Solar Reserve

Aurora Solar Energy Project

Development Application

Appendices

October 2017

Appendices

Appendix A – Title References

Appendix B – Statutory Documentation

Appendix C – Application Plans

Appendix D – Draft CEMP

Appendix E – Additional Information

Product	Register Search (CL 6181/119)
Date/Time	18/09/2017 03:35PM
Customer Reference	3318266
Order ID	20170918011614
Cost	$28.25

REAL PROPERTY ACT, 1886
South Australia

This Crown Lease Register Search is a true and correct extract of the Register of Crown Leases maintained by the Registrar-General.

Pastoral Leases are granted and administered pursuant to the Pastoral Land Management and Conservation Act 1989 by the Department of Environment, Water and Natural Resources.

REGISTRAR - GENERAL SOUTH AUSTRALIA

Crown Lease - Volume 6181 Folio 119

Parent Title(s) CL 1436/40

Creating Dealing(s) RT 12591880

Title Issued 28/09/2016 **Edition** 1 **Edition Issued** 28/09/2016

Estate Type

CROWN LESSEE

Owner

THE CROWN

Crown Lessee

BUCKLEBOO NOMINEES PTY. LTD. (ACN: 008 046 731)
OF PRIVATE BAG 116 PORT AUGUSTA SA 5700

Description of Land

SECTIONS 1, 2, 4 AND 5
HUNDRED OF CASTINE
IN THE AREA NAMED CARRIEWERLOO

SECTIONS 311 AND 312
HUNDRED OF COPLEY
IN THE AREA NAMED CARRIEWERLOO

SECTION 25
HUNDRED OF HANDYSIDE
IN THE AREA NAMED CARRIEWERLOO

BLOCK 679
OUT OF HUNDREDS (PORT AUGUSTA)
IN THE AREA NAMED CARRIEWERLOO

ALLOTMENT COMPRISING PIECES 3 AND 4 DEPOSITED PLAN 47636
IN THE AREA NAMED CARRIEWERLOO
HUNDRED OF COPLEY

ALLOTMENT COMPRISING PIECES 5 AND 6 DEPOSITED PLAN 47636
IN THE AREA NAMED CARRIEWERLOO
HUNDRED OF CASTINE

ALLOTMENT 55 DEPOSITED PLAN 51471
HUNDRED OF COPLEY

ALLOTMENT COMPRISING PIECES 51 AND 52 DEPOSITED PLAN 51471
HUNDRED OF COPLEY

ALLOTMENT COMPRISING PIECES 53 AND 54 DEPOSITED PLAN 51471
HUNDRED OF COPLEY

TOTAL AREA: 282KM² (APPROXIMATE)

DIAGRAM BOOK PAGES 1,2,3,6 AND 7 HUNDRED OF CASTINE
DIAGRAM BOOK PAGES 8,10 AND 47A HUNDRED OF COPLEY
DIAGRAM BOOK PAGE 7 HUNDRED OF HANDYSIDE
DIAGRAM BOOK PAGE 303 OUT OF HUNDREDS NORTH

Lease Details

Lease Number	PE002496
Lease Type	PASTORAL
Commencing On	07/03/1990
Expiring On	14/10/2054

Conditions

CROWN LEASE CONDITIONS VIDE CL 1436/40

Easements

SUBJECT TO CERTAIN RIGHT(S) AND LIBERTIES OVER PORTION OF PIECE 5 MARKED A ON D47636 (AS 8727981)

SUBJECT TO EASEMENT(S) OVER PORTION OF PIECE 51 MARKED A ON D51471 (TT 8252760)

SUBJECT TO EASEMENT(S) OVER PORTION OF PIECES 3 AND 5 MARKED A ON D47636 (TT 8252760)

SUBJECT TO EASEMENT(S) WITH LIMITATIONS OVER PORTION OF ALLOTMENT 55 AND PIECE 3 MARKED K ON THE PLAN ATTACHED TO GU 5086956 TO THE NATURAL GAS AUTHORITY OF SOUTH AUSTRALIA EXPIRING ON 31/03/2038 (GU 5086956)

Schedule of Dealings

Dealing Number	Description
11531746	MORTGAGE TO WESTPAC BANKING CORPORATION
12598780	CAVEAT BY SOLARRESERVE AUSTRALIA PTY. LTD. (ACN: 165 388 410) OVER PORTION

Notations

Dealings Affecting Title NIL

Priority Notices NIL

Registrar-General's Notes

APPROVED FX40361

Administrative Interests NIL

Additional Information

This additional information is provided by the Department of Environment, Water and Natural Resources and does not constitute part of the Crown Leases Register maintained by the Registrar-General. Contact the Department of Environment, Water and Natural Resources to verify the currency of this information and to obtain further details.

Related Leases

Related Leases: PE 002423

Maximum Stocking Rate: 4,900 Sheep Equivalents

Annual Rent

Annual Rent: $0

Rent Review: Rent to be review no later than Unknown

Appendix B – Statutory Documentation

Section 49 Sponsorship letter

Office of the Technical Regulator Certification

SA Water Letter

Government of South Australia
Department of the Premier and Cabinet

B113354

GPO Box 2343
Adelaide SA 5001
DX 56201
Tel 08 8226 3500
Fax 08 8226 3535
www.dpc.sa.gov.au

13 September 2017

Daniel Thompson
Director of Development
Solar Reserve
Level 25, 108 St Georges Tce
PERTH WA 6000

Dear Mr Thompson

CROWN SPONSORSHIP: AURORA SOLAR ENERGY PROJECT

I write to you regarding Crown sponsorship the Aurora Solar Energy Project (the Project) pursuant to Section 49 of the *Development Act 1993*.

The Project has been considered within the Department of the Premier and Cabinet with input from the Department of Planning, Transport and Infrastructure.

Development of the Project has the potential to benefit South Australia and can be considered public infrastructure as it incorporates infrastructure used for the supply of electricity.

Accordingly I, as the Chief Executive of the Department of the Premier and Cabinet, will support the development and specifically endorse the Project comprising 150 MW solar thermal power station at the nominated location (as depicted on "Project Layout Indicative Arrangement" dated 31/08/2017) as a development of public infrastructure as required by Section 49 of the *Development Act 1993.*

If you have any questions regarding the contents of this letter, please contact Chris Gosling on 0415 426 181 or via email chris.gosling@sa.gov.au.

Yours sincerely

Dr Don Russell
CHIEF EXECUTIVE

Government of South Australia
Department of the Premier and Cabinet

Ref: 2017/01873.01 D17014974

Energy and Technical Regulation

Office of the Technical Regulator

Level 8, 11 Waymouth Street
Adelaide SA 5000

GPO Box 320
Adelaide SA 5001

Telephone: 08 8226 5500
Facsimile: 08 8226 5866

www.sa.gov.au/otr

31 July 2017

Daniel Thompson
SolarReserve Australia
Level 25, 108 St. Georges Terrace
Perth WA 6000
By email: daniel.thompson@solarreserve.com

Dear Daniel,

RE: CERTIFICATE FOR DEVELOPMENT OF THE AURORA SOLAR ENERGY PROJECT

The development of the Aurora Solar Energy Project has been assessed by the Office of the Technical Regulator (OTR) under Section 37 of the Development Act 1993.

Regulation 70 of the *Development Regulations 2008* prescribes if the proposed development is for the purposes of the provision of electricity generating plant with a generating capacity of more than 5 MW that is to be connected to the State's power system – a certificate from the Technical Regulator is required, certifying that the proposed development complies with the requirements of the Technical Regulator in relation to the security and stability of the State's power system.

In making a decision on your application, our office has taken the following information into account:

- Your letter to the OTR 'SA Government OTR – SolarReserve letter seeking OTR Approval – Jul 2017' dated 12 July 2017, which was emailed to the OTR by Jennie Burdeniuk of GHD on 18 July 2017;
- An email from Jennie Burdeniuk to the OTR on 28 July 2017 providing some clarification regarding the proposal.

After assessing the information provided, I advise that approval is granted for the proposed project.

Government of South Australia
Department of the Premier and Cabinet

Should you have any questions regarding this matter, please do not hesitate to call David Bosnakis on (08) 8226 5521.

Yours sincerely

Rob Faunt
TECHNICAL REGULATOR

cc: Jennie Burdeniuk - GHD

Energy and Technical Regulations

Level 8, 11 Waymouth Street Adelaide SA 5000 | GPO Box 320 Adelaide SA 5001 | DX541
Tel (+61) 8 8226 5500 | Fax (+61) 8 8226 5866 | www.dpc.sa.gov.au | ABN 83 524 915 929

SA Water

SOUTH AUSTRALIAN
WATER CORPORATION
A.B.N. 69 336 525 019

12 September 2017

SA Water House
250 Victoria Square / Tarntanyangga
Adelaide South Australia 5000

GPO Box 1751
Adelaide South Australia 5001

Telephone +61 8 1300 650 950

Mr Grant Alderson

Development Manager, Australia

SOLAR RESERVE

Level 40, 100 Miller Street

Sydney, NSW 2060

Dear Grant

Water Supply to Aurora Solar Energy Plant.

Thank you for notifying SA Water of your intention to lodge a development application for the Aurora Solar Energy Project.

SA Water would like to confirm that:

- SA Water are in the process of progressing a potable water connection to supply the Aurora project, and
- SA Water has no concerns or comments on the development proposal hence will be in touch in due course with supply options.

If you wish to discuss further please feel free to contact myself on the details below.

Yours sincerely

Wendy Smallwood

Business Relations

Tel: 08 7424 1145

Mob: 0475 818 344

Email: wendy.smallwood@sawater.com.au

Government of South Australia

Appendix C – Application Plans

Project Layout

Power Block Layout

Site plan Admin Building and Security Gatehouse

Admin building Elevation

Security Gatehouse Elevation

Heliostat Assembly General Arrangement

Heliostat Assembly Elevation

General Admin/Workshop Compound Site Plan

Heliostat Dimensions

Transmission Tower Dimensions

Evaporation Pond

PROPOSED SECURITY, ADMINISTRATION, HELIOSTAT ASSEMBLY BUILDING AND CONSTRUCTION LAYDOWN AREA (25ha)

PROPOSED EVAPORATON POND (7ha)

EXISTING RAILWAY CROSSING

PROPOSED OVERHEAD 275kV TRANSMISSION LINE (3 ROUTE OPTIONS)

STUART HIGHWAY

RAILWAY LINE

RIGHT OF WAY

PROPOSED POWER BLOCK (REFER TO AURORA-002)

PROPOSED HELIOSTAT FIELD (800ha)

PLAN

0m 500m 1000m 1500m

TRANSMISSION LINE ROUTE OPTIONS

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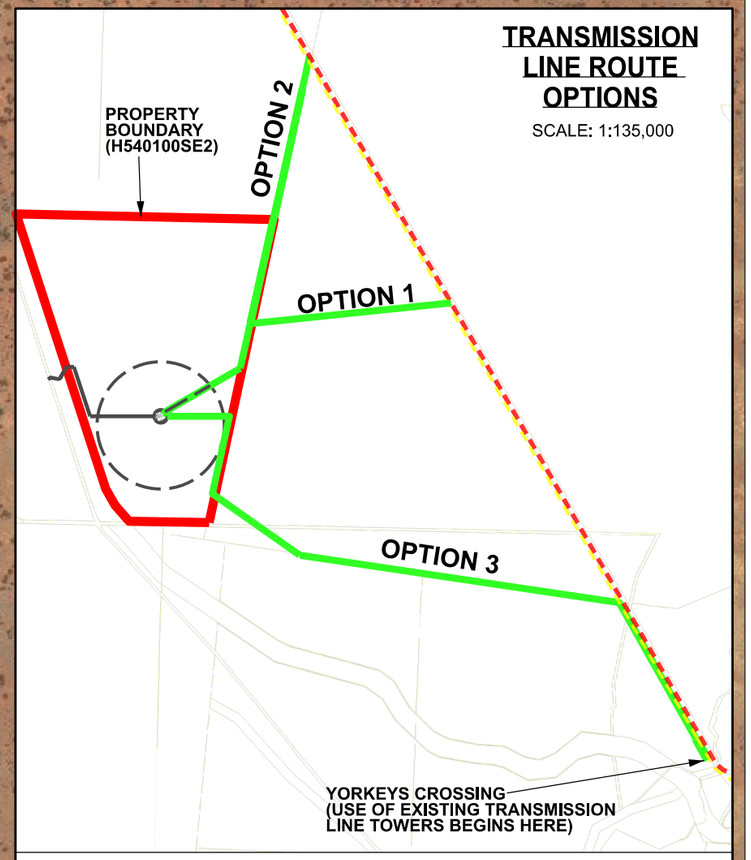


OPTION 1 & OPTION 2 PROPOSED CONNECTION TO EXISTING 275kV LINE (WITH NEW TRANSMISSION LINE TOWERS AND NEW SUBSTATION AT 275kV CONNECTION POINT)

OPTION 3 PROPOSED CONNECTION TO EXISTING DAVENPORT SUBSTATION (WITH NEW TRANSMISSION LINE TOWERS TO YORKEYS CROSSING THEN USE OF EXISTING TRANSMISSION LINE TOWERS TO DAVENPORT SUBSTATION)

Legend:

- Proposed Water Pipeline
- Existing / New Water Pipeline
- Proposed 275kV Transmission Line
- Existing 275kV Transmission Line
- Existing 132kV Transmission Line
- Existing Stuart Highway
- Proposed Access Road (Sealed)
- Proposed Access Track (Unsealed)
- Proposed Fence
- Existing Cadastral Boundary

SOLARRESERVE

AURORA SOLAR ENERGY PROJECT
PORT AUGUSTA, AUSTRALIA

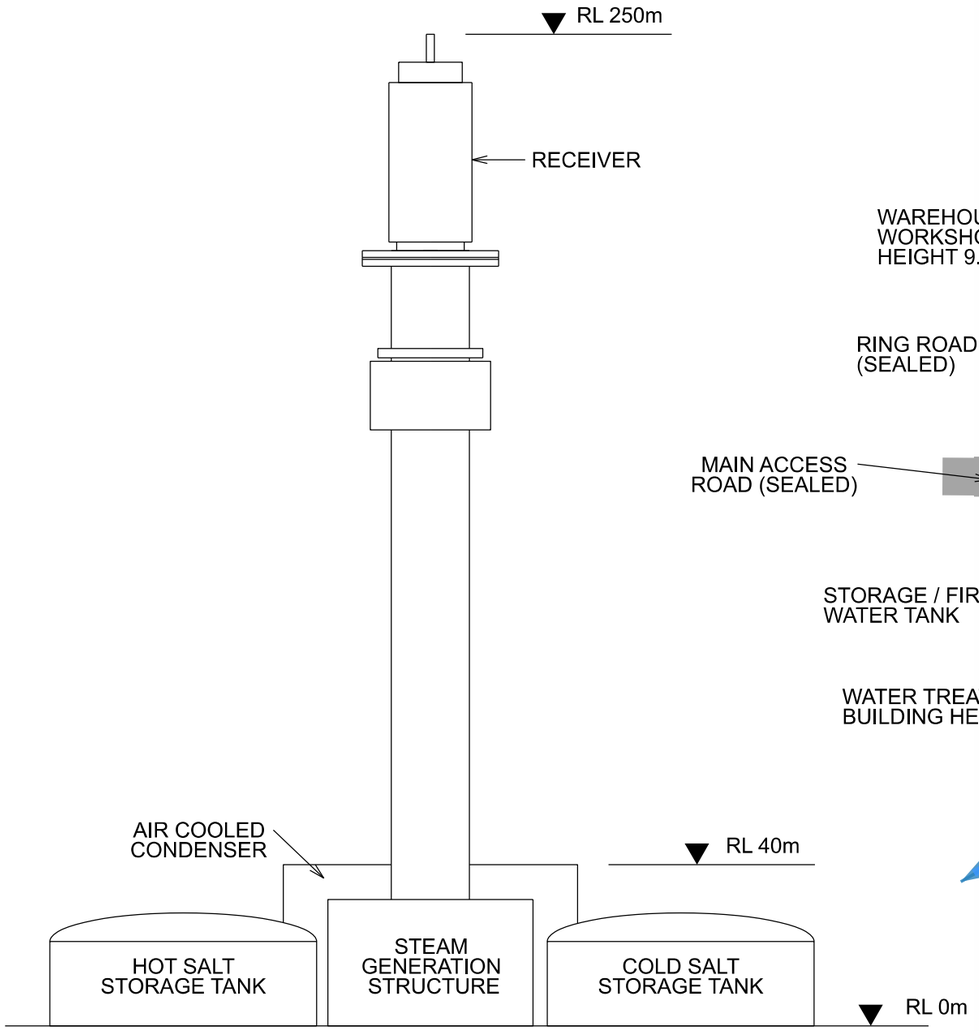
TITLE: PROJECT LAYOUT INDICATIVE ARRANGEMENT

DRG NO.: AURORA-001

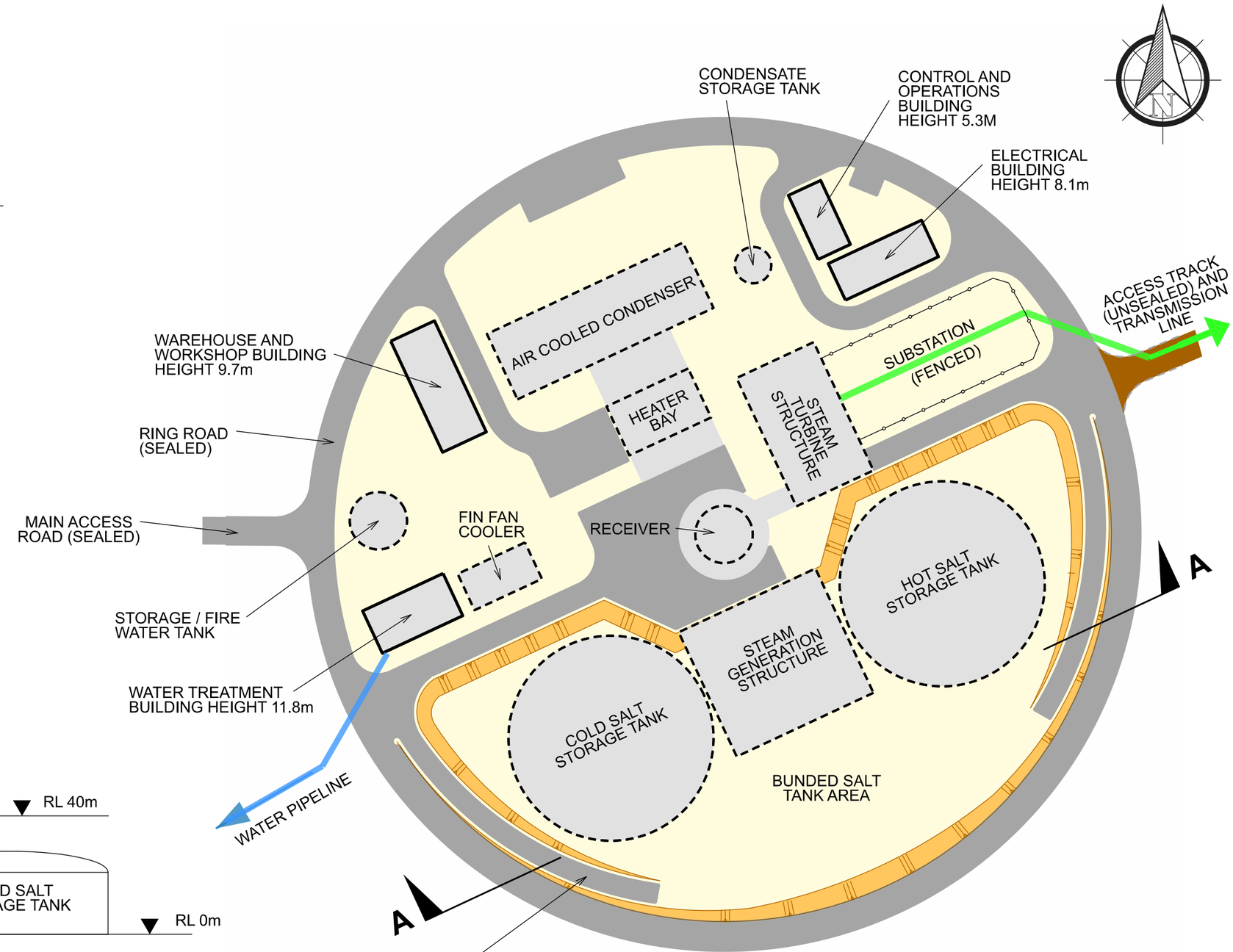
DATE: 27/09/2017

SHEET: 1 OF 1

SCALE: 1:15,000 (UNO)



ELEVATION VIEW A - A



PLAN

0km 50m 100m

LEGEND

- WATER PIPELINE
- TRANSMISSION LINE
- BUILDING
- STRUCTURE / EQUIPMENT
- FENCE
- SEALED ROAD
- UNSEALED ROAD
- GRAVEL
- EARTHWORKS BATTER
- CONCRETE SLAB

SOLARRESERVE

AURORA SOLAR ENERGY PROJECT
PORT AUGUSTA, AUSTRALIA

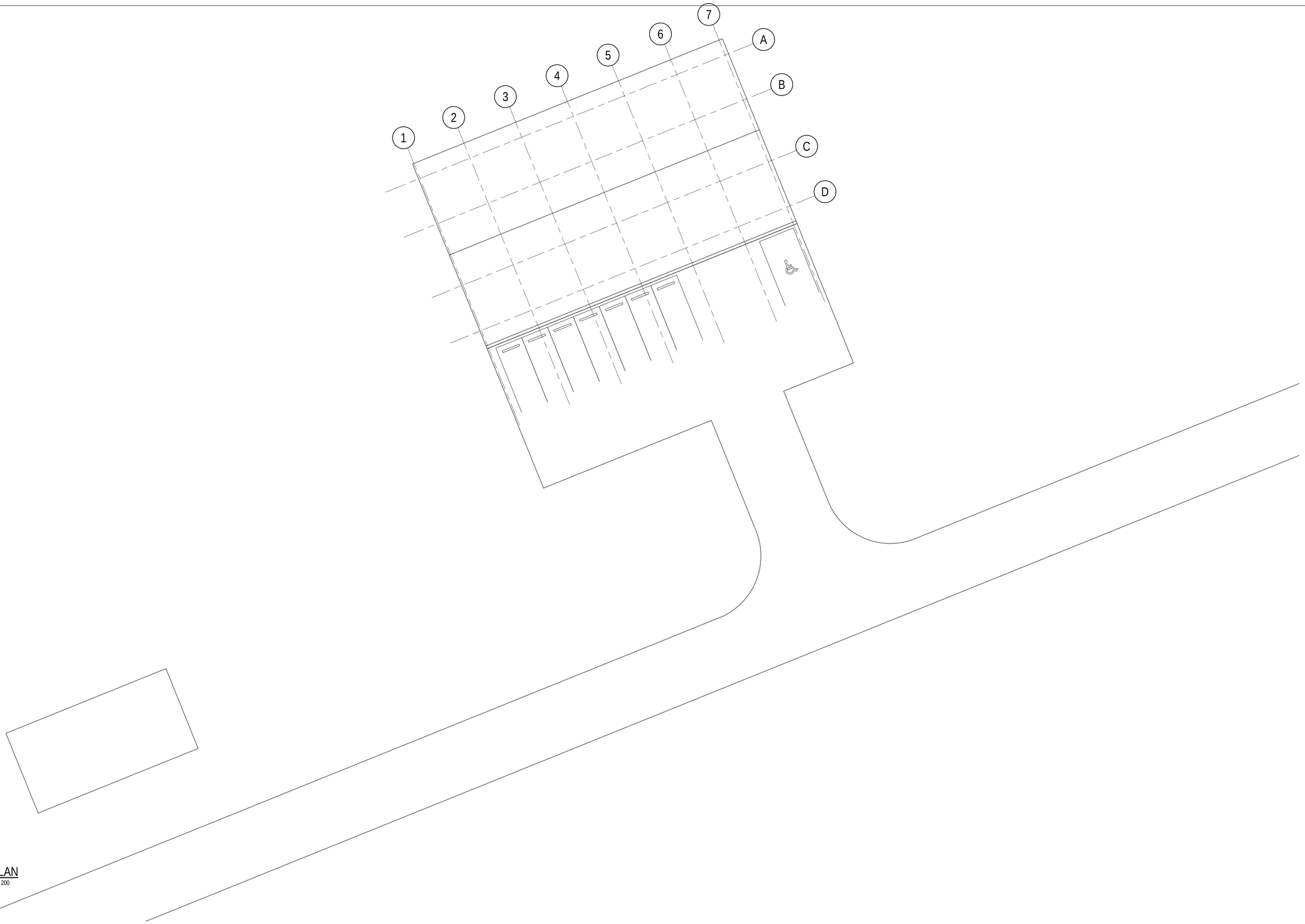
TITLE: POWER BLOCK INDICATIVE ARRANGEMENT

DRG NO.: AURORA-002

DATE: 16/09/2017

SHEET: 1 OF 1

SCALE: 1:1,500



SITE PLAN
SCALE 1 : 200

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SCALE 1:100 AT ORIGINAL SIZE

N

GHD SOLARRESERVE
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GPO Box 2052 Adelaide SA 5001
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E adlmail@ghd.com.au **W** www.ghd.com

DO NOT SCALE

Drawn	Author	Designer	Designer
Drafting Check		Design Check	Checker
Approved (Project Director)	Approver		
Date			
Scale	1 : 200	This Drawing must not be used for Construction unless signed as Approved	

Client **SOLARRESERVE**
Project **AURORA SOLAR ENERGY PROJECT**
Title **SITE PLAN - ADMIN BUILDING**

Original Size **A1**
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Rev:

Plot Date: 15/09/2017 3:41:05 PM
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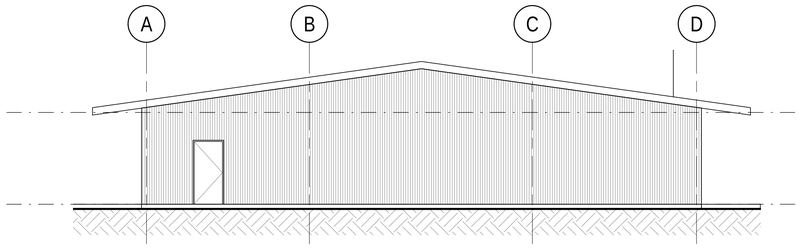

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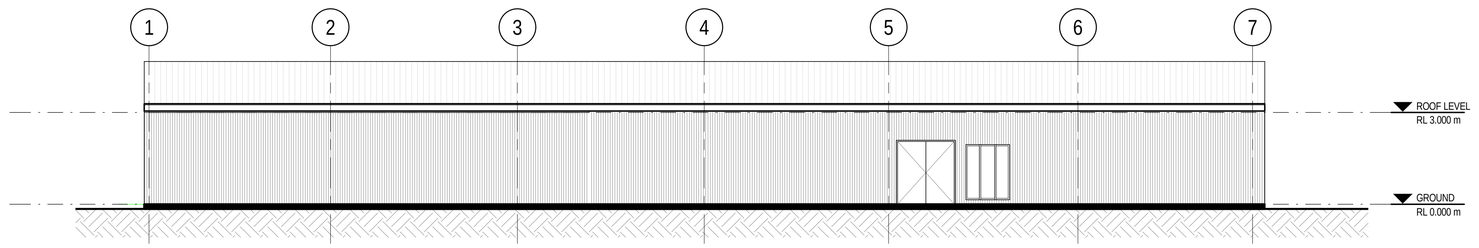

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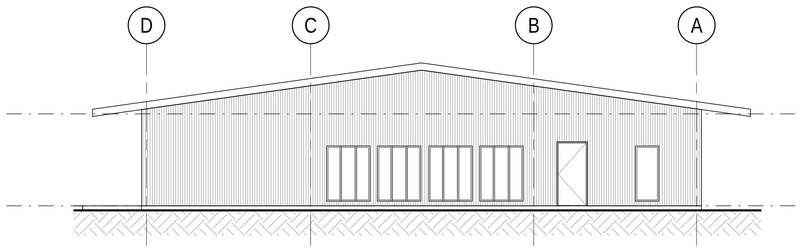

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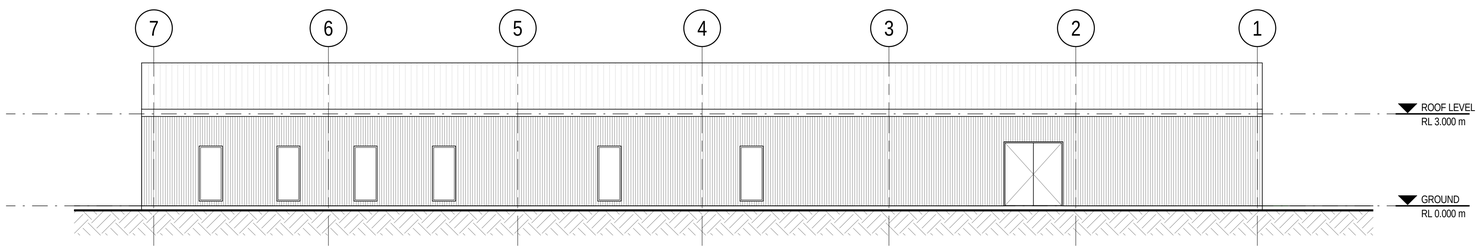

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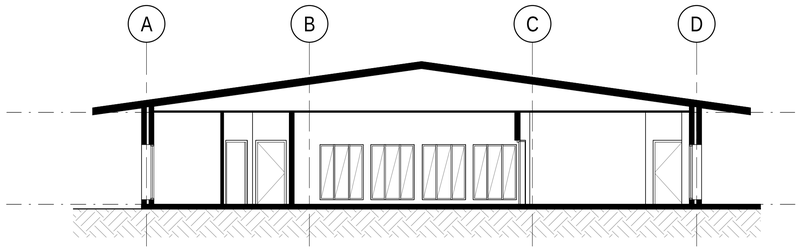

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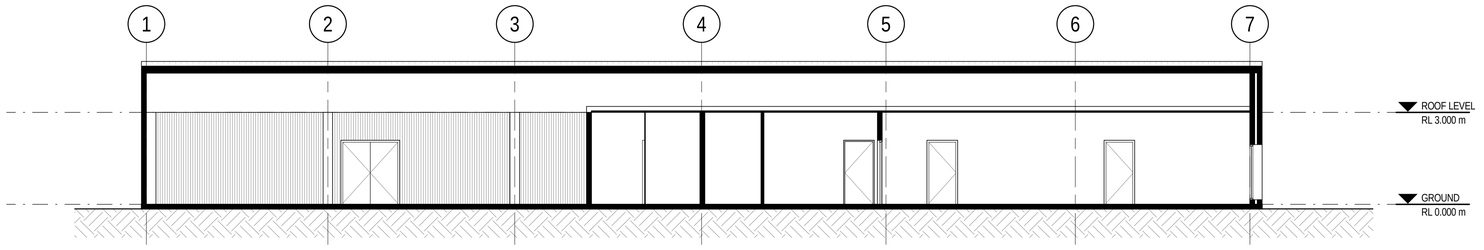

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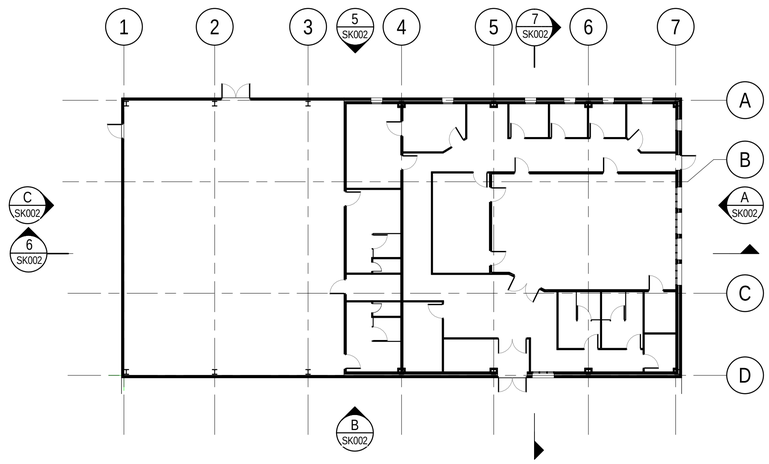

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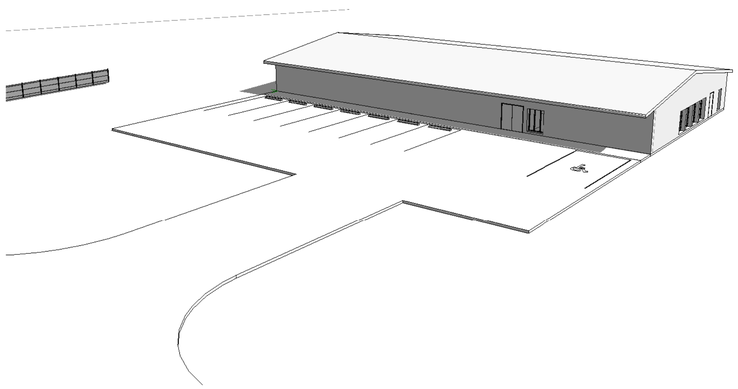

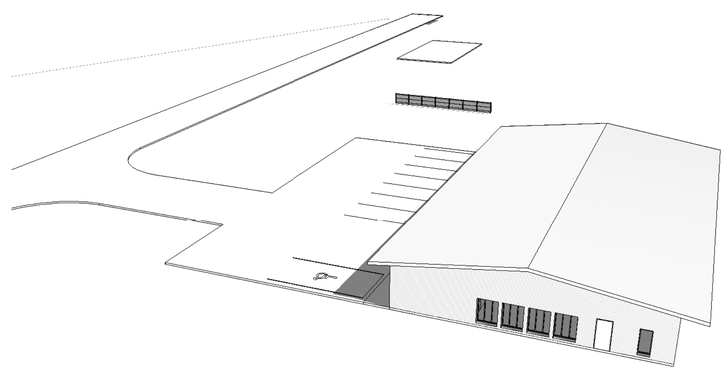

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DO NOT SCALE

Drawn	Author	Designer	Designer
Drafting Check		Design Check	Checker
Approved (Project Director)	Approver		
Date			
Scale	As indicated	This Drawing must not be used for Construction unless signed as Approved	

Client SOLARRESERVE
Project AURORA SOLAR ENERGY PROJECT
Title VARIOUS - ADMIN BUILDING

Original Size A1 **Drawing No: 33-18266-SK002** Rev:

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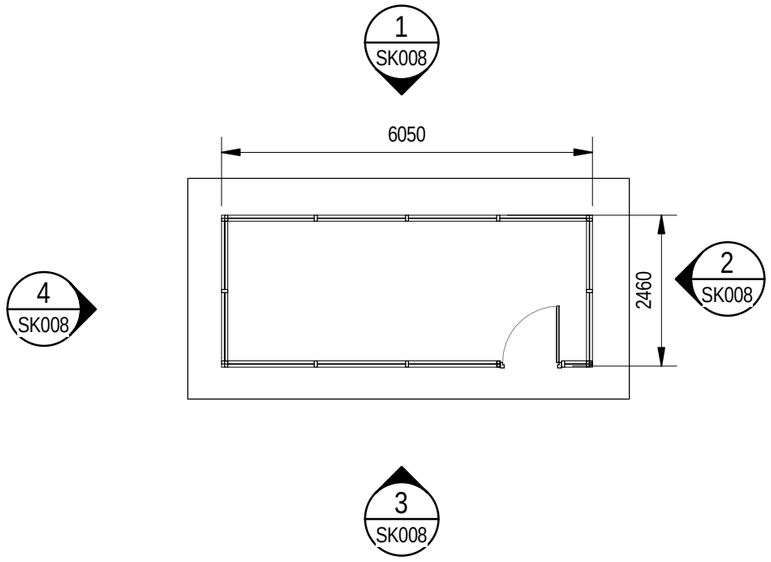

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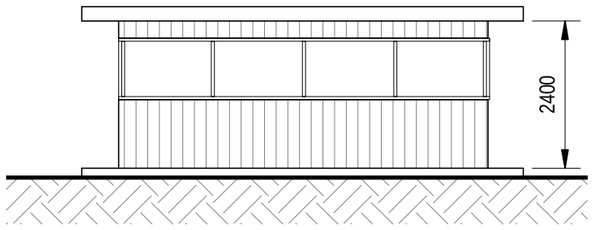

1 / A101 ELEVATION

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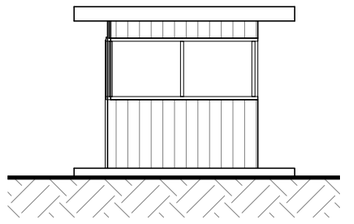

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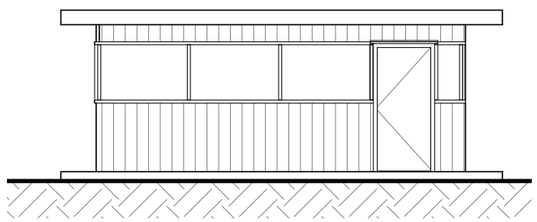

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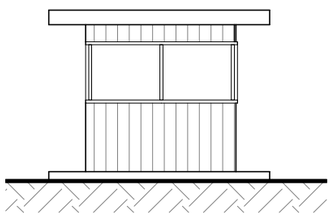

4 / A101 ELEVATION

SCALE 1 : 100

Rev	Description	Job Manager	Date

SOLARRESERVE

AURORA SOLAR ENERGY PROJECT

PLAN AND ELEVATIONS GUARD HOUSE

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E adlmail@ghd.com.au **W** www.ghd.com

scale 1 : 100 for A3 job no. 33-18266

date 09/18/17 rev no.

approved (PD) Approver_ __**SK008**

Plot Date: 18/09/2017 1:57:25 PM Cad File No : C:\Users\jholder\Documents\Revit 2016 Local Files\33-18266-AURORA SOLAR-R16_jholder.rvt

HELIOSTAT ASSEMBLY BUILDING GROUND FLOOR PLAN

SCALE 1 : 200

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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SCALE 1:200 AT ORIGINAL SIZE

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DO NOT SCALE

Drawn	Author	Designer	Designer
Drafting Check		Design Check	Checker
Approved (Project Director)	Approver		
Date			
Scale	1 : 200	This Drawing must not be used for Construction unless signed as Approved	

Client **SOLARRESERVE**

Project **AURORA SOLAR ENERGY PROJECT**

Title **GENERAL ARRANGEMENT PLAN HELIOSTAT ASSEMBLY BUILDING**

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Rev:

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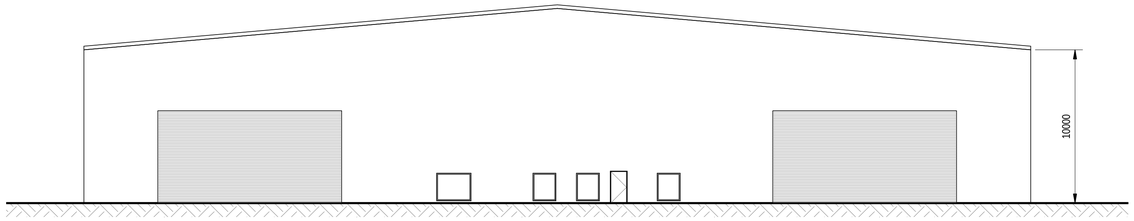

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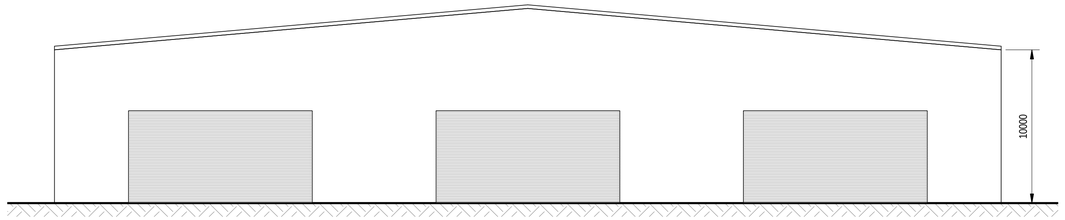

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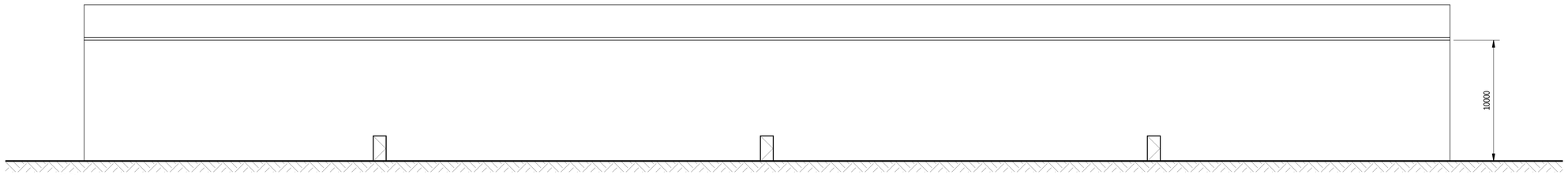

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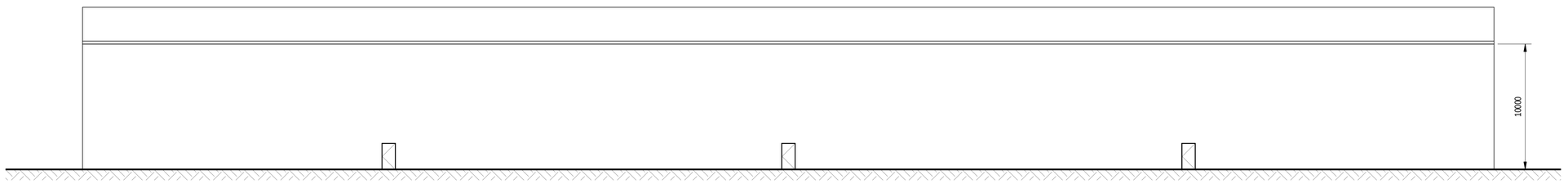

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SCALE 1: 200 AT ORIGINAL SIZE

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Level 4, 211 Victoria Square Adelaide SA 5000 Australia
GPO Box 2052 Adelaide SA 5001
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E adlmail@ghd.com.au **W** www.ghd.com

DO NOT SCALE

Drawn	Author	Designer	Designer
Drafting Check		Design Check	Checker
Approved (Project Director)	Approver		
Date			
Scale	1 : 200	This Drawing must not be used for Construction unless signed as Approved	

Client **SOLARRESERVE**
Project **AURORA SOLAR ENERGY PROJECT**
Title **ELEVATIONS**
HELIOSTAT ASSEMBLY BUILDING

Original Size **A1**
Drawing No: 33-18266-SK004
Rev:

Plot Date: 15/09/2017 5:01:18 PM
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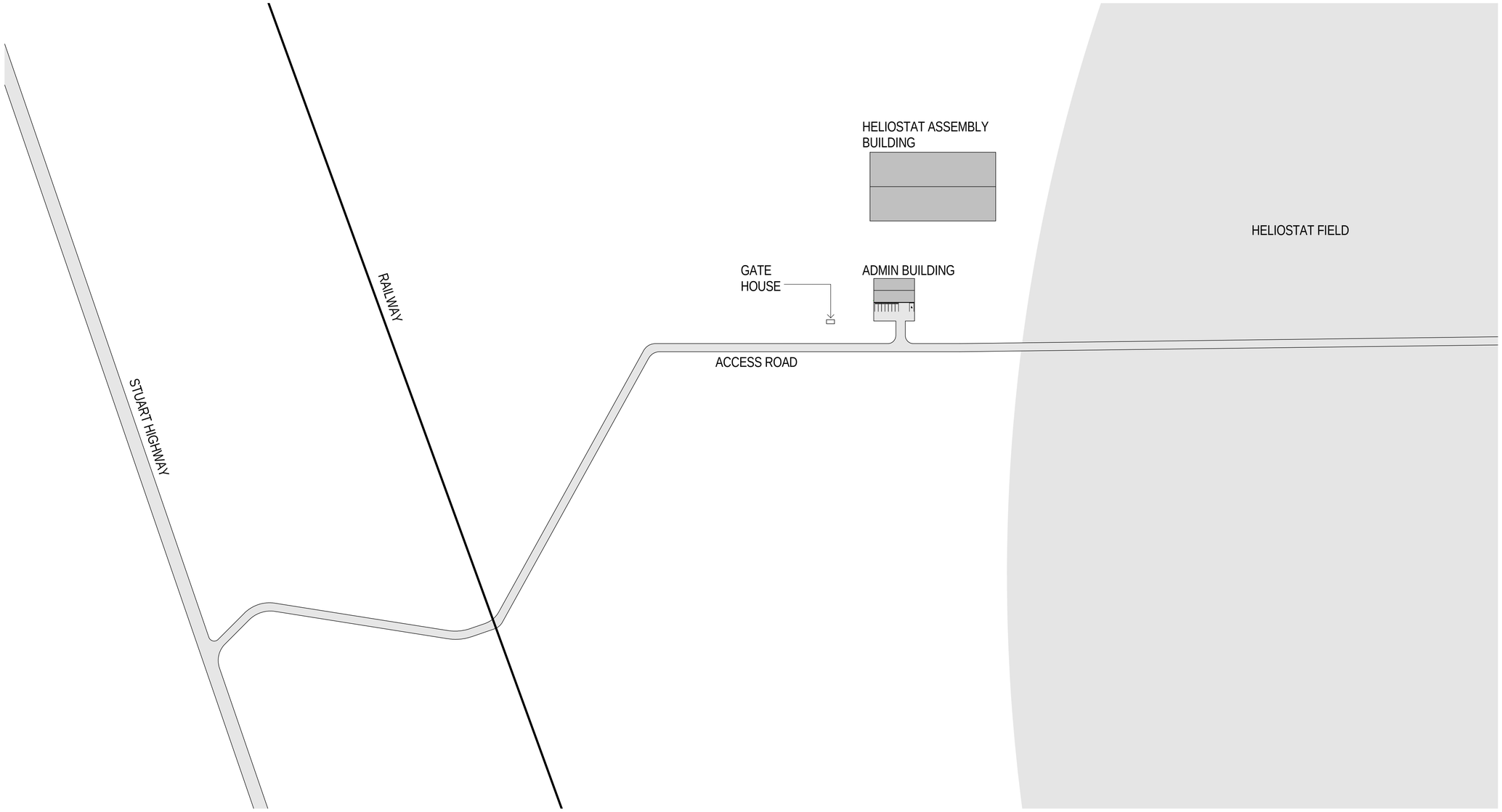

SITE PLAN
SCALE 1 : 2000

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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SCALE 1:2000 AT ORIGINAL SIZE

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Level 4, 211 Victoria Square Adelaide SA 5000 Australia
GPO Box 2052 Adelaide SA 5001
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Approved (Project Director)	Approver		
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Client **SOLARRESERVE**
Project **AURORA SOLAR ENERGY PROJECT**
Title **SITE PLAN**

Original Size **A1**
Drawing No: 33-18266-SK007
Rev:

Plot Date: 18/09/2017 2:32:27 PM
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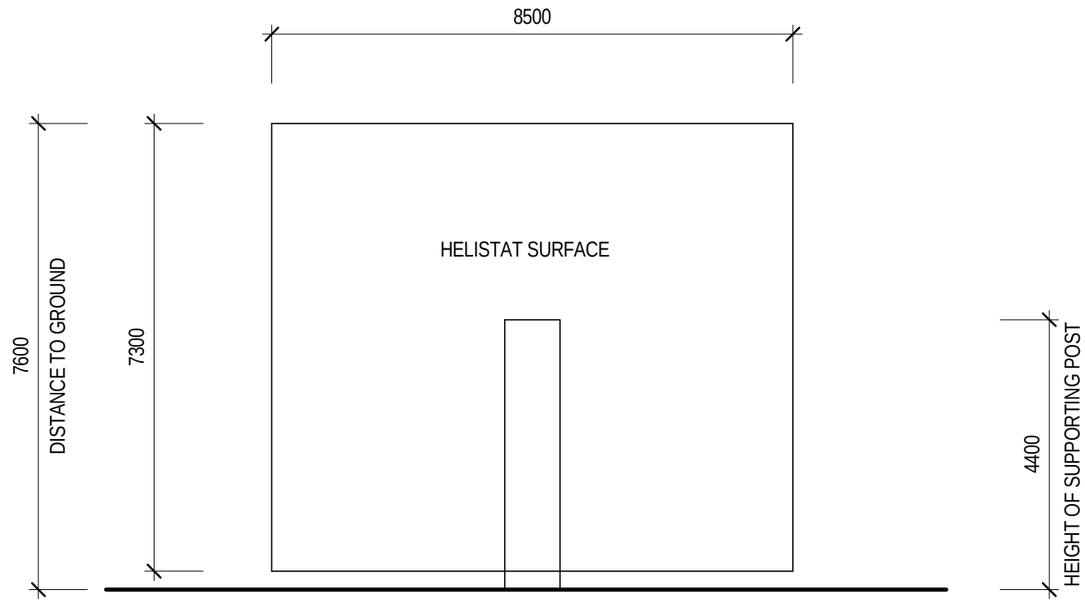

HELIOSTAT DIMENSIONS

SCALE 1 : 100

Rev	Description	Job Manager	Date

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AURORA SOLAR ENERGY PROJECT

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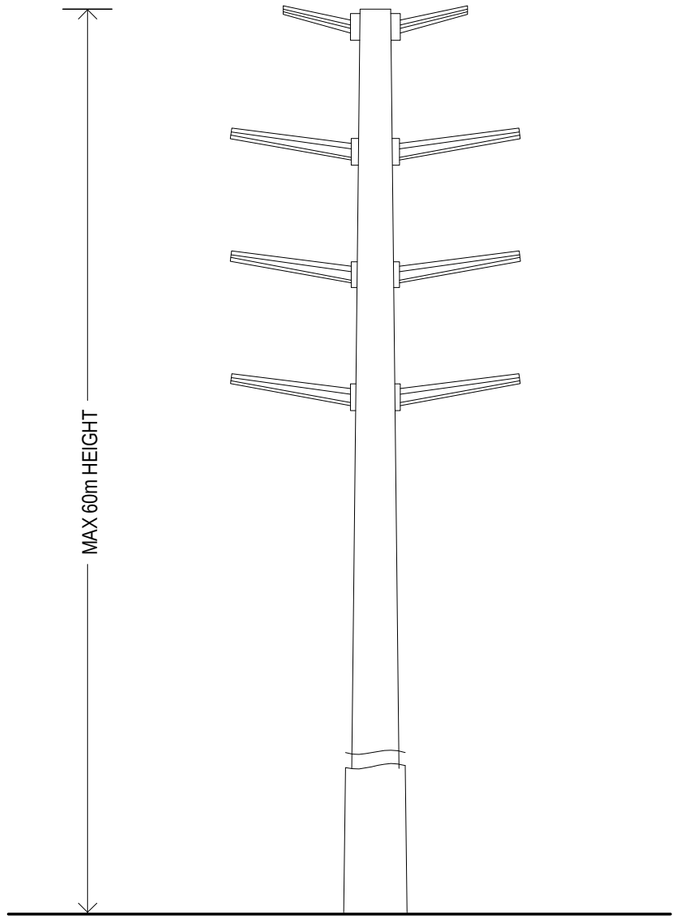

Rev	Description	Job Manager	Date

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AURORA SOLAR ENERGY PROJECT

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date	09/15/17		rev no.		

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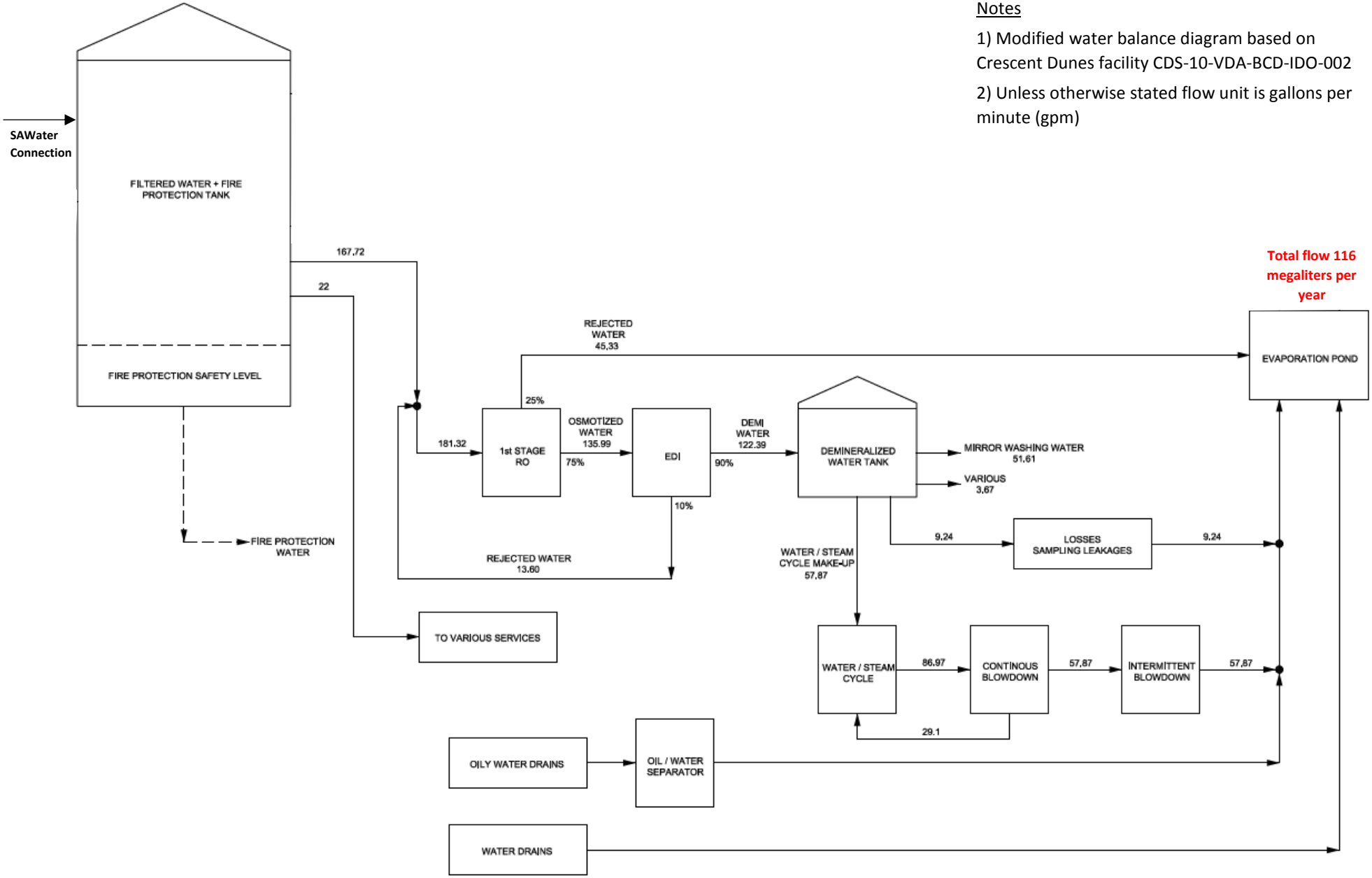
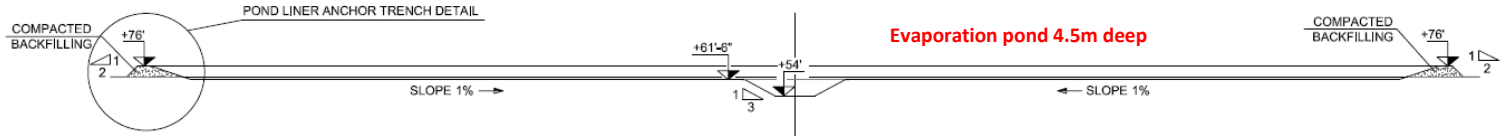
Notes

1) Modified water balance diagram based on Crescent Dunes facility CDS-10-VDA-BCD-IDO-002

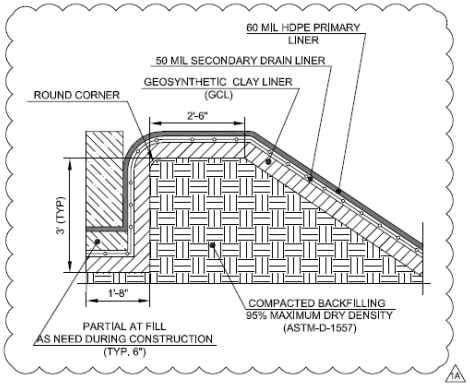
2) Unless otherwise stated flow unit is gallons per minute (gpm)



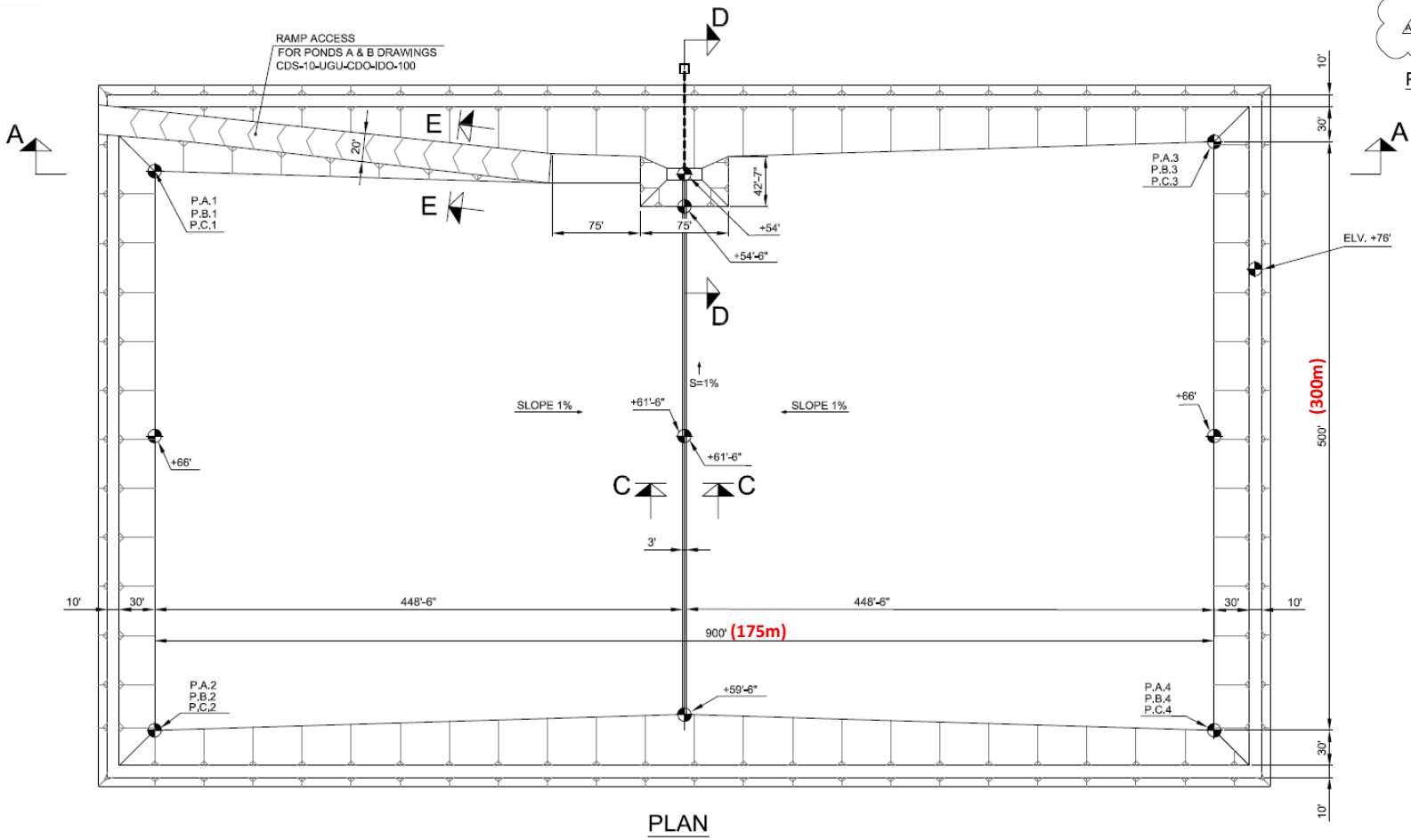
Indicative Aurora Evaporation Pond Water Balance Diagram



SECTION A-A



POND LINER ANCHOR TRENCH DETAIL



PLAN

Indicative Drawing of Aurora Evaporation Pond

Notes

1) Indicative design shown based on Crescent Dunes facility CDS-10-UGU-CDR-IDO-100

2) Unless otherwise stated all units are imperial (feet and inches)

Appendix D – Draft CEMP

SolarReserve

Aurora Solar Energy Project

Draft Construction Environmental Management Plan

October 2017

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1. Introduction

1.1 Introduction

This draft Construction Environmental Management Plan (CEMP) has been prepared to accompany a development application for the proposed Aurora Solar Energy project.

This draft plan sets the guiding principles for final CEMPs to be prepared by the respective construction element contractors and accepted by the relevant authority prior to construction. The CEMP will be submitted to the relevant authority, before being issued to prospective contractors who will undertake the construction works associated with this Project.

This document has been prepared to cover the following phases:

- Implementation and construction phase.
- Site closure and make good phase.

1.2 Purpose of this CEMP

This draft CEMP seeks to provide high level guidance to avoid and/or minimise potential environmental impacts associated with the construction of the Aurora Solar Energy project and identifies potential mitigation measures and strategies that should be adopted during construction.

A final detailed CEMP and issue specific CEMPs will be prepared by the respective construction contractors for review and acceptance prior to works commencing on site. Detailed site-specific mitigation measures will be developed and included in any final CEMP to be prepared by the construction contractors. A CEMP is a dynamic document and is to be updated by the contractor(s) as required to reflect detailed methodology, changes to site conditions or scheduled works. The construction contractor(s) will take responsibility for reviewing and managing the outcomes identified in the CEMP.

The purpose of the CEMP is to provide a high-level structure for the development of the detail CEMP which should also:

- Provide for works to be carried out in accordance with the environmental conditions outlined in the Development Approval;
- Provide for works to be carried out in accordance with the applicable environmental legislation and standards;
- Outline how the environmental features of the site are to be protected during construction;
- Ensure all potential environmental risks associated with construction are identified and assessed;
- Protect environmental features and sensitive receptors;
- Outline measures to monitor and control potential environmental impacts associated with the works that are implemented effectively;
- Provide government, community and other stakeholders with assurance that environmental issues associated with the works are managed appropriately;
- Allocate clear responsibilities for the environmental management at all levels; and
- Optimise construction methods.

1.3 Data Sources

Background documents prepared for the Aurora Solar Energy Project and the development application report for the Aurora Solar Energy project were used to inform the preparation of this draft CEMP. In particular the following documents provided background information:

- Development Application (GHD, 18 Sept 2017)
- Flora and Fauna Assessment (EBS, 14 Sept 2017)
- Cultural Heritage Assessment (EBS 6 Sept 2017)
- Traffic Impact Assessment (GHD, 14 Sept 2017)
- Aviation Impact Statement (Landrum & Brown, 14 Sept 2017)
- SA Arid Lands Natural Resource Management Plan (NRM, 2017-2027)

These studies, and any other finalised post production of this draft document, will need to be reviewed by the contractor prior to completion of the final CEMP.

2. Project Information

2.1 Project Description

2.1.1 Site Context

Location and surrounding towns/features

The project site is located approximately 30km north of Port Augusta on the Stuart Highway. The site is not within a Council area but is close to the Port Augusta Council boundary and is within the SA Arid Lands Natural Resource Management area.

Port Augusta is the nearest centre to the site. This is a significant regional centre that services much of the northern most part of the State and includes a range of regional level services including a hospital, medical centre as well as some regional state agency outlets.

Involved landowners and land use

The project will be located on land that is owned by the Crown but subject to a Pastoral Lease. Much of the surrounding land is also under Crown ownership with overlying Pastoral Leases. Native Title and Mining lease interests may also apply to surrounding land. A number of infrastructure corridors run through the site and the locality generally. It is important that the multiple tenure and land interests in this locality is acknowledged and respected.

Most of the land in the locality is used for stock grazing. Apart from grazing, the land is relatively undisturbed and therefore may contain important cultural artefacts as well as native vegetation.

Topography and climate

The topography of the area is generally flat with localised undulation. The site is located within the Gawler bioregion which features calcrete plains and gypsum dunefields and ranges which drain into terminal salt lakes. The site does not contain any defined drainage lines. Vegetation cover is critical to protecting soil from erosion cause by episodic, irregular and extreme boom and bust periods.

The project is situated in a semi-arid location with a very low rainfall. The mean annual rainfall is less than 220 mm per year. The area has relatively few days of rainfall where the mean rainfall days (rain ≥ 1 mm) is only 34 days in a year. Nevertheless, while the annual rainfall is low, the area does experience isolated high rainfall events (particularly in summer) that can lead to short duration flooding.

Transport and Infrastructure

There are few formed roads in this locality, with the main access to the site being via the Stuart Highway which is a major transport route between South Australia and the Northern Territory. This road is categorised for heavy vehicle transport and has a 110 km speed limit in the vicinity of the site.

A rail line and a mains water pipeline run parallel to the Stuart Highway between the highway and the site.

2.1.2 Site Location and Project Layout

The site is located on the property known as Carriewerloo pastoral station and is accessed only via the Stuart Highway. The core proposed development will cover an area of approximately 800 ha in addition to the transmission line that will connect the project to the national grid.

The infrastructure required for the installation and operation of the solar and storage project includes permanent facilities and temporary facilities for the duration of construction phase. The permanent infrastructure will include two main elements:

- A field of heliostats that are controlled to reflect sunlight to the top of the receivers: and
- A central power block that contains the equipment, materials and plant needed to generate and store energy.

This will be supported with a range of services and infrastructure including access tracks, stormwater management, underground cabling, administration and security building and perimeter fencing.

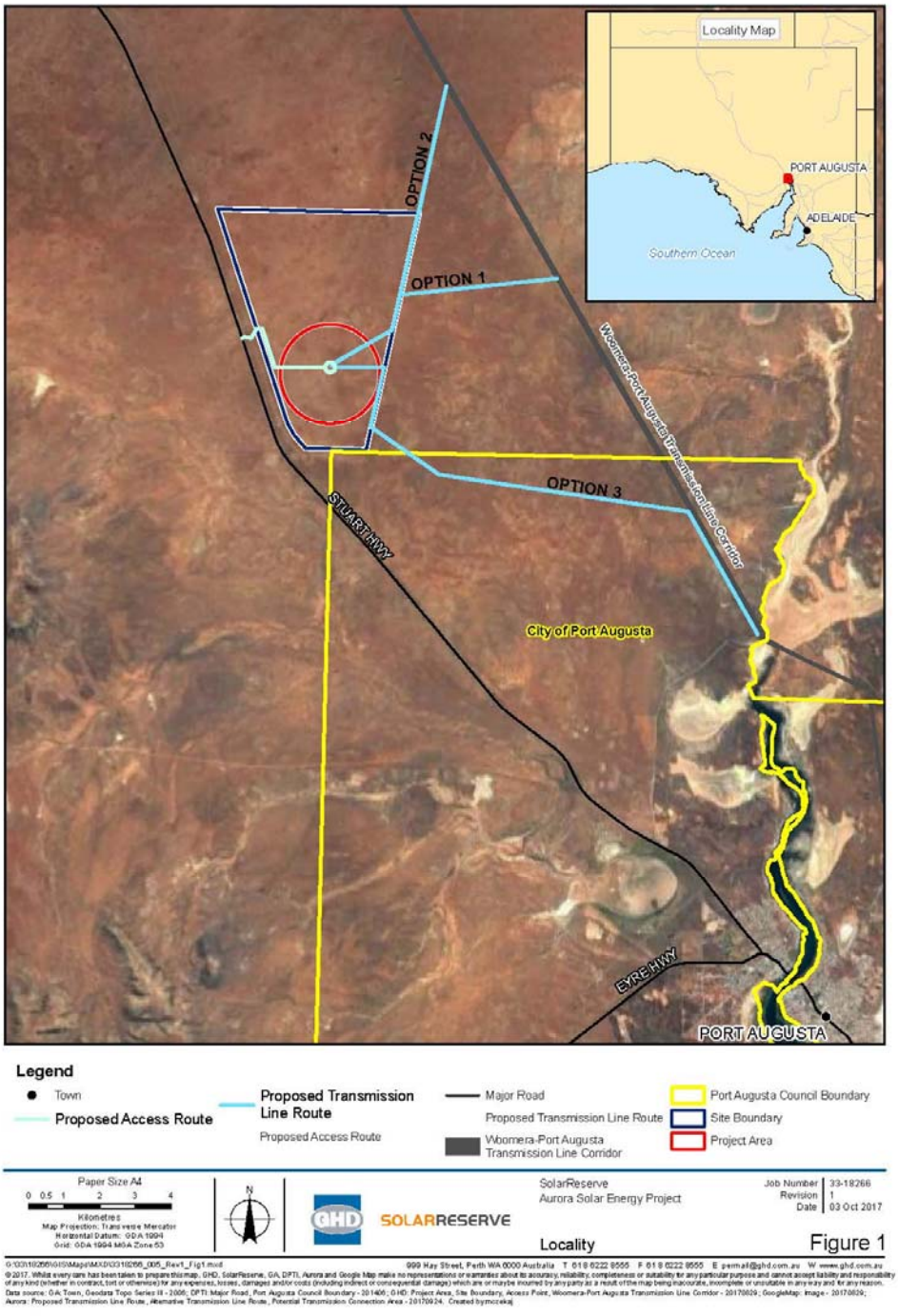

Figure 1 Locality Plan

Construction activities associated with the development will be undertaken over the following phases (which may start simultaneously):

- Site establishment;
- Access tracks and hardstand construction;
- Foundation construction;
- Underground cabling installation;
- Substation and overhead transmission line installation;
- Heliostat assembly (including building construction);
- Equipment delivery and installation;
- Heat transfer fluid preparation;
- Connection to the electricity grid;
- Commissioning; and
- Construction site decommissioning, removal of all temporary structures and restoration of the site.

Temporary infrastructure associated with the construction phase of the proposed wind farm includes a main compound area, laydown area, site offices and staff facilities.

It is expected that the processes involved in the construction will include the following key elements:

- Temporary storage of chemicals, spoil and equipment
- Topsoil stripping and vegetation removal
- Vegetation slashing in the heliostat field
- Excavation and borrow pit development
- Grading and compaction (cut and fill if required)
- Geotechnical investigations and bore hole drilling
- Concrete pouring
- Haul and construction vehicle movements
- Installation of equipment, fencing and cabling.

Temporary construction facilities will be dismantled and sites rehabilitated post construction.

2.2 Sensitive Receptors

This section summarises the environmental features which have been identified as potential sensitive receptors for this project. The potential construction impacts upon these receptors are considered in Section 3.

Table 1 Sensitive Receptors

Standard	Management Criteria
Community	The site is located in a very sparsely populated area. The closest dwellings (homestead) is approximately 1.8 km to the south west of the site. The next closest dwelling is 14 km to the south of the site. The site will be located on a parcel of land that is within a Pastoral Lease and a substantial grazing operation. The lessee will have a right of way to allow access around the project site. The site is within the Barngarla Native Title claim area. Where relevant, discussions and agreements with this group will be established to address use of land and management of cultural heritage.
Ecology	Limited access to water resources in this region means that much of the land has been protected from large scale clearance. Most of the vegetation that exists is native vegetation which is protected from removal or damage. There is evidence of Wedge-tiled Eagle breeding in the proximity to the site and a 500m buffer should be maintained around these nests.
Water Resources	There are no defined drainage line within the site area, although there may be some associated with the transmission line. Access to groundwater resources is not part of the project. While rainfall levels are relatively low, episodic storms can bring heavy rainfall (particularly during summer).
Soils and Geology	The plains of the southern Flinders Ranges are generally calcareous soils of loams and sands, including red calcareous earths, crusty red duplex soils and reddish sands. The geology of the general area contains Quaternary Sediments (mix of gravel, sand and clay layers), Tertiary Sediments (mix of sand, limestone and clay layers) and Proterozoic Basement Rocks.
Cultural Heritage	The project site is within the traditional lands of the Barngarla people. It is highly likely that cultural heritage artefacts will be present on the site. These artefacts are protected by the *Aboriginal Heritage Act 1988*. No sites of European Heritage have been identified within the site.

3. Environmental Management System

Managing environmental issues and promoting environmental awareness during the site works is an essential component of responsible project management. It requires the active consideration of environmental issues and health and safety as a prerequisite to all construction operations. This section identifies the key management measures which will be required to avoid or minimise these likely impacts. The contractor's EMS is expected to comprise an environmental policy and the basic elements indicated in Section 3 of this report.

3.1 Implementation Responsibility

The roles and responsibilities of the following key participants in the construction works for the project are outlined below:

- SolarReserve Principal
- Contractor Superintendent
- Contractor Environmental Manager
- Contractor and Staff.

The Principal will engage a construction company ("the Contractor") who will be responsible for ensuring the final CEMP is developed and implemented by all staff and their subcontractors involved with the construction works.

The Principal should ensure that all contractual documents specifically quote a CEMP in terms of responsibility for addressing and implementing relevant environmental requirements. The contractual documents should also indicate that the Contractor is responsible for ensuring legislative and CEMP compliance controls are maintained on site.

The Contractor is responsible for obtaining all relevant approvals/permits/licences prior to works commencing. The Contractor will appoint an Environmental Manager who is responsible for developing environmental impact mitigation measures compliant with all approvals, permits, licences and management measures and incorporating this into the CEMP for construction works. The Contractor will assign a superintendent who will have overall responsibility for ensuring that all employees, subcontractors, and persons involved with the planning and carrying out of the proposed works are familiar with their obligations to comply with environmental requirements.

Successful implementation relies upon support for, and compliance with, the CEMP's requirements from all involved parties. Responsibilities are detailed below:

Principal (the "Principal")

- Key contact and representative of SolarReserve.
- Ensure contractual documents include environmental responsibilities, adequate training and preparation of a final CEMP prior to construction commencing.
- Overall responsibility for ensuring the project meets its compliance obligations and environmental requirements are implemented.
- Agree procedures for emergency response.
- Agree frequency and method of auditing, monitoring and other matters which are to be reported to SolarReserve.

Environmental Manager (assigned by the Contractor)

- Responsible for managing environmental aspects during the construction and site closure phases and that the Superintendent has the information required to implement site controls successfully.
- Checks all environmental requirements, licences and procedures are implemented.
- Advises staff of special requirements.
- Conducts or commissions a consultant to undertake environmental audits/monitoring during all stages to ensure implementation of requirements.
- Determines and/or ensures environmental controls and procedures are in place and maintained during all phases of the project.
- Determines the training/instructions required for staff to be able to meet their environmental obligations.
- Reports environmental incidents during construction.
- Responsible for the emergency response procedure for environmental incidents.

Superintendent (assigned by the Contractor)

- Supervises and implements environmental controls on site during the construction works.
- Ensures training/instructions required by staff to be able to meet their environmental obligations, are undertaken and recorded.
- Reporting of environmental incidents to the Environmental Manager.
- During an emergency situation, responsible for informing the Environmental Manager and activating the response procedure.

Contractor(s) and Staff

- Implement environmental controls as directed
- Report environmental incidents to the superintendent.

Table 2 summarises the relevant project phase responsibilities relevant to implementation of a CEMP.

Table 2 Project Role Description and Responsibility

Planning	**Principal**	Oversees planning and Tender phase. Responsible for ensuring environmental compliance during the design phase and CEMP preparation.
	Design Consultant	Responsible for design of the facilities Responsible for preparation of a draft CEMP to guide development of a project-specific CEMP and outline legislative requirements.
	Environmental Manager	Responsible for review of the draft CEMP and preparation of final CEMP prior to construction commencing.
Construction Works	**Principal**	Responsible for environmental compliance.
	Superintendent	Oversees construction phase and enforces environmental controls on site.

	Environmental Manager	Ensures Contractor complies with environmental requirements.

3.2 CEMP Review, Reporting and Monitoring

The CEMP will only be effective if it is appropriately managed and utilised. Although the final CEMP will be developed prior to the commencement of construction works by the Contractor with the intention of covering the detailed methodology, circumstances may differ from those anticipated. Consequently it is very important that the CEMP be regularly reviewed and updated. This will ensure that the measures, responsibilities, criteria and corrective actions remain achievable, effective and suitable to the project, whilst maintaining compliance with relevant legislation and policy.

An important principle that is embodied in this draft CEMP is that of "continuous improvement". To facilitate this process it is critical that an appropriate monitoring, reporting and review process be developed and adopted.

3.2.1 Review of CEMP

The CEMP is to be reviewed throughout the construction phase monthly (or at a frequency determined by the Contractor). The review is to examine the following as a minimum:

- The implemented environmental management activities
- The incident reporting and preventative action procedures
- The complaints handling procedures
- The emergency response procedures for environmental incidents.

3.2.2 Monitoring Records

The results of any monitoring required by any approvals, licences or Conditions of Consent granted for the construction phase of the development must be:

- In a legible form
- Kept for at least 4 years after the monitoring or event to which they relate/took place
- Be available upon request to any authorised person.

The following minimum records will be kept in regards to any monitoring / sampling activity:

- The date(s) on which the monitoring was taken
- The time(s) at which the monitoring was collected
- The point at which the monitoring was taken
- The name of the person who conducted the sample.

3.2.3 Sampling Quality Control Plan

Where practicable NATA accredited laboratories will be used for any testing of samples taken in association with approvals, licences or consent conditions. Laboratory detection limits must be below the adopted assessment criteria.

Quality Assurance / Control measures such as collection and testing of duplicates and blind duplicates will be used to ensure the accuracy and quality of the required monitoring.

3.2.4 Follow Up Action

Where adherence to the requirements in this document are found to be unsatisfactory in achieving broader environmental and site management goals, action will be taken to investigate the cause and make amendments to the CEMP as required.

3.2.5 Reporting

The Contractor shall provide a fortnightly report to the Principal to cover the following circumstances:

- Include a report on any monitoring undertaken in accordance with licences, approvals or conditions of consent
- Provide a summary of complaints received during the construction phase of this project
- Report of compliance with the CEMP.

3.3 Training and Site Induction

The Contractor will oversee that all employees, sub- contractors and visitors receive environmental instruction in relation to the CEMP and legislative requirements. Each person will be made aware of and have an understanding of their obligations and duties detailed in this CEMP. Everyone involved with the project should be familiar with the CEMP components that are relevant to their role.

The Principal is responsible for overseeing that the contractual agreement with the Contractor specifies the necessity of providing adequate training to the construction teams. This responsibility is to be assigned to the Superintendent who can liaise with the Principal and other agencies, if required. During construction works, the Contractor must ensure that each operative is trained to use the machinery and materials on site efficiently to avoid environmental nuisance, including noise, air pollution, impacts on water quality, spread of waste material and land contamination.

3.4 Emergency Response and Incident Management

The final CEMP should detail emergency response procedures, with clear lines of responsibility to enable effective response with minimal environmental harm or disruption. The following sections provide an outline of procedures and protocols that should be included in the final CEMP.

3.4.1 Environmental Incidents (Notification of Environmental Harm)

The type of incidents that may require notification in accordance with legislation depends on the extent of harm or the potential damage to the environment. To ensure that SolarReserve has a consistent approach to incident reporting, the Principal must be contacted immediately after the site has been made safe. However, the steps necessary to render the site safe and notify appropriate authorities may require an immediate response from SolarReserve Principal. In addition valuable time may be lost in attempts to contact the Principal who may be unavailable to respond, however attempts to contact the Principle should be made immediately following an event. Therefore the Contractor's Environmental Manager and Superintendent will be responsible for ensuring:

- An immediate assessment of the potential onsite and offsite impacts of the incident
- Consulting (if necessary) with emergency services
- Instigating appropriate steps to mitigate the impacts

- Advising regulatory authorities, where these authorities can provide assistance with mitigation of impacts.

Failure to report an incident may result in enforcement action on all involved.

The Principal will provide written details of the notification to the appropriate authorities within 7 days of the dates on which the incident occurred.

The Principal will liaise with the appropriate authorities to provide suitable details within the time specified.

3.4.2 Emergency Response Plan

Emergencies that may occur during the construction phase of the project include:

- Fire and Bushfire
- Chemical spill
- Flooding
- Explosion
- Wildlife Injury
- Damage to existing infrastructure
- Personnel injury
- Seismic activity.

Prior to the commencement of the construction phase, the Principal and the Contractor are to agree on procedures for emergency response. It is the responsibility of the Contractor to develop, implement and train staff in the emergency response procedures.

To ensure emergencies are managed in an appropriate manner the Contractor is to follow the general procedures outlined in Table 4.

Table 3 General Emergency Response Plan

Standard	Management Criteria
Policy	To minimise the risk of an environmental accident or emergency during construction phase of the Project.
Performance Objective	Ensure that an Emergency Response Plan is kept in place to respond to any accidents or incidents that may impact on the environment and that all personnel are inducted in its application.
Implementation Strategy/ Mitigation Measures	Material Safety Data Sheets for all relevant materials used or stored on site, regardless of quantity, for the construction works shall be kept on site by the Contractor.
	Spill Response Kits, fire extinguishers and other emergency response equipment should be fully maintained and readily available.
	In the event of an emergency the Contractor's Superintendent is to immediately notify the Principal. The Superintendent will also notify the relevant emergency services.
Monitoring	Following an emergency, the affected areas shall be monitored as required. In the event of a spill, it should be ensured that all contaminated material, including soil, has been removed and properly disposed of by a suitably qualified contractor.

Standard	Management Criteria
	Follow up action is to be undertaken to ensure adequate provisions are implemented to minimise or eliminate the risk of reoccurrence of the emergency.
Reporting	Once immediate mitigation steps have been undertaken and the incident contained. All incidents/emergencies will be reported to the Principal. The Contractor is to record emergency information on an Incident/Complaints Form and will include the following: • Location of the emergency or incident • Name and telephone number of the designated contact person • Time of the emergency/incident • The environmental harm or nuisance caused, threatened, or to be caused by the emergency/incident • Any remediation work undertaken • Actions to be taken to prevent further incidents/emergencies and mitigate any environmental harm and/or nuisance caused by the incident/emergency.
Corrective Action	Non-conformance with this plan shall be documented by the Principal and corrective action undertaken to ensure future conformance. All non-conformances shall be documented and passed onto the Contractor.

3.4.3 Incident and Corrective Action Records

All environmental incidents need to be documented, recorded and followed up with identified corrective action(s). Incident Reporting documentation needs to be completed by those personnel involved along with the Contractor's Environment Manager; approval should be sought from the Principal. Corrective actions should be identified and documented in Corrective Action documentation and approved by the Principal's Representative. While identifying corrective actions to be taken, personnel responsible for implementing the corrective action need to be identified and informed of their responsibilities. Corrective Action documentation should be updated throughout the course of the construction works and/or until the identified actions have been fully completed.

Incident/Emergency Response Plan Contact Register

In the event of an incident or emergency occurring at the site, contact will be made with the key emergency services as identified in Table 4.

Table 4 Incident/Emergency Contact Register

Organisation	Title	Telephone Number
Principal (SolarReserve	TBC	TBC
SolarReserve Representative	TBC	TBC
Contractor Environmental Manager	TBC	TBC
Contractor nominated Superintendent	TBC	TBC
EPA	Pollution and Environmental Incident reporting (24 hour)	(08) 8204 2004
Fire Brigade (CFS) **Police** **Ambulance**	Emergency	000

3.5 Community information and grievance procedure

A programme will be established of public information provision to residents or other nearby sensitive receptors which may be impacted by the construction works, including haul traffic. A grievance procedure will be included in the final CEMP and implemented during the construction phase. A complaints register including details of the complaint, how the complaint was actioned / resolved should be maintained and retained throughout the construction period.

3.6 Fire prevention

Fires can eventuate from work activities or during operation. The dry grass may ignite causing damage to the grazing paddocks and adjacent dwellings. Fire may spread causing damage to the ancillary services and structures and smoke may disrupt traffic on adjacent roads.

Liaison with the CFS will be required prior to construction commencing, with regards to requirements during the "Fire Danger Period". Determine, in consultation with CFS, the appropriate firefighting measure and equipment required on site during construction.

Table 5 Fire prevention outline plan

Objective	Minimise the risk of fire resulting from the construction of the Aurora project.
Legislation / Policy	*Electricity Act 1996* *Fire and Emergency Services Act 2005* *Electricity Regulations 2012- General* *Electricity Regulations 2010 – Principles of Vegetation Clearance* *Australian Standard 1851(2012) – Portable Fire Extinguishers* *Australian Standard 1940(2004) – The storage and handling of flammable and combustible liquids.*
Potential Impacts	Fires can eventuate from work activities or during operation. The dry grass may ignite causing damage to the grazing paddocks, local infrastructure and the project. Fire may spread causing damage to the project infrastructure and ancillary services and structures. Smoke may disrupt traffic on the adjacent primary arterial road.
Mitigation	Liaise with CFS during the **pre-construction** stage with regards to requirements surrounding construction, during the "Fire Danger Period" Determine, in consultation with CFS, the appropriate firefighting measures and equipment required on site during construction. Provide CFS and SES information regarding the location of the equipment and measures implemented during the construction stage. **During construction**, the site will be maintained as follows: • Exotic grass must be no more than 200 mm in height; • Maintenance works such as mowing and tree pruning to be done before entering the Fire Danger Season or under CFS supervision. • Leaf litter must be less than 20 mm deep; • No fires would be lit at any time, for any purpose, including burning waste materials; • Spark-arrestors to be installed on all vehicle and machinery powered by internal combustion engines; • Vehicles may only be operated on approved roads and tracks for that class of vehicle. Only diesel powered vehicles may operate "off road" at any time. • Welding to be undertaken under controlled manner;

	• Minimise on-site storage of flammable materials; and • All vehicles to be equipped with compliant fire extinguishers. When conducting work using or generating intensive heat: • Use a fire resistant shield to prevent sparks or hot material from leaving the work area; • Provide a fire proof container for off-cuts; • The work area around active grinding equipment (mom) and hot work source (1.5 m) to be kept clear of flammable material or will be kept wet; and • Fire extinguishers and water tap to be made available in close proximity of the hot works area. During periods of High Fire Danger: • All hot work will be banned and no permits will be issued (including explosives) During **operation and decommissioning**, the same categories of work may be undertaken, therefore all the above applies for the life cycle of the project. Particular measures for safe operation of include: • Communication protocol in case of fire to be implemented to all staff involved in operation and maintenance works; • All staff to be trained in working in bushfire prone area, to be able to respond in case of emergency; • Regular updates to be given to CFS regarding firefighting materials and measures implemented on site; • Location of water supply infrastructure to be clearly indicated on site; and • Firebreaks will typically be created around the perimeter of the site, the storage facility and other buildings.
Strategy	A Fire Prevention Management Plan will be provided as part of the final CEMP.

4. Issue Specific Management Plans

The following sections outlines potential mitigation strategies to avoid and/or minimise potential impacts to various environmental aspects associated with the construction works. Key legislative considerations and potential approvals/permits are highlighted. This will need reviewing against the construction methodology, once finalised. The Contractor's Environmental Manager will need to define the Inspection / Criteria/ Target / Evidence required to determine compliance with each element of the CEMP. Mitigation measures provided represent the minimum requirements that should be adopted in any final CEMP to be prepared prior to commencement of construction. Where indicated, Management Plans should be prepared and provided as part of the final CEMP.

The following outline management plans provided here are:

- Flora and Fauna Protection
- Weed, Pest and Disease Control
- Water Quality Protection
- Soil Management, Erosion and Sediment Control
- Construction Noise and Vibration Control
- Air Quality Control
- Materials, Fuels and Waste Management
- Protection of Sites of Cultural and Natural Heritage Significance.

In addition, specific management plans will be required for:

- Construction traffic
- Remediation and rehabilitation.

4.1 Flora and Fauna and Rehabilitation

Table 6 Flora and Fauna Protection

Objective	Minimise impacts to native flora and fauna including vegetation clearance and manage the works so as to avoid damage to protection vegetation and fauna.
Legislation / Policy	*Native Vegetation Act 1991* *Native Vegetation Regulations 2003* *Environment Protection and Biodiversity Conservation Act 1999* *Natural Resources Management Act 2004* *National Parks and Wildlife Act 1972*
Permits/Approvals	Consent to clear Native Vegetation under Native Vegetation Act 1991. This site contains high quality remnant native vegetation. An application for clearance will be obtained for the site and the transmission route. However, the detailed design stage may result in changes that lead to a higher risk of impact. If additional native vegetation requires clearance an additional approval will be required.

Table 7 Flora and Fauna Protection Mitigation and Controls

Key Construction Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment Topsoil stripping and vegetation removal Excavation and borrow pit development	Potential disturbance to fauna located in areas to be cleared. Potential disturbance to fauna residing in habitats adjacent works area. Native vegetation located within the works area could be impacted. Vegetation within the footprint of the proposal may require clearance approval.	Approvals for clearance will be required and a Flora and Fauna Management Plan will be needed as part of the final CEMP. Minimise the construction area footprint and avoid, where possible, disturbance to native vegetation Vegetation exclusion zones should be clearly identified and communicated to site personnel. Place equipment and stockpile areas on previously cleared areas away from trees, bushes and native grasses, where possible. Avoid work/storage within the drip-line of trees to prevent damage to the tree roots and soil compaction. If there is any removal of native vegetation required during construction, it will be conducted in accordance with the requirements of and approvals under Native Vegetation Act	TBC	Environmental Manager Superintendent

Key Construction Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		1991. Any direction provided by the Native Vegetation Council must be adhered to. Do not burn off cleared vegetation.		
Construction traffic movement	Increased potential for wildlife vehicle strike on haul roads to and from site.	Use existing access tracks where possible to minimise additional disturbance. The risk of wildlife strike on the Stuart Highway is high and should be taken into account. Speed limits on haulage traffic may be required to prevent increased occurrence of wildlife strike.	TBC	Environmental Manager Superintendent
Tidy and make good work areas	Minimise permanent impacts to flora and fauna.	The reinstatement works will be undertaken as soon as practical after the completion of earthworks. Temporary or permanent measures will be implemented either to help with the revegetation process or to provide additional protection against erosion. On steep slopes erosion control matting may be used to provide interim protection until the vegetation cover is fully established.	TBC	Environmental Manager Superintendent

4.2 Weed, Pest and Disease Control

Table 8 Weed, Pest and Disease Control

Objective	Prevent the movement or increase in weeds, pests or diseases.
Legislation / Policy	*Native Vegetation Act 1991* *Native Vegetation Regulations 2003* *Environment Protection and Biodiversity Conservation Act 1999* *Natural Resources Management Act 2004* *National Parks and Wildlife Act 1972*
Permits/Approvals	Permit to move pest plants or animals (Natural Resources Management Act 2004)

Table 9 Weed, Pest and Disease Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment Topsoil stripping and vegetation removal Excavation and borrow pit development	Potential spreading of weeds, pests and diseases. Potential increase in prevalence of pest animals.	A Weed, Pest and Disease Management Plan will be provided as part of the final CEMP. Control weeds on site during construction and monitor the site for any outbreaks. Ensure that raw materials, such as rubble, gravel, sand, soil and water brought into the construction site are free of Phytophthora. Check rock prior to transportation and clean/spray as appropriate. Ensure that all floras brought into this zone are free of Phytophthora. Vegetation from weed species should be disposed of separately at a licensed waste depot.	TBC	Environmental Manager Superintendent
Construction traffic movement	Potential spreading of weeds and pests. Potential increase in prevalence of pest animals.	Follow weed or disease hygiene procedures ensuring vehicles and equipment are cleaned as required.	TBC	Superintendent

4.3 Water Quality Protection

Table 10 Water Quality Protection

Objective	Minimise impact to surface and ground water quality within works area and haul routes.
Legislation / Policy	*Environment Protection Act 1993* *Environment Protection Regulations 2009* *Environment Protection (Water Quality) Policy 2003* *Natural Resources Management Act, 2004* *Stormwater Pollution Prevention, Code of Practice for the Building and Construction Industry* *EPA Guidelines (EPA 396/10) - Water Quality, Dredging and Earthworks Drainage.*

Permits/Approvals	Earthworks drainage authorisation (section 7(6) of Schedule 1 of the Environment Protection Act 1993) may be relevant. Exception to exceed water quality criteria above Protected Environmental Values under the Environment Protection (Water Quality) Policy 2003 may be required. Approvals may be require for actions/activities that have an impact on water resources such as up-grades of watercourse crossings, water extraction, water degradation (Natural Resource Management Act, 2004).

Table 11 Water Quality Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment Topsoil stripping and vegetation removal Excavation Bore hole drilling Grading and compaction (cut and fill if required) Concrete pouring Water usage for construction works Instillation of permanent equipment Temporary storage areas	Impact to the natural movement of surface and groundwater affecting availability to flora and fauna and local communities and landowners. Impacts to water quality can affect aquatic fauna, decreases the aesthetic value of a watercourse or water body and can damage transport infrastructure.	A Water Management Plan will be prepared prior to construction. Stormwater facilities are not blocked or restricted. Runoff from unsealed areas at the construction site does not enter stormwater drains or natural drainage lines. Stormwater diverted around stockpiles. Control surface run-off entering and leaving the work area. The stormwater drainage infrastructure installed will be inspected and its suitability to the permanent configuration of the access tracks, hardstands and buildings compounds will be assessed. Consideration will be given to stormwater drainage control when establishing the construction site. The following objectives will be considered: • Limit site access to designated routes and controlled area; • Locate and secure all stockpiles resulted from excavation or imported materials away from watercourses and concentrated water flow paths; • Ensure that all the stormwater drainage are in place before site clearing works begin;	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		• Assess the impact of the proposed stormwater drainage systems on the adjacent properties; • Consideration to existing underground services will be given when establishing the access tracks and construction site, and protection will be provided where required. • Construction of access road networks may alter surface drainage paths. Drainage should be installed to mitigate potential effects, taking into consideration ephemeral watercourses • Ensure any conditions/obligations relating to a Permit for surface or groundwater extraction is complied with. Chemical testing of any identified water source should be carried out to determine the suitability of water for use in mixing concrete, or for dust suppression.		
Reinstatement of excavation areas Tidy and make good work areas		Cleared areas to be stabilised / rehabilitated promptly.	TBC	Environmental Manager Superintendent

4.4 Soil Management, Erosion and Sediment Control

Table 12 Soil Management, Erosion and Sediment Control

Objective	Minimise erosion within works area and haul routes and minimise sediment laden stormwater leaving the site.
Legislation / Policy	*Environment Protection Act 1993* *Environment Protection Regulations 2009* *Environment Protection (Water Quality) Policy 2003* *Natural Resources Management Act, 2004* *Stormwater Pollution Prevention, Code of Practice for the Building and Construction Industry*

Permits/Approvals	Earthworks drainage authorisation (section 7(6) of Schedule 1 of the Environment Protection Act 1993.) may be required.

Table 13 Soil Management, Erosion and Sediment Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment Excavation and borrow pit development Grading and compaction (cut and fill if required) Concrete pouring	The soil characteristics are likely to be subject to soil erosion by water and potentially wind if ground is disturbed. Soil erosion can contaminate watercourses, lead to loss of vegetation, impact on aquatic fauna, decreases the aesthetic value of a watercourse, reduce the agricultural capacity of land and can damage transport infrastructure.	Soil erosion and generation should be minimised during construction. A Soil, Erosion and Sedimentation Management Plan will be provided as part of the final CEMP. Minimise areas of ground cover/vegetation loss on areas identified for clearance. Erosion and sedimentation control devices installed prior to commencement of construction/works.	TBC	Environmental Manager Superintendent
Topsoil stripping and vegetation removal	Damage to top soil and subsoil.	The Management Plan should be developed that includes the following: • Maps showing areas to be stripped and those areas where vegetation is to be slashed but root stock left in-situ. • Minimise areas of vegetation loss to areas identified for clearance as part of the scheme. • The appropriate method for stripping, stockpiling, respreading and ameliorating the soils. • The location of soil stockpiles and content (e.g. Topsoil type A subsoil type B). • Schedules of volumes for each material. • Expected after-use for each soil whether topsoil to be used on site, used or sold off site,	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		or subsoil to be retained for landscape areas, used as structural fill or for topsoil manufacture. • Identification of person responsible for supervising soil management. Soil should be handled in the right conditions of weather and soil moisture and using suitable machinery in an appropriate way. Soil that is wet or very moist (wetter than the plastic limit) should ideally be allowed to dry further. Use tracked equipment wherever possible to reduce compaction. Confine movement of trucks or dumpers to designated temporary haul routes. Multiple handling of soil materials increases the risk of damage to soil structure so should be minimised. Avoid stripping topsoil, intended for reuse, too deeply so that subsoil becomes incorporated, thereby reducing fertility. Do not remove topsoil from below the spread of trees to be retained.		
Temporary storage of spoil	Soil erosion can contaminate watercourses, lead to loss of vegetation, impact on aquatic fauna, decreases the aesthetic value of a watercourse, reduce the agricultural capacity of land and can damage transport infrastructure.	Implement controls to prevent and minimise the risk of any sediment from earthworks entering the stormwater system. Areas of exposed soil, including stockpiles, are protected from erosion, or that suitable control measures are in place to prevent any mobilised soil being transported off site. Locate stockpiles away from watercourses and not in drainage lines. Stormwater diverted around stockpiles.	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		Any dewatering on site to be undertaken in a manner which prevents sediment entering stormwater drains and water course. Use of sediment curtains, cofferdams or similar to prevent suspended sediment movement during construction within water or areas likely to be inundated. Maintain the sediment control and stormwater drainage devices at all times.		
Construction traffic movement	Soil compaction	Construction traffic must use agreed haul roads to travel to move around site and approved areas for parking to reduce unnecessary soil compaction.	TBC	Superintendent
Reinstatement of excavation and borrow pit areas Tidy and make good work areas		All stockpiles resulting from excavation works will be removed from site. The access tracks width will be reduced to approximately 6 metres. Top soil will be spread over exposed batters and vegetation will be reinstated. The reinstatement works will be undertaken as soon as practical after the completion of earthworks. Cleared/excavated areas to be stabilised / rehabilitated promptly and where possible enhance the natural value of these areas. Temporary or permanent measures will be implemented either to help with the revegetation process or to provide additional protection against erosion. On steep slopes erosion control matting will be used to provide interim protection until the vegetation cover is fully established.	TBC	Superintendent

4.5 Construction Noise and Vibration

Table 14 Construction Noise and Vibration

Objective	Avoid and/or minimise noise and vibration emissions during construction works.
Legislation / Policy	*Environmental Protection Act 1993* *Environment Protection Regulations 2009* *Environment Protection (Noise) Policy 2007* *AS2436 – 1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites* *Australian Standard AS 1055−1997 Acoustics – Description and measurement of environmental noise* *Australian Standard 2187.2 2006 – Explosives – Part 2: Use of explosives*
Permits/Approvals	Blasting permits may be required.

Table 15 Construction Noise and Vibration Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment. All construction activities All installation activities Bore hole drilling Tidy and make good work areas.	Noise and vibration from construction activities may impact on nearby sensitive receptors including residential dwellings and/or wildlife.	A Construction Noise and Vibration Management Plan will be Throughout construction activities the Contractor will be required to observe all obligations under the Environment Protection Act 1993 and Section 6 of AS2436 – 1981 "Guide to Noise Control on Construction, Maintenance and Demolition Sites". Activities to be undertaken must be compliant with requirements of Environment Protection (Noise) Policy 2007. Plant and equipment used to be properly maintained and have noise limitation equipment installed as per manufacturer's specification. Plant and equipment used on site to be stood down when not required. Construction to occur only during the hours specified in the Development Approval. Works carried out outside of the hours will only entail:	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		• works that do not cause noise emissions which exceed the noise limits of the Policy at any nearby dwelling not associated with the project; or • the delivery of materials as requested by Police or other authorities for safety reasons; or • emergency work to avoid the loss of lives, property, and/or to prevent environmental harm; or • works with the prior consent of the Environment Protection Authority (EPA) (an example might be occasional concrete pours on hot days). Nearby residents/stakeholders will be notified of construction activities. Separation distances maintained to the greatest extent possible from construction works or fixed plant, to any sensitive receptors. Site perimeter fencing may need to be established for the work area and may include a noise and vibration barrier where relevant. Noise monitoring undertaken if required upon receipt of a complaint. To monitor potential vibration impacts from construction works on nearby structures, dilapidation surveys may be required.		
Blasting (may be required)	Noise and vibration from blasting activities may impact on nearby sensitive receptors including residential dwellings, structures and/or wildlife.	Blasting permits are required prior to construction, and all blasting will comply with current legislation, ensuring safety for workers and minimisation of impact on surrounding infrastructure and sensitive receptors.	TBC	Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Construction traffic movement	Haul traffic may cause noise and vibration nuisance or damage to residential and sensitive receptors traveling to and from the site	A Construction Traffic Management Plan will be established prior to construction commencing. Appropriate routes for light and heavy construction vehicles selected to minimise disturbance prior to commencement of construction works. Construction traffic must use agreed haul roads to travel to and from site. Approved areas for parking will be identified. All vehicles and equipment will be operated and maintained to comply with regulatory standards in order to control noise emissions. Best practice in regard to construction traffic in residential or township areas.	TBC	Environmental Manager Superintendent

4.6 Air Quality Control

Table 16 Air Quality Control

Objective	Avoid and/or minimise air quality impacts during construction works.
Legislation / Policy	Environmental *Protection Act 1993* *Environment Protection Regulations 2009* *Environment Protection (Air Quality*) Policy *1994*
Permits/Approvals	NA – Dust control may be required to prevent visibility impacts on Stuart Highway

Table 17 Air Quality Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment. All construction works	Dust from construction impacting surrounding environment including visibility	An Air Quality Management Plan will be provided as part of the final CEMP.	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Concrete pouring Tidy and make good work areas.	on primary road, water bodies and wildlife. Odour from construction works impacting amenity of surrounding area.	Dust controls to be implemented during construction including management of stockpiles (height, orientation etc.) and the use of suppressants including water spraying as required. Works that are likely to generate dust will cease when dry or windy conditions are conducive to the release of dust should dust suppression strategies be rendered ineffective. Air Quality monitoring undertaken if required upon receipt of a complaint. Stockpiles covered or watered down. Develop and follow a fire prevention plan.		
Construction traffic movement.	Exhaust fumes from construction and haulage to and from site impacting surrounding environment including residential areas and wildlife. Dust emitted from transported loads.	A Construction Traffic Management Plan will be prepared prior to construction commencing which will identify the haul route and any specific mitigation required i.e. management of potential fugitive material during transportation, operation of equipment to control exhaust emissions, a procedure for complaints. All vehicles and equipment will be operated and maintained to comply with regulatory standards for exhaust emissions. Construction site roads watered down. Spray with water and/or cover pavement materials and aggregates before transporting. Any loads of dust generating or odorous materials entering or leaving site to be covered.	TBC	Superintendent

4.7 Materials, Fuels and Waste Management

Table 18 Materials, Fuels and Waste Management

Objective	Avoid and/or minimise impacts associated with the release of hazardous substances or materials. Avoid and/or minimise waste generation during the construction works.
Legislation / Policy	*Environment Protection Act 1993* *Environment Protection Regulations 2009* *Dangerous Substances Act 1979* *Dangerous Substances Regulations 2002.* *Controlled Substances Act, 1984* *Natural Resources Management Act, 2004* *Environment Protection (Waste to Resources) Policy 2010* *EPA Guidelines for Stockpile Management – Waste and Waste Derived Fill* *EPA Guidelines for Bunding and Spill Management* *EPA Current criteria for the classification of waste - including Industrial and Commercial Waste (Listed) and Waste Soil* *Concrete batching Industry Guidelines (EPA) 2009*
Permits/Approvals	Dangerous Substances (Dangerous Substances Act 1979) and/or Waste Transporter's licence (Environment Protection Act 1993 and Environment Protection Regulations 2009.)

Table 19 Materials, Fuels and Waste Management Mitigation and Control

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment. Temporary storage of chemicals, spoil and equipment. Permanent storage areas for fuels and equipment. Blasting Concrete pouring Tidy and make good work areas.	Contamination of the environment with hazardous substances and/or materials.	Prior to construction commencing, a Materials, Fuels and Site Waste Management Plan will be established which will identify the materials and storage requirements for all chemicals used on site or transported to site. All hazardous chemicals and dangerous goods used or stored at the subject site during construction will be stored in accordance with the Dangerous Substances Act and the EPA Guidelines. Material Safety Data Sheets for all relevant materials used or stored on site, regardless of quantity, for the construction works shall be kept on site by the Contractor. Spill kits will be located on site to be used in the event that there is an incident and appropriate personnel will be trained in the use of this equipment. Storage of materials should not be in areas at risk of inundation. All hazardous chemicals and dangerous goods should be stored away from any drainage channels and stormwater drains. Decanting/pumping of hazardous substances and materials to occur in bunded area where possible. Spills cleaned up immediately (spill kit). Emergency procedures in the event of a spill should be documented.	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment. All construction works Tidy and make good work areas.	Waste generated during construction impacting upon the environment. Waste generated during construction inappropriately disposed of offsite and impacting the environment.	Prior to construction commencing, a Materials, Fuels and Site Waste Management Plan will be established which will identify the type and amount of waste to be generated during construction and procedures for the storage, reuse, recycling and/or appropriate disposal of waste. Contaminated soil and/or groundwater disposed of appropriately, if required. Management of waste in accordance with all statutory and licensing requirements. Any food waste should be contained and removed from site regularly to prevent attracting pest species. Implement to reduce waste: • Re-use of materials wherever possible in accordance with legislative requirements. • Adequate waste separation repositories. • All waste generated during construction separated at source and taken to an appropriately licenced waste disposal facility if not able to be re-used on site. • No burning or waste burial on site. • Management of litter and site debris.	TBC	Environmental Manager Superintendent
Grading and compaction (cut and fill if required)		Any use of waste derived fill undertaken in accordance with legislative requirements. If waste fill required, should be suitably assessed by a qualified environmental professional and have classification status confirmed prior to importation to site. Site Contamination Audit Report, if required, prior to the use of waste derived fill during construction.	TBC	Environmental Manager Superintendent

4.8 Protection of Sites of Cultural and Natural Heritage Significance

Table 20 Protection of Sites of Cultural and Natural Heritage Significance

Objective	Manage the works to prevent or minimise impacts to sites or artefacts of Indigenous or European heritage.
Legislation / Policy	Native *Title (South Australia) Act 1994* *Aboriginal Heritage Act 1988* *Heritage Places Act 1993* *Aboriginal and Torres Strait Island Heritage Protection Act 1984 (Cwth)* *Native Title Act 1993 (Cwth)* *Environment Protection Act 1993*
Permits/Approvals	Authority to disturb an Aboriginal site or object (Section 23 approval under the Aboriginal Heritage Act 1988).

Table 21 Protection of Sites of Cultural and Natural Heritage Significance Mitigation and Controls

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
Site Establishment. Topsoil stripping and vegetation removal. Excavation and borrow pit development Blasting. Tidy and make good work areas.	Damage to sites or artefacts of indigenous or European heritage or to their setting.	An Archaeological and Cultural Heritage Management Plan will be provided as part of the final CEMP. Work with the Barngarla Community prior to construction commencing to meet the requirements of any signed agreements. Should any archaeological occurrences be located during the course of the works the contractor and the Principal must report such an occurrence to the appropriate Aboriginal organisations and Aboriginal Affairs and Reconciliation agency in accordance with the Aboriginal Heritage Act 1988. All work is to cease that may negatively impact on the sites integrity until it has been assessed by an appropriately qualified Cultural Heritage professional with representation from the Indigenous recognised Aboriginal stakeholders. Should known or suspected human remains be located during the course of construction all work should cease within the locations vicinity that may	TBC	Environmental Manager Superintendent

Key Tasks	Potential impact	Control / Action	Inspection / Criteria/ Target / Evidence	Responsibility
		compromise it and the process outlined in the below flowchart followed.		

Figure 2 Site Discovery Procedure

4.9 Scope and limitations

This report has been prepared by GHD for SolarReserve and *may only be used and relied on by* SolarReserve *for the purpose agreed between GHD and the* SolarReserve *as set out in this report.*

GHD otherwise disclaims responsibility to any person other than SolarReserve *arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by SolarReserve *and others who provided information to GHD (including Government authorities], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

Appendix E – Additional Information

Central Tower Receiver Glint/Glare (Blue Book), SolarReserve, 2011

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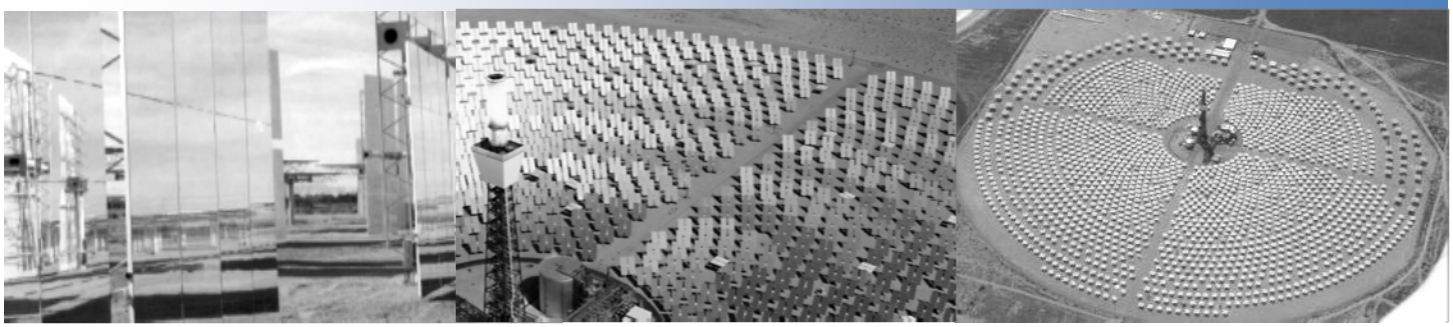

Central Tower Receiver Glint/Glare

SolarReserve CSP Power Tower Plant

Acknowledgement
SolarReserve wishes to express its appreciation for the review and guidance of Clifford K. Ho of the Sandia National Laboratories on this report.

Revision	Description	Date	By
A	Release for Internal Review (Purpose: Saguache Permitting)	05/25/2011	Charles Diep
B	Release for External Review	07/15/2011	Charles Diep
C	Revised Calculations per Cliff Ho at Sandia Review	09/10/2011	Charles Diep

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1.0 General

In the course of project permitting and impact assessment, there have been inquiries from interested parties on the optical impact of a SolarReserve central tower receiver. Although several recent papers from Sandia National Laboratories ("Sandia") address this topic globally for concentrating solar power technologies in substantial detail, (Ho, Ghanbari, & Diver, Methodology to Assess Potential Glint & Glare Hazards from Concentrating Solar Power Plants--Analytical Models & Experimental Validation, August 2011), (Ho & Khalsa, September 2010), (Ho & Diver, September 2009), this report provides the calculations and an assessment of the specific optical characteristics of the SolarReserve tower receiver ("receiver") and its solar collector field ("heliostat field").

The SolarReserve concentrating solar thermal plant consists of a field of approximately 1.10 million square meters of mirrors in discrete units (known as "heliostats") that surround a thermal receiver mounted on the top of a tower. The receiver is located near the center of the field. For a site location in the northern hemisphere, the receiver is slightly offset to the south. The receiver is approximately 30.5 meters (100 feet) tall mounted on an approximately 164 meters (540 feet) tall tower from grade level. The active heat exchange surface length of the receiver is 18.6 meters (61 feet), with centerline approximately 171 meters (561 feet) high from ground level.

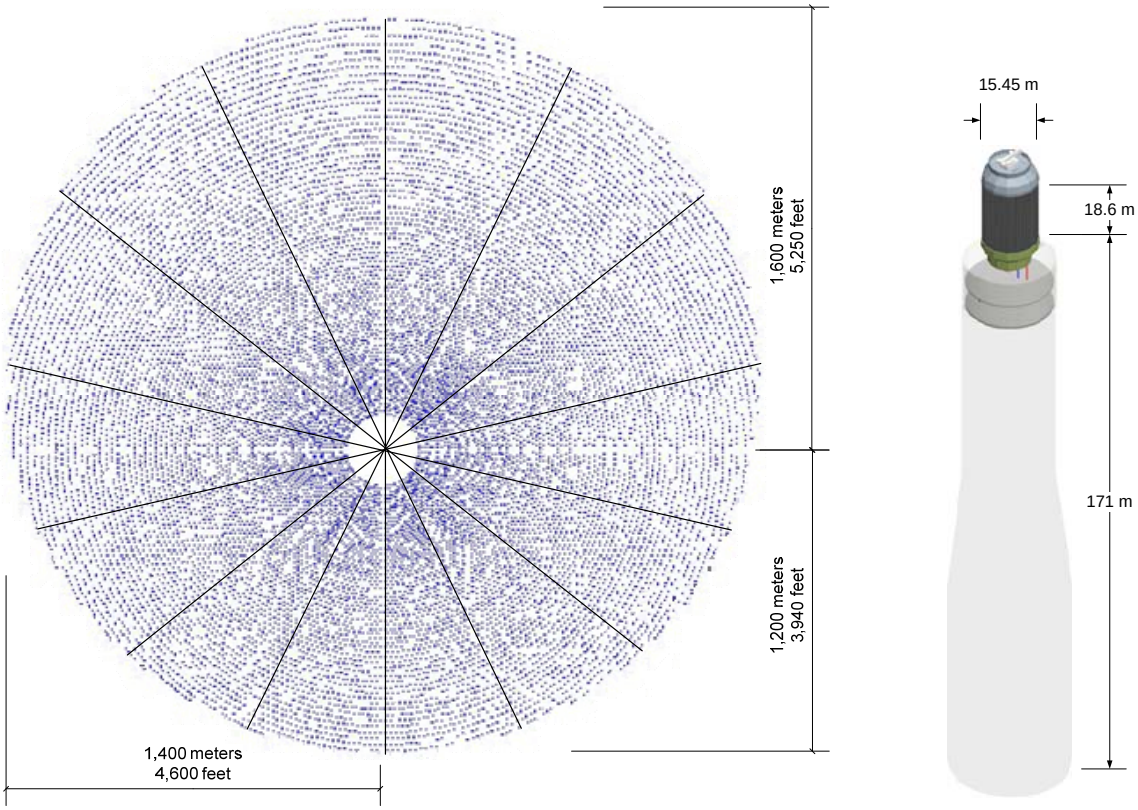


Figure 1 - Typical Heliostats Field Layout and Tower Receiver

As shown above, the furthest heliostats away from the receiver on the east-west sides are approximately 1,400 meters (4,600 feet). To the north, the furthest heliostat is 1,600 meters (5,250 feet) away. The furthest heliostat to the south is 1,200 meters (3,940 feet) away.

2.0 Receiver and Heliostat Field Characteristics

Under normal operating conditions, the heliostats in the collector field redirect sunlight onto the central tower receiver. Thermal energy is collected, stored and used to generate power. Because the location and angle of each heliostat is different relative to the sun and the receiver, the heliostats will deliver a reflected image that is typically less than the full reflective potential of the mirror surface due to the angle of incidence. A greater angle of reflection off the heliostat will yield a smaller effective reflective area. This is generally described as the cosine effect, or cosine loss, for central receiver plants. This effect is illustrated in the figures below.

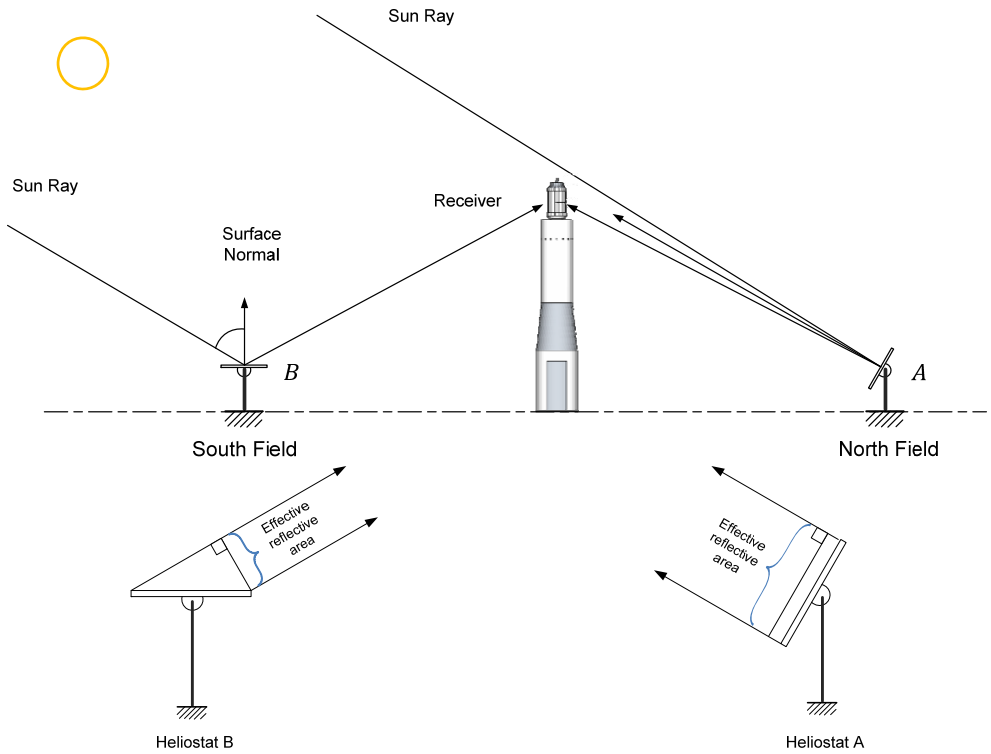


Figure 2 - Illustration of the Cosine Loss Effect on Optical Reflection

Other losses associated with central receiver systems include: 1) the imperfect reflectivity of the mirrors and mirror soiling; 2) blocking and shading amongst heliostats; 3) atmospheric attenuation due to dust, moisture and air pollutants; and 4) spillage from reflected images that do not strike the receiver surface. The figure below shows the relative optical effectiveness of the heliostat field at a moment in time.

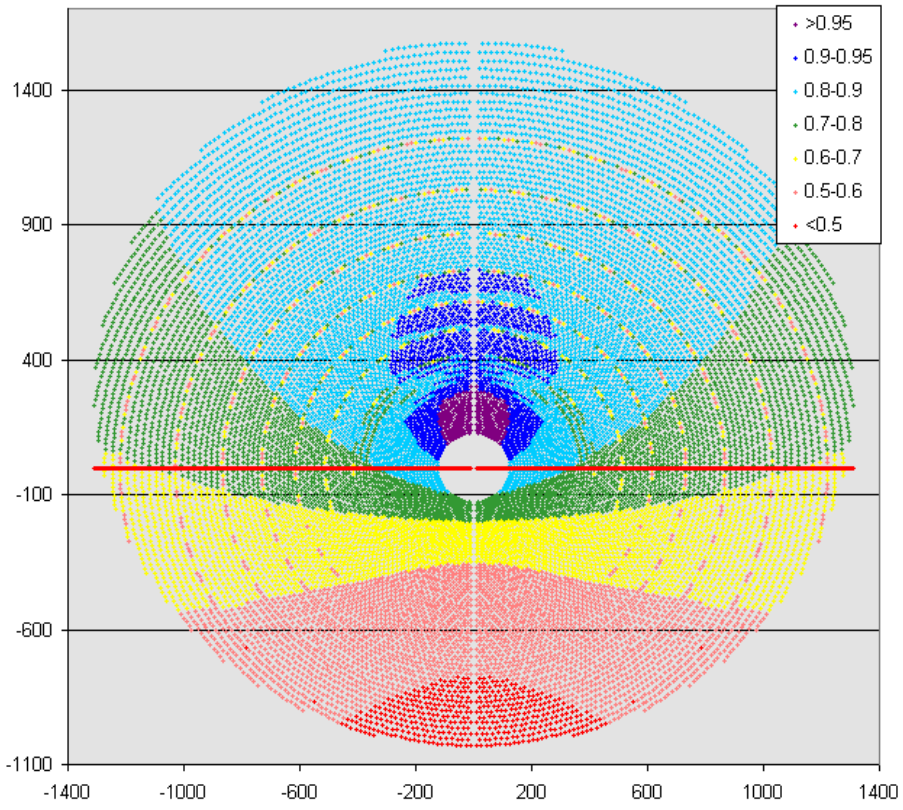


Figure 3 - Field Optical Contribution at Solar Noon

The incident flux on the receiver varies circumferentially. The north hemispherical side of the receiver generally receives a greater amount of flux due to the higher number of heliostats. The heliostat field control system is designed to optimize flux distribution on the receiver to ensure the optimized operation and maximize yield. To assess the potential optical impact of the receiver, analyses of the receiver flux profiles at the design point, which is solar noon at the vernal equinox, and two other operational points, solar noon at the summer and winter solstices, are conducted and presented later in this report.

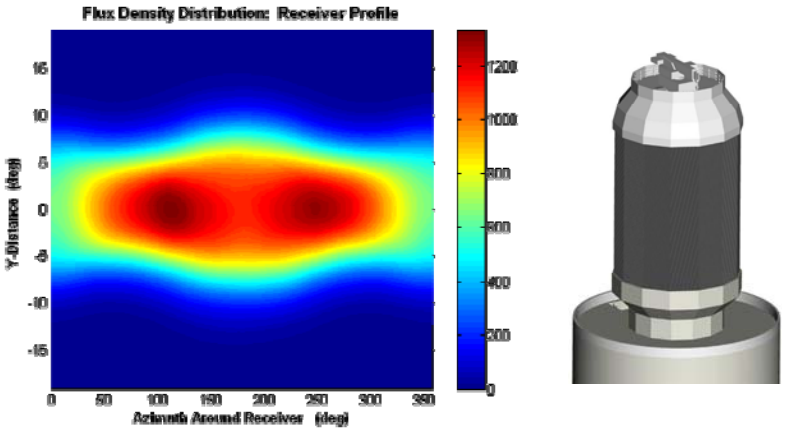


Figure 4 – Simulated receiver flux profile on the receiver at a point in time.

3.0 Glint and Glare

As described in work published by Sandia, *glint* is a momentary flash of light, whereas *glare* is a continuous source of brightness relative to ambient lighting. The difference between glint and glare is temporal.

The figures below show examples of glint and glare. The receiver surface is not continuously flat, but actually consists of many metal tubes coated with specialty black paint. The black coating on the receiver tubes is of a matte textured finish rather than a smooth shiny finish. The uneven and textured surface provides additional heat transfer area and causes unabsorbed light to scatter and diffuse, rather than to reflect from the receiver.

Figure 5 - An example of glint during a transient condition

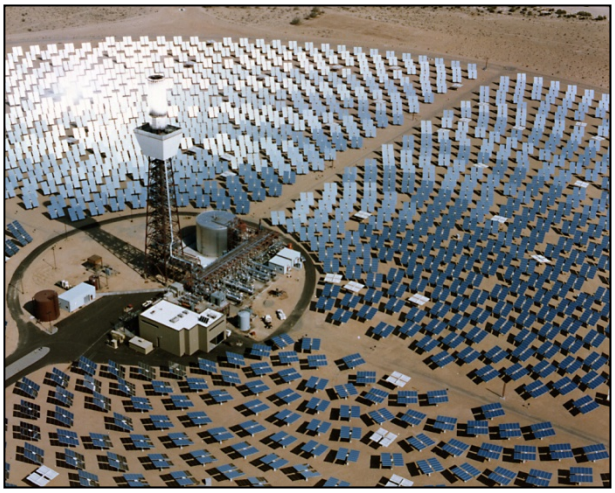


Figure 6 - An example of glare from the receiver and the collector field during normal operation

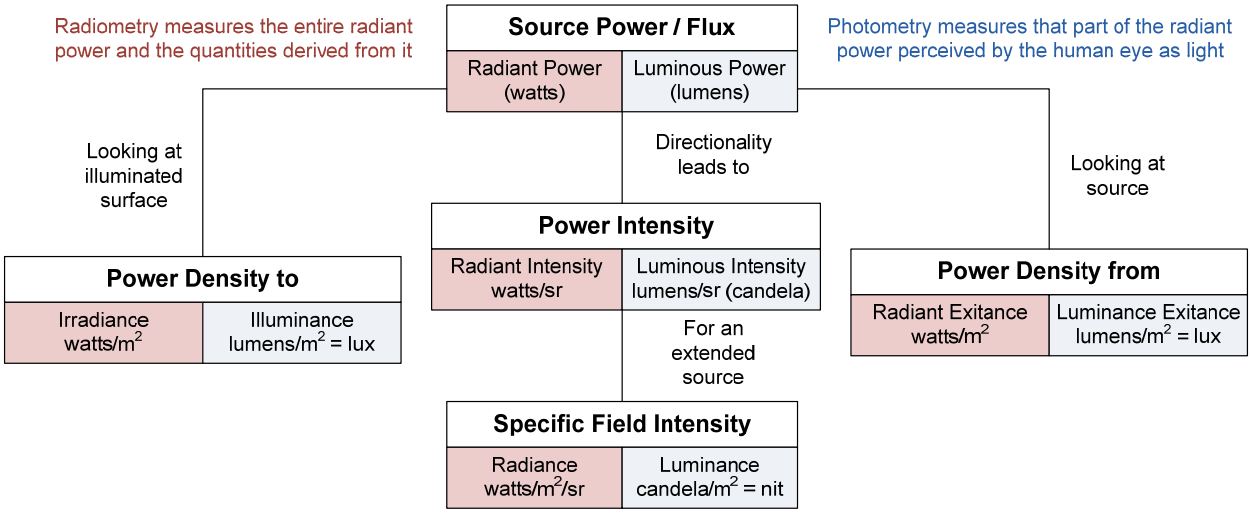
The solar field is oriented in a circular array surrounding the tower. For an elevated observer as shown in the figures above, color contrast associated with the heliostats will vary throughout the day as the heliostats track the sun. From one elevated viewing point as shown in the figure, a wedged section of the heliostat field will exhibit a glare of white surfaces. The balance of the heliostats will typically appear blue or dark blue showing reflection of the sky. Under normal plant operation, the resulting light vectors from the heliostat field will be directed at the tower receiver and will result in a brightly illuminated receiver that will be visible during daytime as shown in the figure above.

4.0 Illuminance and Irradiance

In order to facilitate a quantitative as well as a qualitative discussion on the topic, the difference between illuminance and irradiance is briefly summarized in this section. *Illuminance* is a measure of light intensity as perceived by the human eye with every wavelength weighted differently (according to the human eye's sensitivity), while *irradiance* is a measure of the physical energy with all the wavelengths weighted equally. In the discussion of visual impact (pertaining to the human visual system), illuminance is typically the metric used. With respect to energy collection and potential hazard

assessment, irradiance is used. The following chart provides a relationship between illuminance and irradiance. Power density is presented twice because a distinction is typically drawn between looking an illuminated source (luminance) and an illuminated surface (illuminance).

Figure 7 - Relationship between Photometry (Illuminance) and Radiometry (Irradiance)



As shown above, the **lux** (lx) is the SI unit of illuminance and luminous emittance. The luminance indicates how much luminous power leaves a surface in a particular direction per solid angle and per projected angle, and how bright an object will be if perceived by a human eye looking at the surface from a specified viewing vector point. Illuminance is an indicator of how much luminous power is directed on a surface per unit area. The following table provides a range of illuminance from a range of common day sources.

Table 1 - Typical Illuminance (lux)

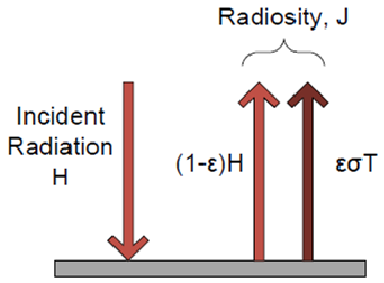
Illuminance (lux or lumens/m2)	Example
0.01	Quarter moon
0.27	Full moon on a clear night
50	Family living room
100	Very dark overcast day
320–500	Office lighting
400	Sunrise or sunset on a clear day.
1,000	Overcast day; typical TV studio lighting
10,000–25,000	Full daylight (not direct sun)
32,000–130,000	Direct sunlight

As shown above, in direct sunlight, the illuminance is approximately 100,000 lux. This corresponds to a solar irradiance of approximately 1,000 W/m^2 (or 1 kW/m^2, or "one sun") for a normal clear sky day around noon. Since irradiance can be calculated, the receiver illuminance from a view point location of interest can be estimated proportionally.

5.0 Tower Receiver

In order to estimate the illuminance from the receiver, the maximum amount of energy (irradiance) emitted and reflected from the receiver are estimated. The total irradiance from the receiver is the sum of the thermal (long wave) radiation due to the surface temperature of the receiver and the reflected radiation due to incomplete absorption.

Total Receiver Radiosity (W/m^2) = Thermal Emission + Reflected Irradiance



5.1 Thermal Emission

The thermal emission (long wave emission from a hot body) component *(j)* is estimated using the Stefan-Boltzmann Law for a grey body. The equation is provided below where the emissivity is assumed to be 0.89, which is typical of black epoxy paint.

Stefan's Law: $j = \boldsymbol{\varepsilon\sigma}T^4$

Where,

$\boldsymbol{\varepsilon}$ = Emissivity of the grey body

σ = Stefan-Boltzmann constant = 5.6704 E-8 $W/m^2/K^4$

T = Surface temperature of the body in (°K)

At a maximum receiver surface temperature of 621.1 °C (894 °K / 1150 °F), the thermal emission from the receiver is estimated as follow.

Thermal Emission = (0.89) (5.6704 E-8) $(894)^4$ = **32.2 kW/m²**

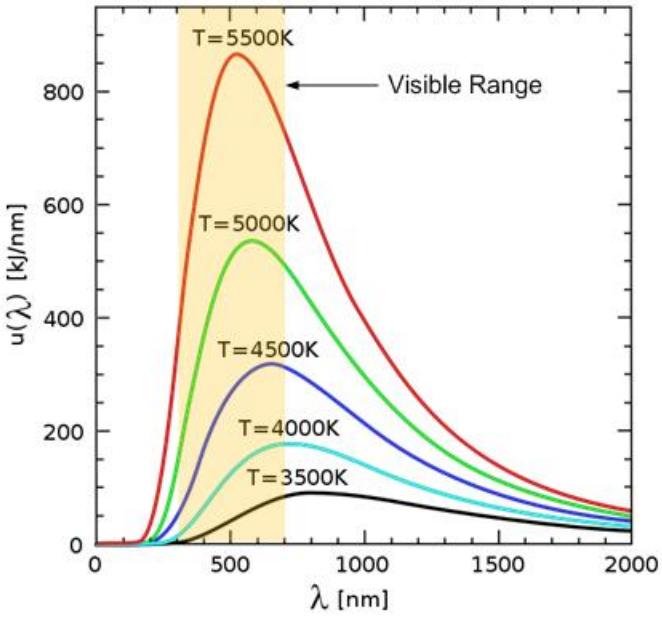
As shown in the table of data gathered by the pyrotechnic industry below, the receiver surface temperature of 621.1 °C (1,150 °F) would have exhibit a bright red and slight orange color. The amount of radiation in the visible spectrum (~390 - 750 nm) will be negligible.

Table 2 - Visual temperature phenomena of solid bodies

Temp (°K)	Temp (°C)	
750	480	Faint Red Glow
850	580	Dark Red
1,000	730	Bright Red, Slightly Orange
1,200	930	Bright Orange
1,400	1,100	Pale Yellowish Orange
1,600	1,300	Yellowish White
> 1,700	> 1,400	White (yellowish if seen from a distance)

To further explain the wave spectrum contribution, Planck's Law, which describes the electromagnetic radiation emitted from a radiating body, can be referenced. Without introducing the complexity of the equation and its variations, the following figure shows Planck's Law in terms of the intensity of the peak wavelength as a function of surface temperature. As shown, the higher the temperature of the radiating body, such as the case of the sun, the more visible light that the body emits. For this reason, it is expected that the visible light of the sun reflected from the receiver will dominate the illuminance, i.e. reception on the human eye.

Figure 8 - Spectral Intensity of peak wavelength as a function of surface body temperature.



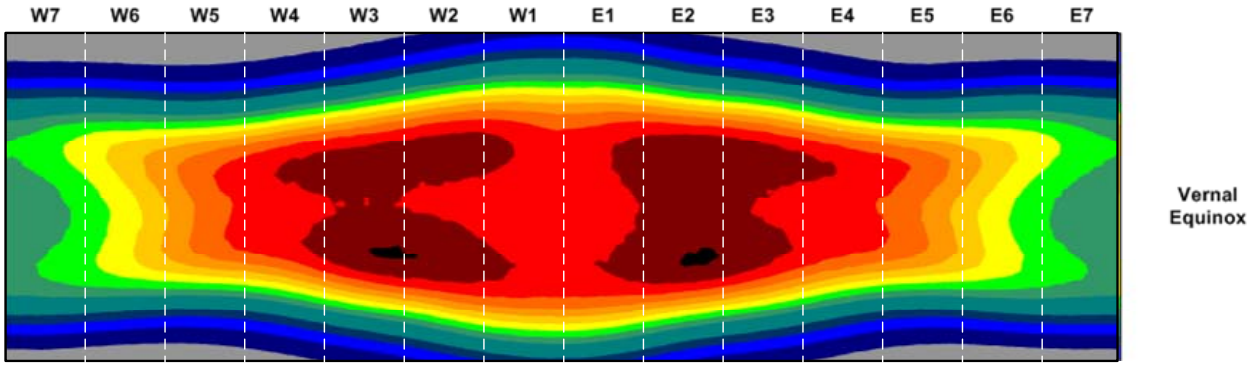
5.2 Reflected Irradiance

The reflected irradiance component is calculated based on the less-than-perfect absorption of the receiver (i.e., less than a total black body). Based on the specification of the black solar paint applied on the receiver, the optical thermal absorption efficiency is rated at 94%. Based on manufacturer's specifications, this efficiency is expected to remain constant throughout the life of the paint. The amount of re-radiation is therefore approximately 6% of the incident radiation.

The incidental flux directed at the receiver varies around the receiver. The flux distribution on the receiver is a function of time of year (sun position), available sunlight, ambient air temperature, and wind condition. For conservatism, to ensure that the maximum case is considered, a condition of solar irradiance of 1,000 W/m2 on a clear day at solar noon is evaluated at the vernal equinox, as well as the summer and winter solstices. Since the field perimeter is not concentric with respect to the solar tower, the potential impact at viewpoints around the field is also evaluated.

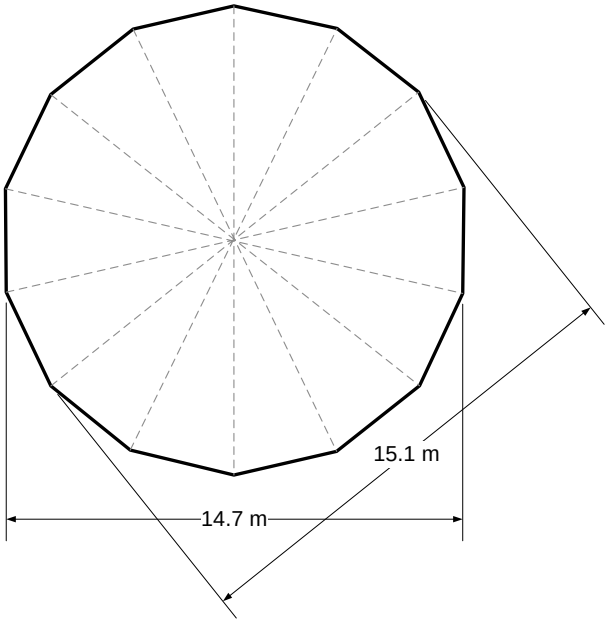
The following figure shows the flux distribution at the vernal equinox with the receiver (displayed in an unwound fashion.) The receiver is actually not a perfect cylinder; the profile is segmented in fourteen (14) panels that form the tetradecagonal shape of the receiver. The horizontal center is in the north direction, with panels sequentially identified in the east and west of the north centerline.

Figure 9 – Solar noon flux distribution on receiver at the vernal equinox with DNI of 1,000 W/m²



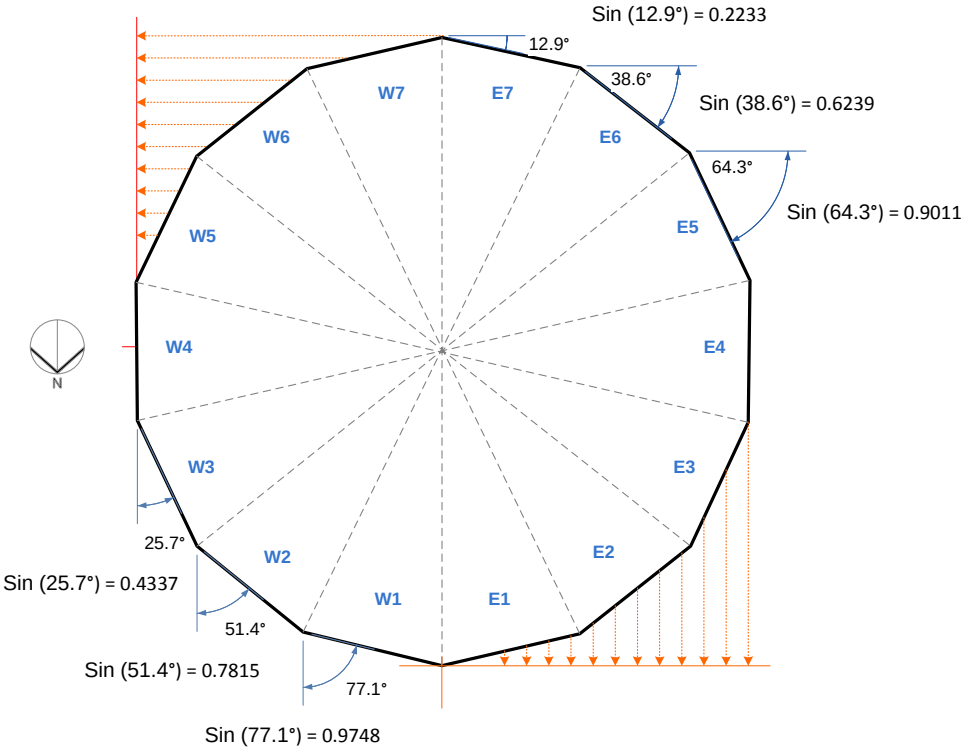
In addition to the uneven flux distribution, the tetradecagonal shape of the receiver actually has two different apparent viewing widths as shown below.

Figure 10 – Apparent receiver width at different viewing angles



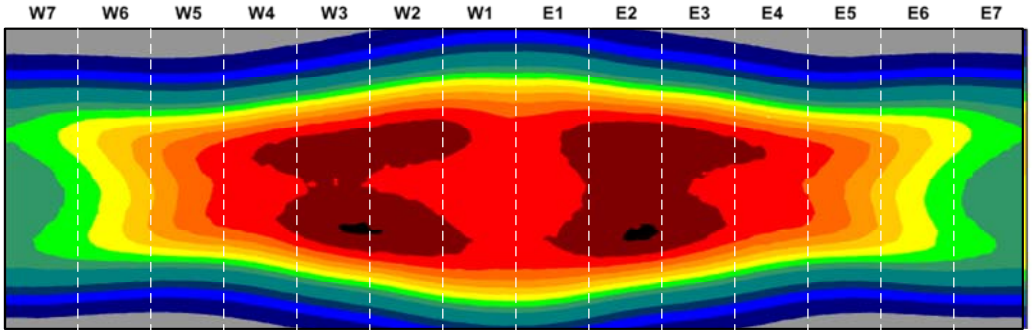
From any given angle, a viewer will see six or seven receiver panels. Each panel's flux will have a different contributing factor due to the angle of the panel with respect to the viewer, as shown in the figure below. The sum of all panels' fluxes, after accounting for angular factors, is represented as the flux to one "view plane." The view plane flux will be less than the total flux from the surface due to this angular factor.

Figure 11 – Geometric contribution by each receiver panel at the respective reference plane



Using the relationship shown in the figure above, the equivalent flux densities with respect to the viewpoint angle and distance are calculated for each of the three (3) key flux profiles below.

*Figure 12 – Solar noon receiver flux profile at the **vernal equinox** with DNI of 1,000 W/m²*



1,000 kW/m² Surface | 741 kW/m² Plane — 0° from North, 1,600 m to perimeter

972 kW/m² Surface | 645 kW/m² Plane — 12.9° from North, 1,571 m to perimeter

979 kW/m² Surface | 726 kW/m² Plane — 25.7° from North, 1,543 m to perimeter

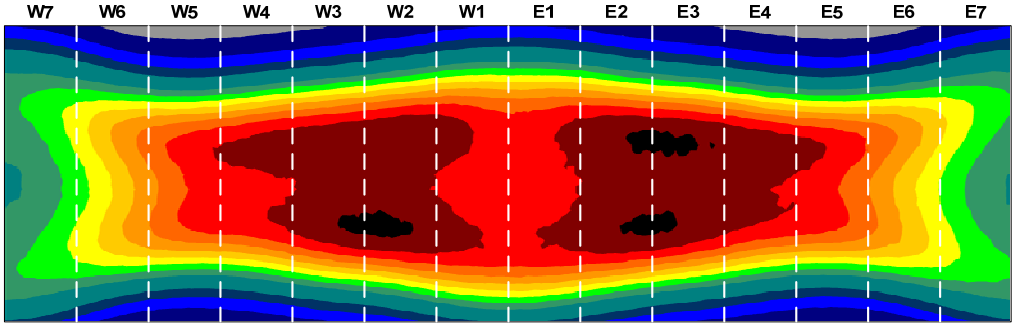
38.6° from North, 1,514 m to perimeter — 938 kW/m² Surface | 620 kW/m² Plane

51.5° from North, 1,486 m to perimeter — 924 kW/m² Surface | 684 kW/m² Plane

90° from North, 1,400 m to perimeter — 802 kW/m² Surface | 518 kW/m² Plane

603 kW/m² Surface — 180° from North, 1,200 m to perimeter — 424 kW/m² Plane

*Figure 13 – Solar noon receiver flux profile at the **summer solstice** with DNI of 1,000 W/m²*



962 kW/m² Surface | 710 kW/m² Plane — 0° from North, 1,600 m to perimeter

941 kW/m² Sur2face | 620 kW/m² Plane — 12.9° from North, 1,571 m to perimeter

947 kW/m² Surface | 699 kW/m² Plane — 25.7° from North, 1,543 m to perimeter

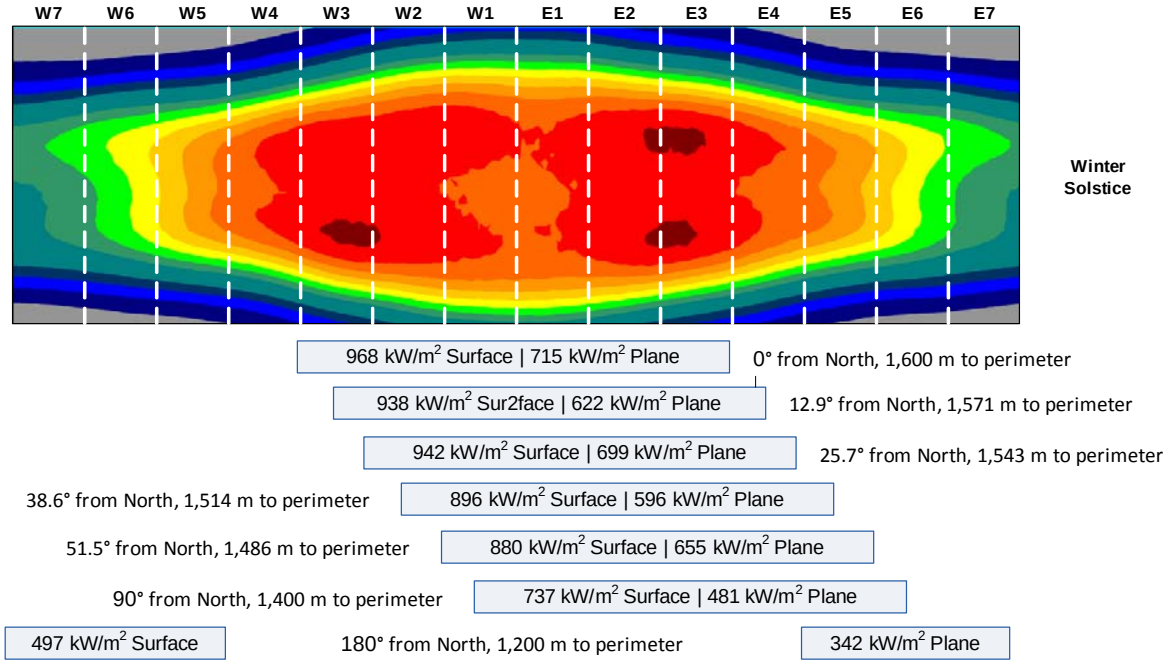
38.6° from North, 1,514 m to perimeter — 919 kW/m² Surface | 602 kW/m² Plane

51.5° from North, 1,486 m to perimeter — 909 kW/m² Surface | 670 kW/m² Plane

90° from North, 1,400 m to perimeter — 821 kW/m² Surface | 531 kW/m² Plane

679 kW/m² Surface — 180° from North, 1,200 m to perimeter — 482 kW/m² Plane

*Figure 14 – Solar noon receiver flux profile at the **winter solstice** with DNI of 1,000 W/m²*



From the flux values calculated above, it appears that the highest apparent flux at any view plane is 741 kW/m² viewed directly from the north. However, since the north perimeter is furthest away from the receiver, it is necessary to evaluate other flux to perimeter distance scenarios. This is done in the next section.

6.0 Potential Impact

The visual impact of the receiver to an observer is also a function of the receptor distance from the receiver. As shown in the figure to the right, the light intensity as observed (per steradian)[1] is the receiver intensity over the solid angle subtended by the receiver and the vantage point of the observer's position. While the intensity of the source does not change, the irradiance or thermal flux is less the further it is away from the source as the total radiation is distributed over a larger area. The relationship is the inverse of the distance squared (i.e., $1/r^2$). This equation is provided by Ho, C.K. et al (2011) *[Eq. 21]*:

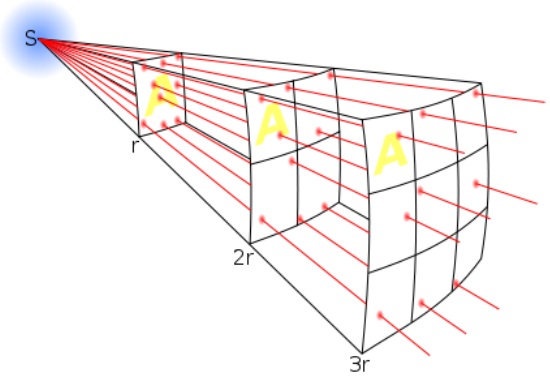


Figure 15 - Flux as a function of distance from illuminating source

$$E_d = \frac{P_d}{\pi A_d}\frac{A_s \cos(\theta)}{r^2} \qquad \text{(Equation 1)}$$

Where,
E_d = Irradiance at a distance (W/m²)

[1] Note that the radiant intensity is independent of distance from the radiating source; however, the radiant flux changes as the dispersed/exposed surface increases as a function of distance from the radiating source.

$\frac{P_d}{A_d}$ = Receiver irradiance (W/m²)

A_s = Apparent surface area of the receiver (W/m²)

θ = Angle from observer to receiver

r = Slant distance from observer to receiver

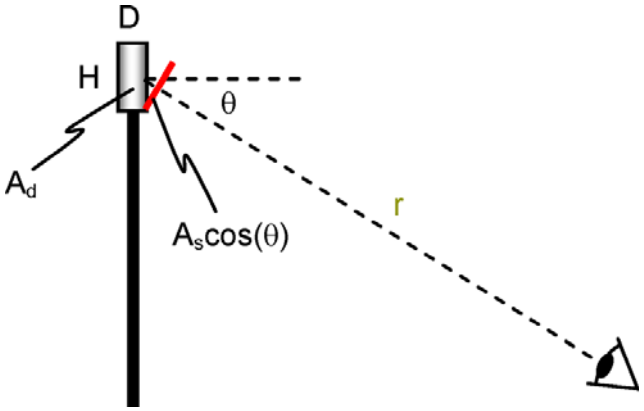


Figure 16 - Tower receiver diffused irradiance as a function of distance.

Note that the term P_d/A_d in this case is replaced by the irradiance at the reference plane calculated in Figures 12 to 14. The irradiance at the observer viewpoint is thus calculated for each receiver flux to viewpoint angle and distance scenario and summarized in Table 3 below. Furthermore, the level of irradiance at the observer location can then be compared to the experience of viewing a 60 MW incandescent light bulb.

In terms of brightness to the human eyes, the receiver illuminance received by the eye can be estimated by assuming that the receiver flux has the same characteristics as those from the sun. Since bright sunlight provides luminance of approximately 100,000 lux at the Earth's surface with solar flux of approximately 1,000 W/m², the receiver luminance at the various power and distances can be calculated as follow:

Irradiance W/m² x 100,000 lux / 1,000 W/m² ≅ luminance (lux)

The luminance to the eye is thus calculated for each viewpoint at each of the key operating points in Table 3. From the calculation worksheet, the luminance at perimeter ranges from 120 to 169 lux. The highest being at the south perimeter, 1,200 meters away with diffuse irradiance of 1.69 W/m² noon time at the summer solstice.

6.1 Incandescent Light Bulb Comparison

For comparison purpose, this level of luminance can be compared with that of an incandescent light bulb. For a 60 W incandescent light bulb, the luminous power is approximately 820 – 890 lumens. If the light bulb is isotropic and is the only illumination in a room, the illuminance equivalent to viewing the light bulb at a distance of approximately 2 feet (0.6 meters) away is estimated below:

(860 lumens)/($4\pi r^2$) = 169 lux solving for (r) = 2.1 feet (0.61 meter)

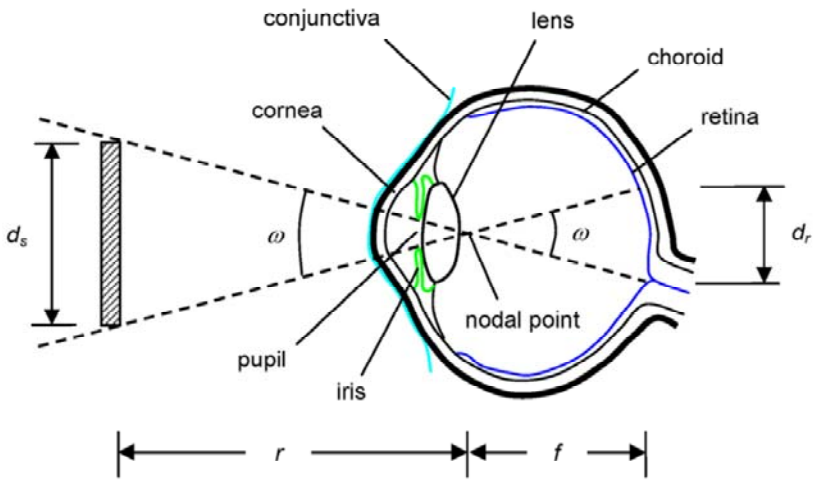
6.2 Potential Retinal Impact

In addition to the light bulb comparison, impact to the retinal can be assessed as well. For this, Ho, C.K et al (2011) provided the equations *(Eq. 22 & 23)* below:

$$E_{r,d} = \frac{P_d d_p^2 \tau}{4 A_d f^2} \qquad \text{(Equation 2)}$$

$$\omega = \frac{\sqrt{4 A_S \cos(\theta)/\pi}}{r} \qquad \text{(Equation 3)}$$

Figure 17 - Image projected on the retina of the eye



Where

$E_{r,d}$ = Diffused Retinal Irradiance (W/cm²)

$\frac{P_d}{A_d}$ = Receiver irradiance (W/m²)

d_p = Diameter of the pupil (W/m²)

θ = Angle from observer to receiver

A_s = Apparent surface area of the receiver (W/m²)

τ = Transmissivity (0.5)

f = Approximate focal length of the pupil (0.017)

ω = Angle subtend of the receiver

r = Slant distance from observer to receiver

Note that the retinal irradiance is both a function of the subtend angle of the receiver as well as the diffuse irradiance at the location of the observer. Using these equations, the irradiance on the retina of the pupil is calculated for each pairing of receiver irradiance to observer distance in the following Table 3

The results of the calculation show that the retinal irradiances ranges from 3.6E-3 to 7.7E-3 W/cm² with subtend angles of 15.3 to 11.6 mrad, respectively. At these levels, the glint and glare levels from the receiver will not cause potential eye damage, and is unlikely to leave potential after-image in the retina, as shown in the safety boundary figure compiled below.

Figure 18 - Potential impacts of retinal irradiance as a function of subtended source angle. Data for irreversible eye damage are for 0.15 second exposure (typical blink response time). Source: Ho, C.K et al - Journal of Solar Energy Engineering, Vol. 133, 031021 to 031021-9.

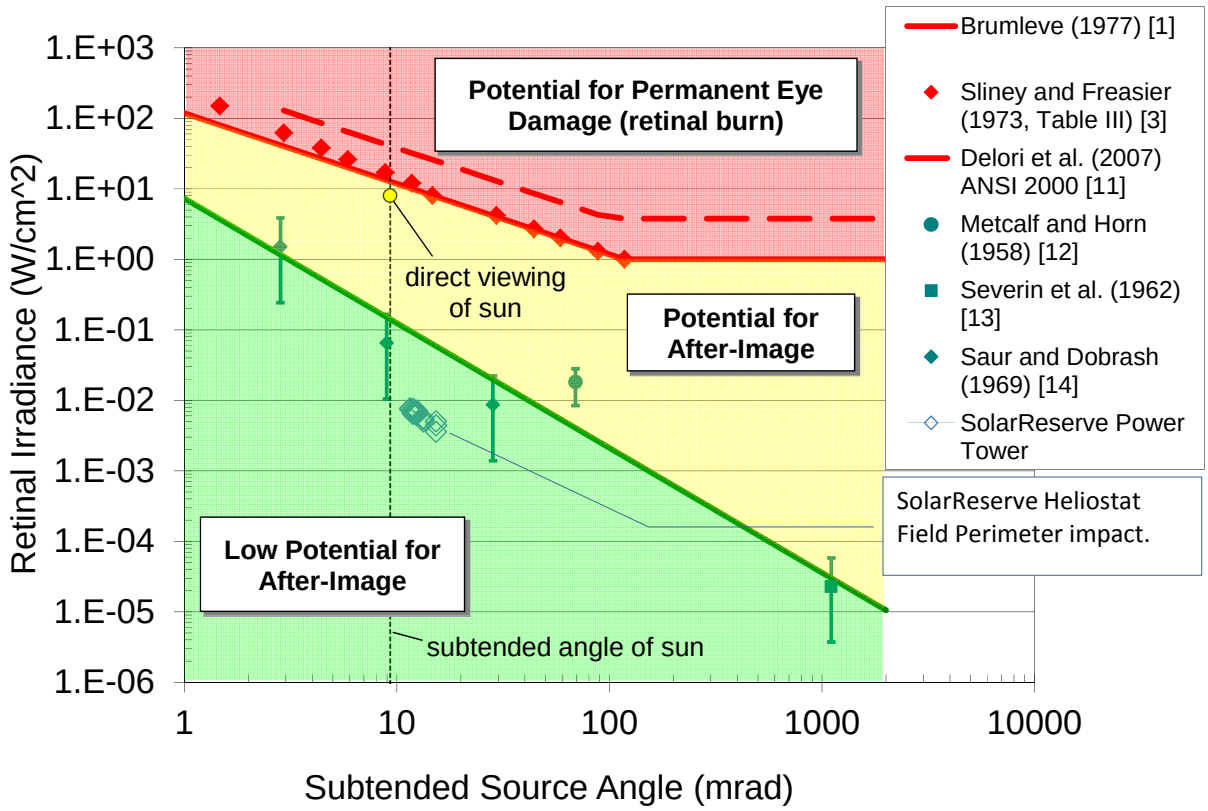


Table 3- SolarReserve power tower glint/glare calculations

Power Tower Glint/Glare Calculations

Fixed Parameters:

Height to center of receiver (*h*): 180.3
Height of the receiver (*me*: 18.59

Eye focal length (*f*) *in m*: 0.017
Daylight Pupil diameter (*dp*) *in mm*: 2
Transmission coefficient (*τ*): 0.5

Luminance of 60W incandescence light bu 860
Luminance of the sun *in lux per 1 kW/m²*: 100,000

Time of Year	Point of View	Horizontal Distance from Tower to Perimeter Observer *L* (m)	Slant Distance from Receiver to Observer *r* (m)	Direct Normal Flux on Viewable Panels (kW/m²)	Flux Normal to Observer (kW/m²)	Diffuse Flux from the Source (Receiver) E_s (kW/m²)	Visible Receiver Area to Observer A_s (m²)	Diffuse Irradiance Recieved by Observer E_d (W/m²)	Subtended Angle to Observer ω (mrad)	Diffuse Retinal Irradiance at the Observer Cornea $E_{r,d}$ (W/cm²)	Receiver Luminance at the Observer (Lux)	60 W Light Bulb Equivalent Viewing Distance (feet)
Vernal Equinoxes	North	1,600	1,610	1,000	741	44.5	273	1.48	11.6	0.0077	148	2.2
	12.9° off North	1,571	1,582	972	645	38.7	281	1.37	11.9	0.0067	137	2.3
	25.7° off North	1,543	1,553	979	726	43.6	273	1.56	12.0	0.0075	156	2.2
	38.6° off North	1,514	1,525	938	620	37.2	281	1.42	12.4	0.0064	142	2.3
	51.5° off North	1,486	1,497	924	684	41.0	273	1.58	12.4	0.0071	158	2.2
	East	1,400	1,412	802	518	31.1	281	1.38	13.3	0.0054	138	2.3
	South	1,200	1,213	603	424	25.4	273	1.49	15.3	0.0044	149	2.2
Summer Solstice	North	1,600	1,610	962	710	42.6	273	1.42	11.6	0.0074	142	2.3
	12.9° off North	1,571	1,582	941	620	37.2	281	1.32	11.9	0.0064	132	2.4
	25.7° off North	1,543	1,553	947	699	41.9	273	1.50	12.0	0.0073	150	2.2
	38.6° off North	1,514	1,525	919	602	36.1	281	1.38	12.4	0.0062	138	2.3
	51.5° off North	1,486	1,497	909	670	40.2	273	1.55	12.4	0.0070	155	2.2
	East	1,400	1,412	821	531	31.9	281	1.42	13.3	0.0055	142	2.3
	South	1,200	1,213	679	482	28.9	273	**1.69**	15.3	0.0050	169	2.1
Winter Solstice	North	1,600	1,610	968	715	42.9	273	1.43	11.6	0.0074	143	2.3
	12.9° off North	1,571	1,582	938	622	37.3	281	1.32	11.9	0.0065	132	2.4
	25.7° off North	1,543	1,553	942	699	41.9	273	1.50	12.0	0.0073	150	2.2
	38.6° off North	1,514	1,525	896	596	35.8	281	1.37	12.4	0.0062	137	2.3
	51.5° off North	1,486	1,497	880	655	39.3	273	1.52	12.4	0.0068	152	2.2
	East	1,400	1,412	737	481	28.9	281	1.28	13.3	0.0050	128	2.4
	South	1,200	1,213	497	342	20.5	273	1.20	15.3	0.0036	120	2.5

7.0 Heliostat Field

Under normal plant operations, the sun's rays reflected from the heliostat field will be directed at the tower receiver. In general, unless an observer is at the receiver location, no beam from any mirror will be directed at observers.

For an elevated observer, the heliostat field will generally have the color of the sky with a certain section appearing brighter, i.e., exhibiting a glare. On occasion when certain heliostats are not in commission, such as if they are in stow position, glint or glare from certain angles may be possible. The glare would be similar to sunlight reflecting off a still body of water or a building with glass windows.

Similarly, the degree of brightness for the reflecting source is a function of solar intensity, viewing angle, time of day and distance away from the heliostat field. The apparent size of the heliostat field is a direct function of viewing distance for the observer. The area and intensity of the brightness will appear to be less the farther away the observer is from the heliostat field. However, this would be dependent upon the configuration of the heliostats. In the unlikely case where all the heliostats were stowed face-up during the daytime, the intensity and size of the reflected image could remain constant over long distances.

For a ground level observer outside the heliostat field perimeter, only the back of the heliostats will be visible. The outer rows of heliostats will also shield the inner rows of heliostats as well as heliostats from the opposing field. If by some remote opportunity that a line of sight is exposed to a heliostat on the opposing side, the potentially reflected beam would not impact the observer at ground level since the lowest vertical position that the heliostat can achieve is 84° (if a fully vertical mirror were considered 90°.) This is by design, since the heliostat must provide clearance for the control box mounted on its pedestal.

Since the function of the heliostat is to reflect sunlight onto the receiver, the front facet of the heliostat will mostly be tracking the sun throughout the day and shading the rest of the heliostat structure. On occasions throughout the year, a fraction of an inner row heliostat will block the reflected beam from a heliostat on an outer row. These brighter segments of heliostat backs would be visible to the perimeter observer looking at the back of the heliostats; however, the brightness would be no greater than if the non-reflective structure were directly exposed to sunlight.

During transient conditions, i.e. morning starts, or midday or end-of-day shutdowns, the heliostats will be moving at higher speed either from the overnight stow position (mirror facets completely horizontal) to tracking position for startup, or in reverse order for shutdown. While in motion, temporary glints may occur to an elevated observer. The glint from a heliostat in motion would not persist for a stationary observer.

8.0 Summary

The purpose of this report is to provide both quantitative and qualitative data on potential glint and glare associated with the operation of the SolarReserve solar power tower plant. All potential sources at the plant were evaluated, which include the central receiver, the individual heliostats, and the heliostat field. Glare is characterized as a continuous source of brightness relative to ambient lighting. With regard to the receiver, the glare is primarily from diffusely reflected sunlight. Thermal emission also occurs due to its operating temperature, but the contribution to visible glare from thermal emission is extremely small. The receiver will appear white and slightly yellow as shown in the photo below with illuminance at the eye diminishing rapidly with increasing distance away from the receiver. At the south perimeter closest to the receiver, at 1,200 meters away from the receiver, where the irradiance is the highest at this perimeter location, the brightness is comparable to looking at a 60 W incandescent light bulb at a distance of two (2) feet away. Atmospheric attenuation was neglected.

The retinal irradiance at the perimeter is also evaluated to assess for potential permanent eye damage and after-image. This is a function of both the irradiance contribution at the observer location as well as the angle subtend of the receiver. The analysis shows both potentials to be extremely unlikely.

Individual heliostats may exhibit glint during transient conditions when the viewing angle at a higher elevation momentarily intercepts the heliostat's reflective plane. At ground level outside the perimeter, an observer looking at the heliostat field is unlikely to see glint or glare from individual heliostats due to inherit design and operational constraints. To an elevated observer at distance, a section of the heliostat field exhibit glint or glare that is similar to sunlight reflected off of a still body of water or a building with glass windows.

Figure 19 – Solar Two receiver during full power operation (Barstow, CA, U.S.A)

9.0 Works Cited

[1] Ho, C., & Diver, R. (September 2009). Hazard Analyses of Glint & Glare from Concentrating Solar Power Plants. *SolarPACES 2009.* Berlin, Germany.

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