

## GPS in Schools: Agencies Partnering for Industry

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## ABSTRACT

*The ‘GPS in Schools’ project as it relates to NSW and ACT is a showcase example of commonwealth, state and territory agencies collaborating together to facilitate a program that will provide enduring benefits to our industry. The surveying teams from NSW Public Works and the ACT Office of the Surveyor-General partnered with Geoscience Australia to successfully roll out this important industry and educational program as part of the AuScope Geophysical Education Observatory project. Our teams were successful in identifying suitable high school sites for the installation of seven (five in NSW, two in ACT) Tier 3 Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS). These receivers have not only provided further densification and redundancy to the CORSnet-NSW network but have provided a focal point for education and industry promotion to the up and coming surveyors of tomorrow. This paper discusses the experiences of both the NSW Public Works and the ACT Government survey teams who liaised and coordinated with individual schools and teachers, suppliers, contractors and fabricators to get the job done. With more than a little help from NSW Land and Property Information (LPI) in the site assessment, fabricating and installation phases of the project, our teams were able to deliver the projects on time and on budget. This program has established a link between Geoscience Australia and each of the seven schools through CORSnet-NSW, the distribution of educational material and various GNSS receivers. This relationship will drive further educational advancements for students in the fields of geoscience, surveying and spatial reference systems. Furthermore, the most positive outcome has been the direct interaction between industry and students that has enabled school students in both jurisdictions to engage with real-life surveyors and spatial professionals, which may never have happened under typical circumstances.*

**KEYWORDS:** GNSS, educational, Geoscience Australia, NSW Public Works, ACT government, NSW LPI, CORSnet-NSW, industry promotion.

## 1 INTRODUCTION

In 2013-15, Geoscience Australia (GA), with funding through the AuScope Australian Geophysical Observing System (AGOS) program (AuScope, 2016), rolled out the ‘GPS in Schools’ program Australia-wide through collaboration agreements with State and Territory geoscience agencies. Jurisdictions were offered funding and Global Navigation Satellite System (GNSS) hardware to establish Continuously Operating Reference Stations (CORS) in a number of their schools.

As stated in the collaboration agreement between GA (Commonwealth) and the States (NSW Government), the main objectives of the program are to:

1. Maintain and enhance the understanding of crustal deformation in Australia for applications in fundamental geospatial infrastructure and emerging geophysical energy issues.
2. Encourage the integration of scientific research and education by engaging students, teachers and the public in GNSS observing through a program called 'GPS in Schools'.

Additionally, both the NSW and ACT project teams saw that benefits could be yielded from the program to foster interest and broaden the knowledge of high school students in the area of surveying and spatial information with a particular focus on GNSS mapping technology. This program has already been successfully rolled out in other states across Australia.

Following installation of the CORS (i.e. GNSS antenna, receiver, mount and auxiliary equipment) in each of the five NSW high schools, the equipment will be owned, operated and maintained by the NSW Government through Land and Property Information (LPI) who is the custodian of CORSnet-NSW, its state-wide network of GNSS CORS (e.g. Janssen et al., 2015, 2016). The ACT Government through the Office of the Surveyor-General owns and maintains the CORS installations in the ACT. All seven CORS built under this project form part of the CORSnet-NSW network (LPI, 2016).

This paper has been adapted from the NSW Public Works submission to the 2015 Excellence in Surveying & Spatial Information (EISSI) Awards to include the experience of our ACT Government colleagues for the purposes of this paper.

## **2 PROJECT DETAIL**

The objectives of the 'GPS in Schools' program were briefly explained in the previous section, along with the program's drivers, and the associated expectations of the key stakeholders. Prior to discussion of the project management principals, this paper will summarise the overall project outcomes in order to help with the contextual understanding of the discussion to follow.

In terms of project scope outcomes, the teams have clearly exceeded all expectations. Seven Tier 3 CORSnet-NSW GNSS CORS have been successfully installed in high schools across the two jurisdictions, meeting stringent quality requirements (LPI, 2012). Our teams have also assisted with establishing a link between Geoscience Australia and each school through the distribution of educational material, and education and guidance in the use of Garmin handheld GNSS receivers. This relationship will drive further educational advancements for students in the field of earth geosciences, surveying and spatial reference systems. Furthermore, the most positive outcome has been the direct interaction between industry representatives and students. This has enabled many school students to engage with real-life surveyors, which may never have happened under typical circumstances. The following sections demonstrate how each team reached these project outcomes.

## 2.1 Summary of Roles

Table 1 provides a breakdown of how the project tasks were allocated amongst the NSW Public Works project team.

Table 1: Task allocation.

Project Director	Project Manager	Project Surveyor
<ul style="list-style-type: none"> <li>- Approval of decision-making and risk assessment</li> <li>- Decision to take project on despite considerable risks</li> <li>- Overall strategic direction</li> <li>- Primary contact with GA and LPI management</li> <li>- Seek background information from ACT colleagues</li> <li>- Contract negotiations with GA and LPI</li> <li>- Documentation review, edit, and approval</li> <li>- Industry publicity of GPS in Schools program through presentations at SMIC and Consulting Surveyors Surveying Taskforce</li> <li>- CORS subscription negotiations</li> <li>- Payment of hardware orders</li> <li>- Chair regular project meetings</li> <li>- Organise freight of equipment to Bathurst for pre-assembly</li> <li>- Assist with material for schools start-up tutorial including presentations on surveying careers</li> <li>- Prepare EISSI Awards submission</li> </ul>	<ul style="list-style-type: none"> <li>- Control and monitoring of project budget</li> <li>- Preparation of monthly status report to GA including progress, budget, issues arising</li> <li>- Ordering of hardware and electrical components under instruction from LPI</li> <li>- Preparation of monthly invoicing</li> <li>- Report and contribute to regular project meetings</li> <li>- Cold-calling of schools to explain program and seek interested parties</li> <li>- Maintain and update communications register with schools</li> <li>- Engagement with school senior representative, e.g. Principal</li> <li>- Drafting of documentation and schools correspondence</li> <li>- Mail in / mail out of schools correspondence</li> <li>- Logistics liaison with LPI operations representative</li> <li>- Initial desktop site review</li> <li>- Engagement of electrical contractor, seek quotes</li> <li>- Payment of hardware orders</li> <li>- Peer review EISSI Awards submission</li> </ul>	<ul style="list-style-type: none"> <li>- Drafting of schools documentation including information package, installation agreement</li> <li>- Logistics liaison with LPI CORS installer</li> <li>- Initial desktop site review</li> <li>- Cold-calling of schools to explain program and seek interested parties</li> <li>- Report and contribute to regular project meetings</li> <li>- Site suitability inspections</li> <li>- Engagement with school representative, e.g. Maths or Geography teacher, regarding installation</li> <li>- Liaison with electrical contractor</li> <li>- Develop Project Safety Plan</li> <li>- Supervise field deployment for site installations</li> <li>- Installation logistics</li> <li>- Lead schools start-up tutorial including use of Garmin handheld devices, CORS explanation and drafting of supporting documentation</li> <li>- Peer review EISSI Awards submission</li> </ul>

## 2.2 Program of Works

Table 2 details the NSW Public Works planned schedule with milestones. Four of the five installations were completed early, with the final installation delayed at the request of the school and in consultation with GA and LPI. In addition to this installation program, our team also conducted a start-up tutorial at each school.

Table 2: Planned program.

	NovemberDecemberJanuaryFebruaryMarchAprilMay																														
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Task																															Milestone Date
Project Inception & Start Up Meetings																															14/11/2014
School Selection Completed																															21/11/2014
School Agreements Received																															19/12/2014
Site Visits, Testing and Receiver Location Decided																															30/01/2015
Fabrication & Purchase of Equipment Completed																															13/02/2015
Installation Commenced																															1/03/2015
Installation Completed																															15/05/2015
Handover Completed and Final Invoice Issued																															29/05/2015

### 3 PROJECT MANAGEMENT

#### 3.1 Managing Expectations (Perceived or Real)

The NSW project team identified in the early stages that bias towards certain schools or regions may have been perceived by some stakeholders. With only five permanent GNSS receivers to be installed over the whole of NSW, there was potential for some stakeholders to question why they had missed out. Furthermore, there may also be perceptions around independent vs. public vs. systemic schools, well-resourced vs. under-resourced schools, and Sydney metropolitan vs. regional and rural schools.

This situation raised the question of how the team was going to evenly and equitably distribute the GNSS receivers and what criteria were going to be applied to ensure that sound, evidence-based decisions were being made about which schools were to receive the infrastructure and which were not. All decision-making was captured within MS Excel spreadsheets including a communications log and desktop site assessment log.

As highlighted earlier, the schools were clearly a key stakeholder, but so too was LPI. After all, it was LPI who was going to be the eventual asset owner, so it made sense to base our decision-making around their needs and CORSnet-NSW objectives. It was deemed important by the project team that not only were the schools to benefit, but the overall CORSnet-NSW network should be consolidated and improved upon as a result of these installations. We were mindful of not simply agreeing to install the receivers in the first schools that showed some interest in the program. We judged that the schools' location should be geographically well-suited in terms of its value to the overall CORSnet-NSW network.

Accordingly, LPI was consulted and asked to identify the short-to-medium term objectives in terms of locations for upcoming GNSS CORS infrastructure. LPI was able to provide the team with some high-level objectives as well as some more detailed preferences for sites. The objectives LPI put forward included:

- **Densification of the existing network:** In the Sydney metropolitan area this meant locating reference stations in the 'middle ring' of Sydney. Currently, there are a number of CORS in the outer suburbs and many in the inner suburbs. For example, between Port Botany CORS and Waterfall CORS there is a straight-line distance of nearly 40 km. Between Fort Denison CORS and Cowan CORS there is nearly 45 km. Based on this information, suburbs such as Sutherland and Hornsby were therefore identified as examples of preferred locations for new sites. In regional areas, between CORS at Wollongong and Nowra was a distance of nearly 80 km. It followed that the southern Illawarra region was identified as a preferred geographic location for a new CORS.
- **CORS black spots:** These locations were identified but were typically quite remote or were not well-served by mobile phone coverage.
- **Back-up stations:** These typically were identified in larger regional centres. To ensure redundancy and to minimise risk to the ongoing use of the network, LPI identified that back-up receivers in some areas would be a prudent and desirable objective to work towards. From this analysis, two of the eventual new sites selected, Armidale and Goulburn, fitted well with this LPI objective. Many other regions were also identified but were either found to be not suitable from a site analysis perspective or schools in the region did not demonstrate a strong interest in the program when contacted.

GA was keen to roll out the program by providing funding, educational material and equipment, but site selection turned out to be influenced by LPI and the CORS site criteria. In terms of the NSW Public Works project team and its influence on site selection, clearly, if we could identify a majority of sites that were not overly remote from our offices, then managing the budget by keeping travel and accommodation costs to a minimum would be a good outcome.

The initial site in the ACT was selected through happenstance. The science laboratory at Melrose High School, in the suburb of Pearce, already participates in the ‘Australian Seismometers in Schools’ program (AuSIS, 2016), and the school approached the ACT Office of the Surveyor-General with a view of joining the ‘GPS in Schools’ program. The location of Melrose High School (Pearce CORS) provided a suitable enhancement of CORSnet-NSW by increasing network density, and hence the redundancy of the existing Canberra stations (Figure 1).

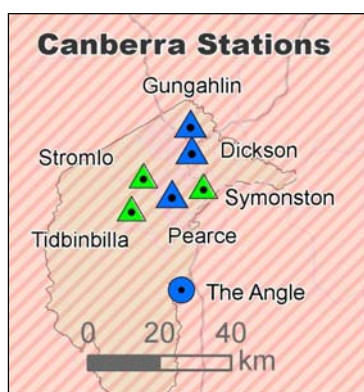


Figure 1: CORSnet-NSW stations in the ACT (LPI, 2016).

Gungahlin College (years 11 and 12), located in the northern suburbs of Canberra, was chosen as the second ACT site to improving network geometry and redundancy. Furthermore, the Canberra Institute of Technology (CIT), which provides Certificate and Diploma courses in surveying and spatial science, has a campus co-located at Gungahlin College. In addition to providing education and industry exposure to the college students, the linkages between CIT and the Office of the Surveyor-General have now been enhanced.

### 3.2 Managing Time and Cost

Contractually, the deadline stipulated by GA was for the CORS to be installed by mid-May 2015. Both ACT sites were built and operational by September 2014. However, given that the NSW contract was only signed off in October 2014, and that the school summer holidays (typically of 6-8 weeks duration) fell in between those milestone dates, the NSW delivery program was identified as critical. The NSW team set about planning and completing as many tasks as possible prior to the end of the 2014 school year. With schools closed, contact with principals and teachers was not going to be feasible during these times. In addition, our own staff would be taking recreational leave over summer, so clearly the project was going to be stalled during this period.

In reality though, GA wanted to be assured that although the actual installation may not be completed at each school by the deadline of mid-May 2015, their expectation was that the final five schools must be identified, that agreements were in place with the schools, and arrangements for installation were well progressed by that time. The risk being that if the

project had not progressed to the satisfaction of GA, NSW Public Works may not have been paid, yet contractually we would be obliged to complete the project. In terms of the final progress outcome, GA was very pleased that our team had achieved four out of five installations by the mid-May deadline. The final deployment was planned and an approximate installation date agreed upon with the school (The Armidale School).

To manage the time commitment of each NSW team member, project meetings were held where clear tasks and an expected hours budget for each task was allocated. The team were very organised and in the early stages of the project only undertook tasks that had to be done. There was a danger of over-committing resources to this project with potentially scores of schools needing to be inspected and teaching staff consulted and educated about the program. A conscious decision was made to limit the number of resources on this project to the three key members to lessen the chances of extra staff doing more than was necessary, particularly early on in the project. During our early discussions with LPI, our team was introduced to Russell Commins from LPI. Russell is LPI's key CORS infrastructure officer and both the NSW Public Works and ACT Office of the Surveyor-General project teams would like to acknowledge the vital role he has played in ensuring the success of this project.

With Russell's advice and proactive approach the procurement of the necessary hardware and electrical components was made easy and efficient. His involvement saved the project time and money through expert advice and assistance on key elements of the installation preparations. Through Russell, LPI was able to assist with the following:

- Advice on site suitability criteria.
- Reviewing information documentation to be forwarded to schools.
- Attending site inspections and helping to identify suitable buildings for the CORS antenna, secure rooms for the receiver cabinet and routes for cabling conduits.
- Fabrication and design of the stainless steel CORS monument, which included the CORSnet-NSW Adjustable Antenna Mount (CAAM), providing a legally traceable survey monument that allows the GNSS antenna to be oriented to True North without the need to introduce an antenna height (Commings and Janssen, 2012).
- Providing a list of components and hardware to purchase for each installation.
- Providing lists of preferred suppliers for the above.
- Pre-assembly of components and hardware at LPI in Bathurst prior to installation.
- Transport of pre-assembled units to the schools.
- Installation and CORS unit commissioning.

Not only did Russell's involvement with the project ensure a quality installation was achieved at each site, we believe that it was hugely beneficial in saving the project valuable time and costs through his experience and proactive approach to helping our team reach our objectives. Costs on the project were also minimised through the use of our in-house staff for some of the more minor or simpler tasks.

### **3.3 Managing Quality**

It was vital that the experts in CORS infrastructure were involved to ensure that the quality of the final installations was as high as possible and met CORSnet-NSW specifications (LPI, 2012). Again, through Russell's involvement, the quality and the efficiency with which the installations progressed was very high (Figure 2). With all components pre-assembled and tested off-site, any quality problems were able to be identified and resolved prior to the installation team and contractor arriving on site.





Figure 2: Installation of cabinet for Barrack Heights CORS, Warilla High School.

With the installation process being well-organised and efficient, this reflected well on the project teams and the stakeholders such as LPI and GA. The schools had been provided with succinct and timely information about the installation process and they were widely impressed with the quality of the work and the assistance provided by the team.

Of the four fundamental principles of project management (i.e. time, cost, quality and scope), the quality component of the installations was regarded as the easiest element to manage and that was comfortably handled through Russell's involvement.

This project was, however, about far more than just the CORS installations and there was a tangible opportunity to enhance the experience for the schools and for the project outcomes to reflect well on the project team and the industry as a whole. This opportunity was through the documentation and correspondence provided to the schools. The NSW project team identified that if we initially supplied simple and succinct documentation, then the quality of the experience could be enhanced, which could result in more than enough schools showing interest and ultimately signing up to host one of the CORS.

It was agreed that after the initial phone contact with the school, a follow-up information pack would be forwarded to the main school contact. This document would explain the program and its benefits to students. It was identified that the document must be presented in clear, simple terms and language, with helpful pictures and a clear explanation of the process involved. With schools often being solicited to participate in various programs, it was important that our submission did not end up being dismissed by the schools. It was evident that we had to effectively manage the communication stream to the school and get the schools on board by highlighting three key benefits of the program:

1. The CORS infrastructure and educational material would be provided to the school at essentially no cost.
2. There would be a tangible benefit to both the teachers and students in terms of geospatial and science education.
3. The program would not require a substantial input of a teacher's time, i.e. the program would not be a drain on the school's teaching resources.

If we could demonstrate these three key advantages, then it was far more likely that the principal of each school would endorse the program and would allow the teachers and students to actively participate in the 'GPS in Schools' program.

The appendix contains a copy of an information pack sent to the schools. This document signified the first formal correspondence with the school. In terms of managing quality, this document was instrumental in setting the standard for the overall implementation of the program. The document sets out to briefly explain the program, the drivers, the benefits, the responsibilities of the parties involved, and how to go about getting involved. We also included references to supporting reference material and links to helpful websites.

Testament to the quality of this document and the associated phone and email contact, 15 information packs were sent out to NSW schools, from which 7 positive responses were received. Only one school indicated they were not interested.

### **3.4 Managing Scope**

The scope as defined in the terms of the Collaboration Agreement contract signed by GA and NSW Public Works was quite clear: *“GA will provide 5 GNSS antennas and receivers to the Collaborator (NSW Public Works) and funding for deployment in five NSW educational facilities. The Collaborator will install the 5 GNSS receivers and antennas and perform all project management associated with the installations.”*

On face value, this presented as a reasonably straightforward project management exercise. However, the complexity of dealing with multiple stakeholders and their differing priorities would dictate that the project team had to gain a clear understanding of each stakeholder’s perceived expectations to enable a clear vision of the actual scope of the project. To that end it was important to do what was reasonable in terms of satisfying the stakeholder expectations, yet have a clear understanding of any cost implications that may be associated with these expectations. We needed to communicate clearly to the stakeholders that we would do what could be done within the confines of the approved budget.

Once each site had been inspected and the specific location for the antenna, cabling and cabinet had been decided, an installation agreement was drafted for each site. Each school was asked to review the agreement and sign off that what was being proposed was officially agreed to. More discussion about the installation agreement follows below, but it was this document that played an important role in limiting scope and managing expectations.

Once the project had progressed to a stage where the team was comfortable with the budget, we then were able to consider implementing those initiatives that were clearly beyond the scope nominated within the Collaboration Agreement with GA, such as providing guidance, instruction and advice to the teachers and students post-installation. Both project teams felt an obligation to extend our scope beyond just the installation, and to provide an initial start-up tutorial to each school. This extra effort would reflect well on the project teams and the industry as a whole. This thinking also fitted well with the overall program objectives of encouraging students to take up surveying as a career. This additional effort added significant value to the program, was outside the scope, but was done within the constraints of the approved budget.



### **3.5 Managing Risk Factors**

#### **3.5.1 Exposure to Financial Loss**

To ensure all risk factors are considered prior to taking on any project, NSW Public Works undertakes a process of due diligence through the 'go / no go' process. This process considers the type of projects, the available resources, the likelihood of success, likely risks and their mitigation measures before a decision is taken to proceed with a fee proposal. Unlike most projects, the 'GPS in Schools' program was offered to us directly through LPI and GA. Our in-house experience with schools and managing projects including procurement of contractors led our team to the conclusion that we could take this project and make it successful. The ACT Office of the Surveyor-General had previous experience in the establishment of Dickson CORS (build with help from LPI), and was confident, again with LPI technical assistance, that another two CORS builds would be successful.

#### **3.5.2 Unclear or Poor Communications**

As described earlier, one of the biggest risk factors to the take-up and implementation of the program was being able to generate sufficient interest in enough schools at the outset. The NSW team identified that with five hosts ultimately required, we would need perhaps three times as many schools initially showing interest. This would then give the team a pool of potentially 15-20 possible sites from which to selectively choose from. Each school would need to meet certain site criteria to progress to the next stage of the selection process. If we could only generate a small pool of interested schools, there was a high likelihood that those sites would be deemed to be unsuitable, therefore leaving the project exposed.

The information pack (see Appendix) was a key document for the reasons explained in section 3.3. This document delivered the first formal clear communications to the school stakeholders and was crucial in mitigating the risk associated with the take-up of the project.

#### **3.5.3 Schools Slow to Respond**

With a tight deadline for implementation of the project, if the schools were slow to respond to our initial contact, again, the pressure to identify enough schools to select from would rise. To help progress the initial responses from the schools, the NSW team would follow up each information pack mail-out with a phone call to the school to make sure that it was received and if any help was needed. Clearly, with the schools having other priorities, personal follow-up by phone calls was an effective project management tool and helped to extract responses from schools in a timely manner.

#### **3.5.4 Lack of Interest by Schools**

It was unknown at the commencement of the project whether or not 'GPS in Schools' was a program that schools would be interested in. Somewhat surprisingly, but with credit to the team members who personally contacted individual school principals and explained the offering, the initial feedback from the schools was one of high interest and enthusiasm. With many students and teachers exposed to satellite positioning technology on a daily basis through smart phone technology, using street maps, in-car navigation and other applications, the appetite to take that basic education several steps further was appealing.

### **3.5.5 Information Management**

With multiple stakeholders, a variety of information had to be captured, including site information, school contact person, LPI site preferences, schools that had previous contact with GA, and names of suppliers and contractors. It was important that this information was captured and recorded succinctly to avoid duplications and information gaps. Through the use of simple spreadsheets to record and capture events, a valuable information log developed and contributed to efficiency gains. For the site selections, we also logged the decision-making process through the spreadsheets, so that if any questions arose about why certain schools were selected or not, then we had documented steps and reasoning behind each decision.

### **3.5.6 Cost of Identifying Suitable Sites**

For the NSW Public Works team to successfully manage the budget, doing long road trips to visit multiple sites all over the state just to complete an initial cull was judged to be not feasible. Armed with the CORSnet-NSW site criteria (LPI, 2012), the LPI preferences and GA's list of schools that they had previously dealt with, a very effective, desktop-only, site suitability assessment was undertaken using essentially free online street maps and aerial imagery, including Google Maps and Street View. These tools allowed our team to develop a picture of the terrain surrounding the school, the nature of the main buildings and a feel for the vegetation coverage of the site. Those schools that did not make it through the desktop cull were not contacted at all, thus saving valuable time. Our team only focussed on schools that passed this initial desktop cull, and from there the schools were contacted, and if an interest was shown, then we would make arrangements to visit the school.

### **3.5.7 Work Health and Safety**

Just as project risks discussed previously were important factors to consider, work safety risks were assessed and control measures put in place to ensure the safety of all personnel involved. Common hazards at each site included working at heights, potential asbestos contamination, use of power tools and electrical hazards. Additionally, the need to keep inquisitive students and other people clear of the installation site, particularly when the installation team were working from an elevated work platform, was paramount (Figure 3).



Figure 3: Installation of a GNSS antenna monument, demonstrating a number of work safety measures in action.

Both the NSW and ACT teams took overall responsibility for work safety at each site and developed the Project Safety Plan accordingly. All those involved in the installation, including our teams, electrical contractors and LPI staff, were asked to sign on to our over-

arching Project Safety Plan. No work safety incidents were reported as at the completion of the two ACT and five NSW installations. One consideration in selecting the actual site for the CORS installation was whether the building could be accessed easily and safely.

### **3.5.8 Potential Lack of Expert Support**

It was also unknown at the commencement of the projects if both NSW Public Works and the ACT Office of the Surveyor-General would be able to call on LPI for support in the installations. Discussions were held and LPI kindly provided that support through Russell Commins to work on installing the GNSS infrastructure (Figures 4 & 5). Without that support, the outcome of the project may have been very different. As NSW Public Works were not keen to be the eventual owners of the infrastructure, LPI gratefully stepped in and arranged for the infrastructure to be incorporated into CORSnet-NSW and to take ownership of these assets. However, in the ACT the ownership and responsibility of Pearce CORS and Gungahlin CORS remains with the ACT Office of the Surveyor-General.



Figure 4: East Corrimal CORS antenna at Corrimal High School.



Figure 5: Pearce CORS cabinet, Melrose High School.

## **4 ADDING VALUE**

Not only were the schools to host the CORS infrastructure, the GA program included an educational package developed by the University of Tasmania and a number of Garmin handheld GNSS devices. By the time the project had progressed to the stage where installation costs were known and could be forecast, the project team had a good idea of what

funding would be available to provide some added value to the project at the back end. Both teams felt that we could compliment the GA offering through engaging directly with students and teachers at each of the seven schools. The teams undertook to invest some time in providing the schools with a start-up tutorial that included a brief description of the CORS network, satellite positioning technology, use of the Garmin handheld devices, careers options and study pathways into surveying and mapping careers. From this, additional documentation and presentations were developed. Following the CORS installation, the teams arranged for a follow-up visit to the schools where the students were presented with the Garmin GNSS devices, the educational material and the tutorial presentation.

Our team also felt it was important that from the perspective of industry promotion, publicising the program, our teams' efforts and the contributions of LPI and GA was an important value-add to the overall program. The first author delivered presentations to the Surveying and Mapping Industry Council (SMIC) and to a meeting of the Surveying Taskforce hosted by Consulting Surveyors NSW. Publication of those presentations also followed in industry newsletters.

In the ACT, the 'GPS in Schools' project was the catalyst for the SSSI (ACT Region) 'Let's Locate' educational program, which aims to increase the spatial literacy of school students through exposure to surveying and spatial technologies (G. Ledwidge, pers. comm., 2015).

## **5 CONCLUDING REMARKS**

The GPS in Schools project has provided numerous tangible benefits to the surveying and spatial information industry through the collaborative efforts of several stakeholders. The project has brought together contributors from throughout the industry including federal and state government agencies, surveying professionals, schools and teaching professionals, technicians, students, and surveying industry groups. Both the NSW and ACT teams are proud to have been involved in the CORS installations, industry promotion and educational activities. We feel we have contributed to the improvement of the CORS network as well as educating high school students on aspects of surveying and spatial information. Hopefully, this exposure may encourage some students to pursue a career in the spatial sciences.

The project presented each team with challenges. However, this paper demonstrates that by taking a project management approach to this engagement, our teams were able to focus on time, cost, quality and project scope to achieve the desired outcomes for all stakeholders whilst managing project risks and expectations successfully.

This paper also demonstrates what can be achieved through government agencies partnering and collaborating together for positive industry outcomes. The model implemented to manage this project should be promoted and used to provide further benefits to our important industry.

## **ACKNOWLEDGEMENTS**

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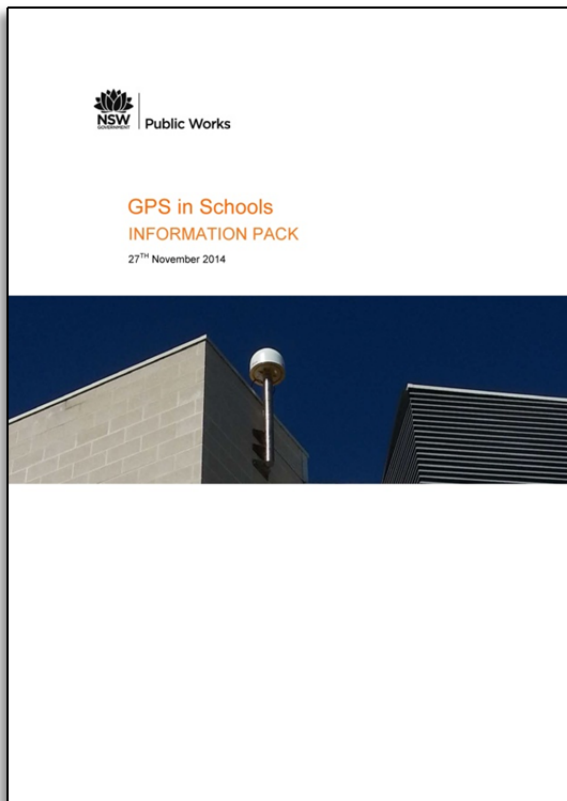
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- Surveying and Mapping Industry Council (SMIC) – inviting our team to present this topic at SMIC meetings and for publicising the positive outcomes of the program (Narelle Underwood, Chair).

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## APPENDIX: Schools Information Pack



**DOCUMENT CONTROL**

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### What is the GPS in Schools Project?

The GPS (Global Navigation Satellite System) in Schools project is funded by Geoscience Australia (Commonwealth Government) and is an initiative with essentially three objectives:

- Encourage the engagement of students in geoscience through the integration of research and education.
- The strengthening of the CORSnet-NSW network of permanent Global Navigation Satellite System reference stations.
- Encourage students to consider surveying and related geospatial sciences as a potential career.

Under the agreement between the NSW Government and Geoscience Australia, NSW Public Works has been allocated five GNSS receivers to install within suitable high schools in NSW and your school has been identified as a potentially suitable site to host one of these receivers. This project has already been successfully rolled out in other states across Australia.



### What Equipment will be Installed?

It is proposed to install five Tier 3 CORSnet-NSW reference stations in high schools throughout NSW as part of this program. The tier relates to the physical standards of the installation. Higher order installations, including Tier 1 and 2 require concrete pillars and stable rock foundations. A typical Tier 3 installation is far less substantial and typically consists of:

- A stainless steel mast, attached to a masonry building, where the mast (with GNSS antenna attached) would extend above the eave line of the building (see image below).
- A GNSS receiver, data communication hardware, power supply and other ancillary electronic devices in a small secure cabinet within the building to which the mast is attached (see image below).
- Cabling for power and data, and associated conduits, brackets and hardware.



Antenna Mast



Receiver Cabinet

Photos: Tier 3 CORSnet Reference Station as installed at Gungahlin ACT

### What are the Benefits?

Schools participating in the GPS in Schools Project will receive the following:

- a CORSnet-NSW Tier 3 GNSS antenna and receiver installed on-site
  - a focal point for education relating to surveying, satellite technology and the geospatial sciences
- a full CORSnet-NSW licence which will enable on-line access to GNSS signals from the entire CORSnet-NSW reference station network
  - Licence will enable users equipped with RTK (Real Time Kinematic) capable GNSS equipment to obtain survey-accurate real time positioning data. NB: Provision of this RTK capable equipment is not part of GPS in Schools Project.
- an educational package developed by the University of Tasmania relating to the capture and use of GNSS positional data.
- phone and email support from Geoscience Australia to help schools make use of GNSS data and educational material in class exercises.

#### Other Benefits

- installation, operation and maintenance are essentially at no cost to the school. The equipment is owned by NSW Government. All ongoing communication costs associated with the reference station will be paid for by NSW Government.
- assistance from Geoscience Australia to facilitate school visits to the Geoscience Australia Educational Centre in Canberra.
- an opportunity for students to engage with NSW Public Works Surveyors during the site assessment and installation phase.
- assisting the NSW Government and Geoscience Australia achieve their educational and scientific goals by hosting a CORS station that is an integral part of the state-based positional reference framework.
- an increased awareness of geography, physics and the spatial sciences for students and teachers alike, and developing awareness of career options.



### What are the Schools Responsibilities?

The schools participating in the GPS in Schools Project do have some responsibilities including:

- Initially, NSW Public Works Surveyors will require access to the school to provide an introduction to the project and the personnel involved, and to undertake an initial site suitability assessment. Additional visits to the site are likely during the assessment and installation phases.
- Allowing schools-compliant contractors to access the site and undertake the installation works, this will include access to power for installation and ongoing operation of the equipment (NB: ongoing power costs are considered minimal)
- Nominating a school representative to be the contact person on site. Ideally, we are targeting geography and physics teachers to take up this opportunity. The contact person will also need to be able to accompany NSW Public Works Surveyors on the site suitability assessment.
- Once installed, the antenna will require unobstructed access via a ladder or cherry-picker, depending on the site. The school will need to keep the area in the immediate vicinity of the antenna reasonably clear of vegetation or other physical obstructions to allow for occasional maintenance (NB: It is expected that the equipment may need to be accessed once or twice per year).
- The school must sign a **Memorandum of Understanding (MoU)** which sets out the agreement between the school and NSW Government. If the site is found to be suitable the MoU will be negotiated prior to installation proceeding.
- Provide NSW Public Works with an up to date Asbestos Register.

For a site to be deemed suitable, there are some criteria that need to be met. These will be investigated at the site suitability assessment, namely:

- The antenna requires a clear view of sky down to 10° above the horizon, with no short-medium term prospect of being built or grown out.
- Both the antenna and cabinet need to be securely located – ensures tamper free operation of reference station.
- Potential risks introduced by the installation of any component of the reference station, including aesthetics are to be acceptable or resolved to the satisfaction of the school and NSW Government.



### What is CORSnet-NSW?

CORSnet-NSW is a network of Global Navigational Satellite System (GNSS) Continuously Operating Reference Stations (CORS) located around New South Wales with data links to NSW Land and Property Information (LPI NSW).

Currently CORSnet-NSW has 157 stations spread across the State with that number growing to a planned density of towards 200 stations over the coming years. Where possible, CORSnet-NSW equipment is housed in LPI NSW own regional offices. Where this has not been feasible, LPI NSW has worked in partnership with other government departments, local councils and the private sector to accommodate the equipment. Of the 157 operational stations, 7 are located in Rail Corp facilities, 96 are located in local council buildings and 18 more under agreement in NSW State Government offices (further information on rollout and partnerships is available at [http://www.lpi.nsw.gov.au/surveying/corsnet-nsw/network\\_information](http://www.lpi.nsw.gov.au/surveying/corsnet-nsw/network_information))



CORSnet-NSW enables suitably equipped users operating in the coverage area to receive data from the GNSS base stations and offer survey-accurate positioning in real time as well as providing access to stored data for higher order post-processing applications.

CORS technology is now being used worldwide with applications developing in many fields including scientific research, precision navigation, engineering and precision agriculture. In NSW, state government agencies and corporate industry involved in infrastructure development (road, rail, ports) and utilities (power, water, telecommunications) find CORSnet-NSW an efficient system for their precise positioning tasks such as asset capture, planning work and as-built surveys.

For LPI NSW, CORSnet-NSW is an efficient resource for densifying cadastral (title boundaries) control to improve the spatial accuracy of the Digital Cadastral DataBase (DCDB). In addition it is fast becoming an invaluable resource for the operation of aerial photography and LIDAR



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programs. It is expected that over time, CORSnet-NSW will replace the need to maintain a significant portion of the existing physical survey control network in the region including current trig stations.

Each CORS typically consists of the following equipment:



➤ **Stable monument.** The monument is used to mount the antenna and may range in type and size from a small pole mounted on a rooftop to a free-standing pillar concreted into the ground.



➤ **High precision GNSS receiver.** All receivers in service are able to use signals from both the American GPS and Russian GLONASS satellites. New installations will utilise receivers which are also able to take advantage of signals from other GNSS satellites such as the European Galileo, Japanese QZSS and Chinese Compass systems as well.



➤ **Antenna.** CORSnet-NSW uses precision antennae which are passive (receiving only) and relatively small (less than 40cm in diameter). Each antenna is connected to the receiver using low loss coaxial cable with a lightning arrestor installed.



➤ **Power Management.** Dependent upon the type of installation, each setup will use either a UPS or other form of battery backup. The UPS is a 240/12 volt battery backup unit which powers the receiver. Its dual function is to both control power surges to the receiver and offer extra operating time for the system in the event of a power failure. The alternative is a direct battery configuration that will provide additional up time in the event of a mains power failure.

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### To Get Started

The school needs to:

- Read and review the covering letter and information document.
- Nominate a school representative as the preferred contact.
- Complete the quick questionnaire indicating your interest and supply other information requested in the questionnaire.
- Return the signed questionnaire to the NSW Public Works contact in a timely manner
- If your school indicates interest in the project, NSW Public Works will contact the nominated school contact person to arrange an initial site suitability assessment in the coming weeks.
- The school DOES NOT need to sign the sample MoU yet. The MoU will be discussed and agreed upon prior to the installation proceeding.

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### Questionnaire

If your school is interested in participating in the Geoscience Australia GPS in Schools Project please complete and return the following questionnaire.

- Our school is interested in participating in this project ☐ YES / ☐ NO
- Schools nominated contact for all future correspondence with NSW Public Works:

Name: \_\_\_\_\_  
School: \_\_\_\_\_  
Position: \_\_\_\_\_  
Phone: \_\_\_\_\_  
Email: \_\_\_\_\_

- Can the school provide an up to date Asbestos Register prior to the site suitability assessment if required? ☐ YES / ☐ NO

I / the School understand that completing this questionnaire does not guarantee a CORSnet-NSW reference station will be installed at the school. It merely indicates an interest in proceeding to the next stage of the selection process. I / the School understand that the final selection of schools to receive CORSnet-NSW reference stations will be dependent upon, but not limited to factors such as:

- The location of the school with respect to existing CORSnet-NSW reference stations.
- The physical suitability of the site for install and maintenance.
- GNSS signal quality at site and data communication rates from the site to LPI.

Name: \_\_\_\_\_ Title: \_\_\_\_\_  
Signed: \_\_\_\_\_ Date: \_\_\_\_\_

Please scan and email response within 2 weeks of receiving this information pack to:

**Adam Veersema**  
Assistant Principal Surveyor  
Surveying and Spatial Information Services  
NSW Public Works  
[Adam.Veersema@finance.nsw.gov.au](mailto:Adam.Veersema@finance.nsw.gov.au)

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### Helpful Links and Websites

- **Geoscience Australia**  
More information on global positioning systems and CORS, including information on educational programs.  
<http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/gnss-networks>  
<http://www.ga.gov.au/education/visit-our-education-centre>
- **Land and Property Information (LPI NSW)**  
More information, details and useful links related to the CORSnet-NSW system.  
<http://www.lpi.nsw.gov.au/surveying/corsnet-nsw>
- **NSW Public Works – Surveying and Spatial Information Services**  
More information on the Surveying and Spatial Information Services team of NSW Public Works.  
<http://www.publicworks.nsw.gov.au/infrastructure-engineering/surveying-spatial-information>