

SKA1 - Infrastructure Element Australia

SKA Engineering meeting
10th November 2015

Antony Schinckel (Consortium Lead)



- Scope of works – Work Package responsibility
- Organisation of consortium and resources
- Status
- Milestone progress and Status – Stage 2
- Funding
- **Key areas of design:**
 - Location, core - context
 - Power distribution and roads
 - Buildings including remote huts
 - Site monitoring, Communications, Vehicles
 - Water and sanitation
 - Integration of existing infrastructure – MRO Control building, MSF
 - (Integration of existing infrastructure – Pawsey)
 - (Power generation)
- Issues and opportunities
- Summary

Infrastructure Australia Work package responsibility I



- Work package incorporates:
 - Internal roads and access,
 - Power distribution from connect point to all required locations
 - Buildings:
 - Low CPF
 - Remote processor huts
 - Other – office, maintenance facilities, sheds ?
 - Accommodation
 - Some fibre reticulation
 - Water and sanitation
 - Vehicles, Communications and Site monitoring
 - Some power generation options – remote power generation

Includes integration of existing Australian infrastructure:

- MRO facilities
- MRO Support Facility in Geraldton
- Optic-fibre connection between facilities
- (Pawsey Centre in Perth, subject to hosting agreement)
- Consortium passed PDR and completed Stage 1 in March 2015.
- Funded for Stage 2 until CDR in July 2017*

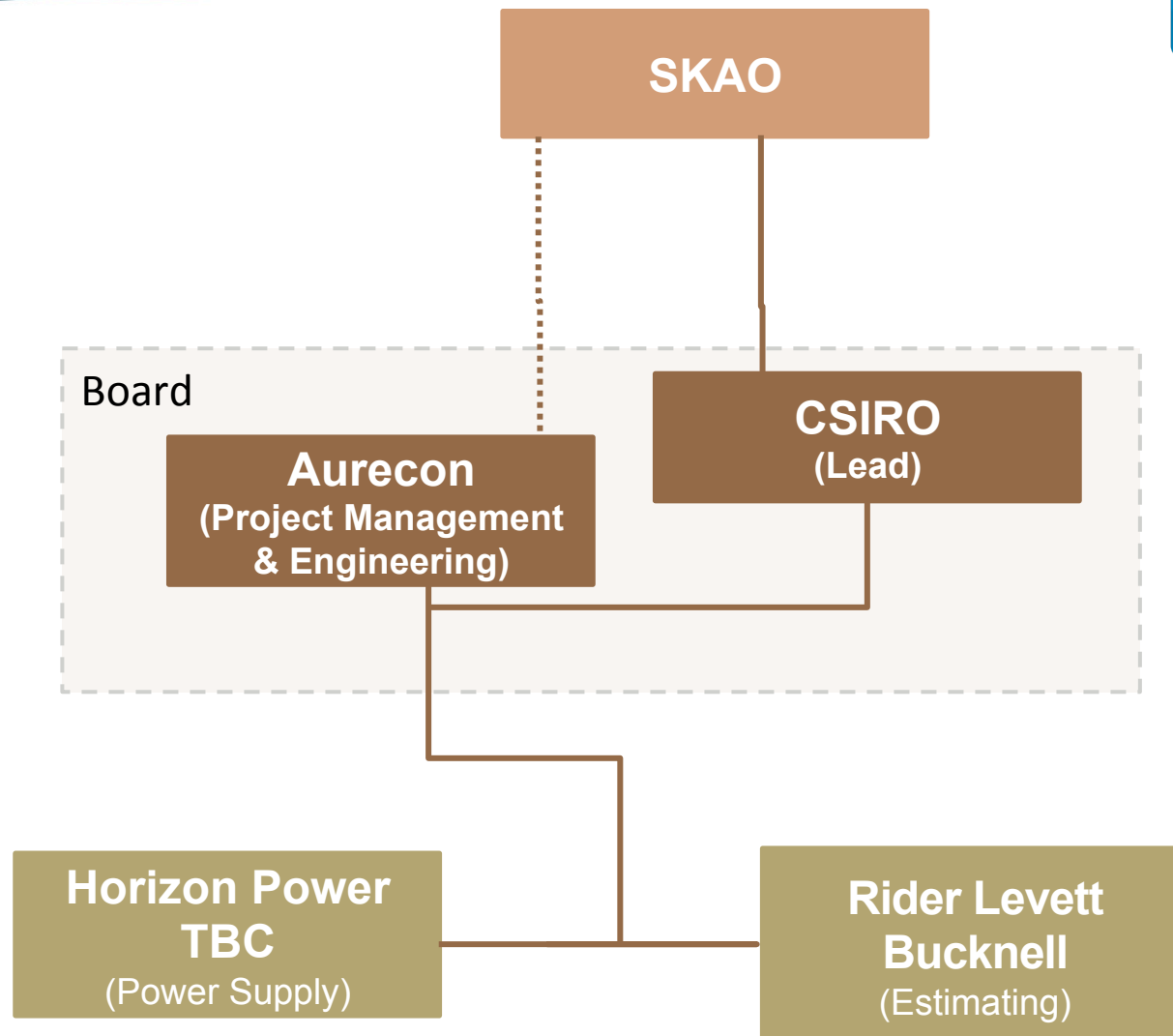
*ECP submitted

NOTE: a highly reactive Consortium (we don't lead any ICD)

- **BUT note ALMA Lessons Learnt !!!!!**

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Consortium members



Resources



Aurecon

Name	Role
Stephen Negus	INFRAUS Board Chairman
Rebecca Wheadon	Project Manager
Shandip Abeywickrema	Project Engineer & Lead Subsystem Engineer - Buildings
James Massoud	Lead Subsystem Engineer - Power
Justin Adamson	Lead Subsystem Engineer - Water & Sanitation, Access
Kjeld Madsen	System Engineer
Angus Leitch	Verification Team Leader
Karen Gardon	Risk Manager
Jo Duncan	Project Controls
Lisa Simmonds	Health & Safety Manager

CSIRO

Name	Role
Antony Schinckel	Consortium Lead
Graham Allen	Subsystem Engineer – Power & Vehicles
Carol Wilson	Subsystem Engineer – RFI Lead
Kate Chow	Science Officer
Ron Beresford	Subsystem Engineer
Raji Chekkala	Configuration Manager

RLB

Name	Role
Mark Bendotti	Cost Estimating Lead
Alistair Aitken	Cost Estimating
Asitha Perera	Cost Estimating

Horizon Power (TBC)

Name	Role
David Edwards	Subsystem Engineer - Power
David Stephens	Subsystem Engineer - Power
Laurie Curro	Verification

Board: Lewis Ball (CASS)
Steve Negus (Aurecon)
SKAO, DIIS Observers

*Not all team members shown

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Complete:

- PDR complete, and associated documentation
- Early Stage 2 required submissions / plans:
 - RMP, PMP, SEMP, Healthy & Safety
- Topographic, hydrological and geotechnical surveys scoped and tender documents produced
 - Topographic survey contractor appointed
- Building options for SKA1 Low CPF

Underway:

- Continuing Input to ICD development
- Study on options for remote vs distributed power
- Update of design work and costings for Low configuration
 - Awaiting new configuration
- System Engineering L2 and 3 requirements

Milestone Progress

Milestone date	Stage 2 Milestones	Nominal Earned value allocation (€)
Apr-15	Kick Off	0
Jul-15	Plan Milestone, SEMP and Survey tender docs approved	288,612
Oct-15	Health & Safety Management Plan, Cost plan update post RBS	144,306
Nov-15	Ground survey/feature survey complete	72,153
Jan-16	Preliminary design and study of alternative overhead power option	72,153
May-16	Draft Detailed Design Milestone 1	288,612
Aug-16	Draft RAM Analysis, Draft Detailed Design Milestone 2, Preliminary power distribution and access networks complete, next draft Cost Report and EMC Control Plans	505,071
Sep-16	Geotechnical and water survey complete	48,102
Nov-16	Detailed Design Milestone 1	360,765
Jan-17	Detailed Design Milestone 2	192,408
Feb-17	EMC Control Plans, Plan Milestone (Construction Management, Operations and Maintenance)	96,204
Apr-17	Detailed Cost Report, Final Risk Report, Detailed Design Specification for CDR, CDR Issue	288,612
Jun-17	CDR Closeout	48,102
Total		€ 2,405,100

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- INAU only funded for Stage 1 of Precon (Apr 2015)
- Joint proposal with SKAO and INSA submitted for Stage 2 through the EU Horizon 2020 program
- Grant for €4.96m was successful
 - INAU will receive €2.4m of the grant once the contract is signed
 - Funding will cover the majority of Stage 2 detailed designs but is not adequate for the full Stage 2 design works
- Australian Govt Department of Industry, Innovation and Science granted INAU \$1.5m AUD to cover some of shortfall and to bridge funding prior to EU funds availability
- EU contract progressing

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SKA1-LOW Location



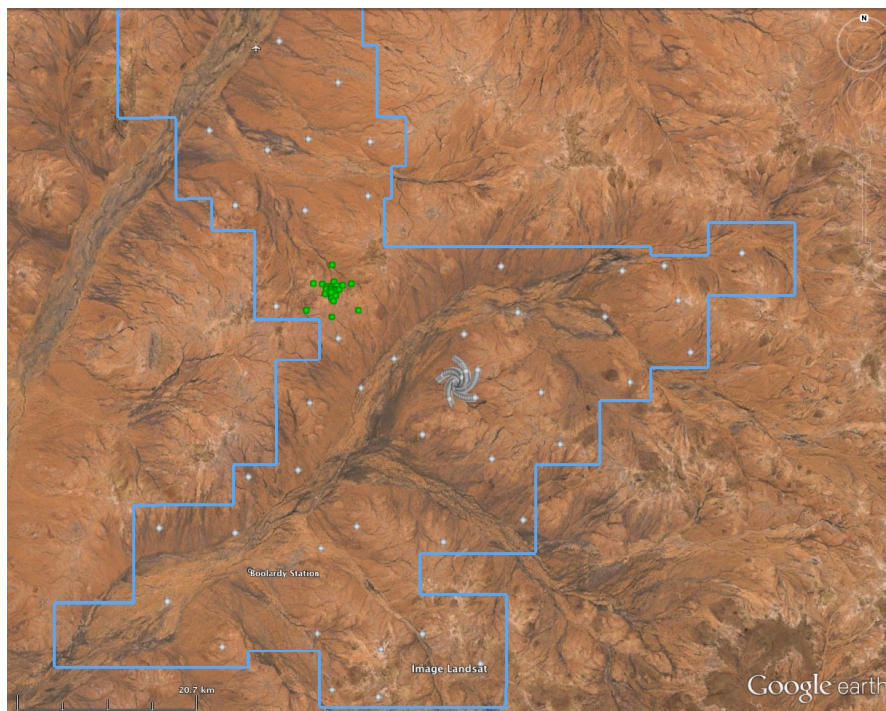
- SKA1-LOW located within Boolardy Station, Murchison, WA (3,500 sq km)
- LOW core location selected, approx. 19.5km between LOW core and ASKAP core



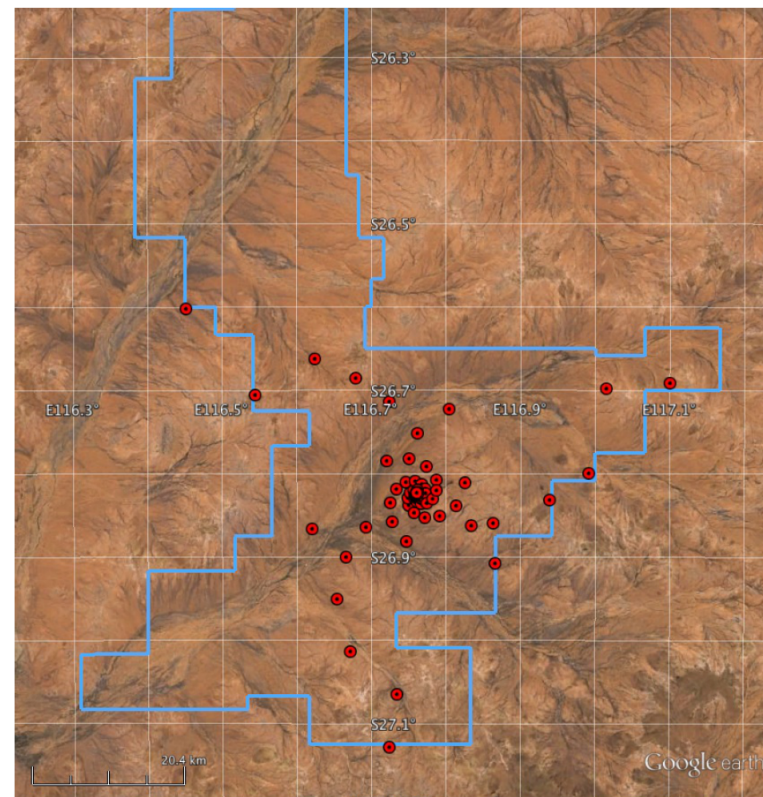
Current SKA1-Survey and SKA1-Low Configurations



INFRA AUS working to updated configuration for PDR



RB45 Configuration
(Architecture Pack)

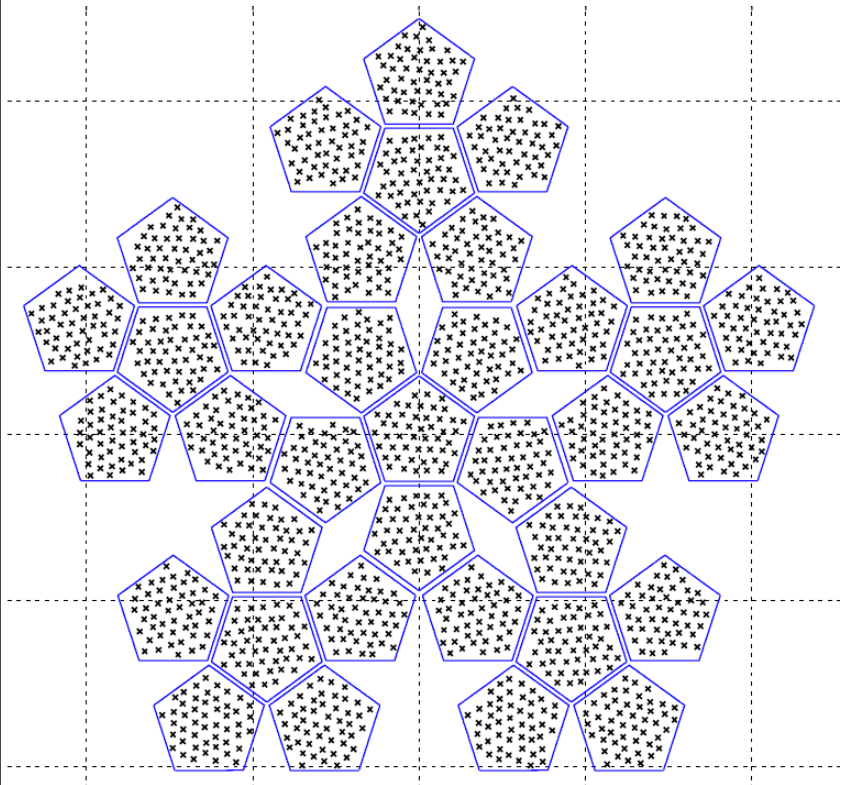
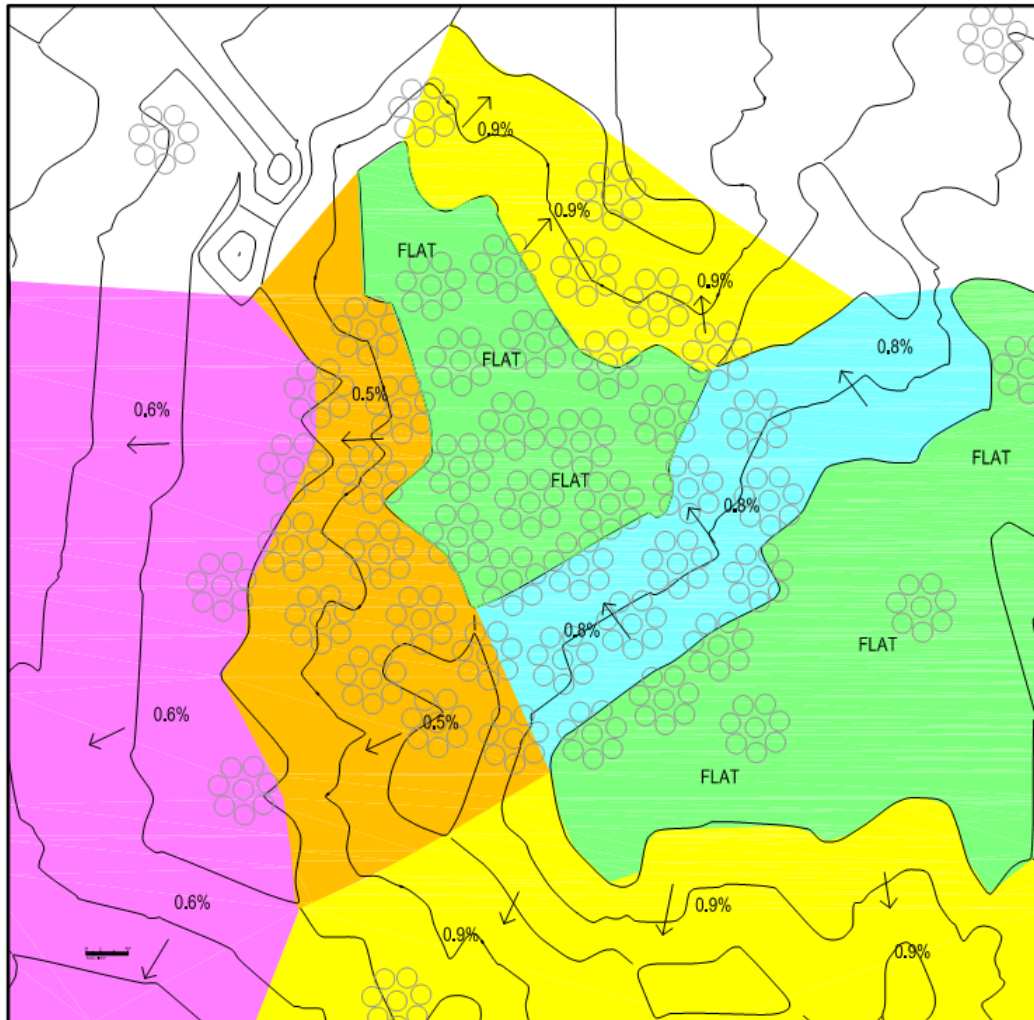


(Latest configuration)
350 m radius, 6.4 km, 35 km

Prepared Ground - Low Core



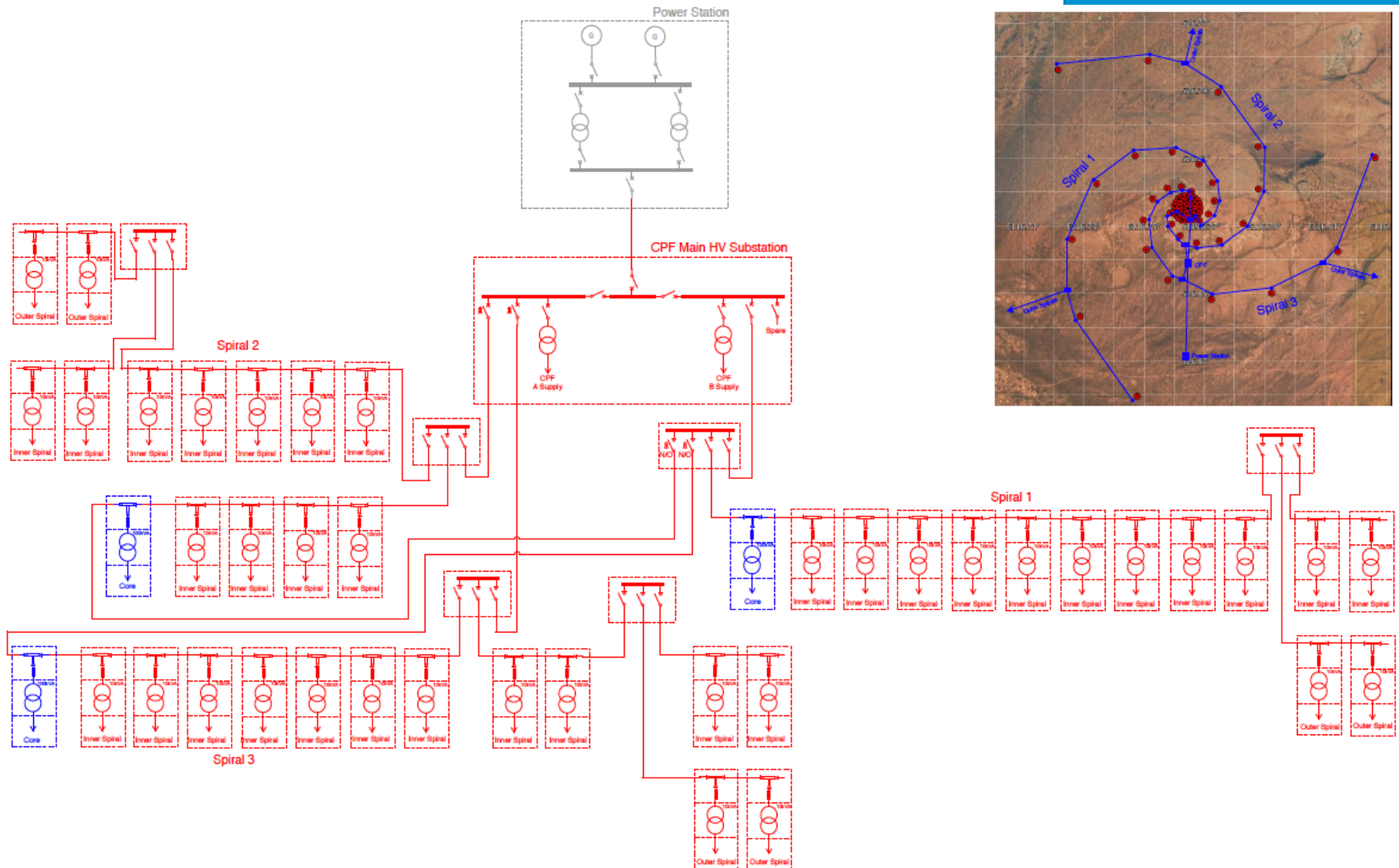
Prepared Ground - Low Core – contours



Power Distribution - HV

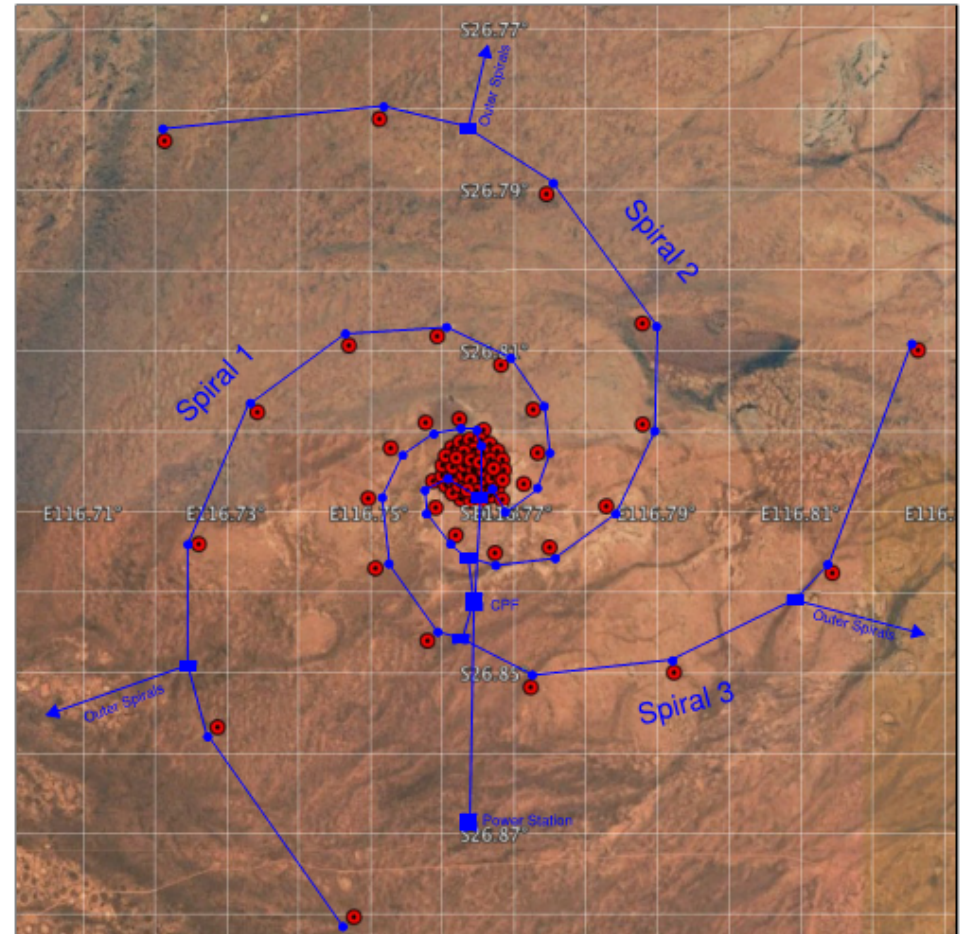


INFRASTRUCTURE AUSTRALIA

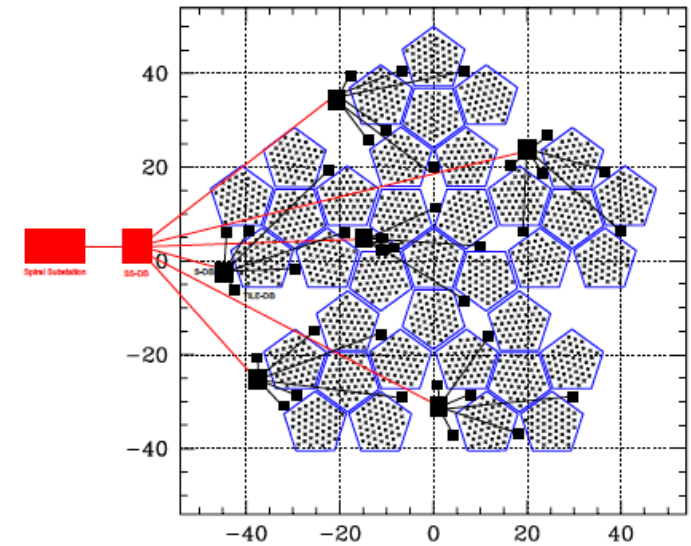
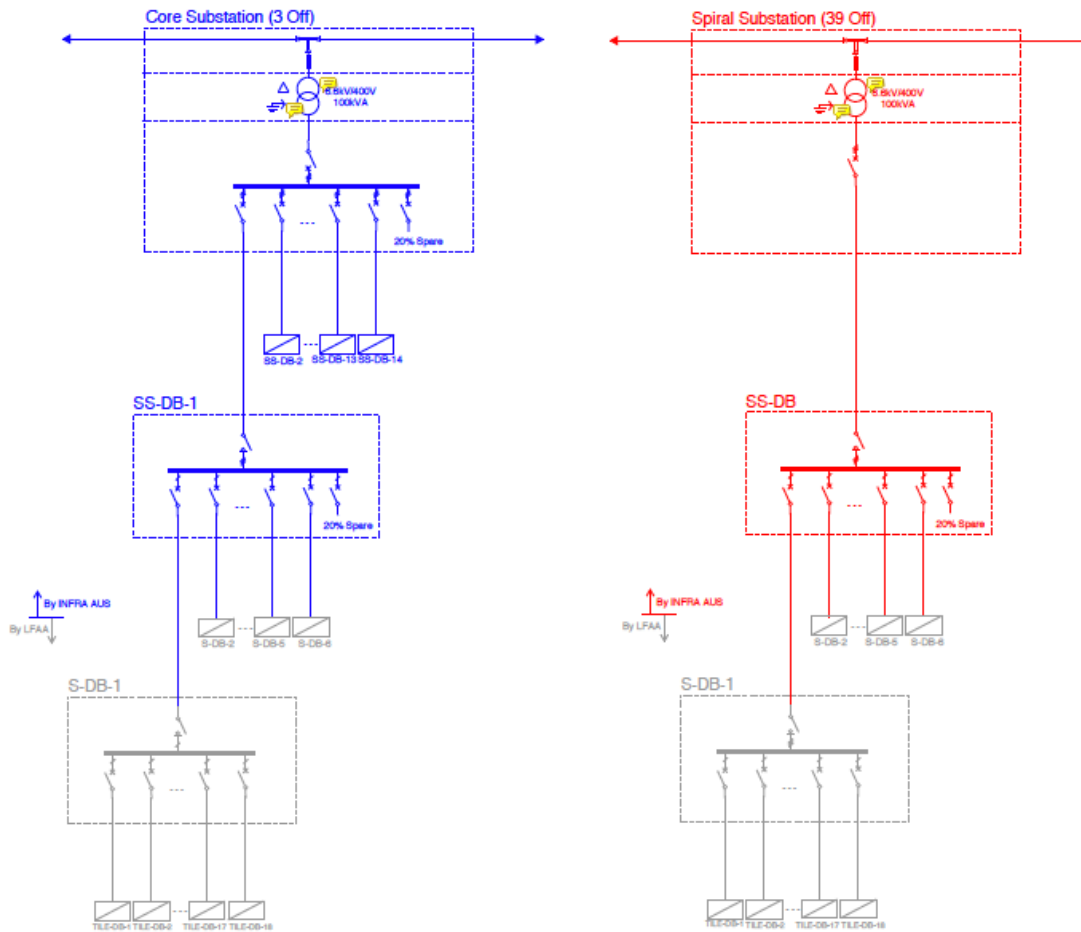


Power Distribution - HV

- Buried cable from on-site Power Station to Low CPF
- Distributed power to spirals in the dense core (350m) and out to 6.4km radius (regular 'spirals')
- Outside of this 'core' it may be a mix of buried cable and solar PV
- Stations close to ASKAP fed from ASKAP Power (TBC)
- Trade-off study to be completed following configuration finalisation



Power Distribution – LV Schematic



Power Distribution – Remote Stations Solar



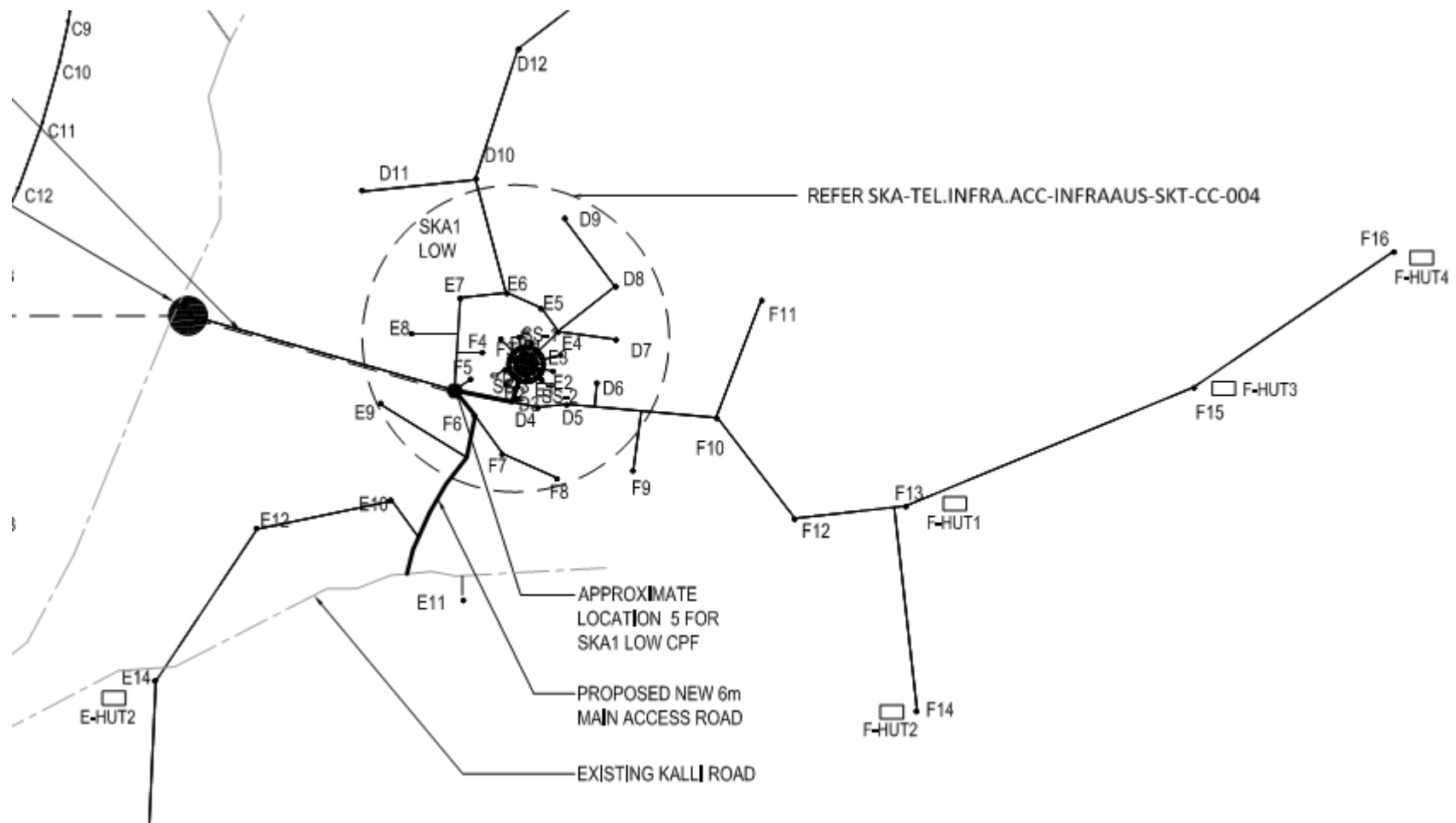
Inputs

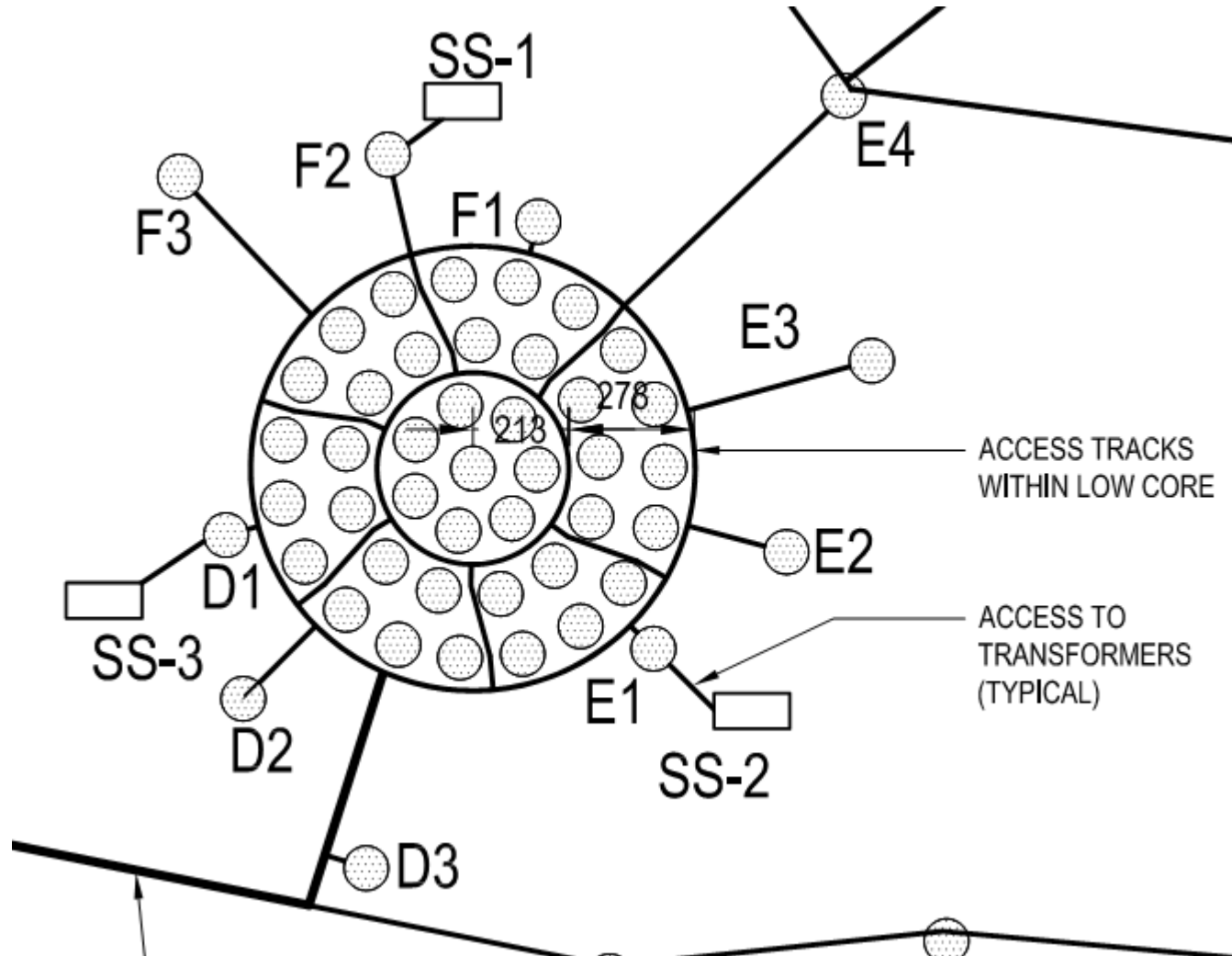
Item	Value
Location	Meekatharra
Electrical load	2,500W
Power use	24/7
Panel tilt angle	45 degrees
Azimuth	0 degrees (True North)
Autonomy	Scenario 1: 12h Scenario 2: 1day Scenario 3: 2days Scenario 4: 3days
Loss of Load (LOL)	Option 1: 0.1% Option 2: 2%
PV Panel	Standard 260Wp polycrystalline

Initial Results

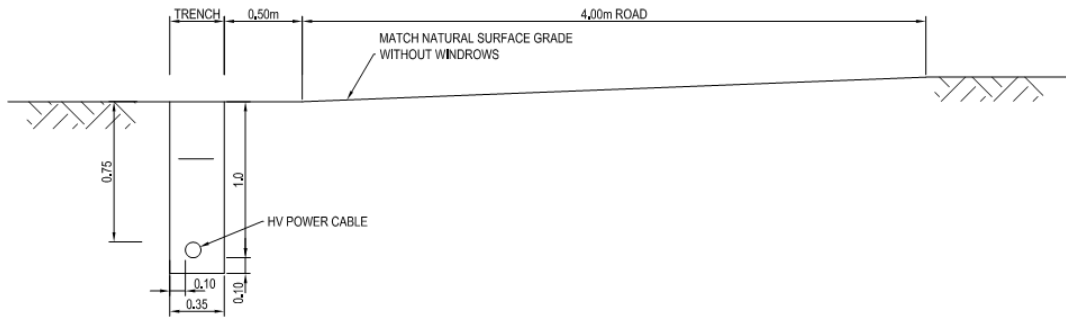
Component	Station 100% Renewable	Superstation 100% Renewable	Superstation Diesel (1 Hour Window)
Batteries (kWh)	65-70	420	420
PV array (kWp)	39-41	180	140
Tilt angle (deg)	40-45	35-45	35-45
Diesel genset (kW)	0	0	100
Hours of diesel	0	0	15

Access

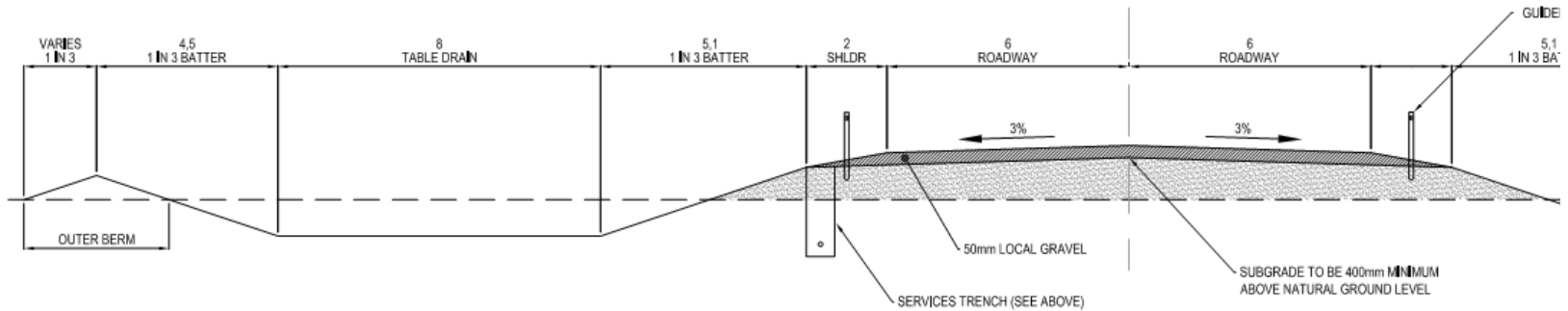




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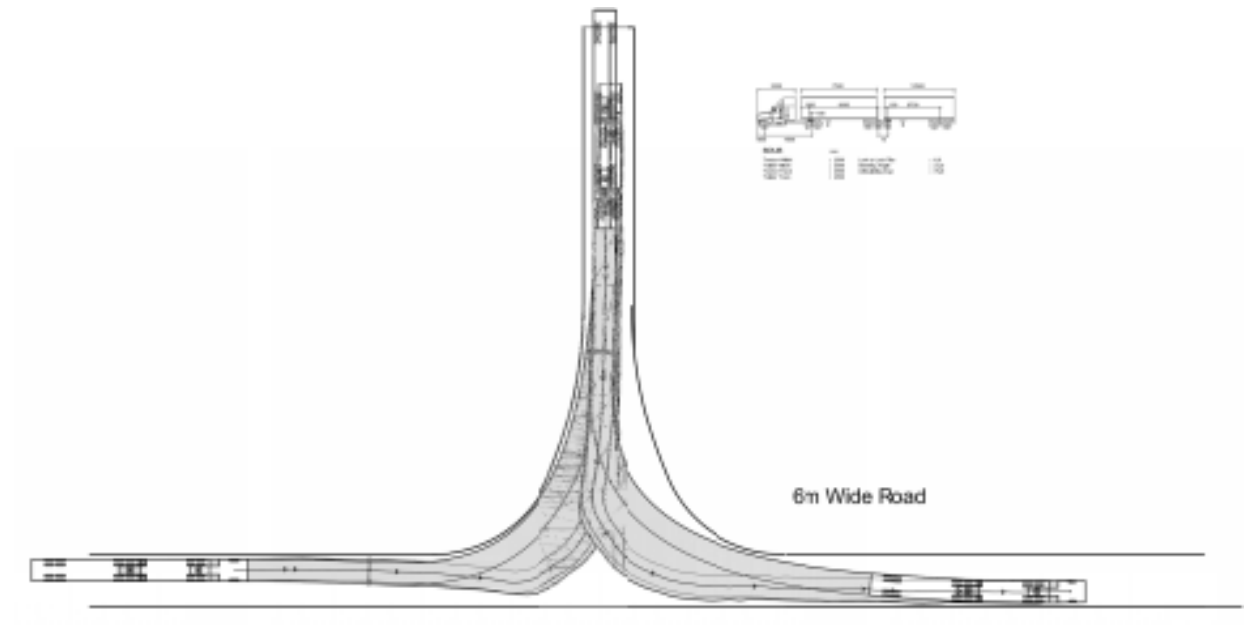
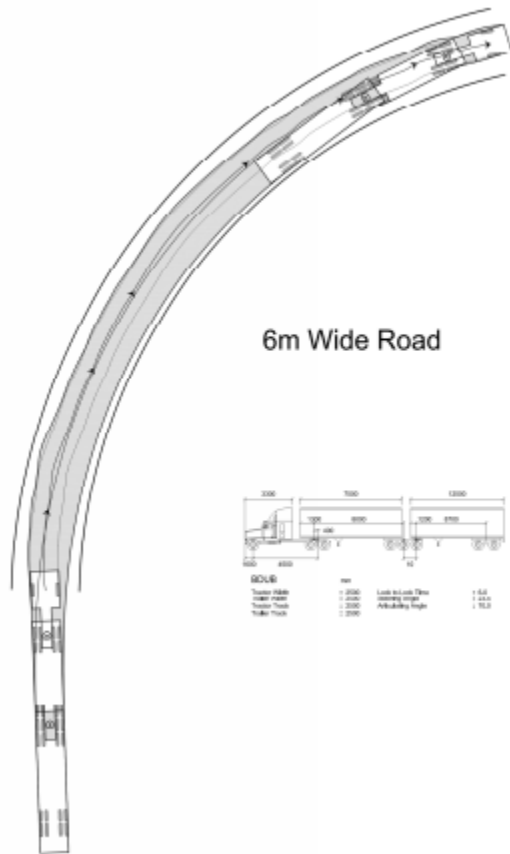


TYPICAL SECTION WITH TRACK AND TRENCH (SINGLE POWER CABLE)
SCALE: NTS



TYPICAL SECTION - MAIN ACCESS ROAD

Access



Buildings – Rack Budgets



- Central buildings only
- Current estimates

Low CPF	
Work package	No racks
LFAA Signal Processing	130 ± 5
LFAA Control System	(inc.)
CSP	28
TM	2*
SADT	5*
TOTAL	165* ± 5

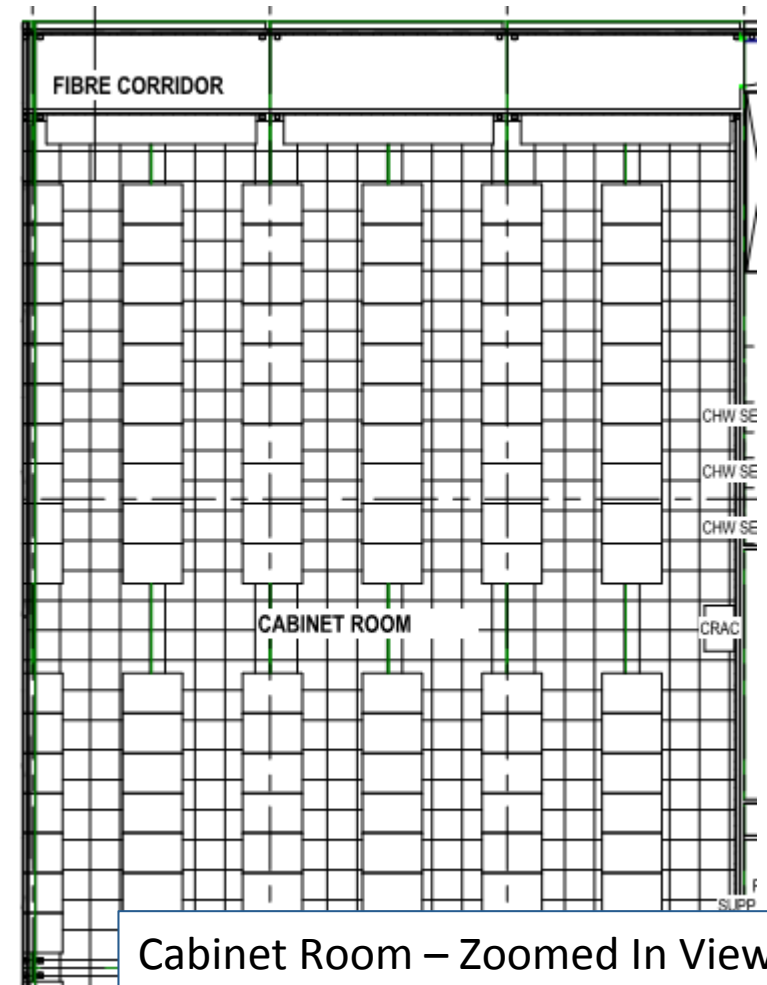
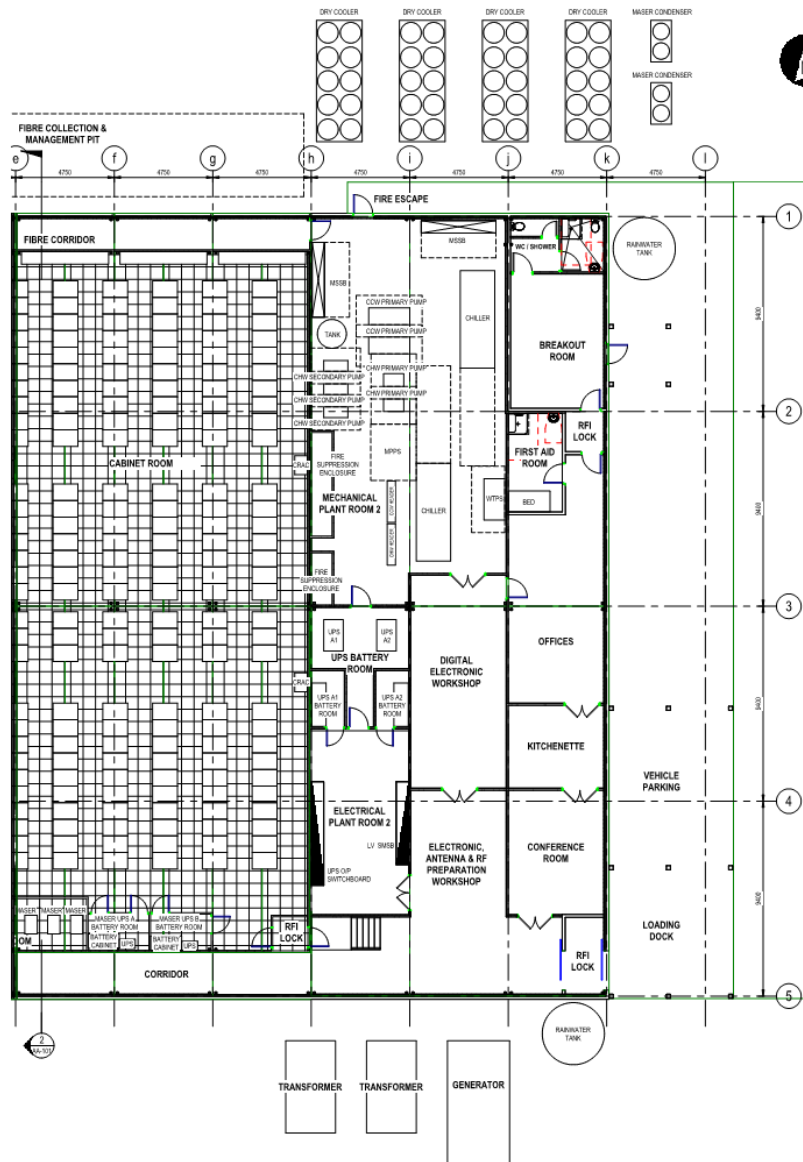
Low

- New facility close to Low core proposed. Building area up to ~1100 sq m required.
- Modular building concept, similar to successful strategy for ASKAP
- Using CSIRO RFI/EMC standards for initial design
 - Double shielded for primary DSP systems
- Minimal additional rooms
- Remote facilities (aka “huts”) required on the spiral arms for housing ADC, some signal processing
 - Remote facilities may use local solar power supply

Buildings - SKA1 Low CPF



INFRASTRUCTURE AUSTRALIA

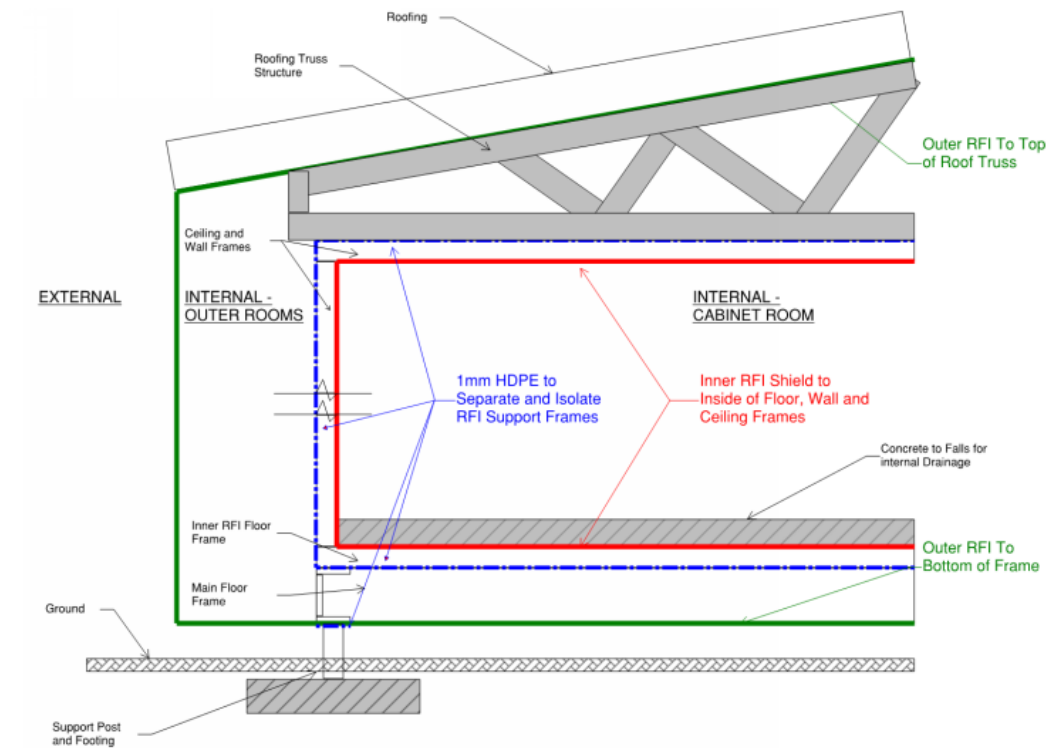
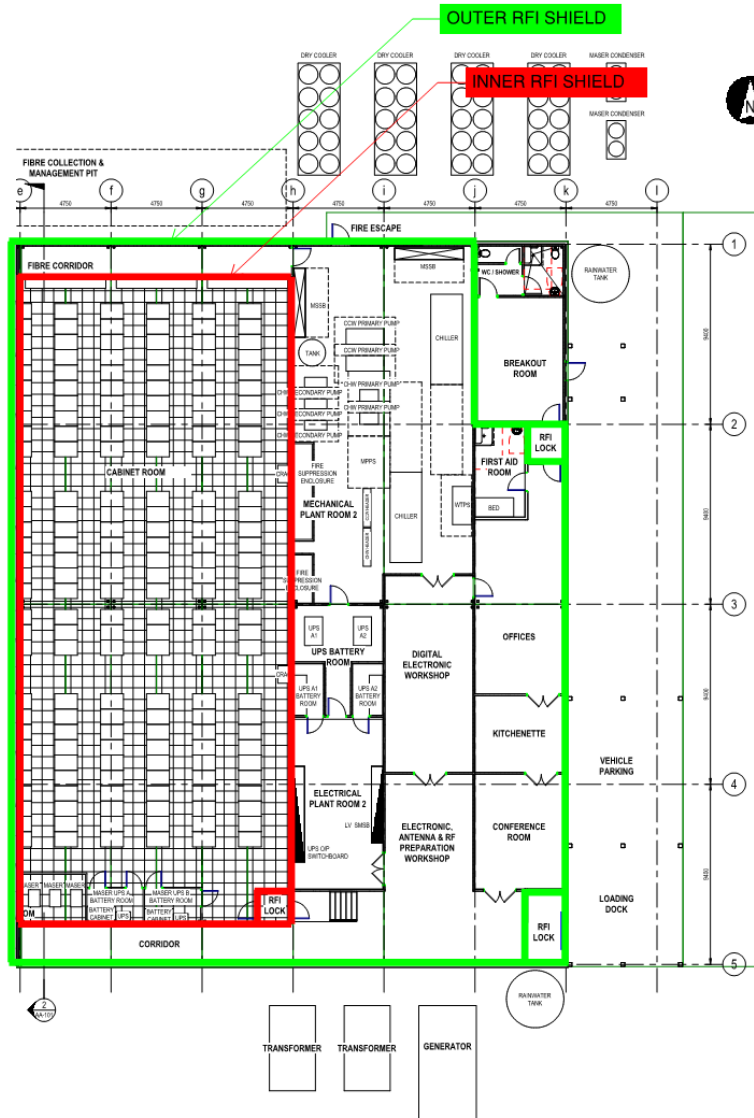


Cabinet Room – Zoomed In View

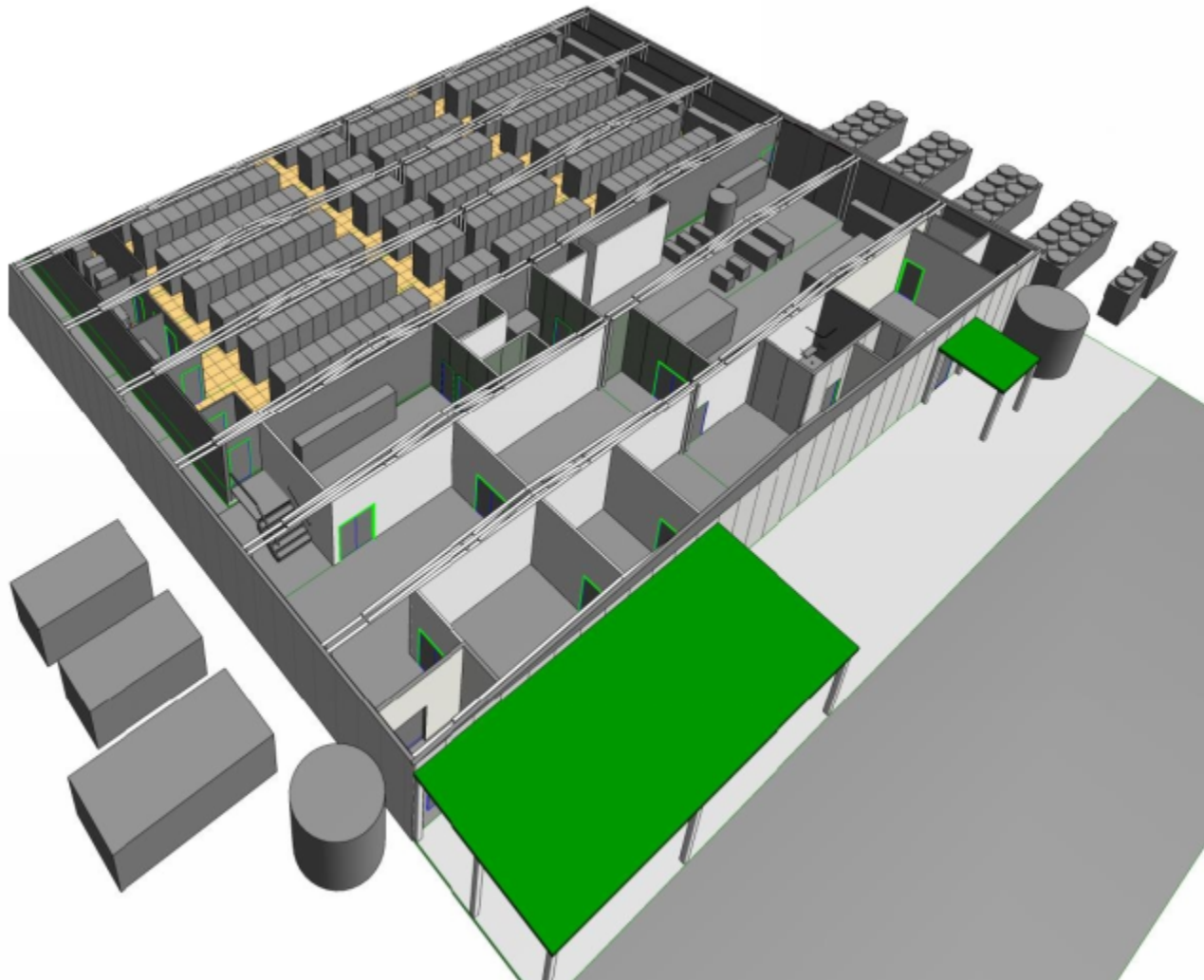
Buildings - SKA1 Low CPF



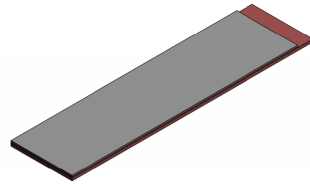
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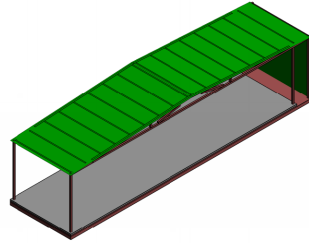
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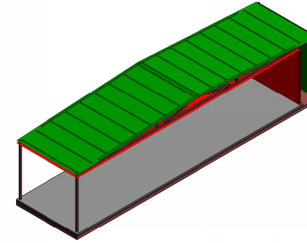
Buildings – Module Buildup



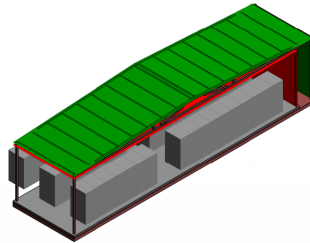
1. MODULE FLOOR



2. MODULE STRUCTURE & OUTER RFI SHIELD



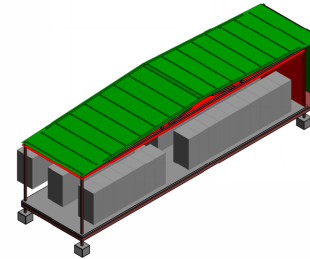
3. MODULE INNER RFI SHIELD



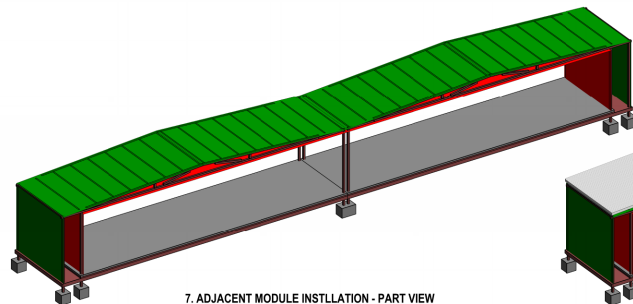
4. MODULE EQUIPMENT
(MODULE NOW READY FOR TRANSPORT TO SITE)



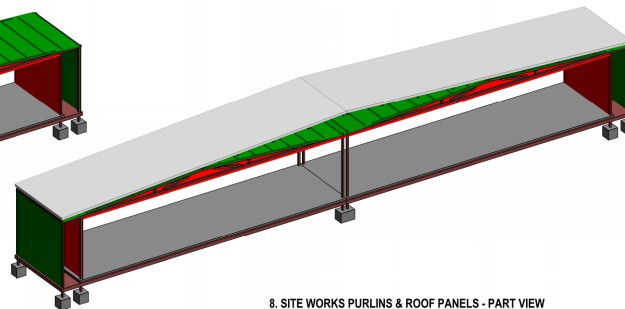
5. SITE WORKS FOOTINGS & STUB COLUMNS



6. MODULE INSTALLATION



7. ADJACENT MODULE INSTALLATION - PART VIEW
(SITE WELD RFI SHIELDS TOGETHER AT MODULE JOINTS)

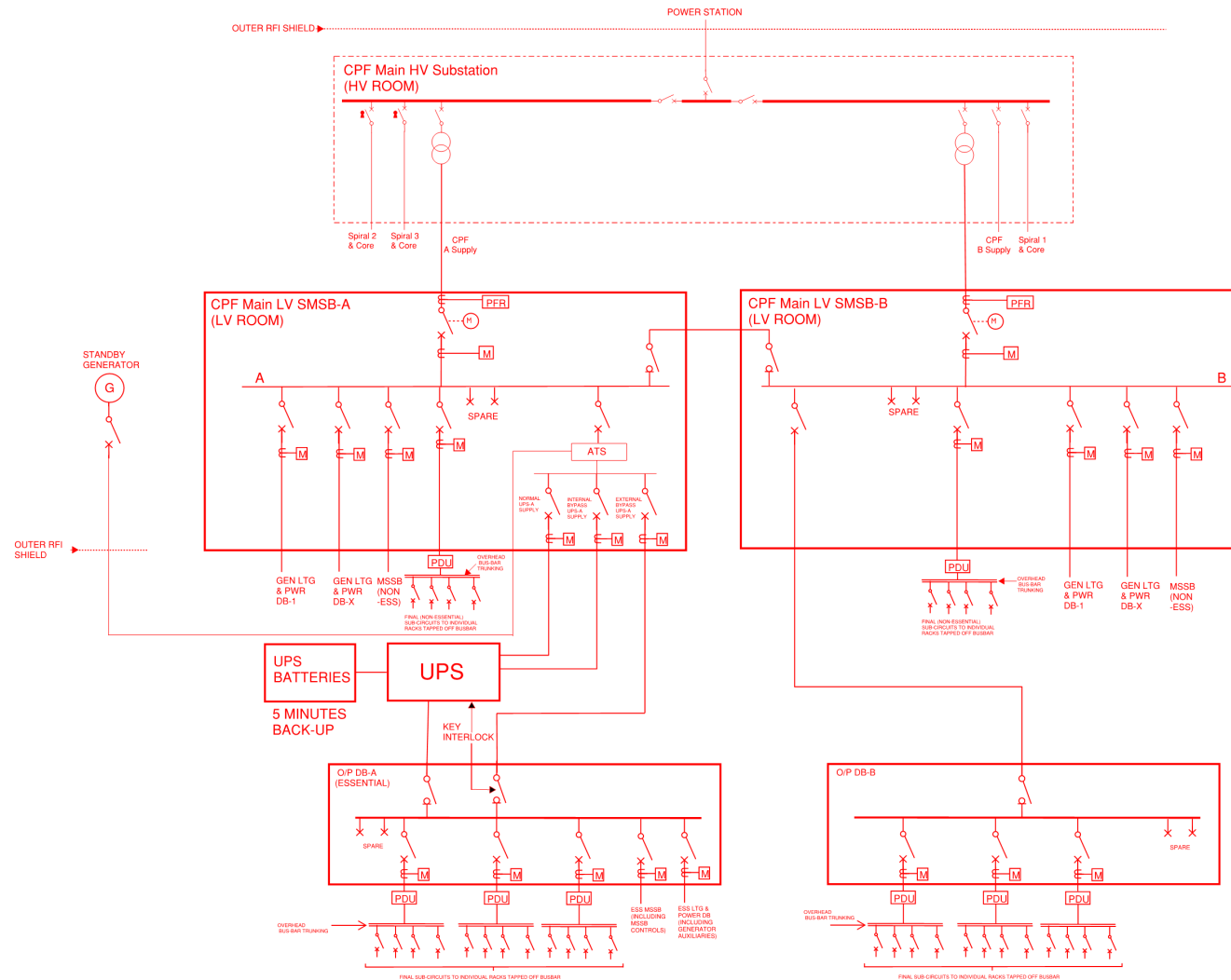


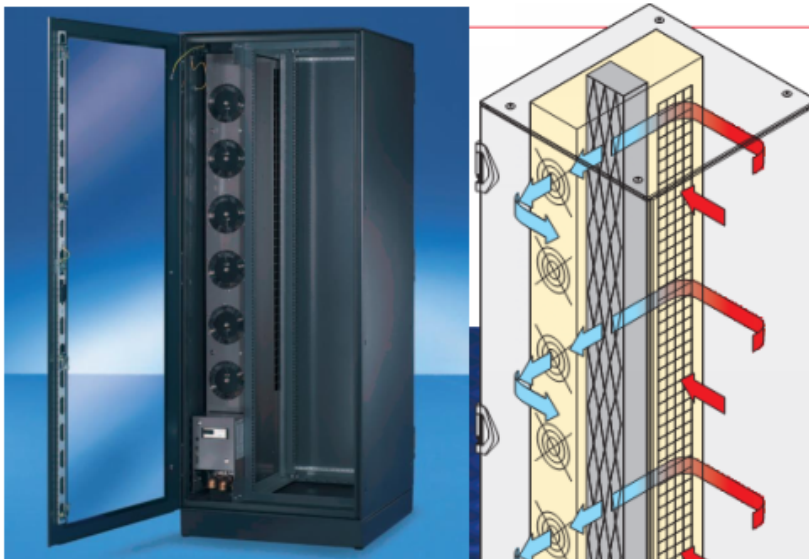
8. SITE WORKS PURLINS & ROOF PANELS - PART VIEW

Buildings - Electrical



INFRASTRUCTURE AUSTRALIA

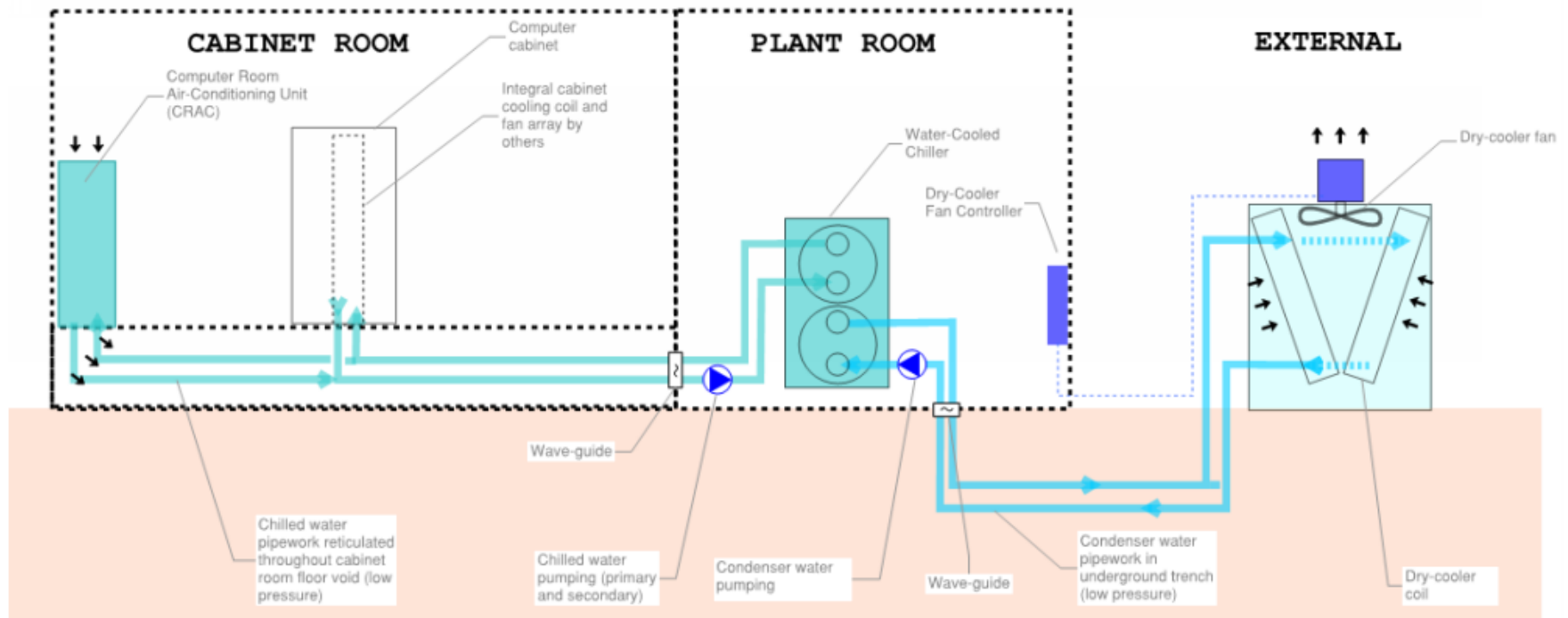




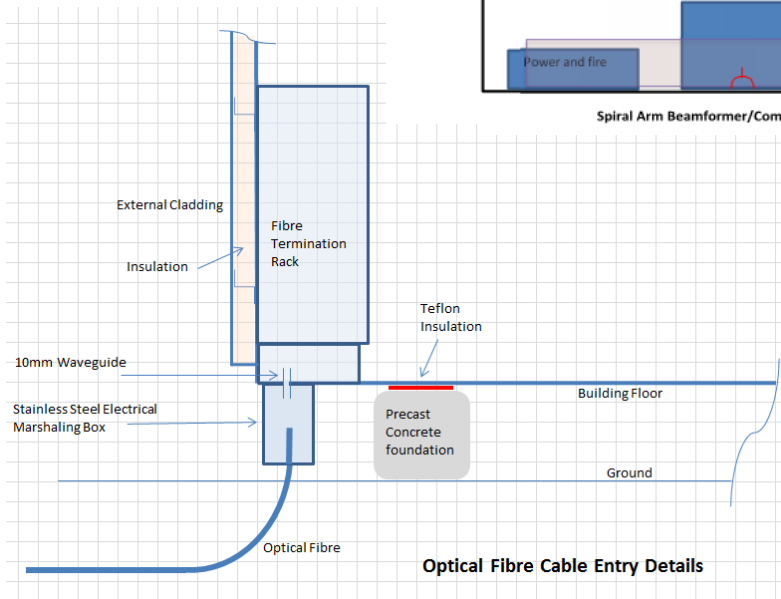
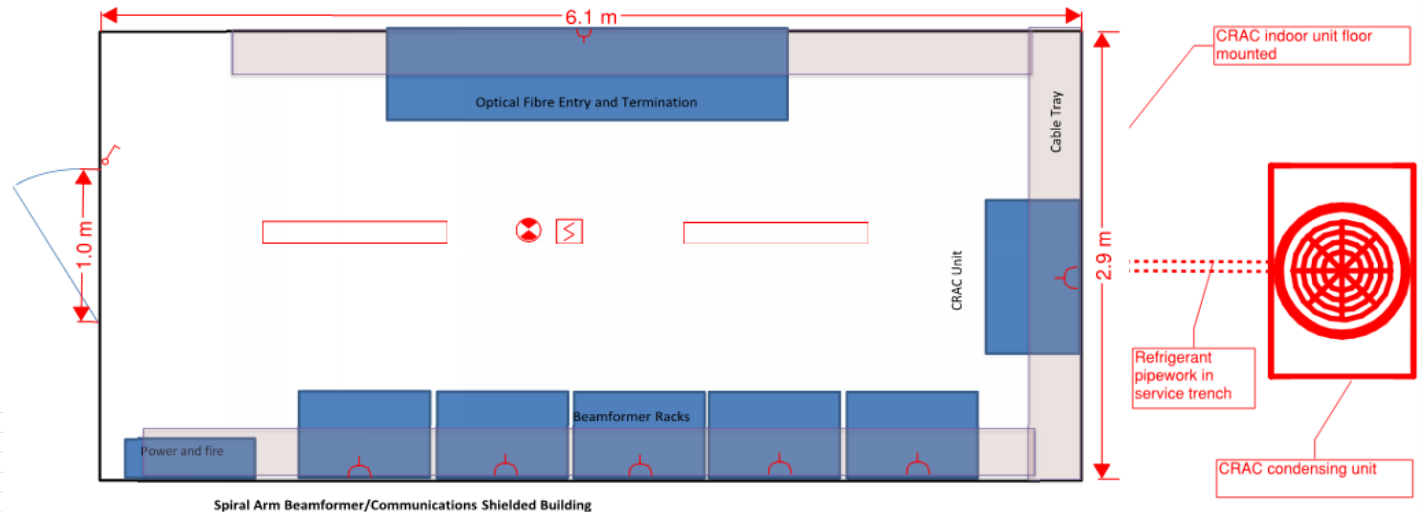
Low CPF

- Water cooled racks to be provided within Cabinet room (by relevant work package)
- ASKAP (Schroff) sample rack shown
 - Up to 20 kW / rack viable
- Chilled water provided to rack
- (Some discussion around use of liquid – liquid heat exchange system for Correlator racks – TBC)

Buildings - Mechanical



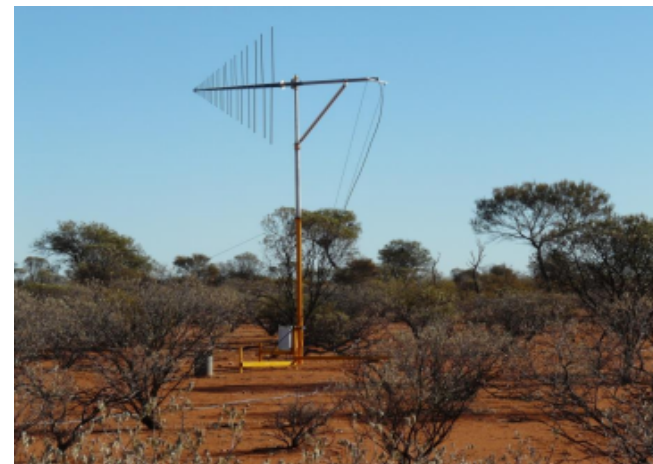
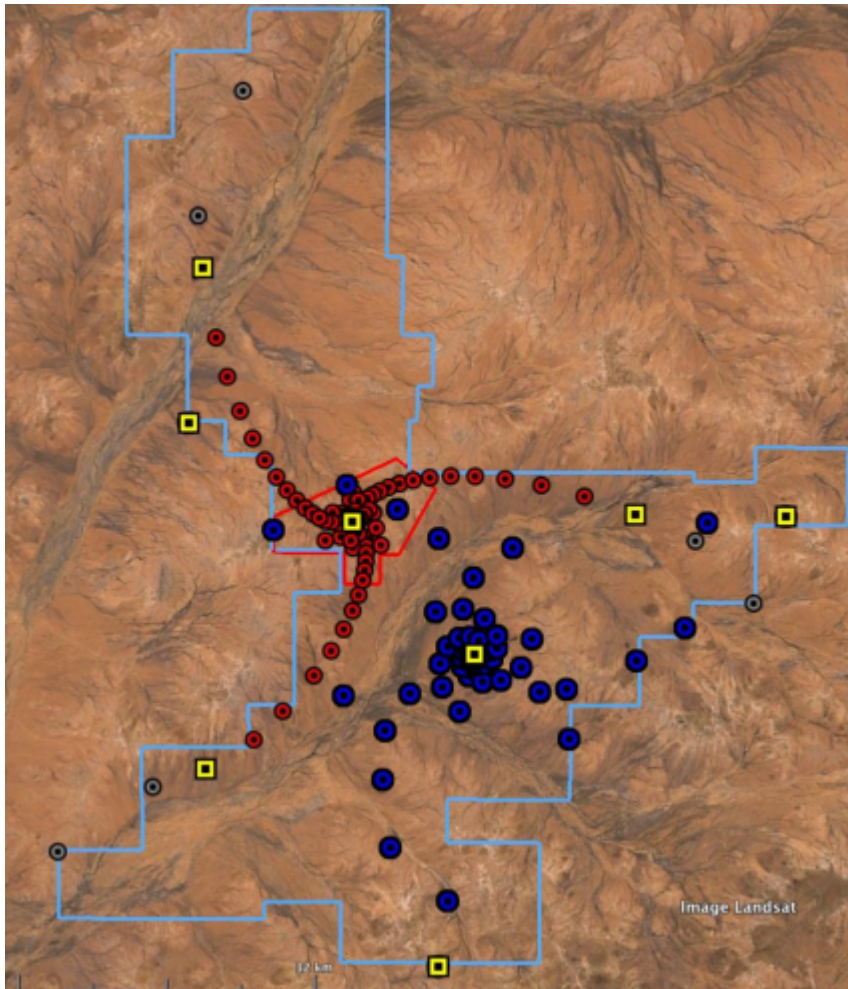
Huts– PDR concept



- Huts for ADC required on Low spiral arms
- Optimisation may be possible for Low spiral arms to reduce cost (subject to configuration)

Site monitoring – PDR concepts

- Visual, Weather, RFI, Tropospheric all required at PDR



RFI:

- 27 meter tower
- 600 m west of ASKAP CPF
- 3 antennas (plan:4)
- Fibre optic connection to CPF

Weather:

- CSIRO design (modified COTS)

Visual:

- Fixed and PZT (minimal)
- CSIRO (modified COTS)

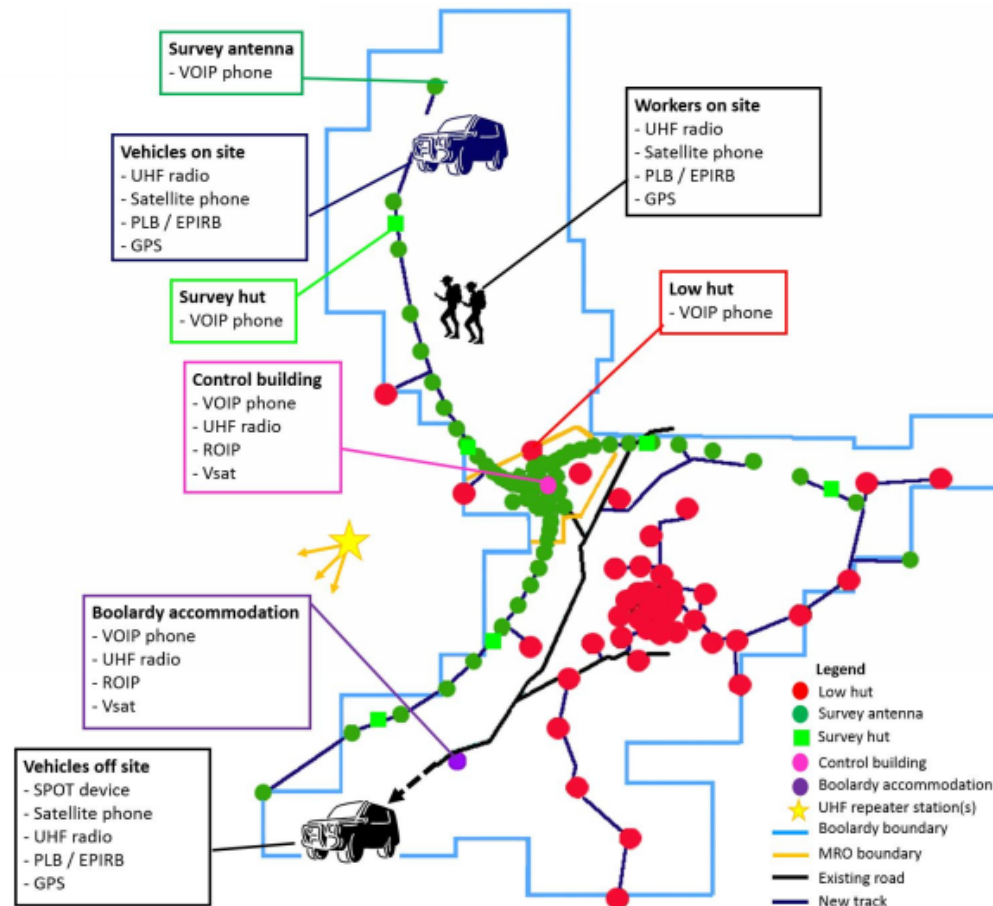
Tropospheric:

- Current 2 station unit (near ASKAP)
- 3rd antenna, relocation (?)



Communications – PDR Concept

- (Update for post-RBS)

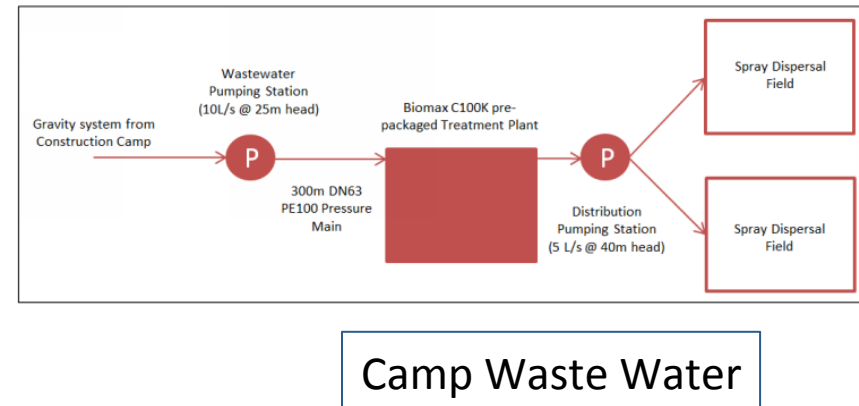
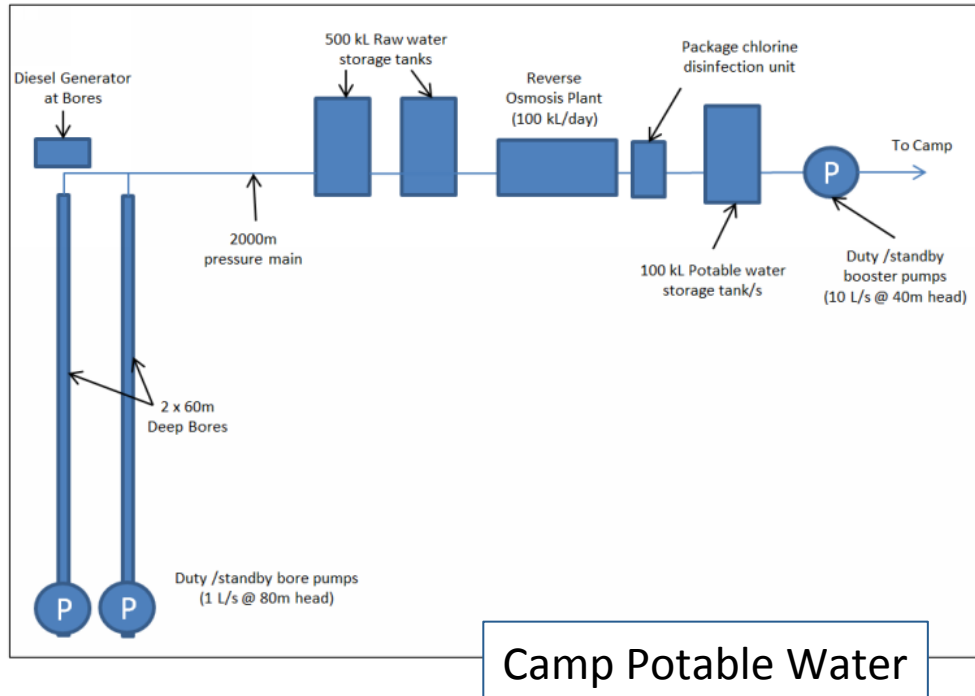


Vehicles – PDR Recommendation



VEHICLE TYPE	Vehicle	Number	Procurement Method
General	4WD Utility	5	Purchase outright
General	4WD Sedan (or Dual Cab Utility)	8	Purchase outright
General	Trailer	4	Purchase outright
General	2WD Wagon	2	Purchase outright
Ancillary	20+ seat coaster bus	1	Purchase outright
Specialist	4WD Fire truck	1	Purchase outright
Specialist	4WD 5+tonne truck	1	Purchase outright
Specialist	All terrain Telehandler	1	Purchase outright
Specialist	Elevated Work Platform (Manlift)	1	Purchase outright
Specialist / contractor	Grader	1	Lease, Hire or Sub-contract
	Front End Loader	1	Lease, hire or sub-contract
	Water Tanker	1	Lease, hire or sub-contract

Water & Sanitation – PDR Concept



(Power Generation)



Two power working groups established; both chaired by SKAO:

- Australian Power Strategy Working Group (APSWG), Alistair McPherson
- Power Supply Options Workgroup (PSOW), Adriaan Schutte

APSWG was formed:

- to explore funding options for the provision of power in Australia, including how to minimize whole of life cost.
- members from SKAO, CSIRO, the Department of Industry, Innovation and Science, and the WA Office of Science.

PSOW group is focussed on :

- technical aspects
- investigate power supply options
- covers a broader scope of work (South Africa and Australia).

“Prescriptive customer” ~ not cheapest solution

(For INAU, primary power generation is currently out of scope. Small contributions are still made by INAU to inform the above processes.)

Power Generation – MRO Power Station



- Horizon Power (diesel, switchgear, cable)
 - 4 diesel generators
 - 2 x 240 kW, 2 x 1005 kW
- CSIRO – EMC: photovoltaic, battery, management
 - Photovoltaic array (LDK modules)
 - 5,280 solar panels
 - 2 hectares / 5 acres
 - 1.6 MW peak
- Battery energy storage system
 - Lithium ion (Samsung)
 - **Capacity 2.5 MWhr Largest in Australia !**
 - Delivers power at rate of 1 MW
- (In construction : October 2015 – June 2016)

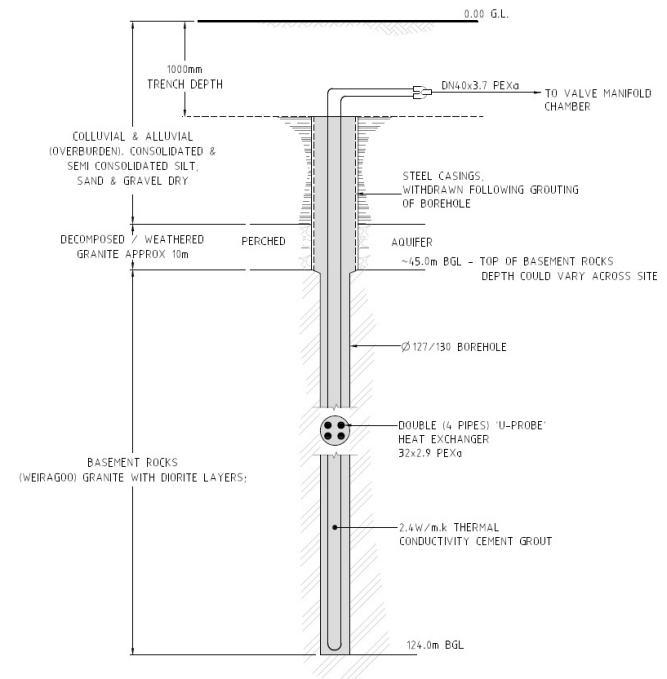
Existing Infrastructure - MRO



Existing Infrastructure - MRO



- RFI shield design allows for ease and repeatability of welds
- Optical fibre entry boxes (waveguide/cutoff)
- Hybrid cooling system (geo – efficient)
- Purpose built transformers on the antenna foundation pads



Existing Infrastructure – MSF (Geraldton)

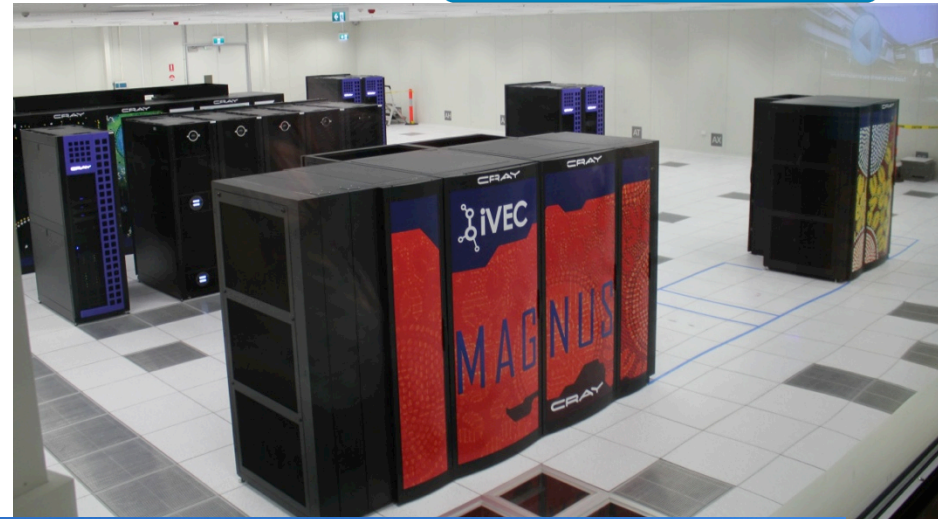
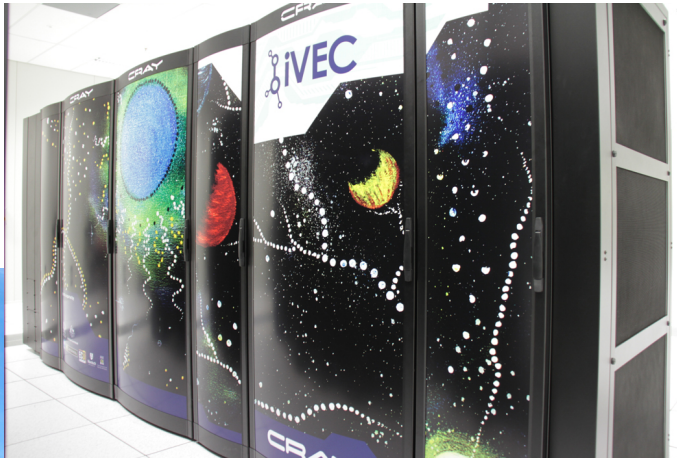


- On Geraldton University Campus near GUC, Durack Inst. of Technology
- Combined 820 sq m office / lab space
- Space for expansion to south (DoE)

(Existing Infrastructure – Pawsey HPC)



- \$80 million HPC (Perth)
- Cray IVY BRIDGE 1.4 Petaflop
- 40 Petabyte tape library
- SKA white space (500 sq m)*



Issues /Risks

- Scope Creep
 - Work required that is not in budget, but is required, e.g., Pawsey, power generation
- Final Low Configuration needed ASAP
 - The existing Architecture Pack (RB45) configuration is >100% over budget
- RFI standards need finalisation
- Core Requirements and ICD Completion – schedule (and cost) impacts
 - ECP impacts
- Geo and hydro survey dependence on heritage process
- Operations requirements / standards / model not defined in detail – impacts ?
- Program extension will increase the Stage 2 costs

Opportunities

- Solar power stations for remote outlying Low Stations
- Introduction of new member country partners (power solutions)
- Whole of Life cost reductions

- Local engagement (community) – yes
- Understand local contractor and culture conditions – yes
- Inadequate system engineering – yes
- Complexity of civil works – yes (especially with “industry unusual” technical e.g. RFI)
- Understand local environmental – yes
- HSE - yes

Future:

- Contracts - do engineering based, logical splits, not political
- Local supervision – on site, yes

- Australian Infrastructure Stage 2 work currently on schedule and budget
 - Though a **July 2017** CDR has also been proposed to account for schedule slippage
- Major cost items identified and flagged to SKAO
 - Working to produce alternatives to high cost drivers
 - Power (and fibre) distribution on spiral arms
 - Low CPF – RFI implications
- Primary issues:
 - Low Configuration
 - EU Funds release
 - Scope boundaries
 - Lack of definition in other project WPs may cause slippage in Infrastructure schedule (linked to risk of INAU proceeding ahead of confirmed inputs)
 - ICD quality / completion inconsistency
 - Some policies not agreed yet (e.g. RFI / EMC management, Operations, Maintenance)

Questions?

