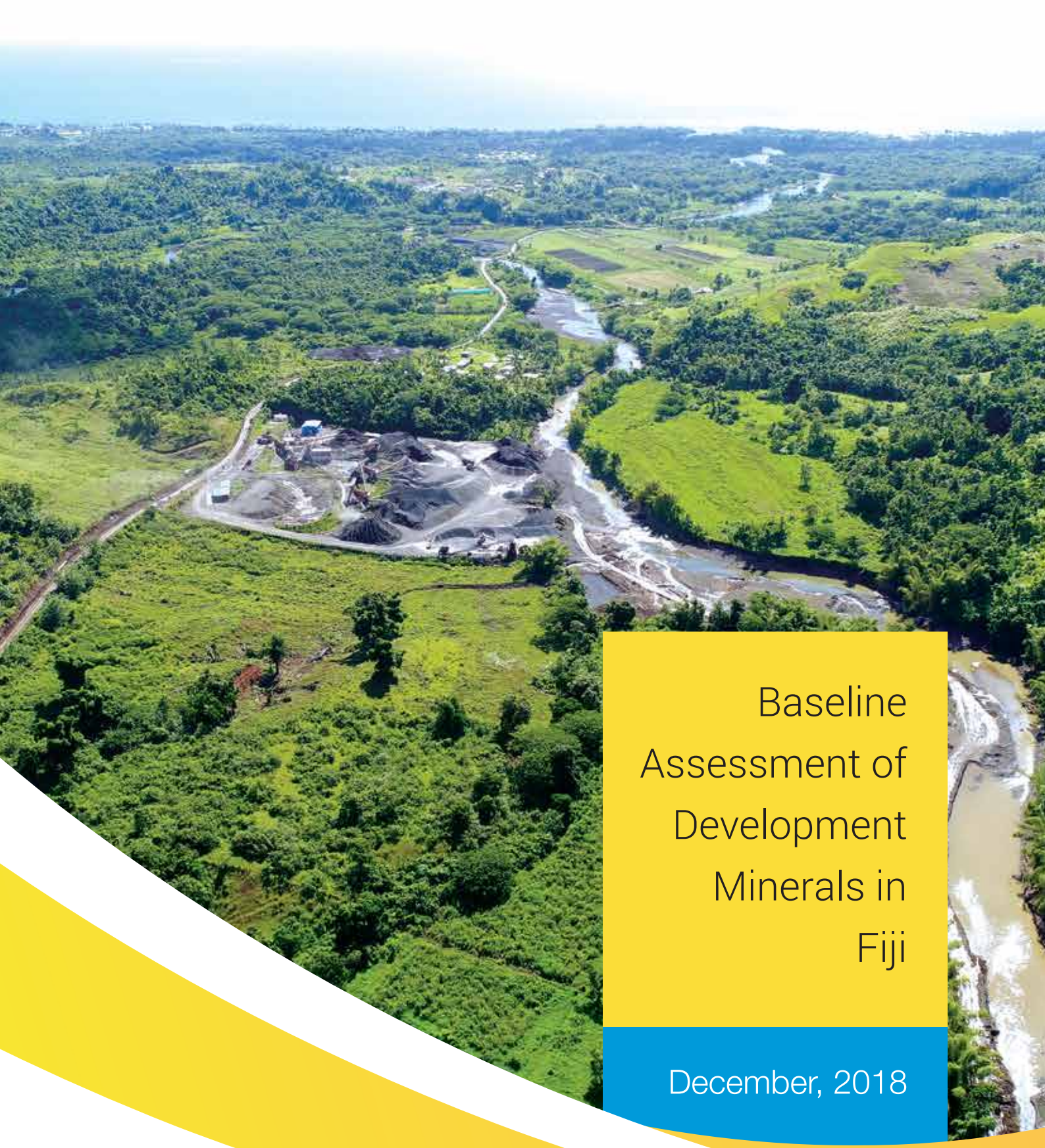


Baseline Assessment of Development Minerals in Fiji

December, 2018

Programme Partners:

ACP-EU Development Minerals Programme.
Implemented in Partnership with UNDP

www.developmentminerals.org

Baseline Assessment of Development Minerals in Fiji

December, 2018

Programme Partners:

ACP-EU Development Minerals Programme.
Implemented in Partnership with UNDP

www.developmentminerals.org

UNDP Pacific Office in Fiji
Level 8, Kadavu House
414 Victoria Parade
Suva, Fiji
Ph: + (679) 331-2500
www.developmentminerals.org

Authors: Robert Smith, Gary Lee, Akuila Tawake, Epeli Waqavonovono, Ken Chambers, Tevita Bukarau, Christine Prasad, Donato Roqica, Isireli Nagata, Timaima Nainoca, Ville Peltovuori, Priya Devi, Josefa Caniogo, Mihaela Stojkoska, Lacina Pakoun, Caroline Ngonze and Daniel M. Franks

Series editors: Daniel M. Franks, Lacina Pakoun, Caroline Ngonze

About the authors

This study was designed by the ACP-EU Development Minerals Programme and performed by the Pacific Community (SPC), GEM Division. Robert Smith led the Pacific Community research team and is lead author of the report. Daniel Franks led the study design and is the Chief Technical Advisor and Programme Manager of the ACP-EU Development Minerals Programme.

R.S, G.L, A.T, E.W, K.C, T.B, C.P, D.R, I.N, T.N, V.P, J.C, L.P., C.N. and D.F. designed the research; R.S, G.L, A.T, E.W, K.C, T.B, C.P, D.R, I.N, T.N, V.P, P.D performed the research; R.S, G.L, A.T, E.W, K.C, T.B, C.P, D.R, I.N, T.N, V.P, P.D, J.C, L.P., C.N. and D.F analysed the data; R.S, G.L, A.T, E.W, K.C, T.B, C.P, D.R, I.N, T.N, V.P, J.C, M.S, L.P., C.N. and D.F. wrote and edited the study.

Cover design: Ana Beatriz Dominguez Organero
Cover Photo: Dawasamu River.
Photo Credit: Poate Degei.

Acknowledgements: The authors would like to acknowledge the important contributions of the Fiji Standing Committee on Natural Resources, comprising Hon. Joeli Cawaki, Hon. Alevereti Nabulivou, Hon. Kiniviliame Kiliraki, Hon. Josefa Dulakiverata and Hon. Samuela Vunivalu. The study benefited greatly from the support of: Maximin Emagna, ACP Secretariat; Sergio Piazzardi, European Commission, International Cooperation and Development; Degol Hailu, Godefroid Bigirimana, Asan Amza, Isikeli Valemei, Olita Antonio and the operational and support staff, UNDP; and was guided by feedback from the Neglected Development Minerals Technical Working Committee: Marika Ritova, Sakiusa Waqanisau, Makereta Takala, Raijeli Taga, Apete Soro, Onisiomo Fonmanu, Sereima Koli, Christine Prasad, Kitione Raratabu, Laikini Waqanisau, Josateki Savu, Aram Goes, Emani Tawake, Andrew Coriakula, Alfred Atalifo, Stephen Hallacy, Nunia Thomas.

Special additional thanks to the many people throughout Fiji who contributed their time, knowledge and experience to the study, including: Malakai Finau, Permanent Secretary of Lands and Mineral Resources; Salaseini Daunabuna, Permanent Secretary of Employment, Productivity and Industrial Relations; Peni Toga, Mineral Resources Department, Fiji Ministry of Lands & Mineral Resources; Leba Gaunavinaka, Department of Lands, Fiji Ministry of Lands & Mineral Resources; Kamal Chetty and Tuma Greig, Investment Fiji; The Water Authority of Fiji; Visvanath Das, Fiji Revenue and Customs; Carmine Piantedosi, Land Transport Authority; Aram Goes, Paula Salabula and Samueala Tawakedrau, Fiji Roads Authority; The Ministry of Waterways; Artika Devi and Bimlesh Krishna, Bureau of Statistics; Tevita Kuruvakadua, Solomoni Nata and Epeli Ravula, iTaukei Land Trust Board; Sigatoka Town Council; Lami Town Council; Tavua Town Council; Dip Narayan, Ba Town Council; Nadi Town Council; National Archives of Fiji; Fiji Development Bank; Harvey Probert, Chairman, Mining and Quarrying Council; Hector Smith, The Road Haulage Association; Cama Raimuria and Mitchell Chand, IXOM; Fiji National University; Stephen Hallacy, Construction Industry Council; Dick Watling, Nature Fiji; Cecil Browne and Ashleigh Matheson, Bank of the South Pacific (BSP); Russell Howorth; Sarah Beavis, Australian National University; Paulo Vanualailai; The Fiji Times; Nouzab Fareed, Fijian Holdings Ltd; Valebasoga Quarries Ltd; Peter Watts, Fulton Hogan Hiways Ltd; Bula Earth Quarries Ltd; Humes Industries Ltd; Azard Construction Company Ltd; Hanif Industries Ltd; Natural Gift Carriers Ltd; Hussains Quarry Ltd; Quality Quarries Ltd; Kashmir Transport Ltd; Digtrac Crushers Ltd; Fairdeal Ltd; Titi's Sand Supplies Ltd; Chands Concrete Industries Ltd; Surya and Sons Ltd; Ambika Prasad and Sons Ltd; Pioneer Concrete Industries; Waimanu Trucking Ltd; Niko Buke and Atunaisa Nayago, Goldrock Ltd; Winstone Aggregates Ltd; Standard Concrete Industries Ltd; Concrete Solutions Ltd; Flametree Development Ltd; Fushun Quarry Ltd; All Earthworks Ltd; Nands Civil Contractors Ltd; Ashik and Shazad Investment Ltd; B&Y Investment Ltd; Draubuta Quarry Ltd; Petra Industries Ltd; Prataps Civil and Ashphalt Quarries Ltd; Raseru Investment Ltd; SD Transport Ltd; TF Jan Ltd; Tulsi and Sons Ltd; Vinjay Vakash Hire Ltd; Toll Construction Ltd; Fletchers Construction Ltd; Artwave Construction Ltd; Abbco Builders Ltd; David Johnston, Island Quarries Ltd; Juicy's Taxi Ltd; Sowani Tuidrola, Pacific Cement Ltd; Roy Singh, Hotspring Hire Services Ltd.

This study is published as part of the publication series: Development Minerals in Africa, the Caribbean and the Pacific.

About the ACP-EU Development Minerals Programme: The ACP-EU Development Minerals Programme is an initiative of African, Caribbean Pacific (ACP) Group of States, coordinated by the ACP Secretariat, financed by the European Commission and United Nations Development Programme (UNDP) and implemented by UNDP. This €13.1 million capacity building program aims to build the profile and improve the management of Development Minerals in Africa, the Caribbean and the Pacific. The sector includes the mining of industrial minerals, construction materials, dimension stones and semi-precious stones.

TABLE OF CONTENTS

Key Definitions

Beneficiation: any process adding economic value to Development Minerals, such as, crushing and screening construction aggregate into different sizes, pulverising limestone to produce agricultural fertilisers, cutting granite to form dimension stones, and polishing of semi-precious stones for jewellery.

Development Minerals: Development Minerals are minerals and materials that are mined, processed, manufactured and used domestically in industries such as construction, manufacturing, and agriculture. Development Minerals are economically important close to the location where the commodity is mined and include industrial minerals, construction materials, dimension stones and semi-precious stones (Franks, Pakoun, Ngonze, 2016).[1] [2]

[1] Industrial minerals: substance of economic value, exclusive of metal ores, mineral fuels, and gemstones (e.g. barite, bentonite, borates, calcium carbonate, clays, diatomite, feldspar, granite, gypsum, industrial sand, kaolin, silica, soda ash, talc, wollastonite and zeolite). Construction material (a sub-category of industrial minerals sometimes called 'industrial rocks'): substances used in the construction of infrastructure, housing and other built structures (e.g. gravel, limestone (cement), construction sand, aggregate, scoria, glass, ceramics, bricks). Dimension stones (a sub-category of industrial minerals and construction materials): rock quarried for the purpose of obtaining blocks or slabs that meet specifications as to size (width, length, and thickness) and shape (e.g. granite, marble, slate, sandstone). Semi-precious stones: a mineral crystal or rock that is generally cut and polished to make jewelry, but that does not include diamond, ruby, emerald and sapphire (precious stones). Examples of semi-precious stones include quartz, amythyst, garnet, aqua-marine, opal and pearl.

[2] Franks, DM, Pakoun, L and C Ngonze. 2016. Development Minerals: Transforming a neglected sector in Africa, the Caribbean and the Pacific. United Nations Development Programme.

Acronyms and Abbreviations

ACP:	African Caribbean Pacific Nations
EU:	European Union
DoL:	Department of Lands
EIA:	Environnemental Impact Assessment
EMA:	Environnent Management Act 2005
iTLTB:	iTaukei Land Trust Board
FBoS:	Fiji Bureau of Statistics
FCEF:	Fiji Commerce and Employers Federation
FRA:	Fiji Roads Authority
FRCA:	Fiji Revenue and Customs Department
FNU:	Fiji National University
Kyr:	thousand years ago
LTA:	Land Transport Authority
Ma:	million years ago
MoE:	Ministry of Environment
MoL:	Ministry of Labour
MoW:	Ministry of Waterways
MRD:	Mineral Resources Department
NGO:	Non-government organisation
QOEMP:	Quarry Operational and Environmental Management Plan
SDG's:	Sustainable Development Goals
SIDS:	Small Island Developing States
SPC:	Pacific Community
SPREP:	Secretariat of the Pacific Regional Environment Programme
UNDP:	United Nations Development Programme
WAF:	Water Authority of Fiji

Executive Summary

This Baseline Assessment of Development Minerals is a timely study for Fiji. Development Minerals play an oversized role in Fiji's domestic development, especially in the areas of infrastructure, housing construction, road building, agriculture and disaster reconstruction, as well as supporting a large number of Fijian small and medium-sized domestic enterprises. At the same time, the study has highlighted important issues adversely impacting the current social, economic, and environmental conditions of Fiji, which if not rectified, have the potential to manifest further and significantly obstruct development in Fiji.

The mining and quarrying of Development Minerals in Fiji is dominated by crushed aggregate, gravel and sand, used for construction materials, and to a lesser extent limestone, used for agricultural purposes. There are indications that the demand for Development Minerals will significantly increase in Fiji. A gargantuan quantity of construction materials are required to construct the infrastructure proposed in the Government of Fiji's '5 Year National Development Plan', and Development Minerals have an important role to play in achieving all 17 of the 'Sustainable Development Goals'. However, globally the Development Minerals sector has been neglected, and this is also the case in Fiji.

This study is the first comprehensive assessment of Development Minerals in Fiji. The study has identified 86 regulated extraction sites; of which 76% are located in Fiji's Rivers. In 2017, the total estimated Development Mineral production from regulated sites was 3,584,400 m^3, which is equivalent to excavation of an area approximately 10m deep over five times the footprint of Suva's Albert Park. This figure is approximately 8 times higher than the total reported official production of hard rock quarry, soft rock quarry and river gravel extraction in Fiji. The study also reveals that the value of the sector is up to seven times larger than previously reported. The corresponding Gross Output estimate for 2017 is between FJ$190.3M and FJ$369.1M, which is substantially higher than latest official Fiji Bureau of Statistics Gross Output record of FJ$53.0M. Additionally, government records indicate average royalty payments of FJ$1.9M per annum in recent years, this is 81% lower than the anticipated annual royalty estimate of FJ$10.2M (based on the 2017 production estimate). It appears, therefore that significant gaps exist in the accounting of the sector and the potential revenues for the Fiji Government and Fijian communities.

The Development Minerals sector is overwhelmingly dominated by domestic small and medium-sized enterprises with 95% of surveyed companies involved in the sector majority Fiji owned (ranging from two to two-hundred and fifty employees). The study estimates that 2325 Fijians are directly employed in the regulated part of the sector of Viti Levu and Vanua Levu, with a stark minority female staff (4%). In comparison the formal quarry sector of Jamaica employs 12% women, while the predominantly informal artisanal and small-scale mining of Development Minerals in Uganda (44%), Zambia (41%), Guinea (41%) and Cameroon (18%) employ significantly higher percentages of women. This finding highlights the crucial importance of opening up pathways and opportunities for woman to contribute to the sector. The employment figures reported above do not include employees involved in sector support services (such as transportation companies, mechanics, lawyers, surveyors, explosives dealers, equipment dealers, environmental consultants, geologists, drilling companies and electricians), civil servants involved in the administration of the sector, nor those involved in the downstream use of Development Minerals (such as construction companies and sugar cane farmers). Due to the fact that the commodities produced in the Development Minerals sector are at the foundation

of many key sectors in Fiji, including construction, infrastructure, and agriculture, to name a few, the number of employees is significantly larger. The employment numbers reported here indicate that the Development Minerals sector is 50% larger than the large-scale metal mining sector in Fiji.

The study has identified significant and acute negative social and environmental impacts associated with river gravel extraction of Fiji's perennial rivers, supporting the Fiji Governments decision to phase out river gravel extraction and establish a network of hard rock quarries in strategic locations. Fijian communities depend on rivers for services including drinking water, food (e.g. Qoliqoli's), washing, transportation, tourism, and agricultural irrigation. Inspections of 48 extraction sites and interviews with over 100 community members conducted as part of the study demonstrate that river extraction in Fiji is inhibiting the critical function of a number of important river systems. Conversely the environmental impact of hard rock quarries were found to be moderate, with greater potential for effective rehabilitation. Examples of rehabilitation of hard rock quarries in Fiji include Vuda Marina and the Colo-i-Suva Rainforest Eco-resort. The study also finds that hard rock quarries have the potential to produce more consistent, high quality material, with the potential to improve the quality of construction and the durability of roads in Fiji.

The transition to supply by a network of hard rock quarries will require major changes to the business operating environment, which currently incentivises river gravel extraction. Initiatives are needed to improve access to finance (perhaps through the Fiji Development Bank), review royalty and licensing application fees (which currently favour gravel extraction), undertake business process mapping on licensing procedures, create templates for partnerships with iTaukei landowners, and promote domestic investment through a collaboration between the Mineral Resources Department and Investment Fiji.

The study has found that the absence of a clear system for land-use planning, that incorporates assessments of geological reserves of quarried materials is contributing to conflicts in land use practice. For example, the aforementioned impact of river gravel extraction on the supply of potable water, the safety of tourism enterprises utilising rivers, and flood mitigation works; as well as the encroachment of urban infrastructure on established hard-rock quarry sites and quarry reserves. The study supports the development of the Fiji 'Land-use Master Plan.'

The study has compiled the most comprehensive database of regulated and unregulated extraction sites in Fiji to date. The database was then complemented by a comprehensive field survey of extraction and beneficiation sites. The survey inspected a total of 104 sites (46 regulated extraction sites; 40 regulated beneficiation sites; 18 unregulated extraction sites). The survey inspected 52% of extraction sites in the Central Division (14/27), 39% of extraction sites in the Northern Division (13/33), and 73% of extraction sites in the Western Division of Fiji (19/26). The survey inspected 87% of beneficiation sites in the Central Division (13/15), 56% of beneficiation sites in the Northern Division (10/18), and 94% of beneficiation sites in the Western Division (17/18). During the course of the study a further 30 unregulated extraction sites were identified, of which 18 were inspected. Several stockpiles of coral sand were also observed, indicating the presence of unregulated beach mining. Beach mining has the potential for significant adverse impacts on Fiji's coastal environment, which is already under threat from climate change.

The study deployed five distinct survey instruments as part of data collection. A total of 146 instruments were completed. In addition 34 interviews were conducted and 14 focus groups held. This extensive knowledge base provides confidence that the findings of the study are representative of the state of the Development Minerals sector in Fiji.

The legal and policy framework is outdated and subsequently does not support sustainable development of the sector. Much of the legislation originates from the colonial era (such as the Quarries Act 1939) and includes inappropriate content such as gender discrimination. Reference to the Development Minerals sector in the existing policy framework is minimal, no specific policy has been formulated for the sector, nor does the framework acknowledge the unique and crucial role that the sector plays in Fiji's domestic development. Rectification of legislative issues and introduction of a policy targeting sustainable development of the Development Minerals sector are vital interventions required to improve the state of the sector.

An in depth assessment of the institutional operating environment has found that the stakeholders responsible for administering the Development Minerals sector are under-resourced and are subsequently struggling to administer the sector effectively. A shortage exists in the number of individuals in Fiji with skills relevant for quarry management and the available opportunities for individuals with such skills to find employment in institutions and organisations supporting the sector. The ACP-EU Development Minerals Programme has supported the establishment of the 'Certificate IV in Geology, Mining and Quarrying' at Fiji National University, which is a step in the right direction, but must be accompanied by the creation of opportunities for its graduates to put these newfound skills in the service of the sector.

The range of Development Minerals mined and used for the domestic development of Fiji is comparatively narrow to other countries assessed as part of the ACP-EU Development Minerals Programme. Significant scope exists to establish several new Development Mineral industries in Fiji, including; cement produced from local resources, industrial lime, ceramics utilising residual clays, clay bricks, glass production from silica sand resources, industrial salt production, and phosphates. Cement and glass imports alone accounted for approximately FJ$50.0M in 2017. Development Minerals also present a great opportunity for landowners in Fiji. The study has found examples of landowners investing royalty revenues generated from hard rock quarries in sustainable and inclusive investment models, which invest funds in long-term projects to generate community revenues beyond the lifetime of the quarry, as well as financing short-term projects to address immediate community development needs. Numerous landowners expressed serious interest in the sector; however, they have voiced confusion regarding the regulations governing the sector. More information resources are needed to explain the relevant rules and procedures. Based on interviews with over 100 community members it is evident that landowners still lack knowledge about the potential options to establish extraction sites, particularly the potential for hard rock quarries.

Introduction

The Pacific Community (SPC) was engaged by the United Nations Development Programme (UNDP) to carry out a *'Baseline Assessment of Development Minerals in Fiji'.*

The baseline assessment is part of a wider ACP-EU Development Minerals Programme initiated by the African Caribbean Pacific Group of States (ACP), financed by the European Union (EU) and UNDP, and implemented by the UNDP. The programme is a three year, €13.1 million capacity building initiative that aims to build the profile, and improve the management of development minerals. The ACP-EU Development Minerals Programme has six key objectives:

1. Enhance employment and incomes, including employment and incomes of women
2. Improve the policy and regulatory environment
3. Minimize environmental impacts on communities
4. Address individual and community rights and prevent conflict
5. Ensure decent working conditions
6. Facilitate South-South cooperation and cross-country learning

Under the programme; forty countries are participating in regional level training and knowledge exchange, and six focus countries (including Fiji) have been selected for in depth capacity building and country level training.

The baseline assessment is a holistic study of the Development Minerals sector in Fiji (mainly construction materials and agricultural lime). The purpose of the study is to highlight the existing dynamics of the industry as a whole, identify the key issues, and outline potential opportunities for improvement.

The scope of the study comprises five principal components:

1. Comprehensive profile of the sector.
2. Assessment of the legal and policy framework.
3. Assessment of institutional and technical operating context.
4. Environmental, health and safety (H&S), and socio-economic analysis.
5. Market and value chain analysis.

SPC prepared an '*Inception Report*'[3] in September 2017, which presented a detailed methodology for each of the five key components outlined above. This was followed by a '*Field Report*'[4] which analysed the actual fieldwork achievement against the proposed methodology in the '*Inception Report*', identified limits, and proposed corrective measures to remedy identified issues. This '*Baseline Assessment of Development Minerals in Fiji Report*' presents the results of the assessment and is the final deliverable for the study.

[3] SPC, 2017, Baseline Assessment of Development Minerals in Fiji: Inception Report.
[4] SPC, 2018, Baseline Assessment of Development Minerals in Fiji: Field Report.

Study methodology

Approach

The study was conducted in a phased approach including an inception phase, a field work and data collection phase, analysis and reporting. Each phase included production of a report. Specifically, the inception and field work phases included:

Inception phase

- Literature review
- Site sampling and size
- Stakeholder/ target groups sampling and size
- Data collection tools developed and data collection techniques used
- Data processing techniques and matrix—design
- Field work preparation with sector stakeholders

Field work

- Data collection—primary and secondary data
- Data processing, analysis and reporting
- Quantitative data processing
- Qualitative data processing
- Field work limitations

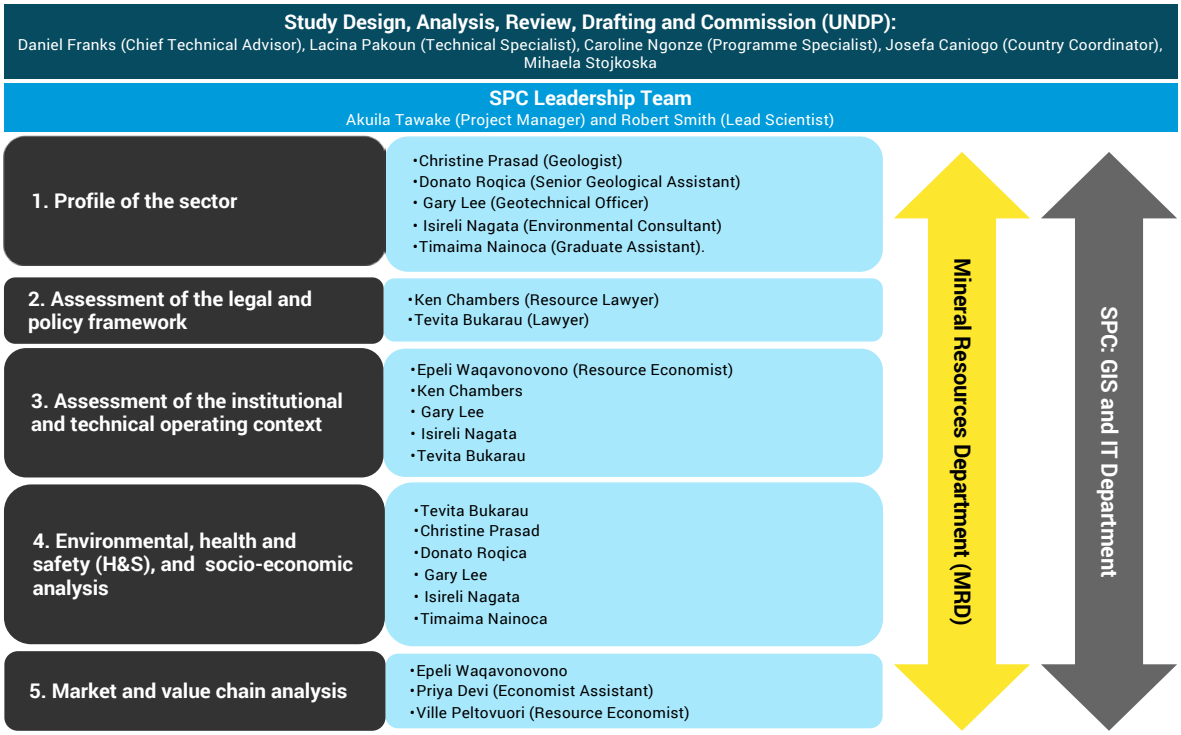
Due to the multidisciplinary nature of the study the team implemented a specific methodological approach for each of the five individual components, as well as general approach for the entire assessment because of the interconnected complexion of the components.

General methodological approaches applied across all five components of the study included:

- A focus on the Northern, Central and Western Divisions of Fiji.
- Identification of priority Development Minerals for detailed analysis.
- A partnership approach with the Mineral Resources Department (MRD) and other key agencies holding data in Fiji
- The use of Geographic Information Systems (GIS) and Information Technology (IT)
- Special attention to issues of gender and youth

A team of specialists was assembled to execute a specific detailed methodology for each of the 5 individual components, see Figure 1 for an organigram of the project team.

Figure 1: Project team



Specific methodologies for the five individual study components comprised the following essential elements:

1. Profile of the Sector

Identification of extraction sites:

- Consultations were held with various stakeholders at national, divisional and local levels to identify all known extraction sites on record.
- The following specific stakeholders were consulted; Department of Lands (DoL), iTaukei Land Trust Board (iTLTB), Mineral Resources Department (MRD), Rural Local Authority, Department of Environment, Local Councils, Fiji Bureau of Statistics (FBoS), the Mining and Quarrying Council of the Fiji Commerce and Employers Federation (FCEF), and the Registrar of Companies.
- The Yellow Pages and local knowledge (snowball techniques) were also utilised to identify additional extraction sites not on record.

Identification of beneficiation sites:

- Consultations were held with various stakeholders at national, divisional and local levels to identify all known extraction sites on record.
- The following specific stakeholders were consulted; MRD, Local Councils, Registrar of companies and the Mining and Quarrying Council of (FCEF).
- The Yellow Pages and local knowledge (snowball techniques) were also utilised to

identify additional beneficiation sites not on record.

Site visits to extraction and beneficiation sites:

- A trilingual team (iTaukei, Hindi and English) conducted site visits to 46 extraction sites and 40 beneficiation sites across the Central, Western and Northern Divisions.
- Data collected during site visits included; coordinates (using a handheld GPS), photographs and notes documenting operations, and Development Mineral samples.
- Meetings where held with site representatives and the respective questionnaires in Appendix 1 and 2 were conducted.
- Questionnaire results were uploaded into a master spreadsheet for quantitative analysis.
- While conducting the site visits (and via Google Earth imagery) the team also actively observed any unregulated extraction and beneficiation operations and obtained the same data when possible.

Survey of downstream consumers:

- The Registrar of Companies, local councils and the Yellow Pages were consulted to identify downstream consumers of development minerals (e.g. construction companies, hardware stores etc.).
- A trilingual team (iTaukei, Hindi and English) conducted interviews with 33 consumers (using the questionnaire in Appendix 4) across the Central, Western and Northern Divisions.

2. Assessment of the Legal and Policy Framework

Identification of the legal and policy framework:

- A team of two lawyers consulted the Pacific Islands Legal Information Institute (PacLII), library resources, and governmental publications to gather relevant policy documents, academic writing, case law from the Pacific region (including Australia and New Zealand), resource management statutes, and regulations.
- Relevant officers within the relevant government departments were also interviewed as part of the policy framework identification process.

Desktop analysis of the legal and policy framework:

- Strengths, weaknesses, opportunities and threats (SWOT) analysis was conducted on identified legislation, with an emphasis on identifying loopholes and incongruities.

Field assessment of legal and policy framework:

- The legal team attended community consultations, interviews with private operators, meetings with institutional stakeholders, and official meetings (e.g. Environmental Impact Assessment review meetings) to witness the implementation of the legal and policy framework, and observe various stakeholders interpretations of the framework.

3. Assessment of the Institutional and Technical Operating Context

Institutional operating context:

- Focus group discussions were held with various institutional stakeholders.
- Institutional organigrams were analysed.
- SWOT analysis was carried out for respective stakeholders.
- Official records were compared with records from alternative sources.

Technical and business operating context:

- Site visits were conducted to 46 extraction sites and 40 beneficiation sites, and the questionnaires in Appendix 1 and 2 were completed.
- 12 Mining and Quarrying Council meetings were attended to observe the existing dynamics in the industry and challenges faced by the private sector.
- 3 focus group discussions were held with banks and financial organisations to discuss the availability of finance and the risk profile of the sector.
- A focus group discussion was held with Investment Fiji to discuss investment attraction activities related to the sector.
- Focus group discussions were held with Fiji National University related to the human resource capacity of the sector.
- Quotes were requested from equipment suppliers to identify approximate equipment start-up costs for different types of operations.

4. Environmental, Health and Safety and Socio-economic Analysis

Environmental:

- 60 Environmental Impact Assessment (EIA) reports were evaluated to assess the quality of environmental studies and the consideration of potential impacts prior to approval of extraction/beneficiation operations.
- Focus group discussions and interviews were held with relevant institutional stakeholders, environmental consultants, private operators and community members to discuss environmental impacts.
- MRD environmental monitoring and infringement reports were observed and the study team also sat on the panel of two official EIA review meetings.
- While conducting site visits to the extraction and beneficiation sites during the 'profiling of the sector' observations related to a variety of environmental factors were documented, including cross-checking operations with EIA reports.
- Historical imagery was analysed to identify temporal changes associated with extraction operations. Additional site visits to historic quarry sites were conducted to observe rehabilitation examples.

Occupational health and safety:

- 5 Quarry Operational and Environmental Management Plans (QOEMP) were evaluated from a health and safety perspective.
- While conducting site visits to the extraction and beneficiation sites during the 'profiling of the sector' observations related to a variety of health and safety factors were documented, including cross-checking operations with QOEMP reports.
- Records of injuries and deaths in the sector over the past 10 years were obtained from MRD and the Ministry of Employment, Productivity and Industrial Relations.
- Focus group discussions regarding health and safety were held with the main supplier of explosives in Fiji and MRD.
- A trial blast using emulsion technology was observed to ascertain the potential H&S benefits.

Socio-economic and community health and safety:

- A situation analysis was conducted to identify both the positive and negative socio-economic impacts, including; community impacts, cultural impacts, demographic impacts, gender impacts, health impacts, infrastructure impacts, human rights impacts and political impacts.
- Over 100 community members living adjacent to extraction and beneficiation sites were interviewed using the questionnaire in Appendix 3.
- All Fijian media over the past 5 years was analysed to identify reports related to the Development Minerals sector.
- Focus group discussions were held with the Ministry of Waterways, Water Authority of Fiji, Fiji Roads Authority, Land Transport Authority, Road Haulage Association, tourism operators and the construction industry council to ascertain the impact of the Development Minerals sector on these stakeholders.
- EIA community consultation meetings were attended.

5. Market and value chain analysis

Demand profile:

- Identification of demand profile via; surveying extraction/beneficiation companies to identify consumers, Bureau of Statistics trade statistics, reviewing the Yellow Pages, business registration data from local councils, and field visits to neighbouring Pacific Islands countries.

Supply profile

- Identification of the supply profile via; fieldwork conducted during the 'Profile of the Sector' and trade statistics from the Bureau of Statistics.

Market/ competitiveness analysis

- Identification of prevailing sector characteristics via data collected during the 'Profile of the Sector', analysis of labour productivity based on data from the Bureau of Statistics and comparison with data from other countries.

Value chain

- Identification of the value chain via; fieldwork conducted during the 'Profile of the Sector', interviews with key stakeholders, and trade statistics from the Bureau of Statistics.

Refer to the 'Baseline Assessment of Development Minerals in Fiji: Inception Report' for a detailed breakdown of the methodology for each individual component.

Site sampling techniques and sample size

The study aimed to undertake a comprehensive survey of all extraction and beneficiation sites identified within the Northern, Central and Western Divisions of Fiji (including licensed and unlicensed operations). The decision to survey all sites was due to the fact that: the study is the first of its kind in Fiji; it is practically feasible to execute a full-spectrum sample size given the geographic context and anticipated size of the Development Minerals industry in Fiji; and a full database of licensed sites did not previously exist in Fiji with disparate agencies holding incomplete collections. The compilation of a reliable database of the collections held by each agency took much longer than anticipated, and the study did not achieve the objective of a survey of all sites, however, a comprehensive sample of 46 extraction sites and 40 beneficiation sites was surveyed (as presented in Table 1 and Table 2).

Table 1: Regulated extraction sites survey summary (Source: SPC Fieldwork, 2017).

Division	No. Identified	No. Surveyed	%
Central	27	14	52%
Northern	33	13	39%
Western	26	19	73%
Total	**86**	**46**	**53%**

Table 2: Regulated beneficiation sites survey summary (Source: SPC Fieldwork, 2017).

Division	No. Identified	No. Surveyed	%
Central	15	13	87%
Northern	18	10	56%
Western	18	17	94%
Total	**51**	**40**	**78%**

Data collection techniques

The study team utilised the following suite of techniques to collect both empirical and secondary data:

- Focus group discussions
- Workshops
- Interviews
- Surveys
- Site visits
- SWOT analysis
- Examination of 'soft' and 'hard' archives

Data collection tools used

The study team utilised five different survey instruments to collect empirical data. A total of 146 surveys were completed.

- Questionnaire for extraction sites (see Appendix 1)
- Questionnaire for beneficiation sites (see Appendix 2)
- Questionnaire for socio-economic river extraction (see Appendix 3)
- Questionnaire for socio-economic non-river extraction (see Appendix 3)
- Questionnaire for consumers (see Appendix 4)

Target groups and key informants

A total of 253 individual key informants were consulted or interviewed as part of the data collection process. Key informants were contacted (via official letters, phone calls, emails and meetings) at national, divisional and local levels where relevant, as outlined in Table 3 below.

Table 3: Key Informants

Key informants	National Level	Divisional Level	Local Level
Department of Lands (DoL)	✓	✓	
Rural Local Authority*	✓		
iTaukei Land Trust Board (iTLTB)	✓		
Mineral Resources Department (MRD)	✓		
Ministry of Environment (MoE)*	✓	✓	
Ministry of Labour (MoL)	✓		

Fiji Roads Authority (FRA)	✓		
Land Transport Authority (LTA)	✓		
Registrar of Companies*	✓		
City and town councils			✓
Mining and Quarrying Council	✓		
Fiji Bureau of Statistics (FBOS)	✓		
Water Authority of Fiji (WAF)	✓		
Fiji Revenue and Customs (FRCA)	✓		
Ministry of Waterways (MoW)	✓		
Fiji National University (FNU)	✓		
Local communities			✓
Extraction operators			✓
Beneficiation operators			✓
Consumers	✓	✓	✓
Fiji Development Bank	✓		
Fiji Times Newspaper	✓		
Fiji Sun Newspaper	✓		
Nature Fiji	✓		
National Archives of Fiji	✓		
Construction Industry Council	✓		
Road Haulage Association	✓		

Component 1: Profile of the Sector

Fiji Geography

Fiji is an archipelago located in the South Pacific Ocean, consisting of 110 inhabited and 222 uninhabited islands. The Fiji archipelago is distributed over an extensive area of ocean between 15° and 18° south of the equator, and 175° east and 177° west of the Prime Meridian[5]. The archipelago occupies an ocean area of 1,260,000km², with a land area of only 18,272km², giving a ratio of 69:1 in terms of ocean to land. This large 'ocean to land area' ratio presents Fiji with several developmental challenges[6].

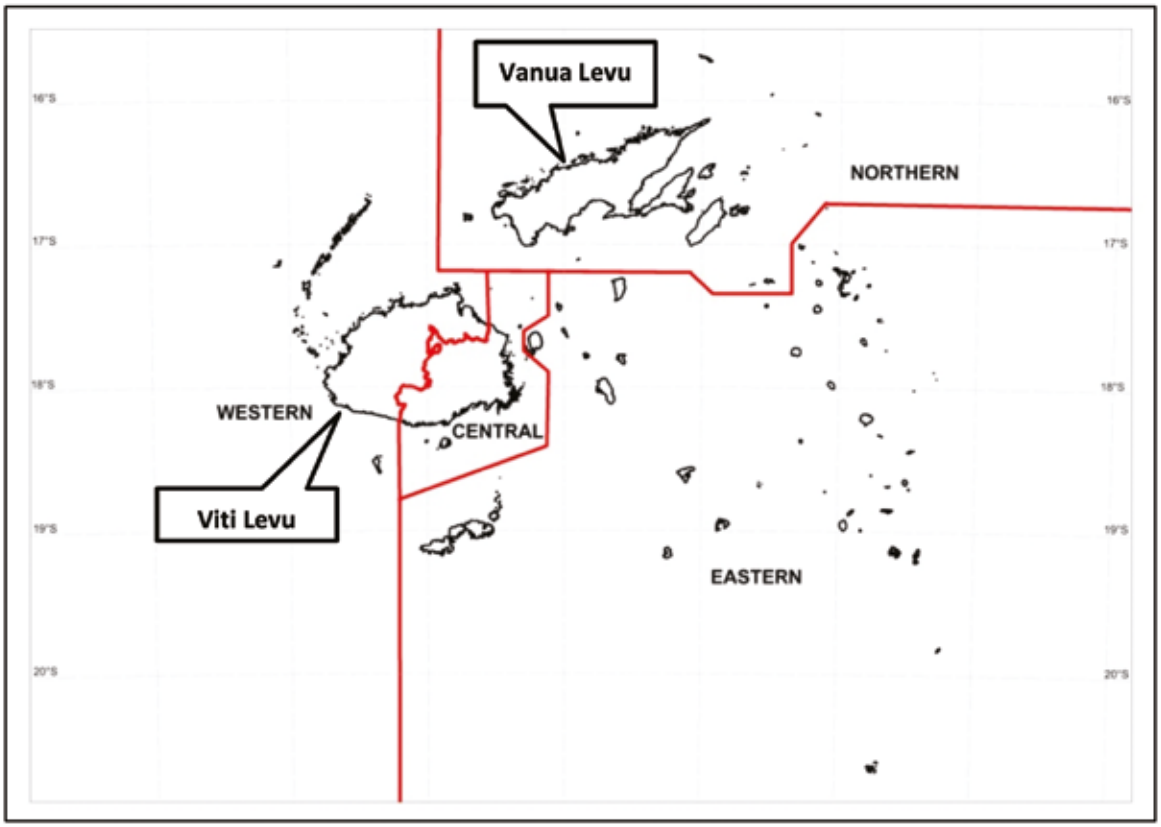
For administrative purposes, Fiji is divided geographically into four divisions; Western, Central, Eastern and Northern (as illustrated in Figure 2). The Western Division refers to the areas of western and northern Viti Levu; Central Division refers to the south and east of Viti Levu, the

[5] The University of the South Pacific, 2006, Fiji: An Encyclopaedic Atlas.

[6] Petterson, M.G., and Tawake, A.K., 2016, Toward inclusive development of the Pacific region using geoscience.

Eastern Division includes the Lau and the Lomaviti groups, and Kadavu, and the Northern Division accounts for Vanua Levu and Taveuni.

Figure 2: Geographic framework of Fiji for administrative purposes (Department of Lands, Fiji)



Ninety-six percent of Fiji's total population (884,887 people) reside on the two largest islands, Viti Levu and Vanua Levu, with only 4% of the population located in the Eastern Division[7]. Thus, the vast majority of the infrastructure and development of Fiji is confined to the Central, Western and Northern Divisions. Because Development Minerals are predominantly mined for domestic use the majority of the sector is also largely confined to the same three Divisions. Furthermore, given the remote and plentiful distribution of islands in the Eastern Division, fieldwork poses significant logistical and timeframe challenges outside the scope of the study. Subsequently, the study focused on the Central, Northern and Western divisions (Viti Levu and Vanua Levu) only. Future research in the Eastern Division is recommended.

Fiji Climate

The Fiji archipelago is located in the tropics and is subject to an annual tropical cyclone season, typically between November and April. Between 1969 and 2010, 117 tropical cyclones passed through Fiji's Exclusive Economic Zone, an average of 3 per year[8]. Frequent cyclones combined with Fiji's large 'ocean to land area' pose substantial risk to Fijian communities and infrastructure.

[7] Fiji Bureau of Statistics, 2018, 2017 Population and Housing Census.
[8] Pacific-Australia Climate Change Science and Adaptation Planning Program, Current and future climate of the Fiji islands, 2015.

The damage caused by cyclones often requires significant quantities of construction materials (Development Minerals) in order to rebuild infrastructure. The quarry sector, however, has not traditionally played a significant role in natural disaster planning despite its out-sized role.

Predominant south-east trade winds influence local climates in Fiji, particularly the rainfall patterns of Viti Levu and Vanua Levu. The relatively elevated topography of Viti Levu (maximum elevation of 1323m, Mt Tomanivi) and Vanua Levu (maximum elevation of 1,111m, Mt Batini) results in orographic rainfall on the south and east of the islands (4,500mm average annual rainfall) and a relatively dry climate on the north and west of the islands (2,000mm average annual rainfall)[9]. This spatial climatic variation inherently influences local geology through increased rates of weathering, erosion, sediment transportation and sediment deposition on the windward sides of Viti Levu and Vanua Levu.

Fiji Geology and Development Mineral types

The following section outlines the geology and the types of Development Minerals in Fiji. Ultimately, the geology underpins the Development Mineral resources available for extraction and beneficiation. However, other factors influence the types of Development Minerals currently being utilised in Fiji, such as, resource mapping (or lack of), digitisation and availability of data, location, infrastructure, technical skillsets, policy, land ownership, economics and distance to market, the business environment, and protected areas.

Geology of Fiji

The Fiji islands represent the exposed portion of an unusual remnant island arc system, positioned within the active boundaries of the Pacific and Indo -Australian Plates. Figure 3 presents the tectonic and morphologic features of the Pacific/Indo-Australian Plate Boundary.

The known geological history begins with eruption of pillow lavas and coarse volcaniclastics with interlayed dacitic volcaniclastic rocks and limestone of late Eocene age. More arc-like basalts where then erupted in the Early Oligocene again with interlayered limestones. These

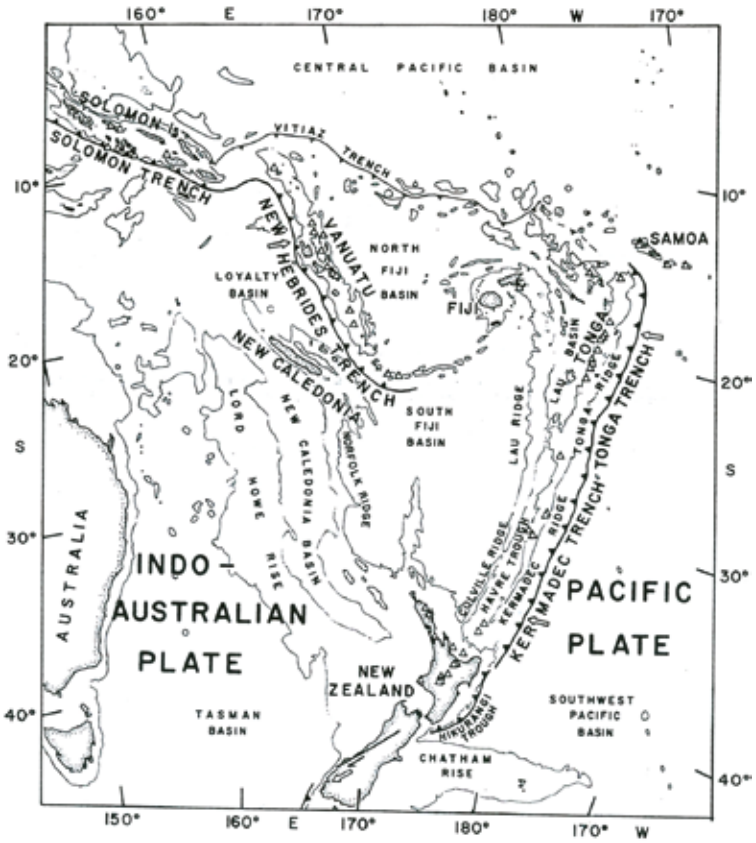


Figure 3: Tectonic and morphologic features of the Pacific/Indo-Australian Plate Boundary (Source: Pacific Council for Energy and Mineral Resources, 1981).

[9] Fiji Meteorological Service, The Climate of Fiji, 2006.

rocks comprise the Yavuna Arc and were intruded by a tonalite stock and dolerite dykes.

Late Eocene rocks also occur in central southern Viti Levu with slightly younger basaltic and andesitic rocks in southwestern to central Viti Levu with lenses of shallow water limestones suggesting an age of Early Miocene. The bulk of the oldest rocks in southern Viti Levu are flows and coarse volcaniclastics of basaltic and dacitic composition of uncertain age. Late Eocene rocks and possible Oligocene rocks have been identified, but it is likely that most are Early to middle Miocene in age.

The Colo Orogeny occurred on the Viti Levu Platform from Late Middle Miocene to the Late Miocene, about 12.5 to 7 Ma. Extensive folding and faulting and intrusion of gabbro and tonalite stocks took place, with widespread emergence. This orogenic phase produced a widespread unconformity.

During the waning of the Colo Orogeny, basalts were erupted along the northwest margin of the Viti Levu Platform to produce the Yasawa islands.

Volcanism began to build the present Vanua Levu at about the same time. Voluminous acidic eruptions occurred in the northeast, at about 7 Ma, whilst soon after eruptions of basaltic to andesitic lavas and pyroclastic rocks began further west. Much of this volcanism was submarine and continued to about 3.7 Ma with the last eruptions possibly subaerial.

In Viti Levu, erosion products from the island resulting from the Colo Orogeny formed conglomerates and finer grained clastic from the Late Miocene (7Ma) and included plutonic rocks. Calc-alkaline rocks, mainly andesites, were erupted in two areas, and andesites richer in potash occur in other places, ages ranging from 6.5 Ma to 5.3 Ma. Sedimentation was wide spread. The Messinian sea level is well represented in the Suva area. Marl was deposited throughout the Early Pliocene in the Suva area (5.2 Ma to 3.2 Ma), with minor tuff input. A hiatus for most of the late Pliocene occurred.

Early Pliocene shoshonitic volcanism occurred on Vatulele and built Beqa and other nearby islands. To the east and southeast of Viti Levu tholeiitic to shoshonitic volcanism produced the islands of the Lomaiviti and Moala groups. In western Vanua Levu a large shield volcano, the Seatura Volcano was built (dates 3.4 to 2.8 Ma).

Deep-sea marls were deposited along the southeastern coast of Vanua Levu in the Late Pliocene with sedimentation continuing into the Pleistocene. A belt of Pleistocene ocean limestone occurs along much of this coast, much of it in-situ reef. Sedimentation also took place on a shallow shelf east of Viti Levu, beginning about 2 Ma and continuing into the Pleistocene. These strata now occur up to at least 45 m above sea level. Capping these are fluvial gravels to clays with altitudes up to 100 m ASL. Similar fluvial deposits occur in southwestern Viti Levu to at least 60 m ASL.

The mid Pliocene Seatura Volcano marks the beginning the current phase of magmatism in Fiji- alkali- basalt volcanism. Other major centers of eruption are Koro and Taveuni which cannot be said to be extinct.

Kadavu Group is probably a result of volcanism above a portion of the South Pacific Basin that has been obliquely subducted along the Hunter Fracture Zone. There is a progression from submarine basic rocks in the north (3Ma) through basic andesite and hornblende andesite to biotite andesite to dacite in the southwest, late Pleistocene. Almost all the rocks are relatively rich in potash.

The Lau Group lies on the Lau ridge with the oldest rock possibly around Late Eocene. The oldest lavas exposed are around 12 Ma. The most-widespread volcanic rocks of the Lau Volcanic Group

are Late Miocene, 10- 5.4 Ma; pyroxene andesite the most common and most rocks are subaerial, hydroclastic or the result of violent shallow marine eruptions. On almost all of the islands with these rocks they are overlain with limestone, latest Miocene to Pliocene of age. Further volcanism occurred around 4.5 Ma to 2.5 Ma ago (Korobasaga Volcanic Group) with basalt strongly dominant, but hornblende andesite to dacite forms prominent plugs in one area. The Mago Volcanic Group comprises subaerial and shallow alkali basaltic rocks erupted in four areas from 2.2Ma. Reef limestone with subordinate facies occurs widely in the Lau Group and in many parts of Fiji. Viwa Island to the west of the Yasawa island chain is a notable up raised reef limestone island where various terraces occur, with a reef forming terrace at 6-7 m AMSL that has been dated at 130ka.

Rotuma consists of subaerial alkali-basalt flows and pyroclastic rocks of Pleistocene and possibly Recent in age (Rodda 1988).

The two largest islands, Viti Levu and Vanua Levu (the focus of this study) rose from shallow shelfs approximately 200m deep (the Viti Levu and Vanua Levu Platforms). The shelfs are separated by a basin (the Bligh Water) just over 1000m deep, however evidence suggests the geological structure is probably continuous between the two platforms, so they are treated as one major structural unit, the Fiji Platform[10].

Rodda (1994), provides a comprehensive overview of Fiji's geology[11]; the paper was the primary reference for preparing this geological summary, and we recommend it for further reading. A summary of the main geological units comprising the geology of Fiji is provided in Table 4, and the 1: 1,000,000 Geological Map of Fiji is presented in Figure 4.

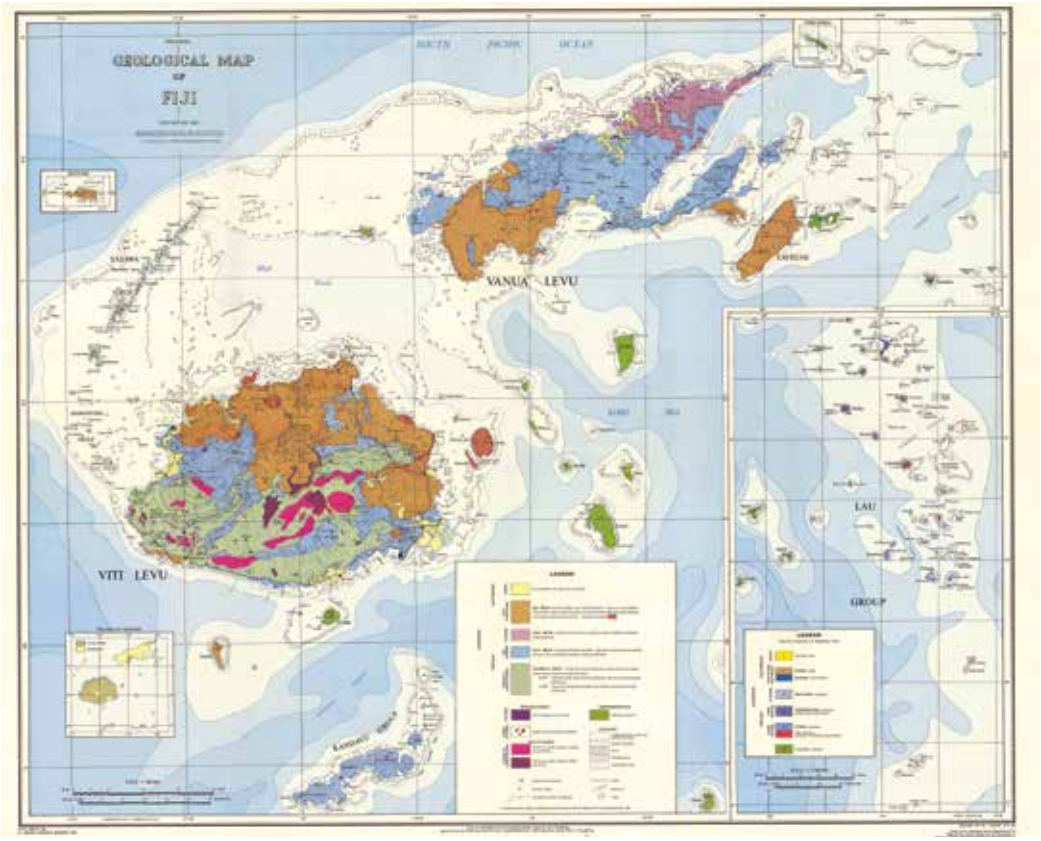
Table 4: A summary of the Geology of Fiji (Source: Original, based on Rodda, 1994).

A Summary of the Geology of Fiji		
Unit	Approximate Age	Description
Yavuna Group	Late Eocene to Early Oligocene (37.8 to 23.0 Ma)	The oldest known rocks in Fiji and represent part of a volcanic arc (Yavuna Arc). The Group consists of basaltic pillow lavas, dacite, a tonalite stock, and shallow-water limestone.
Wainimala Group	Late Oligocene to Middle Miocene (28.1 to 11.6 Ma)	The group is broadly defined as a deformed volcanic-sedimentary group showing low grade metamorphism related to younger plutonic intrusions. The volcanic rocks of the Wainimala group are both pyroclastic and flow deposits of various different compositions, including; basalt, andesite, trachyte and rhyolite. The sedimentary rocks of the Wainimala Group consist of limestone, sandstone and mudstone. Phyllite, schist and gneiss are also present due to metamorphism associated with the intrusion of the Tholo Plutonic Suite.
Colo Plutonic Suite	Middle and Late Miocene (11.6 to 5.3 Ma)	These intrusive rocks occur in an elongate belt from the south-west to the east of Viti Levu. The suite predominantly consist of gabbro and tonalite, with occasional granodiorite and diorite.
Tuva Group	Middle to Late Miocene (11.6 to 5.3 Ma)	This group of rocks are strongly deformed in places; and predominantly consist of breccia, conglomerate, sandstone, with minor mudstone.

[10] Smith, R and Raicebe, T, Bathymetric map of Fiji, 1984.
[11] Rodda, P, Geology of Fiji, 1994.

A Summary of the Geology of Fiji		
Unit	Approximate Age	Description
Macuadrove Super-Group	Late Miocene onwards (7.2 Ma onwards)	This group of rocks are predominantly submarine and only occasionally subaerial. Volcanic rocks types include; basalt, andesite, dacite, rhyolite. Sedimentary sandstones and marls are also present.
Various sedimentary rocks	Late Miocene to Holocene (7.2 Ma onwards)	The sedimentary rocks from the Late Miocene onwards consist of various grain sizes corresponding to paleo sea levels and tectonic events. Rock types include; marl, sandstone, limestone, conglomerate, greywacke and reworked volcanoclastics.
Calc-alkaline Volcanic Rocks	Late Miocene to Early Pliocene (7.2 to 3.6 Ma)	Predominantly volcanic rocks consisting of andesite, dacite and basalt, with occasional intrusive plugs at the remnant volcanic centres, including gabbro, microsyenodiorite, tonalite, granodiorite
Shoshonitic Volcanic Rocks	Early Pliocene (3.6 to 2.6 Ma)	Predominantly basalt with associated monzonite intrusives.
Alkali-basaltic Volcanic Rocks	Middle Pliocene onwards 3.6 Ma onwards)	Basaltic rocks associated with an extensional tectonic setting.
Coral reefs and associated deposits	Quaternary to present day (2.6 to 0 Ma)	This unit consists of emerged reefs, present day reefs, lagoon deposits and beach deposits.
Alluvium	Holocene to Present Day (11,700 to 0 kyr)	This unit consists of the unconsolidated sediments (sand, silt and gravel) deposited by rivers.

Figure 4: 1: 1,000,000 Geological Map of Fiji (Source: Geological Survey of Fiji, 1965).



Development Minerals

The mining of Development Minerals in Fiji predominantly consists of aggregate, clay and sand, used for construction materials, and to a lesser extent limestone, used for agricultural purposes[12].

To date no dimension stones or semi-precious stones have been extracted from Fiji, because no resources have ever been proven. The Qalimare Limestone (a marble deposit) was once investigated as a possible source of dimension stones, however the quality was deemed sub-standard. Furthermore, the Qalimare deposit was declared a 'Government Protection Area' in an amendment to the Mining Act of Fiji in 1983, which prohibited any further speculation regarding its use as a potential source of dimension stones. Some local Fijian companies do manufacture dimension stones but the source material is exclusively imported.

Exploration and feasibility assessment of the potential of Development Minerals in Fiji (for example assessing the feasibility of processing plutonic rocks of Fiji into dimension stones) was outside of the scope of the baseline assessment.

In summary, the industry in Fiji consists of a limited selection of Development Minerals, and is largely made up of construction materials and to a lesser extent limestone (Table 5).

Table 5: Fiji Development Minerals Summary

Name	Development Mineral Type	Definition for the purpose of this assessment
Aggregate	Construction	Any naturally occurring fragments of rock > 2mm.
Sand	Construction	Any naturally occurring fragments of rock between 0.06mm and 2mm.
Clay	Construction	Any naturally occurring inorganic soil (with a strength <1MPa) comprised of grains <0.06mm[13].
Limestone	Construction Industrial	Any rock comprising <50% calcium carbonate.

[12] Mineral Resources Department, Bibliography Records Volume 1-13.

[13] In fine-grained soils the grains between 0.002mm and 0.06mm are technically classified as silt, and the grains <0.002mm are classified as clay (NZGS, 2005). For the purpose of this assessment all fine-grained soils <0.06mm are classified as clay.

Overview of the regulated extraction and beneficiation sites

The study team requested databases of all active extraction sites on record at the following government bodies:

- DoL
- iTLTB
- Rural Local Authority
- MRD
- MoE

DoL, iTLTB and MRD all provided databases of active extraction sites, but the study team was not provided access to the databases of the MoE and Rural Local Authority. This process highlighted the fundamental issue that no government body has a comprehensive database of all extraction sites. Subsequently, the study team compiled the databases provided by DoL, MRD and iTLTB to form a database of active regulated extraction sites in Viti Levu and Vanua Levu. It is important to note the completeness of the database is limited due to a lack of data from the Rural Local Authority and MoE, and also by the completeness of the record keeping at DoL, MRD and iTLTB. However, for the purpose of this study, all other active extraction sites observed during the fieldwork are assumed unregulated.

The study team also compiled a database of active regulated beneficiation sites based on the following:

- Database of crusher and screening sites on record at MRD
- Concrete, gravel and lime companies in the Yellow Pages
- Council business license records
- Local knowledge (snowball techniques)

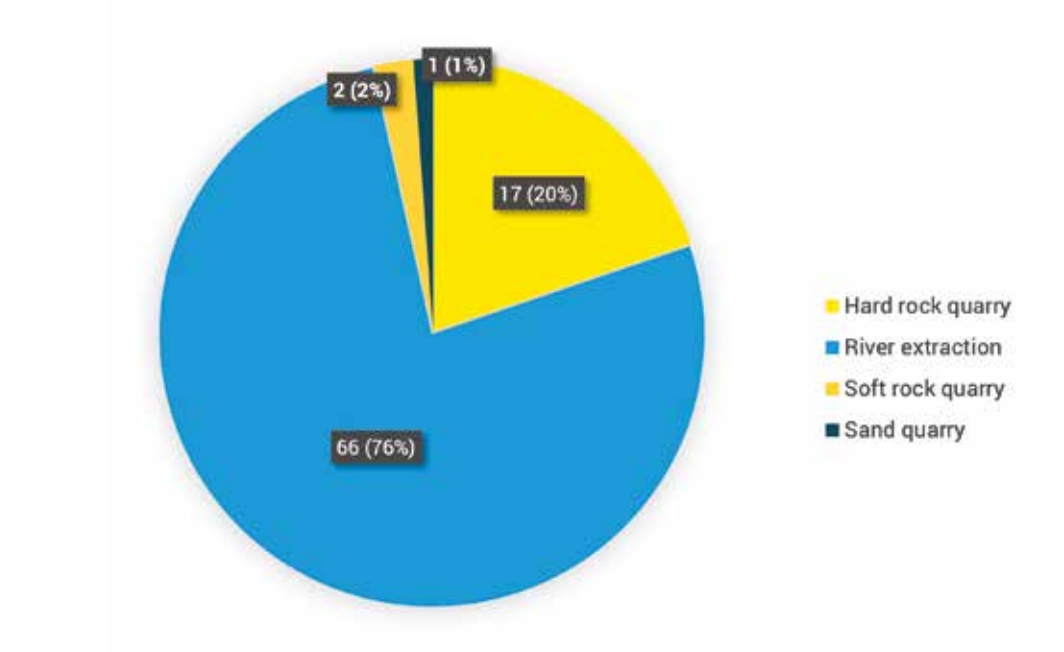
For the purpose of this study, all other active beneficiation sites observed during the fieldwork are assumed unregulated. The Registrar of Companies was also contacted, but did not respond with any data.

Based on the nature of the extraction sites, the regulated sites were categorised into the following four categories:

1. Hard rock quarry: extraction from a strong rock mass, requiring the use of explosives.
2. Soft rock quarry: extraction from a weak rock mass, by the means of mechanical excavation.
3. Sand quarry: terrestrial extraction of sand by the means of mechanical excavation.
4. River extraction: extraction of unconsolidated gravel and sand from the riverine environment by the means of mechanical excavation or dredging.

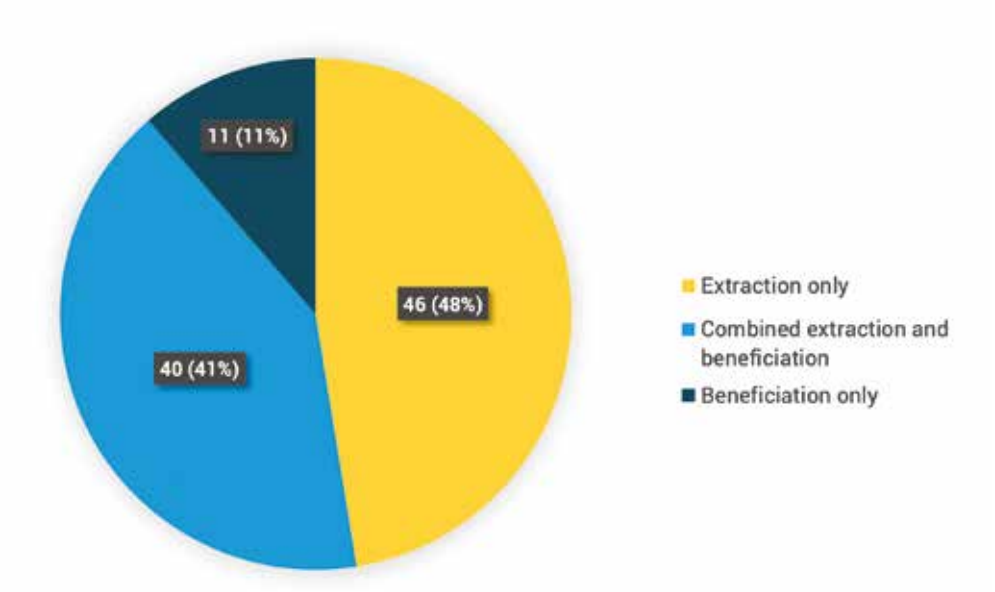
Figure 5 below graphically represents the characterised breakdown of regulated extraction sites. Notably, the vast majority (76%) of the sites are located in riverine environments, while only 20% of the sites are hard rock quarries (typically producing the highest quality construction material).

Figure 5: Characterised breakdown of regulated extraction sites (Source: SPC Fieldwork, 2017).



A number of the regulated sites comprise combined extraction and beneficiation. Of the 40 combined extraction and beneficiation sites, all of the 17 hard rock quarries are in this category, compared to only 23 of the 66 river extraction sites. Eleven sites purely focus on beneficiation, predominantly concrete manufacturing companies. Figure 6 below presents the composition of the extraction and beneficiation sites.

Figure 6: Regulated extraction and beneficiation sites composition (Source: SPC Fieldwork, 2017).



The river gravel extraction and beneficiation sites typically exhibited the following characteristics:

- Removal of gravel and sand from the active river channel, bars and banks, using a mechanical excavator or dredge.
- Stockpiling and beneficiation of material close to the extraction site, or transportation of the material by truck to a separate beneficiation site.
- Beneficiation consisting of washing, crushing and screening of the material.
- The quality of Development Mineral products is variable and inconsistent due to the numerous different source outcrop lithologies feeding the river systems.
- Significant environmental and social impacts (depending on the scale of the operation) affecting extended sections of river ecosystems, with reduced scope for effective rehabilitation (further detail discussed in 'Environmental and socio-economic analysis' section of this report).
- Varying levels of occupational health and safety measures in place, but typically sub-standard with poor signage and a lack of compliance with the stipulations in environmental management plans (further detail discussed in the 'Occupational health and safety' section of this report).

Figure 7 to Figure 27 present photographs of river extraction sites observed during the fieldwork.

Figure 7: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 8: River gravel extraction site near an FRA crossing (Source: SPC Fieldwork, 2017).

Figure 9: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 10: River gravel extraction site (Source: SPC Fieldwork, 2017).

Figure 11: River gravel extraction and beneficiation site (Source: SPC Fieldwork, 2017).

Figure 12: River gravel extraction site (Source: SPC Fieldwork, 2017).

Figure 13: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 14: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 15: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 16: River gravel extraction (Source: SPC Fieldwork, 2017).

Figure 17: River dredging operation (Source: SPC Fieldwork, 2017).

Figure 18: River gravel extraction site (Source: SPC Fieldwork, 2017).

Figure 19: River gravel extraction
(Source: SPC Fieldwork, 2017).

Figure 20: River gravel extraction
(Source: Facebook, 2017).

Figure 21: River gravel extraction site
(Source: SPC Fieldwork, 2017).

Figure 22: River gravel extraction
(Source: SPC Fieldwork, 2017).

Figure 23: River gravel extraction site
(Source: SPC Fieldwork, 2017).

Figure 24: River gravel extraction site
(Source: SPC Fieldwork, 2017).

Figure 25: River gravel extraction site
(Source: SPC Fieldwork, 2017).

Figure 26: River gravel extraction site
(Source: SPC Fieldwork, 2017).

Figure 27: River gravel extraction site (Source: SPC Fieldwork, 2017).

Figure 28: Beneficiation adjacent to a river gravel extraction site (Source: SPC Fieldwork, 2018).

The hard rock quarry extraction and beneficiation sites typically exhibited the following characteristics:

- Blasting of volcanic or plutonic rock by qualified professionals using explosives.
- Transportation of blast rock to a processing area on site for beneficiation consisting of crushing, screening and washing.
- Consistent and high quality Development Mineral products due to homogenous volcanic or plutonic rock bodies.
- Localised environmental and social impacts with scope for effective rehabilitation, with examples of fully rehabilitated sites such as Coli-i-Suva Rainforest Eco Resort and Vuda Marina.
- Storage of explosives on site in a magazine.
- Varying levels of occupational health and safety measures, however typically a higher standard than river extraction sites, with signage and compliance with health and safety stipulations in the QOEMP reports.

Figure 29 to Figure 37 present photographs of hard rock quarry sites observed during the fieldwork.

Figure 29: Hard rock quarry in the Central Division (Source: SPC fieldwork, 2017).

Figure 30: Hard rock quarry in the Northern Division (Source: SPC fieldwork, 2017).

Figure 31: Hard rock quarry in the Northern Division (Source: SPC fieldwork, 2017).

Figure 32: Hard rock quarry (Source: SPC fieldwork, 2017).

Figure 33: Hard rock quarry in the Northern Division (Source: SPC fieldwork, 2017).

Figure 34: Hard rock quarry in the Central Division (Source: SPC fieldwork, 2017).

Figure 35: Hard rock quarry (Source: SPC fieldwork, 2017).

Figure 36: Hard rock quarry (Source: SPC fieldwork, 2017).

Figure 37: Hard rock quarry (Source: SPC fieldwork, 2017).

The sand and soft rock quarries typically exhibited the following characteristics:

- Excavation of sand or soft rock (including residual clay) using a mechanical excavator.
- Stockpiling of material on site, or loading of material into trucks for direct transportation to customers.
- Consistent quality Development Mineral products due to homogenous nature of the resources.
- No beneficiation was observed.
- Varying levels of localised environmental and social impacts with scope for effective rehabilitation. One of the soft rock quarries demonstrated no compliance with environmental measures and made no attempt to rehabilitate the area, leaving the local environment in a severely impacted state.
- Varying levels of occupational health and safety measures and compliance with stipulations in the QOEMP reports.

Figure 38 to Figure 39 present photographs of the terrestrial sand and soft rock quarry sites observed during the fieldwork.

Figure 38: Sand quarry in the Western Division (Source: SPC fieldwork, 2017).

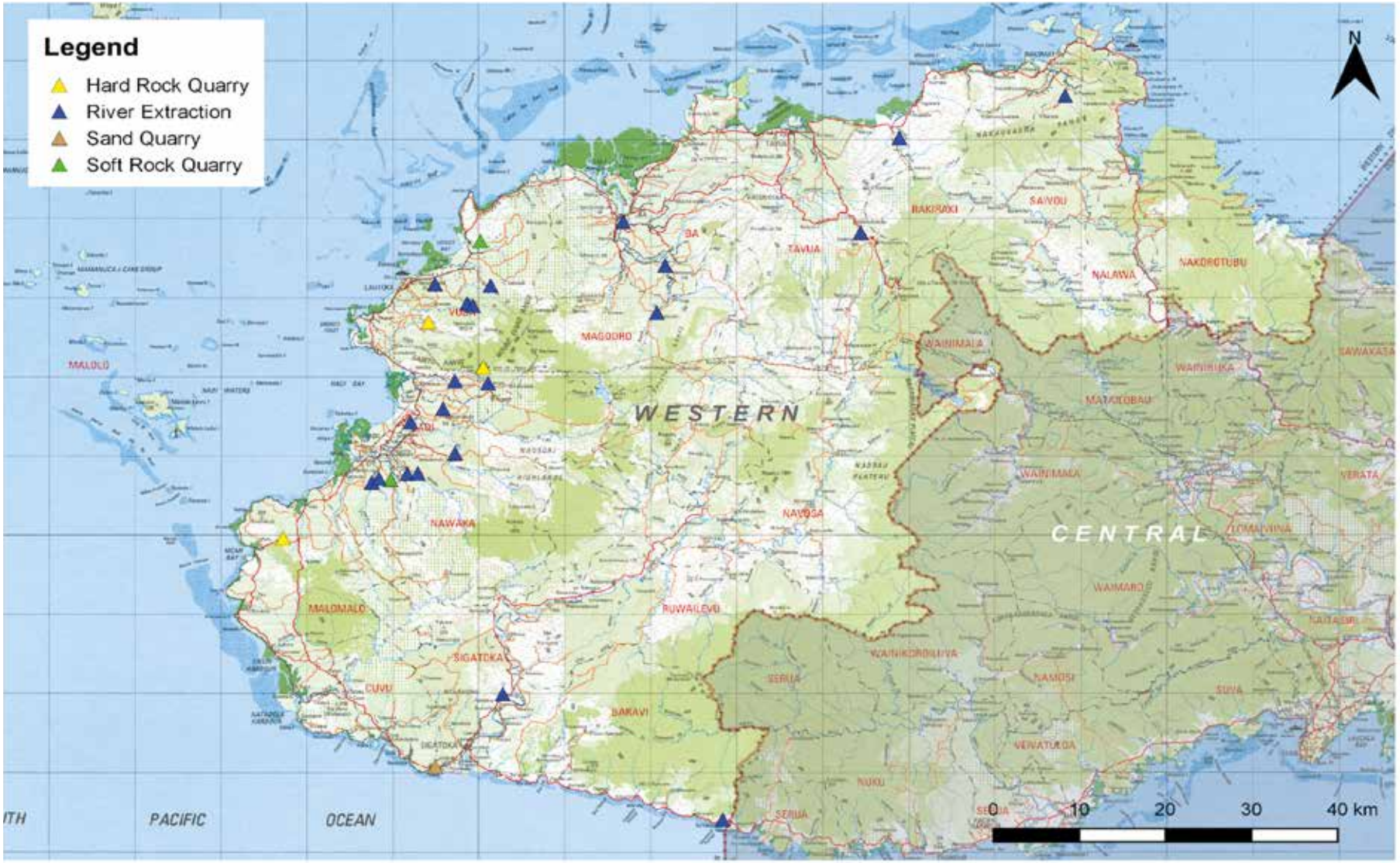
Figure 39: Soft rock quarry; poor environmental compliance and no rehabilitation (Source: SPC Fieldwork, 2017).

Divisional maps of the regulated extraction and beneficiation sites are presented in Figure 40 to Figure 45 below.

Figure 40: Map of the regulated extraction sites in the Central Division (Source: SPC fieldwork, 2017).

Figure 41: Map of the regulated beneficiation sites in the Central Division (Source: SPC Fieldwork, 2017).

Figure 42: Map of the regulated extraction sites in the Western Division (Source: SPC Fieldwork, 2017).



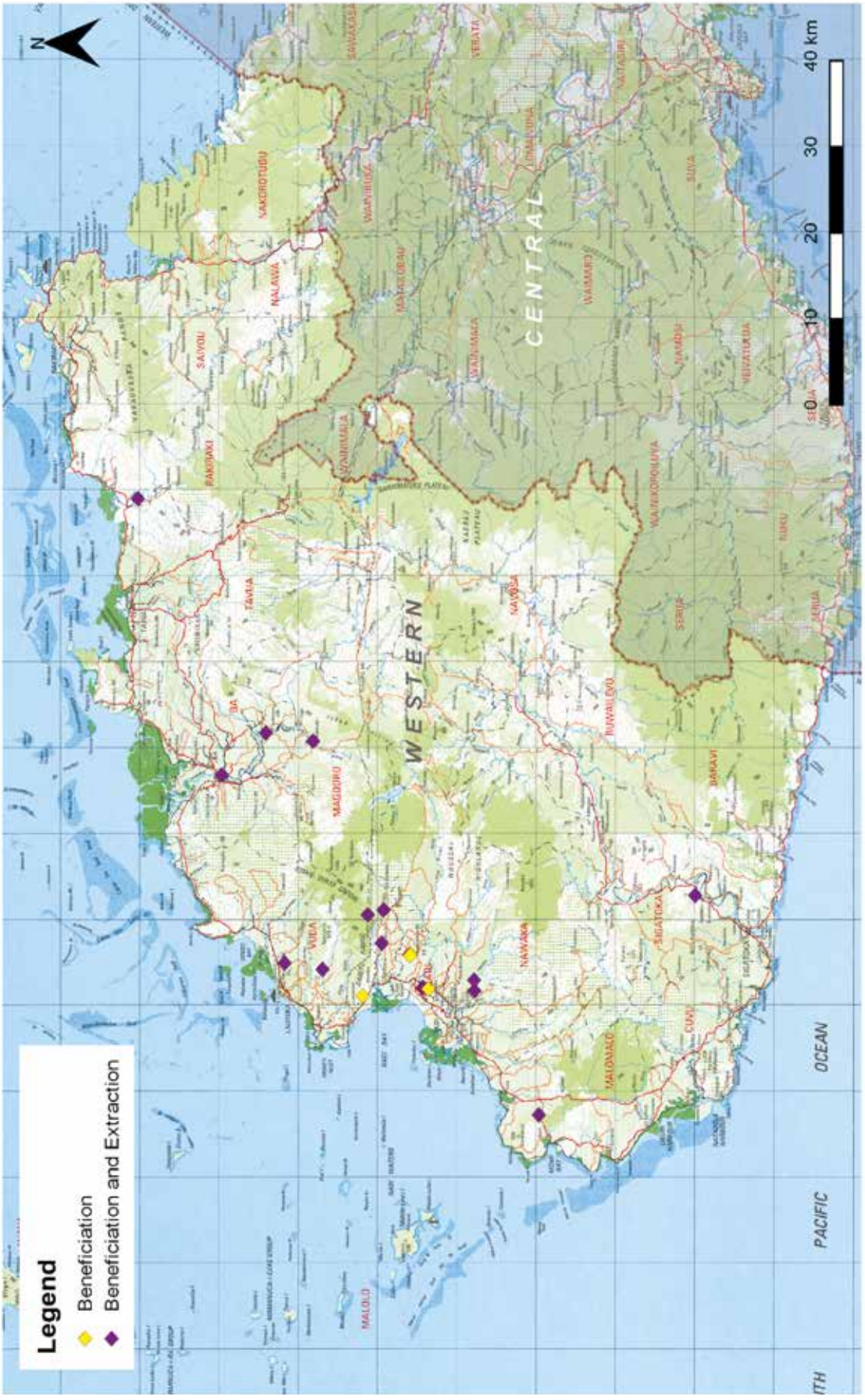


Figure 43: Map of the regulated beneficiation sites in the Western Division (Source: SPC Fieldwork, 2017).

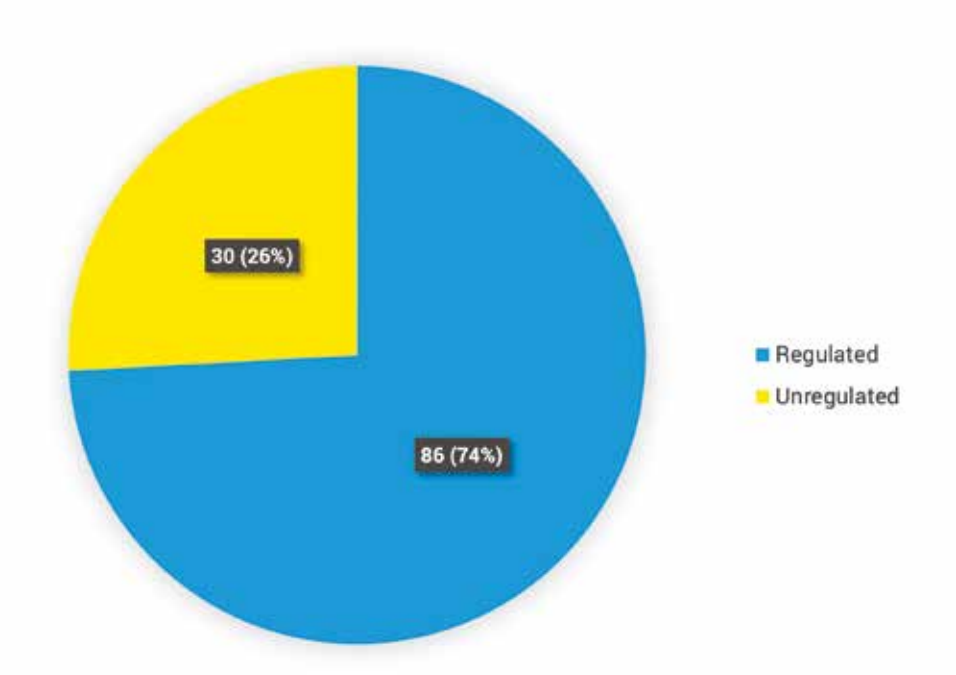
Figure 44: Map of the regulated extraction sites in the Northern Division (Source: SPC Fieldwork, 2017).

Figure 45: Map of the regulated beneficiation sites in the Northern Division (Source: SPC Fieldwork, 2017).

Overview of the unregulated extraction and beneficiation sites

As outlined above, no comprehensive database of all extraction sites previously existed and therefore differentiating between regulated and unregulated sites was difficult. For the purpose of this study, the combined datasets from DoL, iTLTB and MRD were used as the basis for differentiating between regulated and unregulated sites. As shown in Figure 46, the study team observed 30 unregulated extraction sites during site visits and via reviewing Google Earth imagery. This number only represents the unregulated extraction observed by the study team; the actual number of unregulated sites is likely higher. River gravel extraction has the highest number of unregulated activity with 27 sites observed as opposed to 2 unregulated soft rock quarries and 1 unregulated hard rock quarry.

Figure 46: Regulated vs unregulated extraction sites (Source: SPC fieldwork, 2017).



The nature of the unregulated gravel extraction sites typically comprised 2-3 personnel using 1 excavator and 1-2 trucks (see Figure 47 to Figure 50). The study team also observed a 1-man river gravel extraction operation, where the operator extracted gravel from the active river channel using an excavator, loaded the material directly into a truck, then dismounted the excavator and drove the truck to an unknown destination once the load was full, leaving the excavator in the river channel.

The study team observed trucks transporting Development Minerals without license plates and the required Land Transport Authority (LTA) labels (such as weight limit). Extraction and transportation of gravel at night was also observed.

Some of the unregulated extraction sites were located directly adjacent to bridge and crossing structures (as they provide an easy access point), extraction in these areas has the potential to damage the transport infrastructure (see Figure 48). A review of Google Earth imagery of the Namosi River (commonly referred to as the 'Mosi River') in Nadi highlighted 9 unregulated extraction sites over an approximately 18km long stretch of river. The Ministry of Waterways

also observed the unregulated extraction of gravel on the Mosi River and expressed particular concern about this activity, because it has the potential to destabilise the flood retention weirs on the river[14].

Figure 47: Unregulated river gravel extraction site (Source: SPC fieldwork, 2017).

Figure 48: Unregulated river gravel extraction site immediately downstream of Irish crossing (Source: SPC fieldwork, 2017).

Figure 49: Unregulated river extraction (Source: SPC fieldwork, 2017).

Figure 50: Unregulated river extraction (Source: SPC fieldwork, 2017).

The unregulated hard rock quarry operation comprised an excavator removing loose material produced during historical blasting at a disused quarry. The study team did not observe any unregulated use of explosives.

The unregulated soft rock quarry shown in Figure 51 comprised at least 5 personnel using 3 excavators and 2 trucks. According to discussions with personnel on site, the operator was granted an iTLTB lease for agriculture; however, instead of being utilised for agriculture, the site has been developed into a soft rock quarry, without the necessary approvals (such as an EIA and QOEMP), nor appropriate compensation to the local resource owners via the gazetted iTLTB royalty rates.

An unregistered excavator was observed removing material and loading it into a truck at an unregulated soft rock quarry in the Western Division, as shown in Figure 52. According to information provided the study team by site personnel, the material was being used for land reclamation as part of a foreshore development in Lautoka.

[14] Ministry of Waterways, Personal communication, 2017.

Figure 51: Unregulated soft rock quarry (Source: SPC fieldwork, 2017).

Figure 52: Unregulated soft rock quarry (Source: SPC Fieldwork, 2017).

Crushers were observed at two of the unregulated river extraction sites, indicating the presence of unregulated beneficiation. According to Fiji Revenue and Customs Records (FRCA), a total of 83 crushers were imported into Fiji in the last 10 years. The study team recommends that MRD crosscheck the number of crushers operating at the 39 regulated crushing sites against the FRCA records, to ascertain the likely scale of unregulated crushing.

The study team also observed activity indicating the presence of an unregulated market for coral sand, this is concerning as the potential environmental and socio-economic impacts of beach mining are significant. Potential impacts include; increased rates of coastal erosion, damage to coastal ecosystems and tourism attractions (e.g. coral reefs and beaches), and reduced resilience against the impacts of climate change and natural disasters. Figure 53 to Figure 58 display stockpiles of coral sand observed during the study, the location of the extraction sites is unknown.

Figure 53: Coral sand stockpile in the Northern Division (Source: SPC fieldwork, 2017).

Figure 54: Coral sand stockpile in the Northern Division (Source: SPC fieldwork, 2017).

Figure 55: Truck offloading coral sand in the Northern Division (Source: SPC Fieldwork, 2017).

Figure 56: Coral sand stockpile in the Central Division (Source: SPC Fieldwork, 2017).

Figure 57: Coral sand stockpile (Source: SPC Fieldwork, 2017).

Figure 58: Coral sand stockpile (Source: SPC Fieldwork, 2017).

Actual and potential uses of Development Minerals in Fiji

Actual uses of Development Mineral in Fiji

Development Minerals in Fiji are predominantly used for two main purposes:

1. Construction materials
2. Agricultural lime

The vast majority of Development Minerals are utilised as construction materials (all 86 extraction sites produce construction materials), including the following products:

- Concrete
- Road aggregates
- Sand
- Sealing chips
- Fill
- Plaster
- Tile adhesive
- Large rock for erosion protection
- Landscaping rock

These construction materials are used to develop a plethora of infrastructure in Fiji; the 'Development Minerals required to implement the government's 5-year national development plan' of this report indicates the type of infrastructure the government intends to develop in the near future (2017-2022). It is important to note the plan does not include the significant infrastructure developed by private investment in Fiji; such as, tourism facilities (e.g. resorts and hotels), factories, business facilities (e.g. offices), shops, warehouses, apartments, and many more.

One quarry in Viti Levu produces agricultural lime. The material is used to improve soil quality,

which increases agricultural production, and thereby reduces agricultural imports and increases agricultural exports[15]. According to discussions with the sole manufacturer of agricultural lime in Fiji, product sales have not reached their full potential. Continued awareness raising and marketing of the product to the farming sector is required to ensure the full benefits of agricultural lime are realised.

Potential uses of Development Minerals in Fiji

As discussed below, there is definitely potential for Fiji to utilise Development Minerals for several other purposes additional to current utilisation. Some of the prospective Development Mineral industries are already conducted at a grassroots level (with potential for expansion), some are industries that existed in the past (with potential for reestablishment in the present-day context), and others are entirely new industries for Fiji. We recommend the government seriously considers the potential options discussed below, as they have huge potential to support the economy and sustainable development in Fiji through job creation, and reducing the dependence on imported materials.

A report produced by the British Geological Survey (BGS) in 1993[16] (25 years ago) is the last known study of the Development Minerals sector in Fiji. The study provides an initial insight into the potential of the industrial minerals sector in Fiji, and makes a series of recommendations, including:

1. To compile a basic inventory of all significant occurrences of industrial minerals in Fiji.
2. To make detailed field and laboratory investigations of selected industrial mineral deposits in Fiji. Emphasis would be placed on limestones for lime, dimension stones, clay materials for burnt brick production, and phosphates.
3. To identify new industrial mineral resources and to research new markets for known mineral deposits.
4. To prepare reports and maps detailing the results of recommendations 1 to 3 above, for potential investors from within and outside Fiji.
5. To prepare appropriate guidelines for environmentally acceptable sustainable development of industrial mineral resources in Fiji.
6. To conduct training for MRD staff in evaluating industrial minerals.

It would appear that these recommendations have not previously been actioned. However, as discussed below, the recommendations remain relevant.

The raw materials required to produce Portland cement are lime, alumina, silica, iron oxide, and gypsum. All of these raw materials are available in Fiji, with the exception of gypsum. The only known deposits of gypsum are in Wainikoro and Nukundamu, where the occurrence is in small lenses at depths not suitable for economic extraction[17]. Historically Portland cement

[15] Market Development Facility, Aglime for Fiji, 2013
[16] British Geological Survey, Industrial Minerals Potential of Fiji, 1993.
[17] Mineral Resources Department, Raw Materials for Cement in Fiji, 1983.

was produced in Fiji using locally sourced materials (with the exception of gypsum which was imported)[18]. Between 1959 and 2004 lime (in the form of coral sand) was dredged from the back reef slope of the barrier reef fronting Laucala Bay and Suva Harbour (see Figure 59 and Figure 60), in water depths between 2.5m and 12m. Silica, alumina and iron oxide was sourced in the form of sand from the Navua and Rewa Rivers, or from crusher dust produced at Nasinu Quarry. The coral sand represented approximately 80% of the raw material requirements, and thus when the dredging operations ceased in the late 2004 (due to environmental reasons), so too did the production of cement from local materials. Thus, Fiji began importing clinker to produce cement in 2005, a practice which continues today. Subsequently, the local cement workforce suffered an 86% reduction, from approximately 500 employees to approximately 70 employees[19]. In 2016 Fiji imported approximately 250,000m^3 of cement clinkers at a cost of FJ$26.2M[20]. The current dependence on imports makes the Fiji construction industry (and the associated development objectives) vulnerable to external market forces. According to discussions with a cement manufacturer, the viability of the local cement manufacturing industry is threatened, due to a 300% increase in the price of clinker (since Fiji began importing clinker in 2005), combined with an increase in shipping costs. Should the cost of cement production increase further, there is a risk that it may become more economical to import cement directly, and thus cease local cement production. The importation of clinker is associated with several issues additional to the impact on Fiji's Balance of Payments; clinker suppliers require 3 months' notice to produce orders ready for shipment to Fiji (which can result in a shortage of supply), the logistics of offloading the clinker from the ships and transporting it to the cement production factories puts stress on both the maritime and land transport infrastructure, offloading is limited to periods of dry weather, issues with dust has created conflict with other businesses in the area, and at times issues with offloading the clinker has slowed down production timeframes resulting is supply issues. A study conducted by MRD in 1983[21] highlighted the presence of raw materials for cement production in Fiji. The study investigated several limestone deposits in Fiji (an alternative to dredging coral sand), and highlighted the potential to open a new cement factory using lime produced from the investigated limestone deposits. The report recommended further detailed analysis of the limestone deposits, and also further investigation of the pozzalanic material of Vanua Levu as a partial substitute for Portland cement. The BGS study conducted 10 years later (in 1993) investigated 5 limestone deposits which highlighted the suitability of all 5 deposits for cement production. The study also identified the suitability of some of the limestone deposits for other applications such in sugar refining, glass manufacturing, fillers, pigments, steel and iron manufacturing, and chemical manufacturing. The foreword to the 1983 MRD report (from the then Director of Mineral Development, H.G. Plummer) states "deposits of industrial minerals can be more important to national development than their more spectacular metalliferous counterparts. They may also be longer lasting and have a more pervasive effect on that development. Hence the report is expected to be of lasting value", in line with these fitting words, the study team recommends serious consideration (including detailed research and market analysis) of reinstating cement production utilising local resources (to reduce the reliance on imported clinker), as well as expanding the lime industry for other purposes.

[18] Stuart Ward, Coral sand dredging in Fiji: The impacts and the future of this industry, 1997.
[19] Cement manufacturer, personal communication, 2018
[20] Bureau of Statistics, Cement imports, 2016
[21] Mineral Resources Department, Raw Materials for Cement in Fiji, 1983.

Figure 59: Coral sand dredging operation in Suva (Source: Robert Smith, 1994).

Figure 60: Coral sand dredging operation in Suva (Source: Robert Smith, 1994).

Industrial lime is also utilised in the leaching process at the Vatukoula Gold Mine. Historically this material was produced locally from crushed limestone, however the mine currently imports lime[22]. There is certainly potential to produce industrial lime locally given the numerous limestone resources in Fiji. We recommend that any further assessments of lime resources (including for cement production described above) should consider the specifications required in the gold leaching process.

Residual clays (the result of in-situ weathering of parent rock) are widespread throughout Fiji. At hard rock and soft rock quarries, significant volumes of clay overburden often needs to be removed to access the target rock. This clay is often considered unwanted material and is simply dumped to waste. Current clay utilisation is primarily confined to fill material, such as coastal land reclamation projects, landfills, and the 'clay cores' of the hydropower dams in the interior of Viti Levu. Clay is also utilised for traditional pottery making, but only at the grassroots level, with potential for expansion[23]. In most instances non-cohesive granular fill is preferred over cohesive clay due to: difficulties with compaction, slope stability issues, response to changes in moisture content, and settlement issues. However, historical evidence suggests that the clay resources in Fiji may potentially be more valuable than currently perceived, and there is in fact scope to utilise the resources for practical purposes. Prior to 1912, the Fiji Tile and Brick Company operated a clay-pit in Wailekutu, where they produced bricks and tiles from the residual clay of the Veisari Sandstone Formation[24]. A further study in 1944 tested several residual clay deposits to ascertain their suitability for brick production[25]. The study identified several clay deposits (in close proximity to Suva) suitable for manufacturing brick, tiles and pipes. Further studies conducted in 1969[26], 1982[27], and 1993[29] also concluded that suitable clays exist in Fiji to support the development of a ceramic industry, however no significant development of a ceramic industry has occurred. Given the current perception of residual clay as a 'waste material' and the widespread extent of the resource in Fiji, the feasibility of a local ceramic industry warrants further consideration in the present-day context. The residual clay deposits are also prospective resources for local cement production (described above). Alumina, silica and iron oxide are raw materials required in the

[22] Vatukoula Gold Mine, personal communication, 2018.
[23] https://www.sfu.ca/archaeology/museum/exhibits/virtual-exhibits/fijian-pottery-at-nakabuta-village.html
[24] Geological Survey of Fiji, The Geology of Southern Viti Levu and Mbenga, 1968.
[25] White, F.T.M, Brickmaking with Fiji clays, 1944.
[26] Williams, M, Tests of soils and weathered rock as materials for brick manufacture, 1969.
[27] New Zealand Department of Scientific and Industrial Research, Ceramic Clay Deposits in the South Pacific Islands, 1983.

production of Portland cement, all of which are present in the residual clay resources of Fiji[28]. Residual clay may also have a role to play in supporting wider sustainable development in the Pacific region; the Government of Nauru is currently planning to rehabilitate its post-phosphate mining landscape, and this process will require soil to establish a local agriculture industry. Subject to further studies, it may be feasible to export residual clay from Fiji to support rehabilitation works in Nauru.

In 2016 Fiji imported US$11.2M of glass products[29]. The study conducted by BGS in 1993 is the last known research regarding the potential for developing a glass production industry in Fiji. Silica sand is the raw material required for glass production; BGS tested 2 samples of silica sand from Davuilevu to assess suitability for glass production. The raw samples included too much coarse material and unacceptable levels of impurities. However, BGS suggested it would be possible to process the material through screening and magnetic separation, to upgrade the raw silica sands to suitable grades for glass production. This is particularly relevant given the advances in mineral processing technology and techniques in the last 25 years since this recommendation was made. The report also noted that the silica sand resources in Fiji are largely unexplored in terms of both quantity and quality, despite the existence of potential resources with good access near Suva, and recommend further investigation of the resources. An earlier feasibility study by the Commonwealth Fund for Technical Cooperation (CFTC) in 1982 also investigated the potential of a glass bottle project in Fiji[30]. Three sand deposits were investigated during the study; one in Wainabuku, and two in Sigatoka. The study concluded that none of the deposits where suitable for glass production without a considerable beneficiation programme. However, CFTC recommended further consideration of the Wainibuku Deposit (containing 93.4 % SiO_2) which may be suitable for glass bottle production when subjected to magnetic separation and froth flotation. According to information available to the study team; no further investigations have been conducted, and current glass production in Fiji is carried out using imported materials. Therefore the study team recommends further research into the feasibility of developing a glass production industry in Fiji, to support the local economy and reduce the reliance on imported glass products. Any such study should consider increased recycling of glass waste and the potential to export glass within the Pacific region, given Fiji's strategic location and infrastructure.

Lomawai Village in the Western Division produces salt using traditional methods. The process (which has been carried out for several generations) involves collecting salt water in excavations on mangrove mudflats (see Figure 61), the water is boiled to produce a salt residue, which is laid on mats for bleaching by the sun, before being packaged ready for sale in baskets woven from mangrove stems. The salt production is small-scale and supports an eco-tourism initiative where tourists are given a tour of the salt-works, and the salt produce is sold to tourists (as well as locals)[31]. The salt production at Lomawai is the major source of income for most the women in the Village[32]. In 2017 Fiji imported FJ$2.8M worth of salt from Australia, China, Germany, United Kingdom, Hong Kong, India, Japan, Republic of Korea, New Zealand, Pakistan, Singapore, Taiwan, and he United States[33]. There is scope to replicate the salt-works at other coastal villages in Fiji

[28] Fiji Mineral Resources Division, Raw Materials for Cement in Fiji, 1983.
[29] https://atlas.media.mit.edu/en/visualize/tree_map/hs92/import/fji/show/2501/2016/
[30] Commonwealth Fund for Technical Cooperation, Fiji: Feasibility Study of a Glass Bottle Project, 1982.
[31] http://www.fiji-budget-vacations.com/lomawai-salt-making-village.html
[32] The Fiji Times, Keeping a Tradition Alive, 2014.
[33] Fiji Bureau of Statistics, Salt imports, 2016.

(and potentially consider larger scale operations) to reduce the financial burden of salt imports, and support the local economy (particularly women living in coastal communities).

Figure 61: Lomawai Village salt production (Source: United Nations Population Fund, 2015).

Phosphorus is an essential element for all life forms, and humans derive phosphorus almost entirely from their diet. Industrial scale agriculture utilises manmade fertilisers containing phosphate. The mining of phosphate to support the production of fertilisers is currently important for food security. Research has suggested that economically viable phosphate deposits may be exhausted within the next century[34], consequently phosphate is projected to become a scarce resource in the near future. Therefore creating an inventory of phosphate resources in Fiji is not only valuable for safeguarding future food security, but also economically strategic for export opportunities. A detailed survey by MRD of the phosphate deposits on Tuvuca Island in the Lau Group proved 431,000 tonnes averaging 16.4% $P_2O_{5,}$ another 1,193,000 tonnes averaging 8.8% and a further 213,000 tonnes averaging 4.5%[35]. The historic example of phosphate on Nauru provides an enduring example of the need to conduct any future phosphate mining in an environmentally responsible manner.

The Qalimare Limestone (a marble deposit) was once investigated as a possible source of dimension stones, however the quality was deemed sub-standard. Furthermore, the Qalimare deposit was declared a 'Government Protection Area' in an amendment to the Mining Act of Fiji in 1983, which prohibited any further speculation regarding its use as a potential source of dimension stones. Currently all dimensions stones are imported or manufactured locally from

[34] Ali, S.H, Clifford, M.J., and Matusbae, K., Mining and Socio-ecological Resilience in Mineral-Rich Small States: An Integrative Approach to Phosphate Mining on Nauru, 2017.
[35] Mineral Resources Department, The Phosphate Deposits and Geology of Tuvutha, 1981.

imported materials. There is potential to investigate other rock types as potential sources of dimension stones, such as the intrusive rocks of Fiji. However; the majority of the intrusive rock resources are located in remote locations and have thick weathering profiles, meaning they are difficult to access and would require significant overburden removal. Therefore, the economics of a potential dimension stone industry are challenging, and potentially prohibitive.

Although 17 hard rock quarries are currently producing construction materials in Fiji, there is enormous potential to develop additional hard rock quarries. In 2017 approximately two thirds of the Development Mineral construction materials were produced from river gravel extraction sites. As discussed in the 'Environmental Impact Analysis' section, the current river extraction from Fiji's perennial rivers is unsustainable, and is being conducted with significant adverse social and environmental impacts. Therefore, as discussed throughout this report, the study team recommends phasing out of river gravel extraction, with the exception of certain areas where it is beneficial to Fijian communities (supported by thorough scientific studies) or is small scale, and the establishment of hard rock quarries in strategic locations.

Overburden and tailings from the metal mining sector present an opportunity to recycle Development Mineral resources currently perceived as waste. Two notable examples include the ongoing bauxite mining on Vanua Levu and the proposed iron sand mining in the Sigatoka and Ba rivers. Firstly, the bauxite mining involves open cast extraction of aluminium rich soils. The bauxite soils occur in a weathered basalt formation, subsequently remnant basalt boulders (products of spherical weathering) are scattered throughout the deposit. The boulders are perceived as a waste product and a hindrance to rehabilitation of the post-mining sites[36]. Subject to quality testing, the boulders are likely suitable for a variety of applications including; crushed aggregate, rock protection and landscaping boulders. Secondly, the proposed iron sand mining in the Sigatoka and Ba rivers involves the dredging of magnetite rich alluvial sand deposits. The proposed beneficiation process involves washing the sand and separating the magnetite via magnetic separation. Therefore, the proposed by-product of the iron sand extraction process is clean alluvial sand suitable for construction purposes. Subject to testing, the sand by-product is likely to produce comparatively high strength concrete due to its purity and angularity relative to the aeolian (wind-blown) dune sands currently utilised for construction in Fiji. These two examples also present an opportunity for the State and respective landowners to optimise the potential revenues of the extraction operations via additional royalties associated with the Development Minerals.

Businesses involved in the Development Minerals sector and the economic importance for Fiji

Seventy-five companies are participating in the regulated extraction and beneficiation of Development Minerals in Viti Levu and Vanua Levu. Forty-one of the companies provided information regarding the percentage of local ownership, and of this data set, 39 companies are locally owned (95%), with only 2 companies having majority foreign ownership. The bulk (84%) of the 75 regulated companies are operating out of a single location, as outlined below:

[36] MRD, personal communication, 2018.

- 63 companies operate at a single location
- 9 companies operate in 2 locations
- 1 company operates in 3 locations
- 1 company operates in 4 locations
- 1 company operates in 12 locations

Thirty-eight of the regulated companies provided employee statistics, as outlined below:

- 1185 employees were directly employed by the 38 companies who responded with data
- An average of 31 employees per company
- The gender demographics of the surveyed workforce include 1143 males and 42 females
- The largest company employs 250 employees
- The smallest company employs 2 employees

Based on 75 regulated companies, and an average of 31 employees per company, we estimate 2325 Fijians are directly employed in the regulated Development Minerals sector in Viti Levu and Vanua Levu. This figure does not account for; the unregulated portion of the sector, sector support services (such as transportation companies, mechanics, lawyers, surveyors, explosives dealers, equipment dealers, environmental consultants, geologists, drilling companies and electricians), civil servants involved in the administration of the sector, nor those involved in the downstream use of Development Minerals (such as construction companies and sugar cane farmers). Compilation of employment demographics for these areas was outside the scope of the study. However, the total number of employees linked to the Development Minerals sector likely accounts for a notable portion of Fijis' total working population (325,144 people). The results of the '2017 Population and Housing Census'[37] are currently being compiled by the Fiji Bureau of Statistics (FBOS). Once the results are published, we recommend analysis of the results to give a more complete indication of the total number of employees linked to the sector.

FBOS is responsible for compiling the official statistical records related to Fiji's economy, such as Gross Domestic Product (GDP). The Mining and Quarrying sector is one of the nineteen sectors forming Fiji's GDP records. The Development Minerals component of the Mining and Quarrying sector is classified by sub class category '08101- quarrying of sand, stone and clay'. The latest published records (2014)[38] are based on a primary survey of 16 companies involved in the sector (as per Registrar of Companies records) with a total of 426 employees (significantly lower than the employee estimate described above). The actual number of regulated companies involved in the sector is 75, and at least 30 unregulated sites are also operating; therefore it appears that the Fiji Bureau of Statistics Gross Output record of FJ$53,033,004 (for sub class category 08101) is a

[37] Fiji Bureau of Statistics, 2017 Population and Housing Census, 2018.
[38] Fiji Bureau of Statistics, Economic Surveys: Mining and Quarrying 2014, 2016.

major underestimation of the Development Minerals industry output and its contribution to Fiji's economy.

Potential implications associated with the undervaluation of the sector include:

- Underreporting of Fiji's overall GDP
- Inadequate budgets for the government institutions responsible for administering the sector, leading to a lack of institutional capacity to regulate the sector and consequent increased likelihood of adverse environmental and socio-economic impacts
- Lost royalty revenues
- Lost tax revenues
- Increased potential for undetected corruption

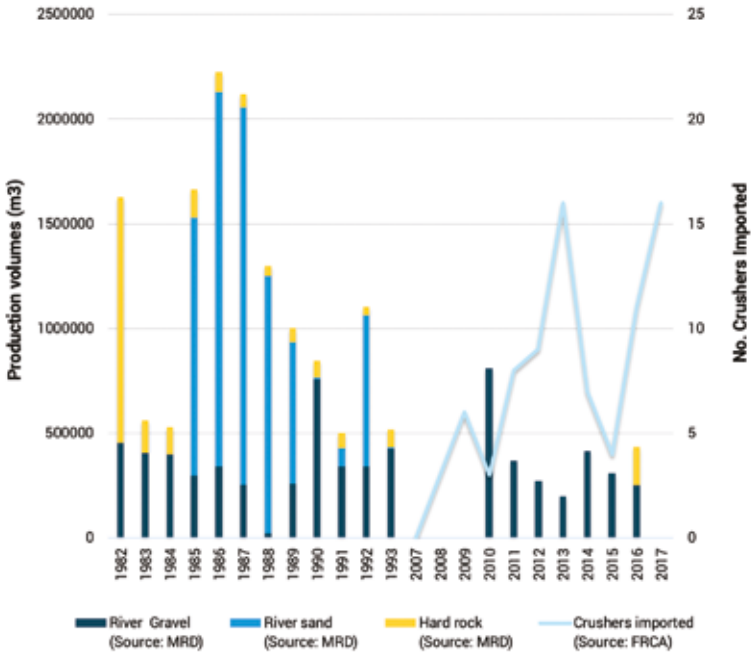
Subsequently, the study team attempted to capture a more accurate valuation of the sector and its contribution to Fiji's economy. The study team requested raw production volumes (for the regulated sites) from MRD. This process highlighted three fundamental issues:

1. MRD is only responsible for administrating the Quarries Act, Mining Act and Explosives Act and assists MoE to administrate the Environment Management Act. Therefore, MRD is responsible for administrating; hard rock quarries, sites requiring explosives and sites with crushing equipment. Thus, MRD does not administrate gravel extraction from rivers if crushing equipment and explosives are not used. In addition, the record keeping and collaboration between institutional stakeholders is inconsistent. According to the database provided to the study team MRD is only monitoring 41 (48%) of the 86 regulated extraction sites.

2. Companies are not submitting production figures to MRD. As shown in Figure 62, production records from 2010 onwards are significantly lower than historic records, which does not correlate with the recent increased construction activity in Fiji and the corresponding spike in the importation of crushers. This also indicates a decline in the record keeping at MRD, represented by the gap in MRD production records between 1993 and 2010.

3. MRD is not conducting regular resource volume surveys to audit and independently monitor the industry.

Figure 62: Development Mineral production vs crusher imports into Fiji (Source: SPC fieldwork, 2017).



In order to obtain a better understanding of the quantity of raw material being produced from hard rock quarries, the study team consulted the main supplier of explosives in Fiji (supplying to 10 quarries) to estimate indicative production figures based on explosive sales and blast records over the past 3 years. The average indicative production volume for the 10 quarries was then applied to the remaining 7 regulated hard rock quarries to approximate total annual production estimates for all 17 of the regulated hard rock quarries, see Table 6. This exercise highlighted the approximate extent to which extraction operators are underreporting production figures to MRD; in 2017 the estimated underreported volume was 1,244,400m^3, this is equivalent to approximately 20 rugby fields with 10m deep excavations.

Table 6: Analysis of hard rock production figures (Source: SPC fieldwork, 2017).

Year	MRD hard rock production records (m^3)	Production estimate based on data from explosive supplier (m^3)
2015	0	1,208,700
2016	183,702	1,037,850
2017	0	1,244,400

In order to obtain a better understanding of the volume of material being produced from the regulated river extraction sites, the study team utilised the following information:

- Monthly production estimates supplied by 13 river extraction companies
- Field observations e.g. number and size of excavators and trucks.
- Truck counting information in certain areas.

The scale of river extraction operations observed during the fieldwork was variable and based on the available information we characterised the sites into the following categories:

- Smaller sized operations, typically producing approximately 10,000m^3/year, accounted for approximately 25% of the observed sites.
- Medium sized operations, typically producing approximately 24,000m^3/year, accounted for approximately 50% of the observed sites.
- Larger sized operations, typically producing approximately 60,000m^3/year, accounted for approximately 25% of the observed sites.
- The largest river extraction operation has at least 26 trucks and is considerably larger than any of the other operations observed throughout the fieldwork, therefore was treated separately when estimating the total production volume for river extraction sites. This particular company provided an annual production estimate which is included in the overall estimate, we cannot disclose this individual estimate for confidentially reasons.

For 2017, we estimate the total production from the 66 regulated river extraction sites was 2,300,000 m^3.

The one regulated sand quarry and the two regulated soft rock quarries were amalgamated for the purpose of the production estimate, to ensure individual company information is not disclosed. Production estimates were based on site observations and indicative geometric measurements from historical Google Earth imagery. We estimate the combined production volume from the sand and soft rock quarries to be 40,000 m^3 for 2017.

A summary of the estimated production figures from the regulated extraction sites and equivalent estimated royalty values is provided in Table 7 below. The total estimated production is 3,584,400 m^3, which is equivalent to approximately a 10 m deep excavation over the entire footprint of an area the size of five Albert Park's (Suva), approximately two thirds of this material originates from Fiji's rivers.

The estimated equivalent royalty value for the production estimate is approximately FJ$10.2M. Available data on actual royalties paid includes:

- In the 5 years since the inception of the constitution in 2013, the total sum of gravel royalty paid to DoL is FJ$1,406,649.06[39], which equates to an average of FJ$281,329.81 per annum.
- Over the 4 year period between 2013 and 2016, the total sum of gravel royalty paid to iTLTB is FJ$6,635,557.53[40], which equates to an average of FJ$1,658,889.38 per annum.

The combined royalty records for iTLTB and DoL (based on the data presented above) equates to FJ$1,940,219.19 per annum. This is 81% lower than the anticipated annual royalty estimate of FJ$10.2M (based on the 2017 production estimate presented in Table 7), thus indicates either

[39] Parliament of the Republic of Fiji, Sitting Minutes from 8th March 2018, 2018.
[40] iTLTB, Royalty records, 2013-2016.

incorrect royalty payments, or incorrect record keeping pertaining to royalties (or both). When it is taken into account that iTLTB historically collected royalties at a rate of FJ$6.61/m for river gravel extraction (between 2013 and 2016), the collected royalties represent an even lower percentage of the anticipated royalties described above.

Table 7: Extraction site production estimates for 2017 and equivalent royalty estimates (Source: SPC fieldwork, 2017).

Development Mineral Site Type	Estimated production for 2017 (m^3)	% of total production volume	Equivalent Estimated Royalty Value ($)*
Hard Rock Quarries	1,244,400	35%	FJ$4.1M
River Extraction Sites	2,300,000	64%	FJ$5.8M
Sand and Soft Rock Quarries	40,000	1%	FJ$0.3M
Totals	**3,584,400m^3**	**100%**	**FJ$10.2M**

*DoL royalty rate of $2.50/$m^3$ used for river extraction sites, iTLTB rate of $3.31/$m^3$ used for hard rock quarries, and iTLTB rate of $6.61/ m^3 used for the soft rock and sand quarries.

We note that actual royalty rates will differ depending on specific resource ownership at the extraction sites.

The study team is not privy to tax records from FRCA, therefore were not able to document the tax revenues that are generated from the industry. However, theoretically the tax revenues should be significantly higher than the royalty revenues. Therefore, the combined expected revenues generated from the Development Minerals sector represent a notable sum of money available for sustainable development in Fiji. However, we note the royalty rates are outdated and thus do not reflect the true value of the resource. The respective royalty rates also differ between the different institutional stakeholders. The DoL royalty rate[41] (last updated in 1997) for gravel extraction in a river is FJ$2.50 per m^3, while the iTLTB royalty rate[42] (last updated in 2014) for rock is FJ$3.31 per m^3, and FJ$6.61 per m^3 for sand and gravel (on dry land). We recommend the royalty rates are assessed, and updated to ensure appropriate royalty revenues are generated.

The production estimate equates to 4 m^3 of Development Minerals produced per capita in Fiji in 2017. This indicates the average annual consumption of Development Minerals per Fijian, but does not reflect the exact local consumption per capita because it does not account for exports, or material produced from the unregulated sites. Therefore the actual consumption per capita may be higher or lower than 4 m^3 depending on the quantity of exports relative to unregulated production. The container in Figure 63 provides a visual representation of 4 m^3.

[41] Government of Fiji, Cabinet Decision: Gravel/sand extraction and recompense for the loss of traditional fishing rights, 1997.
[42] Government of Fiji, iTaukei Land Trust (Gravel) (Amendment) Regulation 2013, 2014.

Figure 63: 4 m^3 container (Source: www.brisbane skips.com, 2018).

A full set of financial statements for all companies selling the final products is required to comprehensively capture the total contribution of the Development Minerals sector to Fiji's GDP. The study team did not have access to this information; however, we obtained sufficient confidential data (production and sales figures) from extraction and beneficiation operators to make a credible Gross Output estimate for the upstream extraction sites.

Eighteen extraction operators provided prices per m^3 for various Development Mineral products. The operators provided a broad range of prices, particularly for river extraction sites (as the quality of material produced is variable). Other notable factors influencing the broad price ranges include; different product types (reflecting the beneficiation required e.g. crushing and screening), market dynamics (supply and demand e.g. armour rock production requires minimal beneficiation but the supply is scarce and demand is high, so a relatively high price is charged), and geographic location (competition).

Due to the broad range of prices and absence of specific sales data for various products, we opted to estimate a Gross Output range based on the first and third quartiles of the prices provided. The results indicate the Gross Output of the extraction sites is between FJ$190.3M (359% higher than the FBOS records) and FJ$369.1M (696% higher than the FBOS records), as presented in Table 8 below. We consider this range to be the most appropriate method of expressing the Gross Output estimate given the available data, however we also calculated Gross Output utilising the mean of the prices, to provide a single Gross Output estimate figure of FJ$283.9M (535% higher than the FBOS records). Therefore it appears that the FBOS Gross Output record is a major underestimation of the Development Minerals sector and its contribution to Fiji's economy.

Table 8: Gross Output estimate for the Development Minerals sector in Fiji.

Development Mineral Site Type	Volume (m^3)	Range of prices for upstream production per m^3 (FJ$)	Estimated Gross Output for the extraction sites* (FJ$)
Various products (river extraction)	2,300,000	$15 to $250	$115.0M to $230.0M
Various products (hard rock quarries)	1,244,400	$45 to $140	$74.7M to $136.9M
Various products (sand and soft rock quarries)	40,000	$15 to $55	$0.6M to $2.2M
Total estimated Gross Output for the Development Mineral extraction sites			FJ$190.3M to FJ$369.1M

*The Gross Output range is based on the first and third quartiles of the prices provided by private operators, and accounts for the upstream production only (e.g. does not account for downstream value added products such as concrete).

We note the Gross Output presented in Table 8 is for the upstream value chain only (e.g. initial products sold from the extraction sites) and therefore does not account for the downstream value added products such as concrete, plaster mix and tile adhesive etc. The downstream value chain is discussed in the 'Market and Value Chain Analysis' section of this report. It is also important to note that the estimate is for the regulated sites only, hence the unregulated sites (at least 30) are not included in the estimate. Therefore, the true value of the total Development Minerals sector (including the downstream production and unregulated sites) is likely considerably higher than the estimate presented in Table 8.

The study team obtained further information to support the validity of the estimated production and Gross Output figures, including:

- Approximately 600,000m^3 of Development Minerals were consumed in 2017 to deliver the Fiji Roads Authority (FRA) Maintenance and Renewals Programmes[43]. The Maintenance and Renewals Programmes only represent FJ$164.8M of the total FRA budget (FJ$527.2M)[44], therefore the total quantity of Development Minerals consumed by FRA in 2017 is likely significantly higher. We requested the bill of quantities for all FRA contracts, to ascertain the exact quantity of Development Minerals consumed by the total FRA programme of works in 2017, but the study team was not privy to this information. Consequently we used the Maintenance and Renewals consumption figures to indicated the total estimated FRA consumption; approximately 3,641 m^3 of Development Minerals were consumed for every million dollars spent on the Maintenance and Renewals programmes, applying the same rate to the total FRA budget, we estimate the Fiji Roads Authority consumed 1,900,000 m^3 in 2017.
- The study team obtained cement production figures from the main supplier of cement in Fiji (which we assume represents approximately 50% of the market)[45], including quantities sold domestically and international exports. Cement is mixed with proportional quantities of water and Development Minerals (sand and gravel) to form concrete. Therefore, based on domestic cement sales and local concrete mix

[43] Based on volumes provided by principal contractor.
[44] Government of Fiji, Fiji Roads Authority 2016-2017 Budget Major Highlights, 2016.
[45] Cement manufacturer, personal communication, 2017.

designs, in 2017, we estimate 1,164,240 t of Development Minerals were utilised in local concrete production, which equates to 714,000m^3 (assuming an average density measure of 1.63t/m^3 for the sand and gravel).

- A developer provided invoices equating to FJ$1,000,000 of Development Minerals purchased to construct a single resort in 2017[46]. The tourism sector is responsible for a considerable amount of the infrastructure development in Fiji, therefore FJ$1,000,000 of Development Minerals consumed to construct a single resort indicates the considerable quantity of Development Minerals required by the entire tourism sector in 2017.

The combined FRA and concrete consumption estimates represent 73% of the total Development Mineral production estimate presented above. Therefore, these figures support the production and Gross Output estimates presented above, and thus indicate the Development Minerals sector is currently significantly undervalued. However, as stated previously, a full set of financial statements for the businesses involved in the sector is required to identify the true value of the sector, and comprehensively estimate the contribution of the Development Minerals sector to Fiji's GDP. Therefore, we recommend the government implements a comprehensive audit to identify the true value of the sector, and to improve confidence that the correct taxes and royalties are being received.

Development Minerals required to implement the 5 Year National Development Plan

In November 2017 the Ministry of Economy published a 5 year National Development Plan[47] which identifies government development projects planned over the upcoming 5-year period (2017 to 2022). The study team analysed the document to assess where Development Minerals are required to implement the projects and programmes identified in the Plan. The activities (requiring Development Minerals) are tabulated below under the respective sectors identified in the Plan. Table 9 provides an insight into how the government intends to utilise Development Minerals to support wider development in Fiji, and thus indicates the planned government demand for Development Minerals until 2022 (note this does not include private investment).

[46] Resort developer, Personal Communication, 2017.
[47] Ministry of Economy, 5-Year & 20-Year National Development Plan, 2017.

Table 9: Development Minerals required to implement the 5 Year National Development Plan.

Sector	Planned Development	Development Mineral Requirements
Water: Development Minerals are required to support the vision of "clean and safe water in adequate quantities, and proper and adequate sanitation for every Fijian household".	• Construction of 12 water treatment plants • Construction of 1 new reservoir • Upgrade of 7 reservoirs • 1,497.6km of pipe works • Construction of 1 weir • Construction of 11 water package plants • Construction of 5 desalination plants • Construction of 36 rural sewage plants • 579 rural water supply projects	Fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required as backfill in trenches for pipework and sand is required in water treatment plants.
Energy: Development Minerals are required to support the vision of "a resource-efficient, cost-effective and environmentally sustainable energy sector".	• Construction of 4 biofuel plants • Construction of 24 biogas plants • Construction of 10 hydro systems • Construction of 2 hybrid systems • Construction of 1,100 solar systems • 600 grid extension schemes • 148 other renewable energy areas	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill in trenches for cables.
Housing Development: Development Minerals are required to support the vision of "accessible and adequate housing for all".	• Support construction of 11,711 households • Increase home ownership from 32% to 42%	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill of service trenches.
Food & Nutrition Security: Development Minerals are required to support the vision of "every Fijian has access to adequate food of acceptable quality and nutritional value".	• Increase food sourced domestically from 32% to 42%	Crushed lime has a crucial role to play in improving the soil quality to support increased agricultural yields and local food production capacity[48].
Education: Development Minerals are required to support the vision of "quality education for all".	• Construction of 5 infant schools • Construction of 4 secondary schools • Construction of 1 university campus • Complete rehab works of schools damaged by Cyclone Winston • Upgrade 12 schools	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill in trenches for services. Concrete has a crucial role to play in increasing the resilience of the education infrastructure in Fiji[49].

[48] Market Development Facility, Aglime for Fiji, 2013.
[49] Fiji Institute of Engineers, Cyclone Winston Damage Assessment Findings & Moving Forward, 2016.

Sector	Planned Development	Development Mineral Requirements
Health and Medical Services: Development Minerals are required to support the vision of "access to quality health facilities necessary for good health, and to health care services, including reproductive health care".	• Construction of 4 health centres • Construction of 3 hospitals • Construction of 2 warehouses • Construction of 1 radiotherapy unit • Construction of 1 new maternity unit • Construction of 1 new workshop	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill in trenches for services. Concrete has a crucial role to play in increasing the resilience of the health and medical infrastructure in Fiji51.
Land Transport: Development Minerals are required to support the vision of "access to transportation through an efficient and sustainable transport network".	• Maintain 7,524km of road each year • Maintain 1,251 bridges each year • Maintain 47 jetties each year • Replace 1,838km of road • Replace 38 bridges • Replace 62 crossings • Replace 2 jetties • Construction of a second transinsular road on Vanua Levu • Construction of 1 new jetty • Upgrade and widen the road between Nausori and Korovou • Construction of school and healthcare roads • Sealing of sections of road in front of communities • 123 rural road construction projects • Construction of 16km of road seal extensions • Construction of 125 bus stops • Construction of 10 jetty waiting facilities • Construction of climate resilience projects • Upgrade Queens Road from Nadi to Suva • Upgrade Denerau Road • Construction of seal extensions to resorts • Upgrade and widening of the road between Nadi and Lautoka • Upgrading of Nadi town bridge • Upgrading of Labasa main street • Construction of Suva bus rapid transit project • Construction of 25 Suva transportation projects	Aggregate is required for road maintenance and construction, fill is required for new road construction and repairs of landslips, large rock is required for coastal protection of roads and jetties, and concrete is required for bridges, footpaths, jetties, crossings, drainage, bus stops and structural repairs of roads.
Youth and Sports: Development Minerals are required to support the vision of "empowering youth to be agents of change and promoting sports for development".	• Construction of 5 new training centres • Construction of 5 rural sports complexes • Construction of 1 games village • Construction of 68 rural sports grounds	Fill will be required for site preparation, concrete is required for the structures and foundations, gravel may be required for drainage trenches, and aggregate is required as backfill in trenches for services.

Sector	Planned Development	Development Mineral Requirements
National Security and Rule of Law: Development Minerals are required to support the vision of "an inclusive, safe, secure, stable and prosperous Fiji".	• Construction of 7 police stations • Construction of 9 police quarters • Construction of 5 court houses • Construction (or upgrade) of 6 corrections facilities • Extension of 24 police stations • Replace or upgrade 13 police living quarters • Upgrade 10 court complexes	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill in trenches for services.
Inter-island Maritime Transport Network: Development Minerals are required to support the vision of "safe, efficient, reliable, and affordable shipping services".	• Construction of 6 offices • Rehabilitation of 25 lighthouses	Fill will be required for site preparation, concrete is required for the structures and foundations, and aggregate is required as backfill in trenches for services. Concrete is likely required for rehabilitation of lighthouses.
Sustainable cities and towns: Development Minerals are required to support the vision of "creating vibrant and environmentally sustainable urban centres"	• 30 municipal council investment projects	Little detail is provided on these projects, but fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required for road construction, and aggregate is required as backfill in trenches for services.
Culture and Heritage: Development Minerals are required to support the vision of "protection and promotion of unique Fijian culture heritage for sustainable development".	• Construction of 13 cultural heritage centres • Restoration and upgrade of 14 heritage centres	Fill will be required for site preparation, concrete is required for the structures and foundations, and concrete may be required for restoration of heritage sites.
Domestic Air Services: Development Minerals are required to support the vision of "unlocking our economic potential through consistent and reliable domestic air services".	• Construction of 1 new airport • 2 new airports upgraded and resurfaced • 5 airstrips upgraded and maintained	Fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required for airstrip construction and maintenance, and aggregate is required as backfill in trenches for services.

Sector	Planned Development	Development Mineral Requirements
International Airports and Seaports: Development Minerals are required to support the vision of "enhancing Fiji's status as a vibrant and modern regional and international hub for people and cargo movement".	• Upgrade Nadi International Airport • Upgrade Nausori International Airport • Construction of 1 transit hotel in Nadi • Construction of 1 aviation academy • Expand one slipway • Construct 1 new seaport • Upgrade 2 existing ports	Fill will be required for site preparation and land reclamation, concrete is required for the structures and foundations, aggregate is required for airstrip construction and maintenance, large rock is required for coastal protection, and aggregate is required as backfill in trenches for services.
Manufacturing and Commerce: Development Minerals are required to support the vision of "building sustainable and globally competitive manufacturing and commerce".	• Construction of the Wairabetia Economic Zone • Establishment of 1 rural industrial company	Fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required for road construction, and aggregate is required as backfill in trenches for services.
Expanding the Rural Economy: Development Minerals are required to support the vision of "promoting equal opportunities, access to basic services and building resilient communities".	• Relocation of 2 villages • Construction of 1 river bank protection project • Drainage and flood protection (river dredging)	Fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required for road construction, and aggregate is required as backfill in trenches for services. Rock or concrete is likely required for river bank protection, and Development Minerals will be dredged as part of the flood protection works.
Sugar: Development Minerals are required to support the vision of "a sustainable sugar industry".	• Develop an additional 37,600ha for sugar cane planting • Upgrade 2,869 roads per year, a total of 14,345 roads upgraded over 5 years • Increase sugar cane production from 1.39M tonnes to 3.0M tonnes.	Crushed lime has a crucial role to play in improving the soil quality to support increased sugar yields and aggregates are required to construct, upgrade and maintain the sugar cane road network.
Non-sugar agriculture: Development Minerals are required to support the vision of "competitive, sustainable and value adding agriculture".	• Construction of 3 story Agronomy Laboratory • Construction of 9 rural offices and quarters • Construction of 4 flood retention dams • Dredging of rivers for flood protection • Construction of a new rice mill • Increase yields from 124,429.4 tonnes to 193,723 tonnes • Increase milk production from 11,214,163 litres to 29,239,405.8 litres	Crushed lime has a crucial role to play in improving the soil quality to support increased agricultural yields.

Sector	Planned Development	Development Mineral Requirements
Fisheries: Development Minerals are required to support the vision of "sustainably managed fisheries resources".	• Construction of Coastal Fisheries Management Division unit	Fill will be required for site preparation, concrete is required for the structures and foundations, aggregate is required for road construction, and aggregate is required as backfill in trenches for services.
Information and Communication Technology: Development Minerals are required to support the vision of "universal access to information and competitive telecommunication services delivered on a secure platform"	• Install fibre optic cable between Viti Levu and Vanua Levu • Install fibre optic cable covering Viti Levu	Aggregate is required as backfill in trenches for cables on land, and concrete may be required for housing the inter-island cable.

The planned activities identified above highlight the extent of Development Minerals required to implement the 5-year National Development Plan, and the emphasise the critical importance of Development Minerals to wider sustainable development in Fiji. According to the Construction Industry Council, the existing Development Minerals sector is inefficient and struggles to meet the demand of current infrastructure projects[50], therefore poses risk to successful implementation of the substantial government infrastructure works planned in the next 5 years, and beyond. Phasing out river gravel extraction in the context of large increase of demand for construction materials will indeed be a very significant challenge. These constraints may be further exacerbated should cyclone damage add additional demands for post-disaster reconstruction and recovery.

We were unable to calculate quantities of Development Minerals required to implement the 5-year Plan because it is 'high level' in nature. However, we recommend the government estimates the quantity and spatial locations of Development Minerals required to implement the 5-year and the 20-year development plans. This information will assist the establishment hard rock quarries in strategic locations; to ensure adequate supply of quality materials, and optimise transport distances from extraction sites to end-use locations (this is discussed in more detail in the 'Institutional and technical operating context' section).

Perhaps the Fiji Roads Authority (FRA) provides the best example of the current Development Minerals sector struggling to supply government infrastructure projects. The latest published FRA plan (2016)[51] identifies the availability of gravel for road construction as one of the biggest challenges constraining project delivery. FRA have experienced issues related to[52];

[50] Construction Industry Council, Minutes of General Meeting 31/01/2018, 2018.
[51] Fiji Roads Authority, 2016 Corporate Plan, 2015.
[52] FRA, Personal Communication, 2017.

1. Aggregate quality failing to meet specifications[53].
2. Timely supply; lack of stockpiles, and lengthy production timeframes.
3. Spatial locations of extraction sites leading to large haulage distances, which leads to; timeframe issues, increased costs, increased carbon footprint, and accelerated consumption of road life. The Nabouwalu to Dreketi project is a prime example; the project comprised construction of approx. 70km of sealed road on Vanua Levu, but no extraction sites producing sealing chip of sufficient quality were present on Vanua Levu. Therefore the sealing chip was shipped from Viti Levu (Nadi) to Vanua Levu at significant cost (the study team was not privy to specific costs and quantities).

Subsequently, the FRA have established a Gravel Management Team, tasked with pursuing extraction licenses in strategic locations for FRA projects. The team has already obtained 2 extraction licenses on Kadavu, which are producing material for road maintenance. This action by FRA is a pragmatic response to existing situation, however the approach is focused on the FRA programme of works only (often at the individual project level) and therefore does not consider the holistic demand for Development Minerals in Fiji, or the overall socio-economic and environmental impacts of the sector. Additionally, the management of Development Mineral resources is not a core business function of the FRA, it is a function of the Ministry of Lands and Mineral Resources. Therefore, as discussed in the 'institutional and technical operating context' section of this report, we recommend MRD (in collaboration with other relevant stakeholders) undertake a programme of works to support the development of a network of hard rock quarries in strategic locations, considering the holistic demand for development minerals in Fiji (including FRA projects).

A gargantuan quantity of cement is also required to deliver the 5-year National Development Plan. This further justifies the consideration of establishing a cement production industry utilising locally sourced resources (and reducing the reliance on imported clinker), to reduce the risk of external market forces adversely impacting the government's ability to deliver the 5-year National Development Plan.

Component 2: Assessment of the Legal and Policy Framework

Introduction

This section assesses the following facets of the legal and policy framework governing the regulation of the Development Minerals sector:

- *Constitution of the Republic of Fiji*
- *Crown Lands Act*
- *Environment Management Act*
- *iTaukei Lands Act*
- *iTaukei Land Trust Act*

[53] Fiji Broadcasting Corporation, Quality of Materials not of Standard:FRA, 2018

- *Land Transfer Act*
- *Land Use Decree 2010*
- *Magna Carta*
- *Mining Act*
- *Native Lands Ordinance XXI (1880)*
- *Quarries Act*
- *Quarries Ordinance*
- *Rivers and Streams Act*
- *Rivers and Streams Ordinance*
- *Roads Act*
- *Roads Ordinance*
- *State Acquisition of Lands Act*
- *State Lands Act*
- *Town Planning Act*

The specific objectives are to:

1. Provide an overview of land and resource ownership in Fiji.
2. Provide an overview of policies relating to the extraction of Development Minerals.
3. Provide an overview of applicable legislation.
4. Assess the existing policies and legislation in terms of implementation gaps, achievements and challenges.
5. Propose recommendations that the government may consider for better management of the Development Minerals sector.

Land and Resource Ownership

Fiji is a common law jurisdiction with a land mass of approximately 1.8 million hectares of which about 92% is under customary ownership, 6% is freehold and about 2% is state land. Native (customary) land is primarily (although not exclusively) governed by the *iTaukei Lands Act* and the *iTaukei Land Trust Act* (with application of the *Land Transfer Act* to leases of native land). State land (including dominion over beds of rivers and streams, foreshore, seabed, and reefs) is governed by the *State Lands Act* (again with application of the *Land Transfer Act* to leases of state land). Freehold is governed by the *Land Transfer Act* (with application of the *State Land Act* to freehold grants). The complexity of this colonial era web is significant, and the list of institutions with post-colonial spheres of influence affecting the Development Minerals sector is extensive. The

common law restrictions on state expropriation of land come from *Magna Carta* (1215) which was a central part of the unwritten constitution which came to Fiji with British sovereignty in 1874. The source of title for customary land is historical or ancestral possession. In Fiji (as distinct from other common law jurisdiction like Australia and New Zealand where it was conceptualized as a usufruct at best), native title along with freehold is and always has been conceived as a tenure.

This distinction is set out in section 1 of *Ordinance XXI of 1880* relating to native lands which states "the tenure of the lands belonging to the native Fijians as derived from their ancestors and evidenced by tradition and usage shall be the legal tenure thereof" (*Native Lands Ordinance* 1880) and it is reasonably well settled in common law jurisdictions that apart from prerogative minerals, which are owned by the state, the law is that customary owners have a tenure that runs from the centre of the earth to the sky and includes everything which is not part of the State's prerogative ownership. The Privy Council decision in *AG for the Isle of Man v Mylchreest* (1879) 4 App Casa 294 is one of the leading cases, concerning clay forming part of the customary estate. Freehold is founded on a grant under what is now known as the *State Lands Act* which in Fiji excludes minerals. State land is allodial, depending on a valid acquisition of pre-existing customary ownership. In common law jurisdictions the State can retain the minerals when it makes a freehold grant, and it always has power to expropriate, but in Fiji that right has always been restricted by constitutional provisions in the same form as section 27 of the *Constitution of the Republic of Fiji* which says that any acquisition must be for a public purpose on payment of fair compensation.

Public purpose in this context probably includes on-sale for private sector economic development because it is included in section 2 of the *State Acquisition of Lands Act* definition, but the declaration in section 30(1) of the Constitution that "[a]ll minerals in or under any land or water, are owned by the State…" comes from a clear blue sky; where there has been no express expropriation under domestic law, there is common law authority to support the proposition that this legislation is restrictively interpreted to exclude land where there has been no actual taking: section 30 probably does not operate as an expropriation by itself (except perhaps where it amounts to a *fait accompli,* or where the executive is directing the judiciary). This statutory interpretation principle applicable to the *Rivers and Streams Ordinance* is set out in:

J.P.Bailey Ltd v AG [1875-1946] 3 FLR 439 where the Fiji Supreme says "…the section can be read as vesting in the [State] only so much of the [underlying] estate in the land constituting the bed of the stream as is necessary to ensure that the stream and its bed may be perpetually open to the public but leaving so much of the estate as does not fall within that description in the owner of the freehold." This outcome comes from a well-established principle of the common law on expropriation, that **"**such intention [to expropriate without paying compensation] should not be imputed to the Legislature unless it is expressed in unequivocal terms."

In Fiji, this version of expropriation in any event would be beyond the power of Parliament and unconstitutional: contrary to section 40 and section 27 in the 1997 and 2013 Constitutions. The legal principles applicable to ownership of navigable and non-navigable rivers and streams, and the foreshore and seabed, which is substantially larger than the dry land mass area in Fiji, and where significant Development Mineral resources are to be found, is clothed with a further difference of legal opinion between customary owners and the state which was addressed in *AG v Ngati Apa* (the New Zealand foreshore and seabed case). Already there is a gap here between theory and practice.

Policies

There is no policy in Fiji that deals specifically with the extraction of Development Minerals although there are many general policies which target the environmental effects of development such as the Integrated Resource Management Policy, the Sustainable Coastal Management Policy, the National Biodiversity Strategy and Action Plan and many more. REDD+ Fiji is a policy framework specifically for deforestation and forest degradation, COP 23 targets climate change in Fiji, however there is yet to be a policy framework created for the sole purpose of sustainable development of the Development Minerals sector. Partly due to the lack of policies available for the extraction of Development Minerals, extractors work unmonitored and unregulated which takes its toll on the environment, particularly on river and streams ecosystems as this is where the bulk of extraction takes place.

Environmental Impact Assessment

The Environmental Impact Assessment is perhaps the most comprehensive policy there is for the mitigation of the environmental impacts associated with the extraction of Development Minerals. It is a legal requirement for developers under the *Environmental Management Act* and the MoE plays a permissive role in the provision of extraction. Without the approval of the Environmental Impact Assessment (EIA) report, extraction is prohibited. The Environmental Management Unit under the *Environmental Management Act*, is responsible for scoping development proposals or assisting the EIA administrator in scoping; reviewing EIA reports and commenting on any environmental management plan contained in the report; and monitoring and enforcing conditions on approved development proposals. The EIA report is a step by step process that involves screening, scope, study and report, review and decision as outlined in Table 10 below:

Table 10: Environmental Impact Assessment (EIA) process.

The EIA Process	
Step 1: Screening	Decision made by the approving authorities on whether an EIA is required.
Step 2: Scoping	Identifying possible environmental impacts and determining which of the impacts are significant and need detailed investigation. Also establishes the Terms of Reference for the EIA study.
Step 3: Study and Report	Collect environmental baseline data, assess possible significant environmental issues, and develop appropriate methods to resolve these issues.
Step 4: Review	The EIA report can be reviewed internally, by a registered review consultant or a review committee, or it can also be reviewed through public consultation.
Step 5: Decision	The decision may be to approve the proposal (with or without conditions), recommend an additional study on the proposal, or not approve the proposal.

During the EIA scoping exercise, a detailed Terms of Reference (ToR) is prepared which is used to guide the preparation of the EIA report. It is reviewed to ensure that the environmental assessment is complete, and that all the tasks in the ToR have been completed satisfactorily. It is also to ensure that the report presents as accurate a picture as possible of the likely environmental

effects of the project.[54] After the EIA has been approved, the developer needs further approval from the Department of Town and Country Planning to commence with site development. The requirements needed are as follows; the Construction Environment Management Plan and Operational Environment Management Plan from the Department of Environment after EIA approval, and consent form from Ministry of Health. In *Ranadi Plantation Partnership v Ravuikadavu* HBM 44 of 2016 (Consent Order made 27 April 2016) there is an indication that the Court has jurisdiction to supervise the Department of Environment in the performance of its statutory duties.

5-Year and 20-Year National Development Plan

Fiji's National Development Plan is an encompassing policy document that aims to develop Fiji's holistic economy in the next 20 years. Although there is almost no mention of the extraction of Development Minerals, Chapter 3.2.15 discusses the mining industry, with the vision, "a sustainable mining industry." The plan promises that the "government will ensure sustainable mining practices and ecological balance together with equitable sharing of revenue amongst investors, landowners and the State [and that] the Mining Act, policies and institutional framework for mining and quarrying and the monitoring and evaluation of operations will be revised and updated for better oversight in areas such as Occupational Health and Safety (OHS) and environmental safeguards. Monitoring the environmental impact of mining and quarrying activities will be strengthened" (Ministry of Economy, 2017).

Strategic Development Plan 2007-2011

The Strategic Development Plan 2007-2011 is a variety of policies and strategies that are aimed at developing Fiji's economy in the future. Chapters 2.7 and 3.2.6 are designated to the 'Environment' and 'Mineral and Groundwater Resources' respectively however, more emphasis is put on "epithermal gold (associated with volcanic centres), porphyry copper-gold (Namosi), and smaller base-metal deposits (Udu, Wainivesi)"[55].

Policy Shortfalls: A Case Study

The following case study is a microcosm illustrating many of the real time problems in the legal and policy framework of the Development Minerals sector, with conflicts evident between customary and imported land tenure systems, land ownership, the absence of a clear policy basis for laws regulating the sector, flaws with existing legislation, effects of climate change and EIA reports that need to have more policies in place to regulate environmental consequences. The environmental ramifications of sand and gravel extraction and the lack of policy options operate in this context as a platform that may disadvantage the resource and people in the environment in which it sits without viable obligations to account for adverse environmental and social impacts or to pay tax on revenues.

The Navua River is in the Serua and Namosi provinces. It runs from the highlands of Viti Levu to the coast at Navua. It is about 50km west along the coastal highway from Suva and is one of the most significant sources of sand and gravel in Fiji.

[54] Department of Environment, Environmental Impact Assessment (EIA) Guidelines, 2008.
[55] Government of Fiji, Strategic Development Plan 2007-2011, 2007.

The Navua River was initially on the southern boundary of land owned by the Morel family but has since changed its course and now bisects the Morel land. Part of the river runs through freehold land and the villagers around it depend on the river for their livelihood. Thus, unregulated sand and gravel extraction along the course of Navua River is likely to adversely impact the surrounding communities who are dependent on the Navua River for several critical ecosystem services.

Raymond Morel was born on 14th September 1838 in England. He first arrived in Fiji in the early 1870s and took up freehold land in Navua now known as Laqere and Naivakaroko; which was a gift from the Tui Namosi (chief of the province) for planting coffee and cattle-grazing purposes during the early 1870's. The Tui Namosi intended this land to be Morel ancestral land, and it has always been regulated by Fijian custom. Raymond Morel married an iTaukei and raised four boys, who after his death, received ¼ undivided share of the land to be held by them for the Morel descendants and their extended family who now live in Cagilaba Village, which is located on Naivakaroko.

The Navua River was initially on the southern boundary for the Morel land, but after Cyclone Bebe in 1988 substantially altered its course almost overnight, the Navua River now bisects the land. The old river bed which is now dry land, and no longer subject to State dominion under the *Rivers and Streams Act* and disputably reverts to the underlying iTaukei owners. The land in question is approximately 140 acres and hosted not only Horace Morel's immediate family but also extended branches of the ancestry. Four of Raymond Morel's 21 grandchildren; Teresa, George, Lyon and James Morel are assumed to have transferred their shares in the land to Vishnu Mishra who later transferred the land to BD Lakshman & Sons (Properties) Limited. The majority of the Morel family however were unaware of any sales or transfers and continued to live on their ancestral hereditary estate. In 1978, BD Lakshman wrote to the Turaga-ni-koro for the Morel Family, demanding that they sign a lease and pay rent, or vacate. There was a meeting at the village and BD Lakshman was told that it was Morel land, they would not sign a lease or pay rent. No application for vacant possession was made under section 169 of the *Land Transfer Act* and the Morels remained in adverse possession from 1976 until early 2017 when Lakshman took steps to challenge it. Presently, Lakshman & Sons Limited are extracting sand and gravel from the river, leading to environmental impacts on the Cagilaba villagers who rely on the river for food and livelihood functions (*Mairi v BD Lakshman & Sons (Properties) Ltd*, HBM 145/2017).

Overview of Fiji's Legal Framework

This section has two objectives; firstly to provide an overview of the enacted legislation in Fiji relevant to the Development Minerals sector, and secondly to analyse the issues prevalent in the relevant legislation.

Constitution of the Republic of Fiji 2013

The following sections of the Constitution are relevant to the Development Minerals sector:

Section 27

- *"Every person has the right not to be deprived of property by the State [except] when necessary for a public purpose…"*

Section 30

- *"(1) All minerals in or under any land or water, are owned by the State, provided however, that the owners of any particular land (whether customary or freehold), or of any particular registered customary fishing rights shall be entitled to receive a fair share of royalties or other money paid to the State in respect of the grant by the State of rights to extract minerals from that land or the seabed in the area of those fishing rights."*
- *"(2) A written law may determine the framework for calculating fair shares under subsection (1), taking into account all relevant factors, including the following—*
    a. *any benefit that the owners received or may receive as a result of mineral exploration or exploitation;*
    b. *the risk of environmental damage;*
    c. *any legal obligation of the State to contribute to a fund to meet the cost of preventing, repairing or compensating for any environmental damage;*
    d. *the cost to the State of administering exploration or exploitation rights; and*
    e. *the appropriate contribution to the general revenue of the State to be made by any person granted exploration or exploitation rights."*

(Constitution of the Republic of Fiji, 2013)

Section 30 of the 2013 Constitution has a loophole in that it provides for the payment of a fair share of royalties only but there is nothing mentioned about fair compensation for expropriation of the extraction of minerals. The likely implications of this issue is that the landowning unit and extractors may not see eye to eye in all aspects of extraction.

In addition, sand, gravel and rock are not defined as minerals according to Section 30 of the Constitution and/or by Section 7 of the *State Lands Act* and there is a discrepancy between the definition of minerals in the *Quarries Act* and the definition in the *Mining Act, State Lands Act* and the Constitution. This creates an issue of licensing in that extraction taking place on freehold land will not require a license or an EIA unless it is extracted for the purpose of delivering it to a crusher, even if the extraction is significant. However, if it is extracted from a stream bed then it will require a license and an EIA. Thus, the *Environmental Management Act* requires an EIA for excavating from a river bed and mining to perform an Environmental Impact Assessment however, the same requirements do not apply for sand and gravel extraction from dry land, even if it causes significant environmental impacts.

State Lands Act

The section relevant to sand and gravel extraction in the *State Lands Act* (formerly known as the *Crown Lands Act)* are section 7 which states that "a grant under this Act shall not confer any right to any precious metals, coals or minerals of any description including crude oil as defined in the Petroleum (Exploration and Exploitation) Act" (*States Land Act (Cap.132)*).

Like the 2013 Constitution, the *State Lands Act* excludes sand, gravel and rock from the definition

of minerals and there is no legislative provision that requires permission for the extraction of sand, gravel and rock. Therefore, by implication of this, sand, gravel and rock are not minerals contemplated by Section 30 of the Constitution or by Section 7 of the *State Lands Act*. There is still much uncertainty about extraction from rivers and streams which run through freehold land or native land which is managed by the iTaukei Land Trust Board and the enforcement of royalty payment obligations (and the payment of tax) for these activities remain unresolved.

Rivers and Streams Act

Section 2 of the *Rivers and Streams Act* states that "all waters in Fiji which the natives have been accustomed to traverse in takias or canoes, whether the same be navigable for vessels built on the European model or not, and whether the tide flows and reflows in the river or at the particular part thereof navigable by takias or canoes or not, which are hereinafter styled "rivers", and also those waters which are included by the term "rivers" by the law of England, shall, with the soil under the same, belong to the Crown and be perpetually open to the public for the enjoyment of all rights incident to rivers" (*Rivers and Streams Act (Cap. 136)*).

The *Rivers and Streams Act* gives jurisdiction to the Ministry of Lands to issue licenses for sand and gravel extraction on native, freehold and state land. This jurisdiction however, is limited to rivers and stream beds and also limited for the purpose of public access/enjoyment.

Quarries Act

Section 2 of the *Quarries Act* states that "this Act shall apply to every excavation and place (not being a mine) in which persons work at the removal of rock, earth, clay, sand, soil, gravel, limestone, or such other common mineral substances as have been declared by the Minister under section 2 of the *Mining Act*, by notice in the Gazette, not to be minerals, by means of explosives, and any tunnel in the construction of which explosives are used, and any rock-crushing or treatment plant which may be operated in connexion with the operations hereinbefore mentioned or identical operations save that the work of removal is effected by means other than explosives, and every such place is in this Act referred to as a quarry" (*emphasis added)* (*Quarries Act (Cap. 147)*).

The application of section 2 is problematic in that it clashes with the definition of minerals in the *Mining Act* and additionally, it only captures extraction using explosives or destined for a rock-crushing or treatment plant.

Mining Act

Section 2 of the *Mining Act* states that "in this Act, unless the context otherwise requires -

"minerals" includes the following minerals:

(a) "precious metals" which shall include gold, silver, platinum, palladium, iridium, osmium, or ores containing them, and all other substances of a similar nature;

(b) "precious stones" which shall include amber, amethyst, beryl, cat's-eye, chrysolite, diamond, emerald, garnet, opal, ruby, sapphire, turquoise, and all other stones of a similar nature;

(c) "earthy minerals" which shall include asbestos, ball-clay, barytes, bauxite, bentonite, china-clay, fuller's earth, graphite, gypsum, marble, mica, nitrates, phosphates, pipeclay, potash, salt, slate, soda, sulphur, talc and all other substances of a similar nature;.....

but shall not include clay, gravel, sand, stone or other common mineral substances, and for the purpose of avoiding doubt the Minister may from time to time by notice in the Gazette declare any mineral substance to be included in or excluded from this definition; (emphasis added)." (Mining Act (Cap. 146).

It is evident that in this Act, sand, gravel and stone are expressly excluded from the definition of minerals thus, if sand and gravel are extracted from freehold land it is free and clear of the licensing framework unless it is extracted from the bed of a stream, or for the purposes of delivering it to a crusher. If the latter, it is a quarry and it needs a license from Mineral Resources Division of the Ministry of Lands. Colonial era policy evident in the legislation governing Development Minerals in Fiji appears from our investigation to have been that the extractions of Development Minerals which warranted regulation was the extraction from any river or and stream or from Native Land. Apart from the extraction from those sources, the policy and the legal framework did not apply. That colonial era policy and framework was possibly enlarged by the enactment of the *Environment Management Act* in 2005 (operative from 1 January 2008) which lists mining, and excavating from a river bed as Part 1 activities but does not mention extraction of sand and gravel which is likely to cause significant environmental or resource management impact anywhere in the 2nd Schedule to the Act: so whether the EIA section of the Act applies to this activity or undertaking even if the impact is significant is uncertain.

Town Planning Act

The *Town Planning Act* does not include extraction of Development Minerals unless extracting forms part of a regulated activity.

Roads Act

The *Roads Act* gives the State authority to extract for the purpose of facilitating road construction or repair with minimal compensation based on damages caused, not on value of material extracted.

Conclusion and recommendations

Following the review of existing policies and law, the following options may be considered by the government to ensure the sustainable use and management of Fiji's Development Minerals.

There is currently no formalized national policy that is available for the Development Minerals sector. From the Existing Policies section above, the Environmental Impact Assessment covers the extraction of Development Minerals however it is not specifically for sustainable development of the Development Minerals sector and is rather an umbrella policy document for the environmental impacts prevalent in Fiji. In addition to the EMA, there are also other policy documents however, their coverage of the Development Minerals sector is minimal to non-existent. Moreover, the policies that are in place are not always implemented, enforced or monitored, rendering the policies void when it comes to its practice in real time development and extraction.

Therefore, a primary recommendation would be the formulation and strict implementation of a specific policy focused on sustainable development of the Development Minerals sector. This policy should look at the use and management of Development Minerals in Fiji, bearing in mind that the sustainability needs to be emphasised throughout the policy document. The policy document should aim to:

- Establish the guidelines for the environmentally and socially responsible extraction of Development Minerals in order to ensure that adverse impacts are minimised and managed effectively.
- Monitor all current and future extraction activities and bring to an end any activity that is unsustainable or illegal.
- Integrate the extraction of Development Minerals in existing legislation and propose new legislation(s) that deal specifically with extraction, mainly, the relationship between landowners, the government and the extractors.
- Ensure that all extractions are subject to an Environmental Impact Assessment.
- Iron out the discrepancies in the definitional issues that are evident in the existing legislation.
- Designate a single and specific Ministry or Department to oversee and manage the extraction of Development Minerals.
- Establish a standard procedure for issuing of licenses and have a specific Ministry or Department that is responsible for all issuances of licenses.
- Review current policies and legislations and update them to reflect current environmental and social issues relating to the extraction of Development Minerals.
- Increase awareness and create awareness programs on the importance of the Development Minerals sector for sustainable development in Fiji.
- Establish a beneficial relationship between landowners, extraction companies and the government to ensure that all parties are advantaged by the extraction of Development Minerals.
- Provide a framework for prioritising Development Mineral resources in land-use planning.
- Outline procedures for informing the Development Mineral supply chain of upcoming infrastructure projects.
- Accurately document the contribution of Development Mineral sector to Fiji's GDP.
- Support the establishment of hard rock quarries, including considering government incentives and improving access to finance.
- Establish pathways to increase women's participation in the sector.

If the above recommendations are compiled and enforced; the policy document will provide a clear vision for the Development Minerals sector to realise its full potential and contribute to the sustainable development agenda via improving the social, environmental and economic conditions in Fiji.

Component 3: Assessment of the Institutional and Technical Operating Context

Key institutional stakeholders, roles, and responsibilities

A total of 13 different institution stakeholders are involved in the governance of the Development Minerals sector in Fiji, as listed below:

- Ministry of Local Government, Housing, Environment, Infrastructure and Transport
    - Department of Environment (now a Ministry on its own, as of late 2017)
    - Land Transport Authority
- Department of Town and Country Planning & Rural Local Authorities
- Ministry of Lands and Mineral Resources
    - Department of Lands
    - Department of Mineral Resources
- Ministry of Health and Medical Services
- Department of Health
- iTaukei Lands Trust Board
- Ministry of iTaukei Affairs
    - iTaukei Lands & Fisheries Commission.
    - iTaukei Affairs Board
    - Provincial Offices'
- Ministry of Fisheries
- Ministry of Labour

This diverse group of institutional stakeholders supports the recommendation in the 'Assessment of the Legal and Policy Framework' to develop a specific policy for sustainable development of the sector as such a policy would provide a platform for this diverse group of institutional stakeholders to cooperate effectively.

The roles and responsibilities of the institutional stakeholders are discussed in the Table 11 below.

Table 11: Roles and responsibilities of the institutional stakeholders

Institution	Roles & Responsibilities
Ministry of Local Government, Housing, Environment, Infrastructure and Transport	**Department of Environment (now a Ministry)** The Department of Environment is the institution responsible for • Conducting EIA pursuant to legal requirement in EMA 2005. • Monitoring EIA reports. • Approving EIA reports. • Approving the *Construction Environment Management Plan* after the EIA report has been approved • Approving the *Environment Management Plan* after the EIA report before construction and operation takes place at the extraction site. • Scoping development proposals or assisting the EIA administrator in scoping; reviewing EIA reports and commenting on any environmental management plan contained in the report; and monitoring and enforcing conditions on approved development proposals. • To monitor extraction operations ensuring operator complies with the conditions set forth in the EIA. • To sanction and or penalize operators who breach the conditions set forth in the EIA **Department of Town & Country Planning & Rural Local Authorities** • Issuance of Business Licences for proposed operators for sand & gravel extraction. • Within Town & City areas, the zoning of development areas for sand & gravel extraction. **Land Transport Authority** • Issue motor vehicle registration • Monitor overloading.

Institution	Roles & Responsibilities

Ministry of Lands & Survey and Mineral Resources	**Lands Department**
	• To issue licenses for sand and gravel extraction on native, freehold and state land under the Rivers and Streams Act. This jurisdiction is limited to:
	  • rivers and stream beds; and,
	  • Extractions for the purpose of public access/public enjoyment.
	• To issue licenses for quarries under the Quarries Act but their power depends on supply to a rock crusher or treatment plant.
	• Survey of boundary of extraction licence site.
	• Managing the extraction from the beds of rivers and streams
	• To ensure proper & relevant access to extraction site
	• Recipient of royalty payments[56] for sand & gravel extraction from waterways & quarry extractions.
	• To sanction Licensees who breach Licence provisions.
	
	Mineral Resources Department
	• To issue licence for sand & gravel extraction for the purposes of delivering it to a crusher (i.e. Quarry Operations).
	• Managing the extraction from the beds of rivers and streams
	• To ensure proper & relevant access to quarry extraction site
	• To monitor extraction volume so it is consistent with royalty payment submitted by operators to Mining Inspectors per half yearly and annual returns submitted by Quarry operators to Inspectors at the Mineral Resources Dept.
	• Monitoring the river extraction operations to ensure that Licensee operates within the terms of the licence and within the licence area.

Ministry of Health and Medical Services	**Department of Health** • Enter any area for the purposes of water supply or sewerage or the disposal of sewage and inspect the same. • Has the power to stop activities that disturb or contaminate water/waterways. • Environmental Health • OHS impacts on Health
iTaukei Lands Trust Board	• To issue licenses for sand and gravel extraction on iTaukei land under the *TLTA Cap 134*[57] and in line with common law position established in the Bailey Case[58] in rivers and streams passing through native land. • Surveying of boundary of extraction licence site. • managing the extraction from the beds of rivers and streams astride Native Lands • To ensure proper & relevant access to extraction site • To sanction Licensees who breach Licence provisions. • Receipt of royalties paid under the relevant Gravel Regulations[59] paid in by extractors payable to iTaukei owners. • Distributing royalties paid in by extractors to the relevant iTaukei owners. • Monitoring the extraction operations to ensure that Licensee operates within the terms of the licence and within the licence area.

[56] (Royalty paid per Cabinet Decision C. P. (97) dated 08.04.97 and effective from 01.01.98
[57] iTaukei Lands Trust Board, Cap 134
[58] JP Bailey Ltd v Attorney General [1946] FJLawRp 15; [1875-1946] 3 FLR 439 (19 September 1946)
[59] iTaukei Land Trust (Gravel) (Amendment) Regulations 2013 (Effective 01.01.14).

Institution	Roles & Responsibilities
Ministry of iTaukei Affairs	**iTaukei Lands & Fisheries Commission** • Ascertaining the corresponding qoliqoqli owners (fishing rights owners) to the respective extraction sites chosen for development. • In consultation with Ministry of Fisheries, the calculation of the appropriate compensation to be paid to qoliqoqli owners. **iTaukei Affairs Board** • Recipient of itaukei owner's $0.50 component of the royalty payments paid to Director of Lands by extractors from rivers and streams and extractions. • Upon receipt, the same royalty component is to be held in trust until distribution to the respective land owning unit. **Provincial Council Offices'** • Validates the identity of the respective Land Owning Unit/s to the iTaukei Lands & Fisheries Commission. • Facilitates and conducts meetings with respective Land Owning Unit/s connected to the proposed development explaining the formal requirements. • Facilitates meetings with government authorities and private agencies with respective Land Owning Unit/s connected to the proposed development explaining the formal requirements and assisting in the process to the realization of the development proper. • Facilitating returns to authorities for the Land Owning Unit/s. • Authenticates the validity of Land Owning Unit/s consent to the iTaukei Lands & Fisheries Commission for purposes. • Authenticates the validity of Land Owning Unit/s consent to the iTaukei Lands Trust Board for Land leasing and licencing purposes.
Ministry of Fisheries	• In consultations with iTaukei Lands & Fisheries Commission and the relevant provincial office, the calculation of the appropriate compensation to be paid to qoliqoqli owners and processing the same.
Ministry of Labour	• Issue Compliance Letter. • Check the components of the excavator, front load crusher and OHS. • OHS compliance at worksite.

Site management, compliance monitoring and enforcement

Discussions with key government stakeholders throughout the study identified the opportunity to improve the collective capacity of the institutional stakeholders to effectively monitor the Development Minerals sector. This is formally recognised by the government in the 'A Green Growth Framework for Fiji' publication[60] which states; "this is apart from the dredging of smaller rivers and streams by small contractors which tend to go relatively unmonitored. Overall, the lack of institutional capacity is a major impediment to better understanding and more effectively policing quarry activities".

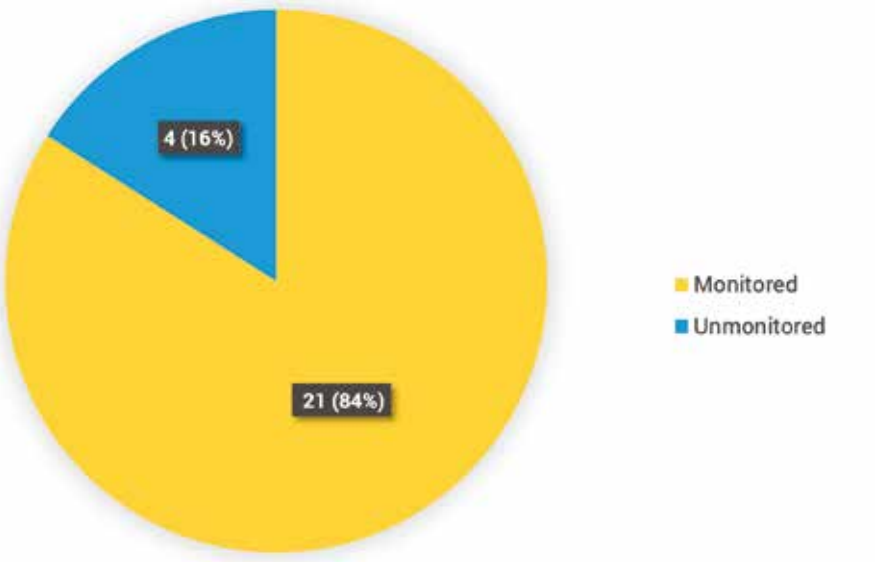
A database (and map) of all active extraction sites is a fundamental precursory tool to enable the development of an effective monitoring plan (including recruiting human resources), and implementation of the monitoring plan. A map of the active extraction sites being monitored by

[60] Ministry of Strategic Planning, National Development and Statistics, A Green Growth Framework for Fiji, 2014.

each respective institutional stakeholder was requested. No institutional stakeholder provided a comprehensive map (or database) of all extraction sites. iTLTB provided a thorough GIS database for all the extraction sites located on Native Land, and MRD provided a thorough database for all hard rock quarries and the majority of crushing sites. We recommend the institutional stakeholders prioritise development of a GIS database of all active extraction sites.

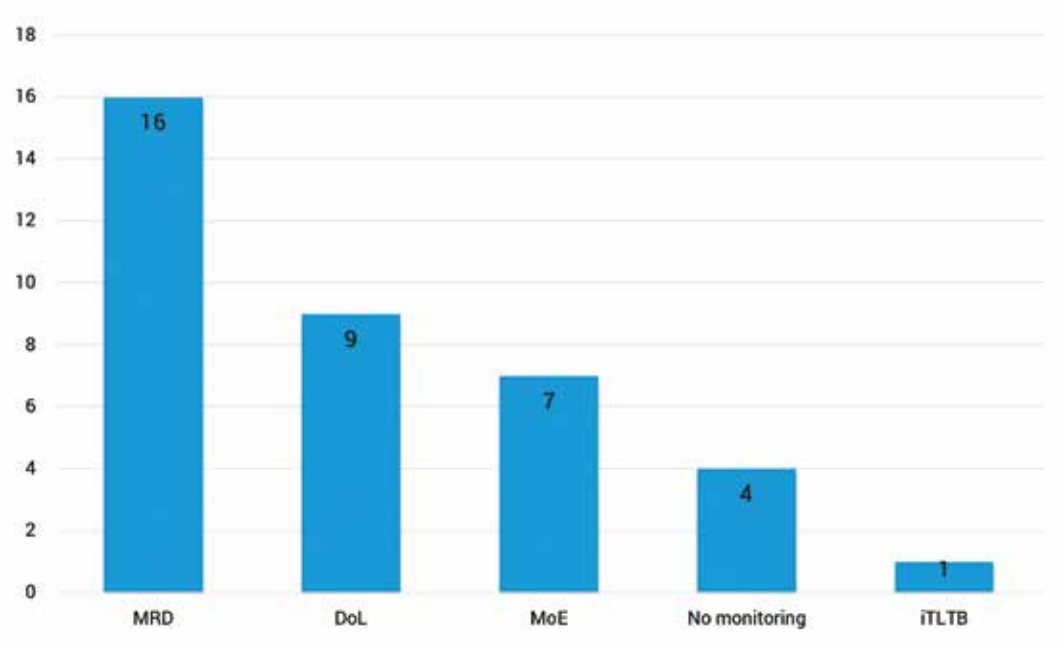
Twenty-five regulated extraction operators provided details regarding which institutional stakeholders monitor their respective sites, and 13 of these operators provided additional information regarding the frequency of monitoring. Of the 25 operators; 21 (84%) reported some form of monitoring by at least one institutional stakeholder, while 4 (16%) of the operators reported no monitoring at all other than an inspection during the license application process, as shown in Figure 64.

Figure 64: Monitored vs unmonitored sites, as reported by operators (Source: SPC Fieldwork, 2017).



A breakdown of the sites monitored by the respective institutional stakeholders (as reported by the operators) is presented in Figure 65; 16 sites (64%) reported monitoring by MRD at frequencies ranging between 2 weeks and 3 months, 9 sites (36%) reported monitoring by DoL at frequencies ranging between 1 month and 3 months, 7 sites (28%) reported monitoring by MoE at frequencies ranging between 1 month and 3 months or sporadically in response to complaints, and 1 site (4%) reported monitoring by iTLTB.

Figure 65: Sites monitored by respective institutional stakeholders, as reported by operators (Source: SPC Fieldwork, 2017).



Six of the respondents operated hard rock quarries, 5 of these operators (83%) reported regular monitoring by MRD, while only 1 operator (17%) reported an absence of monitoring. Therefore it appears MRD implements a relatively regular monitoring schedule of hard rock quarries when compared to river extraction sites. The hard rock quarry which reported an absence of monitoring is located in the Northern Division, which is likely influenced by the fact that MRD is located in the Central Division, and does not have an office in the Northern Division. As presented in the SWOT analysis for MRD above, the study team recommends MRD staff are positioned in the divisional offices of DoL, or MRD offices are established in the Northern and Western Divisions.

MRD provided the study team with an organigram which highlighted a critical human resources issue. The department has 108 positions in its official structure, of which only 75 are filled, therefore 31% of the positions are vacant. This is a relatively high vacancy percentage, indicating the opportunity to improve the human resource capacity of the Department, and ensure retention of existing staff. More alarmingly; the teams specifically involved in monitoring the Development Minerals sector (the Environment Unit and Mining Division) have a combined total of 20 positions, of which only 10 are filled, meaning a 50 % vacancy rate. Promisingly, in the 2017-2018 budget MRD was allocated sufficient funding to establish 6 new positions specifically allocated for monitoring the Development Minerals sector. This is a positive step towards improving MRD's ability to monitor and regulate the Development Minerals sector. We recommend further strengthening of MRD's human resource capacity (both in terms of numbers and skillsets), and ensure retention of existing staff.

The study team was not privy to the MoE organigram however based on discussions with the Director MoE has a total of 11 personnel within its EIA section; with a distribution of 5 in the Central Division, 3 in Western Division, and 3 in the Northern Division[61]. The EIA team is responsible for

[61] Department of Environment, Personal communication, 2018.

administering the environmental compliance of a large portfolio of development in Fiji, not just the Development Minerals sector. Therefore it is likely that a lack of resources, particularly human resources (both in terms of numbers and skillsets) is the major factor hindering MoE's ability to effectively monitor and enforce environmental compliance in the Development Minerals sector. This observation is supported by similar observations from other studies, such the World Bank 2017 Systematic Country Diagnostic assessment, which stated:

> **"Building greater resilience will further require better enforcement of existing regulations and updating of the planning, risk monitoring, and management frameworks. Currently, many ministries have limited capacity to enforce regulations. This is a significant risk to government as these regulations are the safety nets that are designed to avoid disasters such as environmental pollution, adherence to building standards, and health and safety standards. For example, the Ministry of Local Government, Housing and Environment is limited in its ability to evaluation environmental impact assessments."**[62]

The information presented above highlights an inconsistent monitoring system, both in terms of which respective stakeholder conducts monitoring, and the frequency of monitoring. Outcomes influenced by the lack of consistent monitoring (and subsequent enforcement) include:

- adverse social and environmental impacts
- the lack of production records and significant undervaluation of the sector
- increased scope for unregulated operations and subsequent losses of tax and royalty revenues
- uneven playing field for Development Mineral operators

Subsequently, we recommend the institutional stakeholders collaborate to generate a comprehensive GIS database of all active extraction sites (including known illegal sites); to facilitate the development of a regular monitoring plan, where the roles and responsibilities of the individual stakeholders are clearly defined, and to enable the recruitment of sufficient human resources. The database will require regular collaboration between the institutional stakeholders to ensure the database remains up to date and relevant. The recommended transition from disseminated river gravel extraction sites to a network of quarries in strategic locations will facilitate improved monitoring of the sector, due to the fixed location of quarries, and the relatively larger scale of the operations (thus less individual sites).

Land-use planning

Currently Fiji does not have a Land Use Master Plan (with a map and GIS database) to assist government to regulate land use in an effective and principled way. Promisingly DoL has initiated a project to develop a Land Use Master Plan[63]. This study has identified numerous conflicting land use practices that support and highlight the need for this initiative. A Land Use Master Plan would provide a framework for communication between government departments and appropriate

[62] World Bank, Systematic Country Diagnostic, 2017.
[63] http://www.lands.gov.fj/index.php/department-2/land-use-master-plan

stakeholder consultation during the licensing process of Development Mineral extraction and beneficiation sites. The plan would facilitate the provision of appropriate conditions on license approvals, or support the rejection of inappropriate applications, and thus would reduce the conflicting land use practices currently evident on site. Four examples of conflicting land use practices are presented below to support the development of a Land Use Master Plan. The impacts of the conflicting land use practices are discussed in more detail during the socio-economic analysis component of this report.

The Water Authority of Fiji (WAF) highlights contamination of waterways (caused by gravel extraction and dredging) as one of the critical risks threatening the Authorities ability to supply safe, clean drinking water (see Figure 66)[64]. Water and Development Minerals are both essential natural resources for sustainable development in Fiji, therefore it is important that the two resources are managed in harmony. The effective management of both natural resources would be greatly supported by the development of a Master Land Use Plan which delineates WAF water catchment areas and excludes gravel extraction and dredging in these areas.

Figure 66: Instream extraction and washing of gravel in the Waimanu River, upstream of two WAF intake sites (Source: Dick Watling, 2017).

The Namosi River (commonly referred to as the 'Mosi River') in Nadi provides an example of conflicting land use practices and an opportunity for improved cooperation between government departments. The Ministry of Waterways (MoW) maintains a series of flood retention weirs on the river to mitigate the downstream flood risk in Nadi. This is an important function contributing to the resilience of Nadi. Gravel extraction also takes place on the Mosi River, but the MoW was not consulted during the approval process of the extraction licenses[65]. Subsequently, it is unlikely that the interaction between the gravel extraction and the flood retention weirs has been appropriately considered and managed. Gravel extraction in the same river as flood retention weirs poses two notable issues that warrant careful consideration and consultation with the MoW during the licensing approval process. Firstly, extraction of the sediment accumulated behind the weir

[64] Dick Watling, Water Authority of Fiji: Water Catchment Management Discussion Document, 2017.
[65] Ministry of Waterways, Personal communication, 2017.

(see Figure 67) needs to be undertaken in a controlled manner which does not destabilise the structure and subsequently increase the flood risk to the downstream residents in Nadi. Secondly, weirs restrict the transportation of sediment downstream, thus extraction of sediment from the channel downstream of the weir is likely to exceed the deposition of sediment, and consequently result in degradation (lowering) of the bed level. This poses risk to infrastructure located near the river, such as bridges maintained by the Fiji Roads Authority (see Figure 68).

Figure 67: Gravel extraction taking place immediately upstream of a flood retention weir (Source: Google Earth, 2017).

Figure 68: Degraded riverbed level adjacent to a bridge in the Mosi River (Source: SPC fieldwork, 2017).

Aside from the Mosi River example, MoW conducts regular dredging on certain rivers to manage flood risks, and also carries out desilting (removal of sediment) from behind weirs. According to discussions with MoW staff[66], the material dredged from the rivers is stockpiled on the river banks and not used for any practical purpose, and the sediment removed from behind weirs is placed in the channel downstream of the weirs. This is inefficient use of Development Mineral resources (particularly given issues with sand supply struggling to meet demand[67]) and may have adverse environmental impacts. It is an example of an institution working in isolation, without considering the big picture, and highlights the scope for improved collaboration. The study team recommends Development Minerals extracted during MoW works are sold and utilised for infrastructure Development. We are aware of at least one historic case where a 200,000 tonne stockpile dredged from the Navua River in the 1990's (by the Land and Water Resource Management Division, now the Ministry of Waterways) was sold to a local company for concrete production[68], therefore more efficient utilisation of the resources has occurred in the past. A cabinet decision made on the 8th April 1997 states "that a special rate of $4.00 per cubic metre be levied on sand sold from the various drainage and irrigation dump sites that were stockpiled from dredging operations, and this is to be increased in the event dredging costs increase", therefore a gazetted rate for the sale of the material exists. However, this rate is 21 years old and greatly underestimates the current market value of the resource. The study team recommends the government considers removing the gazetted rate and selling the material through an open tender process to ensure it is sold at market value, and the scope for preferential sale to a contractor (corruption) is removed. Alternatively; the gazetted rate could be updated to reflect the current market value of the resource (and regularly updated rate from thereon), this approach is not recommended as it is less transparent and creates opportunity for corruption, and requires regular updating of the rate to reflect the current market value.

The dredging works conducted by MoW also provide an example of conflict between high value minerals and Development Minerals, which exemplifies the dis-connectivity between regulatory stakeholders. Special Prospecting Licenses (SPL) and Special Mining Leases (SML) are issued to companies with interests in developing high value mineral resources. According to consultation with an SPL holder, MoW engaged a contractor to dredge a river within their SPL, without consulting and obtaining the permission of the SPL holder[69]. The sediment dredged from the river is the prospective resource the SPL holder is interested in. The resource was stockpiled on State Land which restricted the SPL holder's access to the resource, and has led to a dispute between the SPL holder and the state. According to discussions with the SPL holder, the SPL holder observed thieves stealing material from the stockpile, which further compounded the conflict. Additionally, the material was stockpiled with minimal consideration of the surrounding environment, which resulted in vegetation (including coconut trees) dying (see Figure 69), and the SPL holder was subject to criticism from the surrounding community, as the community falsely perceived the dredging works to be carried out by the SPL holder. Therefore, a lack of effective land use planning and consultation has led to conflict between stakeholders, which has increased the risk profile and damaged the business environment for companies interested in high value minerals. In this situation, a master land use plan would enable effective communication between stakeholders,

[66] Ministry of Waterways, Personal Communication, 2017.
[67] Concrete manufacturer, Personal communication, 2018.
[68] Tonkin & Taylor International Ltd, Geotechnical Investigation and Preliminary Design of Rokobili Development, 2017.
[69] Personal Communication, 2018.

and expectantly prevent the conflict from occurring. MRD regularly updates SPL and SML maps (Figure 70 and Figure 71), which could be easily linked to a master land use map database. As shown in Figure 70 and Figure 71, existing SPL's and SML's cover large areas of Viti Levu and Vanua Levu, therefore numerous Development Mineral resources also lie within these areas. Subsequently, the potential for similar conflicts between high value mineral license (or lease) holders and Development Mineral operators is high. Particularly given the proposed development of a network of hard rock quarries, for example many of the strong basalt rock resources on Viti Levu are covered by overburden which may contain bauxite (a high value mineral). Therefore the study team recommends the SPL and SML maps are made publicly available on the MRD website, and the process for consultation between Development Mineral operators and SPL (or SML) holders be clearly defined in information brochures developed to explain the licensing process.

Figure 69: Material dredged by a contractor engaged by MoW, leading to a dispute with an SPL holder (Source: SPL Holder, 2017).

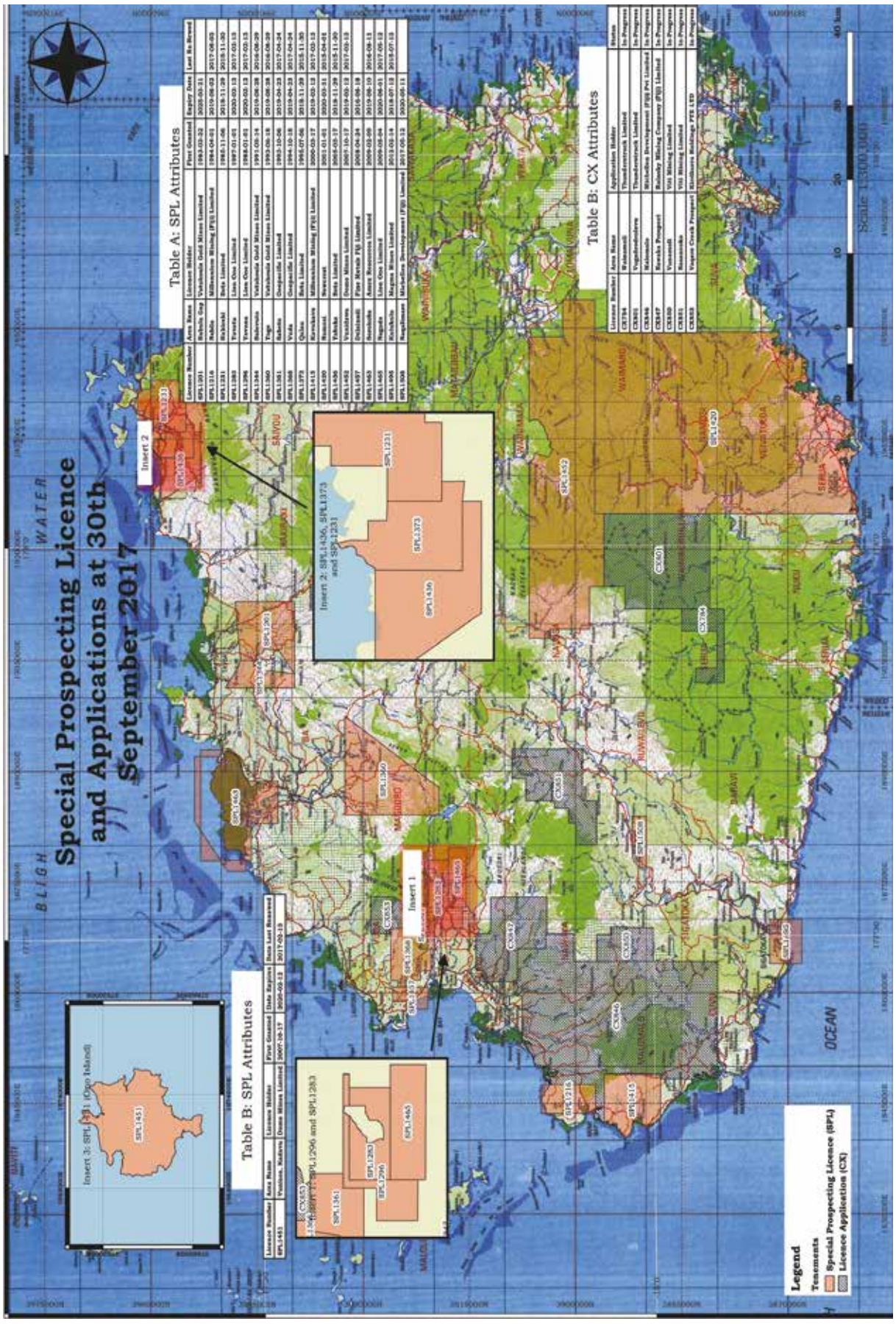


Figure 70: SPL and SML map of Viti Levu (Source: MRD, 2017).

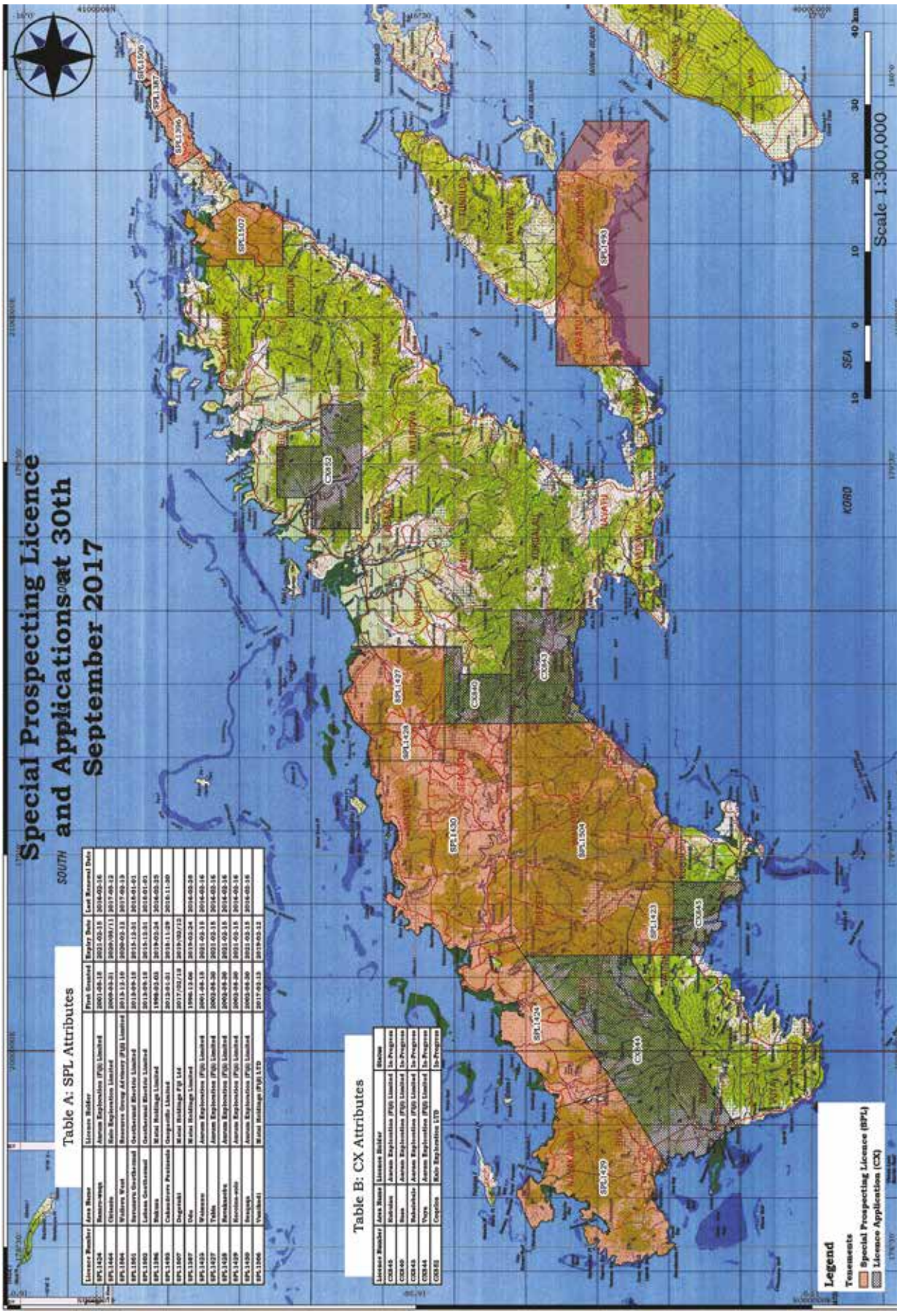


Figure 71: SPL and SML map of Vanua Levu (Source: MRD, 2017)

A final example of conflicting land use practices is at a relatively large hard rock quarry located in the Suva-Nausori corridor (Fiji's most populated region). A subdivision has been approved within close proximity to an existing quarry (and construction has begun), without prior consultation with MRD as to how the proposed development may interact with the existing quarry (see Figure 72). The study team was informed of the issue at a Mining and Quarrying Council meeting and subsequently accompanied MRD to observe the issue on site[70]. This situation presents numerous potential community and occupational health and safety hazards which (according to the information provided to the study team) weren't addressed during the subdivision approval process; including security of the explosive magazine, safety issues on the haulage road, fly-rock risk during blasting operations, the long term rehabilitation of the quarry, dust contamination, and noise contamination[71]. Therefore the new land use activity (the subdivision) will likely restrict the ability of the established land use activity (the quarry) to continue its existing operations. Both shelter and Development Minerals are essential to Fijian communities, therefore, it is fundamental that both land use practices are managed in a way that minimises potential conflicts. In this situation, a Land Use Plan would help facilitate improved inter-government department consultation during the approval process and thus help mitigate potential community and occupational health and safety hazards.

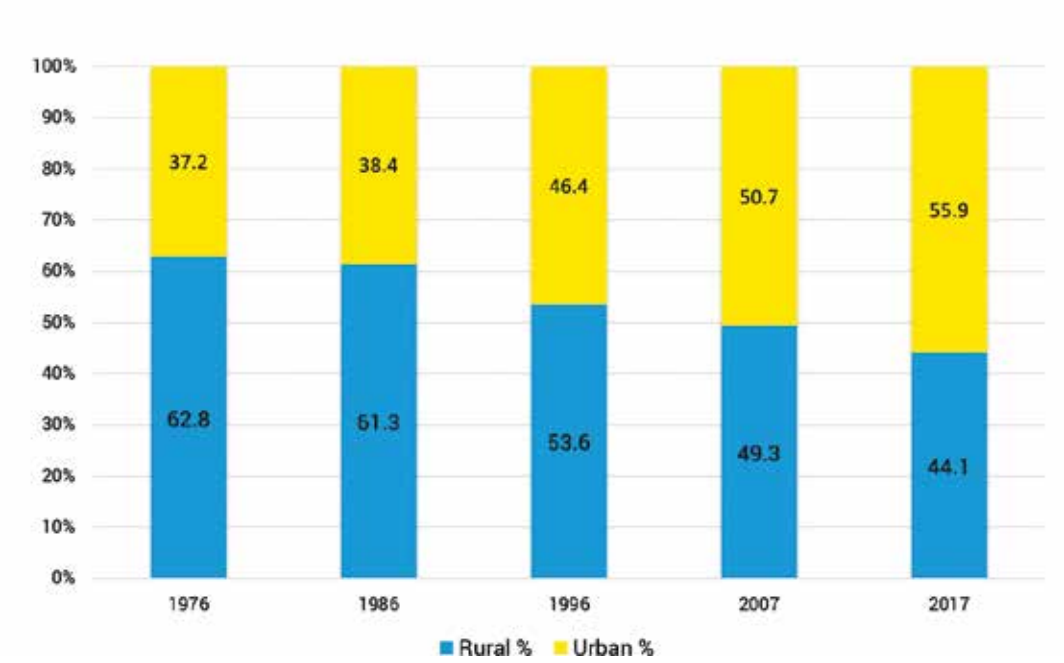
Figure 72: New subdivision development under construction adjacent to existing hard rock quarry (Source: SPC Fieldwork, 2018).

Therefore, conflicting land use practices observed during the study support the initiative of DoL to develop a Land Use Master Plan for Fiji, which incorporates Development Mineral resources, as the output will improve the collective institutional capacity of the Development Minerals sector, and support wider sustainable development in Fiji.

The '2017 Population and Housing Census' indicates that during the decade of 2007-2017, Fiji's urban population increased by 16.3%, while the rural population decreased by 5.3%. This rural-urban drift trend is evident in the population data since the first census data was collected in 1976, as presented in Figure 73.

[70] Mining and Quarrying Council Meeting, December Meeting Minutes, 2017.
[71] MRD, Personal communication, 2018.

Figure 73: Rural-urban drift trend in Fiji between 1976 and 2017 (Source: Fiji Bureau of Statistics, 2017).



The trend highlighted in Figure 73 creates demand for Development Minerals through the additional infrastructure required to support the increasing urban population. The rural-urban drift also threatens the supply of Development Minerals, and highlights the need to digitise an inventory of Development Mineral resources for appropriate consideration during land use planning, for the following reasons:

- To ensure Development Minerals are adequately considered during land-use planning.
- To ensure infrastructure is not unintentionally constructed over valuable Development Mineral resources, thus preventing extraction and utilisation.
- To facilitate protection of quality hard rock resources in strategic locations, for future quarry development.

We recommend hard rock resources are identified and designated for quarry development in land use plans, as their location is fixed (dictated by the geology). When designating areas for quarry development, it is important decision makers consider future infrastructure development, to facilitate establishment of quarries in close proximity to 'end use' locations (usually urban areas). Development Minerals are already being transported large distances in Fiji; for example, sealing chip was transported over 200km by boat between Viti Levu and Vanua Levu for the FRA Nabouwalu-Dreketi Road Project, and a significant amount of the aggregate consumed for construction projects in Suva is currently being transported from the Dawasamu (approx. 75km) and Navua (approx. 45km) Rivers. Implications of not protecting hard rock resources in strategic locations close to urban areas include:

- Increased costs of raw construction materials associated with increased haulage costs.
- Increased congestion on the road network.

- Delays to construction projects.
- Increased fuel consumption and carbon footprint.

Geo-data mapping, digitisation and reserve estimation skills

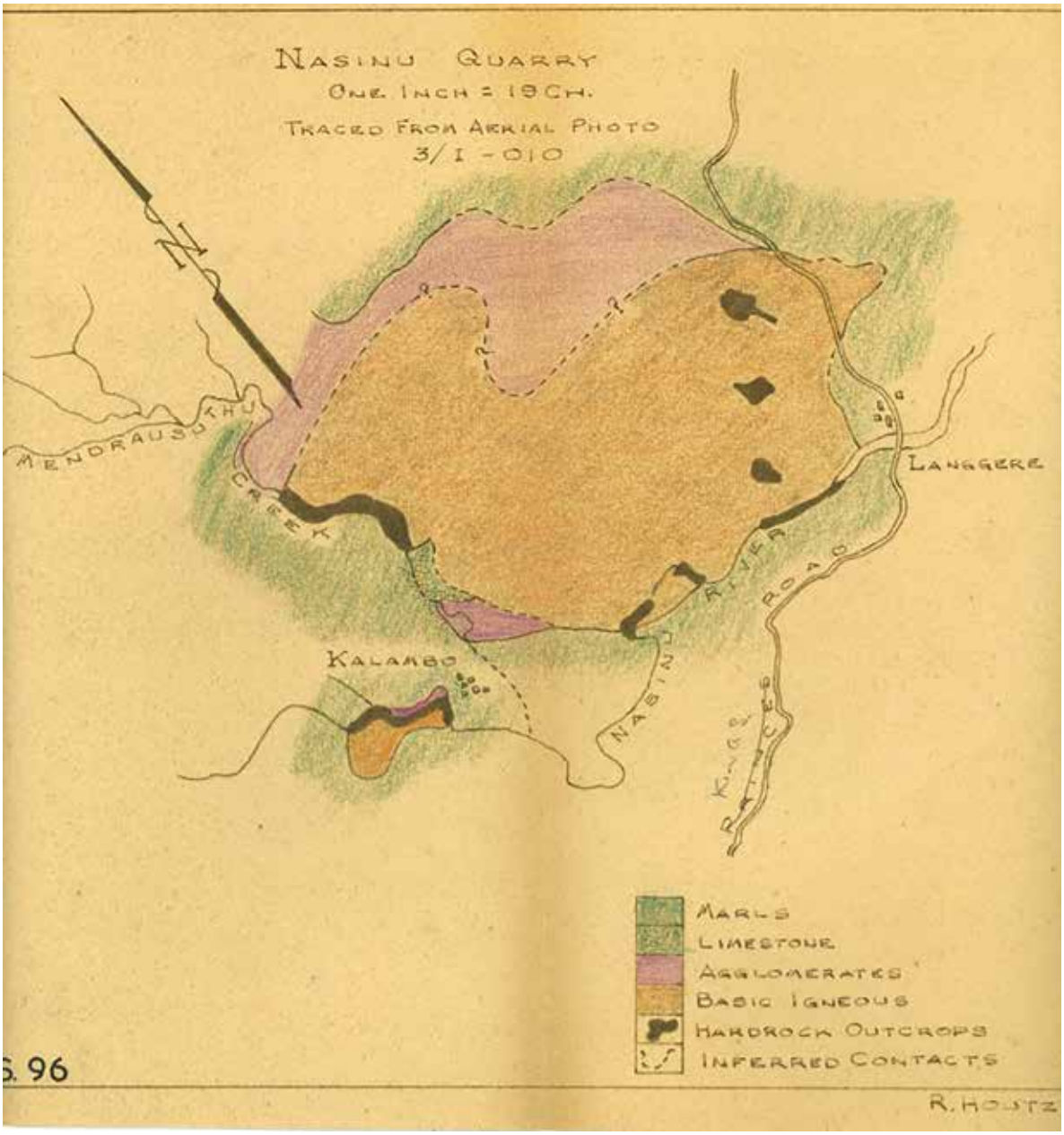
A fundamental initial step towards managing any natural resource effectively is to "build and maintain a good understanding of the resource base",[72] especially in a small island developing state context with limited land resources. This is particularly important in the case of Development Minerals in Fiji; because they are essential for domestic infrastructure development, have the potential to generate significant state revenues for sustainable development, support local food production through the use of lime as fertiliser, and provide the scope to develop several new local industries. The ACP-EU Development Minerals Programme recognises geo-data mapping, digitisation and reserve estimation as a key skillset in the sector and has conducted targeted capacity building initiatives for private sector stakeholders and government officials in Fiji.

MRD is the principal authority responsible for compiling and managing the database of Fiji's mineral resources. The Ministry of Lands and Mineral Resources has approximately 50 staff trained to use ArcGIS software, some staff also utilise Bentely Microstation, LISCAD, AUTOCAD, QGIS and MapInfo, and thus there is significant GIS capacity within the Ministry.[73] The MRD team until recently conducted a programme of works focused on mapping mineral resources, digitising the information in a GIS database and promoting the data to attract investment, largely focused on high value minerals, to the neglect of Development Minerals. The following section demonstrates examples of how Development Minerals have been neglected in terms of geo-data digitisation in Fiji and presents an opportunity for MRD to incorporate Development Minerals into the existing programme of works.

Historically, MRD conducted mapping of existing and potential quarries, this is reflected in the numerous historic reports and publications. The desktop study identified multiple publications concerning Development Mineral resources. However, many of these publications are in hardcopy format only, subsequently the awareness and availability of this data is restricted, therefore the data is easily overlooked by stakeholders such as landowners, government decision makers and potential investors. For example; the Geological Survey published a report titled 'Report on Quarry Rock Reserves in the Suva Area' in 1957[74], the report investigated 3 existing quarries and 5 potential quarry sites, and presented valuable data regarding resource volumes and quality. However, the report is only available in its original hard copy format in the MRD Library, see Figure 74 below for an example of a map from the report. The potential quarry sites identified in the report present an opportunity for landowners to generate long term income and achieve economic prosperity, provided the generated incomes are invested responsibly (refer to the 'Mataqali Lomanikoro' case study). Therefore, knowledge of identified hard rock resources (the resource base) is vital in ensuring landowners are aware of the opportunity, and in an informed position to effectively manage their land and resources. The data is also essential for government decision makers (to ensure the resources are adequately considered during land use planning), it is also very important information for raising awareness among potential investors.

[72] Natural Resource Charter, Natural Resource Governance Institute (Second Edition), 2014.
[73] Ministry of Lands and Mineral Resources, Personal communication, 2018.
[74] Geological Survey, Report on Quarry Rock Reserves in the Suva Area, 1957.

Figure 74: Example of non-digitised Development Mineral resource information (Source: Geological Survey, 1957).



As part of this study the hard rock resources mapped in the 'Report on Quarry Rock Reserves in the Suva Area' were digitised and georeferenced to display the location of the identified resources with respect to current infrastructure as presented in Figure 75 and Figure 76. Since the report was published 60 years ago, none of the identified potential quarries have been developed, and it appears infrastructure has been constructed without consideration of the hard rock resources. Therefore it is evident the data contained in the report has been neglected, and subsequently overlooked by landowners, government decision makers and potential investors. The complete set of georeferenced quarry resources are provided in Appendix 5.

Figure 75: Digitised and georeferenced hard rock resources identified by the Geological Survey in 1957 (outlined by the red lines), with respect to current infrastructure.
(Source: Google Earth, image date 2017)

Figure 76: Digitised and georeferenced Nasinu hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note the substantial infrastructure built over the resource and encroaching on the quarry operation.
(Source: Google Earth, image date 2017)

The 'Report on Quarry Rock Reserves in the Suva Area' is just one example of the previous publications related to Development Minerals. There is plethora of publications related to the geology of Fiji, which are summarised in bibliographies compiled by the late Peter Rodda, thus we recommend:

- A thorough desktop study to identify data related to Development Mineral resources.
- Digitisation and georeferencing of data in a Geographic Information System (GIS) database.
- Equitable distribution (open), promotion and awareness raising of data amongst key stakeholders, including; landowners, government (particularly decision makers involved in land use planning), and potential investors.

We also note that many of the previous publications were conducted several decades ago. Thus while conducting the desktop study we also recommend MRD plans further Development Mineral exploration activities, given the present day context (e.g. market for Development Minerals and current infrastructure), and technological advances in geological investigation techniques in recent decades.

Sector promotion activities

Investment Fiji is the marketing arm of the Fiji Government providing services and assistance to promote, facilitate and stimulate increased investments and exports.[75] Investment Fiji focuses on both local and foreign investors and targets investment opportunities that are beneficial to Fiji's economy and align with the countries overall vision. Extractive industries are not one of Investment Fiji's priority promotional areas; they are considered a second tier promotional activity. Specifically for Development Minerals no current investment promotion takes place and collaboration with MRD is minimal.

The Ministry of Agriculture provides a good example of the potential positive outcomes of increased collaboration. Historically the Ministry of Agriculture and Investment Fiji had minimal interaction, however in recent years the two have worked together to successfully promote and attract investment in several agricultural products, which has subsequently created numerous jobs, improved local food production and contributed positively to Fiji's economy[76].

We perceive an opportunity for MRD and Investment Fiji to collaborate and attract appropriate investment in the Development Minerals sector. The effectiveness of promotional activities would be dependent on a plethora of factors, nevertheless the current policy and regulatory environment in the Development Minerals sector is a potential impediment. Investment Fiji endeavours to attract environmentally responsible investors who strive to make a positive impact in Fiji. Based on discussions with Investment Fiji, attraction of environmentally responsible hard rock quarry investors is more favourable when supported by monitoring and enforcement of a regulatory framework that promotes environmentally responsible practices, and prevents competitors producing output (sand, rock or gravel) at a lower cost using environmentally irresponsible extraction techniques. Improvement in this area is recommended before promotion

[75] http://www.investmentfiji.org.fj
[76] Investment Fiji, personal communication, 2018.

takes place[77]. We recommend wider government consultation when formulating the investment attraction strategy; particularly inclusion of large consumers of Development Minerals such as the Fiji Roads Authority, to ensure the market is suitably informed of programmed government infrastructure development projects and the associated demand for Development Minerals. The 5-year Development Plan provides a useful baseline for forecasting Development Mineral demands for government projects in the near future.

Much of the recent media coverage of the sector is negative in nature, perhaps depicting the current dynamics of the industry. Titles of articles (relevant to the Development Minerals sector) published in Fijian media between 2014 and 2018 are listed below:

- Ecosystem Destroyed (Fiji Times, 2014).
- Threat from Extraction (Fiji Times, 2014).
- Gravel Extraction Concern (Fiji Sun, 2015).
- Company Issued Second 'Stop Work' Notice (Fiji Sun, 2016).
- Petition against Quarry Setup (Fiji Times, 2016).
- 16M Investment in Stone Crushing (Fiji Times, 2016).
- New Quarry Opens (Fiji Times, 2016).
- Well-Hidden Reliance (Fiji Times, 2016).
- Katonitabua Clarifies Gravel Royalties (Fiji Times, 2017).
- Gravel Extraction Concern (Fiji Times, 2017).
- Quarry Permits under Review (Fiji Times, 2017).
- Villagers Fret Over River Gravel Extraction (Fiji Times, 2017).
- Maururu Road Open to Traffic (Fiji TV Online, 2017).
- Quarry Capacity Pleases Group (Fiji Times, 2017).
- LTA Plans to Acquire Portable Scales to Tackle Overloading (Fiji News, 2017).
- FRA Disappointed With Heavy Goods Vehicle Companies (Fiji News, 2017).
- Over 400 Vehicles Fined for Overloading (Fiji News, 2017).
- Illegal River Gravel Extractions Takes its Toll in Mosi River (Fiji Sun, 2018).
- Gravel Payments (Fiji Times, 2018).

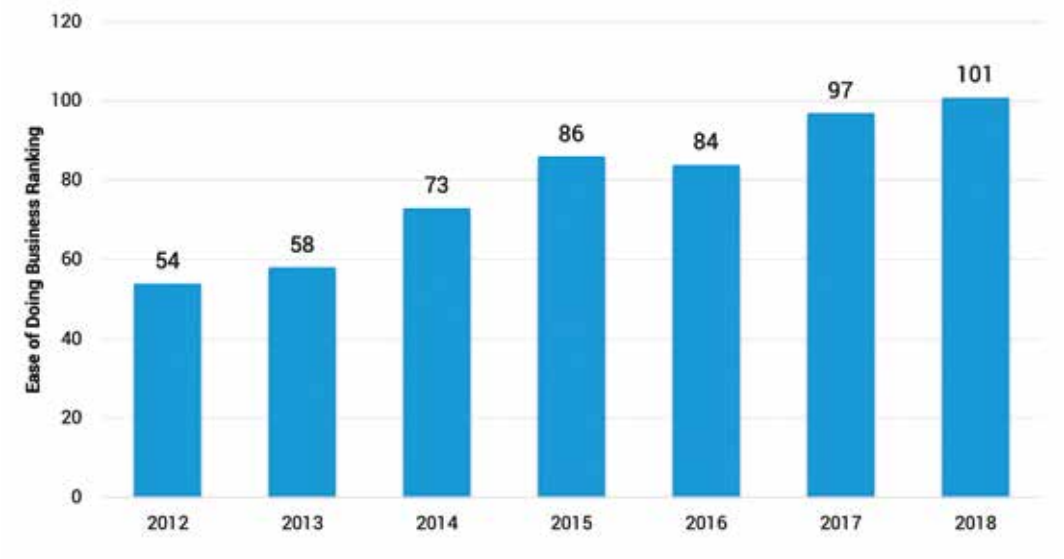
[77] Investment Fiji, personal communication, 2018.

Moving forward, the Mining and Quarrying Council provides a platform for potential collective collaboration between stakeholders to produce media articles which promote a balanced view of the sector, such as Development Minerals contribution towards development in Fiji.

Business environment and access to finance for Development Mineral operators

According to the World Bank 2018 'Ease of Doing Business' report, Fiji ranks 101 out of 190 surveyed economies (see Figure 77)[78].

Figure 77: Ease of Doing Business Ranking for Fiji 2012-2018 (Source: World Bank, 2018)

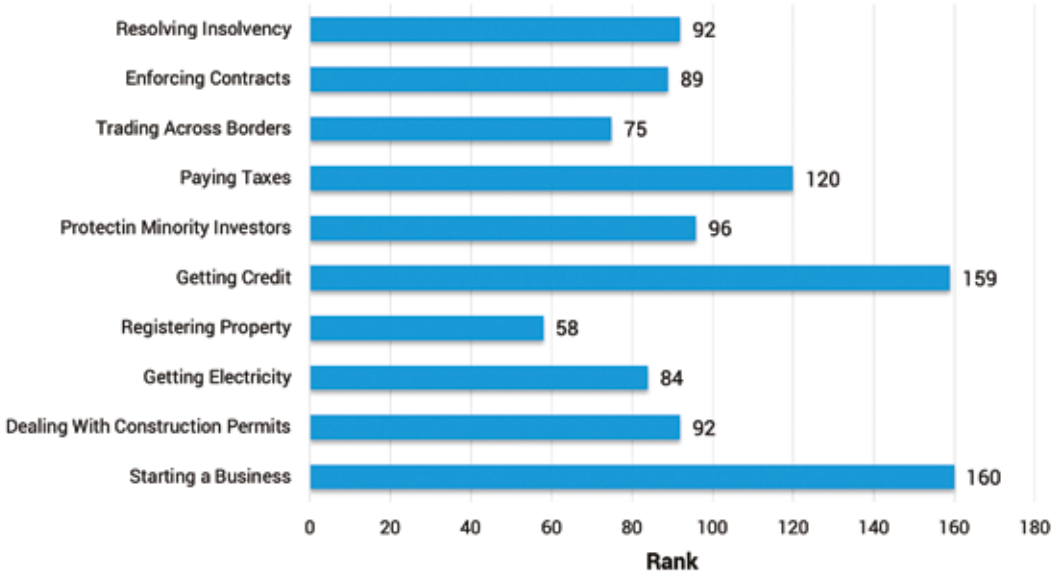


Fiji's overall 'Ease of Doing Business' ranking has declined from 54th in 2012 to the present position of 101st. This trend indicates an overall decline in Fiji's business and investment environment since 2012. However, in 2017 the Government of Fiji sought the assistance of the World Bank and established a special taskforce to address relevant areas that will help improve Fiji's 'Ease of Doing Business' rankings and the overall business environment in Fiji[79]. Promising actions are underway; such as the adoption of digital technology to improve systems, and streamlining of permitting processes through business process mapping (in conjunction with experts from Singapore) to identify and eliminate unnecessary processes[80]. There is an opportunity to specifically improve the business environment in the Development Minerals sector through applying the same initiative to streamline the licensing process. Fieldwork indicates the idea of a streamlined process is supported by the private sector, as 26 of the operators surveyed supported the idea of a 'one-stop shop' for licensing and monitoring, and no operators were against the idea (see question 23 in Appendix 1). Private operators also identified the timeframe to obtain a license relative the license issuance period as a critical issue; operators reported 6 month timeframes to obtain a licenses, and license issuance periods of 12 months[81].

[78] World Bank, Doing Business 2018 Economy Profile: Fiji, 2018.
[79] Reserve Bank of Fiji, What is the World Bank's "Doing Business" Report? , 2017.
[80] Fiji Sun, Building Permits Soon to be Made Faster, 2017.
[81] Private extraction operators, personal communication, 2017.

A breakdown of the individual rankings for each respective indicator comprising the overall 'Ease of Doing Business' ranking is summarised in Figure 78.

Figure 78: Ease of Doing Business Ranking Breakdown for Fiji 2018 (Source: World Bank, 2018)



Currently Fiji's best ranking is 'Registering Property' (58th). According to the World Bank, it takes on average 69 days to register a property, 5.5 days shorter than the East Asia and Pacific region average of 74.5 days.

Fiji's worst ranking 'Starting a Business' (160th); According to the World Bank, it takes on average 40 days and costs 16.9% of income per capita to complete the procedural requirements to start a business. Therefore, new Development Mineral operators entering the Fiji market are subject to relatively high costs and long timeframes to start a business, before completing the other industry specific procedural requirements such as obtaining a quarry license.

Fiji also ranks poorly in terms of 'Getting Credit' (159th). In 2016, Fiji ranked 78th for 'Getting Credit', the rapid decline to 159th is associated with the suspension of the Fiji's only operating data bureau (Data Bureau Limited) in May 2016, which limited access to credit information. According to the Reserve Bank of Fiji, the decline in the 'Getting Credit' ranking is expected to be temporary because the passing of the 'Fair Reporting of Credit Act' in May 2016 is anticipated to provide a legal framework for credit reporting agencies to operate with the Reserve Bank of Fiji acting as a regulator[82]. As discussed below, data obtained from financial institutions, Investment Fiji and operators, also indicates that access to finance is a specific issue in the Development Minerals sector.

Development Mineral operators face relatively high upfront capital costs associated with equipment (e.g. drilling rigs, crushing machines, excavators and trucks) and often require financial assistance to facilitate equipment purchases. Access to finance is a challenge for operators

[82] Reserve Bank of Fiji, What is the World Bank's "Doing Business" Report? , 2017.

because banks and finance companies in Fiji typically perceive the Development Minerals sector as a high-risk industry, due to the following reasons[83] [84]:

- High equipment 'wear and tear' and associated maintenance costs.
- Low equipment lifespans.
- High risk of equipment breakdown halting quarry production and the ability of the operator to make loan repayments.
- In the event a borrower fails to make loan repayments and the lender repossesses the collateral equipment (such as a crusher); the market for selling the equipment in Fiji is relatively small, and therefore the likely sale price (relative to the initial purchase price) is low.
- Incidents of asset stripping have resulted in the need for financial lenders to conduct routine monitoring and cataloguing of equipment condition to ensure the tangible security of the loan is intact.
- Limited license periods for some extraction operations.

Subsequently assess to finance is restricted to investors with adequate start-up equity, good tangible security cover and a clear demonstration of how loans will be serviced. Banks typically refuse to invest in second-hand equipment due to the higher risk associated with the depleted condition of the asset. Finance companies are typically more willing (than banks) to invest in the Development Minerals sector as they generally take higher risks, however they also charge higher interest rates and typically cap lending at approximately FJ$1M (this is insufficient to purchase certain types of equipment such as crushers). On a case by case basis, finance companies may invest in second-hand equipment, however they will require an independent valuation, which is not available locally in Fiji, so needs to be conducted by an external consultant which can cost in order the of FJ$10,000 [85].

Adequate start-up equity is a key challenge, typically comprising at least 50% of the equipment cost, and sufficient working capital. Therefore, many prospective Development Mineral operators require multimillion-dollar start-up equity, particularly hard rock quarry and beneficiation investors. Adequate start-up equity is less of a challenge for operators extracting gravel from rivers (particularly operators selling the raw gravel to beneficiation sites); because the value of the required equipment is significantly lower (approximately 10 times lower, see Table 12).

83 Bank, personal communication, 2018.
84 Finance company, personal communication, 2018.
85 Quarry owner, personal communication, 2018.

Table 12: Typical equipment start-up costs

Typical equipment start-up costs*					
Hard rock quarry and beneficiation		River gravel extraction		River gravel extraction and beneficiation	
2 x 12T Excavator	$1,000,000	12T Excavator	$340,000	12T Excavator	$340,000
10 wheeler Truck	$150,000	10 wheeler Truck	$150,000	10 wheeler Truck	$150,000
Primary Crusher	$1,000,000			Mobile Jaw Crusher	$1,000,000
Secondary Crusher	$1,000,000		Screening and washing plant	$1,000,000	
Drilling rig	$700,000		50 kva Generator	$60,000	
50 kva Generator	$60,000				
Explosive magazine	$20,000				
Screening and washing plant	$1,000,000				
FJ$ 4,930,000		**FJ$ 490,000**		**FJ$ 2,540,000**	

*** Costs are for new equipment and are indicative only; to demonstrate the relative differences in equipment start-up costs for hard rock quarries and river gravel extraction. Costs are based on information from suppliers and the Mining and Quarrying Council.**

It is important to note the start-up costs presented in the Table 12 are for typical equipment only. Hard rock quarries also face relatively high start-up capital costs associated with: exploration and resource proving, site clearance and the removal of overburden, lease agreements, the construction of site access and facilities, which can be in the order of serval million Fiji dollars. Working capital is also higher for hard rock quarries, associated with maintenance costs, and explosives. The results of this financial reality are evident in the observed 'regulated sector' dynamics, with 66 river gravel extraction sites (only 23 with beneficiation) and only 16 hard rock quarries. The relatively low financial cost of extracting Development Minerals from rivers is being conducted at a high cost to the environment and Fijian communities (as discussed in 'Environmental impact analysis' section of this report). The existing hard rock quarry operators compete based on a higher quality product; however if the government opts to limit extraction of gravel from rivers and transition to a network of hard rock quarries in strategic locations, the financing of hard rock quarry investments should be considered further. Potential avenues for assisting hard rock quarry investments include; government incentives, support from Development Banks (e.g. the Fiji Development Bank) and attraction of investors through Investment Fiji. The study team presented to the Fiji Development Bank as part of the assessment; the bank expressed interest in financing hard rock quarries, and is already providing financial assistance to promote the use of

crushed limestone in the agricultural sector[86].

Additionally, the current regulatory framework financially incentivises gravel extraction and financially discourages the establishment of quarries. DoL is responsible for issuing licenses for gravel extraction in rivers, while the iTLTB is responsible for issuing quarry licenses on the majority of land (92% of land in Fiji is Native Land). The respective royalty and license application fee pricing structures of the institutions is as follows:

- DoL royalty rate[87] (last updated in 1997) for gravel extraction in a river is FJ$2.50 per m^3.
- iTLTB royalty rate[88] (last updated in 2014) for rock is FJ$3.31 per m^3 and FJ$6.61 per m for sand and gravel (on dry land).
- DoL license applications fees are FJ$3.00.[89]
- iTLTB license applications fees are FJ$5,192.50.[90]

Therefore the current pricing structures of the royalty and license application rates are an impediment to the establishment of a network of hard rock quarries. This highlights the need for multi-stakeholder cooperation in order to resolve the issues currently prevalent in the sector.

Throughout the course of the study road haulage legal weight limits was a major concern repeatedly raised by Development Mineral operators via individual interviews, questionnaires[91], the Mining and Quarrying Council meetings[92] and the Construction Industry Council meetings[93]. Development Mineral operators (and the wider Road Haulage Association) believe that current limits are detrimental to the industry's ability to transport material, and are seeking increases to the current legal weight limits. It is worth noting that some haulage runs between extraction and beneficiation sites are in the order of 50-100km, and many haulage runs (particularly delivery of material to construction sites) are often along the main arterial road network routes in the major cities.

On the other hand, the Fiji Roads Authority[94] and the Land Transport Authority[95] recognise increased loads as contributors to transport infrastructure damage and road safety issues (see Figure 79), and are therefore encouraging the Road Haulage Association members to invest in lighter, more efficient vehicles (with less dead load). Negotiations between the Road Haulage Association, FRA, LTA, and the Ministry of Infrastructure and Transport are currently ongoing, and a more appropriate and easily adaptable set of legal weight limits are being considered[96]. However,

[86] http://www.fdb.com.fj/fdb-seals-partnership-with-standard-concrete-industries-to-promote-aglime/
[87] Government of Fiji, Cabinet Decision: Gravel/sand extraction and recompense for the loss of traditional fishing rights, 1997.
[88] Government of Fiji, iTaukei Land Trust (Gravel) (Amendment) Regulation 2013, 2014.
[89] Department of Lands, Extraction on State Lands-The New Requirements, 2018
[90] Department of Lands, Extraction on State Lands-The New Requirements, 2018
[91] SPC, Fieldwork, 2017.
[92] Mining and Quarrying Council, Various Meeting Minutes, 2017 and 2018.
[93] Construction Industry Council, Minutes of General Meeting 31/01/2018, 2018.
[94] The Fiji Times, Overloading a cause of structural failures, 2017.
[95] The Fiji Sun, Overloading Compliance Improves: LTA, 2017.
[96] Road Haulage Association, Personal communication, 2018

the Road Haulage Association is currently awaiting clarity around the potential new legal weight limits prior to upgrading its fleet (to lighter more efficient vehicles), as the enforced weight limits will have a pivotal influence on the types of vehicles that operators chose to invest in.

Figure 79: Damaged transport infrastructure (Source: Fiji One, 2017)[97].

In the meantime, Development Minerals are being transported in relatively heavy trucks, which (in some cases) are only able to transport half-full loads, given the 'Land Transport Regulations 2000'. Although this may improve the longevity of transport infrastructure and some road safety issues, negative impacts associated with trucks transporting half-full loads (as opposed to full loads) include:

- Double the transportation costs, resulting in an increase in the cost of producing Development Minerals, which subsequently increases the cost of dependent activities such road and house construction (ultimately bared by the consumer).
- Twice the number of truckloads required to transport a given volume of Development Minerals, which results in more trucks on the road and greater congestion.
- An increase in the carbon footprint of the industry.
- A decline in the ability of the industry to supply Development Minerals in a timely manner.

Therefore, the current road haulage situation is affecting the business environment for Development Mineral operators and is having wider implications on the Fijian economy. Clearly

[97] http://fijione.tv/maruru-road-open-to-traffic/

careful consideration of road safety and transport infrastructure issues is required prior to making a decision on whether more appropriate and easily adaptable legal weight limits are feasible, however the study team recommends timely resolution of this matter so Development Mineral operators (and the wider Road Haulage Association) can move forward and make informed investments in lighter and more efficient vehicles.

All 41 Development Mineral operators surveyed by the study team noted that the demand for Development Minerals is high, driven by a booming construction industry[98]. The demand profile for the industry is discussed in detail in 'Market and Value Chain Analysis' component of this report, but it is important to highlight here that although the business environment for the Development Mineral Operators has its challenges, the outlook in terms of demand for Development Minerals is very good.

Technical context for Development Minerals operators

The Fiji Commerce and Employers Federation (FCEF) is Fiji's National Private Sector Organisation under the umbrella of the Pacific Islands Private Sector Organisation (PIPSO). FCEF's mission is to "provide the employers of Fiji with the knowledge, understanding, and capability to maintain the best possible labour relations, while seeking to grow their businesses and the economy by encouraging the government to provide the environment for the private sector to prosper"[99]. FCEF has nine standing councils representing different components of the private sector, of which the Mining and Quarrying Council represents the Development Minerals sector. The Manufacturing, Trade and Export Council is also relevant, particularly for downstream beneficiation operators involved in the manufacturing of value added products such as concrete.

The functions of the Mining and Quarrying Council include:

- Monthly meetings to discuss issues pertinent to the industry.
- Facilitate government liaison to resolve issues related to the industry.
- Act as a forum for networking and the exchange of views and experiences.
- Collection, collation and analysis of employer related statistics
- Organisation of workshops and seminars related to the industry.
- Conduct an annual salary survey to provide members with information related to employee remuneration.
- Study industrial relations and promote industrial peace.
- Consider initiatives to promote Fiji as an attractive investment location.
- Provide members with advice related to employment issues.

Thus, the Mining and Quarrying Council provides a forum for dialogue and resolution of many of the issues identified in this report.

[98] SPC, Operator surveys, 2017.
[99] http://www.fcef.com.fj/

We attended several of the Mining and Quarrying Council meetings throughout the study, and also obtained membership details from the secretariat. This highlighted a significant underrepresentation of Development Mineral operators on the Council, and the scope to improve membership. The Mining and Quarrying Council has 33 member organisations, of which only 4 are extraction companies from the Development Minerals sector. The 'Profile of the Sector' identified a total of 75 regulated companies involved in the Development Minerals sector, including 67 extraction operators. Therefore, only 4 of the 67 eligible companies (6%) are members of the Mining and Quarrying Council. FCEF were notified of this underrepresentation by the study team and are currently in the process of inviting Development Mineral operators to become members of the Mining and Quarrying Council.

Quarry and site management skills

Operators displayed variable quarry management skills however hard rock quarries and river extraction sites with combined beneficiation typically displayed higher levels of quarry management skills than river extraction sites. For example hard rock quarries and river extraction sites with combined beneficiation typically had adequate signage, personal protective equipment and a site office with relevant documentation such as the Quarry Operational and Environmental Management Plan, whereas river extraction sites typically did not meet these site management requirements.

Community relations and conflict prevention capabilities

Based on site visits and interviews with surrounding communities it is evident that hard rock quarries typically have better community relations compared to river extraction sites. Hard rock quarries typically had a site office with a complaints record book to record community complaints, whereas river extraction sites typically did not (with exception of relatively large river extraction sites with combined beneficiation). The relatively long-term nature of quarries allows the operator to establish a relationship with the surrounding community and contribute to the sustainable development of the community through royalty revenues, employment opportunities and improving infrastructure (for example access roads and water supplies). Hard rock quarries on Native Land also trigger the involvement of iTLTB which provides a conduit for community liaison and conflict resolution and distribution of royalties to the iTaukei community. Whereas river extraction sites are relatively short-term in nature, are mobile due to the dynamic nature of the deposits, and typically conflict with several communities utilising the river for a variety of other functions.

Environmental management skills

Operators raised concerns regarding a lack of awareness of environmental consultants qualified to conduct EIA assessments for the extractives sector, highlighting the opportunity for DoE to increase the visibility of the registered environmental consultant's database. Field observations indicate variable environmental management skills from extractive site personnel; quarry operators typically displayed far greater environmental management skills when compared to river extraction operators. For example silt fences were observed around hard rock quarries to prevent sedimentation in surrounding creeks, however no silt fences were observed at river extraction sites even though the potential for sedimentation is far greater.

Geo-data

Prior to the ACP-EU Development Minerals programme operators typically had limited geo-data capacity. The capacity building initiatives conducted during the programme have increased operators awareness of geo-data technology and how it can be used to improve business operations. Private sector operators were given licenses to GIS software packages and are implementing return to work plans (plans to implement the lessons learnt from the trainings in day-to-day operations), with multiple operators noting improved business outcomes[100]. One of the larger operators in Fiji with multiple extraction sites on Viti Levu and Vanua Levu noted the potential for the technology to improve record keeping and allow real-time access to data (across multiple locations) for accurate and timely decision making. The operator also noted the training was very beneficial in developing an improved Quality Management System in preparation for independent certification later in the year.

Numerous operators expressed interest in establishing hard rock quarries however they noted that the quality and availability of data concerning potential quarry resources is a major issue preventing the establishment of hard rock quarries. Operators reported consulting MRD for a database of prospective quarry resources but were not provided with adequate data.

Access to finance

As discussed in the 'Business environment and access to finance' section, operators noted that the availability of is a key issue. This presents several opportunities to improve access to finance such as improving the legal and policy framework, sensitising financial institutions, training operators with business skills, and establishing a Pacific Guarantee Fund (similar to the Africa Guarantee Fund[101]) to improve access to finance for small and medium sized enterprises.

Laboratory testing

Specifications associated with construction projects in Fiji often require materials to pass a series of laboratory tests to ensure the materials are of sufficient quality for specific engineering applications. Laboratory testing is available locally in Fiji through at least 2 independent laboratories, and one of the cement manufacturers has an in-house IANZ accredited laboratory. None of the operators consulted during the study raised the availability of laboratory testing as a specific issue. However, one operator highlighted the cost of laboratory testing as an issue.

Capacity gaps and training needs

The study has highlighted a shortage in the following skillsets:

- Earth sciences - particularly geology.
- Detailed scientific review of environmental impact assessments
- Surveying and resource mapping

[100] Private operators, personal communication, 2018.
[101] http://www.africanguaranteefund.com/

- Quarrymen - particularly blasters (the use of explosives)
- Record keeping and data management

We recommend the educational institutes consider offering courses to educate Fijians and enable these capacity gaps to be filled with local personnel in the future. The ACP-EU Development Minerals Programme recently supported the establishment of a 'Certificate IV in Geology, Mining and Quarrying' at FNU, which is a positive step in the right direction. And provides a good basis or further detailed course to be developed. In the short term the government may wish to consider recruiting expatriates to fill some of the current voids, particularly in MRD and MoE.

Component 4: Environmental, Community, Occupational Health and Safety and Socio-Economic Impact Analysis

Environmental impact analysis

Rivers are dynamic systems, connected to the land, coast and ocean, providing habitats for numerous organisms, therefore altering the natural environment of a river has the potential for far reaching cumulative impacts. Below we summarise the impacts identified through direct observations, and via information provided by community members living adjacent extraction operations. A total of 105 community members were surveyed using the questionnaire in Appendix 3, and 46 regulated extraction sites were visited during the fieldwork.

Sediment (physical, chemical and biological) is a naturally occurring component of Fiji's aquatic systems. The naturally occurring concentrations of suspended sediment vary both spatially (associated with variations in sediment sources e.g. geological and biological variations), and temporally (primarily associated with weather events such as cyclones and floods, and in the long term tectonic events such as earthquakes, which increase the rate of sediment transportation). However, river extraction has the potential to increase suspended sediment above natural levels via five primary means:

1. The direct action of extracting sediment from the river channel disturbs the bed and releases sediment into suspension.
2. Washing of gravel (either in or adjacent to the river channel) releases sediment into suspension.
3. Insufficient site drainage can release concentrated sediment into the river channel, resulting in increased suspended sediment.
4. The removal of gravel and boulders exposes finer sediments in the river bed, which are more prone to erosion (particularly during flood events), resulting in increased suspended sediment.
5. The disturbance of river banks, lowering of the bed level, and diversion of the channel, can decrease the slope stability of the rivers banks and thus make them more susceptible to erosion (particularly during flood events), resulting in increased suspended sediment.

We observed numerous examples of increased suspended sediment associated with river extraction sites, as shown in Figure 80 to Figure 85. No sediment control measures (such as silt fences) were observed, and it is common practice for operators to extract material directly from the active river channel.

Figure 80: Increased suspended sediment downstream of an extraction site on the Nawaka River (Source: SPC Fieldwork, 2017).

Figure 81: Increased suspended sediment downstream of a gravel extraction site on the Dawasamu River (Source: SPC Fieldwork, 2017).

Figure 82: Increased suspended sediment adjacent to an extraction site on the Sabeto River (Source: SPC Fieldwork, 2017).

Figure 83: Example of turbidity generated from two gravel extraction sites on the Navua River, directly adjacent to a Fijian community (Source: Google Earth, Image date 7/06/2017).

Figure 84: Example of increased suspended sediment generated from a river extraction and beneficiation site located on the Dawasamu River (Source: SPC Fieldwork, 2018).

Figure 85: Accumulation of sediment downstream of the extraction site on Dawasamu River presented in Figure 84 (Source: SPC Fieldwork, 2018).

Of the 105 community members surveyed, 93 (89%) reported suspended sediment (or "dirty water") as a negative impact associated with river extraction activities adjacent to their land. Additionally 10 community members reported observing oil spillages in the river. The communities emphasised that they depend on the water in the river on a daily basis for several critical subsistence functions, including:

1. Drinking
2. Watering plantations
3. Cooking
4. Bathing
5. Washing clothes and other household items
6. Livestock (e.g. cows and goats) drink the water

Therefore increased suspended sediment associated with river extraction decreases the hygiene standards of Fijian communities and creates health risks. This is evident, as 55 of the 105 community members surveyed (52%) reported health issues associated with "dirty water" in the river, including; skin diseases, ringworm, typhoid and scabies. Additionally, 49 of the community members explained that the health issues had triggered involvement from the local health authorities.

The Water Authority of Fiji (WAF) has identified sediment generated from river extraction operations in water catchment areas as "perhaps the most serious continuing threat" to the organisations ability to supply drinking water of sufficient quality, and describes the activity as "completely avoidable sediment generation within rivers."[102] Near estuary dredging also has the potential to increase saltwater intrusion further upstream and thus alter the water quality.

Fijian communities also depend on fisheries (in the rivers and downstream ocean systems) as a crucial source of protein and income. All aquatic organisms require certain levels of dissolved oxygen to survive. Sediment generated by river extraction has the potential to decrease dissolved oxygen levels via chemical and biological reactions and processes which consume dissolved oxygen. Specific impacts on dissolved oxygen levels vary depending on the quantity and characteristics of the sediment. If oxygen levels drop below required thresholds, organisms die or migrate to alternative habitats.

According to a study by the European Inland Fisheries Advisory Commission (EIFAC)[103] excessive suspended sediment can be harmful to fisheries in the following ways:

1. Acting directly on the fish swimming in the water in which solids are suspended, and either killing them or reducing their growth rate, resistance to disease etc.
2. Preventing the successful development of fish eggs and larvae.
3. Modifying natural movements and migrations of fish.

[102] Dick Watling, Water Authority of Fiji: Water Catchment Management Discussion Document, 2017.
[103] European Inland Fisheries Advisory Commission, Report on Finely Divided Solids and Inland Fisheries, 1964.

4. Reducing the abundance of food available to the fish.

5. Affecting the efficiency of methods for catching fish.

Approximately 143 species are known to spend at least half of their adult lives in freshwater, of which 132 are native to Fiji, and at least 5 are considered endangered.[104] In addition to the risks posed by increased sediment, river extraction is currently altering and in many cases destroying habitats (such as pools and rapids) which many of the freshwater species depend on. Anecdotal evidence collected during consultations with communities living adjacent to river extraction sites, indicates that freshwater species populations decline (or completely disappear) due to river extraction. Thirty-six of the 105 surveyed community members (34%) reported negative impacts on Qoliqoli's (fisheries) following establishment of river extraction operations, including the following species; Ika Droka, Kai, Tilapia, Valu, Daniva, Malavi, Sogasoga, Kanace, Tuka, Dina and prawns.

Downstream impacts on marine fisheries and coral reef systems are typically not considered during Environmental Impact Assessments,[105] however suspended sediment generated from river extraction sites can result in increased concentration of sediment transported to the coastal environment, and therefore has the potential to impact marine fisheries and coral reef systems. This was highlighted by Dr Sarah Beavis (of the Australian National University) who is conducting research into the environmental and social impacts associated with the extraction operations on Dawasamu River. Dr Beavis noted "on June 31st 2017, an extensive, and well defined sediment plume was observed from the headland at Takalana Bay Resort, extending in a NE direction from the mouth of the river out into coastal waters and the traditional fishing grounds of the village of Nataleira. Local women fishers complained that their daily catch had been depleting since commencement of the extractive industries. A decreasing catch has significant implications in terms of both dietary protein intake and livelihoods for the villagers. Furthermore, there is potential for sedimentation to have ecological impacts on Moon Reef Marine Reserve."[106]

The increased sediment transported downstream and deposited at the coast also has the potential to increase dredging works required to maintain sufficient vessel drafts on navigation channels. It also has the potential to decrease the channel capacity and therefore increase flood risks. Following closure of a river extraction site, the sediment extracted from the river system can result in a reduction of the available sediment in the system and subsequently reduction in the amount of sediment transported to the coastal environment, which can lead to coastal erosion. Based on the 58 reports obtained during the study, these impacts are not thoroughly considered and mitigated in current EIA's.

Many Fijian communities rely on rivers as navigation channels for boat transportation. In the case of the Navua River, Fijian communities operate an eco-tourism initiative (as their primary source of income) where tourists are treated to a tour of the Navua gorge in small boats and a traditional Fijian experience at an inland village. Alteration of the river (particularly disturbance of large boulders) has the potential to increase health and safety hazards for Fijians and tourists utilising the river for boat transportation. Twenty-one of the 105 community members surveyed across

[104] Nature Fiji, Position Statement on the Unsustainable Extraction of Fiji's River Gravel, Sand and Rocks, 2014.

[105] Based on the 58 Environmental Impact Assessments viewed during the study.

[106] Dr Sarah Beavis (Australian National University), Personal Communication, 2018.

Fiji reported increased health and safety hazards associated with river extraction sites, including cases of damaged and capsized boats. Figure 86 and Figure 87 display examples of large boulders disturbed by river extraction operators, which pose hazards to community members utilising the river for boat transportation.

Figure 86: Disturbed boulders, potentially hazardous to boat transportation (Source: SPC Fieldwork, 2017).

Figure 87: Disturbed boulders, potentially hazardous to boat transportation (Source: SPC Fieldwork, 2017).

Rivers are dynamic systems, thus river positions naturally migrate over time. However, river extraction has the potential to increase the rate at which rivers migrate via three primary mechanisms:

1. Direct excavation of the river banks.
2. Lowering of the bed level creating higher banks which are more susceptible to slope instability and erosion.
3. Diverting the river channel and directing the flow towards the river banks, increasing the rate of erosion.

Forty-nine (47%) of the community members interviewed noted erosion (and loss of land) as an issue associated with river extraction. The increased rates of river migration and subsequent loss of land has several adverse implications for Fijian communities, including:

- Loss of flora (trees and crops) living on the river banks.
- Loss of habitat for raising livestock on river banks
- Direct loss of land and consequent legal implications.
- Widening of river channel and a reduction in the water level.

The study team georeferenced several historic aerial images of the Navua River to ascertain river movements between 1951 and 2010 as presented in Figure 88. It is difficult to ascertain the amount of increased erosion attributable to river extraction, however it is clear that the river has migrated several times over this period, and illustrates the dynamic nature of river systems. This information is critical when trying to understand the behaviour of a river system, and potential impacts gravel extraction may have on river migration, however none of the 58 EIA's viewed conducted analysis of past river movements based on georeferencing of historic aerial images (multi-temporal image analysis).

Effective monitoring of river changes requires the establishment of a series of cross-sections tied to ground control points, and regular surveying. The study team is not aware of any examples of a monitoring regime for any river extraction site in Fiji, nor did any of the 58 EIA's capture sufficient baseline data (such as cross-sections and bathymetric surveys) to form the basis for monitoring. This also creates issues for accurately auditing extraction volumes and ensuring correct royalties are paid to the State and surrounding community.

Figure 89 displays the position of the Dawasamu River in 2016 (prior to extraction), and the red line indicates the subsequent position of the river in 2017 after extraction. Conversely Figure 90 displays the position of the same stretch of Dawasamu River 1 year later in 2017 (after extraction), and the blue line indicates the original position of the river in 2016 (prior to extraction). The images indicate that approximately 12,000m² (3 acres) of land has been lost, along with a notable amount of vegetation. This accelerated loss of land and alteration of the river is almost certainly caused by the extraction operation.

Figure 91 to Figure 95 display some examples of slope instability observed in river banks throughout the fieldwork.

Figure 88: Navua River position changes in the Nakavu area; red line= 1951 position, green line= 1977 position, orange line= 2010 position (Source: Google Earth, image date 2014).

Figure 89: Dawasamu River before extraction. Red line indicates extent of land lost after extraction (Source: Google Earth, image date 2016).

Figure 90: Dawasamu River after extraction. Blue line indicates the original position of the river (Source: Google Earth, image date 2017).

Figure 91: River bank instability and river migration adjacent to extraction site (Source: SPC Fieldwork, 2017).

Figure 92: Diverted river channel and increased river bank erosion (Source: SPC Fieldwork, 2017).

Figure 93: Unstable river bank adjacent to extraction site (Source: SPC Fieldwork, 2017).

Figure 94: Excavation directly in the river bank (Source: SPC Fieldwork, 2017).

Figure 95: Evidence of direct river bank excavation (Source: SPC fieldwork, 2017).

Fijian communities also utilise rivers for recreational purposes such as swimming. The impacts of river extraction often impact the aesthetic appearance of the river system and decrease the hygiene of the water, thus create an environment which in less conducive for recreational activities. Figure 96 shows the Dawasamu River prior to extraction compared to Figure 97 which shows the river during extraction. The obvious contrast between the two images depicts a reduction in the quality of the environment for recreational purposes; note the presence of a Fijian community living directly adjacent to the site.

Figure 96: Dawasamu River before extraction (Source: Google Earth, image date 2016).

Figure 97: Dawasamu River during extraction (Source: Google Earth, date 2017)

Only one of the 58 EIA's observed during the study attempted to quantify the sustainable rate at which gravel could be extracted from the system. The exercise was conducted by a specialist consultant from New Zealand, and was an environmental safeguard requirement of the Asian Development Bank (ADB), as the applicant was intending to use the material on an ADB project. Qualitative field observations and anecdotal evidence indicate the current rate of extraction in the majority rivers is unsustainable (this is evident in the Sabeto River, see Figure 98). Discussions with some operators highlighted extremely destructive extraction techniques such as excavating holes up to 5m deep in the river channel to "catch" gravel and prevent it from travelling downstream to competing gravel extraction companies.[107]

[107] Excavator operators, personal communication, 2017.

However further site specific research is required to quantitatively assess extraction rates relative to deposition rates (sustainability).

Figure 98: Gravel resources exhausted in the Sabeto River (Source: SPC Fieldwork, 2017).

If the current practices continue into the future, Fiji faces a potentially perilous scenario where current river gravel sources are exhausted, the gravel extracted from the rivers has been used to construct infrastructure over (or near) alternative hard rock sources close to urban centres, and the country is faced with an abrupt issue where the remaining hard rock sources are in remote locations, with relatively high associated costs.

The study team is not aware of any river extraction site with a successful rehabilitation story. This is due to the fact that unsustainable river extraction offers little scope for effective rehabilitation, either by natural processes or human intervention. Over time, gravel deposits may gradually replenish and fisheries may recover, but this process may take significant periods of time (greater than human lifetimes). Some of the gravel deposits are the result of historic seismic and volcanic activity which resulted in large volumes of transported sediment[108]. These events are linked to paleo-tectonic settings which are no longer evident, and therefore are unlikely to occur again (at least on human timescales), and if these events were to occur, the consequences for the downstream communities would likely be catastrophic. Land lost due to increased erosion will likely never recover unless, costly engineering works are constructed, including land reclamation and retaining walls (which require Development Minerals). Vegetation lost due to erosion would require planting after the engineering works are constructed, and would take decades to regrow to its original condition. Figure 99 presents an example documented by MRD of a river extraction site after extraction is complete.

[108] J, P. Terry, C, D. Ollier, and C, F. Pain, Geomorphological Evolution of the Navua River, Fiji, 2002.

Figure 99: River extraction site upon completion of extraction (Source: Mineral Resources Department, 2018).

Conversely the impacts associated with hard rock quarries are relatively isolated and therefore easily managed and monitored. Quarries also offer scope for effective rehabilitation with examples such as the Colo-i-Suva Rainforest Eco Resort (Figure 100 and Figure 101) and the Vuda Marina (Figure 102). Figure 103 demonstrates the isolated nature of a hard rock quarry in the Central Division, where the impacts are confined to the relatively small footprint of the quarry and therefore have limited impact on the surrounding waterways and coastal environments. The site also offers scope for effective rehabilitation and long-term employment opportunities for the surrounding community, such as an abseiling and rock climbing tourism initiative.

Figure 100: Princess Road Quarry in 1959 (now the site of the Colo-i-Suva Raintree Eco-resort), note the lack of vegetation around the quarry pit, which is now been rehabilitated into a lake (Source: P. Ibbotson, 1959)109.

Figure 101: Colo-i-Suva Rainforest Eco Resort now, an example of a historic quarry which has been effectively rehabilitated into an eco-resort, where the local ecosystem is flourishing. Note the re-establishment of vegetation around the old quarry pit (Source: www.coloisuva.com.fj).

109 Mineral Resources Department, Princess Road Quarry, 2011.

Figure 102: Vuda Marina, an example of a historic quarry which has been effectively rehabilitated into a marina, which contributes positively to Fiji's society and economy (Source: www.vudamarina.com.fj).

Figure 103: Drone image of a hard rock quarry on Viti Levu, demonstrating the isolated nature of the impacts relative to river gravel extraction (Source: Island Quarries, 2018).

Discussions with Environmental Consultants indicate the current quality of EIA reports and depth of scientific studies is dictated by the market (the extraction companies), as the MoE approval process does not subject reports to a comprehensive scientific critical review process. Therefore EIA consultants are offered insufficient budgets to conduct thorough scientific studies, thus the quality of current EIA's is substandard, and does not appropriately address the environmental

impacts associated with the extraction activities.[110] This is clearly evident in the EIA reports, to the extent of "copy and paste" of site specific material from one report to another.

Based on these findings the study supports the Government of Fiji's plan to phase out large-scale river gravel extraction and transition to a network of hard rock quarries in strategic locations. The '2013 Fiji's State of Environment Report' co-published by the Government of Fiji and the Secretariat of the Pacific Regional Environment Programme (SPREP) recommended the government "address the rapid rate of gravel and boulder extraction from rivers, and develop alternative sources e.g. quarrying and implement a policy on the sustainable extraction of river rock"[111]. The impacts presented in the Report (forming the premise for this recommendation) include:

- Reduced sediment retention, increased peak flows, and extreme flooding further downstream.
- Decrease in the overall biodiversity; including a decline in native fisheries which play an important role in the diet and livelihoods of Fijian communities, leading to impacts on food security and income.
- Detrimental impact on reefs and beaches near the mouths of rivers due to increased erosion and nutrient loading.
- Decline in the overall condition of the terrestrial aquatic system condition.

The Non-government organization (NGO) 'Nature Fiji' (also known as Mareqeti Viti) shares a similar viewpoint to that presented by the government and SPREP in the '2013 Fiji's State of Environment Report'. Nature Fiji first released a Position Statement on "the unsustainable extraction of Fiji's river gravel, sand and rock" in 2010, and re-released the statement again in 2014 following a lack of action[112]. The position statement highlights the "unsustainable exploitation of many of Fiji's rivers and streams", and stresses "the urgent need to phase out commercial extraction of rock, gravel and sand from rivers, to be replaced by the establishment of a regional network of hard rock quarries". In the position statement, Nature Fiji discuss that river extraction dramatically changes the hydraulic characteristics of Fiji's perennial rivers, leading to the following consequences:

- Destruction of river habitats with consequences for Fijian aquatic fauna, such as loss (or a great reduction) in prawns and Ika Droka. Which also impacts the ability of subsistence dwellers to obtain a major portion of their dietary protein and to enjoy an unaffected rural lifestyle they are accustomed to.
- Transforming the river into a 'culvert-like' condition, meaning that floods are not 'held up' by varied topography, and proceed down the catchment at a much faster rate. Leading to much larger floods at the river mouth, particularly during high and rising tides (which has been happening increasingly in Nadi over the past two decades and in Labasa during Cyclone Ami). This also increases the need to construct costly flood retention dams.

[110] Environmental consultants, personal communication, 2018.
[111] Ministry of Strategic Planning, National Development and Statistics, A Green Growth Framework for Fiji, 2014.
[112] Nature Fiji, Position statement on the unsustainable extraction of Fiji's river gravel, sand and rocks, 2010 and 2014.

- Fine gravel, sand and silt are delivered much faster to the mouth of the river where they are deposited. This impedes navigation and may increase flooding, leading to the need for more frequent costly dredging to mitigate these effects.
- Lowering the base course of rivers, undermines the structures which were built when the rivers were at a higher level, such as bridges, Irish crossings, culverts, irrigation off-takes, and river walls and flood retention weirs. Undermining such structures means that they will not withstand the design forces they were built for and will sooner or later have to be replaced.

Nature Fiji also highlighted that the impacts are being felt by Fijian communities, and the associated economic costs are being paid for by taxpayers, not the gravel extraction companies, therefore the true economic cost is not reflected in the price of gravel.

There is no doubt field observations recorded during the study show that the environmental impacts associated with river extraction are numerous, some subtle, and others extremely blatant. Therefore; the recommendation made by the government and SPREP (in the '2013 Fiji's State of Environment Report') and the Nature Fiji Position Statement remain even more relevant today, as the extent of gravel extraction has increased to a situation where 66 regulated river extraction sites (and at least 27 unregulated sites) are producing approximately two-thirds of Fijis Development Mineral supply, and subsequently the associated adverse social and environmental impacts are extensive.

Some stakeholders expressed views that river gravel extraction is an appropriate means of sourcing construction aggregates in Fiji because it is common practice around the world, including in neighbouring Pacific countries such as New Zealand. However, this reasoning does not take into account the inherent environmental and social conditions evident in Fiji. For example, river gravel is a sustainable source of construction materials in the South Island of New Zealand due to several unique factors which are not evident in Fiji. Firstly, New Zealand is located on an active convergent boundary between the Australian and Pacific plates; this tectonic setting has produced over 20,000m of uplift on the Southern Alps mountain range over the past 12 million years, however the highest peak (Mt Cook) is only 3,764m high. This is due to relatively high rates of erosion transporting the uplifted rock mass to the lowland plains and seafloor[113]. Over millions of years the tectonic and metamorphic processes (associated with the convergent plate boundary) have generated and exposed rock masses with copious fractures, faults, and foliations. These rock mass defects are planes of weakness, thus increase the potential for erosion. The triggering mechanisms behind the high rates of erosion are due to several unique phenomena, particularly; freeze-thaw cycles linked to the altitude and climate of the Southern Alps, seismic induced erosion caused by earthquakes associated with the tectonic setting, glacial erosion due to the climatic conditions favouring the formation of glaciers (past and present), and relatively high rates of orographic rainfall resulting from the interaction between the prevailing westerly winds and the Southern Alps topography. Subsequently, the high rates of uplift and erosion result in braided river systems (see Figure 104), glacial outwash gravels and river terraces. These unique geomorphological deposits support sustainable and environmentally responsible gravel extraction, as it is feasible to isolate extraction from the active river channel, resulting in relatively

[113] https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Major-Faults-in-New-Zealand/Alpine-Fault

minor impacts to the river ecosystem. Furthermore the relatively high rates of gravel deposition result in relatively high thresholds for sustainable extraction rates.

Figure 104: Gravel extraction in the Waimakariri River braided river system in the South Island of New Zealand (Source: Google Earth, 2018).

In contrast Fiji is a remnant island arc, believed to be the site of former subduction of the Pacific plate below the Australian plate during the Eocene to the late Miocene[114]. In the current tectonic setting Fiji is located approximately 900km to the west on the Tonga-Kermadec trench and approximately 1000km east of the New Hebrides trench[115]. Therefore Fiji is not located on an active convergent plate boundary thus is not subject to the same rapid rates of tectonic uplift and mountain forming processes as seen in New Zealand. Consequently the corresponding seismic activity and associated earthquake induced erosion in Fiji is considerably lower that New Zealand. The typical seismic Z-Factor's for Viti Levu and Vanua Levu range from 0.15 to 0.35 compared to 0.6 in the Southern Alps[116]. Fiji is located at approximately 18° latitude and the highest altitude is 1,324m (Mt Tomanivi) therefore the climate (and paleoclimates) are too warm to support the formation of glaciers and freeze-thaw erosion. The tropical climate in Fiji supports relatively rapid

[114] Auzende, J. M., R. N. Hey, B. Pelletier, D. Rouland, Y. Lafoy, E. Gracia, and P. Huchon (1995), Propagating Rift West of the Fiji Archipelago (North Fiji Basin, SW Pacific), J. Geophys. Res., 100, 17,823–17,835.

[115] Zhang, N., and R. N. Pysklywec (2006), Role of mantle flow at the North Fiji Basin: Insights from anomalous topography, Geochem. Geophys. Geosyst., 7, Q12002, doi:10.1029/2006GC001376.

[116] Stirling,M. W.; Horspool, N. A; Gerstenberger, M. C. 2014. Seismic Z-Factor Map for Fiji, GNS Science Consultancy Report 2014/261. 14p.

rates of chemical weathering, resulting in an abundance of tropical residual soils coating Fiji's landscape (particularly on the windward sides of the Viti Levu and Vanua Levu). The relatively thick weathering profile means the exposed outcrops in Fiji's catchments are typically less likely to generate gravel during erosional events when compared to the metamorphic and sheared rock masses exposed in the Southern Alps. Subsequently the gravel deposits in Fiji are relatively small and typically located within the active river channel, therefore extraction of Fiji's gravel deposits has significant scope to adversely impact Fiji's river systems. Additionally, the social dimension of the communities surrounding Fiji's river systems provides further scope for adverse impacts. Rural communities in Fiji depend on rivers for several critical basic needs. Approximately 38% of the rural population lives below the basic needs poverty line and the rural bottom 40% derive 40% of their incomes from agriculture. Even for the higher quintiles subsistence agriculture remains an important source of livelihood, contributing 10-15% of income[117]. Communities depend on Qoliqoli's (fisheries) as a staple source of protein and agriculture is widespread on land adjacent to river banks, river extraction has the potential to decrease these critical food sources via depleting fisheries and increasing erosion of agricultural bearing land. Communities depend on the water flowing in Fiji's rivers for drinking and hygiene purposes thus reduced water quality associated with river extraction threatens these critical ecosystem services. Communities depend on rivers for boat transport thus river extraction has the potential to decrease transport safety and thus reduce access to markets and connections with wider Fijian society. Therefore the environmental and social conditions in Fiji present significant scope for adverse impacts (as observed during the study) thus justify the proposed transition to hard rock quarries. It is important to note minimal research has been conducted on the nature of Fiji's gravel deposits and the scope for sustainable and environmentally responsible extraction. We recommend further research to assess the suitability of some specific sites for sustainable river extraction, particularly on the larger rivers such as Navua, Sigatoka and Rewa.

In certain remote locations, small-scale extraction of river gravel may remain a practical option, provided appropriate scientific investigations are carried out prior to approval (including demonstration that the proposed extraction rate does not exceed the sustainable rate of extraction), and appropriate environmental safeguards are implemented during operation. However, we recommend hard rock sources where feasible.

Dredging for sand remains a practical option, provided thorough environmental impact assessments are carried out prior to approval, and appropriate environmental safeguards are implemented during operation. We recommend scientific studies are conducted to identify sediment 'sinks' where sustainable sand extraction is feasible. We also recommend collaboration with the Ministry of Waterways to capitalise on opportunities to source sand from areas requiring dredging for flood mitigation and navigation purposes.

Some stakeholders may argue that a transition from river gravel extraction to hard rock quarries will increase the cost of Development Minerals (and subsequently the cost of construction in Fiji) due to the relatively high start-up and working capital requirements associated with hard rock quarries. However, there is no clear evidence to support this opinion, and further detailed analysis is required to assess the likely impact on the cost of construction. However, based on discussions with the private sector it is likely that the transition may in fact reduce construction costs due to the following reasons:

[117] World Bank, Systematic Country Diagnostic Report, 2017.

- Confidence of supply at the time of tendering: currently the supply of Development Minerals from individual river extraction sites is relatively small and irregular, thus river extraction companies cannot guarantee large supplies within designated contractual timeframes. Consequently there is a lot of uncertainty and risk for construction companies at the time of tendering. Therefore contractors are forced to obtain prices from multiple suppliers, and base tender prices and construction timeframes on the most expensive rate, with the greatest transport costs[118]. Establishment of relatively large hard rock quarries with regular production volumes will greatly reduce this uncertainty, thus construction companies will have greater confidence at the time of tendering, and subsequently will submit lower tender prices. This is particularly relevant for large scale civil works such as roads, airports and large buildings.

- Economies of scale: individual hard rock quarries are typically relatively large compared to river extraction sites, therefore the economies of scale concept applies. Meaning that although hard rock quarries are faced with higher start-up costs, the quarries can take advantage of a proportionate saving in costs gained by the increased level of production. Hence quarry operators can transfer this cost saving onto the consumer via the price of Development Minerals.

- Potential strategic location of quarries: if hard rock quarries are appropriately considered during land use planning, there is scope to develop hard rock quarries relatively close to urban centres, when compared to the existing network of gravel extraction sites. Therefore this would result in a reduction in transport costs and a subsequent reduction in the cost of construction.

- Greater assurance of quality: hard rock quarries typically produce more consistent and higher quality Development Mineral products due to the relatively homogenous nature of hard rock resources relative to river gravel deposits. This greater quality assurance will not only increase the quality of construction, which increases design lives and reduces maintenance costs, but it has the potential to directly reduce the cost of construction; as it reduces the required frequency of quality control testing and supervision, and also reduces the scope for contractual disputes and rework.

Therefore, a transition to hard rock quarries may in fact reduce the overall cost of construction in Fiji, however further detailed analysis is required. Nevertheless, it is clear the proposed transition to hard rock quarries will help ensure the true economic costs of the extraction activities (including environmental externalities) are better reflected in the price of Development Minerals.

Occupational health and safety impact analysis

A range of health and safety (H&S) standards were observed throughout the study. The only consistent H&S standard observed was that fact that none of the 46 extraction and 40 beneficiation sites visited during the fieldwork conducted a formal H&S site induction, or required the study team to sign a visitor book. The main supplier of explosives in Fiji was the only stakeholder to do so. This is concerning, as conducting a health and safety induction and having visitors sign a

[118] Various construction companies, personal communication, 2017 and 2018.

visitor book is an elementary requirement of good H&S compliance. The results of not conducting an induction include:

- Visitors are not aware of potential H&S hazards associated with the site, thus are vulnerable to the hazards.
- Visitors are not aware of risk mitigation steps in place to manage the potential hazards (such as exclusion zones), therefore cannot be expected to comply with such measures.
- Visitors are not aware of procedures in place when incidents or disasters occur (such as evacuation plans and muster points) therefore cannot be expected to respond in the appropriate manner should an incident or disaster occur.

The study team did observe H&S policies, evacuation plans, and signs showing PPE requirements at some sites, however none of the operators formally introduced the field staff to these documents. The study team recommends all sites conduct H&S inductions and have visitors sign a visitor book to acknowledge they have been inducted to the site and are aware of the potential hazards and mitigation procedures in place.

The Workers Compensation Unit of the Ministry of Employment records statistics on injuries and deaths related to the combined mining and quarry sector, as presented in Table 13 below. This study is purely focusing on the Development Minerals sector (e.g. quarrying) therefore the mining statistics are not relevant. Thus the study team consulted the MRD H&S records in order to ascertain the number of incidents related to the Development Minerals sector only. This process highlighted a clear disconnect between the records of the Ministry of Employment and the records of MRD. MRD records are stored in a hard copy filing system which appeared incomplete, for example, Ministry of Employment records indicate 53 injuries and 3 deaths in the Mining and Quarrying sector in 2016, while observed MRD records indicated 0 injuries and 0 deaths over the same period. Therefore the study team was unable to obtain specific H&S statistics for the Development Minerals industry. The Ministry of Employment records indicate a general increase in the number of H&S incidents between the years of 2007 and 2010. A total of 258 injuries and 20 deaths in the combined metal mining and Development Minerals sectors were recorded during this period. These statistics warrant further analysis to determine the proportion of H&S incidents attributable to the Development Minerals sector.

Table 13: Mining and quarrying H&S incidents reported to the Workers Compensation Unit of the Ministry of Employment 2007-2017 (Source: Ministry of Employment, 2017).

Year	Injury	Death		Total
		Fatality	Natural	
2007	1	-	-	1
2008	-	-	1	1
2009	1	1	-	2
2010	5	-	5	10
2011	24	1	2	27

Year	Injury	Death		Total
		Fatality	Natural	
2013	13	1	2	16
2014	35	-	1	36
2015	29	-	2	31
2016	53	1	2	56
2017	53	1	1	55
Total	**258**	**8**	**20**	**286**

The observed use of personal protective equipment (PPE) was inconsistent, and only 1 operator checked the personal protective equipment of the study team. At some sites appropriate PPE (hard hat, high visibility clothing, safety glasses and safety boots) were worn by all staff, other sites had only a portion of the staff wearing appropriate PPE, and the study team observed some sites where no PPE was worn at all. Therefore the use of PPE was variable, for example; the study team observed one crushing site with all staff wearing appropriate PPE, and then a senior manager of the company arrived and began walking around the site without a hard hat and wearing a t-shirt, shorts and flip flops.

In general the hard rock quarries and beneficiation sites had appropriate signage, but only 1 sign was observed at a river extraction site (see Figure 105). This is concerning as the Rivers and Streams Act grants the public rights to access rivers and streams, yet the public are not being informed (via signage) of the presence of potentially hazardous gravel extraction operations. Observed signage was used for several purposes including:

- Notification in regards to the presence of the operation.
- Notification that no unauthorised access is allowed.
- Restricting the speed limit on access roads.
- To display the contact details for the operation.
- Notification of the required PPE.
- Identification of particularly dangerous areas.
- To identify explosive magazines, and notify that no smoking is allowed.

A range of different signage types are in use and were observed during the fieldwork (see Figure 105 to Figure 110). Some sites used trilingual signage (English, iTaukei and Hindi) as shown in Figure 106. The study team recommends the use of trilingual signage to reduce the risk of misinterpretation.

Figure 105: The only sign observed at a river extraction site (Source: SPC Fieldwork, 2017).

Figure 106: Trilingual signage (Source: SPC Fieldwork, 2017).

Figure 107: Signage at river gravel beneficiation site (Source: SPC Fieldwork, 2017).

Figure 108: Explosive magazine signage (Source: SPC Fieldwork, 2017).

Figure 109: Explosive magazine signage.

Figure 110: Hard rock quarry site signage (Source: SPC Fieldwork, 2017).

Typically, the highest health and safety standards were observed at hard rock quarries. This is partially due to the institutional framework, as MRD is responsible for regularly monitoring all hard rock quarry sites in accordance with the Quarries Act and Explosive Act. This is not the case for river extraction sites, as explosives are not used, and involvement of MRD under the Quarries Act is only triggered if the river extraction site has a crusher. In a positive move towards improving the monitoring of river extraction sites, in 2017 MoE and MRD agreed that MRD will assist MoE to administer the Environment Management Act. However MRD provided a database of sites

the department is monitoring, the database only included 21 sites, which is substantially less than the 86 sites identified during the 'Profile of the Sector'. Therefore the involvement of MRD in monitoring of all active extraction sites is a work in progress and requires further collaboration between MRD and other institutional stakeholders.

The main supplier of explosives in Fiji has a major influence on the H&S standards in hard rock quarries, as the company is party to a several global supply agreements and UN conventions, which impose strict health and safety standards. The supplier conducts a series of H&S checklists which the quarry must meet prior to the sale of explosives taking place. This is an important safeguard as the H&S threats associated with explosives are very high. The explosives supplier has declined purchases on several occasions, due to H&S requirements not being met, and sales did not take place until the appropriate mitigation measures were put in place. The supplier noted government pressure to sell explosives in some instances, this is concerning and could potentially lead to a major H&S incident.

Vehicle accidents associated with the transportation of Development Minerals and materials (such as explosives) is a hazard with the potential to harm the general public. This is not a unique hazard to the Development Minerals industry, however the trucks used in the sector are restricted to slower speed limits (when comparted to the general public) and are often subject to dangerous overtaking manoeuvres[119], creating an elevated risk of accidents. This further justifies the need for strategic planning of future Development Mineral extraction sites, to reduce transportation distances, and therefore reduce the risk of road accidents.

Strict checklists are conducted to minimise the risk of incidents associated with the transportation of explosives[120], and the introduction of a new emulsion blasting product (in late 2017) looks set to further reduce the risk. Before explosives are transported, a route risk assessment[121] is also conducted to:

- Identify high risk areas so that alternative routes can be taken where possible.
- Identify anticipated traffic volumes so that explosives can be transported when traffic volumes are low.
- Check weather conditions so that explosives can be transported during favourable conditions.
- Identify safe stop areas along the route.

During the study a successful trial of a new emulsion explosive product (see Figure 111 to Figure 114) was held on the 30/10/2017 at Mau Quarry in the Central Division. The product has H&S benefits associated with the storage, transportation, and use during blasts. The product is stored at the explosive supplier's magazine, which reduces the need for individual quarry operators to store explosives on site. The product includes two gels which separately are 'Class 1' explosives (low grade) and don't become a Class 5 explosives (high grade) until they are mixed together. The product is transported to the site as two separate gels and the gels are not combined until they are mixed together by a hose which is inserted down the blast holes. Therefore the product remains a

[119] Personal communication, Development Mineral truck drivers, 2017.
[120] Mineral Resources Department, Vehicle Checklist for Carrying Explosives, 2017.
[121] IXOM, Route Risk Assessment Procedure, 2017.

relatively low grade explosive until it is underground, which reduces the H&S risks associated with storage, transportation and handling during blasting operations.

Figure 111: New emulsion explosive product (Source: SPC Fieldwork, 2017).

Figure 112: Hose used to mix the two separate emulsions gels down the blast holes (Source: SPC Fieldwork, 2017).

Figure 113: Bench prior to trial emulsion blast (Source: SPC Fieldwork, 2017).

Figure 114: Bench after trial emulsion blast (Source: SPC Fieldwork, 2017).

A number of health and safety issues associated with the surrounding communities were also identified throughout the course of the study, including:

- Conflict between boat tour ecotourism operators and river extraction operators on the Navua River.
- Contamination of waterways used for cleaning and drinking water.
- Increased risks for villagers using rivers for boat transport.

These issues are discussed in more detail in the 'Assessment of the Institutional and Technical Operating Context' and the 'Socio-economic Impact Analysis'.

Socio-Economic Impact Analysis

The socio-economic analysis was conducted in three different dimensions:

1. The impact of the Development Minerals sector on Fijian communities.

2. The specific impact of the sector on gender and youth.
3. The progress towards achieving the Sustainable Development Goals (SDG's).

Impact on Fijian Communities

A total of 105 community members (from 19 different villages) were surveyed using the questionnaire in Appendix 3 (see Figure 115 for an example of a community consultation). As presented in the 'Environmental Impact Analysis' section of this report, the survey identified numerous negative social impacts associated with the sector, particularly related to river extraction operations. Fijians communities rely on river ecosystems for a variety of functions essential to their basic livelihoods, including travel via boats to villages with no roads, fishing (for subsistence diets and income generation), bathing and cleaning, supplying water for drinking and cooking, and agriculture on the riverbanks (for subsistence diets and income generation). The community consultations revealed that the current extraction of gravel from rivers is degrading (and in many cases destroying) the ability of river ecosystems to support these critical functions.

Figure 115: Consultation with community members (Source: SPC fieldwork, 2017)

Aside from the adverse impacts, communities also expressed concerns regarding:

Royalties

Community members expressed concerns regarding the undervaluation of royalty rates with respect to:

- Fair compensation for negative impacts.
- Fair compensation relative to final product values.

River gravel extraction sites are administered under the DoL royalty system where; FJ$2.00/$m^3$ of royalty is paid to the State, and an additional FJ0.50m^3$ is distributed to the TAB trust (of which iTaukei are beneficiaries) as compensation for loss of traditional fishing rights. Final product prices vary, however in majority of cases 0.50m^3$ represents less than 1% of the resource value, and as low as 0.5% in some cases.

However, up until 2017 the iTLTB was issuing river gravel extraction licenses (due to a previous view of resource ownership, which has recently been resolved by iTLTB and DoL) and compensating the consenting iTaukei community (Qoliqoli owners) at a rate of FJ$6.61/m^3. iTLTB still issue gravel extraction licenses for 'dry pits' located on Native Land outside of the active river channel.

The following is a case study based on actual production figures from an operator on the Navua River, to give an indication of the monies received by qoliqoli owners/freehold owners from royalties for extraction of sand and gravel._Extraction in a 6-month period in 2013 along the Navua River was as follows:

Table 14: Department of Lands royalty example.

Month	Total Extraction Cubic Metres	Royalty Rate Paid to State : $2. 00	Royalty Rate Paid to Freehold Owner as Fishing Rights Owner - $0. 50
Month 1	5, 190 m^3	$10,380.00	2,695.00
Month 2	4, 125 m^3	8,250.00	2,062.50
Month 3	6, 125 m^3	12,250.00	3,062.50
Month 4	4, 605 m^3	9,210.00	2,302,50
Month 5	8, 745 m^3	17,490.00	4,372.50
Month 6	1, 920 m^3	3,840.00	960.00
Half-Year Total	30, 710 m^3	$61,420.00	$15,725.00
Annual Forecast Total	**61, 420 m^3**	**$122,840.00**	**$31,450.00**

There is much disgruntlement by qoliqoli owners when they compare the damage to their qoliqoli with the insufficiency of funds set aside their component of royalties administered by the Director of Land for their recompense. iTLTB has a more frequent periodical review of royalty rates which can be seen in the Gravel Regulation, last updated in 2014[122]. This current disgruntlement of qoliqoli owners finds its source in the fact that Lands Department's royalty rates for river bed extractions have not changed since 1997, now a period of 21 years.

In contrast, if the sand and gravel extraction figures shown in the above table were to be extracted from a dry pit on iTaukei lands, the royalty rates would be as follows:

Table 15: iTLTB royalty example.

Month	Total Extraction Cubic Metres	Royalty Rate Paid to Qoliqoli Owners $6. 61
Month 1	5, 190 m^3	$34,305.90
Month 2	4, 125 m^3	27,266.25
Month 3	6, 125 m^3	40,486.25
Month 4	4, 605 m^3	30,439.05

[122] Itaukei Land Trust (Gravel) (Amendment) Regulation 2013, effective from 01.01.14

Month	Total Extraction Cubic Metres	Royalty Rate Paid to Qoliqoli Owners $6. 61
Month 5	8, 745 m^3	57,804.45
Month 6	1, 920 m^3	12,691.20
Half-Year Total	30, 710 m^3	$202,993.10
Annual Forecasted Total	**61, 420 m^3**	**$405,986.20**

The common communal entity that is usually the qoliqoli owners is the Yavusa (tribe), made up of a few Mataqalis' (clans). We cannot estimate the population of a Yavusa because it differs markedly from Yavusa to Yavusa around Fiji. For the purpose of this Case Study, the Yavusa qoliqoli owner called Yavusa "X" has 5 Mataqalis' and each mataqali has an average number of 100 members, therefore Yavusa "X" membership is 500. When the above royalty monies of $405,986.20 is distributed amongst the 500 members, it shall be calculated as follows:

Table 16: Distribution of iTLTB royalty example.

#	Items Payable	Amount
a	Royalties monies to be distributed to Qoliqoli owners	$405,986.20
b	15% (going rate) payable to TLTB as trustee for the expenses of collection and administration costs[123].	60,897.93
c	Balance to be distributed to Yavusa "X" as qoliqoli owners	$345,088.27
d	Qoliqoli owners total in Yavusa "X" is 500 persons. Therefore divide total royalties with number in the Yavusa "X": $\frac{\$345,088.27}{500}$	$690.18

Each qoliqoli owner in the Yavusa "X" shall hence collect $690.18 from the TLTB being royalty monies distributed annually.

The recent transition from iTLTB issuing extraction licenses within river channels, to only DoL issuing licenses in river channels is the source of much confusion regarding applicable royalty rates. The field team was privy to several incorrect royalty rates (as high as FJ$13.00/$m^3$) being communicated at community consultations.[124] Compounding the confusion is the fact that the 'consent form' does not stipulate any conditions of consent, including the applicable royalty rate. Therefore it is difficult to ascertain what royalty rate was communicated to the community at the time of consent. This creates significant scope for the communication of incorrect royalty rates and therefore conflict regarding royalty payments. To help resolve this issue we recommend 'standard conditions' are developed for the consent form, including stipulation of the applicable royalty rate.

For river extraction sites, community members also voiced concerns that consent is only required from the Qoliqoli owners within the boundaries of the specific area of extraction, yet the impacts of the extraction (including impacts on adjacent fisheries) extend far beyond the

[123] Section 14(1) of the iTaukei Lands Trust Act, Cap 134
[124] Community consultation, 2018.

boundaries of the specific extraction area. This complication creates an environment for conflict between communities, and further supports the proposed transition to a network of hard rock quarries with relatively isolated impacts (confined to the extraction area). To explain this in more detail; the royalty for hard rock extracted from Native Land is FJ$3.31/$m^3$ which is payable to the specific landowning unit via iTLTB (who deduct a 15% administration fee). Therefore the specific landowning unit impacted by the quarry operation is responsible for consenting the operation, and receives the corresponding royalty compensation. In contrast, for river extraction sites, only the Qoliqoli owners within the specific boundaries of extraction are responsible for consenting the operation (generally incentivised by direct arrangements between the Qoliqoli owners and the operator), while the adverse impacts effect numerous Fijian communities connected to the river system, who do not receive any direct form of royalty compensation.

We recommend that DoL and iTLTB collaborate and reassess all royalty rates on a regular basis:

- To ensure the rates do not incentivise river gravel extraction over hard rock quarrying
- To be consistent across departments
- To consider reasonable compensation for adverse impacts
- To ensure resource owners (whether State of iTaukei Landowners) receive a 'fair share' of the resource value

Community consultations during the EIA process

Community consultations are an essential component of the EIA process as they provide the opportunity for community members to voice opinions regarding the proposed development, and thus establish the foundation from which mitigation measures are formulated to manage concerns. Community members have expressed concerns regarding the advertisement of consultations. The typical method of notifying community members is via advertising the meeting in one of Fiji's two main newspapers. Community members have argued that many Fijians do not buy newspapers, and when they do they do not read through every advertisement looking for notifications of EIA consultations. Therefore it is likely that many relevant community members do not get the opportunity to voice their opinion at community consultations simply because they are unaware of the consultation taking place. We recommend this is addressed by requiring developers to contact relevant communities directly (not just the community owning the land at the proposed development), in addition to newspaper advertisements. Community members also voiced concerns regarding inefficient responses from relevant government departments when they feel conditions of the EIA have been breached, citing slow response time to inspect concerns and a lack of follow up action and monitoring. These observations from community members support the opportunity to increase the institutional capacity of the relevant departments.

Clarity of the regulations and processes governing the sector

Community members expressed concerns regarding the processes and regulations governing the Development Minerals sector, and the roles and responsibilities of the various institutional stakeholders. Only 19% of the 105 surveyed community members stated that they understand the relevant processes and regulations. This highlights the need to develop clear (trilingual) information brochures which summarise the relevant regulations and processes governing the Development Minerals sector, including royalty payment procedures and rates, the licensing process, resource ownership definition, and where to go for certain grievances. This will not only

assist Fijian communities, but also operators and EIA consultants who expressed confusion related to the sector.

Awareness of potential Development Mineral initiatives and support for developing resources

Fijian communities expressed serious interest in the Development Mineral sector as an opportunity for revenue generation. However, it is apparent that landowners lack knowledge regarding options, particularly the potential for hard rock quarries. Interested landowners often think river gravel resources are the only option (and in fact these resources are the property of the state). Based on the community consultations conducted during this study it appears there is no clear pathway for community members to seek advice. Therefore we recommend the development of resource inventories, and quarry business model templates (perhaps similar to the Mataqali Lomanikoro example) to assist landowners in realising the full potential of their resources, and reduce the risk for investors. An innovative example of a potential option involves development of 'dry pit' gravel resources (located in historic river positons away from the active channel), and the income generated from the gravel extraction could be utilised to rehabilitate the pits into aquaculture ponds, creating a mechanism for food production and long term income generation for the community. Potential dry pits could be identified via multi-temporal image analysis of historic river positions.

Development Minerals are used to construct a broad range of infrastructure which modern-day Fijian communities depend on, including:

- Houses - which provide shelter for Fijian communities.
- Roads - for the transportation of goods, services and people.
- Water infrastructure - to supply potable water to Fijian communities, and discharge waste water.
- Energy infrastructure - providing Fijian communities with electricity.
- Food manufacturing infrastructure - offering food security to Fijian communities.
- Schools and Universities - enabling Fijian communities to receive an education.
- Health care facilities - providing Fijian communities with access to healthcare.
- Security and legal infrastructure - supporting peace and justice for Fijian communities.
- Resilient infrastructure - protecting Fijian communities against the impacts of natural disasters and climate change.
- Business infrastructure - creating a platform for economic development and providing Fijian communities with employment opportunities.
- Maritime and airport infrastructure - connecting Fijian society with communities and marketplaces at domestic, regional and global levels.

Therefore, at the macro level, it is evident that Development Minerals have an abundance of positive impacts on Fijian communities, and in fact modern-day Fijian society would not be able to function without them. Development Minerals also have the potential to positively impact localised Fijian communities at the micro level through direct employment and revenue generation opportunities.

Case Study: Mataqali Lomanikoro

The partnership between Mataqali Lomanikoro (the landowning unit) and Flametree Quarry in Sawani is a case study which provides a model example of the positive impact of the sector at the micro level:[125]

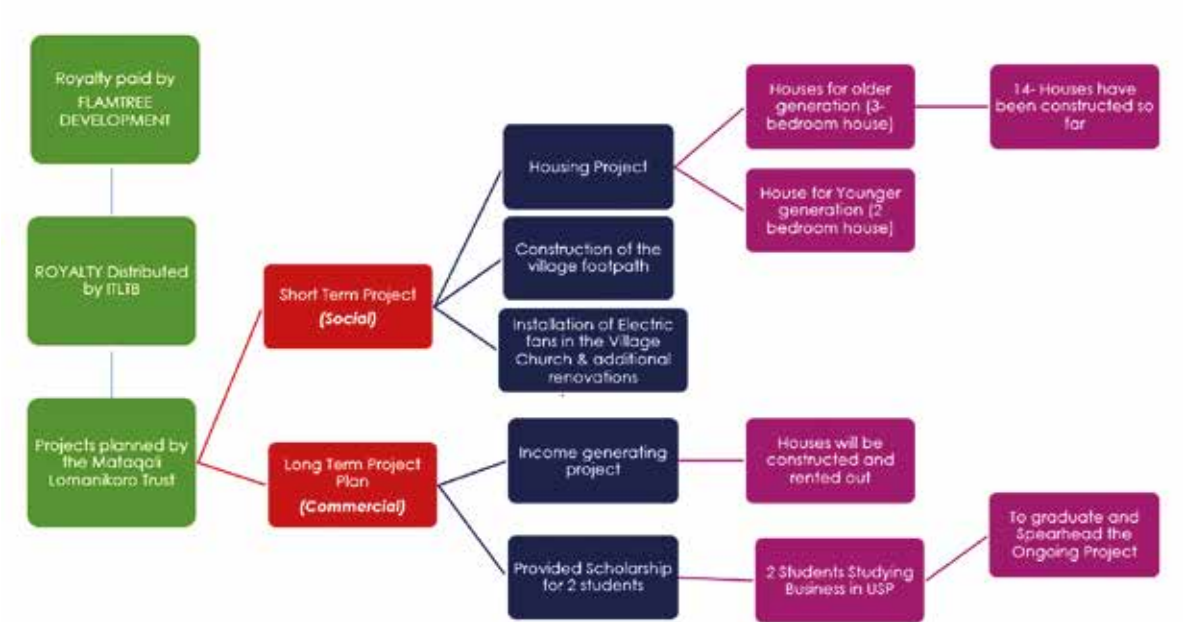
- The quarry employs 8 members of the neighbouring village.
- The quarry agreed to pay a royalty at a rate of 10% of the final product value.
- The quarry has sold more than 200,000m^3 and paid more than FJ$1.2M in royalties to iTLTB.

Mataqali Lomanikoro has established a Trust which is implementing a strategy to invest the revenues generated from the extraction in a sustainable way, which benefits the community as a whole. The Trust has a both short term and long term strategic visions, as shown in Figure 117. The short-term strategy involves implementing 'Social Projects' to address pertinent social issues in the village, including: a housing project for the youth and elders (14 houses have already been constructed as of 2017, Figure 116), construction of a village footpath, and the installation of electric fans in the village church. The long-term strategy involves investing revenues in rental properties to generate long term revenues for the community, well beyond the extraction life of the quarry. The long-term vision also involves an education component where two students from the village have received scholarships to study business at the University of the South pacific, with the intention that the students will implement the knowledge and skills learnt at University to advance the ongoing project.

Figure 116: One of the fourteen houses constructed using revenues generated from Flametree Quarry (Source: MRD, 2016)

[125] Mineral Resources Department, NDM Benefits Sharing Model- Mataqali Lomanikoro, Colo-i-Suva, 2017.

Figure 117: Mataqali Lomanikoro Trust revenue investment strategy (Source: MRD, 2017).



The Mataqali Lomanikoro/Flametree Quarry model is exemplary and highlights the scope for hard rock quarries to enable long term sustainable development for Fijian communities. The model is dependent on the following principals of good resource management:

- Transparent and continuous communication between stakeholders.
- Ensuring the community gets a 'fair share' of the generated revenues.
- Investing the revenues generated from the extraction in a sustainable and inclusive manner.

The Mataqali Lomanikoro is an exceptional circumstance and not the norm in Fiji. We recommend other Fijian communities interested in developing their Development Mineral resources consider a model similar to the Mataqali Lomanikoro example.

Gender and youth

The study team sought data related to gender and youth throughout the course of the study, aiming to acquire a comprehensive insight into the demographics of both gender and youth throughout all aspects of the Development Minerals sector.

The study team acquired gender data for 1285 personnel involved in the Development Minerals sector. The data encompasses a wide spectrum of the sector including private companies, government and educational institutions. Of the 1285 surveyed personnel, 1222 (95%) are male, and only 63 (5%) are female. This is disproportional when compared to the overall Fiji gender demographics; with 51% male and 49% female, and highlights a clear underrepresentation of women in the Development Minerals sector. The gender imbalance in the Development Minerals sector is significantly greater when compared to the total Fiji workforce gender demographics, 31%

female and 69% male[126]. Refer to Figure 118 below for a graphical representation of the relative gender demographics.

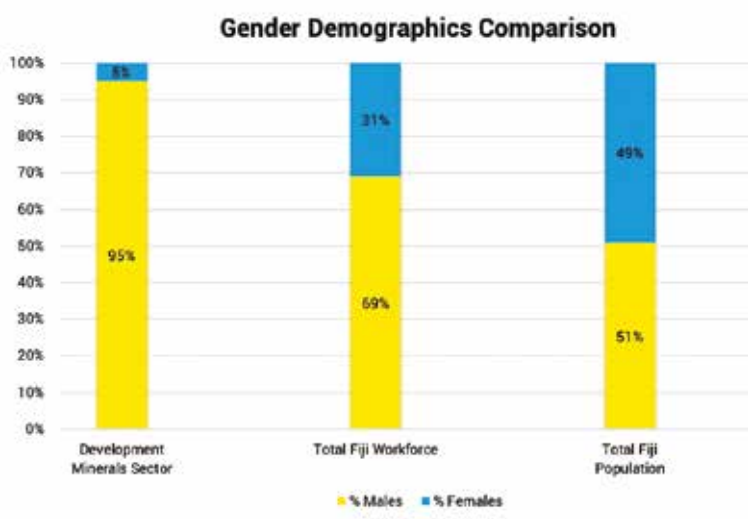


Figure 118: Gender demographics comparison (Source: SPC fieldwork, 2017, and Fiji Bureau of Statistics, 2018).

Thirty-eight of the surveyed businesses responded with data related to employee gender. A graphical representation of the gender demographics for the surveyed businesses involved in the Development Minerals industry (1143 males and only 42 females) is presented in Figure 119. According to discussions with businesses during the fieldwork; 98% of the 42 identified female employees work in non-technical support roles such as cleaning, cooking or clerical positions, and only 2% of the women hold decision making positions. None of the women have a 'Quarryman's' certificate.

The study team requested organisation charts and employee details of the government departments involved in the Development Minerals sector. MRD was the only government department to respond with data related to employee gender. The department employs 75 civil servants, out of which 56 are male and 19 are female. A graphical representation of the gender demographics for MRD is presented in Figure 120.

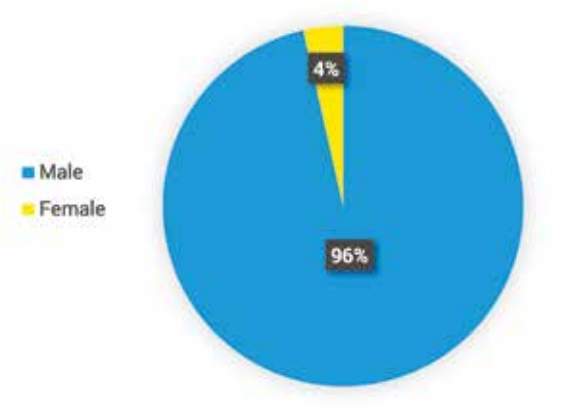


Figure 119: Gender demographics of the private sector involved in the Development Minerals sector (Source: SPC Fieldwork, 2018).

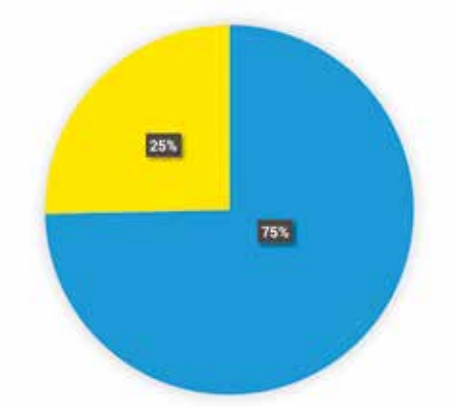


Figure 120: Gender demographics of MRD (Source: SPC Fieldwork, 2018).

Fiji National University (FNU) is the only educational institutional offering education relevant to the Development Minerals sector. FNU launched the 'Certificate IV in Geology, Mining and Quarrying' in 2018 and 25 students have enrolled for the course; of the 25 students, 23 are male and 2 are

[126] Fiji Bureau of Statistics, 2017 Population and Housing Census, 2018.

female. A graphical representation of the gender demographics for the FNU course is presented in Figure 121.

The study team recorded the gender of attendees at the community consultations conducted during the fieldwork. A total of 103 community members attended the consultations, including 64 males and 39 females, as shown in Figure 122. This indicates the likely proportional representation of males and females during community consultations conducted as part of the licensing process for extraction operations.

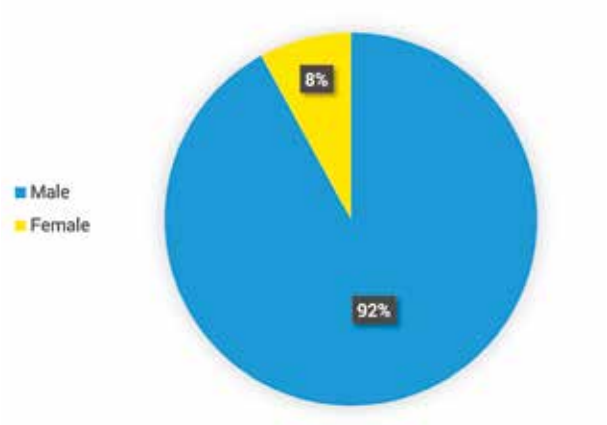


Figure 121: Gender demographics of the FNU 'Certificate IV in Geology, Mining and Quarrying (Source: SPC Fieldwork, 2018).

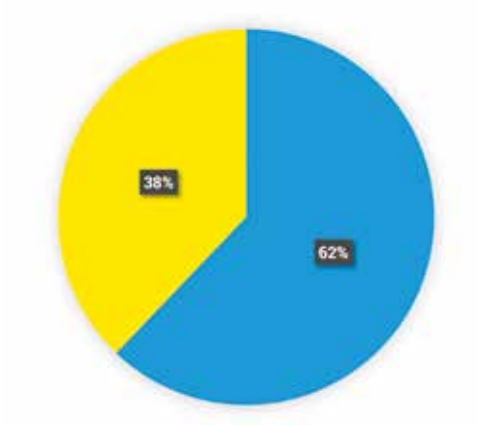


Figure 122: Gender demographics of community consultation attendees (Source: SPC Fieldwork, 2017).

Case study: Female operator

The study team conducted an interview with the only known female operator (owner of a dredging operation) in the Development Minerals sector, to capture her perspective, and the challenges she faces. She revealed that running the dredging operation is very challenging. The particular challenges she faces include:

- Theft of sand from her license area and stockpiles.
- Theft of equipment from her license area.
- She found the yearly renewal of the license particularly challenging and costly. The process took her approximately 3-4 months to obtain a license, meaning she only has 8 months to operate before beginning the application process again. She recommended the authorities consider extending the license period to 5 years, and to streamline the process.
- She found getting approval from the Ministry of Environment particularly slow and highlighted a lack of regular environmental inspections of her site and the adjacent sites on the river.
- Obtaining the required signatures from the Mataqali is difficult, she is required to obtain 100 signatures.
- Competition from foreign business owners with better cash flow.

- Weather and cyclone warning limited her ability to operate at certain times.
- Repairs and maintenance of the dredge are costly.

The female operator had received minimal support from the regulatory departments, as she found the process for obtaining consent to construct a fence around her stockpile (to prevent theft) very challenging, and was yet to construct a fence at the time of the interview in early 2018.

The results of the fieldwork indicate a clear underrepresentation of women in the Fiji Development Minerals sector, particularly in the private sector. The underrepresentation of women in the sector is likely due to several contributing factors. However, the fieldwork highlighted legislative discrimination as a prominent factor, particularly contributing to the lack of women employed in technical roles at extraction and beneficiation sites. 'Paragraph 20' of the 'Quarries Act 1939' states that "no female person shall be employed at a quarry except on the surface in a technical, clerical, or domestic capacity or such other capacity as requires the exercise of normal feminine skill or dexterity but does not involve strenuous physical effort". The Act also highlights that a person must obtain a "quarryman's certificate" in order to become a "foreman-in-charge"[127]. The terms 'foreman" and "quarryman" inherently discriminate against women, and this is supported by the fact that no women have ever obtained a "quarryman's" certificate, according to MRD records (dating back to 1966)[128]. The 'Quarries Act 1939' remains the relevant legislation governing the regulation of quarries; therefore, the legislative gender discrimination remains applicable. As a starting point to improving gender equality in the sector, the study team recommends the Fiji Government reviews the 'Quarries Regulations 1939' and removes the gender discrimination, including updating the term "quarryman" to a more gender sensitive title such as "quarry supervisor". Removal of the legislative gender discrimination is an essential precursory action requiring further interventions to open up pathways for women to participate in the sector.

UNDP defines youth as "young women and men between the ages of 15 and 24"[129]. The study team attempted to identify the representation of youth engaged in the Development Minerals industry by requesting data from all stakeholders consulted during the study, but unfortunately, the majority of stakeholders did not have quantitative records of age.

The statistics of youths employed by the private sector is unknown, because extraction and beneficiation operators did not provide records pertaining to the age of employees. However, observations and conversations with the private sector, indicate youths are typically employed in unskilled roles requiring physical labour, and older adults carry out skilled roles such as machine operators, 'quarrymen' and mechanics. The 2017 Fiji Census data will provide a quantitative dataset of the age (and gender) of people employed in the quarrying and mining sector, however this data was unavailable at the time of this study. We recommend the census data is obtained and analysed to give a more accurate insight into the age (and gender) dynamics of the Development Minerals sector.

Discussions with the Mining and Quarrying Council, MRD, and Development Mineral operators highlighted a specific problem related to the aging population of quarrymen approaching retirement, and a lack of training for young people in this area. The majority of quarrymen learnt the

[127] Laws of Fiji, Quarries Act, 1939.
[128] MRD, Quarryman database, 2017.
[129] UNDP, UNDP Youth Strategy 2014-2017, 2014.

relevant skills and obtained their certificates during an apprentice course offered at Vatukoula Gold Mine. This is the only educational course in Fiji relevant to the quarryman skillset. Subsequently opportunities for young people to learn the quarryman trade are limited, and employers in the Development Minerals sector need to compete with higher wages of the gold mine to attract prospective employees. MRD does not currently have collated records of the date of birth data for quarrymen, thus the study team was unable to ascertain specific age statistics of the current quarrymen workforce. Therefore, we recommend that MRD quantitatively establish the issue by compiling the age demographics of current quarrymen, particularly given the proposed transition from river gravel extraction to more hard rock quarries (and the associated projected demand for quarrymen). Compilation of the gender demographics will likely highlight the issue, and support the development of a training course for young men and women to learn the quarryman trade, and ultimately fill the void vacated by the aging population.

Impact on Sustainable Development Goals

At the United Nations Sustainable Development Summit in September 2015, 193 countries (including Fiji) adopted the 2030 Agenda for Sustainable Development,[130] including the 17 SDGs. The aim of the SDGs is to end poverty, protect the planet, and ensure prosperity for all. Development Minerals play a significant role in the sustainable development agenda in Fiji, through the development directly enabled by utilisation of the resources (such as construction of infrastructure and improved soil quality for agriculture), by providing economic opportunities for predominantly locally owned small and medium sized enterprises, via the government and community revenues (royalties and tax) generated from the sector which become available to finance further sustainable development initiatives, and through the environmental and social impacts associated with the sector. The Development Minerals sector in Fiji directly or indirectly impacts all 17 of the SDG's presented in Figure 123.

Figure 123: Sustainable Development Goals (Source: UN, 2015).[131]

[130] United Nations, Transforming Our World: The 2030 Agenda For Sustainable Development, 2015
[131] http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Table 17 outlines the impacts of the Development Minerals sector in Fiji on each of the 17 SDGs.

Table 17: Impact of the Development Minerals sector on the Sustainable Development Goals in Fiji (Source: SPC Fieldwork, 2018).

Sustainable Development Goal	Impact of the Development Minerals sector
	The sector is essential for inclusive economic growth and poverty alleviation at the macro and micro levels in Fiji. The sector provides opportunities for SME's and directly creates employment at extraction and beneficiation sites, as well as indirectly through the support services (such as mechanics) and downstream industries (such as construction and agriculture). The infrastructure created from Development Minerals (such as roads and buildings) is the foundation for economic growth and further opportunities for the poor. Royalty payments to rural communities' is a mechanism to distribute wealth generated from economic growth to some of the poorest communities in Fiji.
	Development Minerals contribute to local food production in Fiji; through the use of crushed limestone to improve soil quality and crop yields, and through the construction of infrastructure to support food production. A study conducted by the Market Development Facility (MDF) in 2013 indicated that agricultural production in Fiji has significantly reduced due to acid soils[132]. The study concluded that using lime as fertiliser for sugarcane, dairy, dalo and yaqona production, will have a total positive economic impact of FJ$57.5M per annum. Sales are yet to reach their full potential, therefore the total benefits of lime are yet to be realised. At the micro level lime enables individual farmers to increase productivity and thus livelihoods.
	Development Minerals contribute to good health and well-being in Fiji primarily through the use of lime (fertiliser) to support local food production. This reduces the consumption of imported processed food, which is linked to non-communicable diseases such as diabetes. Development minerals are also used to construct recreation facilities for exercise, such as gyms and sports grounds, and health care facilities such as hospitals. Although not quantified to date, anecdotal evidence suggests extraction from rivers likely has a negative impact on the health of surrounding communities, due to contamination of drinking water, and hygiene issues associated with cleaning and bathing areas.
	Development Minerals contribute to education in Fiji through the use of construction materials to build schools, particularly given the damage associated with cyclones. The Fiji Institute of Engineers (FIE) conducted a damage assessment of 219 schools following Cyclone Winston, and concluded that concrete structures performed far better than timber structures[133]. As a solution, FIE recommended concrete structures be used instead of timber structures. Therefore Development Minerals play a crucial role in ensuring the resilience of Fiji's education infrastructure. The industry also supports education through the recently established Certificate in Geology, Mining and Quarrying at FNU, and there is potential to expand the current curriculum to address current capacity gaps.

[132] Market Development Facility, Aglime for Fiji, 2013.
[133] Fiji Institute of Engineers, Cyclone Winston Damage Assessment Findings & Moving Forward, 2016.

Sustainable Development Goal	Impact of the Development Minerals sector
	Currently the industry is having a negative impact on gender equality in Fiji. Based on results of the results of the study, 96% of Fijians employed in the Development Minerals sector are male and only 4% are female. Additionally, the Quarries Act 1939 discriminates against women working at quarry sites. The gender inequality associated with the sector is discussed in more detail in the 'Gender and Youth' section. Moving forward the sector is faced with the challenge of improving gender equality.
	River extraction is currently having a negative impact on sanitation and the availability of clean water for Fijian communities. The Water Authority of Fiji highlights river gravel extraction as one of the critical risks threatening the Authority's ability to supply safe, clean water to Fijian communities. Consultations with communities living downstream of river extraction sites has highlighted several cases of waterways becoming contaminated by sediment (and in some cases oil), to a point where they are no longer suitable for bathing and cleaning, thus leading to a reduction of the hygiene and sanitation levels in the communities.
	Fiji currently generates over 60% of its electricity from renewable sources, including; hydro, biomass, solar and wind. Development Minerals were utilised in the construction of all of the renewable energy infrastructure; from the significant volumes of material required to construct the hydro dams and access roads, to the concrete utilised in the foundations of the solar and wind farms. The government plans to increase electricity generation from renewable sources to 80% by 2021 and 100% by 2036[134], therefore Development Minerals will be required to enable this expansion of renewable energy. The transportation of Development Minerals is contributing to the consumption of fossil fuels. The carbon footprint of the industry could be improved via developing quarries in strategic locations, and resolving the load restriction issue with the Road Haulage Association.
	Development Minerals are essential for economic growth, to the extent that consumption of Development Minerals is often used as an indicator of economic growth[135]; particularly in developing countries. Development minerals are essential for infrastructure development, including transport infrastructure which is the primary conduit for the transportation of goods and services. Therefore, Development Minerals are essential for economic growth and implementation of Fiji's '5 & 20-year Development Plan'149. We estimate the sector directly employs 2,325 Fijians, furthermore the support services and downstream sectors associated with sector create many more work opportunities.

[134] Ministry of Economy, 5 & 20-Year Development Plan, 2017.
[135] Global Cement Magazine, Defining the trend: Cement Consumption vs Gross Domestic Product, 2014.

Sustainable Development Goal	Impact of the Development Minerals sector
	Development Minerals include materials used during the construction of infrastructure, such as: concrete for schools, hospitals and homes, sealing chips for arterial roads, aggregates for rural roads, rock for coastal protection, aggregate for airport runways, concrete and fill for jetties, concrete for renewable energy infrastructure and many more. The infrastructure enabled by the utilisation of Development Minerals is fundamental to industry in Fiji. Development Minerals also support industry development through the innovative rehabilitation of hard rock quarries into productive assets such as the Coli-i-Suva Rainforest Eco Resort and Vuda Marina.
	Rural communities depend on rivers for several subsistence functions; many river extraction sites are increasing inequalities, because urban development is being enabled at the expense of rural riverine ecosystems and the surrounding communities. Development Minerals also contribute to the reduction of inequalities within Fiji through the construction of new infrastructure in rural locations, so that rural communities have access to education (schools), healthcare (hospitals), electricity (foundations) and transport (roads). The construction of infrastructure and associated economic development improves the quality of life in Fiji and thus improves the equality of Fiji's position in the international community.
	Concrete structures are fundamental to resilient and sustainable cities and communities in Fiji, particularly given the threat tropical cyclones pose to timber structures. Therefore Development Minerals are essential to construct the infrastructure at the heart of sustainable cities and communities. However, the current river extraction practices are unsustainable and are adversely impacting the surrounding communities. Based on consultations with communities, impacts include; loss of fisheries, erosion and loss of land, obstruction to boat transport, contaminated drinking water, and contamination of bathing and cleaning areas.
	The current consumption and production of Development Minerals from perennial rivers in Fiji is creating adverse environmental and social impacts. Demand for Development Minerals is predominantly driven by infrastructure development. Much of the infrastructure in Fiji is currently being developed with little consideration of the environmental and social costs. The responsible production and consumption of Development Minerals would be greatly improved if Fiji transitions from river extraction to a network of hard rock quarries in strategic locations.

Sustainable Development Goal	Impact of the Development Minerals sector
	Climate change represents a major obstacle to achievement of Fiji's Development objectives. The 2017 Climate Vulnerability Assessment[136] identifies the availability and quality of construction materials as an issue increasing Fijis vulnerability to the impacts of climate change. This was evident after Cyclone Winston, when rock to rebuild jetties and coastal roads was not available in licensed quarries on Vanua Levu, therefore was extracted from unlicensed sites. Establishing a network of hard rock quarries in strategic locations, with material stockpiled during the cyclone season would increase Fiji's resilience against the impacts of climate change. Development Minerals are also required to construct the planned infrastructure projects for climate resilience, such as coastal protection and upgrading buildings. The environmental impact assessments for river extraction sites do not consider the downstream impacts on the coastal environment, therefore the potential impacts associated with climate change are not considered during the current licensing process. Also, the unregulated coral sand market is likely being excavated from Fiji's beaches, which is likely increasing the risk of coastal erosion, and thus decreasing resilience against the impacts of climate change.
	Approximately 143 species are known to spend at least half of their adult lives in freshwater, of which 132 are native to Fiji, and at least 5 are considered endangered.[137] River extraction is currently altering and in many cases negatively impacting habitats (such as pools and rapids) which many of the freshwater species (like Ika Droka) depend on. Anecdotal evidence collected during consultations with communities living adjacent to river extraction sites, indicates that freshwater species populations decline during and following river gravel extraction. The downstream impacts on marine fisheries and coral reef systems is not considered during environmental impact assessments, however evidence from google earth imagery suggests extraction is linked to increased deposition of fine sediment on coral reefs in some locations. Transitioning from a river extraction to a network of hard rock quarries would help conserve the life below the water in Fiji.
	The physical footprint of hard rock, soft rock and sand quarries directly impacts life on land through the removal of topsoil and flora. This has a very localised impact on the fauna living in the vicinity of the quarry site. However, Colo-i-Suva Rainforest Eco Resort provides a good example of how quarries can be rehabilitated into environments where flora and fauna thrive. The study team observed several cases where river extraction has caused erosion of river banks and loss of land, including the fauna living on the land such as mango trees. These impacts are far more difficult to rehabilitate, with long-term impacts.

[136] Government of the Republic of Fiji, Climate Vulnerability Assessment, 2017.
[137] Nature Fiji, Position Statement on the Unsustainable Extraction of Fiji's River Gravel, Sand and Rocks, 2014.

Sustainable Development Goal	Impact of the Development Minerals sector
	The institutions administering the Development Minerals sector in Fiji are typically under-resourced and do not have strong control over the sector. No government department has a database of all active extraction sites, and sites are not being consistently monitored to ensure operators are complying with the conditions of license approvals. Subsequently the associated record keeping, accounting and valuation of the sector is not an accurate representation of the sector. Fieldwork indicates that at least 30 unregulated sites are operating without the relevant approvals, including an unregulated market for coral sand. The lack of monitoring and enforcement has led to conflict between differing land use practices, such as the conflict between river extraction companies and tourism operators on the Navua River. Confusion around resource ownership and the relevant royalties, particularly in relation to river extraction sites, has led to conflict between landowners and extraction operators. Improving the capacity of the institutions responsible for administering the Development Minerals sector is critical to addressing the current issues evident in the sector.
	Development Minerals support partnerships between Fiji and neighbouring small island developing states (SIDS) with scarce Development Mineral resources, particularly atoll nations. Many of the SIDS in the Pacific region aren't blessed with the geological resources that Fiji has, therefore these less fortunate nations need to import Development Minerals to enable development, and to increase resilience against climate change and natural disasters. Fiji is already exporting Development Minerals to several SIDS in the Pacific region (such as Tuvalu, Vanuatu, Marshall Islands, and Kiribati). Given Fiji's maritime infrastructure and geological resources, Fiji is in a strategic position to build on the existing partnerships and solidify its position as a supplier of quality construction aggregates to support wider sustainable development agenda in the Pacific region.

Component 5: Market and Value Chain Analysis

The Development Minerals sector in Fiji is predominantly characterised by crushed rock, clay, gravel and sand, used for construction materials, and to a lesser extent limestone, used for agricultural purposes. Despite this, the industry is vital to the national economy as it forms the basis for key ingredients in construction and civil engineering works, and even trade.

This section describes the underlying demand to which these minerals are extracted for and the industry's responding supply profile. It will also discuss the competitiveness of locally produced products compared to that of imported varieties, and outline a value chain map with an analysis of the value chain and its opportunities.

The Demand Profile

The industry is vital to the construction and engineering needs of the country. Yet despise this, several information asymmetries currently exist. Data related to companies involved in the upstream extraction of Development Minerals is limited, and subsequently it is difficult to identify robust quantitative linkages to the entities involved in the downstream value adding and utilisation of the resource, whether it be in construction, road making, concrete manufacturing, or production of agricultural lime.

In the section above on 'Businesses Involved in the Development Minerals Sector and the Economic Importance for Fiji', a breakdown of the largest local consumers of locally produced aggregates is

provided. According to estimates derived from the Fiji Roads Authority's (FRA) Maintenance and Renewals Programme, approximately 1.9 million m^3 of Development Minerals was consumed by FRA and its contractors in 2017. Further to this, using cement production figures available from a prominent cement company in the country, it is estimated that approximately 714,000 m^3 of Development Minerals were utilised in concrete manufacturing to produce products for both the domestic and export markets. From this, we deduce that in 2017 approximately 2.6 million m^3 of Development Minerals were demanded by transport infrastructure development, and concrete manufacturing alone.

To understand the external demand-pull of Fiji's key Development Mineral products, namely, aggregates and cement, we observe Fiji's export of these two products, using the latest available trade data from the Fiji Bureau of Statistics (FBoS).

Figure 124 shows the export of aggregates; gravel, sand & crushed rock, between 2011 and 2016.[138] The chart clearly shows that nearby Pacific Island countries, Kiribati and Tuvalu; whose geography are dominated by atolls, as the two main destinations for the export of Fiji's Development Minerals. It shows a particular rising general demand from both countries in recent years, with a sharp increase in exports to Kiribati in 2015. On these two atoll countries that lack aggregates resources - gravel, sand and crushed rock from Fiji is key for their construction needs. Just under 30,000 tonnes of Development Minerals was exported in 2016.

Figure 124: Fiji's export of aggregates- gravel, sand and crushed rock (Source: FBoS)

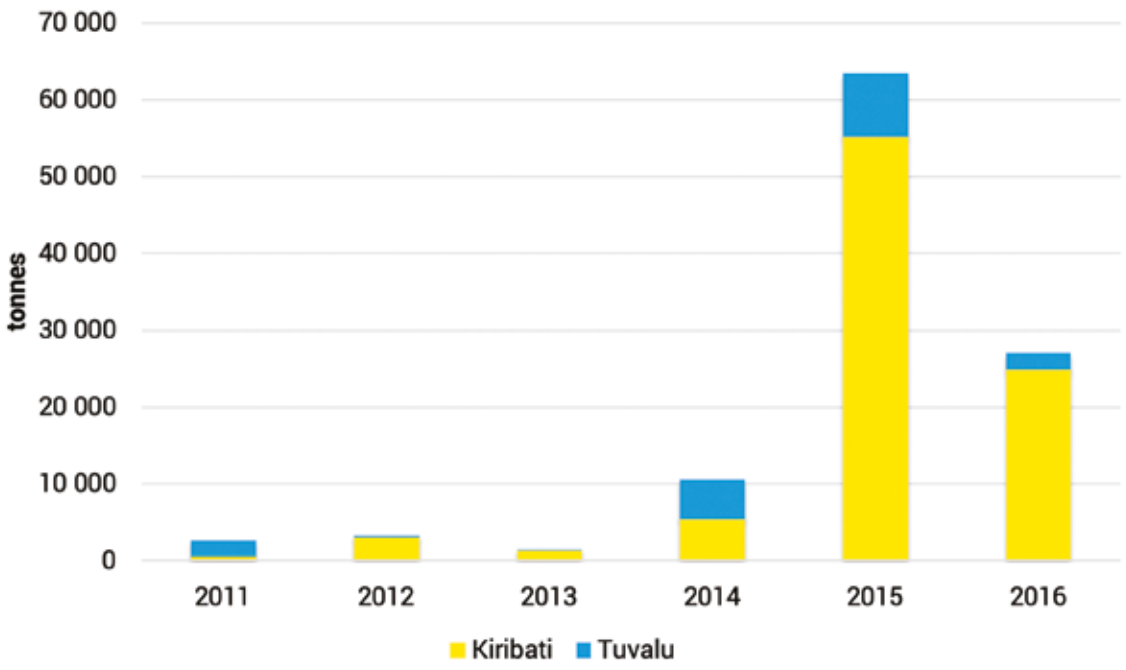


Figure 125 shows the export of cement between 2011 and 2016. It shows a clear increasing trend in demand. Pacific Island countries make up the bulk of destinations for cement from Fiji. A total of

[138] Exports to Tonga, Nauru and Vanuatu were also noted, however, the amounts for these countries were substantially smaller than Kiribati and Tuvalu and as such have been left out of the chart for simplicity.

76,069 tonnes of cement products were exported in 2016. In particular, three countries: Vanuatu (~40%), Samoa (~20%) and Tonga (~20%), imported the bulk of it. This demonstrates the vital role that Fiji's cement production industry plays in countries all over the region and points towards Fiji's strategic position as a regional exporter of aggregates, supporting the wider development agenda in the Pacific region. This finding supports the consideration of re-establishing cement production from locally extracted material.

Figure 125: Fiji's export of cement (Source: FBoS)

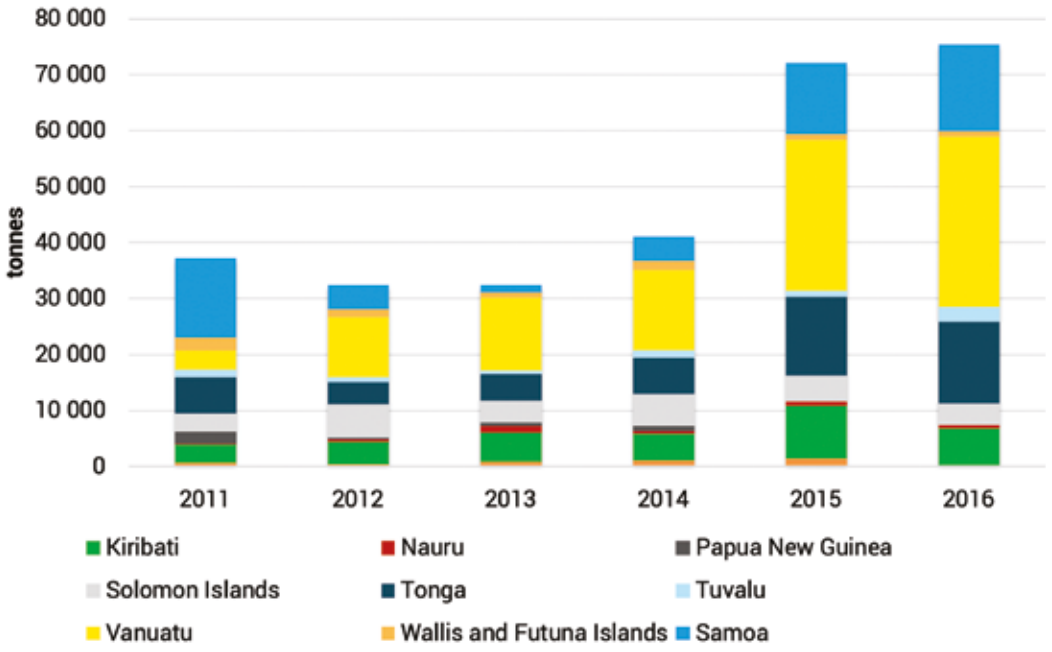


Figure 126 to Figure 129 below present photographs of Fijian aggregates and cement products, observed by the study team in Tuvalu and Nauru.

Figure 126: Cement from Fiji being loaded onto an inter-island vessel on Funafuti port, Tuvalu (Source: SPC Fieldwork, 2018).

Figure 127: Aggregates from Fiji in containers on Funafuti port, Tuvalu (Source: SPC Fieldwork, 2018).

Figure 128: Crushed rock from Fiji in containers on Funafuti port, Tuvalu (Source: SPC Fieldwork, 2018).

Figure 129: Aggregates from Fiji on Nauru to build a community centre using Australian Aid (Source: SPC Fieldwork, 2018).

The Supply Profile

The Fiji Bureau of Statistics is the agency mandated to collect official statistics related to Fiji's economy. Part of its economic compilations include regular industry surveys of nineteen industrial sectors that make up the broad groupings in Fiji's GDP reporting. The Mining and Quarrying sector includes a sub-category called '08101 - quarrying of sand, stone and clay' that captures Development Minerals. The latest published Mining and Quarrying industrial survey (2014) was based on a 'census' survey of 16 companies involved in the sector, as per the Registrar of Companies records. It was noted early on in the study that no regulatory agency had a comprehensive database of companies involved in Development Minerals extraction.

For the purpose of this study, the combined datasets from DoL, iTLTB and MRD were obtained, and the study team followed up with surveying officially registered companies. The field survey revealed 75 regulated companies – spread over a reported 100 sites, found to be currently operating in Viti Levu and Vanua Levu. Of these, 41 companies provided information regarding share of local ownership; 39 companies are locally owned, and only 2 companies have majority foreign ownership. The team also observed 30 unregulated extraction sites. The actual number is likely higher. Of these, 28 were river extraction sites and 3 rock quarries. As such, the FBoS figures underestimate the extent of the sector.

Of the surveyed companies that reported employee statistics, 18% (7) would be classified as micro enterprises, 42% (16) enterprises would be classified as small and 21% (8) would be characterised as a medium-sized enterprise.[139] This means that about four out of every five companies involved in aggregates extraction are Micro, Small and Medium Enterprises (MSMEs). MSMEs are often seen as an important component of a developing country's growth strategy. In Fiji, it has been touted by policymakers as a force to drive growth and raise livelihoods.

The earlier section on 'Businesses involved in the Development Minerals sector and the Economic Importance for Fiji', breaks down estimates of production by upstream extraction activities. It shows a vast amount of output currently not accounted for in official statistics and economic surveys. For 2017, aggregate extraction was estimated at 2.3 million m^3 from river extraction; 1.2 million m^3 from hard rock quarries; and 40,000 m^3 rom sand and soft rock quarries. This gives an estimated total supply of 3.54 million m^3 of aggregates. This production figure is expected to funnel into both local and overseas demand. The two estimated consumption figures from FRA and concrete manufacturing, mentioned above, account for 73% of the estimated total Development Mineral production.

[139] Assuming that the business meet the turnover requirements of the Small and Micro Enterprises Development Act 2002 definition. The SME Development Act 2002 defines a "micro enterprise" as any enterprise which has a turnover or total assets not exceeding $30,000 and employs not more than 5 employees; and a "small enterprise" means any enterprise which has a turnover or total assets between $30,000 and $100,000 and employs between 6 and 20 employees. A "medium enterprise" means any enterprise that has a turnover or total assets between $100,000 and $500,000 and employs between 21 and 50 employees.

Market/competitiveness analysis of imported vs local products

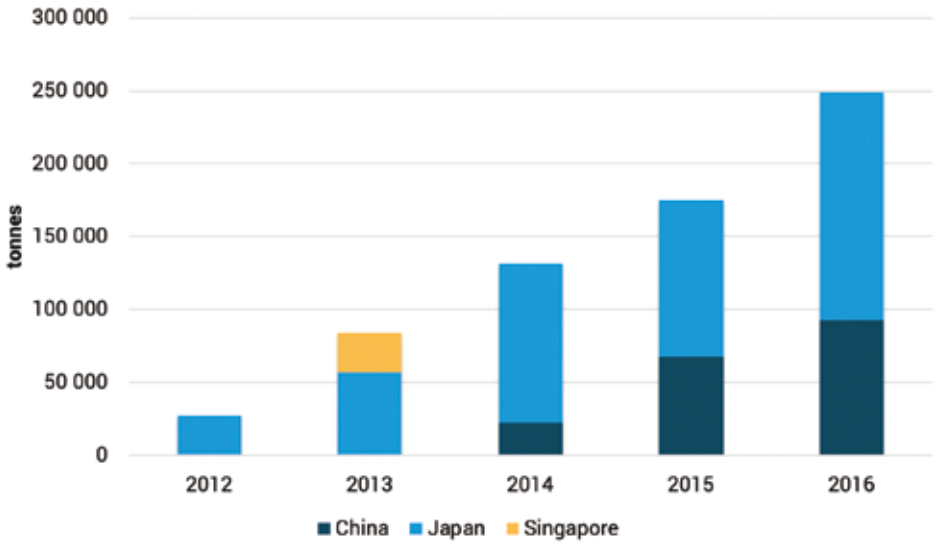
Market analysis

Between 1959 and 2004, Fiji manufactured cement from locally extracted Development Minerals, however, extraction operations ceased in late 2004 and Fiji began importing clinker to produce cement in 2005, a practice which continues today.

Concrete is a key downstream product that is manufactured using Development Minerals. Imported clinker is mixed with locally extracted sand and gravel to produce concrete. Figure 130 shows Fiji's import of cement clinker and the major countries that the country imports from, using the latest available trade data from FBoS.

The chart clearly shows an increasing trend of clinker imported into the country between 2011 and 2016. Fiji's total import of clinker grew by over 800% from 27,109 tonnes in 2012 to 249,161 tonnes in 2016. We note that local cement manufacturers buy bulk clinker and stockpile it for future production; however the trend of increased clinker imports indicates a notable increase in the manufacturing of concrete products in Fiji, and also translates to an increasing demand for Development Minerals to fuel production. The chart also shows that commencing in 2014, China has gradually become one of Fiji's main trading partners for imported clinker, together with Japan. This can be largely attributed to the inflow of substantial Chinese investment in the industry, particularly the establishment of the Tengy Cement factory in 2014[140].

Figure 130: Fiji's cement clinker imports (Source: FBoS).



Competitiveness

To examine the competitiveness of Fiji's Development Minerals industry we consider two particular perspectives, the local market structure and institutions that affect the competitiveness of the industry locally and, its comparative productivity to consider its competitiveness globally.

[140] http://www.tengycement.com.fj/

Prevailing industry characteristics

As expanded upon in the following section on 'Value Chain Development', two particular issues threaten the competitiveness of the industry; the current disparity between different license application fees and royalty rates; and the absence of environmental externalities in the industry's current cost structure.

The prevailing license fees and royalty rates incentivises river extraction over hard-rock quarrying. This discourages entrepreneurs that would venture into the reserved hard rock quarries and encourages the continued encroachment of operators into vital tributaries and river systems.

The lack of available information on the consequences of the different types of quarrying and its absence in the prevailing license fees, royalties and product prices of Development Minerals means that the true value of resources and the methods used to extract them is not reflected. For the future sustainability of the industry, a better reflection of environmental externalities is needed.

Labour productivity in Fiji's mining sector

Productivity is a key economic indicator linked to economic growth and the competitiveness of an economy or industry. It measures how efficiently production inputs, such as labour and capital, are being used in an economy or industry to produce the output. In this case, output per worker is taken as a measure of labour productivity to gauge the general trend of effective labour in quarrying in Fiji. This will also be compared to the trend in a group of Fiji's selected countries.

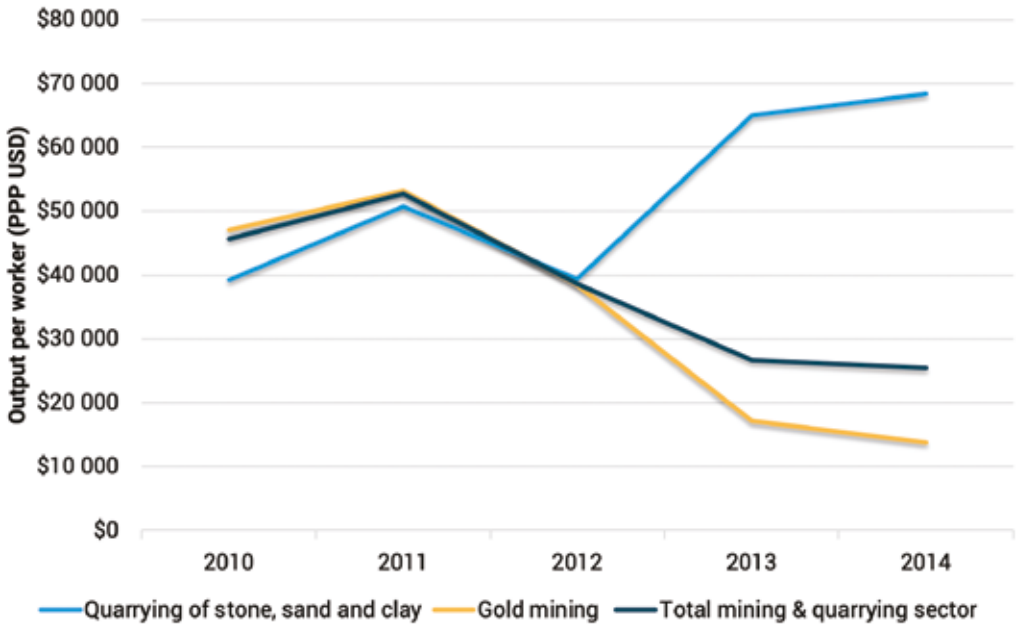
Fiji's mining and quarrying industry is disaggregated into two main categories: gold mining, and quarrying of stone, sand & clay. To calculate labour productivity of these two activities, total gross output value valued at purchasing power parity was divided by reported persons engaged in the industry. This data was sourced from the latest successive FBoS Economic Surveys.

Figure 131 shows that overall labour productivity of the mining and quarrying sector follows a similar trend as the labour productivity for gold mining. It increased between 2010 and 2011, however it has been falling after 2011. The similar movement points to the dominance of gold mining in the overall sector. The decline in gold's productivity can be attributed to the frequent failure of old machinery experienced at Fiji's gold mines coupled with unanticipated accidents at mines.[141]

The labour productivity for quarrying of stone, sand and clay on the other hand has fluctuated. There was a 29% increase from 2010 to 2011 followed by a 22% decline in 2012. After 2012, labour productivity in this sector has been increasing. There was a 65% increase in labour productivity from 2012 to 2013. Recent years in Fiji has seen growing investment from foreign owned companies in Fiji's primary industries. In particular, Chinese owned and operated mining and quarrying activities have been noted since 2012.[142] With these investments, new or better technology and equipment were introduced into Fiji, contributing towards improved labour productivity. Despite mining being more dominant in output, quarrying is relatively more labour productive.

[141] Vatukoula Gold Mine Annual Report 2012
[142] United States Geological Survey, The Mineral Industry of Fiji, 2013

Figure 131: Labour productivity in Fiji's mining & quarrying sector (Source: FBoS)



Comparing labour productivity across countries

To compare the competitiveness of Fiji's Development Minerals industry with that of other countries, data was collected from national accounts available online to construct labour productivity as done above. Figure 132 shows a basket of three countries for whom data for specific industries was available and their calculated labour productivity compared to Fiji's. Not all countries had data disaggregated into quarrying of stone and sand per se, so figures for the overall mining sector was used instead. Australia and Indonesia only had overall mining available. While USA's figures included all mining other than for oil and gas. Unfortunately, no Pacific Island country had adequately available data to be considered in this analysis. It is important to note the limitations associated with the data available for comparison: Australian and USA labour productivity figures are elevated due to the inclusion of large-scale metal mining operations which are typically capital intensive and thus generally have relatively high labour productivity when compared to the Development Minerals sector.

Figure 132 shows a significant disparity in productivity between Fiji and other countries. Fiji's labour productivity is relatively low compared to all three countries. Technology diffusion, education attainment, and quality and safe working conditions are some of the factors that can help explain labour productivity differences across countries.[143]

In Fiji's case, this points to the low labour skill level and poor quality of machinery in Fiji's quarrying industry. Based on conversation and interviews with stakeholders, it was pointed out that sites often experience disruptions of operations because of faulty digging machinery.

Furthermore, the ability to source funds or access credit via financial institutions is fundamental in determining capital investment and productivity. Many operators reported facing difficult

[143] Choudhry, 2012, Determinants of Labor Productivity: An Empirical Investigation of Productivity Divergence.

requirements to meet before accessing credit with banks, discouraging investment into better machines and trucks or even expansion into more environmentally sound practice. To improve productivity of the Development Minerals industry and in turn its competitiveness, more investment needs to be made into the teaching of better skills and knowledge to people interested in taking up careers in mining and quarrying; better access to credit for entrepreneurs looking to invest in the industry; and safer working conditions for employees in the industry.

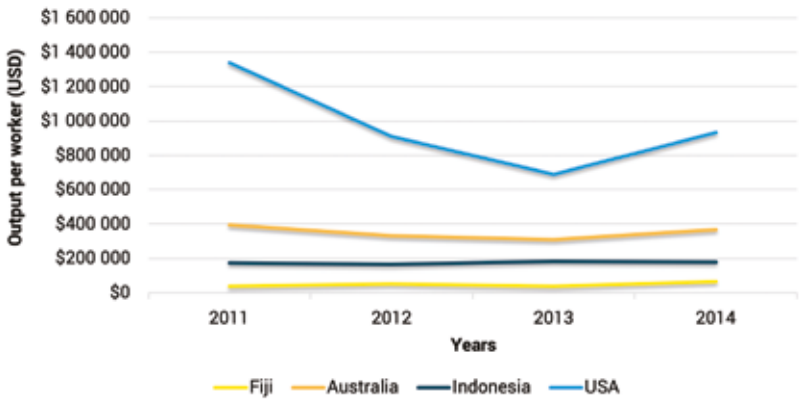


Figure 132: Labour productivity of Fiji's quarrying sector compared with labour productivity of the mining sector of other countries (Source: National Accounts)

The Value Chain

Value chain mapping

Development Minerals in Fiji are extracted through three different types of extraction: (1) river extraction, (2) hard rock quarry and (2) sand and soft rock quarry. As described above, the study team found most of the firms that exist at the upstream activity to be MSMEs working with a relatively small workforce and productive assets to extract and transport extracted aggregates.

The industry's value chain leads down to distinct downstream activities and products. One stream ends up with Development Minerals utilised for civil engineering, like in roads and bridges; the other utilises Development Minerals for construction of houses and buildings. Table 18 and Table 19 below describe the status of actors in the two value chains.

Table 18: Present status of stakeholders in the Development Minerals – civil engineering value chain in Fiji.

Extractors	Beneficiation	Fiji Roads Authority contractors	Road users
High start-up costs. Lack of available information on extraction companies in operation. Large cost difference in operating river vs hard/ soft rock extraction.	Lack of available information on beneficiation companies in operation. Lack of monitoring on workplace laws compliance.	High demand for aggregates at particular standards for specific timelines during projects. Contract for supply of aggregates chosen by competitive bidding.	High expectation to have quality and durable roads. Amongst other things, road durability dependent on quality of aggregates used.

Table 19: Present status of stakeholders in the Development Minerals – construction value chain in Fiji.

Extractors	Beneficiation	Concrete companies	Construction companies	Home owners / Firms
High start-up costs. Lack of available information on extraction companies in operation. Large cost difference in operating river vs hard/soft rock extraction.	Lack of available information on beneficiation companies in operation. Lack of monitoring on workplace laws compliance.	Large scale operations. High and continuous demand for aggregates for manufacturing. Receive high demand for concrete products both domestic and overseas.	Many firms in operation. Dependent on quality of materials coming out of concrete manufacturing companies.	Customers trade-off between preferences and cost of construction. Demand for high quality finished product and good workmanship.

In trying to capture a quantitative summary of the industry's value chain, and given the scarcity of reliable data plus the difficulty in getting stakeholders to provide reliable data, the mapping of a value chain was attempted by analysing the latest industry data from FBoS and drawing estimates of gross value, turnover, and output.

FBoS conducts regular Economic Surveys that record macroeconomic aggregate data of all registered companies in a particular industry. For this product mapping exercise, data was extracted from the latest survey reports of industries that dealt in the extraction, processing, manufacturing or sale of a Development Minerals.[144] It should be noted that there were no activities for the sale of Development Minerals or construction aggregates for that matter noted in the Wholesale and Retail report. A probable explanation being that the sale of processed items was grouped together in the sale of hardware items.

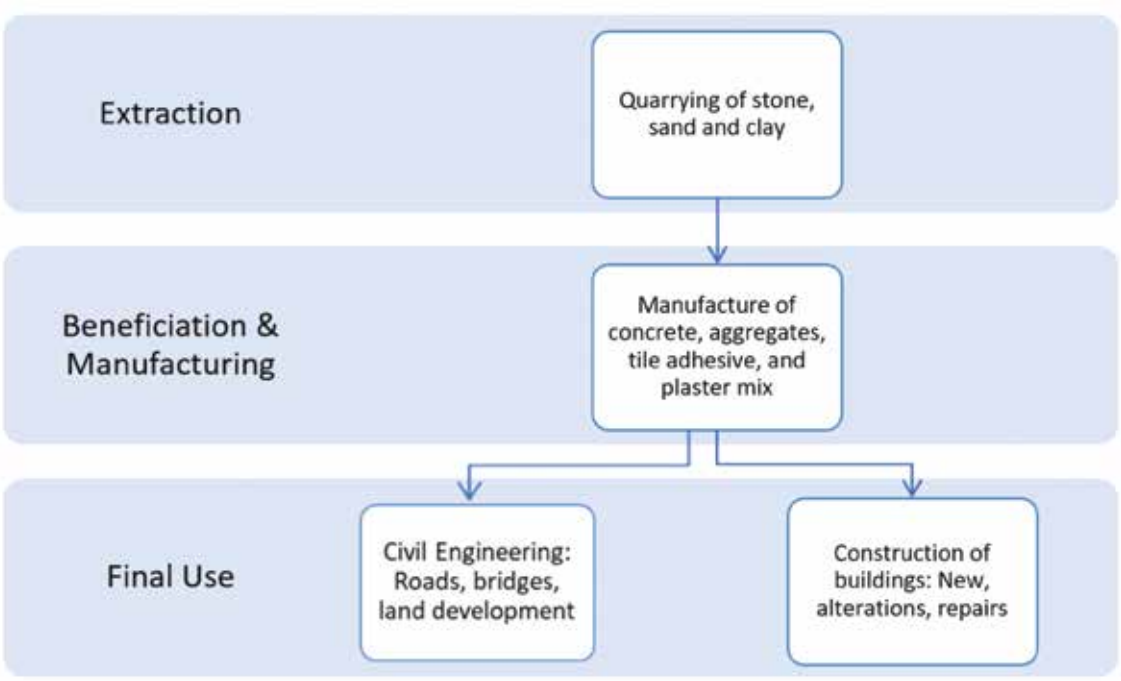
A key criterion to which products were captured and in turn mapped in this exercise, were the activity classification codes that the reports used, specifically the level of aggregation that was reported.[145] The only Development Minerals extraction activity captured in the FBoS classification code is quarrying of sand, stone and clay (08101). Extracted data were then analysed using the United Nations Food and Agriculture Organisation's (FAO) VCA tool.[146] The tool highlighted a distinct product chain that starts in the extraction of construction minerals, and ends in two products, the Constructed Buildings (new and repaired) plus Civil Engineering (constructed roads, bridges and land development), this is shown in Figure 133 below.

[144] Mining and Quarrying 2014, Construction 2013, Manufacturing 2012. At the level of classification codes reported, there were no activities for the sale of development minerals noted in the Wholesale and Retail 2012 report.

[145] FBoS uses the Fiji Standard Industrial Classification 2010 which is derived from the International Standard Industrial Classification (ISIC) with modifications to meet national requirements.

[146] Developed by the Food and Agriculture Organization of the United Nations (FAO), more information on the tool can be found at http://www.fao.org/sustainable-food-value-chains/training-and-learning-center/details-materials/en/c/327856/

Figure 133: Product chain for construction materials.



The chain shows that construction minerals pass through very few actors, despite the aggregation of data. The mineral is first quarried and at times crushed at source (FBOS data groups together both, crushed at site and by another company), then on to a manufacturer that process it into concrete products, aggregates, tile adhesive and plaster mix. Following the processing of these minerals, products funnel into either the construction or the civil engineering sectors of the economy.

Table 20 below shows the gross value added and output generated in activities along the value chain as recorded in FBoS economy surveys. The Bureau only covers 16 companies in its survey, despite the field survey capturing 75 registered companies. Nonetheless, the figures below give a glimpse into the scale of change in value adding and output created at each activity along the chain. Actual figures are most likely far higher.

Table 20: Value chain activities – Gross Value Added and Output (Source: FBoS)

Value chain activities	GVA	Turnover	Output
Quarrying of stone, sand and clay	$26,484,451	$18,320,061	$53,033,006
Manufacture of cement, lime and plaster	$9,772,326	$16,368,591	$28,473,760
Manufacture of articles of concrete, cement and plaster	$14,116,917	$25,140,423	$67,988,895
Construction of buildings	$52,109,971	$16,368,591	$187,169,468
Civil Engineering – Roads, bridges & land development	$47,843,187	$25,140,423	$135,941,631

The table above shows that with the few activities along the value chain, most of the value adding happens at the last activity, either at the construction of building or roads and bridges. The value of output created greatly increases towards downstream activities. Profits earned at different

activities tend to be around the same magnitude suggesting that presence of high production costs and the merger of several separate upstream value chain inputs at downstream activities (e.g. the incorporation of the upstream logging and timber manufacturing sectors into the downstream construction of buildings).

This exercise above has shown the difficulty in obtaining specific data on companies in the Development Minerals industry. Going forward, it is recommended that the Fiji Bureau of Statistics disaggregate their mining and quarrying surveys under their regular economic surveys to detail specific type of gravel and sand extraction. Also, that it captures more extraction companies in its surveys.

To better capture the general contribution and implications of the Development Minerals industry it is recommended that regular data be collected on the macroeconomic the contribution of Development Minerals quarrying to Gross Domestic Product and the wider economy.

Value chain development/ strengthening opportunities and constraints

The Development Minerals sector is key for Fiji's future development agenda, however, for the country to achieve its ambitions and ensure that Development Minerals are sourced sustainably, investment is needed to strengthen opportunities and address concerns. There are a number of constraints that need to be particularly addressed, these include:

- *Lack or non-existent information on resource extraction rates:* It has been discussed above the extent to which a considerable amount of aggregates extracted is underreported. Official figures with relevant regulatory authorities are either lacking or non-existent. To secure Fiji's sustainable supply of Development Minerals for the future, there is a need to correctly capture resource extraction rates. The current licensing conditions set out by iTLTB warrant a tally person to be on site as resources are loaded however when such a person is absent, operators under report the volume extracted. Even more, there is a lack of oversight by both iTLTB and DoL to monitor operator compliance with license conditions, EIA conditions, volume extraction for royalty purposes and damages caused on site. When there are little or no visits to licensed operators, detecting unlicensed and illegal operators will be twice as hard since they operate mostly in rural and remote areas of Fiji and outside of normal working hours. In recent years, unregulated beneficiation sites and even end-product block making are increasingly been noted in peri-urban areas near the major suburban centres. Monitoring has to extend to not only the extraction companies but also downstream users.

- *Environmental cost not accounted for in prices*: The current prices for extracted aggregates, and the specific extraction site that it is sourced from do not adequately factor in the environmental externalities or costs associated with the activity. Table 8 above shows the range of prices that extraction companies charge. River extraction has a range of prices between $15 and $250, whilst hard rock quarries has a range of $45 to $140. While this may show that it is cheaper to procure from a company sourcing from river over hard rock, it does not reflect a range of other economic factors such as transportation costs, quality and consistency of material and the production volumes that favour hard-rock quarried material, nor does it reflect the extent of environmental costs associated with river extraction. River extraction can

cause many implications to a river system and the ensuing economic activities that rely on a river further downstream. Environmental externalities must be factored into the cost structure of aggregates to better reflect the implications to society and the environment. This will discourage extraction that is pervasive and unsustainable.

- *Review of license application fees and royalty rates:* The section on 'Business Environment and Access to Finance for Development Minerals Operators' describes the royalty rate regime and license application fees structure. In summary, DoL's license application fees total FJD 3.00 whilst iTLTB's cost FJD 5,192.50. DoL is responsible for issuing licenses for gravel extraction in rivers, while the iTLTB is responsible for issuing quarry licenses on the majority of land (since 92% of land in Fiji is Native Land). Clearly, the incentive is for operators to invest in river extraction as the application fees to obtain a license disadvantage a hard rock quarry operator. This acts as a high barrier to entry. Also, the DoL's royalty rate for gravel extraction is FJD 2.50 per m^3 whilst iTLTB has royalty rates of FJD 3.31 m^3 for rock and FJD 6.61 per m^3 for sand and gravel. This royalty structure means that a company engaged in rock quarrying will have higher royalty rates to pay for as compared to a company engaged in river extraction.

Ultimately, for the country to secure its long term supply of Development Minerals, more resources need to be invested to capture accurate data related to extraction and beneficiation; stop and deter unlicensed operators; and ensure that the environmental costs of extraction are captured and eventually reflected into the price of materials.

Conclusions and recommendations

Conclusions

The study has highlighted the important role that the Development Minerals sector plays in Fiji's domestic development, especially in the areas of infrastructure, housing construction, road building, agriculture and disaster reconstruction, as well as supporting a large number of Fijian small and medium-sized domestic enterprises. It is evident that Development Minerals play a pivotal role in the sustainable development agenda in Fiji as the sector is linked to all 17 of the SDG's. The study has also shown the wider role the sector plays in the regional Pacific context, highlighting how neighbouring PICTs (particularly atoll nations with scarce domestic resources) are utilising Development Minerals sourced from Fiji to develop resilient infrastructure and adapt to the looming threats of climate change.

At the same time, the study has highlighted important issues adversely impacting the current social, economic, and environmental conditions of Fiji, which if not rectified, have the potential to manifest further and significantly obstruct development in Fiji. Environmental and social impacts associated with river extraction must be reduced to ensure the long-term sustainability of the sector. Conversely the environmental impacts of hard rock quarries were found to be moderate, with greater potential for effective rehabilitation. Hard rock quarries also provide greater scope for positive social outcomes, including poverty alleviation at the community level associated with sustainable and inclusive income generation.

The sector is significantly under-documented in official statistics, which creates obstacles for institutions to effectively administer the sector. Issues associated with the lack of accurate data

include insufficient budget allocations for institutions to govern the sector, lost tax revenues, underreporting of Fiji's overall GDP, increased scope of unregulated operations, and incorrect community royalty payments. It is apparent that the institutions responsible for administering the sector require additional resources in order to better govern the sector.

The absence of a comprehensive Development Minerals resource inventory is a key barrier preventing effective resource utilisation. Considering Fiji's small island developing State context and limited land resource base, it is fundamental that a resource inventory is developed to allow prioritisation of Development Mineral resources in land-use planning. The study has demonstrated how a historical lack of such planning has resulted in conflicting land use practices and unnecessary transportation of construction materials to urban centres, resulting in elevated construction costs.

Access to finance is crucial obstacle inhibiting private sector investment, particularly the establishment of hard rock quarries. Financial institutions perceive the sector as high-risk and the legal framework is currently incentivising river extraction and discouraging investment in hard rock quarries. Improving access to finance (particularly for prospective hard rock quarry investors) is crucial for sustainable growth of the sector.

The legal and policy framework is outdated and subsequently does not support sustainable development of the sector. Much of the legislation originates from the colonial era (such as the Quarries Act 1939) and includes inappropriate content such as gender discrimination. Reference to the Development Minerals sector in the existing policy framework is minimal, no specific policy has been formulated for the sector, nor does the framework acknowledge the unique and crucial role that the sector plays in Fiji's domestic development. MRD is in the process of rectifying legislative issues and introducing policies. This ongoing process is critical to improving the state of the sector.

In spite of these challenges, significant scope exists to establish several new Development Minerals industries in Fiji, including; cement produced from local resources, industrial lime, ceramics utilising residual clays, clay bricks, glass production from silica sand resources, industrial salt production, and phosphates. Cement and glass imports alone accounted for approximately FJ$50.0M in 2017. These prospective sectors present opportunities to support the economy and sustainable development through improving Fiji's Balance of Payments, creating employment opportunities, and decreasing external market risks by reducing Fiji's dependence on imported materials.

Recommendations

Component 1: Profile of the Sector

1. The Government of Fiji should allocate sufficient resources to collect and store accurate data related to the Development Minerals sector, including official statistics such as contribution to GDP.

2. The Government of Fiji and research institutions should undertake further research on Development Minerals in the Eastern Division.

3. The MRD should crosscheck the number of crushers operating at the 39 regulated crushing sites against the FRCA records, to ascertain the likely scale of unregulated crushing.

4. Serious consideration (including detailed research and market analysis) should be undertaken by the Government of Fiji for the reinstatement of cement production utilising local resources (to reduce the reliance on imported clinker), as well as expanding the lime industry for other purposes.

5. Further assessment of lime resources (including for cement production described above) should consider the specifications required in the gold leaching process.

6. Further research should be undertaken into the feasibility of developing a glass production industry in Fiji, to support the local economy and reduce the reliance on imported glass products. Any such study should consider the wider potential to export glass within the Pacific region, given Fiji's strategic location and maritime infrastructure.

7. Analysis of the '2017 Population and Housing Census' results should be undertaken to give a more complete indication of the total number of employees linked to the Development Minerals sector.

8. The Government of Fiji should implement a comprehensive audit to identify the true value of the Development Minerals sector, and to improve confidence that the correct taxes and royalties are being received.

9. As part of the above audit, the royalty rates should be reassessed, and updated to ensure appropriate royalty revenues are generated.

10. The Government of Fiji should estimate the quantity and spatial locations of Development Minerals required to implement the 5-year and the 20-year development plans. This information will assist the establishment hard rock quarries in strategic locations; to ensure adequate supply of quality materials, and optimise transport distances from extraction sites to end-use locations.

Component 2: Assessment of the Legal and Policy Framework

11. The Government of Fiji should formulate and strictly implement a specific policy focused on sustainable development of the Development Minerals sector. This policy should look at the use and management of Development Minerals in Fiji, bearing in mind that sustainability needs to be emphasised throughout the policy document. The policy document should aim to:

    - Establish the guidelines for the environmentally and socially responsible extraction of Development Minerals in order to ensure that adverse impacts are minimised and managed effectively.

    - Monitor all current and future extraction activities and bring to an end any activity that is unsustainable.

    - Integrate the extraction of Development Minerals in existing legislation and propose new legislation(s) that deal specifically with extraction, mainly, the relationship between landowners, the government and the extractors.

    - Ensure that all extraction is subject to an Environmental Impact Assessment.

- Iron out the discrepancies in the definitions that are evident in the existing legislation.
- Designate a single and specific Ministry or Department to oversee and manage the extraction of Development Minerals.
- Establish a standard procedure for issuing of licenses and have a specific Ministry or Department that is responsible for all issuances of licenses.
- Review current policies and legislation and update them to reflect current environmental and social issues relating to the extraction of Development Minerals.
- Increase awareness and create awareness programs on the importance of the Development Minerals sector for sustainable development in Fiji.
- Establish a beneficial relationship between landowners, extraction companies and the Government of Fiji to ensure that all parties are advantaged by the extraction of Development Minerals.
- Provide a framework for prioritising Development Mineral resources in land-use planning.
- Outline procedures for informing the Development Minerals supply chain of upcoming infrastructure projects.
- Accurately document the contribution of Development Minerals sector to Fiji's GDP.
- Support the establishment of hard rock quarries, including considering government incentives and improving access to finance.
- Establish pathways to increase women's participation in the sector.

Component 3: Assessment of the Institutional and Technical Operating Context

12. The study supports the development of a land use Master Plan for Fiji and recommends Development Minerals resources are identified and designated for quarry development in land use plans.
13. Institutional stakeholders should collaborate to generate a comprehensive centralised GIS database of all active extraction sites (including known unlicensed sites); to enable the recruitment of sufficient human resources, and facilitate the development of a regular monitoring plan, where the roles and responsibilities of the individual stakeholders are clearly defined.
14. The Government of Fiji and development focussed institutions and donors should consider investing in strategic capacity building of the departments responsible for administering the Development Minerals sector (particularly MRD and MoE).
15. MRD staff should be positioned in the divisional offices of DoL, or MRD offices should be established in the Northern and Western Divisions.

16. Consideration should be given for Development Minerals extracted during MoW activities to be sold and utilised for infrastructure development.

17. A cabinet decision made on the 8th April 1997 states "that a special rate of $4.00 per cubic metre be levied on sand sold from the various drainage and irrigation dump sites that were stockpiled from dredging operations, and this is to be increased in the event dredging costs increase". This rate is 21 years old and greatly underestimates the current market value of the resource. Consideration should be given to remove the gazetted rate for this sand and for it to instead be sold through an open tender process to ensure it is sold at market value.

18. The SPL and SML maps should be made publicly available on the MRD website, and the process for consultation between Development Minerals operators and SPL (or SML) holders be clearly defined in information brochures developed to explain the licensing process.

19. There is plethora of publications related to the geology of Fiji, which are summarised in bibliographies, we recommend:

    - A thorough desktop study to identify data related to Development Mineral resources. The MRD bibliographies complied by the late Peter Rodda provide a good starting point for this.

    - Digitisation and georefrencing of data in a Geographic Information System (GIS) database.

    - Equitable distribution (open), promotion and awareness raising of data amongst key stakeholders, including; landowners, government (particularly decision makers involved in land use planning), and potential investors.

20. The Ministry of Lands and Mineral Resources should undertake a programme of works to support the development of a network of hard rock quarries in strategic locations, considering the holistic demand for development minerals in Fiji.

21. Collaboration between MRD and Investment Fiji should be considered to attract investment in the Development Minerals sector.

22. Educational institutes should consider offering courses to educate Fijians and enable these capacity gaps to be filled with local personnel in the future. A shortage exists in the following skillsets: earth sciences (particularly geology), detailed scientific review of environmental impact assessments, surveying and resource mapping, quarrymen (particularly blasters qualified to use explosives), and data management. The recently established 'Certificate IV in Geology, Mining and Quarrying' at FNU, is a positive step in the right direction, and provides a good basis for further detailed courses to be developed. In the short-term consideration should be made for recruiting offshore skillsets to temporarily fill current voids.

Component 4: Environment, Health and Safety (H&S) and Socio-economic Analysis

23. The Government of Fiji should develop a detailed implementation plan for the phasing out of river gravel extraction and the transition to a network of hard rock quarries in strategic locations.

24. In certain remote locations, small-scale extraction of river gravel may remain a practical option, provided thorough scientific investigations are carried out prior to approval (including demonstration that the proposed extraction rate does not exceed the sustainable rate of extraction), and appropriate environmental safeguards are implemented during operation. However, we recommend hard rock sources where feasible.

25. Dredging for sand remains a practical option, provided thorough environmental impact assessments are carried out prior to approval, and appropriate environmental safeguards are implemented during operation. Scientific studies are recommended to identify sediment 'sinks' where sustainable sand extraction is feasible.

26. Collaboration between the Ministry of Waterways and the MRD should be pursued to capitalise on opportunities to source sand from areas requiring dredging for flood mitigation and navigation purposes.

27. All operating Development Minerals sites should conduct H&S inductions and have visitors sign a visitor book to acknowledge they have been inducted to the site and to make them aware of the potential hazards and mitigation procedures in place.

28. All operating Development Minerals sites should use trilingual signage to reduce the risk of misinterpretation.

29. Fijian communities interested in opportunities for extracting Development Minerals resources should consider a model similar to the 'Mataqali Lomanikoro' example.

30. Any agency issuing consent forms should develop 'standard conditions,' including stipulation of the applicable royalty rates.

31. DoL and iTLTB shoud collaborate and reassess all royalty rates:

    - To ensure the rates do not incentivise river gravel extraction over hard rock extraction
    - To be consistent across departments
    - To consider reasonable compensation for adverse impacts
    - To ensure resource owners (whether State of iTaukei Landowners) receive a 'fair share' of the resource value

32. For community consultations during the Environmental Impact Assessment Process (EIA), the Government of Fiji should makes it a requirement for developers to contact relevant communities directly (not just the community owning the land at the proposed development), in addition to newspaper advertisements.

33. Resource inventories and quarry business model templates (perhaps similar to the Mataqali Lomanikoro example) should be developed to assist landowners in realising the full potential of their resources, and reduce the risk for investors.

34. The Government of Fiji should review the 'Quarries Regulations 1939' and remove gender discrimination, including updating the term "quarryman" to a more gender sensitive title such as "quarry supervisor."

35. The 2017 census data should be analysed to give a more accurate insight into the age (and gender) dynamics of the Development Minerals sector.

36. MRD should quantitatively establish the age demographics of current quarrymen to highlight the impending skill shortage, particularly given the proposed transition from river gravel extraction to more hard rock quarries (and the associated projected demand for quarry supervisors).

Component 5: Market and Value Chain Analysis

37. The Fiji Bureau of Statistics should disaggregate their mining and quarrying surveys under their regular economic surveys to detail specific types of Development Minerals extraction.

38. To better capture the general contribution and implications of the Development Minerals industry it is recommended that regular macroeconomic data is collected to better capture the contribution of Development Minerals quarrying to Gross Domestic Product and the wider economy.

References

Ali, S.H., Clifford, M.J., and Matusbae, K. 2017. Mining and Socio-ecological Resilience in Mineral-Rich Small States: An Integrative Approach to Phosphate Mining on Nauru.

Act of Supremacy 1534 (26 Hen. 8, c. 1). The Statutes (1950) 3rd edn. London: HMSO

Aguilar, M. 2017. 'Building Permits Soon to be Made Faster', *Fiji Sun*, 28 November, accessed 30 November 2017, http://fijisun.com.fj/2017/11/28/building-permits-soon-to-be-made-faster/

Australian Government. 2015. Pacific-Australia Climate Change Science and Adaptation Planning Program: Current and future climate of the Fiji islands, 2015. 11 p. accessed, 12 September 2017, https://www.pacificclimatechange.net/sites/default/files/1_PACCSAP-Fiji-11pp_WEB.pdf

Auzende, J. M., R. N. Hey, B. Pelletier, D. Rouland, Y. Lafoy, E. Gracia, and P. Huchon. 1995. Propagating Rift West of the Fiji Archipelago (North Fiji Basin, SW Pacific), J. Geophys. Res., 100, 17,823–17,835.

Band, R.B., 1968. The Geology of Southern Viti Levu and Mbengga. Bull. Geol. Sury.Fiji, 15.

Bellù L. Cappi C. 2014. Value Chain Analysis: FAO VCA Tool 3.2, Food and Agriculture Organization of the United Nations (FAO)

British Geological Survey. 1993. Industrial Minerals Potential of Fiji. Technical Report WG/93/11. Nottingham, United Kingdom.

Choudhry, M.T. 2012. Determinants of Labour Productivity: An Empirical Investigation of Productivity Divergence.

Claridge, G.G.C and Dale, W.R. 1982. . Ceramic Clay Deposits in the South Pacific Islands. New Zealand Department of Scientific and Industrial Research. 30 pp.

Commonwealth Fund for Technical Cooperation. 1982. Fiji: Feasibility Study of a Glass Bottle Project. Industrial Development Unit, London. 89pp,

Constitution of the Republic of Fiji. 2013.

Construction Industry Council. 2018. *Minutes of General Meeting 31 January 2018,* Suva.

Crosbie, W. 2006. Fiji: An Encyclopaedic Atlas. Suva. The University of the South Pacific. 419p.

'Defining the trend: Cement Consumption vs Gross Domestic Product', Global Cement Magazine, 29 May 2014, accessed, 18 October 2017, http://www.globalcement.com/magazine/articles/858-defining-the-trend-cement-consumption-vs-gdp

Dyspriani, P. 2011 "Traditional Fishing Rights of National Jurisdiction: Analysis of State Practice" UN-Nippon Fellow 2010-2011, Ministry of Marine Affairs and Fisheries of the Republic of Indonesia

Eifac Working Party on Water Quality Criteria for European Freshwater Fish (1964), Water quality criteria for European freshwater fish. Report on finely divided solids and inland fisheries. E1FAC tech,Pap.,(1):21 p

Evans, N. 2006. Natural resources and the environment in Fiji: A review of the existing and proposed legislation, IWP Pacific Technical Report no.21. Apia, SPREP

Fiji Broadcasting Corporation. 2018. Quality of Materials not of Standard: FRA. 26 March, Accessed 8 August 2017, http://www.fbc.com.fj/fiji/61518/quality-of-materials-not-of-standard-fra-

Fiji Budget Vacations, 2017, Lomawai Village: still making sea salt using traditional methods, Accessed 23 October 2017, http://www.fiji-budget-vacations.com/lomawai-salt-making-village.html

Fiji Bureau of Statistics. 2016. Cement imports. Suva. Republic of Fiji Islands: Bureau of Statistics.

Fiji Bureau of Statistics. 2016. Salt imports. Suva. Republic of Fiji Islands: Bureau of Statistics

Fiji Bureau of Statistics. 2016. Economic Surveys: Mining and Quarrying 2014. Suva. Fiji Islands Bureau of Statistics

Fiji Bureau of Statistics. 2015. Economic Surveys: Construction 2013. Suva. Fiji Islands Bureau of Statistics

Fiji Bureau of Statistics. 2015. Economic Surveys: Manufacturing 2012. Suva. Fiji Islands Bureau of Statistics

Fiji Bureau of Statistics. 2018. 2017 Population and Housing Census: Release 1. Statistical News. Fiji Bureau of Statistics., 13pp. Accessed 20 January 2018, https://www.statsfiji.gov.fj/index.php/component/advlisting/?view=download&format=raw&fileId=2372

Fiji Commerce and Employers Federation. 2017-2018. *Mining and Quarrying Council Monthly Meeting Minutes,* Suva.

Fiji Development Bank, 2018, FDB SEALS PARTNERSHIP WITH STANDARD CONCRETE INDUSTRIES TO PROMOTE AGLIME, Accessed January 17 2018, http://www.fdb.com.fj/fdb-seals-partnership-with-standard-concrete-industries-to-promote-aglime/

Fiji High Court Proceedings. BD Lakshman & Sons (Properties) Ltd v A Morell, HBC 43/2017; BD Lakshman & Sons (Properties) Ltd v Noell, HBC 44/2017; BD Lakshman & Sons (Properties) Ltd v J Morell, HBC 45/2017; Mairi v BD Lakshman & Sons (Properties) Ltd, HBC 291/2017; Mairi v BD Lakshman & Sons (Properties) Ltd, HBM 145/2017

Fiji Institute of Engineers. 2016. Cyclone Winston Damage Assessment Findings & Moving Forward. Suva, Fiji Institute of Engineers

Fiji Meteorological Service. 2006. The Climate of Fiji. Accessed date http://www.met.gov.fj/ClimateofFiji.pdf

Fiji Mineral Resources Department. 1982-1992. Annual Report for the year. Suva. Mineral Resources Department

Fiji Roads Authority. 2015. 2016 Corporate Plan. Fiji Roads Authority, Accessed September 3 2017, http://www.fijiroads.org/wp-content/uploads/2016/07/Corporate-Plan-2016-Final.pdf

Franks, D.M., Pakoun, L. and Ngonze, C. 2016. Development Minerals: Transforming a Neglected Sector in Africa, the Caribbean and the Pacific. United Nations Development Programme.

Franks, D.M. 2017. Reconsidering the role of minerals and matter in international development. Bryan Lovell Meeting 2017: Mining for the Future. p.22-23. The Geological Society, London.

GNS Science, 2009, Alpine Fault, accessed 15 September 2018, https://www.gns.cri.nz/Home/

Learning/Science-Topics/Earthquakes/Major-Faults-in-New-Zealand/Alpine-Fault

Government of Fiji. 2008. Department of Environment: Environment Impact Assessment (EIA) Guidelines, accessed 15 October 2017, https://www.sprep.org/att/IRC/eCOPIES/Countries/Fiji/102.pdf

Government of Fiji, Cabinet decision: Gravel/sand extraction and recompense for the loss of traditional fishing rights. 1997. Suva. Republic of Fiji.

Government of Fiji. 2016. Fiji Roads Authority 2016-2017 Budget Major Highlights. accessed November 3 2017, http://www.economy.gov.fj/s/government-budget.html?download=464:ministry-information-kit-infrastructure-services

Government of Fiji, World Bank, and Global Facility for Disaster Reduction and Recovery. 2017. "Fiji 2017: Climate Vulnerability Assessment - Making Fiji Climate Resilient." World Bank, Washington, DC, Photo: Fijian Government. accessed, DATE, http://www.ourhomeourpeople.com.

Government of Fiji. 2006. Strategic Development Plan 2007-2011, Ministry of Finance & National Planning Suva, Fiji, accessed, 8 September 2018, http://www.sids2014.org/content/documents/172FIJI-SDP2007-2011.pdf

Hilson, G. 2016. Development Minerals in Africa, the Caribbean and the Pacific: Background Study. In Franks, Pakoun and Ngonze (series editors), 'Development Minerals in Africa, the Caribbean and the Pacific'. ACP-EU Development Minerals Programme, United Nations Development Programme, Brussels.

Hinton J., Lyster O., Katusiime J., Nanteza M., Naulo G., Rolfe A., Kombo F., Grundel H., MacLeod K., Kyarisiima H., Pakoun L., Ngonze C. & Franks D.M. 2018. Baseline Assessment of Development Minerals in Uganda. In Franks, Pakoun and Ngonze (series editors), 'Development Minerals in Africa, the Caribbean and the Pacific'. ACP-EU Development Minerals Programme, United Nations Development Programme, Kampala.

Houtz, R. E. 1957. Report on Quarry Rock Reserves in the Suva Area. Bull. Geol. Sury. Fiji, Short Report No.11

JP Bailey Ltd v Attorney General [1946] FJLawRp 15; [1875-1946] 3 FLR 439 (19 September 1946)

Kuridrani-Tuqiri, N. 2015. Value Chain Analysis of Freshwater Mussel or Kai (Batissa violacea) Fishery in Fiji. MS411 Project Report, University of the South Pacific, Suva. IUCN. 56p. Accessed 11 December 2017, https://www.iucn.org/sites/dev/files/value_chain_analysis_of_freshwater_mussel_or_kai_batissa_violacea_fishery_in_fiji.pdf

Land Transport Authority. 2017. Overloading Compliance Improves LTA. *The Fiji Sun* 18 March. Accessed 8 June 2017, http://fijisun.com.fj/2017/03/18/overloading-compliance-improves-lta/

Laws of Fiji. 1946. State Lands Act [Cap.132]

Laws of Fiji. 1942. Fisheries Act [Cap. 158]

Laws of Fiji. 1940. iTaukei Lands Trust Act [Cap.134]

Laws of Fiji. 1939. Quarries Act [Cap. 147]

Laws of Fiji. 1965. Mining Act of Fiji [Cap.146]

Laws of Fiji. 2002 Native Land Trust (Amendment) Act.

Laws of Fiji. 2002. Native Lands (Amendment) Act.

Laws of Fiji. 2002. Small and Micro Enterprise Development Act (no. 1 of 2002)

'Maruru Road Open to Traffic', *Fiji One TV,* 12 July, 2017, accessed 15 July 2017, https://www.fijione.tv/maruru-road-open-to-traffic/

Mineral Council of Australia. 2005. Socioeconomic Benefits and Impacts: An Assessment and Planning Toolkit, 40p

Mineral Resources Department. 2016. NDM Benefits Sharing Model- Mataqali Lomanikoro Colo-i-Suva *presented at UNDP Development Minerals Workshop* Suva.

Mineral Resources Department. 2017. Organisation Structure. Suva.

Ministry of Economy. 2017. 5-Year & 20-Year National Development Plan. Republic of Fiji. 144 pp. accessed, 5 February 2018, http://www.fiji.gov.fj/getattachment/15b0ba03-825e-47f7-bf69-094ad33004dd/5-Year---20-Year-NATIONAL-DEVELOPMENT-PLAN.aspx

Ministry of Lands & Minerals Resources Department of Lands. 2017. Extraction on State Lands-The New Requirements *Presented at the* UNDP Development Minerals Workshop on 24th to 25th of May. Pacific Harbour.

Ministry of Lands and Mineral Resources n.d, accessed 18 January 2018, http://www.lands.gov.fj/index.php/department-2/land-use-master-plan

Ministry of Strategic Planning, National Development and Statistics. 2014. A Green Growth Framework for Fiji: Restoring the balance in development that is sustainable for our Future. Republic of Fiji. accessed, 8 February 2018, https://pafpnet.spc.int/pafpnet/attachments/article/475/GREEN%20GROWTH%20FRAMEWORK.PDF

Movono, L. 2017. Overloading a cause of structural failures. *The Fiji Times.* 11 March. accessed, 13 June 2017, https://www.fijitimes.com/overloading-a-cause-of-structural-failures/

Natural Resource Governance Institute. 2014. Natural Resource Charter (Second Edition).44 pp. accessed, 9 November 2017, https://resourcegovernance.org/sites/default/files/NRCJ1193_natural_resource_charter_19.6.14.pdf

NatureFiji. 2010 . NFMV Position Position Paper - Unsustainable Extraction of River Gravel, Sand and Rocks. accessed, 2 November 2017, https://naturefiji.org/position-paper-unsustainable-extraction-of-river-gravel-sand-and-rock/

Naleba, M.. 2014. Keeping a Alive. *The Fiji Times* 15 August. accessed, 22 September 2017, https://www.fijitimes.com/keeping-tradition-alive-2/

NZ Geotechnical Society Inc. 2005. Field Description of Soil and Rock: Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes. accessed 19 July 2017, https://fl-nzgs-media.s3.amazonaws.com/uploads/2016/06/Field-guide-sheet-description-of-soil-and-rock-2005.pdf

Parliament of the Republic of Fiji. 2018. Daily Hansard from 8th March 2018. accessed, 21 March 2018, http://www.parliament.gov.fj/wp-content/uploads/2018/03/THURSDAY-8TH-MARCH-2018.pdf

Petterson, M.G., and Tawake, A.K. 2016. 'Toward inclusive development of the Pacific region using geoscience' IN: Wessel, G.R. and Greenberg, J.K. (Eds) Geoscience for the Public Good and Global Development: Toward a Sustainable Future, GSA Special Papers, v.260, Maclean: The Geological Society of America. https://doi.org/10.1130/2016.2520(39)

ProAnd Associations Australia Pty Ltd. 2013. Aglime for Fiji: Market Development Facility 84p. accessed, 25 March 2018, http://marketdevelopmentfacility.org/wp-content/uploads/2015/05/Aglime-for-Fiji-_MDF.pdf

Rahiman, A. 1982. Raw Materials for Cement in Fiji. Econ. Inv. Miner. Resour. Dep. Fiji 2. 26 + vi pp., 8 figs.

Rawalai, L. (2016. Villagers cry foul over state of river. *The Fiji Times,* 22 June. accessed 15 August 2017, https://www.fijitimes.com.fj/villagers-cry-foul-over-state-of-river/

Reserve Bank of Fiji. 2017. What is the World Bank's "Doing Business" Report?. Reserve Bank of Fiji. 3pp. accessed, 25 January 2018, https://www.rbf.gov.fj/getattachment/e2f7ea5a-8a4a-401b-915d-f7852497dcd3/What-is-the-World-Bank-s-Doing-Business-Report

Rodda, P. (comp.) 1968-2018. Bibliography of the geology of Fiji. Volume 1-13.Mineral Resources Department, Suva.

Rodda, P. 1981. The phosphate deposits and geology of Tuvutha. Government of Fiji, Ministry of Lands and Mineral Resources, Mineral Resources Dept. [Suva] 43p

Rodda, P. 1994. Geology of Fiji, IN: Stevension, A.J., Herzer, R.H., and Balance, P.F.(eds) Geology and Submarine Resources of the Tonga-Lau-Fiji Region. SOPAC Technical Bulletin 8:131-151

Rodda, P.2011. The Princess Road Quarry, Naitasiri. Fiji Mineral Resources Department Note BP1/212. 3 pp, 5 figs. (Unpublished)

Simoes, A., The Observatory of Economic Complexity, Where does Fiji import Salt from?, Accessed 11 November 2017, https://atlas.media.mit.edu/en/visualize/tree_map/hs92/import/fji/show/2501/2016/>

Simon Fraser University, Museum of Archaeology and Ethnology 1992, Fijian Pottery at Nakabuta Village, accessed 10 February 2018, https://www.sfu.ca/archaeology/museum/exhibits/virtual-exhibits/fijian-pottery-at-nakabuta-village.html

Shi L.,2016.,The Mineral Industry of Fiji IN The Minerals Yearbook 2013: Area Reports: International, v.3 U.S.Geological Survey. 4 pp. accessed, 3 March 2018, https://minerals.usgs.gov/minerals/pubs/country/2013/myb3-2013-fj.pdf

Smith, R. & Raicebe, T. (comps.) 1984, Bathymetric map of Fiji, Fiji Mineral Resources Department

Smith, R. et al. 2017. Baseline Assessment of Development Minerals in Fiji: Inception Report. SPC. Suva. Unpublished Report

Smith, R. et al. 2018. Baseline Assessment of Development Minerals in Fiji: Field Report. SPC. Suva. Unpublished Report

Stirling, M.W., Horspool, N.A, & Gerstenberger, M.C. 2014. Seismic Z-Factor Map for Fiji, GNS Science Consultancy Report 2014/261. 14p

Stuart Ward. 1997. Coral sand dredging in Fiji: The impacts and the future of this industry IN:

Islands in the Pacific Century. 8th Pacific Science Inter-Congress 13-19 July 1997, pp44-54, Suva : Fiji, USP.

Terry, J.P., Oilier, C.D., and Pain, C.F. 2002. Geomorphological Evolution of the Navua River, Fiji. Physical Geography, Vol. 23, 5, pp. 418–426

Tonkin & Taylor International Ltd. 2017. Geotechnical Investigation and Preliminary Design of Rokobili Development. Auckland, Tonkin and Taylor Ltd.

United Nations n.d., Sustainable Development Goals, accessed 8 May 2018, http://www.un.org/sustainabledevelopment/sustainable-development-goals/

United Nations Development Plan. 2014. UNDP Youth Strategy 2014-2017: empowered youth, sustainable future New York, UNDP. 56pp. accessed, 8 May 2018, http://www.undp.org/content/dam/undp/library/Democratic%20Governance/Youth/UNDP_Youth-Strategy-2014-17_Web.pdf

United Nations. 2015. Transforming Our World: The 2030 Agenda For Sustainable Development. 41p. accessed, 8 May 2018, https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

Vatukoula Gold Mines PLC. 2012. Vatukoula Gold Mines Annual Report & Accounts.London. Vatukoula Gold Mines PLC. 88p. Accessed, 21 June 2018, http://www.vgmplc.com/downloads/vgm-annual-report-2012-final-lr.pdf

Watling, D. 2017. Water Authority of Fiji: Water Catchment Management Discussion Document.

White, F.T.M. 1944a. Brick-making with Fiji clays – further investigations. Mines Department, Miscellaneous Report 34.. Suva. Fiji Mineral Resources Department. 3pp

Williams, M. 1969c. Tests of soils and weathered rock as materials for brick manufacture. Fiji Geological Survey Note MW8. 15 pp + 8 figs.

World Bank Group. 2017. Economy Profile of Fiji. Doing Business 2018;. World Bank, Washington, DC. © World Bank. accessed, DATE, https://openknowledge.worldbank.org/handle/10986/28643 License: CC BY 3.0 IGO.

World Bank Group. 2017. Republic of Fiji Systematic Country Diagnostic. World Bank, Washington, DC. © World Bank. accessed, DATE, https://openknowledge.worldbank.org/handle/10986/28541 License: CC BY 3.0 IGO.

Zhang, N., and R. N. Pysklywec (2006), Role of mantle flow at the North Fiji Basin: Insights from anomalous topography, Geochem. Geophys. Geosyst., 7, Q12002, doi:10.1029/2006GC001376.

APPENDIX 1: Questionnaire for Extraction Sites

Baseline Assessment of Development Minerals in Fiji

Questionnaires for Development Mineral Extraction Companies

Please provide details:

Company name: _____

Trading name: _____

Contact Person: _____

Position: _____

Email: _____

Telephone Number: _____

Years of Operation (Please Tick):

<1 ☐

1-5 years ☐

6-10 years ☐

11-20 years ☐

21+ years ☐

Number of Employees

Male: _____

Female: _____

Please indicate your Business Sector (s)

River gravel extraction ☐

Hardrock quarrying ☐

Cartage hire ☐

Export ☐

Batch Plant/Precast ☐

Crushing ☐

If others, please state: _____

1. Who owns the company? What is the percentage of foreign ownership?

   ☐ Local

   ☐ Foreign ☐ >10%

   ☐ >50%

   ☐ >75%

2. Please tick the different products you sell? (including the volume of sold produced annually)

   ☐ Sand _____ ☐ Dust ☐ Other?

   ☐ Gravel _____ ☐ 10-7mm

   ☐ Mixing gravel _____ ☐ 7-4mm

   ☐ Ready Mix _____ ☐ >10mm

3. Cement Purchased in what form?

   ☐ Bulk

   ☐ Bags

4. What is your annual cement consumption?

5. How do you source raw material?

   ☐ Own quarry

   ☐ Have river/stream concession license

   ☐ Sub contract third party supplier

6. What is the location of your current license?

7. If your source is river sand and gravel, if river extraction is banned-how will it affect your operation?

8. What are the methods of extraction used?

   ☐ Blasting

   ☐ Excavator

   ☐ Other

9. Could you please reveal the selling price of your products?

10. Who are your main customers? (specify at least roughly the share of each major customer segment if possible)

	10	25	50	75	100
☐ Government	☐	☐	☐	☐	☐
☐ FRA contractors	☐	☐	☐	☐	☐
☐ Expor	☐	☐	☐	☐	☐
☐ Hardware outlets	☐	☐	☐	☐	☐

11. If you export your products? If yes, please detail (type of products, countries exported to and the quantity per year)

☐ Blocks	Volume: _____	Approx Value: _____
☐ Aggregates	Volume: _____	Approx Value: _____
☐ Concrete products	Volume: _____	Approx Value: _____

12. How are the products transported from quarry to domestic and export customers? Who operates and owns the transport equipment? Who pays for the transport?

☐ Own trucks	☐ <1/ km
☐ Truck contractor	☐ >1-2/km
☐ Both	☐ >2 km

13. Did you hold any other leases of the quarry sites that is no longer active? If yes, provide details (location, type of commodity quarried)

14. How would you describe your relationship with resource owners?

☐ Poor

☐ Fair

☐ Good

15. Can you please describe how you deal with landowners when it comes to land access and aggregate resource usage?

16. What is your opinion on the process of getting a quarry license?

17. Who is responsible for the monitoring of your aggregate extraction sites?

18. Are you aware of any local, regional or national strategic plan or policy document covering extraction of sand or gravel?

19. In your view, what are the major issues related to aggregate extraction?

20. What is your opinion of the future prospects of quarry business in Fiji, e.g. in terms of demand for the products?

21. Have you formed any significant partnerships or other types of cooperation with other companies in the sector?

22. Could you please give an example on the complexity surrounding river gravel extraction?

23. In order to better manage the aggregate licensing and monitoring process in Fiji, there has been suggestions made for one regulatory body to be in-charge of licensing and monitoring process. What is your opinion on this?

24. Are there any other relevant comments you would like us to address?

APPENDIX 2: Questionnaire for Beneficiation Sites

Baseline Assessment of Development Minerals in Fiji

Questionnaires for BENEFICIATION Sites/Companies
Pacific Community (SPC)
Version 2.1 6/7/2017

Introduction

SPC in cooperation with United Nations Development Programme (UNDP) and funded by the European Union (EU) is carrying out a study of the production and use of Development Minerals in Fiji. The purpose of the study is to collect information on how to best support the Development Minerals sector in Fiji to progress. Information collected in this survey is treated confidential by SPC staff. Any published information will not allow the identification of individual companies. In terms of statistics collected, only aggregate figures consisting of a minimum of three companies may be released to the public.

Interviewee information	
Name	
Position	
Company	
Contact details (telephone, e-mail)	

1. What business area are you involved in? (tick all that apply)

Agriculture and forestry	
Quarrying of stone, sand and clay	
Other type of mining and quarrying	
Manufacture of clay building materials	
Manufacture of other porcelain and ceramic products	
Manufacture of cement, lime and plaster	
Manufacture of articles of concrete, cement and plaster	
Cutting, shaping and finishing of stone	
Manufacturing, other, not mentioned above	
Construction of buildings (dwellings, office buildings, farm buildings etc.)	
Civil engineering (roads, utilities, dams, waterways, dredging, industrial facilities etc.)	
Specialised construction activities (demolition, site preparation, electrical, plumbing, building finishing, etc.)	
Wholesale and retail trade	
Accommodation and food service activities (e.g. hotels, restaurants)	
Other, what?	

2. What are the current locations of your business?

3. Please tick the amount of foreign ownership in the company

0 %	Between 0% and 25%	Over 25% and under 50%	50 %	Over 50 % and under 100 %	100 %

4. Please indicate the number of staff working in your business. Please also provide a breakdown by gender and age and record full-time and part-time staff separately.

	Full-time	Part-time
Total staff		
Number of female staff		
Number of staff aged 25 or under		

5. Which of the following products do you produce? Please state the monthly volume produced of each.

	Produced?	Quantity (per month)	Unit (m^3, tonnes, etc.)
Construction aggregate	Yes/No		
Silica sand	Yes/No		
Limestone	Yes/No		
Clinker	Yes/No		
Concrete blocks	Yes/No		
Custom form work blocks	Yes/No		
Ready-mixed cement	Yes/No		
Glass	Yes/No		
Paving stones	Yes/No		
Prefabricated culverts	Yes/No		
Lime for soil conditioning	Yes/No		
Marble	Yes/No		
Sealing chips	Yes/No		

6. Please describe the above mentioned products (block size etc.)

Construction aggregate	
Silica sand	

Limestone	
Clinker	
Concrete blocks	
Custom form work blocks	
Ready-mixed cement	
Glass	
Paving stones	
Prefabricated culverts	
Lime for soil conditioning	
Marble	
Sealing chips	

7. Please indicate the selling price of the products.

	$	Per unit (m^3, tonnes, etc.)
Construction aggregate		
Silica sand		
Limestone		
Clinker		
Concrete blocks		
Custom form work blocks		
Ready-mixed cement		
Glass		
Paving stones		
Prefabricated culverts		
Lime for soil conditioning		
Marble		
Sealing chips		

8. Who are your main customers? Please tick all that apply below and estimate roughly the share of each customer segment.

	Customer sector?	% share of your sales
Agriculture and forestry	Yes/No	
Quarrying of stone, sand and clay	Yes/No	
Other type of mining and quarrying	Yes/No	
Manufacture of clay building materials	Yes/No	
Manufacture of other porcelain and ceramic products	Yes/No	

	Customer sector?	% share of your sales
Manufacture of cement, lime and plaster	Yes/No	
Manufacture of articles of concrete, cement and plaster	Yes/No	
Cutting, shaping and finishing of stone	Yes/No	
Manufacturing, other, not mentioned above	Yes/No	
Construction of buildings (dwellings, office buildings, farm buildings etc.)	Yes/No	
Civil engineering (roads, utilities, dams, waterways, dredging, industrial facilities etc.)	Yes/No	
Specialised construction activities (demolition, site preparation, electrical, plumbing, building finishing, etc.)	Yes/No	
Wholesale and retail trade	Yes/No	
Accommodation and food service activities (e.g. hotels, restaurants)	Yes/No	
Other, what?		

9. Do you export your products? Please indicate the percentage of production exported for each (enter zero for none).

	Percentage of production exported
Construction aggregate	
Silica sand	
Limestone	
Clinker	
Concrete blocks	
Custom form work blocks	
Ready-mixed cement	
Glass	
Paving stones	
Prefabricated culverts	
Lime for soil conditioning	
Marble	
Sealing chips	

10. Which of the following do you use as major inputs for your business? Please state the monthly quantity purchased of each (enter zero for none).

	Quantity (per month)	Unit (m^3, tonnes, etc.)
Construction aggregate		
Silica sand		
Limestone		
Clinker		
Concrete blocks		
Custom form work blocks		
Ready-mixed cement		
Glass		
Paving stones		
Prefabricated culverts		
Lime for soil conditioning		
Marble		
Sealing chips		

11. What are these inputs used for?

12. Where do these inputs come from?

13. How are the inputs delivered to you? (tick all that apply)

By trucks operated by the supplier	
By trucks operated by a third party	
By trucks operated by yourself	
By sea transport operated by the supplier	
By sea transport operated by a third party	
By sea transport operated by yourself	
By other means, what?	

14. For each commodity that you purchase, please indicate the percentage of the total that is imported.

	Percentage of purchases imported
Construction aggregate	
Silica sand	
Limestone	
Clinker	
Concrete blocks	
Custom form work blocks	
Ready-mixed cement	
Glass	
Paving stones	
Prefabricated culverts	
Lime for soil conditioning	
Marble	
Sealing chips	

15. What is your general opinion about the quality of the above inputs produced in Fiji?

Very good quality	
Good quality	
Average quality	
Poor quality	

16. Have you formed any significant partnerships or other types of cooperation with other companies in the sector?

Yes	
No	
If yes, with whom?	

17. In your view, what are the major issues related to processing minerals in Fiji?

18. What is your opinion of the future prospects of your business area in Fiji, e.g. in terms of demand for the products mentioned above?

19. In order to better manage the aggregate licensing and monitoring process in Fiji, there has been suggestions made for one regulatory body to be in charge of licensing and the monitoring process. What is your opinion on this?

20. Are there any other relevant comments you would like us to address?

APPENDIX 3: Socio-Economic Questionnaires

River Extraction

Name: _____

Village: _____

1. What do you use the river for?

2. How often do you use the water from the river in a day/week?

3. How long have your family been using the river for household purposes?

4. Has there been any disease (eg. Skin disease) in the village that is associated with the usage of river water? If yes, please give details

5. Have the local health authorities raised any concern in regards to the use of river water for bathing, etc, in villages/ settlement along the river?

6. How would you rate the importance of the usage of the river for household purposes, and for the village in general?

7. For how long has the _____ company been conducting sand and gravel extraction?

8. Do you know how much aggregates have been taken out in a month or in a year?

9. How much do you receive as royalty payment?

10. How is the royalty payments distributed (number of men and women, age group)?

11. Are you aware of any negative impacts from the extraction operation?

☐ Bad Roads ☐ Dust

☐ Dirty Water ☐ Noise

☐ Erosion ☐ Flooding

☐ Others, Please indicate _____

12. Aggregate extraction has been intensified downstream in the last 10 years. Have you ever been noticing any effect on the water level or the riverbank that may be linked to the extraction activities during this period?

13. To the knowledge, has there been any aggregate assessment of this nature, taking place around here in the past?

14. Have you, at any stage, been receiving some form of assistance from the Department of Environment, iTaukei Land Trust Board (TLTB) or anyone else for the sustainable development of your aggregate resources?

15. Do you understand the legal processes that are involved in obtaining an aggregate extraction license, aggregate development, site monitoring and royal payment?

16. Are you aware of any local, regional, or national strategic plan or policy document covering extraction of sand or gravel?

17. Apart from royalty payment, what other benefits do resources owners receive from the developer in the development of their aggregate resources?

☐ Roads ☐ Cash

☐ Village Housing ☐ Water Pump

☐ Others, Please Indicate _____

18. Is there any evidence of the positive effects of aggregate extraction here in terms of living standard and investment? Please give details.

19. What are your other sources of income?

☐ Subsistence ☐ Fully Employed

☐ Farming ☐ Gratuities from family

☐ Fishing

☐ Other, please indicate _____

20. What would you suggest or would like to see happening in the development of your rock, sand and gravel resources?

21. Do you think resource owners like the people of the village, if given some form of assistance and sound advise, can develop and manage your own aggregate resources in the future?

22. What sort of assistance do you think local communities would need in order for them to develop and manage their own resources?

23. Are there any other relevant comments you would like us to address?

Non-river extraction

Name: _____

Village: _____

1. Are the aggregate resources in each location owned by individual owners or jointly owned by member of a clan (mataqali)?

2. Who owns the aggregate extraction license that allows _____ Quarry to carry out sand and gravel extraction?

3. For how long has the _____ quarry been conducting sand and gravel extraction?

4. Do you know how much money is paid to the landowners for the use of their sand and gravel? If yes provide details.

5. How many people receive money from the quarry (number of men and women, age group)?

6. Do you know what quantity of aggregates have been taken out in a month or in a year?

7. Are you aware of any negative impacts from the extraction operation?

   ☐ Bad Roads ☐ Dust

   ☐ Noise ☐ Erosion

   ☐ Others, Please indicate _____

8. To the knowledge, has there been any aggregate assessment of this nature, taking place around here in the past?

9. Have you, at any stage, been receiving some form of assistance from the government, iTaukei Land Trust Board (TLTB) or anyone else for the sustainable development of your aggregate resources?

10. Do you understand the legal processes that are involved in obtaining an aggregate extraction license, aggregate development, site monitoring and royal payment?

11. Are you aware of any local, regional or national strategic plan or policy covering extraction of sand or gravel?

12. Apart from royalty payment, what other cash or non-cash benefits do resources owners receive from the developer in the development of their aggregate resources?

    ☐ Roads ☐ Cash

    ☐ Village Housing ☐ Water Pump

    ☐ Others, Please Indicate _____

13. Is there any evidence of the positive effects of aggregate extraction here in terms of living standard and investment? Please give details.

14. What are your other sources of income?

☐ Subsistence ☐ Fully Employed

☐ Farming ☐ Gratuities from family

☐ Fishing

☐ Other, please indicate _____

15. What would you suggest or would like to see happening in the development of your rock, sand and gravel resources?

16. Do you think resource owners such as the people of the village, if given some form of assistance and sound advice, can develop and manage your own aggregate resources in the future?

17. What sort of assistance do you think local communities would need in order for them to develop and manage their own resources?

18. Are there any other relevant comments you would like us to address?

APPENDIX 4: Questionnaire for Consumers

Baseline Assessment of Development Minerals in Fiji

Questionnaires for intermediate and final consumers (including wholesale and retail)
Pacific Community (SPC)
Version 2.2 6/7/2017

Introduction

SPC in cooperation with United Nations Development Programme (UNDP) and funded by the European Union (EU) is carrying out a study of the production and use of Development Minerals in Fiji. The purpose of the study is to collect information on how to best support the development of the sector in Fiji. Information collected in this survey is treated confidential by the project/SPC staff. Any published information will not allow the identification of individual companies. In terms of statistics collected, only aggregate figures consisting of a minimum of three companies may be released to the public.

Interviewee information	
Name	
Position	
Company	
Contact details (telephone, e-mail)	

1. What business area are you involved in? (tick all that apply)

Agriculture and forestry	
Quarrying of stone, sand and clay	
Other type of mining and quarrying	
Manufacture of clay building materials	
Manufacture of other porcelain and ceramic products	
Manufacture of cement, lime and plaster	
Manufacture of articles of concrete, cement and plaster	
Cutting, shaping and finishing of stone	
Manufacturing, other, not mentioned above	

Construction of buildings (dwellings, office buildings, farm buildings etc.)	
Civil engineering (roads, utilities, dams, waterways, dredging, industrial facilities etc.)	
Specialised construction activities (demolition, site preparation, electrical, plumbing, building finishing, etc.)	
Wholesale and retail trade	
Accommodation and food service activities (e.g. hotels, restaurants)	
Other, what?	

2. What are the main locations of your business?

3. Please tick the amount of foreign ownership in the company

0 %	1% to 24%	25% to 49%	50 %	51% to 99%	100 %

4. Please indicate the number of staff working in your business. Please also provide a breakdown by gender and age and record full-time and part-time staff separately.

	Full-time	Part-time
Total staff		
Number of female staff		
Number of staff aged 25 or under		

5. Which of the following do you use as major inputs for your business? Please state the monthly volume purchased of each (enter zero for none).

	Quantity (per month)	Unit (m^3, tonnes, etc.)
Construction aggregate		
Silica sand		
Limestone		

	Quantity (per month)	Unit (m^3, tonnes, etc.)
Clinker		
Concrete blocks		
Custom form work blocks		
Ready-mixed cement		
Glass		
Paving stones		
Prefabricated culverts		
Lime for soil conditioning		
Marble		
Sealing chips		

6. What are these inputs used for?

7. For each commodity that you purchase, please indicate what percentage of the total is imported. (enter zero for none)

	Percentage of purchases imported
Construction aggregate	
Silica sand	
Limestone	
Clinker	
Concrete blocks	
Custom form work blocks	
Ready-mixed cement	
Glass	
Paving stones	
Prefabricated culverts	
Lime for soil conditioning	
Marble	
Sealing chips	

8. How are the inputs delivered to you? (tick all that apply)

By trucks operated by the supplier	
By trucks operated by a third party	
By trucks operated by yourself	
By sea transport operated by the supplier	

By sea transport operated by a third party	
By sea transport operated by yourself	
By other means, what?	

9. What is your general opinion about the quality of the above inputs produced in Fiji?

Very good quality	
Good quality	
Average quality	
Poor quality	

10. Have you formed any significant partnerships or other types of cooperation with other companies in the sector?

Yes	
No	
If yes, with whom?	

11. What is your opinion of the future prospects of your business area in Fiji, e.g. in terms of demand for the products mentioned above?

12. What are the biggest challenges and obstacles to your business?

13. Are there any other relevant comments you would like us to address?

APPENDIX 5: Digitised and georeferenced quarry resources identified in 1957

Original publication: *Geological Survey of Fiji. 1957. Report on Quarry Rock Reserves in the Suva Area.*

Figure 134: Digitised and georeferenced hard rock resources identified by the Geological Survey in 1957 (outlined by the red lines), with respect to current infrastructure. (Source: Google Earth, image date 2017)

Figure 135: Digitised and georeferenced Nasinu hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note the substantial infrastructure built over the resource and encroaching on the quarry operation. (Source: Google Earth, image date 2017)

Figure 136: Digitised and georeferenced Kalambo hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note no quarry development has taken place and infrastructure is encroaching on the resource. (Source: Google Earth, image date 2017)

Figure 137: Digitised and georeferenced Naiborebore hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note no quarry development has taken place and residential infrastructure is encroaching on the resource. (Source: Google Earth, image date 2017)

Figure 138: Digitised and georeferenced Colo-i-Suva hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note this hard rock quarry was flooded to form a lake and successfully rehabilitated into an Eco-resort. (Source: Google Earth, image date 2017)

Figure 139: Digitised and georeferenced Savura hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note no quarry has been developed. (Source: Google Earth, image date 2017)

Figure 140: Digitised and georeferenced Wailoku hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note no quarry has been developed and residential infrastructure is encroaching on the access to this resource. (Source: Google Earth, image date 2017)

Figure 141: Digitised and georeferenced Wainakara hard rock resource identified by the Geological Survey in 1957 (outlined by the red line), with respect to current infrastructure. Note no quarry development has taken place, and the report stated in 1957 "the large mass of basic igneous material forming the outcrops along the Wainakara creek should, by rights, have been developed as a quarry long ago instead of Nasinu. (Source: Google Earth, image date 2016)

development.minerals@undp.org

@DevelopmentMin

facebook.com/developmentminerals/

www.developmentminerals.org