ACIL ALLEN CONSULTING

REPORT TO
REGIONAL DEVELOPMENT VICTORIA

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EVALUATION OF THE FOUR SEASONS

ENERGY PILOT PROGRAM

FINAL REPORT

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Executive summary

ACIL Allen Consulting has been commissioned by Regional Development Victoria (RDV) to undertake an evaluation of the Four Seasons Energy Pilot Program (the Program). The evaluation involved a review of key Program documentation provided by the Department and consultations with a range of stakeholders involved in the Program.

Program overview

The Program was established in 2007 to demonstrate alternative sources of heating and cooling energy for regional communities. Funding was made available to trial Ground Source Heat Pump (GSHP) technology at public facilities such as schools, and council and community group buildings.

The Program fully funded the cost of design and installation of GSHP systems at public sites, while private or commercial applicants were eligible for 50 per cent of the capital costs involved with the GSHP installations.

GSHPs transfer energy stored in the ground (or in water) to heat and/or cool buildings. The technology relies on the fact that the earth (beneath the surface) remains at a relatively constant temperature throughout the year, warmer than the air above it during the winter and cooler in the summer. Using pipes buried in the ground as a collector, a heat pump can transfer heat energy absorbed at one location to another.

An Expression of Interest process to participate in the Program was run in October 2007. This process attracted 11 submissions from around the State. A feasibility study was subsequently commissioned by RDV for each site.

Six submissions were funded and a total of $825,182 was provided under the Program to support these projects between January 2008 and August 2012. Of this, $507,000 was used to develop a GSHP at the Wangaratta High School as the Program's flagship project.

The geoexchange systems installed were generally financially viable with payback periods ranging from 2.5 to 24 years. Their viability was improved by the increases in electricity prices of over 70 per cent in real terms from June 2007 to December 2012 (Productivity Commission 2013).

Projects undertaken at the Bendigo Regional Institute of TAFE, the Brush Ski Co-operative and the Mount Beauty Neighbourhood Centre proceeded according to plan and achieved relatively short payback periods, calculated to be less than estimated in the feasibility studies.

At the Kaniva Senior Citizens Clubroom, the longer than estimated payback period was a result of additional costs related to difficulties experienced during installation. At Wangaratta High School the longer payback period resulted from the geoexchange system servicing a smaller area than estimated in the feasibility study.

The expenditure on installations undertaken through the Program was just over $1.11 million. Annual energy cost savings are estimated to total just over $81,000, with the total Program activities having a payback period of 13.2 years[1]. This is less than the estimated payback period of 17.1 years in the original feasibility studies[2].

A number of additional non-financial benefits were also reported, namely:

- the development of project management skills by individuals within participating organisations;
- enhanced relationships between the grant recipients and RDV;
- the impetus for some organisations to look for other funding opportunities; and
- a focus on innovation.

Program administration and delivery

Grant recipients reported that, through the Program, they had established good working relationships with RDV. They noted that RDV was engaged in the Program, was committed to helping the industry demonstrate the technology, and worked to achieve the desired outcomes.

Given the infancy of the industry and the lack of knowledge with GSHP technology in Australia, the engagement of an expert to provide technical knowledge to RDV at the beginning of the Program was an important part of the Program's establishment and in line with good practice. The commissioning of feasibility studies was also considered an important part of the early stages of the Program.

However, stakeholders suggested that the Program would have benefitted if access to technical expertise had been maintained for its duration, and was also made available to grant recipients, who generally were not familiar with the technology or specific requirements of operating such systems.

The lack of technical knowledge was compounded by limited project management skills within the organisations involved in the Program. Implementation of the program would have benefited from more rigorous project management, including additional monitoring and reporting requirements, and more formal reporting and documentation. The latter was considered particularly important given the fact that potential users of this type of technology are looking for documented evidence of the benefits.

Appropriateness

Stakeholders considered that Program was structured well in supporting the geoexchange industry, promoting the use of GSHPs and demonstrating the potential of alternative sources of heating and cooling energy for regional communities across a range of different buildings and locations. The Program assisted the industry to develop and provided valuable support in raising awareness of the technology.

Specific evidence the Program was targeted appropriately is that, despite the relative infancy of the industry and the lack of readily accessible information regarding good practice, the Program did select sites able to demonstrate the role and potential of GSHPs.

Stakeholders did suggest that future initiatives involving relatively new technology should incorporate detailed research prior to program design and implementation to ensure a better

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1 This includes consideration of additional capital costs associated with alternative options. The payback period would be reduced further to 12.5 years if the cost of the Corryong Innovation Space GSHP is excluded, which was never able to be made operational.

2 These estimates were based on original annual energy cost savings and actual cost of installation, including the consideration of additional capital costs associated with alternative options.

understanding of the technology, as well as of the wider industry capability. It was also noted that a very rigorous tendering process is required in such an evolving technology environment, with successful installation experience a critical selection criterion.

Effectiveness

The Program is considered to have been effective at demonstrating the use of GSHP technology in regional communities. Grant recipients indicated that the technology installed generated significant interest and discussion. In addition, the installations funded by the Program have been the subject of a number of promotional activities, such as the publication of the work in a number of local newspapers as well as industry magazines and journals. Industry members consulted as part of the review noted that the Program had raised awareness about GSHPs and the wider geoexchange industry. The Program has also helped build relationships within the industry, as well as knowledge of the skills and capabilities of industry firms.

Specific evidence of the effectiveness of the Program is that grant recipients noted it highly unlikely the projects would have gone ahead in the absence of the grants provided by RDV.

It was suggested that the Program reach and impact could have been even greater if data in relation to the impact on energy use and associated cost savings had been collected and made available to other potential investors in GSHP. In addition, stronger linkages between the work undertaken for specifications/feasibility studies and installation would have fostered greater ownership of project implementation and Program outcomes.

Some grant recipients also noted that the feasibility studies focused on buildings without sufficient regard to ground conditions, which can significantly affect the performance of GSHPs as well as influencing project budgets. They suggested that future Programs should ensure feasibility studies pay greater attention to such relevant factors.

Conclusion and recommendations

The overall assessment is that the Program has been appropriate and effective in achieving its objectives. It has successfully established installations that would not have otherwise occurred. These installations have demonstrated the potential of the GHSP technology and, in some cases, have achieved payback periods shorter than anticipated. Having said that, a number of areas for Program improvement have been identified and are recommended to be included in any future similar programs:

- An evaluation framework should be developed at the outset of programs, which includes key performance indicators and the collection of data on program outputs and outcomes. This would help both assess and demonstrate achieved performance to other potential users.
- Project management, monitoring and reporting processes should be strengthened to help minimise and manage technical and administrative risks.
- Installation and feasibility study work should be more strongly linked to assure continuity of objectives between installation design and implementation.
- Industry stakeholders should be actively involved in the design of programs to ensure they have ownership of, and full engagement with the desired outcomes.
- Experts should be made available for the duration of program to ensure that technical knowledge is available, as and when required, to address implementation and operational issues.

1 Introduction

ACIL Allen Consulting has been commissioned by Regional Development Victoria (RDV) to undertake an evaluation of the Four Seasons Energy Pilot Program (the Program). The Program was established in 2007 to demonstrate alternative sources of heating and cooling energy for regional communities. It was expected that geoexchange Ground Source Heat Pumps (GSHPs) would be a viable alternative to other heating and cooling technologies particularly in areas that do not have access to a supply of natural gas.

The Program made funding available to trial GSHP technology at public facilities (such as schools) and council and community group buildings. Feasibility studies were conducted for selected projects as part of the Program.

The evaluation scope covers Program design, implementation and impact. It provides an assessment of the:

- extent to which Program objectives were achieved;
- Program's overall appropriateness and effectiveness; and
- benefits to facilities where GSHPs were installed.

The evaluation also examines any non-financial benefits of the Program and makes recommendations for the improvement of future similar programs.

This chapter provides a brief outline of the project's scope, describes the operation of GSHPs and details the methodology used to undertake the evaluation.

1.1 Evaluation methodology

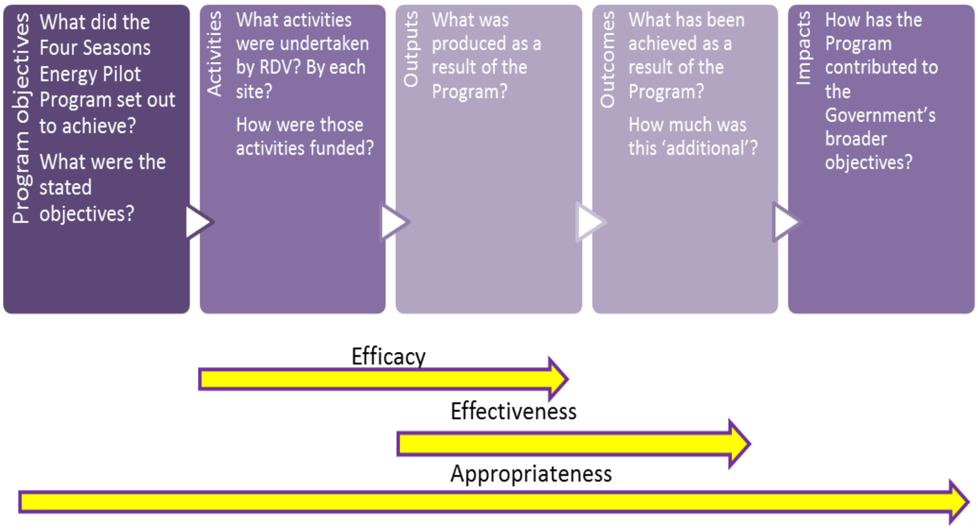
The evaluation framework used to review the Program is provided in Figure 1. This has involved:

- identifying the Program's objectives;
- exploring the activities undertaken through the Program;
- analysing the Program's outputs and outcomes, including the financial viability of the systems installed;
- assessing the administration and delivery of the Program; and
- evaluating the appropriateness and effectiveness of the Program.

The evaluation has been informed by a review of key Program documentation provided by the Department and consultations with a range of stakeholders involved in the Program. This included project officers, grant recipients, installers and consultants who had varying levels of involvement during the Program's operation. In total 10 consultations were undertaken. Appendix B outlines those stakeholders who were consulted for this evaluation.

The assessment of the financial viability of the Program has drawn heavily on the stakeholder consultations. Due to a lack of data on the benefits of installing GSHP systems, the feasibility studies undertaken for each location have also informed this assessment.

Figure 1 **Program review framework**



Source: ACIL Allen consulting

1.2 Report structure

The remainder of this report is structured as follows:

- Chapter 2 outlines the Program's objectives and describes GSHP technology.
- Chapter 3 describes the activities undertaken through the Program.
- Chapter 4 analyses the Program's outputs and outcomes, including financial viability; and
- Chapter 5 assesses the administration, delivery, appropriateness and effectiveness of the Program.

2 Program objectives

This chapter details of the Program and explores its objectives. It also gives a brief overview of GSHP technology.

2.1 The Four Seasons Energy Pilot Program

Funding for the Program was provided as part of the Victorian Government's 2005 Moving Forward initiative (further details are in Box 1). The Program fully funded the cost of design and installation of GSHP systems at public sites, while private or commercial applicants were eligible for 50 per cent of the capital costs involved with the GSHP installations. Program funding was made available for GSHP feasibility studies and trials based on life cycle cost analysis (RDV 2007).

GSHP systems provide efficient, low cost heating and cooling and are increasingly being used in rural and regional areas where reticulated gas is not available. GSHP systems are an established and proven technology in Europe and the United States of America but, at the time that the Program commenced, were relatively untried in Australia (RDV 2007).

GSHPs transfer energy stored in the ground (or in water) to heat and/or cool buildings. The technology relies on the fact that the earth (beneath the surface) remains at a relatively constant temperature throughout the year, warmer than the air above it during the winter and cooler in the summer. Thus using pipes buried in the ground as a collector and a suitable heat pump, heat energy is absorbed at one location and transferred to another. Further details about GSHPs are provided in Appendix D.

An Expression of Interest process to participate in the Program was run in October 2007. This process attracted 11 submissions from around the State. A feasibility study was then commissioned and paid for by RDV for each site. These studies formed the basis for determining the sites for which Ministerial approval for funding would be sought. During this process an expert was commissioned by RDV to undertake the feasibility studies and provide advice and technical knowledge to RDV.

Projects were assessed on the basis of their technical, financial, regional location and greenhouse gas reduction benefits, the level of community consultation and support, as well as their potential to provide demonstration and public education outcomes. In particular, buildings with long operating hours and weekend use were targeted, as the extended operation was expected to demonstrate greater financial benefits (RDV 2007).

Seven submissions were successful:

- Brush Ski Co-operative in Mt Hotham;
- Mt Beauty Neighbourhood Centre;
- Shire of Towong;
- Bendigo Regional Institute of TAFE;
- Wangaratta High School; and
- two senior citizen centres operated by West Wimmera Shire Council, Edenhope and Kaniva.

The Edenhope project was withdrawn as a result of the club installing alternate reverse cycle air conditioners when the geoexchange installation was delayed.

From a total budget of $1 million, $825,182 was provided under the Program to support the six remaining projects between January 2008 and August 2012, of which $507,000 was used to develop a GSHP system at the Wangaratta High School as the Program's flagship project.

The Program also aimed to reduce greenhouse gas emissions through participating organisations switching to geoexchange technology which uses only 25 per cent of the energy used by conventional systems, while at the same time reducing the use of electricity to run heating and cooling systems. This was intended to delay the need for investment to increase the electrical grid capacity (RDV 2007).

Recipients of funding, with advice from RDV, obtained quotes for the installation of the GSHPs, selected and contracted an installer.

Box 1 **The Moving Forward Initiative**

Moving Forward: Making Provincial Victoria the Best Place to Live, Work and Invest (Moving Forward) was launched by the Victorian Government in 2005. Moving Forward was the Government's regional economic policy designed to improve liveability, productivity and sustainability in regional and rural communities.

The Victorian Government recognised that vibrant and healthy regional and rural communities are critical to the economic success of Victoria. In order to ensure this economic success, Moving Forward was designed to stimulate economic activity and attract more people, jobs and investment to regional Victoria, deliver the critical infrastructure, skills and industry required to drive economic growth, support small towns and address new challenges, and provide strong leadership, a clear vision, and engagement with regional Victoria.

The Moving Forward initiative provided $502 million in investments over five years to support the economic success of regional Victoria. It established 13 specific initiatives designed to:

- attract people to live, work and invest in regional Victoria;
- manage growth in regional communities;
- support small towns;
- boost regional arts, cultural and recreational facilities;
- attract investment and promote exports, while promoting competitiveness and growth in primary industries;
- build a skilled workforce;
- meet new challenges in key industries;
- promote sustainable development; and
- address infrastructure by creating transport connections, funding local ports, improving broadband access and improving freight and supply chain links

These initiatives were funded under a twin funds for growth model, which included:

- The Regional Infrastructure Development Fund (RIDF) – the RIDF supported capital works projects needed to develop industry and attract investment and promote growth. It was created in 1999, and its success saw it renewed and enhanced under the Moving Forward initiative, providing an additional $200 million.
- The Provincial Victoria Growth Fund (PVGF) – the PVGF was designed to meet demand for assistance with non-infrastructure related programs, providing $100 million which focused on marketing and promoting regional Victoria, strategic planning around growth and change, addressing skills shortages and fostering new business, industry and investment opportunities.
- Other investment – additional funding of $202.18 million was also committed from other government departments under the Moving Forward initiative.

Source: Regional Development Victoria (RDV) 2005, *Moving Forward: Making Provincial Victoria the Best Place to Live, Work and Invest,* Department of Innovation, Industry and Regional Development, Melbourne

3 Program activities

This chapter provides an overview of the activities undertaken through the Program. It briefly describes each organisation involved in the Program, the buildings which have been connected to GSHPs and the work undertaken.

The projects funded through the Program — and discussed in this chapter — are outlined in Table 1.

Table 1 **Approved projects**

Location	Applicant	Facility
Corryong	Shire of Towong	Business incubator
Bendigo	Bendigo Regional Institute of TAFE	TAFE buildings
Kaniva	West Wimmera Shire Council	Senior citizens centre
Mt Hotham	Brush Ski Co-operative	Alpine accommodation
Wangaratta	Wangaratta High School	School buildings
Mt Beauty	Mt Beauty Neighbourhood Centre	Neighbourhood Centre

Note: The Edenhope project was withdrawn prior to any grant funding being provided.
Source: ACIL Allen Consulting

3.1 Corryong Innovation Space, Shire of Towong

The Towong Shire is located in North East Victoria and covers over 6500 km^2. The Towong Shire Council aims to provide leadership and service to the community that adds value and enhances the social, economic and environmental wellbeing. As part of this aim, the Council has taken a number of initiatives in the economic, business and agricultural development sectors.

The Towong Shire sought funding for the installation of a GSHP system during the construction of a new innovation space for the Shire. This was the first project to be funded under the Program.

The Corryong Innovation Space (the Innovation Space) was constructed as part of the Shire Council's economic development initiative, providing leased space for business and community groups to explore initiatives, which will add value and increase the long term sustainability of Corryong.

The Innovation Space was specifically developed to provide suitable accommodation for small business in the area, in order to stimulate business development and increase employment opportunities. The Space includes a business incubator, designed to provide a physical location for start-up businesses along with shared support facilities and advice. The Innovation Space also aims to attract business from outside the region.

The Space aims to provide businesses with:

- affordable space month-to-month;
- low entry costs;
- space for onsite expansion;
- access to local business networking;
- a registered professional address;

- training and mentoring; and
- subsidised business and utilities services.

The facilities at the Innovation Space serve as business establishment areas, conference, meeting, shed and factory spaces, as well as areas for community meetings, and art and cultural events. The Innovation Space was a new development and consists of eight workshop units and three office/conference buildings, which form part of a larger business park development. The buildings are all single storey, light weight construction structures. The geoexchange system was installed to provide heating and cooling to the three office buildings, which are adjacent to each other.

Work undertaken through the Program

The feasibility study commissioned by RDV proposed a horizontal type ground heat exchanger (GHE) for the Innovation Space. The proposed GHE consisted of five, 40 metre horizontal trenches connected in parallel to a common manifold. Two 'Slinky' type GHE loops were to be installed per trench at a depth of approximately 1.8 metres. Consultations reported that drilling hit 'rivers of sand' and, as a result, the GHE was instead installed vertically (although this was not able to be confirmed by the Towong Shire).

The geoexchange system was intended to service the three separate office buildings, with the project taking 12 months to complete. The heating and cooling in each building was developed to operate independently of the other buildings.

The construction process undertaken by GeoEnergy Australia encountered delays, which required the Towong Shire Council to seek an extension of the project completion date from 30 June 2008 to 31 July 2009. The extension was granted, allowing the grant monies to be paid by 30 June 2010.

In total the project cost just over $52,670 (excluding GST). RDV provided a grant of $52,500 (excluding GST) to install the geoexchange system.[3]

3.2 Bendigo Regional Institute of TAFE

The Bendigo Regional Institute of TAFE (BRIT) is a multi-discipline public educational provider offering over 400 courses annually to around 14,000 students. BRIT services a large, diverse community of staff and students drawn primarily from local areas, and has a 155 year history of delivering qualified employees for local jobs. Courses are provided with flexible study options, including diplomas, certificates, apprenticeships and traineeships which meet national standards.

BRIT has a network of campuses spread across Bendigo, extending as far as Echuca, Castlemaine and Maryborough, featuring state-of-the-art facilities to deliver practical and industry-relevant skills to job seekers or those wishing to up-skill or prepare for further study. BRIT also works closely with industry in order to continue to ensure the courses and programs remain relevant and reflect industry needs.

As a leader in educational delivery in Bendigo, BRIT strives to forge a trusting relationship with the community, in part by meeting its stated values of:

- respect;
- integrity;

[3] The feasibility study estimated that the installation would cost $62,500, with the government grant contributing the majority of the funds and the Towong Shire Council expected to contribute the remaining $10,000.

- accountability;
- service excellence; and
- innovation.

The desire to demonstrate innovation, combined with a focus on sustainability, created the impetus for BRIT to participate in the Program.

Work undertaken through the Program

BRIT constructed two new buildings as part of its $13 million Bendigo Charleston Road Complex Trade Centre development, which included construction of new training facilities, classrooms, workshops and walkways. These buildings, the Electrical Trades Building and the Arrivals Building, were planned to showcase environmentally sustainable features by serving as education demonstrations to instruct future tradespeople in areas of new technology.

The buildings include a range of environmentally sustainable features, such as use of recycled water, rainwater collection, a solar photovoltaic array, and solar hot water and heating. The foyer of the Arrival Building was planned to provide space for the results of geoexchange facility to be publically displayed.

As the courses taught within the trade school are plumbing and heating, the installation of a geoexchange system was intended to both increase students' exposure to the application of GSHPs, and provide a showcase to other energy users of the benefits of geoexchange technology. The geoexchange system was installed with viewing panels to reveal the system in order to educate the students on how the system works.

In March 2009, a $100,000 government grant was approved to install the 204 kW capacity geoexchange system, covering just under 30 per cent of the installation cost which was expected to total $340,000. This included a total of 14 compressors servicing two separate buildings. This was the second project to be funded under the Program.

3.3 Kaniva Senior Citizens Clubroom, West Wimmera Shire Council

Kaniva is a small town located in West Wimmera Shire Council, on the far western border of Victoria. It is situated on the Western Highway linking Melbourne and Adelaide. Kaniva acts as a rural service centre, and gateway to travel options including four-wheel driving, bushwalking, and the Little Desert. It also houses a range of educational and health services, including primary and secondary schools, a library, and a fully operational hospital, along with sporting facilities and a range of community activities and events year round.

The West Wimmera Shire Council received a grant under the Program to install a GSHP in their senior citizens clubroom. The Kaniva Senior Citizens Clubroom is a single storey building consisting of a main clubroom, card room, kitchen and small office. As a small town facility, the Clubroom is primarily used for senior citizen activities on Thursdays and Fridays for up to 25 people, and is used by 15-20 people in a Community Fitness group on a weekly basis. Various community groups also use the clubroom facilities approximately 30 times per year for functions with up to 50 people, as part of the Council's aim to develop a multi-use facility.

The building is constructed of lightweight materials, and operates in an area where temperatures range from negative 0.6 degrees Celsius to over 36 degrees Celsius. Prior to the installation of the GSHPs, the building contained ageing heating and cooling systems.

Work undertaken through the Program

In June 2007, the West Wimmera Shire Council sought a grant for the Kaniva Senior Citizens Clubroom building. This was the third project funded under the Four Seasons program, and was originally intended to be completed by 30 June 2008.

A Program grant amounting to $46,600 was approved for the Senior Citizens Clubroom. While this was intended to cover 100 per cent of the project cost, issues were encountered with the installation and completion of the project. The contractor to the project, [redacted], suffered financial difficulties that led to long delays, and the project installation stopped when the contractor eventually became insolvent.

In February 2011, the Wimmera Shire Council sought an additional $44,524 to complete the project, which increased the total grant to $91,124 and extended the completion date, first to 30 April 2012 and then to 30 June 2012.

The feasibility study originally proposed a GHE consisting of three, 40m trenches connected in parallel to a common manifold, with two 'Slinky' type GHE loops to be installed per trench at a depth of approximately 1.8 metres. However, a vertical system was installed consisting of two 100m ground loops and one 120m ground loop. These were connected to two GSHPs with a cooling capacity of approximately 11 kW.

3.4 The Brush Ski Co-operative, Mt Hotham

The Brush Ski Co-operative is a 40 bed not-for-profit sports cooperative operating a ski lodge in the Mt Hotham Alpine Resort. It normally operates at capacity during the winter period, and as required during other seasons. It is located in Australia's highest building precinct and subsequently exposed to an extreme weather climate. .

The Brush Ski Co-operative was the fourth project funded under the Program, and the first geoexchange system to be implemented in the Alpine region in Victoria, making it the highest geoexchange in Australia.

Brush is incorporated as a Community Advancement Society, which aims to provide affordable public family accommodation for winter snow sports activities. It has 41 members and is subject to the local governance of the Mt Hotham Alpine Resort Management Board, which gave approval for the project application.

Constructed in 1980, the Brush lodge is an architecturally designed, split multilevel building with double-glazed windows, a rendered masonry veneer, fully insulated on all external and internal walls, under-roof and under-floor. The building is 453 m^2, comprised of eight separate carpeted bedrooms and additional communal areas including a fully equipped kitchen, living and eating areas, fireplace, cinema room, a sauna, and a spa located below the main balcony. It is located in an area of Mt Hotham which houses about 40 other club lodges of varying sizes. The building is exposed to extreme weather conditions categorised as Climate Zone 8 which generate the coldest ground temperatures and an extreme winter climate.

Work undertaken through the Program

The previous heating system was provided by hydronic radiator panels, duel powered by LPG and resistive-electric boilers, and hot water was supplied through LPG-fired boilers. The conversion to a geoexchange system was sought following escalating energy costs and a desire for a more efficient and sustainable alternative. At the time of the Program, the increasing cost of bottled LPG at Mt Hotham had the potential to force users onto the electricity grid.

Grant approval for a geoexchange system was provided on 3 April 2008, for an amount of $36,000 which covered 50 per cent of the predicted total installation cost of $72,000 but amounted to only 45 per cent of the actual project cost ($79,680). The recommended geoexchange system for Brush incorporated a 40kW plant capacity and 50kW bore capability. The indoor heating system included a wall mounted hot water system and under-floor heating coils.

The GHE element of the geoexchange system involves a vertical configuration comprising six vertical loops, each 95 metres deep, as the soil conditions did not support a horizontal system.

Following the award of the project contract in April 2008, and despite having to deal with inclement weather and drilling equipment failures, all external ground works were completed within six weeks. The internal elements of construction were hampered by the need to modify components on site when they were not delivered to expected configuration. The project was completed on 20 August 2008, spanning a total of just over four months.

3.5 Wangaratta High School

Wangaratta High School is the main public high school in Wangaratta, North East Victoria. As a central component of the Wangaratta community, the school aims to provide an innovative and supportive learning environment focusing on achievement and excellence.

The school is spread across three campuses, with more than 1,400 students in total. It aims to deliver education with integrity, professionalism, commitment, teamwork and enthusiasm, with tailored programs specific to individual student needs to gain the best outcomes for student learning. Students are also offered a range of extra-curricular activities, including sport and music, to enrich their schooling experience and enhance community ties.

The school also runs programs to develop inclusive education, including:

- literacy support;
- extension programs for Students of Higher Intellectual Ability; and
- Select Entry Accelerated Learning.

These programs provide opportunities at both ends of the student performance spectrum.

The school is currently engaged in a regeneration project which is intended to consist of a complete rebuild of the school. The first stage of the project was completed in 2009 and the second stage at the end of 2011. The third stage is yet to be completed. The $4.6 million Wangaratta High School redevelopment involves four new buildings, consisting of the senior school, science/art/technology buildings, junior school, and administration buildings.

Wangaratta has a high temperature variation ranging from negative 0.6 degrees Celsius to over 35 degrees Celsius, resulting in high energy and power consumption. Despite this, the school is rated as ‘Australia’s Greenest School’, gaining a four green star energy rating due to features such as double glazed windows, recycled bricks, rain water tanks and the geoexchange system.

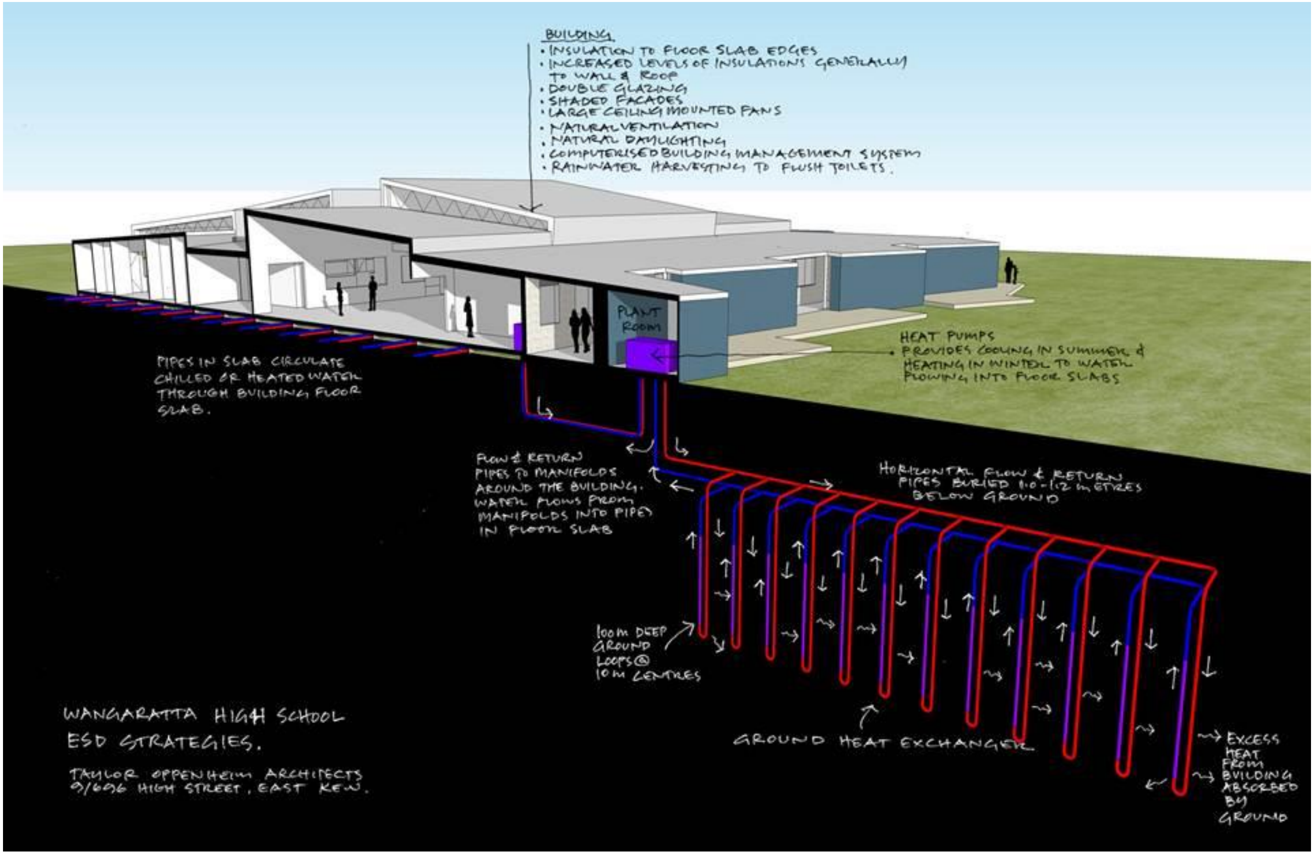
Under the Program, the school received a grant from RDV to install a geoexchange system to service the four new school buildings. This was the fifth project funded under the Four Seasons program.

Work undertaken through the Program

The feasibility study proposed a GHE consisting of 42 vertical loops installed to a depth of 95 metres. The GHE loops are connected by a system of lateral pipe work (see Figure 2).

The system is connected to the main plant room adjacent to the Senior School building, with the remaining buildings linked to the system via High Density Polyethylene pipes installed in underground trenches.

Figure 2 **Work undertaken at Wangaratta High School**



Source: Wangaratta High School

On 12 June 2008, a $507,000 government grant was approved to install the geoexchange system, covering 100 per cent of the total installation cost, which reflects the fact that the system was installed as a showcase project in a public school. The total floor area of the buildings operating geoexchange, once all the redevelopments are completed, is expected to be 7,820 m^2, with a maximum occupancy of 1,740 staff and students.

The Senior School opened in 2009, featuring open, flexible learning spaces and ICT areas and the new canteen, science, visual arts and technology buildings opened in 2011. The GHE system is currently operating in these buildings. In addition, it is intended that the system will be connected throughout the entire school at the completion of the redevelopment, which includes the middle school facility which forms phase 3 of the redevelopment.

3.6 Mt Beauty Neighbourhood Centre

The Mt Beauty Neighbourhood Centre Inc (MTBNCI) is a not for profit community based organisation, governed by elected members volunteering to serve on a Committee of

Management. The MTBNCI aims to assist the Mt Beauty community by offering a range of services, including:

- the Alpine No Interest Loan Scheme (Alpine Nils)[4];
- a Centrelink Access Point;
- tax help;
- venue hire and catering; and
- photo printing, scanning, copy, laminating and book binding, and internet and Wi-Fi services.

The MTBNCI also runs a range of courses in computing and hospitality, such as barista training, Responsible Service of Alcohol, web design and computer basics, along with a range of social and fitness programs.

Members of the community are able to hire different sized rooms, including large and small conference rooms, a computer room, office space, a kitchen and a hall. These rooms are separated by internal plasterboard stud-framed partition walls.

The building is staffed from 9am to 5pm, and open to the public from 10am to 4pm. Weekend courses and evening courses (until 10pm) are also held.

Originally constructed in the 1950s near the Kiewa hydro-electric Scheme, the Mt Beauty Neighbourhood Centre building provides space and services for the local community with approximately 200 people using the facility per week. At the time of the project proposal the centre consisted of a main building (floor area 240m^2) and a small separate hall (floor area 120m^2), both single-storey. Subsequently, a demountable building has been acquired. This building is an annex, linked to the older buildings by a covered deck.

The original two buildings are timber framed with pitched corrugated steel roofing, weatherboard wall cladding, raised timber floor on stumps and small domestic aluminium framed external glazed windows and doors. The walls are not insulated.

Prior to receiving the grant under the Program, the MTBNCI was heated and cooled by old air-conditioning systems that did not work properly. This provided the impetus to seek a grant under the Program. Further, the small size of the Mt Beauty community limits the MTBNCI's ability to raise funds, which made the grant crucial to the viability of the project. This was the sixth project funded under the Program.

Work undertaken through the Program

The feasibility study proposed a horizontal GHE for the Neighbourhood Centre, consisting of eight 40 metre trenches connected in parallel to a common manifold. Two 'Slinky' type GHE loops were to be installed per trench at a depth of approximately 1.8 metres.

On 25 June 2009, a $35,000 government grant was approved to install the GSHP system. This was expected to cover 90 per cent of the installation cost. However quotes from installers were significantly higher than the estimate from the feasibility study. As a result, it was decided not to include the hall in the GSHP project.

The MTBNCI did not have the necessary funds to make progress payments to the contractor so the standard Program grant terms were varied to allow the grant to be paid in advance.

[4] The Alpine Nils is a micro-credit initiative designed to provide access to flexible and affordable credit up to $1,500 to members of the community on low income or with genuine need, in order to facilitate purchases of essential household and personal items. There is no interest or fees charged on these loans, which give people up to two years to repay.

The grant originally required the work to be completed by 30 December 2009. However the Centre is adjacent to a small lake and about a metre above the normal water level in the lake. As a result, the drilling contractor experienced problems with water, as well as hitting 'floater' rocks in the soil (due to the site containing large amounts of fill). This delayed the project and resulted in some re-design of the ground loop. The project was extended to 30 June 2010 and subsequently to 31 December 2010.

As a result of the issues noted above, the cost of the project increased by $8,000 (to total $43,000), $1,000 of which was provided by the Mt Beauty Community Centre, $3,000 from a Bendigo Bank grant, and an increase of $4,000 to the existing grant from the Victorian Government to meet the shortfall.

4 Program outputs and outcomes

This chapter examines the Program's outputs and outcomes. It does this by analysing the financial viability of the systems installed in each location, as well as providing an overall assessment of the financial viability of the Program as a whole. The chapter also considers some unanticipated outcomes generated by the Program, as reported by stakeholders.

4.1 Financial viability

The direct benefits of the Program are mainly centred on a reduction in electricity used by grant recipients and hence reduced energy costs and greenhouse gas emissions. Having said that, a finding of the study is that there are limited data from which to calculate the actual benefits generated.

A particular issue is that additional works were undertaken in some locations, such as the construction of new buildings in Wangaratta and Bendigo. These have added to the electricity consumption and render it difficult to make like-for-like comparisons of current and past energy costs.

In the absence of specific information on energy use of the buildings equipped with GSHPs, including (where appropriate) changes to energy use following the installation of GSHPs, the financial viability assessment in this study has been based on the estimated energy savings outlined in the feasibility study and updated to reflect actual energy prices. Where the work undertaken varied significantly from the worked proposed in the feasibility study, adjustments have been made and are discussed in the analysis.

Importantly, since the establishment of the Program and the analysis undertaken as part of the feasibility studies, electricity prices have increased substantially. From June 2007 to December 2012 nationwide electricity prices increased by more than 70 per cent in real terms (Productivity Commission 2013). The feasibility studies estimated electricity cost savings and payback periods based on an electrical energy cost of $0.15/kWh (Meinhardt 2007). However, average market offer prices in Victoria in 2011-12 were already more than 70 per cent higher at $0.257/kWh (Australian Energy Market Commission 2013).

The following sections discuss the changes to the financial viability related to these price increases as well as other influences on the viability of systems installed under the Program in each location[5].

Corryong Innovation Space – Shire of Towong

The feasibility study estimated the Innovation Space's annual space heating and cooling thermal energy requirements to be approximately 35.4 and 32.4 kW respectively. Based on this, an estimated energy cost saving of $3,600 per annum was predicted as outlined in Table 2. These energy savings calculations were based on a Monday to Friday, 9am-5pm occupancy. However it was suggested that greater savings could be achieved if the facility operated seven days a week.

[5] All other assumptions used in the feasibility studies remained the same.

Table 2 **Feasibility study estimated costs and payback, Corryong Innovation Space**

	Reverse cycle, air cooled air conditioning	Geoexchange system
Annual energy demand	51,300 kWh	**27,000 kWh**
Annual heating cost	$7,690	**$4,050**
Annual CO_2 emissions	71.8 tonnes	**37.8 tonnes**
Cost of installation (excluding GST)	N/A	**$62,900**
Energy cost savings per annum	N/A	**$3,600**
Estimated payback period	N/A	**6.9 years**

Source: Meinhardt 2007, Corryong Innovation Space – Geoexchange Feasibility Study

Consultations revealed that although the system was installed and supposedly ready to operate, it has never worked. The Shire noted that due to the nature of the installation, the system's operation could not be fully checked until the buildings were completed and in operation. When problems were discovered, the Shire Council had the original installer return, test the system and try to fix it. This was not successful and the final payment (approximately $10,000) was withheld.

Subsequently, the Council asked another firm to inspect the system, and it was found that two of the units were not working due to the operation of a high pressure lockout. This occurred due to a lack of airflow across the coil to remove heat, and appeared to be associated with polystyrene partially blocking the coil. The Council received a quote to fix this issue, however, decided that it was not viable to undertake further work[6]. As a result the system has never been operated and no financial benefits have been realised.

Despite this, the Shire Council did report a number of benefits resulting from their participation in the Program. The Shire noted that this project was the first innovative project they had participated in and it has led to a number of other innovative projects and a focus on innovation as part of the Shire's activities. In particular it was reported that innovation has become a key pillar of the Shire and is part of its vision and mission.

Additionally, the Shire reported a number of important learnings arising from their participation. These included learnings in relation to project management as well as building and construction, which the Shire has taken on board in subsequent work. For example, the Shire has implemented more rigorous project management processes, increasing their focus on project monitoring and ensuing high quality outputs are delivered. The Shire also reported learnings about the selection of building materials which are best for the local environment.

Another benefit reported by the Shire was that it enhanced their relationship with RDV as well as encouraging relationships with other funding bodies. This has resulted in a number of successful grant applications, with the Shire now receiving funding from a variety of sources.

Bendigo Regional Institute of TAFE

The geoexchange system installed at BRIT was estimated to provide energy cost savings of approximately $20,000 per annum, based on annual energy savings of 140,000 kWhs as outlined in Table 3. CO_2 emissions were predicted to be approximately 30 per cent less than a conventional heating and cooling system, equating to around 180 tonnes per annum of CO_2 savings. This was based on calculated annual space heating and cooling thermal

[6] Split cycle air conditioners have now been installed to heat and cool the buildings. These systems are connected to a solar system and the Innovation Centre has not paid an energy bill since August 2011.

energy requirements for the buildings of approximately 194.62 kW across 15 separate rooms.

Table 3 **Feasibility study estimated costs and payback, Bendigo Regional Institute of TAFE**

	Previous system	Geoexchange
Annual energy demand	N/A	**N/A**
Annual heating cost	N/A	**N/A**
Annual CO_2 emissions	N/A	**N/A**
Cost of installation (excluding GST)	N/A	**$340,000**
Energy cost savings per annum	N/A	**$20,000**
Estimated payback period	N/A	**17**

Source: Documents provided by RDV

BRIT reported that although the geoexchange installed has performed well, meeting heating and cooling requirements, issues have been experienced with the operation of the system. Of the 14 compressors originally installed three have broken down as a result of filling with mud. One was replaced with another compressor; however this also filled with mud and stopped working. While the remaining 10 systems are performing well, the four affected by mud have had to be replaced with air-conditioning systems instead of geothermal.

BRIT did try to follow this issue up with the installer, however the company has since gone out of business and hence is not honouring warranties. In addition, since the pipes are so deep in the ground other companies cannot test them to try and establish the nature of the problem.

As a result it is anticipated that the total energy savings estimated in the feasibility study would not have been achieved. Assuming that each compressor was a similar size, it has been estimated that 71 per cent of the savings calculated in the feasibility study would have been achieved (based on 10 of the 14 compressors currently working). This would generate annual energy savings of 100,000 kWh.

Based on an electrical energy cost of $0.257/kWh in 2011-12 (Australian Energy Market Commission 2013), energy cost savings of $25,700 have been estimated. This would result in a payback period of 13.2 years, substantially less than the payback period estimated in the feasibility study, as seen in Table 4. Despite the reduced annual energy savings caused by the failure of the compressors, there has been a reduction in payback period resulting from the substantial increase in electricity prices.

Table 4 **Current estimated costs and payback, Bendigo Regional Institute of TAFE**

Description	Amount
Cost of installation (excluding GST)	**$340,000**
Annual energy savings	**100,000 kWhs**
Energy cost savings per annum	**$25,700**
Estimated payback period	**13.2 years**

Source: ACIL Allen Consulting

Kaniva Senior Citizens Clubroom – West Wimmera Shire Council

The feasibility study estimated that the Kaniva Clubroom geoexchange system would provide an estimated energy saving of $1,595 per annum, as outlined in Table 5. This was based on a thermal heating and cooling capacity of 11.4 kW and 18.3 kW respectively.

Table 5 **Feasibility study estimated costs and payback, Kaniva Senior Citizens Clubroom**

	Previous reverse cycle air cooled air conditioning	Geoexchange
Annual energy demand	22,444 kWh	**11,813 kWh**
Annual heating cost	$3,367	**$1,772**
Annual CO_2 emissions	31.4 tonnes	**16.5 tonnes**
Cost of installation (excluding GST)	$24,500	**$44,600**
Energy cost savings per annum	N/A	**$1,595**
Estimated payback period	N/A	**13.8 years** (1)

(1) This includes the consideration of an additional capital cost of $24,000 associated with the alternative option.
Source: Meinhardt 2007, Kaniva Senior Citizens – Geoexchange feas bility study

The West Wimmera Shire Council reported that to date the system has performed well. In particular the cooling system has met the needs of users well, given the hot climatic conditions the Wimmera can experience. The Council reported that the primary benefits generated as a result of their involvement with the Program were electricity cost savings.

Significant difficulties were experienced during the installation at Kaniva, with large delays resulting. The original contractor went into receivership without paying subcontractors. As a result additional funding had to be sought to pay the subcontractors and to engage another installer. This meant that the cost of the system more than doubled from the original estimate. This significantly affected the financial viability of the system.

The total project cost of installing a geoexchange system at Kaniva was $91,124 (excluding GST). Based on an electrical energy cost of $0.257/kWh in 2011-12 (Australian Energy Market Commission 2013), energy cost savings of $2,732 have been estimated. This would result in a payback period of 24.6 years, significantly greater than the payback period estimated in the feasibility study reflecting the additional cost due to the difficulties experienced, as seen in Table 6.

It is noted had these problems not been experienced and the project cost remained as originally estimated, this payback period would have been reduced to 8.3 years.

Table 6 **Current estimated costs and payback, Kaniva Senior Citizens Clubroom**

Description	Amount
Cost of installation (excluding GST)	**$91,124**
Annual energy savings	**10,631 kWhs**
Energy cost savings per annum	**$2,732**
Estimated payback period	**24.6 years** (1)

(1) This includes the consideration of an additional capital cost of $24,000 associated with the alternative option.
Source: ACIL Allen Consulting

Brush Ski Co-operative, Mt Hotham

The feasibility study estimated the Brush Ski Co-operative's heating load to be 40kW. Prior to the installation of the GSHP, the heating system used LPG and electricity as a heat resource. A boiler operated during peak power tariffs and custom manufactured resistant heaters operated during the off-peak times.

This feasibility study estimated that the GSHP system would utilise 25 per cent of the energy consumption of conventional systems, with estimated energy cost savings of $8,760 per annum, as outlined in Table 7.

Table 7 **Feasibility study estimated costs and payback, Brush Ski Co-operative**

	Previous system	Geoexchange system
Annual energy demand	89,494 kWh	**16,571 kWh**
Annual heating cost	$11,190	**$2,460**
Annual CO_2 emissions	48,745kg	**22,205kg**
Cost of installation (excluding GST)	N/A	**$72,000**
Energy cost savings per annum	N/A	**$8,760**
Estimated payback period	N/A	**8.2 years**

Source: Meinhardt 2008, Brush Ski Co-Operative – Geoexchange feasibility study

As a result of the Program, the Co-operative reported that they have focused on reducing their energy and water use. In addition to the installation of the GSHP, the Co-operative has also upgraded insulation and underfloor hydronic heating, investing over $150,000 in energy efficiency improvements. Consequently, significant energy and water savings have been achieved.

The system is reported to be working well and, along with the other energy saving activities undertaken, has enabled the Co-operative to cease using LPG and become energy and carbon neutral. In addition, the Cooperative has reported that the system has generated a significant amount of interest, particularly amongst alpine organisations. The Co-operative has given a number of presentations about the system to interested parties including to alpine industry forums and resort management boards. In addition, the Co-operative regularly gets contacted by organisations and other resorts (up to once a month) to enquire about the work undertaken.

Given the complementary activities undertaken by the Co-operative to reduce energy consumption, as well as a lack of information on the changes in energy use of the Co-operative as a result of the installation of the GSHP, the financial viability assessment has been based on the energy savings estimated in the feasibility study.

The total project cost of installing a geoexchange system at Mount Hotham was $79,680 (excluding GST). Based on an electrical energy cost of $0.257/kWh in 2011-12 (Australian Energy Market Commission 2013), as well as reduced LPG demand, energy cost savings of $11,623 have been estimated. This would result in a payback period of 6.9 years, as seen in Table 8. The increase in electricity costs has reduced the estimated payback period from that of the feasibility study.

Table 8 **Current estimated costs and payback, Brush Ski Co-operative**

Description	Amount
Cost of installation (excluding GST)	**$79,860**
Annual energy savings	**72,923 kWhs** (1)
Energy cost savings per annum	**$11,623** (1)
Estimated payback period	**6.9 years**

(1) This includes savings associated with reduced LPG demand.
Source: ACIL Allen Consulting

Wangaratta High School

The feasibility study estimated energy cost savings of $27,200 per annum for Wangaratta High School as outlined in Table 9. The payback calculation of 14 years for the school was based on a 38 week per annum standard school use, however it noted that it was likely that this usage would be exceeded, shortening the payback period.

Table 9 **Feasibility study estimated costs and payback, Wangaratta High School**

	Previous reverse cycle air conditioning system	Geoexchange
Annual energy demand	370,870 kWh	**189,556 kWh**
Annual heating cost	$55,631	**$28,433**
Annual CO_2 emissions	516 tonnes	**263 tonnes**
Cost of installation (excluding GST)	N/A	**$507,000**
Energy cost savings per annum	N/A	**$35,108**
Estimated payback period	N/A	**14.4 years**

Source: Meinhardt 2007, Wangaratta High School Redevelopment – Geoexchange feasibility study

Representatives from the Wangaratta High School reported that the system is working well and contributes to an enhanced working environment for the students, alongside the new facilities and other benefits of the new buildings. However, there has been some maintenance required, and in periods of high humidity, condensation on the concrete slab has been a problem. In addition, the performance of the system has been enhanced by other related works, such as the completion of work to create an air lock at the main entry point.

The geoexchange facility at Wangaratta High School is the first in the Australian school system. As such it was reported that the Program has been important in demonstrating the technology in such an environment.

Stakeholder consultations also reported that the school redevelopment, including the GHE technology, has attracted significant interest. The new system means that the building temperatures sit between 18 and 24 degrees all year which has significantly enhanced the learning environment. A number of people have commented on this favourable environment, which has increased interest in GSHPs.

The technology at the school has also been the subject of newspaper articles and coverage in industry journals and magazines, therefore successfully demonstrating the use of the technology.

Measuring the cost savings in this instance is limited by the lack of a comparable base case. Since the school buildings connected to the GHE system were newly built, there was no prior electricity usage. This is further complicated by the fact that the school's electricity usage is only measured at a single point for the entire site, rather than on an individual building basis. Hence the financial viability assessment has relied on estimations from the feasibility study.

It is noted however, that to date, Stage 3 of the school's redevelopment has not occurred. This means that approximately 65 per cent of the redevelopment has been completed. Since the feasibility study estimates were based on energy savings generated from the whole school redevelopment it is unlikely that such cost savings have been achieved. The cost savings reported in the feasibility study have been adjusted to take these changes into consideration.

The total project cost of installing a geoexchange system at Wangaratta was $507,000 (excluding GST). Based on an electrical energy cost of $0.257/kWh in 2011-12 (Australian Energy Market Commission 2013), energy cost savings of $30,289 have been estimated. This would result in a payback period of 16.7 years (as seen in Table 10), slightly greater than the payback period estimated in the feasibility study as a result of the redevelopment not yet being completed. It is noted that once the redevelopment is completed and the additional buildings are connected to the system, this payback period will be reduced.

Table 10 **Current estimated costs and payback, Wangaratta High School**

Description	Amount
Cost of installation (excluding GST)	**$507,000**
Annual energy savings	**181,314 kWhs**
Energy cost savings per annum	**$30,289**
Estimated payback period	**16.7 years**

Source: ACIL Allen Consulting

Mount Beauty Neighbourhood Centre

The feasibility study for the project estimated the annual space heating and cooling thermal energy requirements of the two older buildings of the Mount Beauty Neighbourhood Centre to be approximately 35,036 kWh. Prior to installation of the GSHP, the building was cooled by five reverse-cycle non-ducted split system air conditioners, ceiling sweep fans, a window mounted air conditioner and a portable air conditioner. The heating was provided by five convective direct electric heaters with a total heating capacity of 10kW. This was insufficient to deal with the hottest and coldest weather in Mount Beauty.

The feasibility study assumed that the MTBNCI would install insulation in the ceiling and the exterior walls, which has not taken place. The feasibility study estimated that the GSHP system would provide energy cost savings of $3,177 per annum, as outlined in Table 11.

Table 11 **Feasibility study estimated costs and payback, MTBNCI**

	Reverse cycle system	GSHP system
Annual energy demand	48,600 kWh	**8,700 kWh**
Annual heating/cooling cost	$4,803	**$1,626**
Annual CO_2 emissions	21.6 tonnes	**11.7 tonnes**
Cost of installation (excluding GST)	$15,000	**$35,000**
Energy cost savings per annum	N/A	**$3,177**
Estimated payback period	N/A	**6 years** (1)

(1) This includes the consideration of an additional capital cost of $15,000 associated with the LPG heating option.
Source: Meinhardt 2009, Mt Beauty Neighbourhood Centre – Geoexchange feasibility study

The GSHP system is working to the satisfaction of the Centre. Some supplementary air conditioning has been retained in the computer room to manage the additional heat load on very hot days. The ceiling fans have also been retained to help spread the heated/cooled air.

The total project cost of installing a geoexchange system at Mount Beauty was $43,000 (excluding GST). Based on an electrical energy cost of $0.257/kWh in 2011-12 (Australian Energy Market Commission 2013), as well as reduced LPG demand, energy cost savings of $11,258 have been estimated. This would result in a payback period of 2.5 years, significantly reduced from the estimations provided in the feasibility study, as seen in Table 12.

It is noted however, that the estimations calculated in the feasibility study included energy savings based on the hall being connected to the geoexchange system. Hence, the savings identified above are likely to overestimate the total cost savings and the payback period is likely to be longer than 2.5 years. The extent of this increase cannot be measured due to a lack of data on the hall's annual energy consumption.

Table 12 **Current estimated costs and payback, MTBNCI**

Description	Amount
Cost of installation (excluding GST)	**$43,000**
Annual energy savings	**39,900 kWhs** (1)
Energy cost savings per annum	**$11,258** (1)
Estimated payback period	**2.5 years** (2)

(1) This includes savings associated with reduced LPG demand.
(2) This includes the consideration of an additional capital cost of $15,000 associated with the LPG heating option.
Source: ACIL Allen Consulting

Overall financial viability

As the summary financial data in Table 13 shows, the systems installed were generally financially viable with payback periods ranging from 2.5 to 24 years.

Projects undertaken at the Bendigo Regional Institute of TAFE, the Brush Ski Co-operative and the Mount Beauty Neighbourhood Centre proceeded according to plan and achieved relatively short payback periods calculated to be less than estimated in the feasibility studies.

At the Kaniva Senior Citizens Clubroom, the longer than estimated payback period was a result of additional costs related to difficulties experienced during installation. At Wangaratta High School the longer payback period resulted from the geoexchange system servicing a smaller area than estimated in the feasibility study.

The installations undertaken through the Program cost just over $1.11 million. Annual energy cost savings are estimated to total just over $81,000, with the total Program activities having a payback period of 13.2 years[7]. This is less than estimated by the original feasibility studies, where it was anticipated that energy cost savings would result in the total Program activities having a payback period of 17.1 years[8].

Table 13 **Summary of financial viability**

Organisation	Cost of installation, $	Annual energy cost savings, $	Current estimated payback period, years	Feas bility study estimated payback period, years
Corryong	52,670	n/a	n/a	6.9
Bendigo	340,000	25,700	13.2	17.0
Kaniva	91,124	2,732	24.6 (1)	13.8 (1)
Brush	79,860	11,623	6.9	8.2
Wangaratta	507,000	30,289	16.7	14.4
Mt Beauty	43,000	11,258	2.5 (1)	6.0 (1)
Total	**1,113,654**	**81,602**	**13.2** (1)	**17.1** (2)

(1) This includes consideration of additional capital costs associated with alternative options.
(2) Based on original annual energy cost savings and actual cost of installation, including the consideration of additional capital costs associated with alternative options.
Source: ACIL Allen Consulting

7 This includes consideration of additional capital costs associated with alternative options. The payback period would be reduced further to 12.5 years if the cost of the Corryong Innovation Space is excluded, which was never able to be made operational.

8 Based on original annual energy cost savings and actual cost of installation, including the consideration of additional capital costs associated with alternative options.

As noted above, from June 2007 to December 2012 nationwide electricity prices increased by more than 70 per cent in real terms (Productivity Commission 2013).This substantial price increase has enhanced the financial viability of geoexchange systems significantly.

It was also suggested that, during the Program, drilling costs were expensive due to high demand as a result of the drought and the mining boom. Stakeholders reported that current drilling costs would be expected to be cheaper and hence the financial viability of similar projects would be enhanced if they were to be undertaken now.

4.2 Additional benefits

The grant recipients reported a number of other non-financial benefits as a result of their participation in the Program. These are discussed below.

The Program helped several organisations develop capabilities in administering and managing projects and contracts. These included the Shire of Towong, Brush Ski Co-operative, the West Wimmera Shire Council and the Mount Beauty Neighbourhood Centre. In particular, the development of project management skills was noted as a key aspect of participation. These skills have been enhanced through project management courses run by RDV (but not as part of this Program).

The Program also enhanced the relationship between grant recipients and RDV. This was reported to have encouraged organisations to look for further opportunities to work with RDV and fostered a good connection between the two parties.

The Mount Beauty Neighbourhood Centre and the Shire of Towong further noted that the Program created the impetus for them to look for other funding opportunities. The Brush Ski Co-operative, the Bendigo Regional Institute of TAFE and Wangaratta High School also reported that their organisations had benefited from a focus on minimising water and energy use as a result of the Program. It was reported that the Program drew attention to these areas and, as a result, participating organisations had put in place a number of measures to reduce their water and energy use in addition to the work undertaken as part of the Program.

Finally, in Corryong, participation in the Program was reported to have encouraged the Shire of Towong to focus on innovation. It was reported that participation in the Program was the first major innovative project the Shire had been involved in and since then a number of other innovative activities have been undertaken. This has resulted in innovation become a key part of its vision and mission.

5 Program assessment

This final chapter provides an assessment of the Program by looking at its administration and delivery, its appropriateness and effectiveness. It concludes with recommendations for improvement to similar programs in the future.

5.1 Program administration and delivery

Grant recipients reported that the Program had helped facilitate the establishment of good working relationships with RDV. It was noted that RDV were engaged in the Program, committed to helping the industry demonstrate the technology and strove to achieve good outcomes.

RDV received technical and contract management advice from Meinhardt Australia, as well as advice in relation to managing the contractors. Meinhardt Australia also helped RDV assess the contractor's capability. It was important for RDV to have people involved in the Program who had specific technical knowledge of the technology. The use of experts to provide advice and assist with technical issues at the beginning of the Program was consistent with good practice.

The commissioning of feasibility studies was also considered an important part of the early stages of the Program, particularly given the early stage and lack of maturity of the geoexchange industry at that time. This is compounded by the fact that GSHP installations often require the use of local subcontractors to drill suitable diameter holes and undertake the plumbing involved in the installation of ground loops and their connections to the heat pump. Subcontractors may also be required to grout the underground loop. However, GSHPs tend to be of particular interest in regional areas (because of the lack of access to natural gas), precisely where there is a lack of readily available subcontractors with specific knowledge of and experience in the installation of GSHPs.

Another issue for the industry is that potential GSHP clients may be reluctant to incur the expense involved in drilling a pilot hole to determine the suitability of a site for a GSHP. As a result, GSHP installers can encounter unexpected underground conditions that make the installation of pipework for the underground loop more difficult and expensive. These underground conditions can include excessive amounts of water, water and sand mixtures, which are unstable, and thermal capacity and conductivity that is insufficient for the task.

While there is knowledge within the industry of successful GSHP installations, this information is not easy to find. There also appears to be little active sharing of experience. Further, the GSHP industry has shown some instability in recent years, with a number of firms ceasing operations. This is likely to increase uncertainty among potential clients and could limit the take-up of this source of energy.

Despite significant learning occurring within the industry over recent years, there is still a lack of knowledge of international standards, there is no GSHP industry body and a number of operators and subcontractors appear to lack the requisite technical skills. In addition, some installers do not have relevant qualifications, training or accreditation. This means that it is difficult to judge the quality of work undertaken and there is the potential risk of significant issues occurring when investing in this technology. This was evident in at least two of the projects, namely the Corryong Innovation Space and the Kaniva Senior Citizens Clubroom.

Industry representatives noted that the industry is currently looking to address such issues, being in the process of establishing a new industry body which would be an Australasian chapter of the International GSHP Association based at Oklahoma State University. In addition, the industry is increasingly adopting international standards such as those used in Canada, as well as implementing training requirements.

Stakeholders suggested that the Program would have benefitted if the relationship with an expert established at the start had been maintained for the Program's duration. Given the technical nature of the Program, ongoing access to such expertise would have enabled RDV to be a better informed buyer and assisted the project manager(s) in dealing with technical issues.

Local capability was also raised as an issue. Some project managers in the grant recipient organisations did not adequately understand the technology or the specific requirements of operating such systems. As a result they often relied on the contractors undertaking the work. Advice and oversight from an expert within the industry would have helped overcome this issue and assisted project managers to monitor projects. A greater understanding of the technology would help to make project managers more informed buyers and equip them to better manage and deal with issues which arose during installation.

The lack of technical knowledge was compounded by a lack of project management skills within some organisations involved in the Program. It was consistently reported that there were difficulties in the management of individual projects which would have benefited from more rigorous project management, including additional monitoring and reporting requirements, and more formal reporting and documentation. The latter was considered particularly important given the fact that potential users of this type of technology are looking for documented evidence of the benefits.

An example of the impact of project management is the successful installation of the system at Mount Hotham. This was largely due to the strong project management provided by the grant recipient. Few issues were experienced, albeit the installation required intensive input and was managed by the Brush Ski Co-operative members with engineering and project management expertise.

5.2 Appropriateness

Stakeholders considered the Program was structured well in supporting the geoexchange industry, promoting the use of GSHPs and demonstrating the potential of alternative sources of heating and cooling energy for regional communities across a range of different buildings and locations. The Program assisted the industry to develop and provided valuable support in raising awareness of the technology.

Specific evidence the Program was targeted appropriately is that, despite the relative infancy of the industry and the lack of readily accessible information regarding good practice, it did establish sites able to demonstrate the role and potential of GSHPs. There are few GSHP demonstration sites in Victoria, apart from the projects undertaken under the Program. The Program also suitably demonstrated GSHP technology in a range of building types and at a range of scales. For example, the Wangaratta High School fulfilled the objective of showcasing a large scale project. Stakeholders reported that this was important in showcasing the different applications of the technology and its practical operation.

Stakeholders commented that future initiatives involving relatively new technology should incorporate detailed investigation, including the involvement of industry stakeholders, prior to program design and implementation. This would ensure a better understanding of the technology, as well as of wider industry capability. In recognition of the limitations present at the time, it was suggested that a highly rigorous tendering process is required in such an evolving technology environment, with successful installation experience an important selection criterion.

5.3 Effectiveness

The Program is considered to have been effective at demonstrating the use of GSHP technology in regional communities. Grant recipients indicated that the technology installed generated significant interest and discussion, with Mount Beauty, Wangaratta and Mount Hotham reporting strong levels of visitation to inspect the installed systems. Mount Beauty reported at least 20 inspections, Mount Hotham received enquires about the system approximately once a month, and Wangaratta has been used by the installer to show clients examples of the technology, with the aim of securing further business.

The installations have also been the subject of a number of promotional activities, such as the publication of the work at Wangaratta in a number of local newspapers as well as industry journals and magazines. Industry members consulted as part of the review noted that the Program had raised awareness about GSHPs and the wider geoexchange industry. The Program has also helped build relationships within the industry, as well as knowledge of the skills and capabilities of industry organisations. For example, it was reported that an architect, engineer and installing team are still working together with this relationship originating through the Program.

Specific evidence of the effectiveness of the Program is that grant recipients noted it highly unlikely the projects would have gone ahead in the absence of the grants provided by RDV. While to date there is no evidence of any other projects having been undertaken as direct result of the Program, there are a number of related projects currently being considered at Mount Hotham.

With the exception of Corryong, grant recipients reported that the GSHPs had performed well, with the systems providing adequate heating and cooling. The level of performance of the systems was said to be dependent on their design, as well as their installation. Further, the technology is more effective if the demand for heating and cooling is also reduced. For example, the GSHP installed at Wangaratta was noted as being highly effective as the system was integrated into the building’s design, while at Mount Hotham a variety of additional installation upgrades were made to reduce heating and cooling needs and complement the performance of the GSHP.

It was suggested that the Program reach and impact could have been even greater if data in relation to the impact on energy use and associated cost savings had been collected and made available to other potential investors in GSHP. The original intent was for each project to have its energy use monitored for a period of at least five years post-completion with the ongoing monitoring, data collection, analysis and dissemination of results fully funded by the Program (RDV 2007), however this did not eventuate. Given the relatively high upfront cost of the technology, such savings data would have helped demonstrate the benefits and hence potentially expand the Program.

Stakeholders reported that, as result of installation contractors being different to those who developed the feasibility studies, the actual work undertaken did not always reflect the intended design in the feasibility studies. Where installers encountered problems they often did not accept responsibility, rather attributing them to the approach recommended in the feasibility study. Stronger links between specifications/feasibility studies and installation would help foster greater ownership of the work undertaken and a commitment to generating successful project outcomes in line with the Program objectives. For example, the installer could have had the opportunity to comment on specifications outlined in the feasibility study and either agree to these or suggest appropriate alternatives and justify the benefits of any recommended changes.

Some grant recipients also noted that the feasibility studies focused on buildings without sufficient regard to ground conditions that can significantly affect the performance of GSHPs as well as influencing project budgets. It was suggested that future Programs should ensure feasibility studies pay greater to attention to all relevant factors.

5.4 Recommendations

The overall assessment is that the Program has been appropriate and effective in achieving its objectives. It has successfully established installation sites that would otherwise not have occurred, and these sites have demonstrated the potential of the GHSP technology and have achieved payback periods often less than anticipated. Having said that, a number of areas for Program improvement have been identified and are recommended to be included in any future similar programs:

- An evaluation framework should be developed at the outset of programs, which includes key performance indicators and the collection of data on program outputs and outcomes. This would help both assess and demonstrate achieved performance to other potential users.
- Project management, monitoring and reporting processes should be strengthened to help minimise and manage technical and administrative risks.
- Installation and feasibility study work should be more strongly linked to assure continuity of objectives between installation design and implementation.
- Industry stakeholders should be actively involved in the design of programs to ensure they have ownership of and full engagement with the desired outcomes.
- Experts should be made available for the duration of program to ensure that technical knowledge is available, as and when required, to address implementation and operational issues.

Appendix A References

Australian Energy Market Commission 2013, *Electricity price trends, final report*, Possible future retail electricity price movements: 1 July 2012 to 30 June 2015.

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Productivity Commission 2013, *Electricity Network Regulatory Frameworks*, Report No. 62, Canberra.

Regional Development Victoria (RDV) 2005, *Moving Forward: Making Provincial Victoria the Best Place to Live, Work and Invest,* Department of Innovation, Industry and Regional Development, Melbourne

Regional Development Victoria (RDV) 2007, *Four Seasons Energy Pilot Program,* Department of Innovation, Industry and Regional Development, Melbourne

Appendix B Stakeholders consulted

Facility	Contact
Grant recipient	
Corryong (Towong Shire)	Mrs Lauren Elvin
Wangaratta High School	Heather Sarau
Mt Beauty centre	Michael Lacey
Mt Hotham	Murray Neilson
Kaniva Seniors Citizens	Des White
Bendigo TAFE	Peter Sporn Noel Boyd
Installers	
Geoexchange Australia	Mr Yale Carden
Direct Energy	Donald Payne
Feasibility Consultant	
Meinhardt Australia	Dr Mirek Piechowski

Appendix C Discussion guide

ACIL Allen Consulting has been commissioned by Regional Development Victoria (RDV) to undertake an evaluation of the Four Seasons Energy Pilot Program. The Four Seasons Energy Pilot Program was established to demonstrate alternative sources of heating and cooling energy for regional communities. It was expected that geoexchange or ground source heat pumps (GSHP) would be a viable alternative to other heating and cooling technologies particularly where a region did not have access to a supply of natural gas.

This discussion guide seeks information about your experiences that will help inform this project. Below are some indicative questions for discussion. We note that not all of these questions will be relevant or applicable to you, but rather, act as a starting point for discussion. The discussions will be treated as confidential and views will not be attributed to individuals or organisations without prior agreement.

If you have any questions about the consultation process or would like further information about the project please contact Alastair McArthur on (02) 6103 8214 or at a.mcarthur@acilallen.com.au.

Questions for discussions

1. Why did you participate in the Four Seasons Energy Pilot Program?
2. How would you describe your interactions with RDV?
   a) Were they responsive? Flexible? Efficient?
   b) Did you have a clear understanding of what RDV were trying to achieve?
   c) How could this relationship have been improved?
   d) How does this program compare with other government programs you have been involved with?
3. Has the Four Seasons Energy Pilot Program been effective at demonstrating alternative sources of heating and cooling in your community?
4. How has the GSHP system installed at your facility performed?
5. What source of energy would you have used if you had not received the grant?
6. What are the benefits and costs of the GSHP system to your organisation? In thinking about the costs and benefits of the installation of the GSHP system please consider the elements outlined in the table on the following page which we will endeavour to complete with you during the consultation.
7. Have any unanticipated outcomes resulted from the installation of you GSHP system?

Table C1 **Cost benefit data**

Cost benefit factors	Value ($)	Comment
GHSP costs ◆ Contract price ◆ Additional contract costs ◆ Contract management ◆ Grant application costs ◆ Consultant advice ◆ Installation costs		
Expected life span of GHSP		
Facility energy consumptions costs1 ◆ Before completion of the project 2 … Electricity … Gas … Other ◆ After completion of the project … Electricity … Gas … Other		
Annual energy-related maintenance costs before installation of GHSP (if any)		
GHSP operating costs ◆ Energy ◆ Maintenance		
Utilisation of the facility3 ◆ Same as prior to installation ◆ Different (by how much)		
Other changes influencing energy consumption ◆ Additional insulation ◆ Double glazing added ◆ Additional curtains ◆ Other		
Other costs or benefits not covered above		

Note: 1. Please provide these costs over at least one full year.
2. New facilities will not be able to provide this information.
3. The facility may be used more (or less) since the installation of the GHSP. This question is not relevant if the GHSP operates continuously.

Appendix D Ground source heat pumps

Although GSHPs are common in some other countries such as Canada, they are relatively rare in Australia. One company in Australia has installed around 100 GSHPs in recent years, but there are few other companies in operation and it was reported that these have done only a small number of installations. Hence, the industry is relatively small, diffuse and people working within it often have limited experience.

GSHPs transfer energy stored in the ground (or in water) to heat and/or cool buildings. The technology relies on the fact that the earth (beneath the surface) remains at a relatively constant temperature throughout the year, warmer than the air above it during the winter and cooler in the summer. Thus using pipes buried in the ground as a collector and a suitable heat pump, heat energy is absorbed at one location and transferred to another.

GSHPs use a small amount of electricity to operate the heat pump and are therefore a highly efficient technology for heating and cooling. They can achieve Coefficients of Performance (CoPs) (the ratio of heat output to electrical energy input) of up to 5, although CoPs around 2 are reported to be more common.

The advantages of GSHPs are that they:

- can be set up for extremely efficient operation;
- offer significant running cost savings over other sources of energy (20 – 50 per cent);
- can be used to both heat and cool;
- use a renewable energy source;
- are clean, safe and quiet to operate;
- have a long working life (more than 50 years for a closed ground loop); and
- are low maintenance.

The disadvantages of GSHPs are:

- they have a high initial cost
- their performance depends on capacity and weather conditions;
- they are not as effective when ground temperatures are low;
- horizontal trenches require an appropriate area of land while vertical configurations may be more expensive to excavate; and
- they still require some electricity operate.

There are three main elements to a GSHP system:

- a ground loop – a series of connected pipes buried in the ground which circulates fluid that absorbs heat from, or transfers heat to, the soil;
- a heat pump – a pump which when heating a building, removes the heat from the fluid in the earth, concentrates it, and the transfers it to the building (and vice-versa for cooling); and
- a heat distribution system – ductwork or pipes which distribute the heated or cooled air/water from the heat pump throughout the building.

There are a variety of different types of ground loops as outlined in Box D1.

The success of GSHPs is dependent on the installation design matching the heating and cooling needs of the building. This requires a thorough understanding of the movement of heat in the ground, the local geology and the heating and cooling requirements of the building.

As a GSHP draws heat out of the ground, the ground temperature will fall from its natural temperature of around 10°C towards 0°C or colder. The heat pump must then work harder to produce the same output from a lower heat input. As a result the CoP tends to fall over the winter unless the ground loop is large enough and heat is only extracted slowly.

Thus thermal modelling is critical to getting the appropriate heat pump and the correct sizing of the ground loop. The heating and cooling loads of a building are determined in part by the design of the building (including insulation, glazing and eaves), its orientation to the sun, the activities in the building and the ventilation strategies. Modelling addresses these factors.

Box D1 **Ground loops**

Despite the variation in temperature experienced throughout the year, the temperature below ground stays fairly consistent all year, regardless of climate or season. GSHPs use an earth loop to extract heat from the ground. This is comprised of lengths of pipe buried in the ground, or a body of water. The pipe is usually a closed circuit and is filled with a mixture of water and glycol. In winter, the water solution is pumped around the pipe absorbing the energy from the surrounding earth and carrying it into the building. The heat pump then extracts this heat from the water solution and transfers it into the building. In summer, the process is reversed and the water solution carries the heat from the building via the heat pump and rejects the heat energy back into the earth. There a number of options for the ground loop:

- **Horizontal Loop** – If adequate land area is available, a horizontal closed loop is composed of pipes run in trenches in the ground, pipes are placed in trenches up to 150m long and averaging 1.5m deep. The length and the width of the trenches are dependent on the size of area requiring heating or cooling.
- **Vertical Loop** – A drilling rig is used to bore a number of holes of 50-120 metres deep. The number of holes drilled is dependent on the size of area requiring heating or cooling. Pipe pairs in the hole are joined on the bottom with a u-bend. The borehole is backfilled with a grout to give good thermal connection to the surrounding rock or soil. For very small sites this may be the only feasible option. Vertical loops are perfect for properties on small parcels of land or locations with shallow rock where trenching is not possible.
- **Pond Loop** – A pond, dam or body of water can be used as a collector by installing coils of pipe into the water. The coils of pipe are attached to a frame and sunk to the bottom of the pond. The amount of pipe is dependent on the size of area requiring heating or cooling. The pond loop is probably the most economical way of installing a loop as generally no excavation is required.
- **Open Loop** – This type of system uses well or surface body water as the heat exchange fluid that circulates directly through the ground source heat pump system. Once it has circulated through the system, the water returns to the ground through the well, a recharge well, or surface discharge. This option is practical only where there is an adequate supply of relatively clean water, and all local regulations regarding groundwater discharge permit it.

Source: Geoexchange, see http://www.geoexchange.com.au/gxtechnology.aspx