

Findings of the EPA's review of Snowy Hydro Limited Cloud Seeding Program

2018 Annual Compliance Report

© 2019 State of NSW and the NSW Environment Protection Authority

With the exception of photographs, the State of NSW and the NSW Environment Protection Authority (EPA) are pleased to allow this material to be reproduced in whole or in part for educational and non-commercial use, provided the meaning is unchanged and its source, publisher and authorship are acknowledged. Specific permission is required for the reproduction of photographs.

The EPA has compiled this report in good faith, exercising all due care and attention. No representation is made about the accuracy, completeness or suitability of the information in this publication for any particular purpose. The EPA shall not be liable for any damage which may occur to any person or organisation taking action or not on the basis of this publication. Readers should seek appropriate advice when applying the information to their specific needs.

All content in this publication is owned by the EPA and is protected by Crown Copyright, unless credited otherwise. It is licensed under the Creative Commons Attribution 4.0 International (CC BY 4.0), subject to the exemptions contained in the licence. The legal code for the licence is available at Creative Commons.

The EPA asserts the right to be attributed as author of the original material in the following manner:
© State of New South Wales and the NSW Environment Protection Authority 2019.

Published by:

NSW Environment Protection Authority
59 Goulburn Street, Sydney NSW 2000
PO Box A290, Sydney South NSW 1232
Phone: +61 2 9995 5000 (switchboard)
Phone: 131 555 (NSW only – environment information and publications requests)
Fax: +61 2 9995 5999
TTY users: phone 133 677, then ask for 131 555
Speak and listen users: phone 1300 555 727, then ask for 131 555
Email: info@epa.nsw.gov.au
Website: www.epa.nsw.gov.au

Report pollution and environmental incidents
Environment Line: 131 555 (NSW only) or info@epa.nsw.gov.au
See also www.epa.nsw.gov.au

ISBN 978 1 925987 07 2
EPA 2019P1846
August 2019

Contents

Executive summary	3
Introduction	3
Background	3
Purpose	4
EPA review of Snowy Hydro Limited 2018 Annual Compliance Report	4
Review	4
Findings	4
Discussion	4
Conclusions and recommendations	5
Appendix 1	7
Snowy Hydro Limited compliance with the Snowy Mountains Cloud Seeding Act 2004	7
Snowy Hydro Limited compliance with the Environmental Management Plan	8

Executive summary

Since 2004, Snowy Hydro Limited has been conducting a winter cloud seeding trial in the NSW Snowy Mountains area. On 31 May 2013, amendments to the *Snowy Mountains Cloud Seeding Act 2004* (the Act) came into effect. This enabled Snowy Hydro Limited to conduct permanent cloud seeding operations within an expanded area of the Snowy Mountains, according to an Environmental Management Plan approved by the Minister for the Environment and the Minister for Planning and Environment. Approval was given on 28 June 2018.

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 has to provide a report to the EPA by 31 March each year that details compliance with the Environmental Management Plan and the results of any research and monitoring into the environmental impact of cloud seeding operations. The EPA has 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 2018 cloud seeding season. It has found that the report was submitted to the relevant Ministers and the EPA by the due date, and that Snowy Hydro Limited has complied with all its obligations as detailed in the Act in the Environmental Management Plan. This includes environmental monitoring results following the end of the 2018 cloud seeding season.

Introduction

Background

Cloud seeding is a process used to encourage orographic clouds, which are formed as moist air rises over mountains, to create 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 1,400 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. So far, environmental monitoring hasn't detected any significant adverse environmental impacts. The 2018 cloud seeding operations comprised 118 hours of cloud seeding between 11 May and 21 August. Approximately 46.2kg of silver iodide was dispersed during these operations, covering a target area about 2,110km².

Under the Act, cloud seeding operations may only occur according to an Environmental Management Plan that has been jointly approved by the relevant Ministers. The current Environmental Management Plan was approved by the relevant Ministers on 28 June 2018 following the five yearly review as required under the Act.

The Act also requires that Snowy Hydro Limited provides an annual report to the EPA and the relevant Ministers by 31 March. This report must detail 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 has 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 2018 Annual Compliance Report. This is in accordance with the Act and the approved Environmental Management Plan.

Snowy Hydro Limited 2018 Annual Compliance Report

EPA Review

In carrying out its review of the report, the EPA consulted with the Environment Protection Science section of the Office of Environment and Heritage (now Department of Planning, Industry and Environment). The EPA also consulted with the National Parks and Wildlife Service (NPWS) regarding cloud seeding operations that took place within Kosciuszko National Park.

Findings

The review found the following:

- Snowy Hydro Limited has complied with all its obligations as outlined in the Act and within the Environmental Management Plan. There were no accidents or breakdowns that resulted in spillage of cloud seeding agents or fuel, or failure of controls specified in the Environmental Management Plan.
- Monitoring was carried out according to the Environmental Management Plan. This included environmental monitoring for potable water (annual), and soil, sediment, peat mire and moss (five-yearly).
- 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 agents 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 2018 cloud seeding operations, Snowy Hydro Limited dispersed approximately 46.2kg of the approved seeding agent, silver iodide, into suitable storm systems. Weather conditions in the Snowy Mountains at the time resulted in 118 hours of cloud seeding events. This was an increase of 22 hours and 13 minutes on the previous year and 34 hours and 43 minutes over the 2013-17 season average. Consequently, this also led to more silver iodide being used, an increase of 9.8kg from the previous year and 31kg above the 2013-17 season average.

During the 2018 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 2015, the University of Queensland on behalf of Snowy Hydro Limited finished a 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 into this study made several recommendations around the environmental monitoring program. Snowy Hydro Limited has considered the recommendations and amended the Environmental Management Plan in consultation with the EPA and the Office of Environment and Heritage as part of the five-yearly review that was completed in 2018.

The EPA coordinated this five-yearly review of the Environmental Management Plan which fulfilled the requirements of the Act and included consultation with Snowy Hydro Limited and a range of key stakeholders. Consequently, the relevant Ministers approved the current Environmental Management Plan on 28 June 2018.

The Environmental Management Plan includes an adaptive 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 2017, the Environmental Management Plan continues to prescribe five-year intervals between environmental monitoring programs as this was found to be appropriate.

Therefore, according to the Environmental Management Plan, in 2018 environmental monitoring of potable water, soil, sediment, peat mire and moss was undertaken. In addition, Snowy Hydro Limited, with the agreement of the EPA, collected and analysed a number of extra soil, peat mire and moss samples. The environmental monitoring results show that silver concentrations were below the associated values in the Environmental Management Plan. In general, comparison of these results with the 2013 data, being the last time environmental monitoring of soil, sediment, peat mire and moss took place, shows no attributable changes in average silver concentrations.

Further, the annual potable water sample results indicate that silver concentrations remain several orders of magnitude below the relevant value in the Environmental Management Plan. The Annual Compliance Report did show an increase in silver concentrations at the intermediate potable water site compared to past years. However, Snowy Hydro Limited has advised that this was caused by the presence of sediment in the collected sample. Snowy Hydro Limited is reviewing the intermediate potable water sample site to ensure it is representative to detect any changes in silver concentrations in the environment arising from cloud seeding operations.

In previous years, the NPWS has conducted audits of infrastructure within Kosciuszko National Park. The NPWS did not undertake an audit in the 2018 cloud seeding season because cloud seeding operation and maintenance had become normal day-to-day business for Snowy Hydro Limited. The NPWS requested that Snowy Hydro Limited continue to access remote sites via helicopter or by foot to avoid the use of vehicles in un-trailed locations.

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

No current or emerging issues were formally raised by stakeholders for the 2018 cloud seeding season. However, the Environmental Management Plan allows relevant agencies 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 2018 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 28 June 2018
- Snowy Hydro Limited has complied with all its obligations as detailed in the *Protection of the Environment Operations Act 1997*

- analysis of potable water, soil, sediment, peat mire and moss sampling carried out during the 2018 cloud seeding season showed silver concentrations of all these matrices remain below the associated values in the Environmental Management Plan.

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 Department of Planning, Industry and Environment.
- 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: 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).	(4) Addressed Report on cloud seeding operations received by the EPA by 31 March 2018

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 No cloud seeding operations were commenced where the freezing level was greater than 1600 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 not triggered as there were no cloud seeding operations with a freezing level between 1550 metres and 1600 metres.
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)
<p>The Annual Compliance Report will include:</p> <ul style="list-style-type: none"> a) sample locations, data results, evaluation and adaptive management recommendations for the environmental monitoring program b) details (including results and evaluation) of any emerging environmental issues c) results from meteorological monitoring that can demonstrate Snowy Hydro Limited's compliance with the requirement to ensure that increased precipitation falls as snow in areas at an elevation above 1,400 metres above sea level d) results from analyses of downwind precipitation e) the event time and duration over which cloud seeding occurred f) any accidents or breakdowns resulting in spillage of cloud seeding agents, fuel or failure of controls specified in this Environmental Management Plan g) the quantity of cloud seeding agents that were released per seeding event per generator h) progress updates on the Environmental Fate Study, if relevant (not including any project sensitive information, such as unpublished data). 	<p>(4.1–4.4) Addressed (4.5) Addressed No emerging environmental issues (3.1) Addressed Table 4 (3.2) Addressed Figure 3.1 (2.1) Addressed Table 2.1 (2.3) Addressed. No accidents, spills or breakdowns (2.2) Addressed Table 2.2 (4.3) Addressed</p>
<p>In addition to the Annual Compliance Report, Snowy Hydro Limited will prepare a Cloud Seeding Operations Annual Report, which is to be made publicly available on the Snowy Hydro Limited website within a reasonable 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:</p> <ul style="list-style-type: none"> • 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. 	<p>(1.2) Addressed The 2017 Cloud Seeding Operations Annual Report was published on the Snowy Hydro Limited website in July 2018.</p>
<p>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:</p> <ul style="list-style-type: none"> • 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. 	<p>(2.4) Addressed There were no disputes between NSW government agencies and Snowy Hydro Limited.</p>
<p>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.</p>	<p>(2.3) Addressed No new infrastructure was established, no major visual modifications were made to existing infrastructure, and no infrastructure was decommissioned.</p>
<p>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.</p>	<p>(2.1) Addressed OEH and EPA and other identified stakeholders were advised by email.</p>
Obligations under the Environmental Management Plan	Compliance status (report reference)
<p>Existing sites authorised under the Act will be defined by Snowy Hydro Limited (coordinates and identified on a map) and provided to OEH and the EPA prior to commencement of the first annual winter operations.</p>	<p>(1.4 & 2.3) Addressed A map of existing sites and details of their coordinates were provided</p>

<p>Thereafter, prior to the installation of any new authorised sites, updated coordinates and maps are to be provided to OEH and the EPA.</p>	<p>to the EPA and OEH in June 2013. There were no changes to infrastructure in 2018.</p>
---	--

<p>All Management Controls (Table 1) will be implemented, being those included for each of the following activities:</p> <ul style="list-style-type: none"> • installation and modification of generators • operation and maintenance of generators (including release of cloud 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. 	<p>(2.3) Addressed Infrastructure, including cloud seeding agents and fuel, are managed in accordance with these requirements.</p>
---	--

Meteorological monitoring

<p>Downwind precipitation will be monitored – mean wintertime daily precipitation anomalies will be updated each year and included in the Annual Compliance Report following cloud seeding operations to continue to monitor downwind precipitation.</p>	<p>(3.2) Addressed Figure 3.1</p>
--	---------------------------------------

<p>Snow sampling profile sites and preferred access routes will be defined by Snowy Hydro Limited (coordinates and identified on a map) and provided to OEH and the EPA prior to commencement of the first annual winter snow sampling operations. Updated coordinates and maps are to be provided to OEH and the EPA if sites change.</p>	<p>(1.4) Addressed No snow profile sampling was carried out in 2018.</p>
--	--

Environmental chemistry monitoring

<p>Environmental sampling will be undertaken as per Table 3 in the Environmental Management Plan.</p>	<p>(4.1.2) Addressed Table 4.1</p>
---	--

<p>Specific quality controls will be applied to the collection and handling of all samples collected for the cloud seeding program and will include:</p> <ul style="list-style-type: none"> • the use of a new clean plastic vial/bag for each sample • the use of a new pair of clean disposable gloves at each site and procedures to minimise contact with the inside of vials/bags to minimise 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. 	<p>(4.1.3) Addressed Samples were collected and processed in accordance with internal work instructions and quality assurance and quality control procedures.</p>
--	---

<p>Samples sent for laboratory analyses will be analysed for total silver concentration with an appropriate level of quality assurance and quality control.</p>	<p>(4.1.3) Addressed</p>
---	--------------------------

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 Statistical analysis undertaken with exception of potable water environmental monitoring due to extremely low values observed in 2018 and previous years.
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 EMP amended in 2018 as part of five-yearly 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) Addressed Macroinvertebrate sampling conducted 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.	(4.2.1) Addressed Macroinvertebrate sampling sites in accordance with EMP.
The macroinvertebrate sampling program implemented by Snowy Hydro Limited (and endorsed by OEH) uses the NSW Australian River Assessment System protocol.	(4.2.2) Addressed Macroinvertebrate sampling conducted using NSW Australian River Assessment System protocol.
Additional monitoring	
<p>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.</p> <p>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.</p>	(4.5) N/A No emerging environmental issues were raised with, or identified by, Snowy Hydro Limited during this reporting period.