Thinking Infrastructure

MIDPREP/AAMID Workshop, Cape Town

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Tracy Cheetham

8 March 2016

Overview of presentation

- Overview of the South African site
- Summary of existing MeerKAT infrastructure delivered
- SKA1_MID baseline infrastructure & power design (PDR) & challenges
- MFAA demonstrator requirements
- Infrastructure, power and other considerations to meet these requirements
- Looking ahead to SKA2

South African Site & Protection


Government Gazette
Staatskoerant

REPUBLIC OF SOUTH AFRICA
REPUBLIEK VAN SUID-AFRIKA

Vol. 516 Cape Town, Kaapstad, 17 June Junie 2008 No. 31157

THE PRESIDENCY

No. 666 17 June 2008

It is hereby notified that the President has assented to the following Act, which is hereby published for general information:—

No. 21 of 2007: Astronomy Geographic Advantage Act, 2007.

MOPRESIDENTE

No. 666 17 June 2008

Go itsisiwi fano gore MoPresidente o saemnwe Molao o o latelang o o phasalediwang kitso ya botlhe fano:—

21 2007: Molao wa Mafelo a a ...metseng Bolepanaledi wa 2007.

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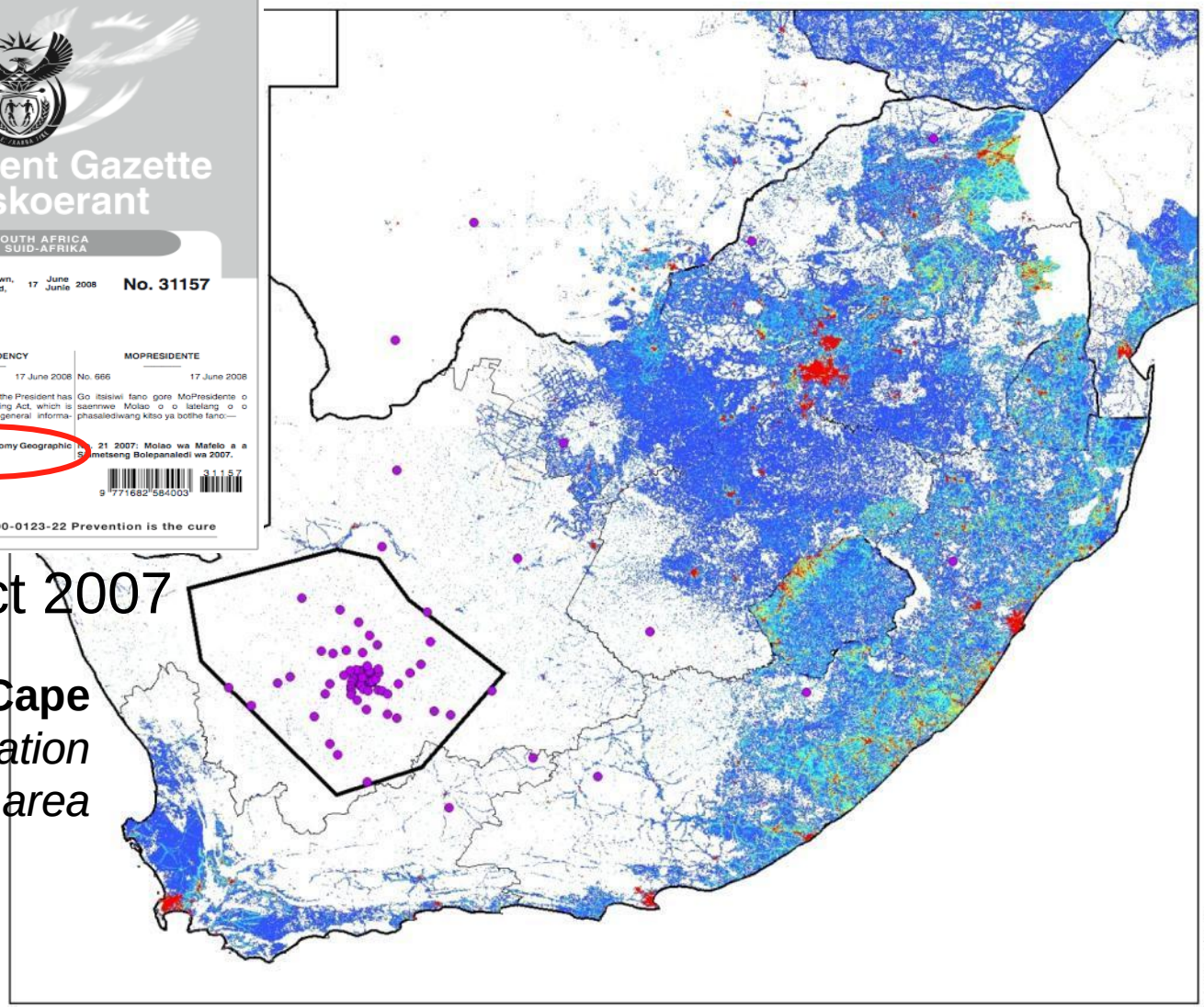
AIDS HELPLINE: 0800-0123-22 Prevention is the cure

AGA Act 2007

Northern Cape

4% population

40% land area



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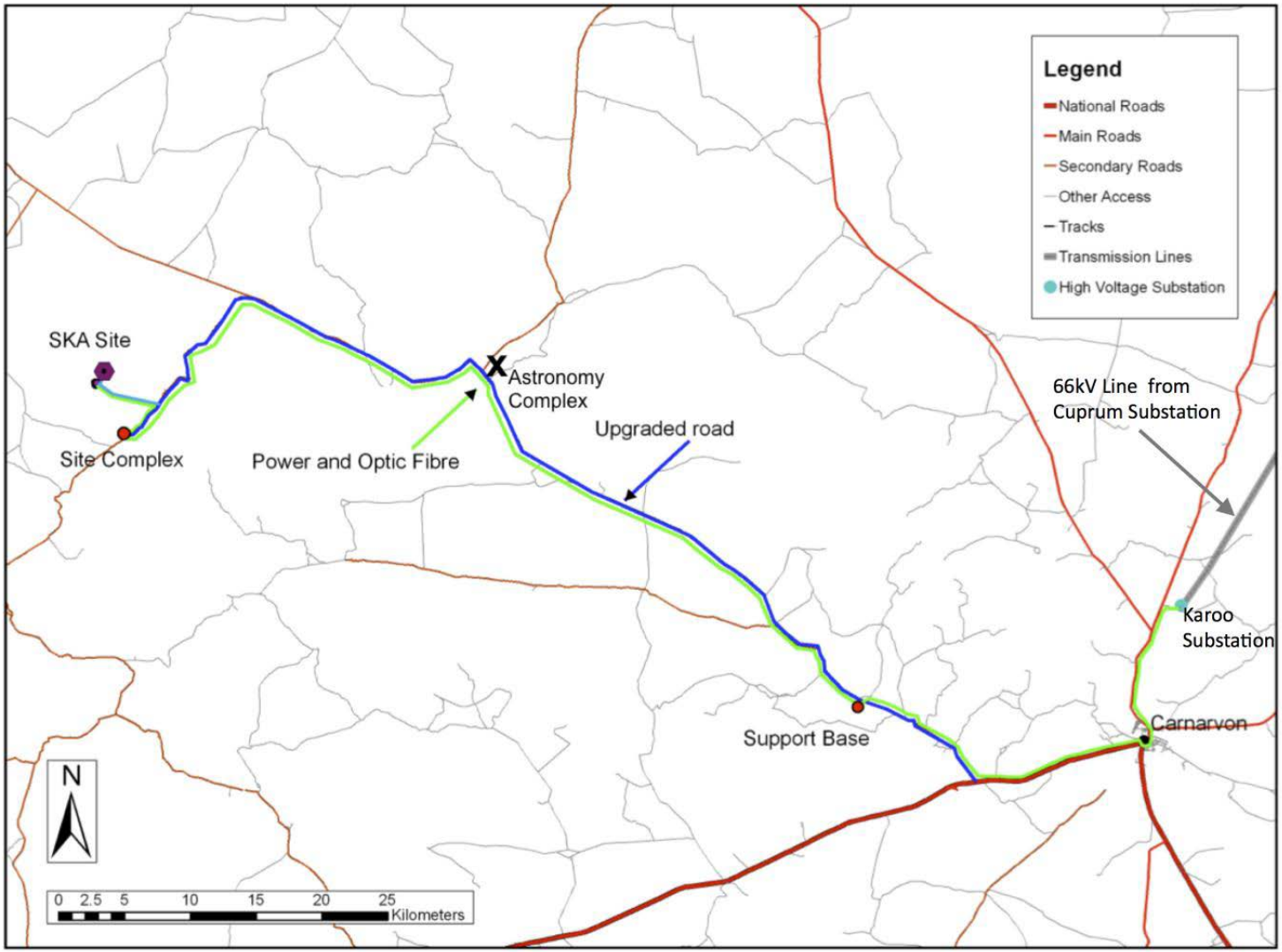
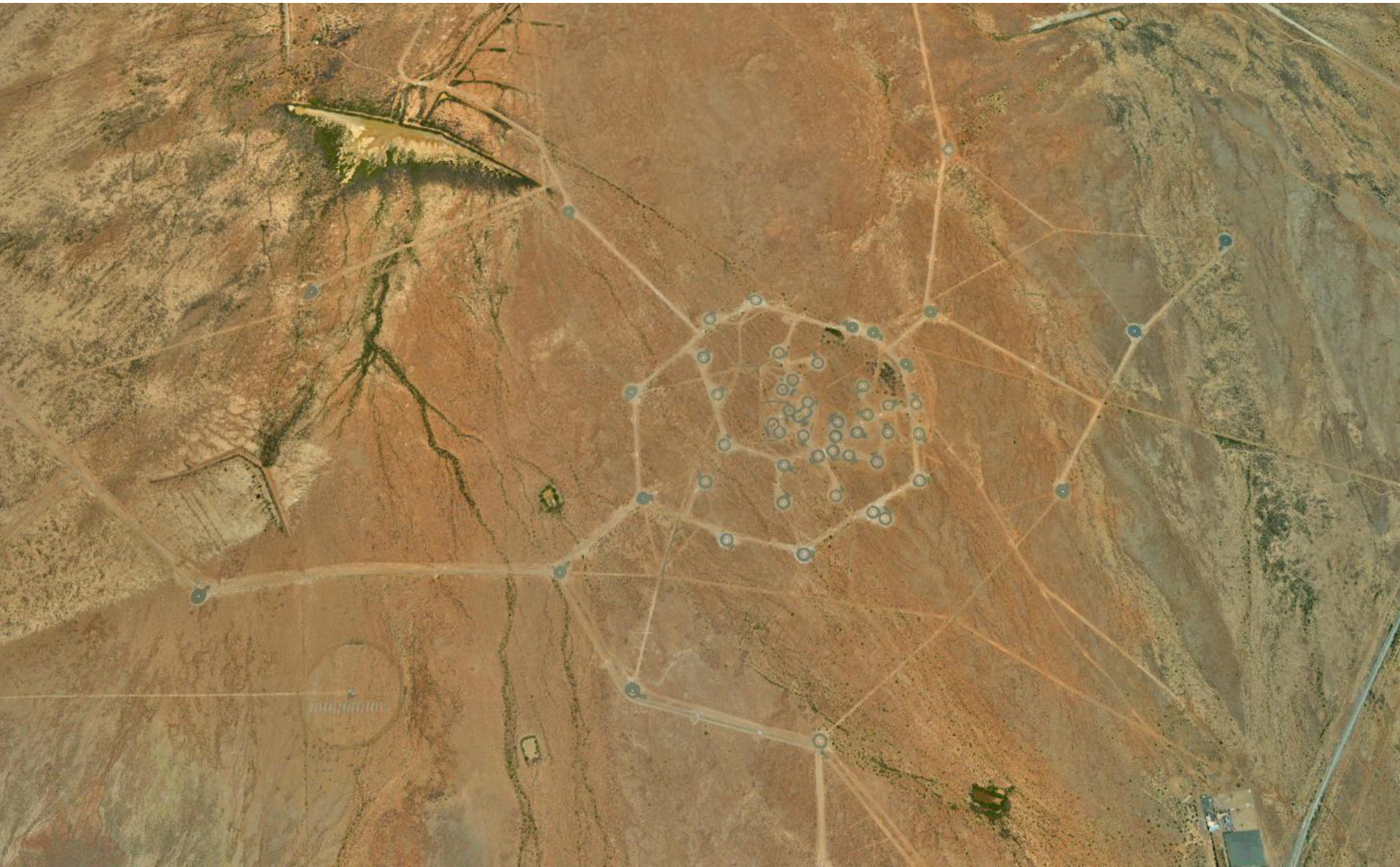
SKA Locality Plan



MeerKAT Infrastructure

Greenfields to Observatory



Long-haul fibre to Cape Town

New 33 kV Powerline with MASS fibre optic cable approaching Core Site

Carnarvon
POP site

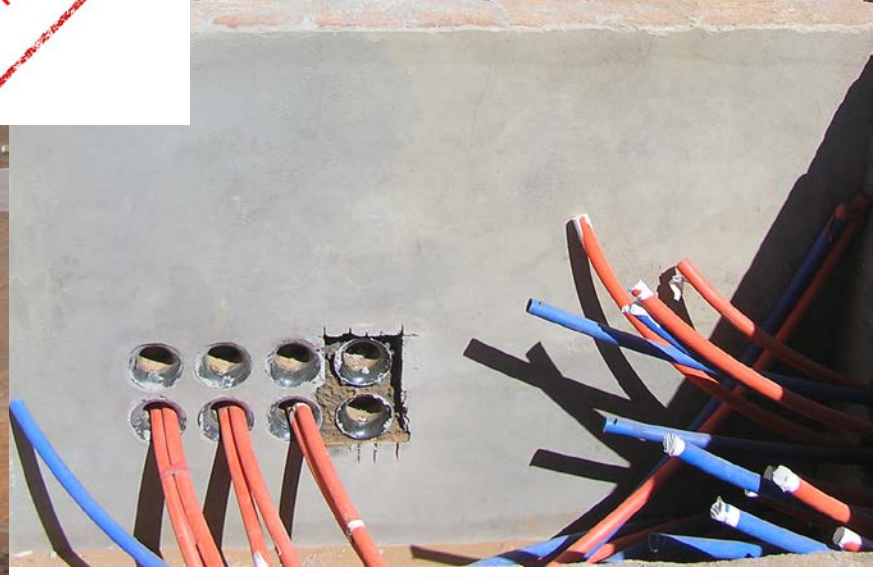
MKAT upgrade to SKA1_MID

Above: New 33kV grid power line to SKA site

Right: Upgrade of Karoo substation to 10MVA

MeerKAT Infrastructure

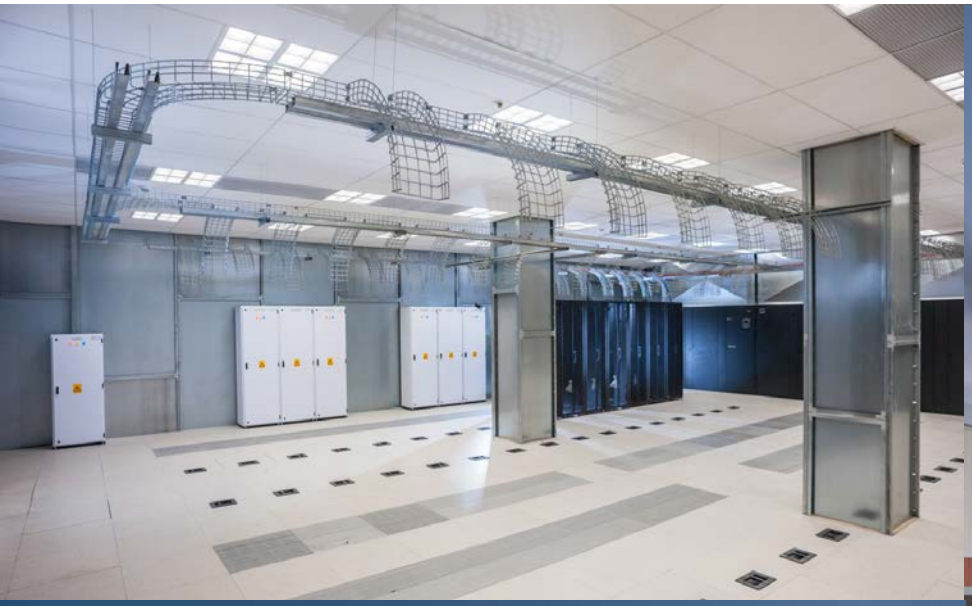
SKA1_MID
Ready



Buildings

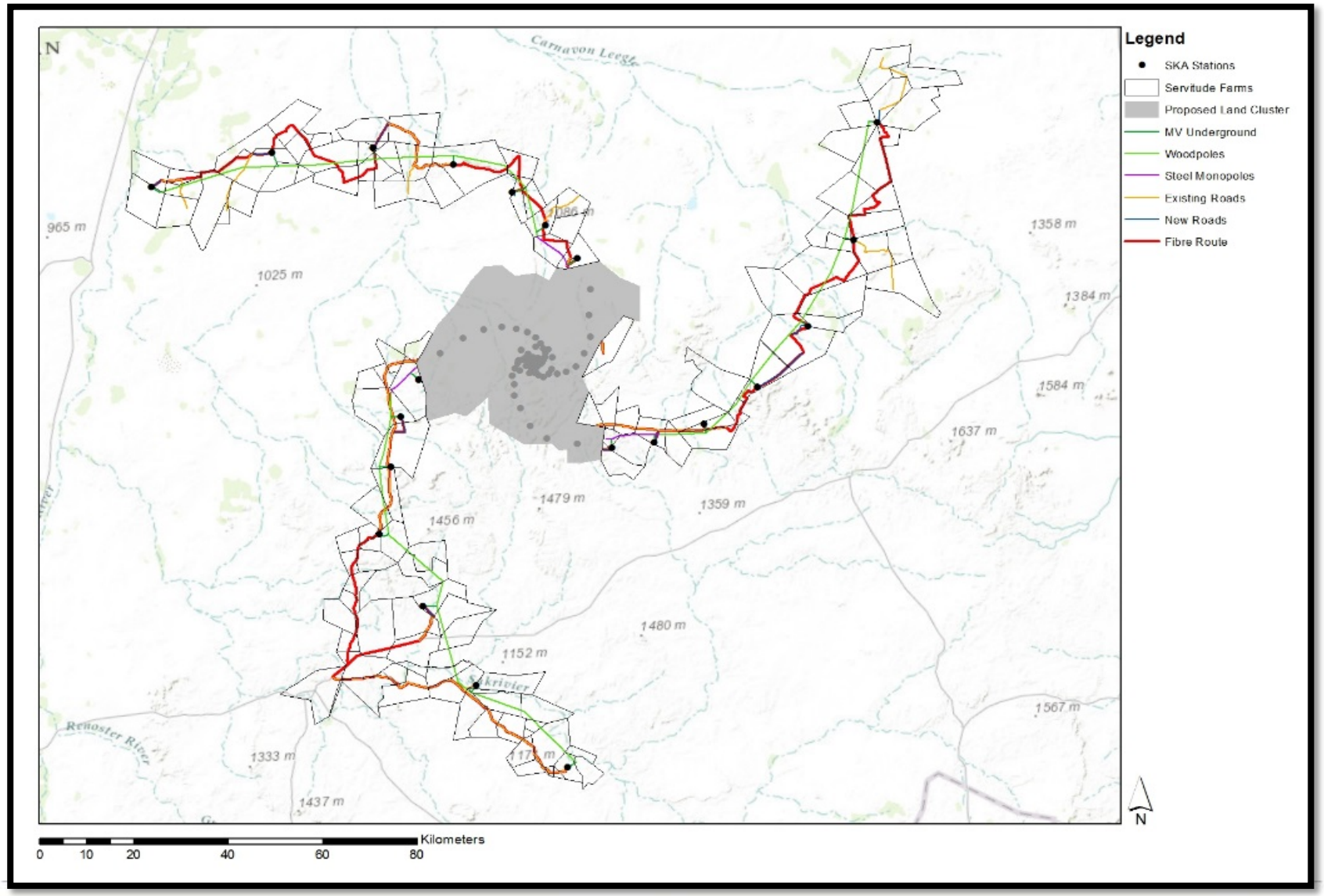
SKA1_MID
Ready

MeerKAT Infrastructure

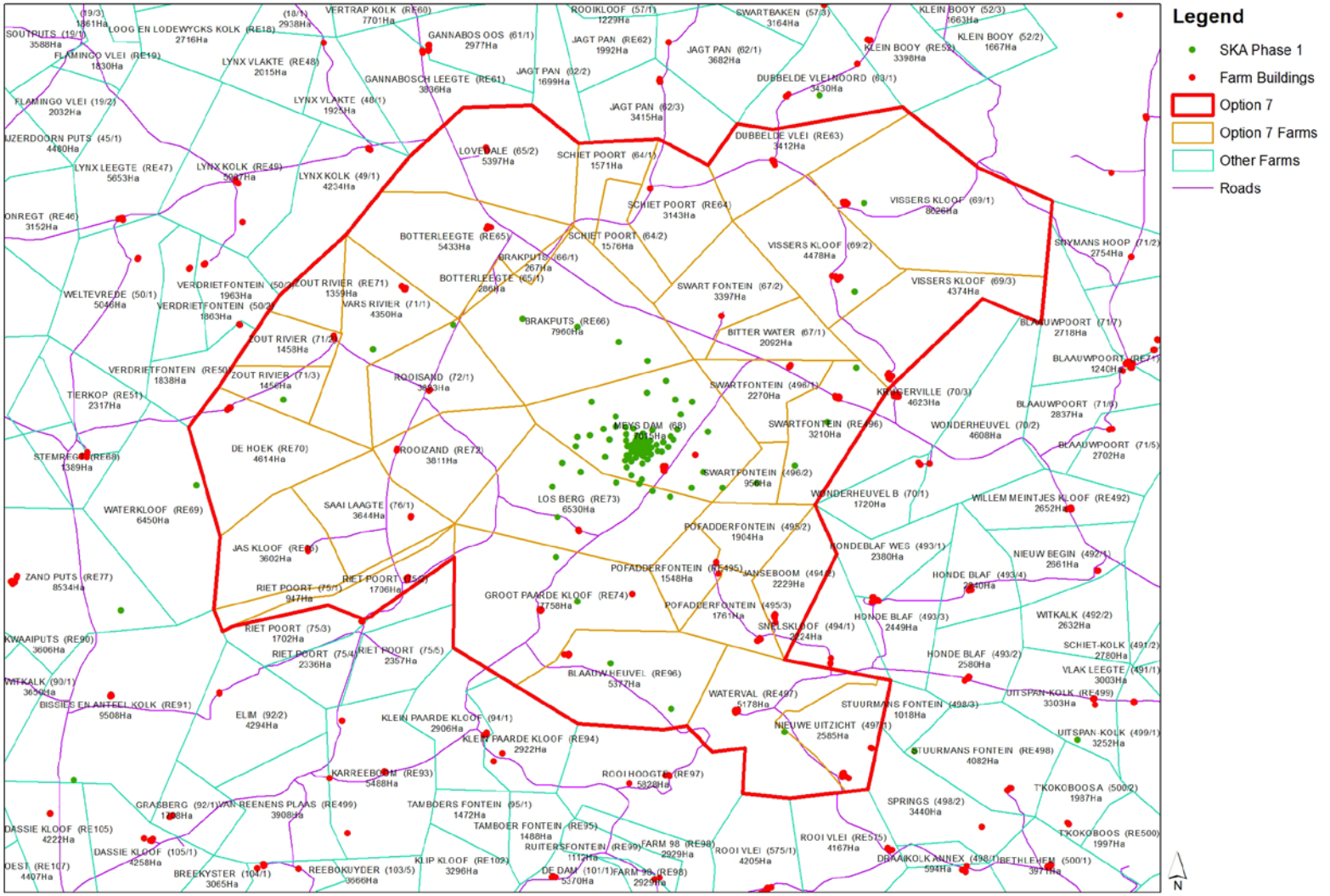


SKA1_MID baseline design (PDR)

SKA1_MID Physical Configuration



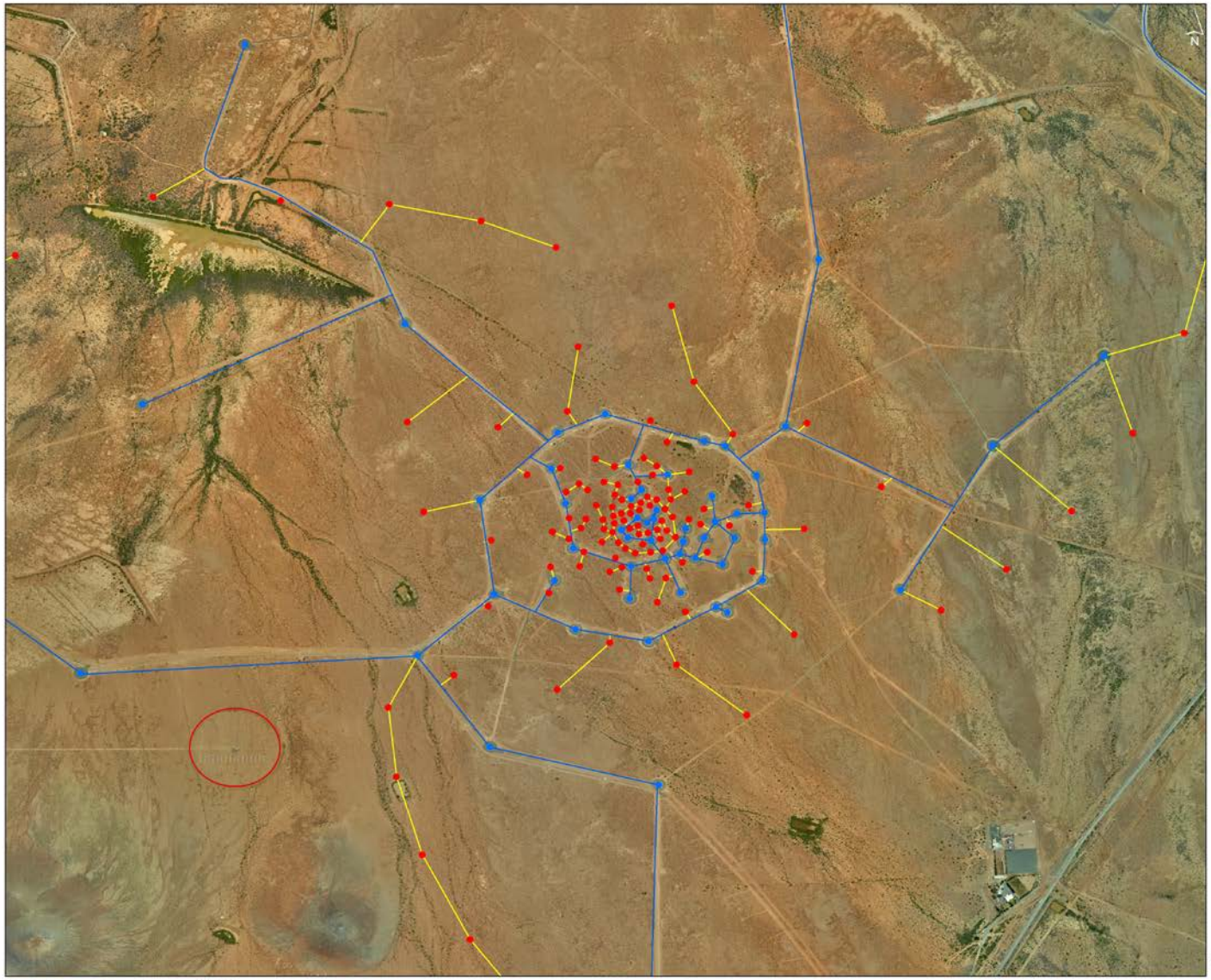
Land in “Core” area to be acquired



SKA1_MID Site Studies

- LIDAR survey completed of 390,000 hectare area
- Geotechnical investigation underway
  - Completion date June 2016
- Geohydrological investigation & flood line analysis underway
  - Completion date June 2016
- Strategic Environmental Assessment underway
  - Heritage, flora, fauna, agriculture, archaeological, agriculture, socio-economic impact, visual impact

MeerKAT / SKA1_MID Core

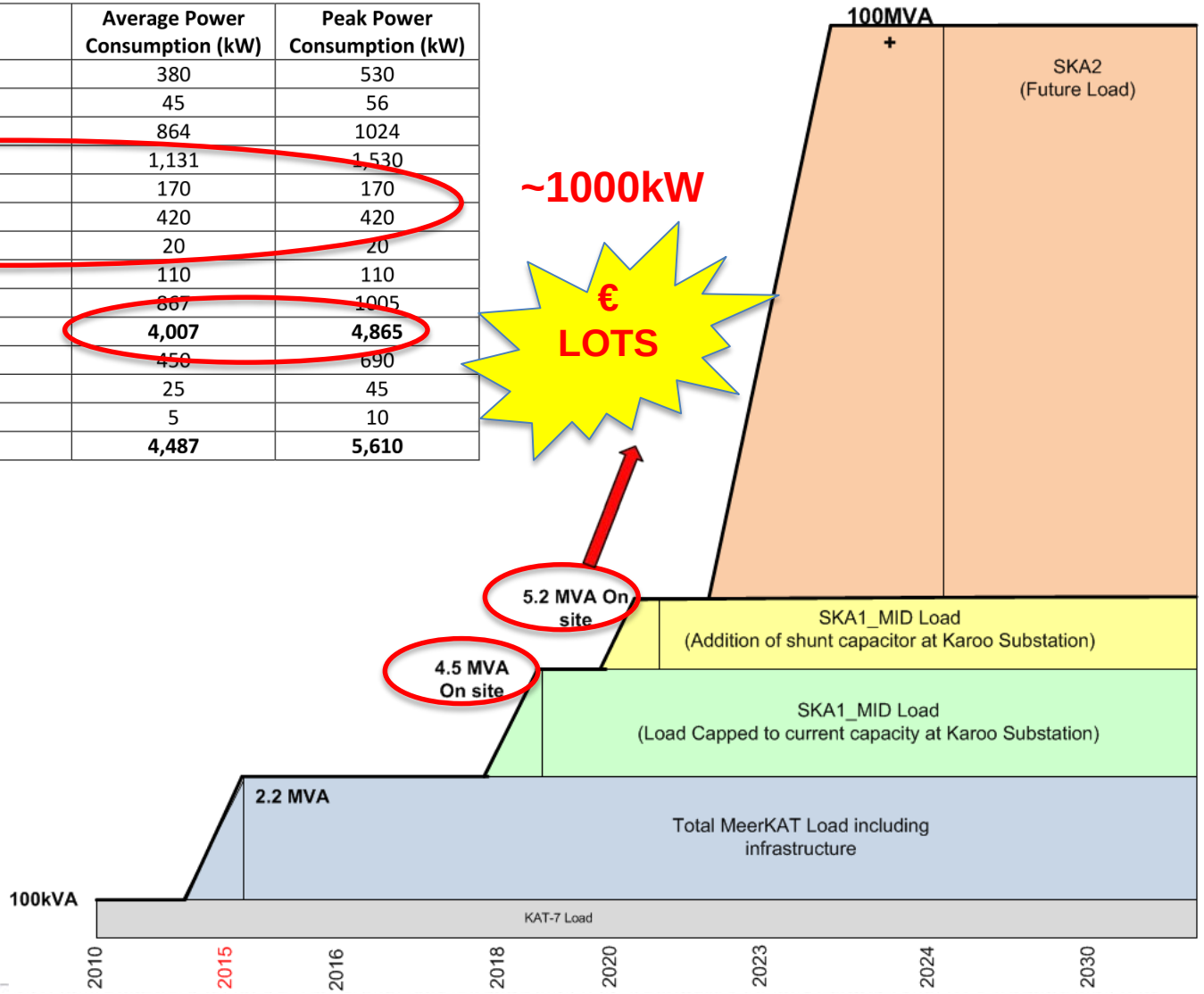


Access

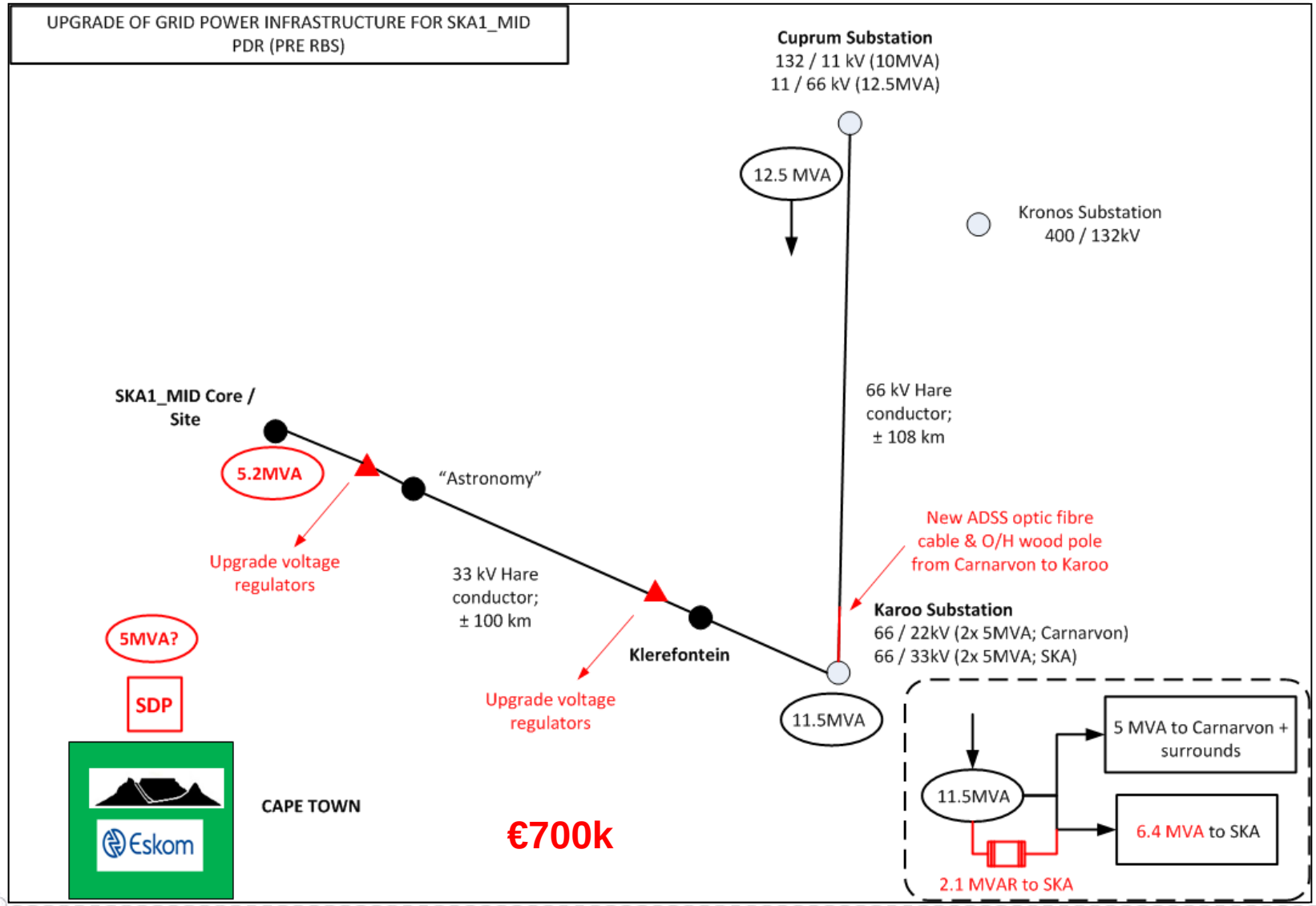
- Approximately 560km of road works required for SKA1_MID
- Of the 560km, 150km will be new roads in the spiral arms; 12km will be new roads in the core and 398km in the spiral arms will be existing farm & district roads which will be rehabilitated to improve access
- Roads will follow independent routing of power line & have separate servitudes

Grid Power – SKA1_MID

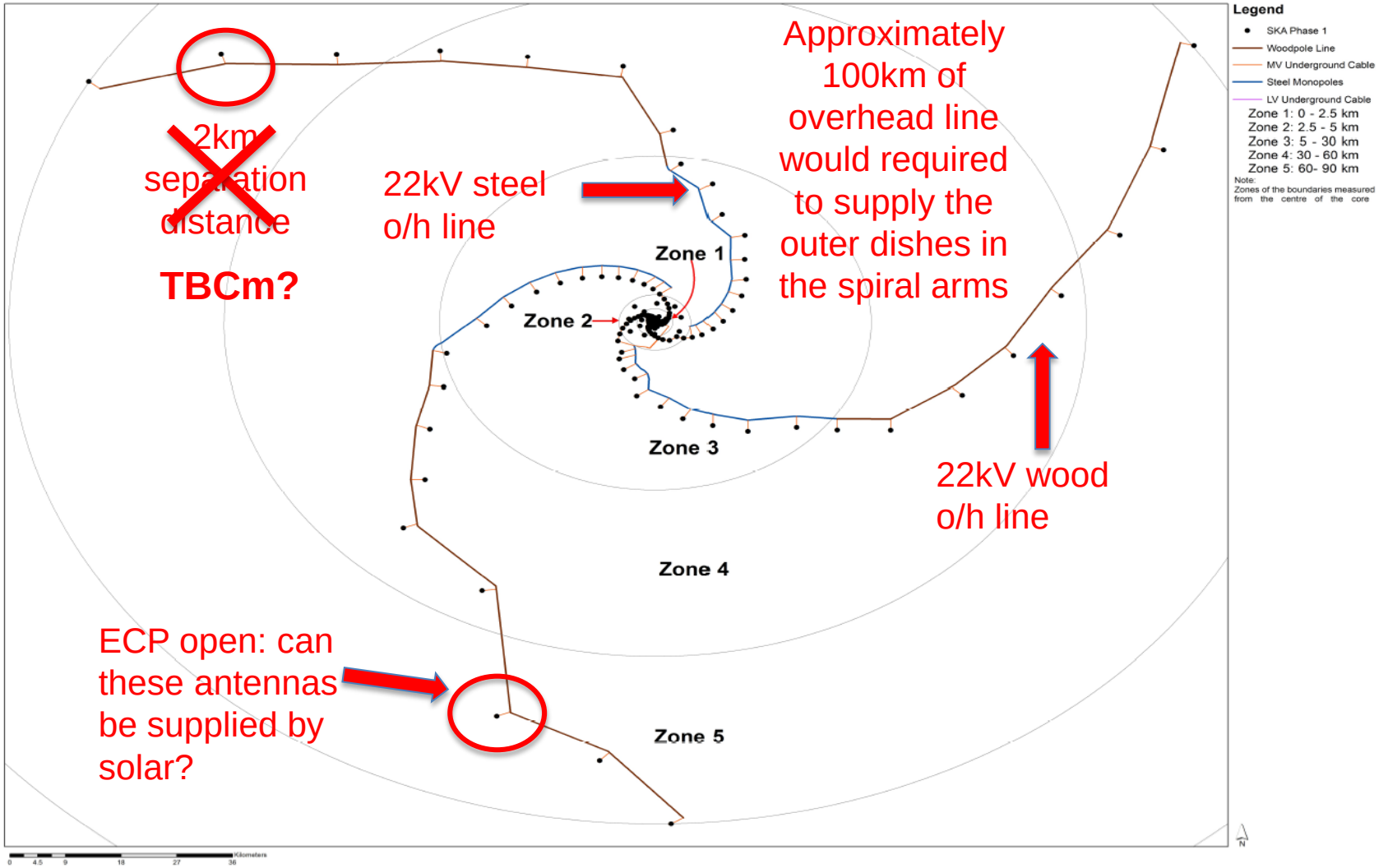
Element	Average Power Consumption (kW)	Peak Power Consumption (kW)
Karoo Site Complex (incl. DRUPS, sheds, etc)	380	530
Existing Equipment (KAT-7, etc).	45	56
MeerKAT Dishes (64)	864	1024
SKA1 Mid Dishes (133)	1,131	1,530
CSP Mid Imaging	170	170
CSP Mid Non-imaging	420	420
TM Mid	20	20
SADT Mid	110	110
Cooling & Site Distribution Losses (INFRA-SA)	867	1005
SKA1 MID SITE TOTAL	**4,007**	**4,865**
33kV Line Losses	450	690
Klerefontein Support Base	25	45
Carnarvon POP Station	5	10
SKA1 MID KAROO TOTAL	**4,487**	**5,610**



Grid Power – current solution



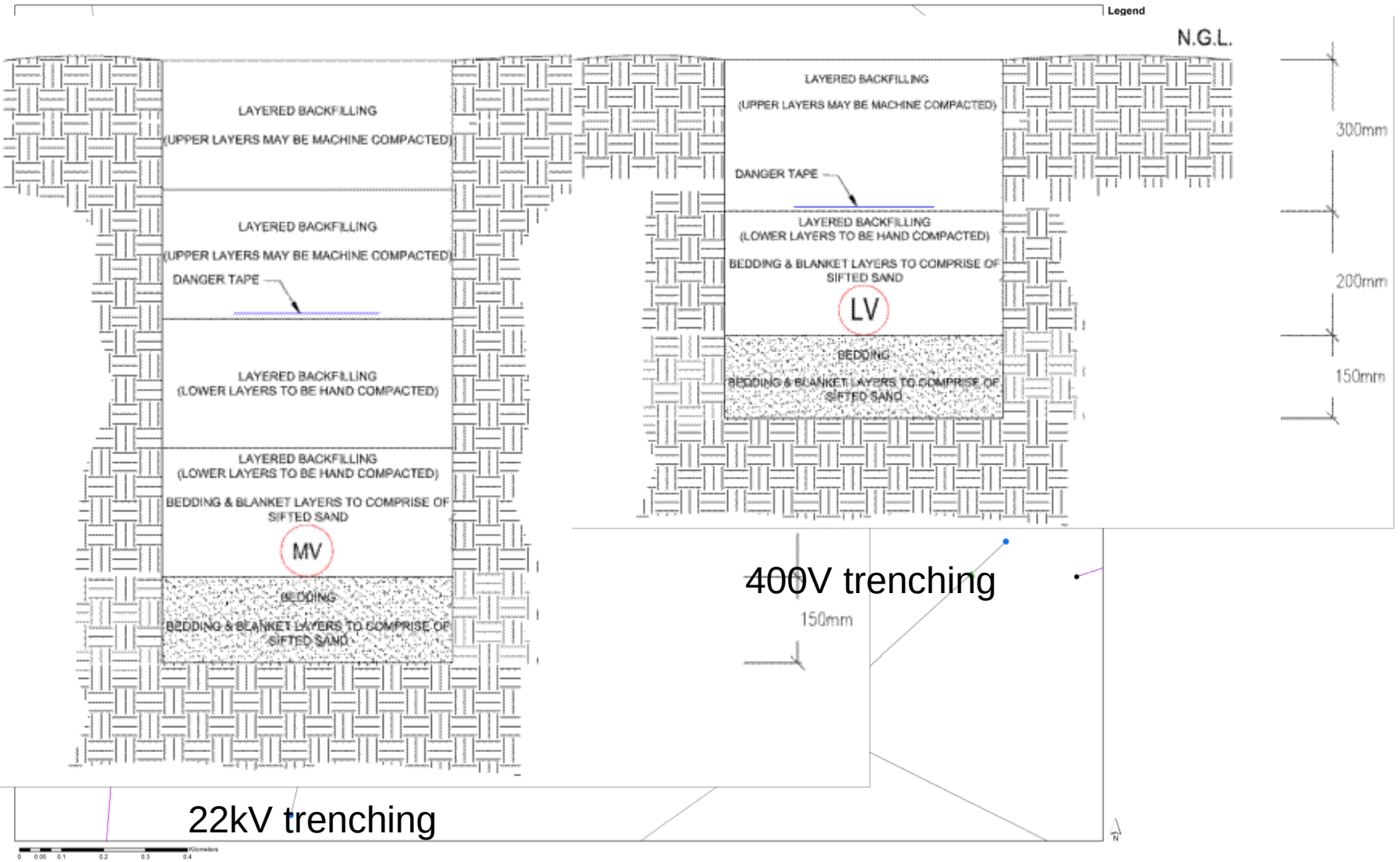
Power to Spiral Arms



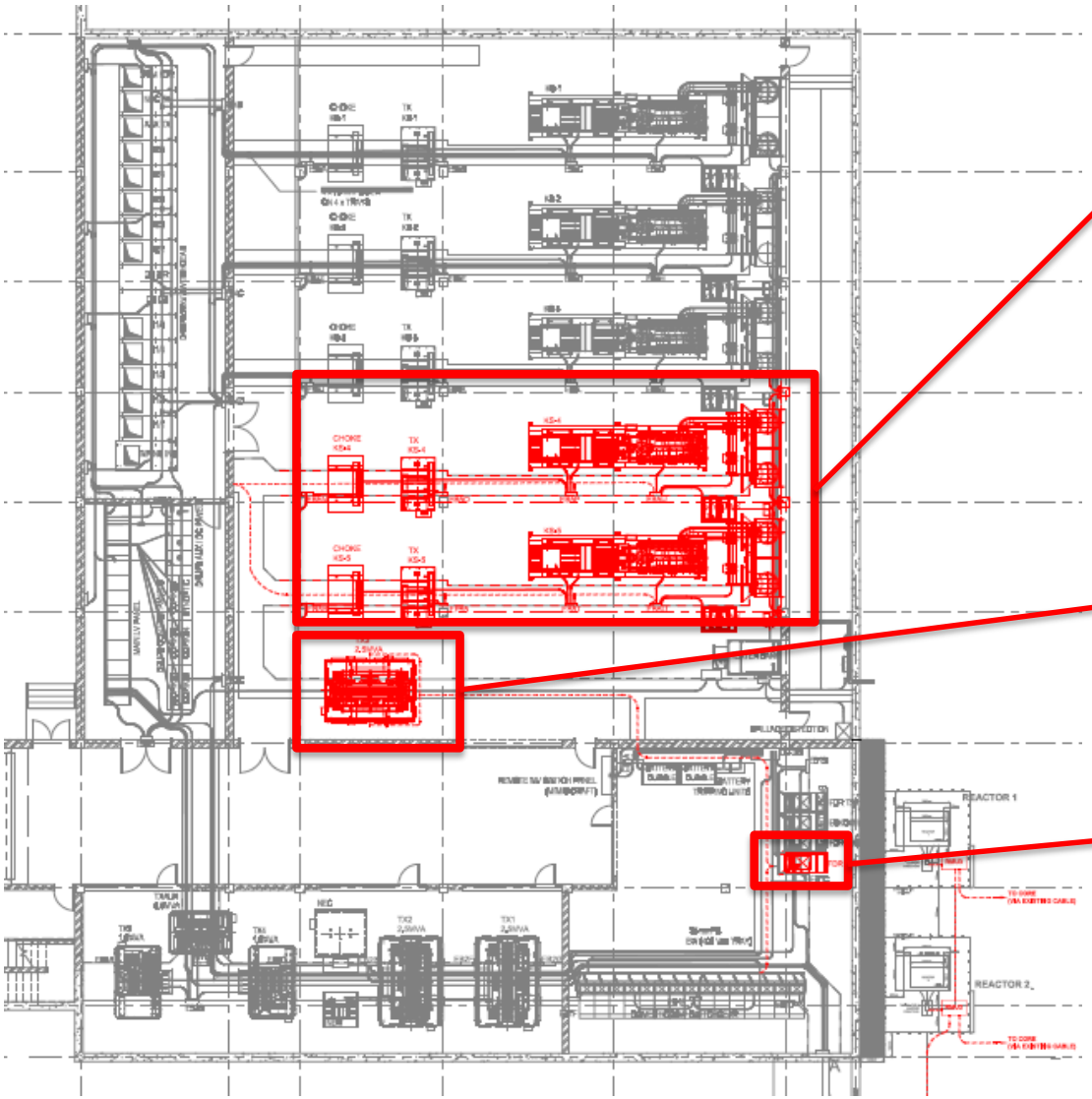
Standalone PV Investigation

- SKAO has raised ECP to undertake feasibility study to determine whether the antennas in the spiral arms can be supplied via standalone photo-voltaic installation
- PV System performance requirements are still being investigated. Once this has been defined, the system will be costed
- PV System will be sized based on Meteo Data for the Karoo Site using an estimated load of 11.5kW (Peak) per dish
- Risks: RFI & separation distances, additional land requirements, storage requirements, maintenance etc.

Power Reticulation in Core



Back-up & UPS Power on Site

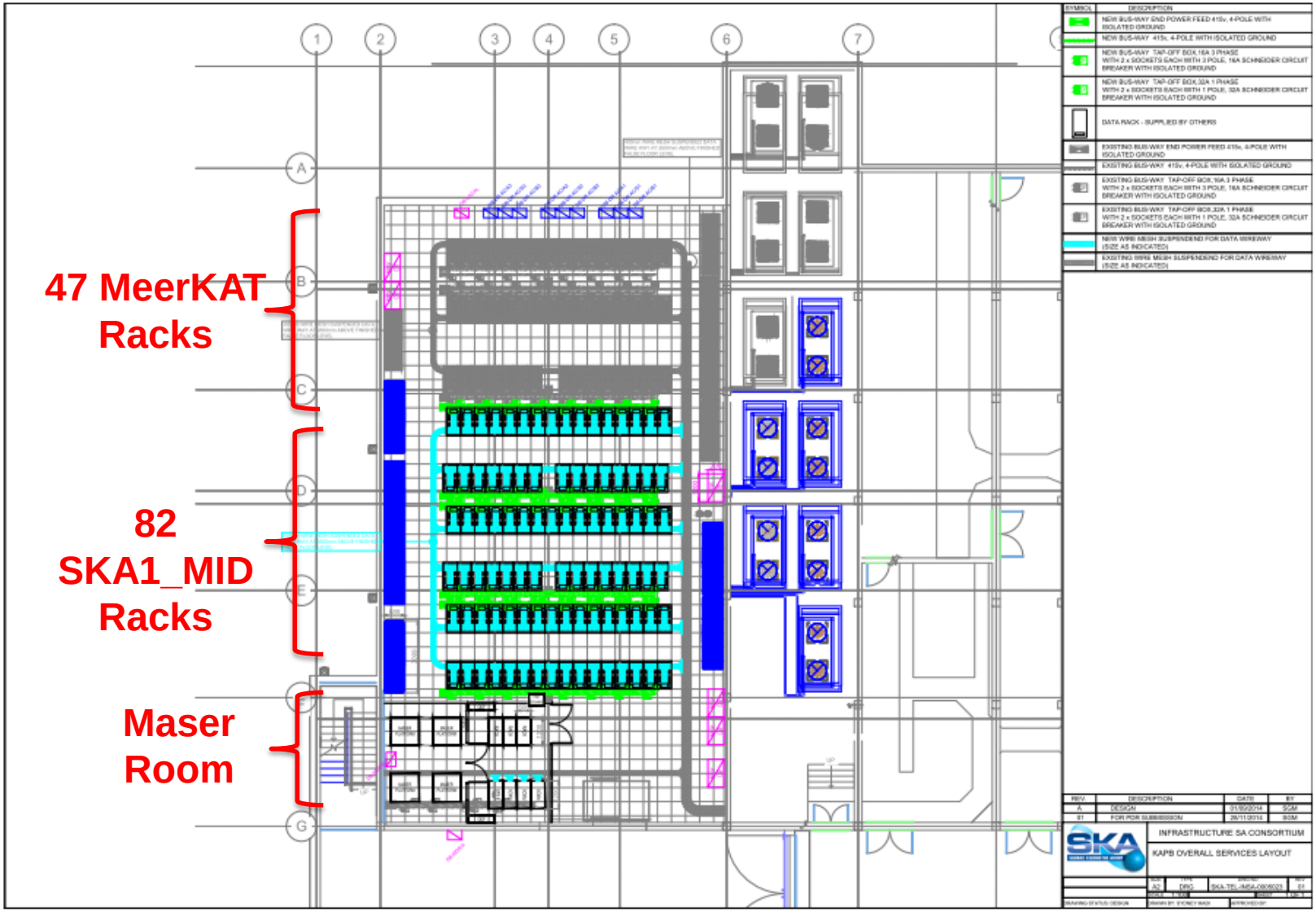


2 x new DRUPS units to existing 3 units = 6.25MVA back-up/UPS power available (No N+1 redundancy)

Add additional 2.5MVA, 33/22kV Transformer

Install additional 33kV breaker for new transformer

Buildings


47 MeerKAT Racks
82 SKA1_MID Racks
Maser Room
INFRASTRUCTURE SA CONSORTIUM
KAPB OVERALL SERVICES LAYOUT

INFRA Construction Deployment

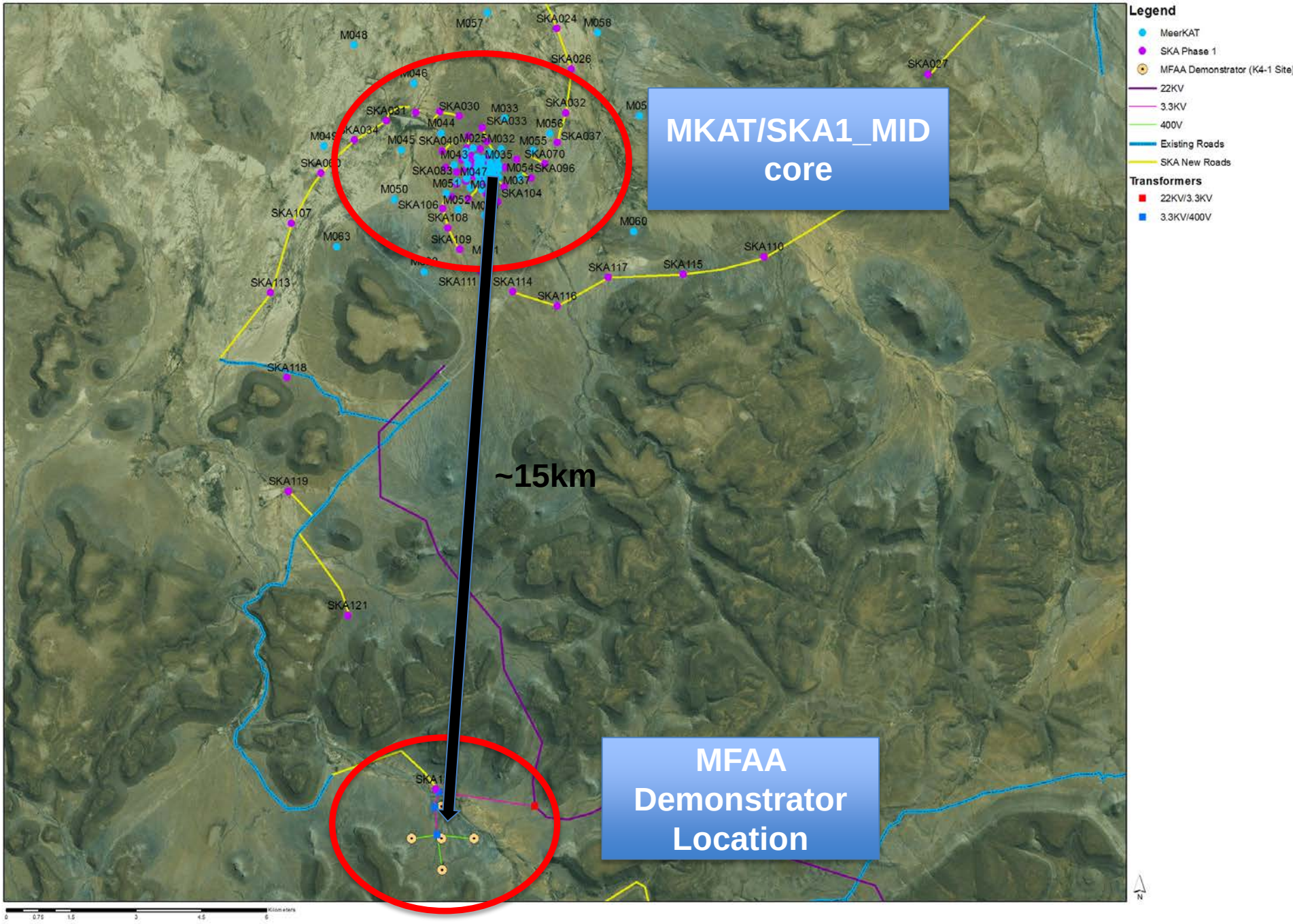
- Propose “big-bang” approach where infrastructure & power deployment in Core and 3 spiral arms concurrently & all activities are co-ordinated from a central point close to the core;
- Estimate 36 month construction period commencing in 2018
- Resources required for management and construction of Infrastructure & Power
- Grouping of construction work packages discussed
- Impact of SKA1_MID deployment on MeerKAT operations (e.g. power outages)

MFAA demonstrator requirements

- Location of MFAA demonstrator (refer to next slides)
- 5 stations with coverage area of 1000m^2
- Power requirement: 200kW for 5 stations
- Configuration / baselines?
- Data requirement: 10Tbps per station?
- Data rack requirements?
- Anticipated deployment: 2020

MFAA demonstrator location

- MeerKAT and SKA1_MID core located on “K3 site”
- Proposal for MFAA demonstrator to be slightly away from MeerKAT/SKA1_MID core yet accessible
- Proposed location: “K4” site – topography provides 360° shielding
- Part of K4 site owned by the NRF
- Area large enough for SKA2 MFAA expansion
- Some SKA1_MID southern spiral arm infrastructure can be re-used


MKAT/SKA1_MID core
~15km
MFAA Demonstrator Location
Legend
MeerKAT
SKA Phase 1
MFAA Demonstrator (K4-1 Site)
22KV
3.3KV
400V
Existing Roads
SKA New Roads
Transformers
22KV/3.3KV
3.3KV/400V
M048
M057
SKA024
M058
SKA026
SKA027
M046
SKA031
SKA030
M033
SKA032
M044
SKA033
M056
M049
SKA034
M045
SKA040
M025
M032
M055
SKA037
M043
M035
SKA070
SKA083
M047
M054
SKA096
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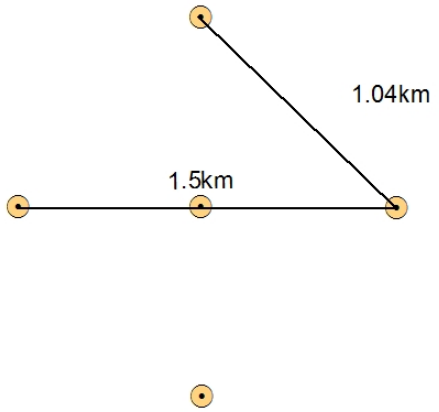
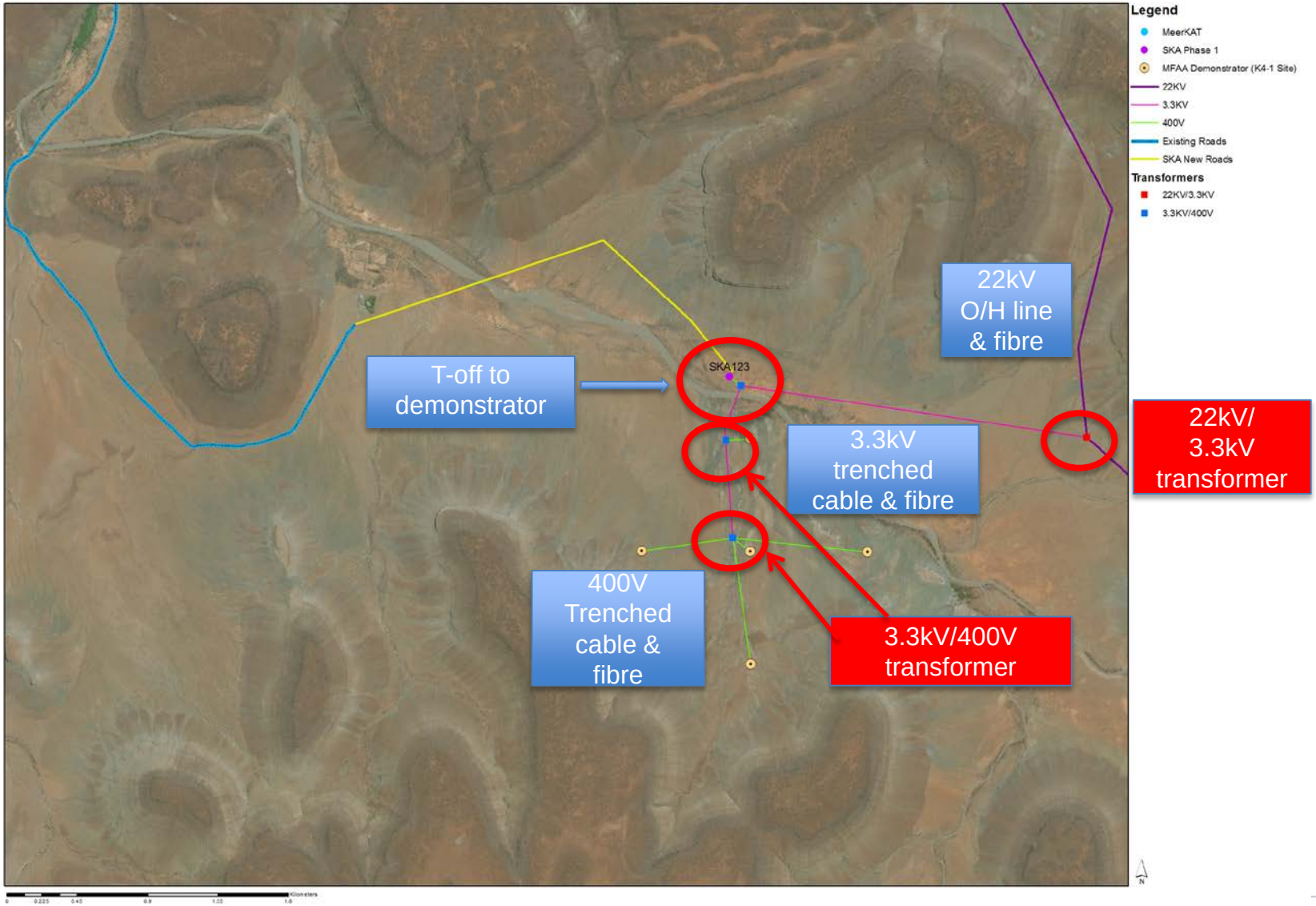
SKA107
SKA108
M060
M063
SKA109
SKA110
SKA117
SKA115
SKA113
SKA111
SKA114
SKA116
SKA118
SKA119
SKA121

MFAA demonstrator configuration

- Configuration assumed by INFRA for now
  - "star configuration"
  - centralized distribution of power and fibre to reduce costs
  - shared RFI-shielded container / bunker to reduce costs



MFAA Power supply options



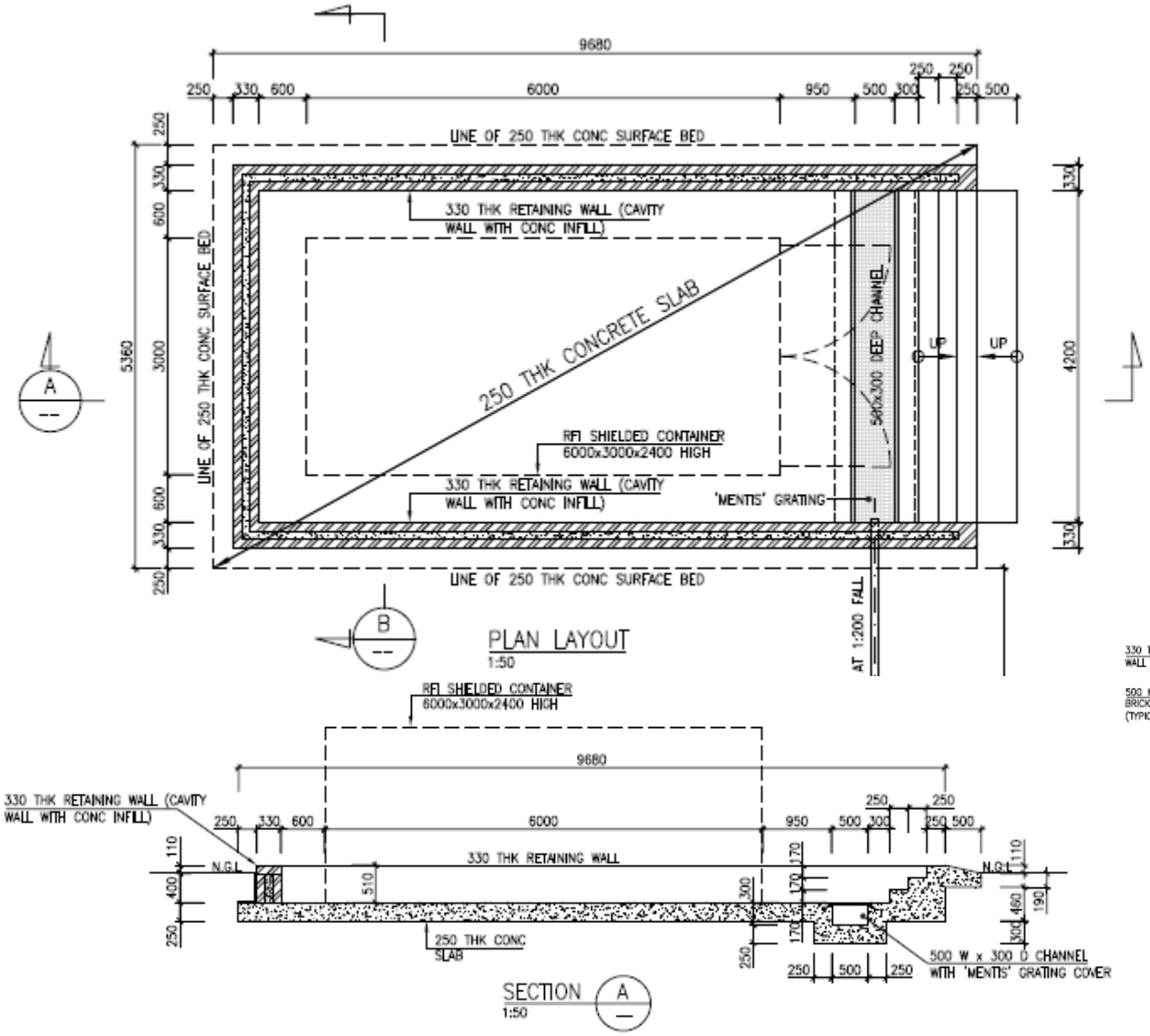
Power challenges

- SKAO will be releasing updated SKA1_MID power budget shortly.
- The existing power budget estimates an average load of 4007kW and a peak load of 4865kW
- The figure above were based on an allowance of 590kW for CSP. The latest ICD from CSP indicates approximately 1000kW of power will be required with an extremely high uncertainty Adding roughly 500kW to the existing power budget would bring the peak load to around 5.3MW (excluding 200kW for MFAA demonstrator)

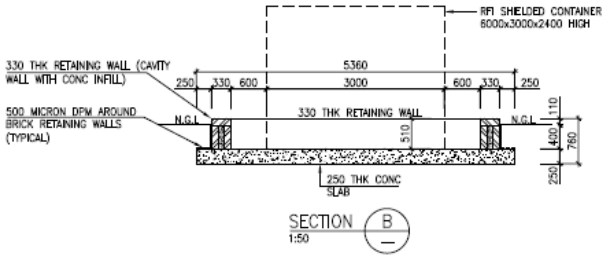
MFAA Power challenges

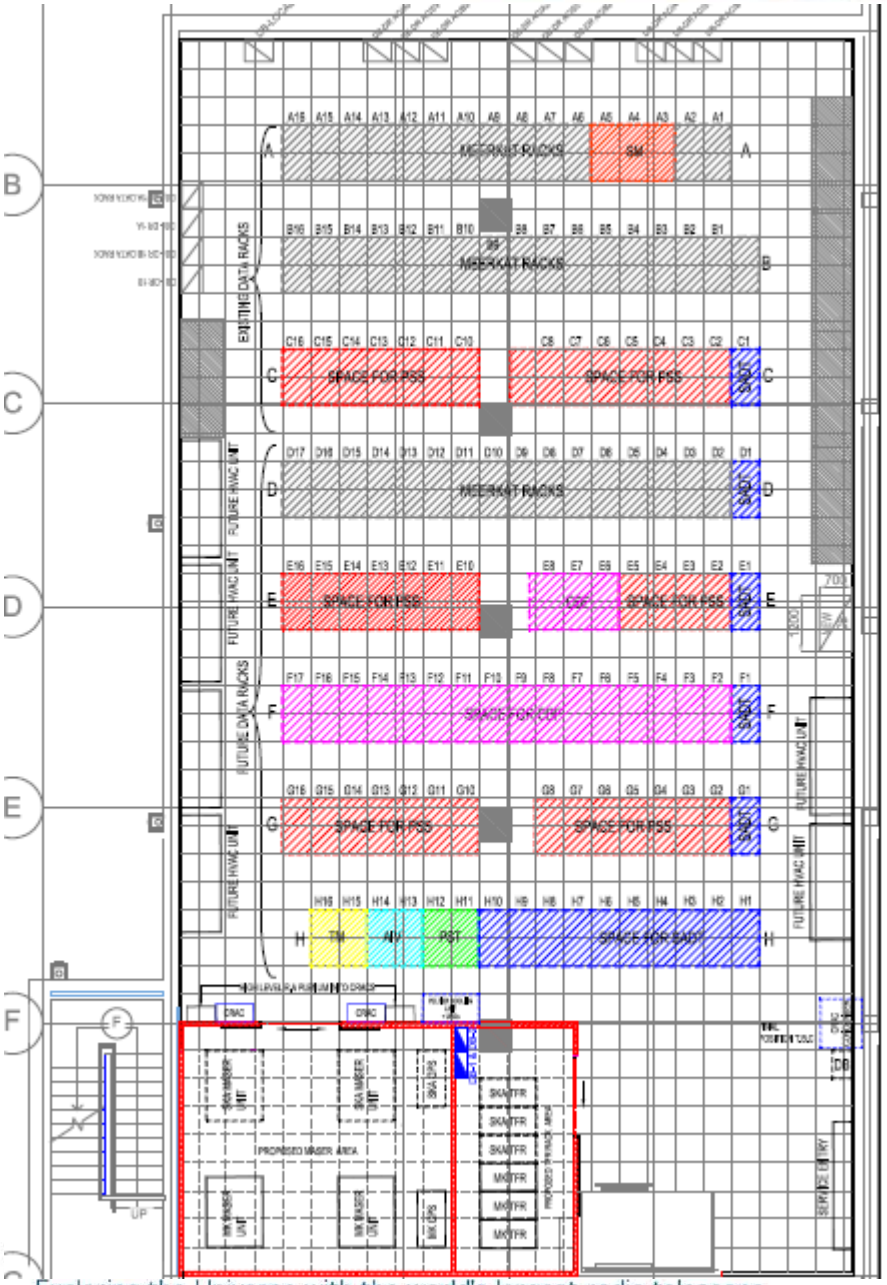
- Power provision for MFAA demonstrator (200kW) is likely to be problematic given current power constraints on site and escalating power budget
- Current thinking is that bulk power supply to site will have to be either upgraded / supplemented
- SKAO has established Power Options Working Group which will look at alternative power supply options (for SKA1 and SKA2) – could include storage facility along 33kV line; solar boost, static power correction, solar cooling etc.
- SKAO responsible for power generation / distribution to site
- Recommendation that the “best guess” power estimate for the demonstrator be submitted to the SKAO Power Engineer for inclusion in the SKA1_MID power budget.

MFAA Centralized processing



6m long, 3m wide, 2,4m high shielded container housing ~6 racks resting on 400mm reinforced concrete slab 400mm below NGL with brick retaining walls & channels





KAPB

SYMBOL	DESCRIPTION	QUANTITY
	MEERKAT EXISTING RACKS	45
	MEERKAT TIME & FREQUENCY REFERENCE (MK TFR)	3
	MEERKAT GPS (MK GPS)	1
	MEERKAT MASER UNIT (MK MASER UNIT)	2
	SKA1 SITE MONITORING	3
	SKA1 TM	2
	SKA1 A|V LM/C	2
	SKA1 TIME & FREQUENCY REFERENCE (TFR)	3
	SKA1 MASER UNIT	2
	SKA1 GPS	1
	SKA1 SADT	15
	SKA1 CSP CBF (640mm WIDE RACKS)	18
	SKA1 CSP PST	2
	SKA1 CSP PSS	40

- KAPB Data Rack area has no space for additional racks

Site Complex

MFAA demonstrator considerations

- Location confirmation of demonstrator & SKA SA Guest Instrument Policy to be concluded
- Number of stations
- Size of stations (diameter)
- Configuration of stations
- Power and data requirements
- Bunker? / container requirements
- Number of racks in central processing area; number of racks at Site Complex
- Ground preparation requirements
- Construction deployment of infrastructure – makes sense to deploy SKA1_MID and MFAA demonstrator infrastructure at the same time
- Who is designing the demonstrator infrastructure and power?
- Environmental Impacts to be assessed through SEA process

Looking ahead to SKA2

- SKA2 configuration TBD
- Servitudes to be secured for stations in spiral arms (outside land to be owned by the NRF)
- Station numbers (250) and sizes (60mØ? each)
- Provision of power and data for SKA2 TBC – MFAA power (30MW?) and data requirements (10Tbps / station?)
- Power and fibre distribution concepts
- Strategic Environmental Assessment for SKA2
- Topography (easy ground preparation) key to positioning of stations

SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Thank You