Report on the findings of the NSW Environment Protection Authority's review of Snowy Hydro Limited Cloud Seeding Program:

2017 Annual Compliance Report



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Executive summary

Snowy Hydro Limited has been conducting a winter cloud seeding trial in the NSW Snowy Mountains area since 2004. On 31 May 2013 amendments to the *Snowy Mountains Cloud Seeding Act 2004* (the Act) came into effect enabling Snowy Hydro Limited to conduct permanent cloud seeding operations within an expanded area of the Snowy Mountains, in accordance with an Environmental Management Plan approved by relevant Ministers. The Act defines the relevant Ministers as the Minister for the Environment and the Minister for Planning and Environment, who approved the Environmental Management Plan on 5 July 2013.

The Act also authorises aerial application of existing and alternative cloud seeding chemicals, and prescribed a review and oversight role for the NSW Environment Protection Authority (EPA). Snowy Hydro Limited is required to provide a report to the EPA detailing its compliance with the Environmental Management Plan and the results of any research and monitoring into the impact of cloud seeding operations on the environment by 31 March each year. The EPA is required to review this report and convey its findings, along with any recommendations, to the Board of the EPA and the relevant Ministers.

The EPA has reviewed Snowy Hydro Limited's Annual Compliance Report for the 2017 cloud seeding season and has found that the compliance report was submitted to the relevant Ministers and the EPA by the due date, and Snowy Hydro Limited has complied with all its obligations as detailed in the Act. Snowy Hydro Limited generally complied with all its obligations in the Environment Management Plan, with the exception of potable water sampling at one site, which was not completed due to safety reasons.

The Act requires that relevant Ministers (i.e. the Minister for the Environment and the Minister for Planning) conduct a review of the approved Environmental Management Plan every five years. The EPA has been chartered to coordinate the review on behalf of the relevant Ministers, which is due to be completed by 5 July 2018. It is proposed that the implementation of any approved adaptions to the Environment Management Plan will be made in advance of the 2018 cloud seeding major sampling campaign.

Introduction

Background

Cloud seeding is a process used to improve the capacity of orographic clouds, which are clouds formed as moist air rises over mountains, to yield precipitation as snow. To achieve this, chemical particles are introduced, or seeded, into these clouds. Snowy Hydro Limited uses silver iodide as the seeding particle in the Snowy Mountains. Silver iodide has physical properties very similar to natural ice crystals. In addition, silver iodide is practically insoluble in water, tends not to dissociate to its component ions of silver and iodine, and does not become biologically available in the environment. Instead, it remains as a solid in soils and sediments.

During cloud seeding operations, the seeded silver iodide particles combine with naturally occurring supercooled water droplets in the clouds to form ice crystals. These crystals then grow until they become too heavy to stay within the cloud, causing them to fall as snow.

To seed the clouds, ground-based generators are arranged along the western side of the Snowy Mountains range. The generators disperse minute quantities of the seeding agent into winter storm clouds as they pass across the range. Cloud seeding operations only target cloud systems travelling from west to east and when temperatures guarantee that precipitation will fall as snow above 1400 metres.

Snowy Hydro Limited has been conducting a winter cloud seeding trial in the NSW Snowy Mountains since 2004. Independent evaluation of the trial indicates that snowfall can be increased by an annual

average of 14% through cloud seeding. Environmental monitoring has, to date, not detected any significant adverse environmental impacts. The 2017 cloud seeding operations comprised 95 hours and 48 minutes of cloud seeding between 8 July and 14 September 2017. Approximately 36.4 kilograms of silver iodide was dispersed during these operations, covering a target area about 2110 square kilometres.

Under the *Snowy Mountains Cloud Seeding Act 2004* (the Act), cloud seeding operations my only occur in accordance with an Environmental Management Plan that has been jointly approved by the relevant Ministers. This Environmental Management Plan was approved by the relevant Ministers on 5 July 2013.

The Act requires that Snowy Hydro Limited provide an annual report to the NSW Environment Protection Authority (EPA) and the relevant Ministers by 31 March, detailing its compliance with the Environmental Management Plan and the results of any research and monitoring into the impact of cloud seeding operations on the environment. The EPA is required to review this report and convey its findings, along with any recommendations, to the Board of the EPA and the relevant Ministers.

Purpose

The purpose of this report is to provide the Board of the EPA and the relevant Ministers with an overview of the findings of the EPA's review of Snowy Hydro Limited's Cloud Seeding Program 2017 Annual Compliance Report in accordance with the Act and the approved Environmental Management Plan.

EPA review of Snowy Hydro Limited 2017 Annual Compliance Report

Review

The EPA has undertaken its review of Snowy Hydro Limited's Annual Compliance Report (the report), in accordance with the Act and the approved Environmental Management Plan. In carrying out its review of the report, the EPA consulted with the Environment Protection Science section of the Office of Environment and Heritage The EPA also consulted with the National Parks and Wildlife Service in respect to cloud seeding operations that took place within Kosciuszko National Park.

Findings

The review of the 2017 Annual Compliance Report found the following:

- Snowy Hydro Limited has complied with all its obligations as outlined in the Act. Snowy Hydro Limited complied with all its obligations within the Environmental Management Plan, except for one potable water site where sampling could not be completed as the site could not be safely accessed (see Appendix 1).
- There were no accidents or breakdowns to report that resulted in spillage of cloud seeding agents or fuel, or failure of controls specified in the Environmental Management Plan.
- Monitoring was carried out in accordance with the Environmental Management Plan.
- Analysis of the monitoring data did not detect any evidence of significant adverse environmental impacts associated with cloud seeding activities.
- Cloud seeding is not having a measurable effect on the concentrations of silver in various parts of the environment.
- There were no new operations involving land-based methods of discharge of seeding or tracing agent within any area of land managed under the *National Parks and Wildlife Act 1974*.
- No modifications or new facilities for cloud seeding operations were installed.

Discussion

During 2017 cloud seeding operations, Snowy Hydro Limited dispersed approximately 36.4 kilograms of the approved seeding agent, silver iodide, into suitable storm systems. Meteorological conditions in the Snowy Mountains during the 2017 cloud seeding season led to increased usage of silver iodide as opposed to the previous year (an additional 8.06 kilograms). During the 2017 cloud seeding season, there were no new operations involving land-based methods of discharge of seeding or tracing agent within any area of land. There were also no modifications or new facilities installed for cloud seeding operations.

In 2014, Snowy Hydro Limited submitted its report on the three-year investigation into the environmental fate of silver in the Snowy water catchment. The investigation found no conclusive evidence that cloud seeding had increased silver concentrations in the environment, with cloud seeding silver unable to be detected over background levels. In addition, the report made a number of recommendations around the environmental monitoring program. Snowy Hydro Limited have considered the recommendations and developed a report recommending proposed changes to the cloud seeding Environmental Management Plan. The report's recommendations were discussed with experts from the EPA and the Office of Environment and Heritage in late 2017.

The Act requires that the Cloud Seeding Environmental Management Plan be reviewed every five years. The Environmental Management Plan was approved on 5 July 2013. Consequently, the Minister for the Environment chartered the EPA as the lead to coordinate this review. Submissions have been sought from Snowy Hydro Limited and a range of key stakeholders. A report on the EPA's findings will be lodged on the EPA's website and any approved adaptions made to the environmental monitoring program will be implemented prior to the 2018 major sampling campaign.

The Environmental Management Plan includes an adaptive environmental monitoring program where the future program is informed by the results of the previous environmental monitoring. Based on the analysis of samples collected from 2004 to 2013, the Environmental Management Plan's prescribed five-year interval between environmental monitoring programs was found to be appropriate. Therefore, in accordance with the Environmental Management Plan, in 2017 potable water was the only matrix sampled with results indicating the silver concentrations were similar to those from previous years and remain several orders of magnitude below relevant guideline values.

The Annual Compliance Report highlighted that 11 of the 12 sites for potable water sampling were sampled in the 2017 cloud seeding season. Due to access restrictions to one site located on private property, Snowy Hydro Limited was unable to collect samples for this location. Snowy Hydro Limited advised that the site is not considered a representative site for potential silver accumulation, and was originally included to provide the landowner with assurance that an independent review of the results would occur.

The EPA notes that Snowy Hydro Limited has made attempts to contact the site owner to seek approval to remove the location from the Environmental Management Plan; however, to date no response has been received. Snowy Hydro Limited has formally requested the site's removal as part of the current five-yearly Environmental Management Plan review.

In previous years, the National Parks and Wildlife Service has conducted audits of infrastructure within Kosciuszko National Park. The National Parks and Wildlife Service did not undertake an audit in the 2017 cloud seeding season because cloud seeding operation and maintenance had become normal day-to-day business for Snowy Hydro Limited. The National Parks and Wildlife Service requested that Snowy Hydro Limited continue its site inspection and auditing process and requested reports of any significant issues or change.

Snowy Hydro Limited reported that no new infrastructure was established or decommissioned during the reporting period, no major visual modifications made to existing infrastructure and no accidents or breakdowns to report that resulted in spillage of cloud seeding agents or fuel, or failure of any of the controls specified in the Environmental Management Plan.

While no current or emerging issues were formally raised by stakeholders for the 2017 cloud seeding season, mechanisms within the Environmental Management Plan allow relevant agencies of the Minister

for the Environment to request consideration by Snowy Hydro Limited of emerging environmental issues between each five-yearly review.

Conclusions and recommendations

After reviewing the Snowy Hydro Limited 2017 Annual Compliance Report and Snowy Hydro Limited on-ground operations, the EPA concludes that:

- Snowy Hydro Limited has complied with all its obligations as detailed in the Act.
- Snowy Hydro Limited has complied with all its obligations as detailed in the Environmental Management Plan for cloud seeding operations approved by the relevant Ministers on 5 July 2013, apart from sampling at one potable water sampling site.
- Snowy Hydro Limited has complied with all its obligations as detailed in the *Protection of the Environment Operations Act 1997.*
- Analysis of potable water sampling carried out during the 2017 cloud seeding season showed similar silver concentrations to those in previous years and remain several orders of magnitude below relevant guideline values.

It is recommended that:

- future reviews are also undertaken in consultation with input from partner agencies of the National Parks and Wildlife Service and the Office of Environment and Heritage
- Snowy Hydro Limited continues to pursue research opportunities on the cloud seeding operations in the Snowy Mountains
- the outcomes of this review are communicated to the relevant Ministers.

Appendix 1

Snowy Hydro Limited compliance with the Snowy Mountains Cloud Seeding Act 2004

Obligations under the Snowy Mountains Cloud Seeding Act 2004	Compliance status (report reference)
The area to be primarily targeted for the increased precipitation is land within the Snowy water catchment.	(1.4) Addressed
Operations may be carried out only if there is an approved Environmental Management Plan.	(1.1) Addressed
Operations must be carried out in accordance with the approved Environmental Management Plan (whether being carried out within or outside the Snowy water catchment).	(1) Addressed All operations carried out within the catchment
The seeding agent used must be an approved seeding agent and used in accordance with the conditions (if any) of its approval as a seeding agent.	(2.2) Addressed
The tracing agent used must be an approved tracing agent and used in accordance with the conditions (if any) of its approval as a tracing agent.	(2.2) Addressed Tracing agent not used
The seeding agent and tracing agent must be discharged by using an approved method.	(2.2) Approved Land-based aerosol generators
The discharge must be carried out in accordance with the conditions (if any) of its approval as a method of discharge.	(2) Addressed
The discharge of the seeding agent is to be carried out at a time when increased precipitation in the Snowy water catchment is likely to fall as snow at an elevation above 1400 metres from the mean sea level.	(3.1) Addressed
Snowy Hydro Limited must consult with the National Parks and Wildlife Service (NPWS) before carrying out any new operations involving a land-based method of discharge of seeding or tracing agent within any area of land reserved under the <i>National Parks and Wildlife Act 1974</i> (i.e. operations in an area that has not been the subject of previous consultation with the NPWS).	(2.3) Addressed No new operations carried out
Snowy Hydro Limited must consult with the NPWS before installing, or carrying out major modifications to, any facilities required to carry out cloud seeding operations within any area of land reserved under the <i>National Parks and Wildlife Act 1974</i> .	(2.3) Addressed No modifications or new installations carried out
Installation of new facilities for cloud seeding operations must not be carried out within any wilderness area (within the meaning of the <i>National Parks and Wildlife Act 1974</i>).	(2.3) Addressed No new facilities installed
A seeding agent is not to be discharged from land-based aerosol generators in any wilderness area (within the meaning of the <i>National Parks and Wildlife Act 1974</i>).	(1.4) Addressed All land-based generators located in approved areas by NPWS
An application for approval of the use of a thing as a seeding agent in cloud seeding operations must be accompanied by details of the health risk assessment carried out in relation to the proposed use of the seeding agent (including the process used to carry out the assessment and the results of the assessment).	(N/A)

Obligations under the Snowy Mountains Cloud Seeding Act 2004	Compliance status (report reference)
An application for approval of the use of a thing as a tracing agent in cloud seeding operations must be accompanied by details of the health risk assessment carried out in relation to the proposed use of the tracing agent (including the process used to carry out the assessment and the results of the assessment).	(N/A)
An application for approval of an Environmental Management Plan must be accompanied by an independent scientific assessment of any proposed cloud seeding operations that differ from the operations currently authorised. Any such scientific assessment must comply with any requirements imposed by the relevant Ministers and notified to Snowy Hydro Limited.	(N/A)
Snowy Hydro Limited must, by 31 March in each year or such later date as agreed by the relevant Ministers, provide a report on its cloud seeding operations during the period of 12 months ending on 31 December in the previous year to the relevant Ministers and to the EPA. Without limiting the generality of subsection (1), the report must contain the following information:	(4) Addressed Report on cloud seeding operations received by the EPA 31 March 2018
 a) details of compliance with the approved Environmental Management Plan b) details of research concerning, and monitoring of, the impact of tracing agents and seeding agents on the environment (including the findings of any such research or monitoring). 	

Snowy Hydro Limited compliance with the Environmental Management Plan

Obligations under the Environmental Management Plan	Compliance status (report reference)
Cloud seeding will not commence if the freezing level over the catchment is greater than 1600 metres, and will be suspended or terminated if the freezing level rises above 1600 metres during cloud seeding campaigns.	(3.1) Addressed There was one instance (Event 1) when preliminary data indicated a freezing level of 1605 metres during operations, resulting in suspension of the event. Final data indicated a freezing level of 1592 metres.
 Additional controls will be implemented when the freezing level is between 1550 metres and 1600 metres above sea level, including: a) video monitoring at locations over the target area at approximately 1400 metre elevation to assist in determining that precipitation is not falling as rain b) when required, undertaking telephone polling to external parties and/or Snowy Hydro Limited personnel within the target area to confirm that precipitation is not falling as rain at approximately 1400 metre elevation. 	(3.1) Addressed Additional controls were implemented during one cloud seeding event (Event 9) when freezing levels were observed between 1550 metres and 1600 metres, in accordance with the conditions of the Environmental Management Plan.
Snowy Hydro Limited will consult with the NPWS prior to undertaking major vegetation management and site access beyond maintenance of the existing tracks and site footprints.	(2.3) N/A

Obligations under the Environmental Management Plan Compliance status (report reference) The Annual Compliance Report will include: (a - 4.1-4.4) Addressed a) sample locations, data results, evaluation and adaptive management recommendations for the environmental monitoring program details (including results and evaluation) of any emerging (b - 4.5) Addressed No emerging environmental issues environmental issues results from meteorological monitoring that can demonstrate Snowy (c - 3.1) Addressed Hydro Limited's compliance with the requirement to ensure that Table 4 increased precipitation falls as snow in areas at an elevation above 1400 metres above sea level (d - 3.2) Addressed results from analyses of downwind precipitation Figure 2 the event time and duration over which cloud seeding occurred (e - 2.1) Addressed any accidents or breakdowns resulting in spillage of cloud seeding Table 2 agents, fuel or failure of controls specified in this Environmental (f - 2.3) Addressed Management Plan the quantity of cloud seeding agents that were released per seeding event per generator (g - 2.2) Addressed progress updates on the Environmental Fate Study, if relevant (not Table 3 including any project sensitive information, such as unpublished data). (h - 4.3) Addressed In addition to the Annual Compliance Report, Snowy Hydro Limited will (1.2) Addressed prepare a Cloud Seeding Operations Annual Report, which is to be made The 2016 Cloud Seeding publicly available on the Snowy Hydro Limited website within a reasonable **Operations Annual Report was**

timeframe after any recommendations from the Board of the EPA and the relevant Ministers. The Cloud Seeding Operations Annual Report will include, but not be limited to:

published on the Snowy Hydro Limited website in August 2017.

- summary statistics of the Environmental Monitoring Program
- details of compliance with approved Environmental Management Plan
- summary statistics on the overall duration over which cloud seeding occurred and the total amount of cloud seeding agents that were released over the season.

Disputes between NSW government agencies and Snowy Hydro Limited with regards to cloud seeding operations will be resolved in accordance with the following escalation process:

- use of established paths of communication between Snowy Hydro Limited and the agency (officer to officer)
- communication between Snowy Hydro Limited Executive Officer and agency Department Director
- communication between the Chief Executives of Snowy Hydro Limited and the agency.

(2.4) Addressed

There were no disputes between NSW government agencies and Snowy Hydro Limited.

Snowy Hydro Limited will continue to consult with other relevant land managers with respect to vegetation management and site access. Snowy Hydro Limited will also consult with relevant land managers in situations where major visual modifications are made to infrastructure or if new sites are installed and/or existing sites are removed. No new infrastructure will be established without the prior endorsement by the relevant land manager.

decommissioned.

(2.1) Addressed

no infrastructure was

(2.3) Addressed

No new infrastructure was

established, no major visual

modifications were made to

existing infrastructure, and

OEH and EPA and other identified stakeholders were advised by email.

The Office of the Environment and Heritage (OEH), the EPA and other identified stakeholders will be advised as soon as practicable following the commencement of, and on the conclusion of, cloud seeding campaigns.

Obligations under the Environmental Management Plan Compliance status (report reference) (1.4) Addressed Existing sites authorised under the Act will be defined by Snowy Hydro Limited (coordinates and identified on a map), and provided to OEH and A map of existing sites and details the EPA prior to commencement of the first annual winter operations. of their coordinates were provided Thereafter, prior to the installation of any new authorised sites, updated to the EPA and OEH in June 2013. coordinates and maps are to be provided to OEH and the EPA. There were no changes to infrastructure in 2017. All Management Controls (Table 1) will be implemented, being those (2.3) Addressed included for each of the following activities: Infrastructure, including cloud seeding agents and fuel, are installation and modification of generators managed in accordance with these operation and maintenance of generators (including release of cloud requirements. seeding agents and increased precipitation) storage and preparation of cloud seeding agents and other chemicals installation and modification of weather stations installation and modification of communications equipment operation and maintenance of weather stations and communications infrastructure operation and maintenance of snow sampling sites implementation of Environmental Monitoring Program removal of infrastructure and rehabilitation of sites. Meteorological monitoring Downwind precipitation will be monitored - mean wintertime daily (3.2) Addressed precipitation anomalies will be updated each year and included in the Figure 2 Annual Compliance Report following cloud seeding operations to continue to monitor downwind precipitation. Snow sampling profile sites and preferred access routes will be defined by (1.4) Addressed Snowy Hydro Limited (coordinates and identified on a map) and provided No snow profile sampling was to OEH and the EPA prior to commencement of the first annual winter carried out in 2017. snow sampling operations. Updated coordinates and maps are to be provided to OEH and the EPA if sites change. **Environmental chemistry monitoring** Environmental sampling will be undertaken as per Table 3 in the (4.1.2) Addressed Environmental Management Plan. Table 5 Specific quality controls will be applied to the collection and handling of all (4.1.3) Addressed samples collected for the cloud seeding program and will include: Samples were collected and the use of a new clean plastic vial/bag for each sample processed in accordance with internal work instructions and the use of a new pair of clean disposable gloves at each site and quality assurance and quality procedures to minimise contact with the inside of vials/bags to minimise control procedures. the potential for sample contamination the washing of all sampling equipment with ultra-pure water or water from the sampling location prior to use the use of a data management system, including the barcoding of each sample to ensure every sample is individually trackable from collection, return to base, dispatch to the laboratory and the return of results. Samples sent for laboratory analyses will be analysed for total silver (4.1.3) Addressed concentration with an appropriate level of quality assurance and quality

control.

Obligations under the Environmental Management Plan	Compliance status (report reference)
For those samples that are analysed chemically, the data is to be analysed statistically and interpreted on the basis of three statistical tools.	(4.1.5) Addressed Due to extremely low values observed in 2017, no statistical analyses were undertaken for this matrix.
Steps in decision tools and environmental suspension criteria will be implemented.	(4.1.1) Addressed
The interim and final results of the Environmental Fate study will be provided to OEH and the EPA upon peer-reviewed publication. In addition, if required, briefings on the project will be provided to OEH and the EPA, including any recommendations for the adaptive management of the Environmental Monitoring Program.	(4.3) Addressed
Research findings from the study will be used to inform the Environmental Monitoring Program and may result in improvements to the current program, if required.	(4.3) Addressed Will be addressed via the current five-yearly EMP review
Macroinvertebrates monitoring	
Sampling will be undertaken on a five-year sampling interval, with the first round of sampling to be undertaken following the first year of cloud seeding operations. If additional river sediment sampling is undertaken due to the triggers outlined in the Environmental Management Plan, macroinvertebrates sampling will also be undertaken at the affected locations.	(4.2) N/A Macroinvertebrate sampling was not required in 2017. Sampling will occur in 2018.
If macroinvertebrate sampling sites are changed and/or added outside of the Environmental Management Plan review process, updates to the Environmental Management Plan will be provided to OEH and the EPA prior to undertaking sampling.	(4.2) N/A Macroinvertebrate sampling was not required in 2017.
The macroinvertebrate sampling program implemented by Snowy Hydro Limited (and endorsed by OEH) uses the NSW Australian River Assessment System protocol.	(4.2) N/A Macroinvertebrate sampling was not required in 2017.
Additional monitoring	
Relevant agencies of the Minister for the Environment may request consideration by Snowy Hydro Limited of emerging environmental issues between reviews of this Environmental Management Plan. For issues to be considered by Snowy Hydro Limited, the agency will provide a clear outline of the issue to Snowy Hydro Limited based on direct evidence or established scientific theory. The agency and Snowy Hydro Limited will then agree on an appropriate research/monitoring/ consultation/reporting regime.	(4.5) N/A No emerging environmental issues were raised with, or identified by, Snowy Hydro Limited during this reporting period.