Development Goals, indicators, South Africa, mine closure, SDG localization, mining communities, community well-being

## INTRODUCTION

The global “Agenda 2030 for Sustainable Development” and its Sustainable Development Goals (SDGs) were developed through a three-year international process that engaged stakeholders from national governments, multilateral organizations, academia, civil society, and the private sector. They were adopted by the 193 countries of the United Nations (UN) General Assembly

in September 2015 and represent an unprecedented global commitment to poverty alleviation, environmental protection, equality, peace and justice (UN General Assembly, 2015). The 17 SDGs are wide-ranging and address environmental, social and economic challenges through 169 targets and 251 global indicators (UN Statistical Commission, 2020). As the SDGs are global goals, work is ongoing around the world to adapt them to the national and local levels (local2030.org), which involves adding indicators and refining existing indicators. Whilst overall responsibility lies with national governments, the SDGs cannot be achieved without a collective, collaborative and coordinated efforts by public and private parties (Yakovleva et al., 2017).

There is a significant role for the mining and minerals industry to play in achieving the SDGs by providing raw materials for technological progress, economic growth and human development (Vidal et al., 2013; Elshkaki et al., 2016), by paying royalties and taxes which support national government efforts, by providing employment, infrastructure and corporate social investment, and by operating sustainably and avoiding negative social, environmental and governance impacts (CCSI et al., 2016; ICMM, 2018; Mancini and Sala, 2018; Sturman et al., 2018; Fraser, 2019). Over the past two decades, demand for the major metals has increased (Luckeneder et al., 2021) and it is expected to continue to grow to 2050, particularly for the critical metals necessary for the clean energy transition (Elshkaki et al., 2018; Watari et al., 2020; Bainton et al., 2021). The Yale Major Metals scenarios show that the greatest demand will occur if the world follows an equitable track—ensuring that developing countries achieve economic growth and a better standard of living (Elshkaki et al., 2018). Thus, achieving the SDGs will require a significant increase in mining for numerous metals. The new orebodies are likely to be deeper, lower grade and more remote or on more sensitive land, require greater energy and water, and produce more waste (Bainton et al., 2021). Thus, they could also hinder the achievement of the SDGs and environmental, social and governance (ESG) issues will be of great importance when designing, planning and operating these mines (Lèbre et al., 2020).

Mining companies often spend significant resources at the local level where their mines sites operate for long periods of time, they can therefore make a big contribution to local development. There are many examples of mining companies creating shared value for themselves and their host communities, contributing to achieving the SDGs (Brink and Pienaar, 2007; CCSI et al., 2016; Yakovleva et al., 2017; Broadhurst, 2019; Moomen et al., 2019; Kumi et al., 2020; World Gold Council, 2020). Since the inception of the Mining and Metals for Sustainable Development initiative in the late 1990s, there has been a proliferation of sustainability initiatives in the mining industry (Sturman et al., 2018), and the SDGs provide an opportunity for mining companies to align their strategy, incentive mechanisms and interventions to national and sub-national priorities (Maennling and Correa, 2020). The SDG indicators are useful for assessing baseline needs of mining communities, tracking performance over time, measuring the impact of interventions by mining companies and the effectiveness of government policy interventions (Maennling et al., 2019; Cole and Broadhurst, 2021). All the

major mining companies have committed to supporting the SDGs, and although companies are increasingly aligning their sustainability reporting with the SDGs, they often highlight the positive contributions while omitting any negative impacts that would hinder progress toward the SDGs (Responsible Mining Foundation, 2020).

South Africa has been a leader in reporting on the MDGs and SDGs, despite facing significant challenges to “leave no-one behind”, being one of the most unequal countries in the world (StatsSA, 2019a). At the local level there is huge variation in levels of well-being, access to services and public goods (Cole et al., 2017, 2018). Mining has played a fundamental role in South Africa’s economic development, starting with the diamond rush to the Kimberley area in 1870 and the gold rush to the Witwatersrand in 1886, which led to massive immigration, urbanization, capital investment and labor migration (Bundy and Cobbing, 2019). Today South Africa is a leading global producer of platinum group metals, chromium, manganese, vanadium, gold, coal, iron ore and several other metals and minerals (Yager, 2021). Over 90 cities, towns, and villages in South Africa host 198 large-scale mines, situated within a quarter of the country’s local municipalities (Cole and Broadhurst, 2021).

Due to the mining industry’s role in the historic racial inequality and the development of the migratory labor system, seen as a key component of the oppressive apartheid system (IRR, 2014), mining companies in South Africa are required to share the benefits of mining with mine employees and mining communities (DMR, 2010). The Mineral and Petroleum Resources Development Act (MPRDA) of 2002 (Republic of South Africa, 2002) is effected through the Mining Charter (DMR, 2018), the Guideline for Implementation of a Social and Labor Plan (DMR, 2010) and Housing and Living Conditions Standard (DMR, 2019). If these are properly implemented, they will contribute to achieving several SDG targets, particularly adequate housing (SDG 11.1), access to electricity (SDG 7.1), piped water (SDG 6.1), sanitation (SDG 6.2), roads (SDG 9.1), healthcare services (SDG 3.8) and sufficient, balanced nutrition (SDG 2.1). Mining itself contributes to decent work (SDG 8) and reducing poverty (SDG 1) while mining companies’ local economic development projects and Corporate Social Investment programmes generally focus on health (SDG 3), education (SDG 4), skills development and job creation (SDG 8), and fostering local enterprise and economic diversification (SDG 8) (Hamann, 2004).

The aim of this study was to identify all the host communities in the West Wits goldfield in South Africa and measure a comprehensive set of relevant SDG indicators, to explore the local variations in well-being that are hidden at national and municipal level, and the implications for communities achieving the SDGs in the context of mine closure. Section The West Wits Goldfield describes the history of mining and communities in the West Wits goldfield in South Africa, situated on the Witwatersrand Basin, which is facing mine closure. Section Methodology describes the methods used for identifying the 47 communities that surround the mines and are home to over 300,000 people who live in towns, mine villages, townships, informal settlements, industrial areas and rural areas. It describes

the identification of 23 relevant SDG indicators and the selection of 13 indicators from SDG 1, SDG 3, SDG 4, SDG 6, SDG 7, SDG 8, SDG 11 and SDG 17 that could be measured using census data. Section Results presents the results of the data collection and analysis which are described, summarized and visualized in radar plots or “barometers for well-being”. Section Discussion discusses the results considering local SDG indicators and data, the challenges in defining mining host communities, and the risks and opportunities related to mine closure.

## THE WEST WITS GOLDFIELD

### Mining History of the West Wits

South African gold mining is located in the Witwatersrand Basin, the world’s largest goldfield which stretches in an arc over 400 km and has seven discrete gold fields, 98 gold-bearing reefs and has been mined at over 146 mines since 1886 (Tucker et al., 2016). These mines have produced more than 52,000 tons of gold, more than a third of all gold globally (Tucker et al., 2016). Gold mining was initially focused on the Central Rand and West Rand, and later the East Rand, and rapid population growth led to the establishment of the towns of Johannesburg, Krugersdorp, Randfontein and Roodepoort in the 1880s (Winde and Stoch, 2010). The huge demand for labor led the gold mining companies to form the Native Recruiting Corporation in 1912 that recruited black workers from across southern Africa (Bezuidenhout and Buhlungu, 2010). In the 1930s, mining extended further southwest to Klerksdorp and the West Wits (also called the Far West Rand), southwest of Randfontein (see **Figure 1**). The West Wits goldfield hosts the deepest mines in the world reaching depths of 4 km (Tucker et al., 2016) and at their peak, were the richest gold mines in the world (van Eeden, 1997; Winde and Stoch, 2010).

The first geological survey of the West Wits was done at Doornfontein in 1932 and proved the continuity of the central Witwatersrand Main Reef and the presence of a new high-grade reef, dubbed the Carbon Leader. **Figure 2** shows a timeline of mining operations on the West Wits, based on a literature review of mining company reports and academic papers. Shaft sinking began at Venterspost shaft in 1934 and Libanon shafts in 1936 and 1939 (now part of Kloof Gold Mines) and continued for decades in the area (Gold Fields, 2009a). Rand Mines registered the Blyvooruitzicht Gold Mining Company in June 1937, began production in 1942 and soon became the most profitable mine in the world with very high *in situ* grades (Blyvoor Gold, 2022). The Blyvooruitzicht uranium pilot plant came into operation in 1949 (Ford, 1993). In 1945 the West Driefontein Mining Company sunk two shafts and started milling in 1952 (Gold Fields, 2009a) while during the 1950s Doornfontein 1 Shaft was developed. In 1957 Anglo American opened three new mines—Deelkraal and Elandsrand (now called Kusasaletu and owned by Harmony) and Western Deep Levels (later called Savuka and owned by AngloGold Ashanti). Two more Blyvooruitzicht shafts were sunk in 1960, and in 1961 Western Areas Gold Mine (later South Deep) began production and Cooke Gold Mine was established. Elsburg Gold Mine (now South Deep) opened in 1965, Kloof Gold Mine in 1968 (Gold Fields, 2009b) and East Driefontein in 1972. Further shafts were sunk and gold processing plants

were established in the area in the 1970s and 1980s, including TauTona in 1981. Leeudoorn shaft (Kloof) and the Mponeng mine both opened in 1993. South Deep completed a new shaft and commissioned a new gold plant in 2002 and converted from conventional to mechanized mining in 2009, the first to do so in the area. All the gold doré from these mines is sent to the Rand Refinery in Germiston, which was established in 1920 by the Chamber of Mines South Africa (Rand Refinery, 2020).

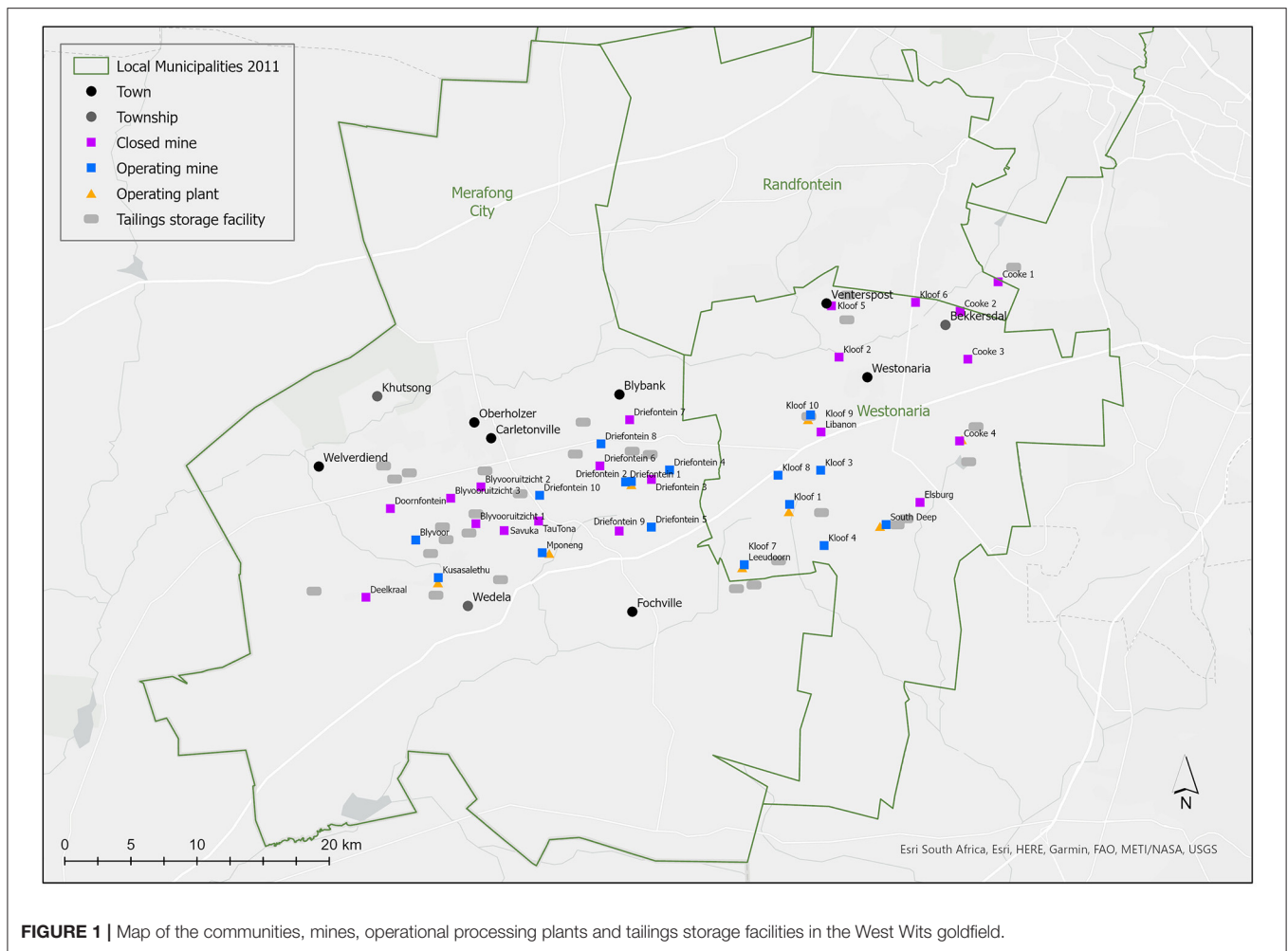
To support the rapidly developing mining industry, new (open<sup>1</sup>) towns were proclaimed—West Wits in 1937, Venterspost in 1937, Westonaria in 1938, Oberholzer in 1939, Bank in 1940, Welverdiend in 1942, Blybank in 1947 and Carletonville in 1948—though Bank did not survive due to the problem of sinkholes (van Eeden, 1997). The first township<sup>2</sup>, Bekkersdal, was established in 1945 to house black African workers followed by Khutsong in 1958 and Wedela in 1978. Bekkersdal expanded significantly in the 1990s through informal settlements, which now house two thirds of residents (Lieverink et al., 2017). From the 1950s, mining companies built mine villages adjacent to the new mines to house white mine workers in mine houses and black workers in compounds or hostels. Unlike the towns, these villages were for mine employees only and consisted solely of houses and hostels and sports and recreation facilities. In 1952 the Westonaria municipality was declared and in 1959 the Carletonville municipality was declared, incorporating towns and the mine villages (Van Eeden et al., 2003). Population growth in the Far West Rand area was rapid, from 34,963 in 1951 to 82,886 in 1960 (Central Statistical Service, 1988), to 313,075 in 1996 (StatsSA, 1998). The only town in the Far West Rand that was not developed to serve the mining industry is Fochville (established as an agricultural center in 1920) and its associated townships Kokosi and Green Park.

### Far West Rand Today

Today, the gold mines and processing plants of the West Wits, and their associated communities, shown in **Figure 1** are located in the highly urbanized Merafong City Local Municipality (LM) and Rand West City LM (formerly Westonaria LM and Randfontein LM) in the south-west corner of the Gauteng province, South Africa’s industrial and financial hub. They are operated by the international mining companies Sibanye-Stillwater, Gold Fields and Harmony, while DRDGold operates tailings treatment at the Far West Gold Recoveries (FWGR). The most recent mine development is the acquisition of Blyvoor Gold Mine (previously Blyvooruitzicht Shaft 5) in 2016 by Blyvoor Gold to bring the underground and tailings retreatment operations back into production. As shown in **Table 1**, these five companies employ over 40,000 employees, 82% of whom are permanent employees, and have a combined life of mine of 181 years, though this ranges from three years for Kusasaletu to 84 years for South Deep. A recent increase in the gold price has

<sup>1</sup>Unlike company towns which are only for mining employees, open towns have no restrictions.

<sup>2</sup>Townships are residential areas in South Africa typically designed as labor dormitories for black workers during Apartheid, with “matchbox houses” and grid-like dusty streets (Bezuidenhout and Buhlungu, 2010).



seen gold being extracted from old waste rock dumps and tailings storage facilities (TSF) by Harmony and Sibanye-Stillwater.

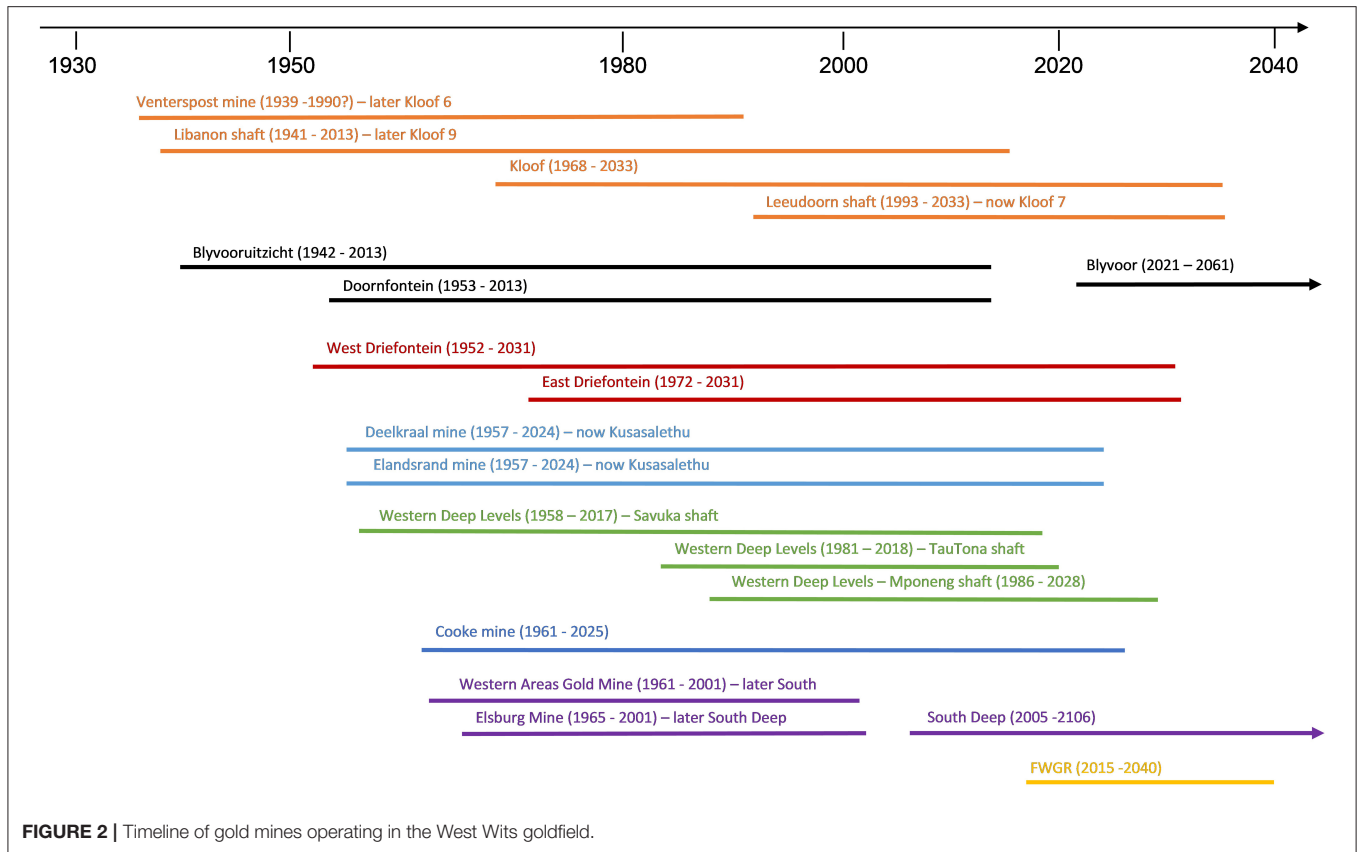
More than half of permanent employees are housed in mine accommodation (single quarters, family units, company houses) and more than a third receive a living-out allowance (Sibanye-Stillwater, 2017a,b; Harmony, 2018; AngloGold Ashanti, 2019). Gold mining in South Africa has always attracted foreign workers, and in 2011, 10% of residents in the Far West Rand were born in other Southern African Development Community (SADC) countries (StatsSA, 2012). Mining also leads to internal migration from other provinces and in 2011 only 47% of residents in the Far West Rand were born in Gauteng, while 15% were born in the Eastern Cape and 9% in the North West province (StatsSA, 2015). The main labor sending areas are the provinces of Gauteng, Eastern Cape, North West and KwaZulu Natal and the neighboring countries Lesotho and Mozambique, however, the Eastern Cape is the focus of local economic development (LED) projects in mining company Social and Labor Plans. In the last decade, mining companies have spent over R150 million on LED projects in the West Wits and the Eastern Cape (see **Supplementary Table S1**). Up to 58% of mine workers are in unskilled jobs which has a significant impact on their ability to find a job if/when the mine closes.

### Mine Downscaling and Closure

Gold mining in South Africa peaked in the 1980s and mine closure in the Johannesburg area was a gradual process stretching over decades (in the late 1900s) as different mines closed down based on their profitability (Winde and Stoch, 2010). These mine closures in the Central, East and West Rand have not had a significant impact on the local economy as they have been based in major cities (Johannesburg and Ekurhuleni) which have transitioned over decades from reliance on mining to manufacturing and services, and industrial areas like the Vaal Triangle south of Johannesburg (the cities of Vereeniging, Vanderbijlpark and Sasolburg). The Far West Rand is different as it is dominated by small towns and mine villages and mining is the biggest contributor to economic activity (72% in 2014 in Westonaria LM) (Rand West City Local Municipality, 2016) and employment (19% in Westonaria LM in 2014 and 25% in Merafong City LM in 2016) (StatsSA, 2016a). As mines downscale and close, those who can find work elsewhere can move to the nearby cities. Those who remain face a contracting local economy with fewer jobs and services.

Gold production in the Far West Rand has been in decline in the past two decades, with production stopping at three





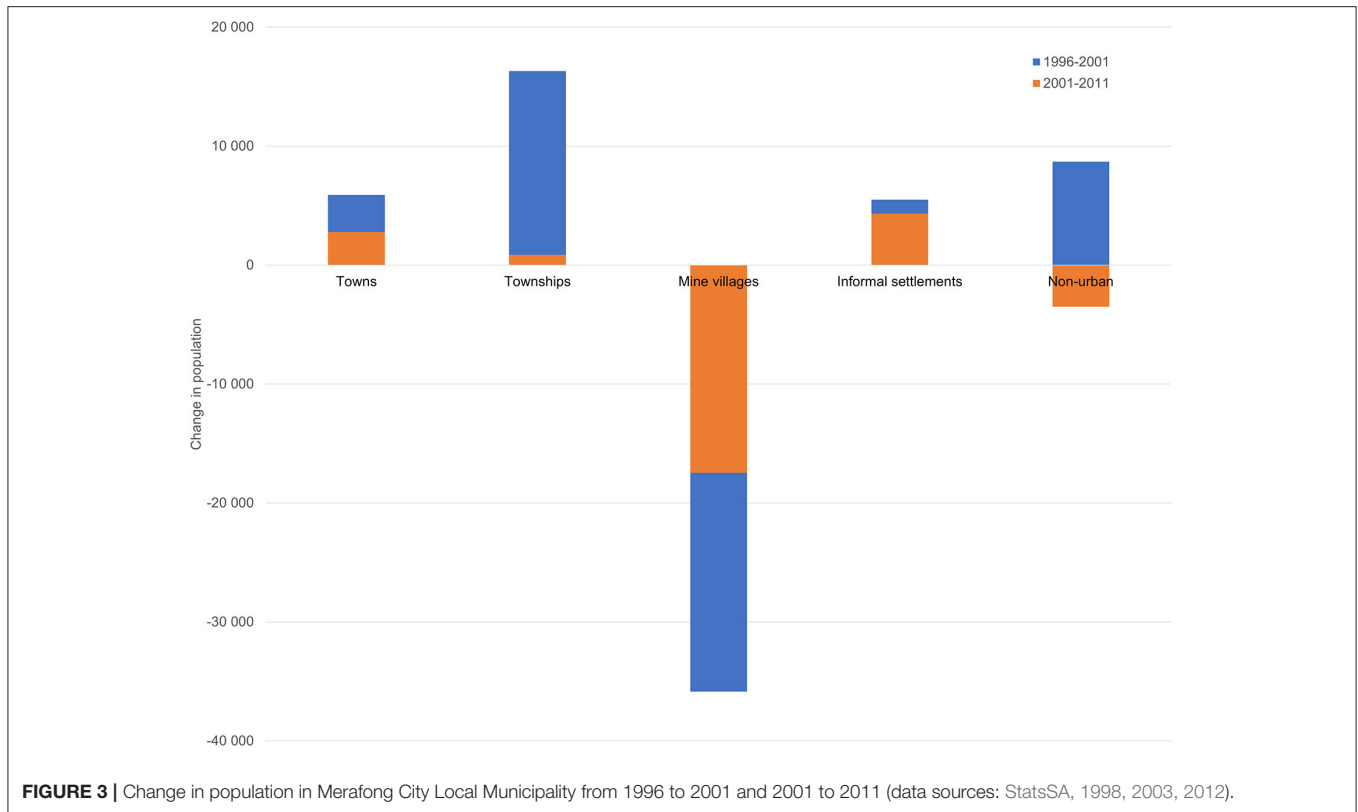
**FIGURE 2 |** Timeline of gold mines operating in the West Wits goldfield.

**TABLE 1 |** Summary of current mining operations and employees in the West Wits (Gold Fields, 2017, 2021; Sibanye-Stillwater, 2017a,b, 2022; Harmony, 2018, 2021; AngloGold Ashanti, 2019; Blyvoor Gold, 2022).

Company	Mine	Processing plants	Permanent employees	Contractors	Life of Mine
Harmony	Kusasaletu (2 shafts)	Kusasaletu	3,764	496	2024 (2 years)
	Mponeng (1 shaft)	Mponeng	4,650	658	2028 (6 years)
Sibanye-Stillwater	Driefontein (5 shafts)	Driefontein 1	10,941	2,141	2031 (9 years)
	Kloof (5 shafts)	Kloof 1	9,858	1,438	2032 (10 years)
	Cooke surface	Kloof 2	855	60	2025 (3 years)
DRDGold	Far West	Driefontein 2	~318	~613	2040 (18 years)
	Gold Recoveries (1 tailings dam)				
Gold Fields	South Deep (twin shaft)	South Deep	2,342	1,801	2106 (84 years)
Blyvoor Gold	Blyvoor (1 shaft, 1 tailings dam)	Blyvoor	600	0	2061 (49 years)
Total			33,319	7,207	181 years

Blyvooruitzicht shafts in 2012/3 due to financial difficulties (partly due to a low gold price), and some Driefontein shafts, the Cooke shafts and TauTona and Savuka reaching the end of their life of mine. This resulted in a significant drop in the labor force of over 20,000 workers and a decrease in the total population from 319,803 in 2001 (StatsSA, 2003) to 309,903 in 2011 (StatsSA, 2012) and 297,745 in 2016 (StatsSA, 2016b). **Figure 3** shows how the population has changed in the different types of communities in Merafong City LM from 1996 to 2001 and then

to 2011, with the mine villages seeing a huge drop and the townships and informal settlements seeing the greatest increase in population. This shift from mine villages to other communities is partly due to the Mining Charter requirement that mining companies improve the standard of mine housing, including the conversion of hostels to single-room apartments and family units, living-out allowances and the promotion of home ownership options for mine employees (IRR, 2014). These measures have probably contributed to the development of informal settlements



around the mines as some mine workers opt for the cheapest accommodation available, sending home as much money as they can to their families (IRR, 2014; Marais et al., 2018b; Cloete and Marais, 2021). The growth in informal settlements is also due to the growth in contract workers in mining, which has meant that many people have moved to mining areas seeking employment (IRR, 2014; Lieferink et al., 2017). Contract workers fall outside the mine housing support programmes, although they may be supported through the SLP programmes if they live in deprived areas. The national government has identified informal settlements as the biggest challenge around mining towns (Manenzhe, 2018).

## METHODOLOGY

### Identifying the Communities

This work builds on previous work (Cole and Broadhurst, 2020, 2021) done to understand and measure the SDGs in mining host communities across South Africa. The communities were identified based on a literature review of the history of gold mining in the area (described in Section The West Wits Goldfield), an analysis of the 2011 national census main places and sub places defined by Statistics South Africa (StatsSA) and their key demographics, shown in Table 2, and an exploration of the area in Google maps, shown in Figure 4. The community boundaries were defined by the “main place” boundaries drawn by StatsSA for the 2011 census. Main places are small towns, rural villages, townships and suburbs in large towns and cities.

They are often subdivided into “sub places”, which can be specific areas like mines, compounds and nature reserves. The identified communities are summarized in Table 3 where they are categorized as towns, townships, informal settlements, mine villages, industrial areas or rural areas. Seven small towns have the highest percentage of white people (43%), the historically advantaged population, and house 17% of the total population. Six non-white townships are home to almost half the population and almost 12% of the population live in informal settlements. The 22 mine villages are located closest to the mines and are still male dominated (73%) as they accommodate many mine workers in single quarters or hostels. There are two small industrial areas—Nufcor, the site of an old uranium processing plant and its employee village owned by the Nuclear Fuels Corporation of South Africa, and Lenz, a military base—and a few agricultural holdings<sup>3</sup>, Dennydale, Kokrus, Ten Acre, Zuurbekom and Waterpan. These communities also have higher proportions of men than the towns and townships.

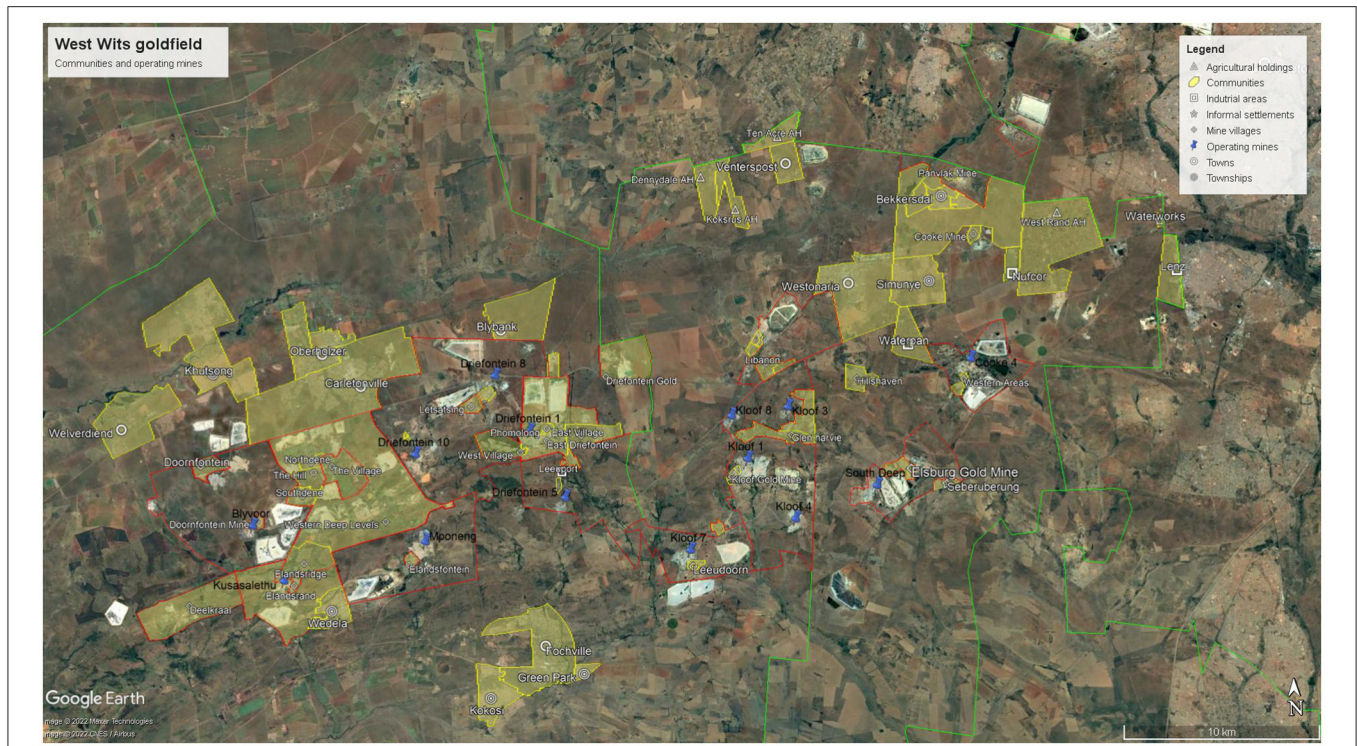
### Indicator Selection

All of the current global SDG indicators, the South African SDG baseline report (StatsSA, 2017) and the South African SDG Voluntary National Review Report (StatsSA, 2019a) were reviewed and those that are appropriate for the local level were identified. Twenty-three social, economic and environmental

<sup>3</sup>A portion of land not less than 1 morgen (8,565 m<sup>2</sup>) used for agricultural purposes.

**TABLE 2** | Communities in the Far West Rand according to Census 2011 (data source: StatsSA, 2015).

LM	Community	Type	Population in 2011	Gender (% male)	Associated mines
Merafong City	Carletonville	Town	19,840	50.5	
	Oberholzer	Town	5,397	49.4	
	Blybank	Town	3,160	55.8	
	Welverdiend	Town	2,708	49.9	
	Khutsong	Township	62,458	48.4	
	Doornfontein	Mine village	1,169	91.0	Doornfontein
	Southdene	Mine village	2,229	56.3	Blyvooruitzicht
	The Hill	Mine village	446	55.1	Blyvooruitzicht
	Northdene	Mine village	614	55.8	Blyvooruitzicht
	The Village	Mine village	698	62.5	Blyvooruitzicht
	Western Deep Levels Mine	Mine village	7,641	73.1	Savuka, TauTona
	Elandsfontein	Mine village	2,892	96.0	Mponeng
	Elandsridge	Mine village	2,490	54.6	Kusasaletu
	Elandsrand	Mine village	2,191	53.5	Kusasaletu
	Deelkraal	Mine village	1,530	92.7	Kusasaletu
	Wedela	Township	17,928	51.1	
	East Driefontein	Mine village	3,876	98.0	Driefontein
	Phomolong	Mine village	823	54.7	Driefontein
	East Village	Mine village	3,968	57.6	Driefontein
	West Village	Mine village	207	47.8	Driefontein
	West Driefontein	Mine village	2,857	57.0	Driefontein
	Letsatsing	Mine village	1,160	94.9	Driefontein
	Driefontein Mine	Mine village	99	87.5	Driefontein
	Leeuport	Informal settlement	5,494	57.0	
	Fochville	Town	9,497	48.5	
	Kokosi	Township	26,407	51.3	
	Greenspark	Township	2,587	50.0	
	Goudvlakte West	Farm	222	53.7	
	Merafong City Non-urban	Farms	6,932	62.2	
	Venterspost	Town	1,272	48.0	
	Westonaria	Town	10,259	50.1	
	Bekkersdal—old	Township	19,688	49.8	
	Bekkersdal—new	Informal settlement	26,511	52.4	
Simunye	Township	18,350	46.6		
Panvlak Mine	Mine village	504	83.4	Cooke	
Cooke Mine	Mine village	525	89.1	Cooke	
Western Areas Gold Mine	Mine village	1,895	77.5	Cooke	
Glen Harvie	Mine village	9,818	68.8	Kloof	
Hillshaven	Mine village	2,561	51.5	Kloof	
Leeudoorn Mine	Mine village	1,706	91.2	Kloof	
Libanon Mine	Mine village	3,124	68.1	Kloof	
Elsburg Gold Mine	Mine village	1,787	83.4	South Deep	
Seberuberung	Informal settlement	1,719	62.9		
Waterworks	Informal settlement	2,249	53.3		
Lenz	Industrial area	395	56.1		
Nufcor	Industrial area	166	48.2		
Waterpan	Agricultural holdings	445	55.0		
Zuurbekom	Agricultural holdings	6,207	53.2		
Koksrus	Agricultural holdings	152	60.0		
Dennydale	Agricultural holdings	340	54.9		
Ten Acre	Agricultural holdings	172	48.3		
Westonaria Non-urban	Farms	1,938	55.9		
Total			309,303	54	



**FIGURE 4 |** Satellite map of communities (yellow), operating mines (blue pins), mine areas (red borders) and local municipalities (green borders) in the West Wits goldfield (based on Census 2011).

**TABLE 3 |** Summary of communities (based on census main places) in the Far West Rand in 2011.

Types of community	Number of communities	Population		Male (%)	Race (% non-white)
		People	%		
Towns	7	52,133	16.9	49.8	57.2
Townships	6	147,418	47.7	49.0	99.8
Mine villages	22	56,810	18.4	73.2	90.3
Informal settlements	4	35,973	11.6	53.7	99.6
Industrial areas	2	561	0.2	53.7	88.5
Non-urban areas	5	16,408	5.3	54.2	92.1
<b>TOTAL</b>	<b>47</b>	<b>309,303</b>	<b>100</b>	<b>54.4</b>	<b>89.9</b>

Source data Census 2011 (StatsSA, 2015).

dimensions were identified within 15 SDGs and 20 SDG targets— income (SDG 1), household goods (SDG 1), food security (SDG 2), health (SDG 3), education (SDG 4), gender equality (SDG 5), water access (SDG 6.1), sanitation (SDG 6.2), water quality (SDG 6.3), electricity access (SDG 7.1), clean cooking fuel (SDG 7.1), employment (SDG 8), access to roads (SDG 9), income inequality (SDG 10), housing (SDG 11.1), access to transport (SDG 11.2), waste management (SDG 11.6), air quality (SDG 11.6), hazardous waste (SDG 12.4), climate-related disasters (13), safety (SDG 16) and internet access (SDG 17)—given in **Table 4**. One indicator was then selected for each dimension based on data availability and the South African Index of Multiple Deprivation, SAIMD (Wright and Noble, 2009). This created a list of 23 suitable local SDG indicators.

Ten of these indicators—including all the environmental ones—could not be measured due to the lack of local level data, despite there being comprehensive data collected by StatsSA and other government agencies for the national and provincial level (e.g., the Victims of Crime Survey, the National Food and Nutrition Security Survey, the National Household Travel Survey). Often environmental indicators are measured for biophysical rather than administrative regions (e.g., freshwater quality), are only reported for selected areas of interest or concern (e.g., air quality), or are only reported at the municipal level (e.g., wastewater treatment). The only indicator selected that is not an official SDG indicator is household goods, which is one of the 11 SAIMD indicators, and a useful proxy for measuring poverty. The SDG 1.2 poverty indicator used in



**TABLE 4 |** SDG indicators of well-being for mining host communities.

SDG	Dimension and SDG target	Indicator used in this study or proposed but lacking local data (in italics)
1 No poverty	Income (SDG 1.2)	% Households with income more than R19,600/year (estimated national poverty line)
	Household goods	% Households that own a refrigerator
2 Zero hunger	Food security (SDG 2.1)	% <i>Population who are undernourished</i>
3 Good health	Health	% Population without a disability
4 Quality education	Education (SDG 4.1)	% Adults (age 20 or older) with NQF4 qualification (Grade 12, NTC3) or better
5 Gender equality	Gender representation (SDG 5.5)	% <i>Ward councilors who are female</i>
6 Clean water and sanitation	Water access (SDG 6.1)	% Population with piped water in their dwelling or yard
	Sanitation (SDG 6.2)	% Population with access to a flush toilet or chemical toilet
	Water quality (SDG 6.3)	<i>Proportion of wastewater safely treated</i>
7 Affordable and clean energy	Electricity access (SDG 7.1)	% Population with access to electricity
	Clean cooking fuel (SDG 7.1)	% Population using clean cooking fuel
8 Decent work and economic growth	Employment (SDG 8.5)	% Labor force (including discouraged jobseekers) employed
	Youth employment (SDG 8.6)	% Youth (age 15–34) employed
9 Industry, innovation and infrastructure	Access to roads (SDG 9.1)	% <i>Rural population within 2 km of all-season road</i>
10 Reduce inequality	Income inequality (SDG 10.2)	% <i>Population living below 50% of median income</i>
11 Sustainable cities and communities	Housing (SDG 11.1)	% Population in formal housing
	Access to transport (SDG 11.2)	% <i>Population with access to public or private transport</i>
	Waste management (SDG 11.6)	% Population with refuse removal
12 Responsible consumption and production	Air quality (SDG 11.6)	<i>Annual mean levels of fine particulate matter, PM10</i>
	Hazardous waste (SDG 12.4)	<i>Hazardous waste generated per capita</i>
13 Climate action	Disasters (SDG 13.1)	<i>Number of people affected by disasters per 100,000 people</i>
16 Peace, justice and strong institutions	Safety (SDG 16.2)	% <i>Population who feel safe walking in their neighborhood in the day</i>
17 Means of implementation	Internet access (SDG 17.8)	% Population with access to internet

this study is based on (and limited by) the income brackets for annual household income used in the census, rather than the official upper-bound poverty line of R779 per person per

month (R9,348 per person per year) for the year 2011 (StatsSA, 2019b), which is not reported at the local level. The health indicator used in this study—per cent of population without a disability—is also not an official SDG indicator but it is meant to be measured as a disaggregation of all social indicators, where possible. It was chosen as local data is not available for the official SDG 3 indicators (e.g., maternal mortality rate, child mortality, HIV prevalence).

### Data Collection and Analysis

Main place and sub place data in StatsSA’s SuperCross Census 2011 Community Profile Database were obtained from DataFirst at UCT, which provides online access to household survey data in South Africa and Africa (StatsSA, 2015). In total, data were collected for 42 main places and 88 sub places in Merafong City LM and Westonaria LM, for the 13 indicators with available data shown in **Table 4**. The individual values for all except youth unemployment (as it is a subset of unemployment) were equally weighted and combined into an overall score to facilitate comparison between communities and community types. The data were plotted on radar plots to create “barometers of well-being” that both communicate the results more easily and facilitate comparison between communities. The comparison is as useful or more so than the individual barometers as it gives relative well-being and reduces the influence of the other circumstances on the analysis. These barometers measure progress from the center (zero) toward an acceptable target or social floor, on the outer ring of the plot (100%).

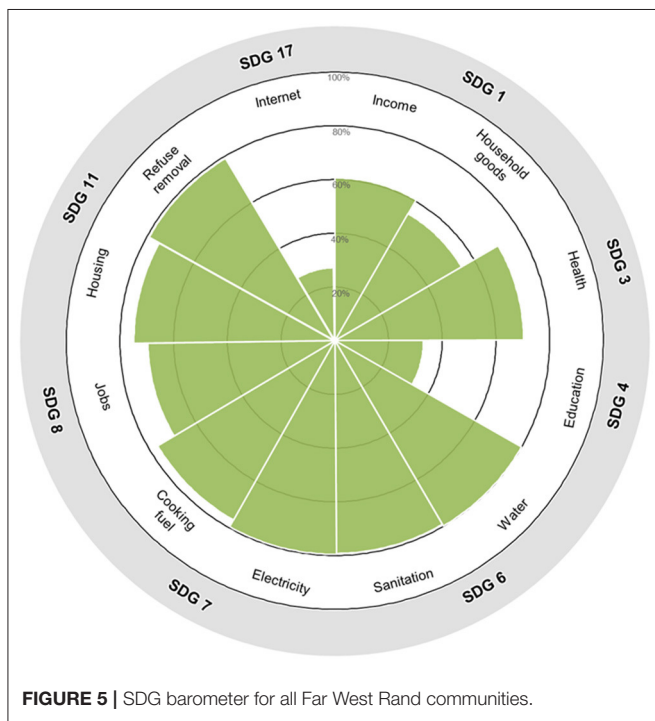
A limitation on the study was that the census does not include data on education, health, employment, income and internet access for collective living quarters and industrial areas because StatsSA uses a different, simpler census questionnaire for institutions (hospitals, prisons, care homes, hostels, boarding schools etc). When aggregating data for main places, StatsSA assigned the institutional population the “not applicable” category despite it being relevant. In the communities in this study, 27,348 people lived in collective living quarters and 3,297 people lived in industrial areas in 2011, together constituting 10% of the total. When calculating percentages in this study, the “not applicable” category was excluded from the total to avoid underestimating the results, unless it was clear that it referred to mine hostels, which were identified by very high household size and percentage of males.

### RESULTS

The socio-economic profiles of all the towns, townships, mine villages, informal settlements industrial areas and rural areas in the Far West Rand are given in **Table 5** and plotted on barometers of well-being in **Figures 5, 6**. Full results for individual communities are provided in the **Supplementary Tables S2, S3**. These overall results show that the towns have the highest levels of well-being, followed by the mine villages, which are probably underestimated because mine hostels are seen as one household and the individuals’ data are not included in the census. Also, mine villages are in main places that sometimes include large

**TABLE 5 |** Summary of SDG indicators of mining host communities in the Far West Rand (all values except overall score are percentages).

SDG	Dimension	South Africa	Far West Rand	Towns	Townships	Mine villages	Informal settlements	Industrial areas	Rural
1	Household income	55.9	60.6	78.0	49.8	85.9	34.6	76.9	63.6
	Household goods	68.4	54.6	88.3	63.1	45.9	6.9	58.3	44.2
3	Health	71.0	70.4	73.8	67.1	74.5	73.6	74.3	69.3
4	Education	28.9	33.1	59.5	28.8	29.7	15.6	65.1	30.4
6	Water access	73.4	80.0	97.9	86.8	95.3	4.8	97.9	53.3
	Sanitation	62.6	79.2	97.8	86.6	95.7	7.8	99.5	68.1
7	Electricity access	84.7	79.5	97.9	84.6	96.2	10.6	99.5	68.9
	Clean cooking fuel	75.6	76.7	97.8	79.5	95.4	8.4	98.9	68.9
8	Employment	64.0	69.6	83.6	55.5	89.6	54.3	65.7	72.9
	Youth employment	50.0	57.9	71.5	48.9	76.2	51.6	57.1	65.6
11	Formal housing	77.6	74.8	99.2	74.7	94.3	13.9	100.0	82.8
	Refuse removal	59.7	79.3	96.9	81.9	95.2	41.4	66.8	28.1
17	Internet access	35.2	27.3	49.6	28.2	21.6	10.3	74.4	18.9
Overall score (average)		6.3	6.5	8.5	6.6	7.7	2.4	8.1	5.6



**FIGURE 5 |** SDG barometer for all Far West Rand communities.

mine lease areas with informal dwellings, which will lower the levels of well-being. Rural areas and townships have similar well-being and are much better off than the industrial areas and informal settlements. Overall, there is significant variation between different types of communities and large differences between individual indicators, with education and internet access having the lowest levels.

### Basic Services

Overall, the Far West Rand has the highest levels of well-being for basic services—access to piped water, sanitation, electricity

and refuse removal—which are all around 80%. The Far West Rand does better than South Africa as a whole on all except electricity access, perhaps because of the high proportion of people living in informal settlements. The levels of basic services varies dramatically across the different types of communities, with all towns and mine villages having above 95% access, and most informal settlements having <5% access (Bekkersdal refuse removal being the exception at over 40%). Townships have fairly high levels of services (between 80 and 90%) while rural areas perform quite badly on basic services, particularly in refuse removal and piped water access.

### Livelihoods

About 70% of the labor force in the Far West Rand is employed, 6% more than South Africa as a whole, though only 61% of households are living above the poverty line of R19,600 per year, indicating many people are working in low earning jobs. This may be partly due to the low levels of education—only 33% of adults have completed Grade 12 or a NTC3 qualification, though this is only 4% higher than South Africa as a whole. Employment levels are significantly higher in towns (84%) and mine villages (90%) and lowest in townships (56%) and informal settlements (55%). Youth employment is lower across all communities but lowest in the townships (49%). It is interesting to note that education levels are quite low in the mine villages, which ties in with the low skill levels reported in mining companies SLPs—ranging from 25% of employees at Driefontein to 58% at Kusasaletu. Income levels are very low in informal settlements with 65% of people living below the poverty line of R19,600 per year. Townships are almost as bad, with half the population living below the poverty line.

### Living Standards

The impact of the large variation in employment and income levels is seen in living standards across the Far West Rand. Fridge ownership (the indicator for household goods) ranges from 7% in the informal settlements to 89% in the towns. The overall value

of 55% for the Far West Rand is 13% lower than the national average, which is counter-intuitive until you consider the high proportion of people living in mine hostels. Health levels do not vary that much across the communities, but this is due to the indicator selected (due to lack of data for other possible health indicators). It is interesting to note that mine villages and industrial areas have the highest proportion of people living with disabilities, although it is only 1% higher than towns and may be a function of different levels of awareness. Clean cooking fuel can be used as a proxy for health as it reduces indoor air pollution (it includes electricity, gas and solar power) and the results show that industrial areas, towns and mine villages have very high levels above 95% while <10% of people in informal settlements use clean cooking fuel. Internet access is low across all types of communities but varies from 50% in towns to 10% in informal settlements.

## DISCUSSION

### Mining Host Community Well-Being and the SDGs

The results of this study have shown extremely different levels of well-being in different types of communities—with historically advantaged towns and mine villages having much better standards of living than townships, rural areas and particularly informal settlements. This is not unlike the rest of South Africa and is related to the legacy of Apartheid policies of racial segregation and control, poor service delivery by local governments struggling to keep up with growing demand, and the high levels of unemployment in South Africa. Significant and urgent effort is required if these most deprived areas are to have any hope of achieving the SDGs by 2030, particularly in the areas of education (SDG 4), internet access (SDG 17) and employment (SDG 8). This is consistent with other local municipalities that host operating mines in South Africa, and South Africa as a whole (Cole and Broadhurst, 2021).

This case study shows the value of disaggregated data which can be used to identify the most vulnerable members of society and enable tailored social and economic policies to give these groups equal access to opportunities (Maennling and Correa, 2020). Unfortunately, efforts by the national government to address informal settlements in mining areas have not made much progress (Manenzhe, 2018) and the COVID-19 pandemic has hurt the national economy and education outcomes, and exacerbated poverty and inequality as job and income losses hit lower-skilled and uneducated workers the hardest (Ferreira, 2021; World Bank, 2021). Positive signs are evident in renewable energy supply (SDG 7), as all the major mining companies in the West Wits are investing in solar power plants, and in research on fiber-producing crop production that promotes economic diversification (SDG 8) and the bioremediation of the land (SDG 2, SDG 15) (Broadhurst et al., 2019).

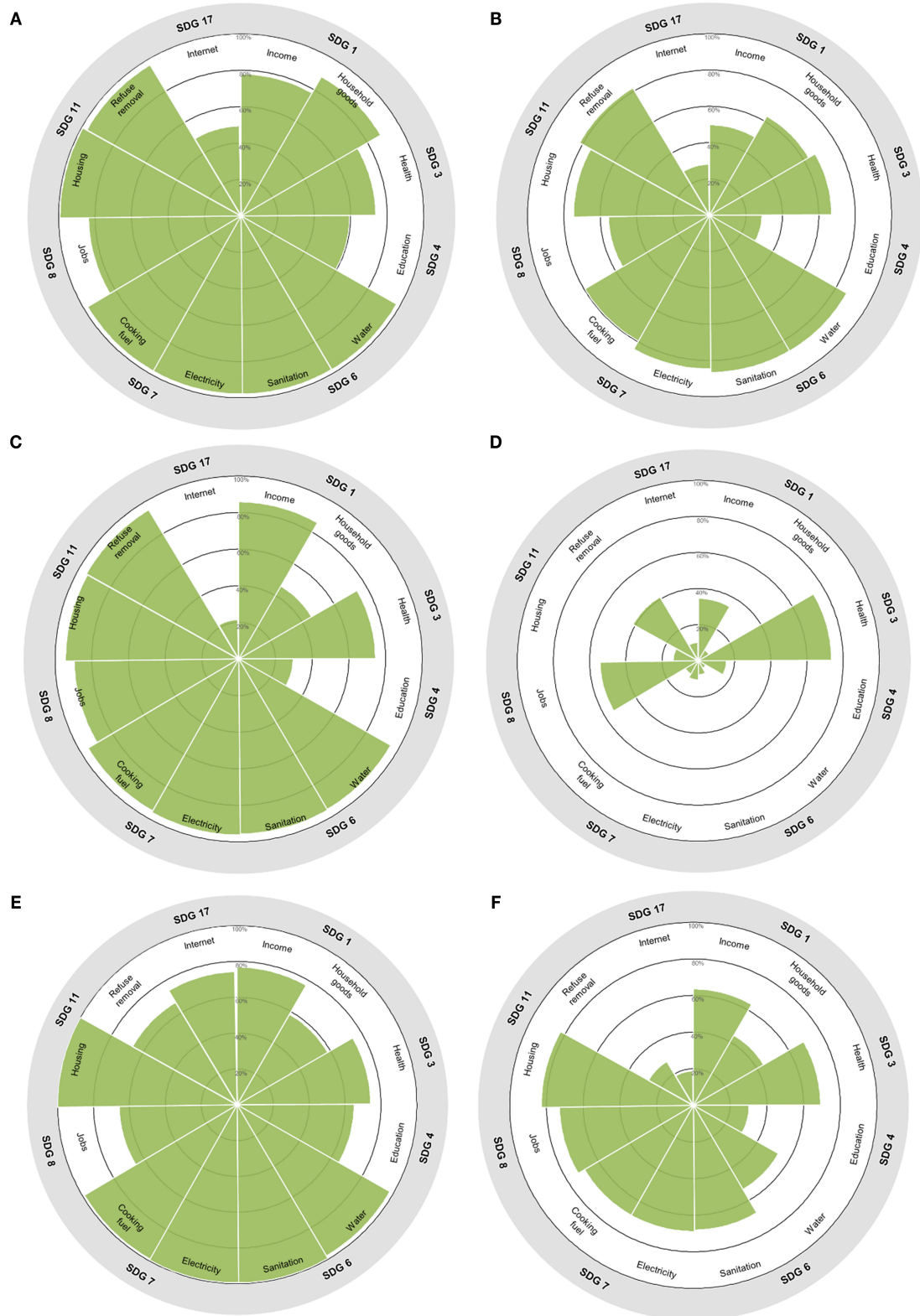
One concern regarding the SDGs that has been highlighted in this study is the lack of local level data, particularly for environmental indicators (SDG 6.3, SDG 11.6, SDG 12.4). This is especially concerning in the West Wits where acid mine drainage

and dust from tailings facilities pose significant environmental hazards (Broadhurst et al., 2019). Since the SDGs were adopted in 2015, there has been a growing call for localization of the SDGs to expose the multiple inequalities that exist within countries. This is also important for the mining industry, where corporate policies on sustainable development are often not implemented at the mine site level (Responsible Mining Foundation, 2022). While the products of mining are essential for achieving the SDGs at the global and national level, local mine host communities are often negatively impacted by mining (Lèbre et al., 2020; Luckeneder et al., 2021). It is essential that adequate reporting and monitoring is conducted. Ideally, this would be a partnership between the mining companies, local and national government and civil society, as envisaged in SDG 17.

### Defining the Mining Host Community

An important aspect of measuring the SDGs in mining communities is defining and delineating these communities. This study and a previous study (Cole and Broadhurst, 2020) has shown that South Africa has very different types of communities, and begs the questions, what is a mining host community? There has been no clear definition of mining communities globally, although underlying the international legal definitions is the idea of shared poverty, inequality and legacy of past exploitation (Heyns, 2019). In Australia and Canada there has been a major shift in the nature of mine communities, with many mine workers living far from the mine site, often in regional towns or cities, and commuting on a weekly basis (Storey, 2016; Marais et al., 2018a). This complicates the definition of community and makes it difficult to measure its well-being. In South Africa, there have been several different definitions used in the regulations. The MPRDA (Republic of South Africa, 2002) focused on historically disadvantaged persons with interest or rights in a particular area of land directly affected by mining while the 2010 Mining Charter added labor-sending areas to the definition (Government of South Africa, 2010) and the 2018 Mining Charter defined a host community as a community within a local or metropolitan municipality adjacent to the mining area (Government of South Africa, 2018). The labor-sending areas are important as remittances sent home by mine workers reduces poverty in rural areas (IRR, 2014)—for example Harmony estimate that half of monthly salaries are sent home (Harmony, 2018). In South Africa, mining companies generally base their Local Economic Development projects in their SLPs on communities chosen by the local municipalities, which is vulnerable to bias and exclusion and can lead to conflict between mining companies and communities. This is even more complicated considering tens of thousands migrant workers come from neighboring states.

Some mining companies refer to a “zone of influence” that includes the communities adjacent to the mine, those further out (perhaps 50 km away) and the municipality or region they are located in. While this is a helpful differentiation, it does not remove the expectations from community members that the mining company is going to directly improve their lives. Some organizations have suggested that mining taxes should be directed into these areas, however, this would significantly reduce the amount available to the national fiscus for more general



**FIGURE 6 |** SDG barometers for the Far West Rand (A) towns, (B) townships, (C) mine villages, (D) informal settlements, (E) industrial areas, and (F) rural farming areas.



expenditure (IRR, 2014). There is the risk that there is large-scale out-migration from mining towns post-closure, and therefore only spending in these towns does not make sense at the national level (IRR, 2014). This case study has highlighted that each mine and mine community is unique—with a different history, cultural context, labor force, company footprint and resources—and solutions need to be negotiated to suit all stakeholders.

## Mine Closure and the SDGs

Mine closure is a growing concern in South Africa and globally, with its potential negative impacts on water resources (SDG 6), land degradation (SDG 14), air quality (SDG 11), jobs and markets for local businesses (SDG 8). The actual reasons why mines close are diverse and include economic, geological, geotechnical, regulatory, community and other pressures (Laurence, 2006). While environmental issues are usually at the forefront of mine closure planning, social and economic impacts in mining-dependent communities are significant and alternative sources of employment and income need to be considered (Holcombe and Keenan, 2020). The lack of alternative economic opportunities in the West Wits and the general low levels of education (SDG 4), internet access (SDG 17) and employment (SDG 8) indicate a high social vulnerability to mine closure. The Far West Rand has experienced some of the impacts of mine closure, most notably with the sudden closure of Blyvooruitzicht mine in 2013 as a result of financial difficulties. Neither mining company on either side of a sale transaction took responsibility for the mine and this led to sudden job losses, electricity being cut off to the mine and mine village, rubbish collection halting, the sewage system breaking down for lack of maintenance, the shaft flooding (increasing the risk of acid mine drainage), and dust suppression measures at the tailings storage facilities ceasing, all resulting in significant health and safety risks to the mine village residents and environmental damage (Lawyers for Human Rights, 2017). Thus mine closure threatens the achievement of numerous SDGs (1, 2, 3, 6, 7, 8, 11, 12, 14, 15).

Despite the short life of many of the operating shafts in the West Wits, this does not necessarily mean that they will close on this date, as this is based on the current mineral reserve. They all have bigger mineral resources which could be converted to reserves if the conditions are right (Harmony, 2021; Sibanye-Stillwater, 2022). The main limitation in the West Wits is the depth of the orebody—the shallow ore has been removed and mines are already the deepest in the world. Minerals Council South Africa (2018) has estimated that mechanization and modernization could extend the life of conventional mines in the West Wits goldfields by 15 years. This has already been proved to some degree by South Deep mine, which has extended its life of mine to 2106 by converting to high profile mechanized mining, and the new Blyvoor Gold mine which has a life of mine of 50 years. With the high gold price (currently ~ USD1,900, about six times what it was 20 years ago), old mines are reopening, such as the Witwatersrand Basin Project in the Central Rand (West Wits Mining, 2022), and mining companies like DRDGold are extracting gold from tailings storage facilities and waste dumps. These recent developments mean that the

West Wits can continue to be a mining area for many years and has the opportunity to minimize the adverse impacts of mine closure on the communities. However, this study has shown that business as usual cannot continue if they hope to meet the SDGs in all communities. Mining companies, local governments and national government must work together to make substantial progress toward the SDGs and ensure no-one is left behind.

## CONCLUSION

The aim of this study was to identify all the host communities in the West Wits goldfield in South Africa and measure a comprehensive set of relevant SDG indicators, to explore the local variations in well-being that are hidden at national and municipal level, and the implications for communities achieving the SDGs in the context of mine closure. It has highlighted the extreme inequalities that exist between neighboring communities and their very different chances of achieving the SDGs by 2030. It has discussed the challenges around lack of local level data, defining who the mining host communities are, and the risks and opportunities related to mine closure. This paper thus provides an in-depth case study into some of the most difficult and contentious debates facing the mining industry today. It is clear that sustainable development in mining host communities relies on collaboration between multiple mining companies, local government authorities, civil society and the communities themselves.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

## AUTHOR CONTRIBUTIONS

MC conceived and designed the work, collected the data, performed the analysis, and wrote the paper. JB conceived the work. Both authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsc.2022.895760/full#supplementary-material>

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