

The background is a dark blue map with a grid of streets and some green circular overlays. The text is centered on the left side of the map.

# It all comes down to the way you look at it.

An introduction to:  
GIS and Location Intelligence in Health





**It all comes down to the way you look at it...**

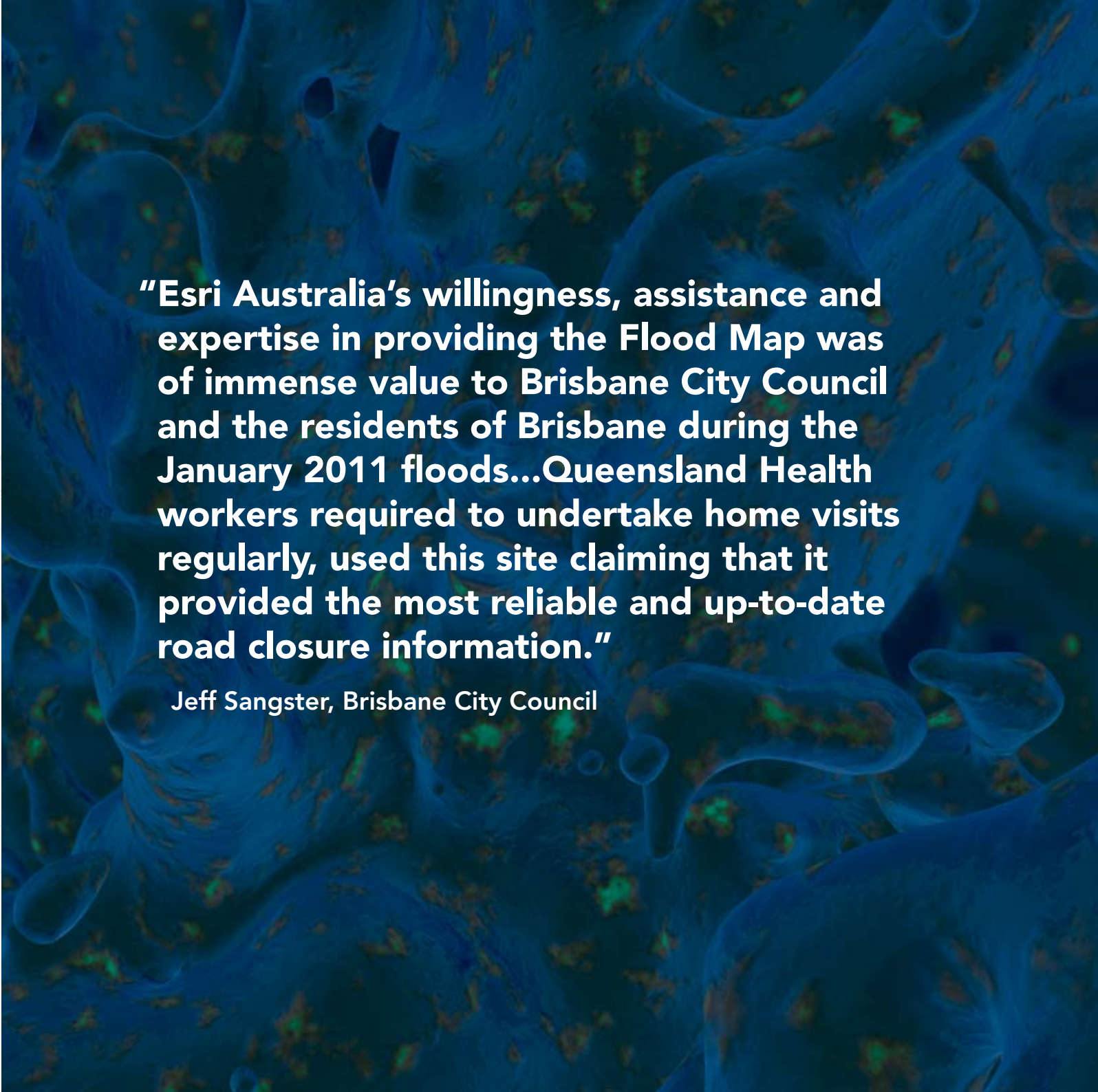
Esri Australia has been a part of the global Esri Network for more than 34 years.

Esri is the pioneer and unquestioned global market leader in Location Intelligence - with more than 350,000 organisations (worldwide) relying upon their GIS solutions.

This booklet provides you with a brief insight into how GIS technology has transformed the Health industry. We invite you to connect with your local Esri Australia team to learn more about GIS in Health or for a demonstration of the technology.

With GIS and Location Intelligence - seeing really is believing...

[esriaustralia.com.au](http://esriaustralia.com.au)



**“Esri Australia’s willingness, assistance and expertise in providing the Flood Map was of immense value to Brisbane City Council and the residents of Brisbane during the January 2011 floods...Queensland Health workers required to undertake home visits regularly, used this site claiming that it provided the most reliable and up-to-date road closure information.”**

**Jeff Sangster, Brisbane City Council**

## Helping the health sector to know their place

Location is inherent in all organisational data: people have residences, assets have proximities, employees have worksites and parcels have both origins and destinations.

By visualising and exploring the spatial relationships within organisational data; and then using the resulting discoveries to guide decision-making – you are effectively leveraging **location intelligence**.

Location intelligence is easily attained through utilising Geographic Information System (GIS) technology. By using the technology we are able to literally map the geographic elements contained within an organisation's data to expose patterns and relationships that may otherwise be hidden in a maze of numeric tables and databases.

Through GIS technology, data is essentially translated into a universal, visual language – enabling organisations to gain a better understanding of the geography of their business.

It's all about knowing your place.

## GIS in Health

GIS is often described as an emerging technology. The truth is – GIS is a mature and sophisticated technology that has been around for more than four decades.

What has emerged in recent years however, is the accepted value of an integrated GIS and location intelligence strategy into core business systems.

Originally, GIS technology was very much the domain of surveyors, land management agencies and the military. However, more and more enterprises - across both the public and the private sectors - are adopting GIS technology solutions.

In terms of the health sector, GIS and location intelligence has a very long and compelling history.

“Through GIS technology, data is essentially translated into a universal, visual language.”

While location intelligence in health management can be traced back to the time of Hippocrates (400 BC), the first effective use of the principles is often believed to be in 1854 when Dr John Snow used a map to plot homes affected by cholera. The case in question was known as the Broad Street cholera outbreak.



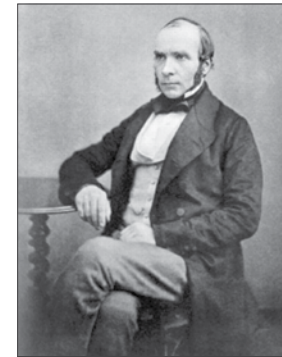
1854, Dr Snow mapped homes affected by the Broad Street cholera outbreak.

Through the simple task of mapping where each of the affected patients resided, Dr Snow was able to identify two potential sources of the disease namely, two public water pumps. Dr Snow's map was the compelling evidence that officials needed to remove the pump handles off the suspect taps.

In turn this action prevented further local residents from becoming infected.

Epidemiology is often used as the poster child of GIS but the technology has applications across all parts of healthcare, from **service provision** and **asset management** to **policy making** and **research**.

The following case studies aim to provide some insight into how GIS technology is transforming the health sector



Dr John Snow.

## Service Provision

GIS is an effective tool for case management, community assessment, and services gap identification. GIS mapping and analysis results offer valuable information for: planning, intervention and support programs; determining program eligibility; and connecting people with services.

Like all data, health services data will reveal more when combined with other information. With GIS, you can easily combine data sets and geospatially correlate it – so as to fully realise its value.



## Case Study #1: Identifying Unmet Needs

The California Department of Public Health's Women, Infants, and Children (WIC) and Maternal, Child, and Adolescent Health (MCAH) programs are working together to use GIS technology to identify locations with people who are eligible for - but not receiving - WIC services.

The California Department of Public Health noted that counts and percentages of WIC-eligible women who were not receiving services only told part of the story. They were interested in locating regions with higher densities of unmet needs and statistically significant clusters of needs on the state, county, and local levels – so they could:

- Guide resource allocation decisions;
- Target outreach efforts;
- Assess program outcomes; and
- Help direct public health policy.



Hot-Spot Analysis: Density of Families Living in Poverty.

The information has since been used to facilitate more informed funding decisions at the state, county, and local levels. The work has also provided information to local WIC directors to help determine whether new or expanded clinic services were needed.

## Asset Management

Health industry administrators contend with a two-edged sword—they need to provide the best quality of care to patients, while efficiently managing human and medical resources.

GIS improves acquisition of timely, accurate, and relevant information essential to the delivery of effective health care services including emergency planning, operational awareness, and trauma management.

By using geographic analysis to locate a new facility, estimate demand for a new service, or make sense of transmission patterns of hospital-acquired infections, GIS provides a better way to relate complex elements and reveal solutions.

The capabilities of GIS technology are limited only by your imagination.

For instance, with GIS you can match facilities and equipment to seasonal incidence of clinical conditions. On a basic level, this could be ensuring the number of beds available meets the expected requirements; a more complex example would be ensuring appropriately equipped emergency response ambulances are located in areas with the highest incidence of cardiac arrest.



With GIS and location intelligence, matching facilities and skills with patient needs becomes intuitive and more efficient.

**“With GIS and location intelligence, matching facilities and skills with patient needs becomes intuitive and more efficient.”**

## Case Study #2: Mapping Facilities and Assets inside the Hospital

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A custom GIS application at the University of Kentucky (UK) now supports occupancy of the 1.2 million square-foot Trauma Centre.

Maps and room data sheets detail each room along with occupancy and accompanying assets including furniture, medical equipment, and technologies.

Built on an Esri GIS platform, the application was developed to enable the hospital to centralise its data sources – in turn dismantling information silos and improving data analysis capabilities.

GIS was chosen because it is a scalable solution, capable of integrating the wide array of data sources contained within hospital-wide systems.

Custom enhancements include the integration of CAD drawings, room data sheet generation,

360-degree panoramic pictures of rooms both fitted and in the pre drywall stage, on-the-fly symbolisation, web site linking, and a powerful asset editing module.

The system is being expanded to integrate other hospital-wide systems and support additional university needs.

This application has significantly streamlined the administration of public facilities.



The University of Kentucky Medical Centre.

## Case Study #3: Workforce Management and Planning

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For many years, health care administrators and hospital human resources (HR) departments have been challenged to find solid business intelligence to assist in their workforce planning.

The direct relationship between a health care facility's workforce and patient care outcomes has long been acknowledged. For this reason, the development of effective workforce planning tools and methods is crucial to helping hospitals address the challenge of successfully recruiting and retaining top-caliber teams of health workers; as well as prepare for the contingency of a large scale emergency (such as natural disasters, incidents with high numbers of casualties, or epidemics).

Compounding these challenges is the global shortage of skilled health workers, which has increased pressure to anticipate, identify and plan for resource deficits.

To address this universal healthcare issue, Stanford University Medical Centre leveraged GIS to significantly improve their workforce planning capabilities.

## Getting in the zone

The Stanford University Medical Centre, comprises of three main components: the Stanford School of Medicine, Stanford Hospital and Clinics, and Lucile Packard Children's Hospital. With 885 licensed beds, the Medical Centre also serves as the primary teaching environment for the Stanford School of Medicine and provides a clinical backdrop for world-class research.

With approximately 2,700 registered nurses, the nursing staff constitutes the largest clinical workforce category within the Centre. Long-range workforce planning for maintaining an adequate nursing staff is a challenging task.

GIS technology was identified as a critical workforce planning tool for the Centre because of its geographic analytic capabilities and the provision of visual – easy to digest – map-based results.

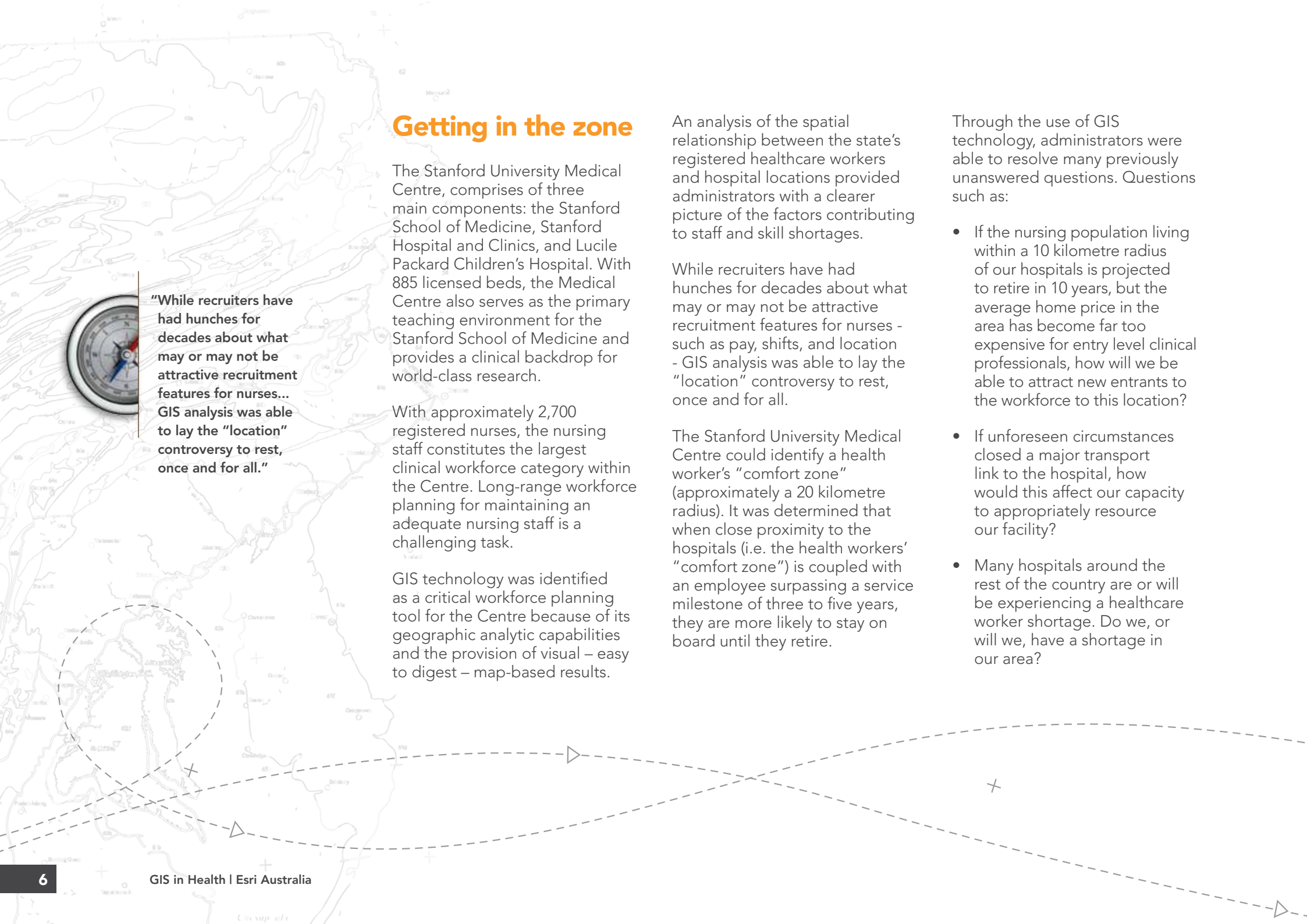
An analysis of the spatial relationship between the state's registered healthcare workers and hospital locations provided administrators with a clearer picture of the factors contributing to staff and skill shortages.

While recruiters have had hunches for decades about what may or may not be attractive recruitment features for nurses - such as pay, shifts, and location - GIS analysis was able to lay the "location" controversy to rest, once and for all.

The Stanford University Medical Centre could identify a health worker's "comfort zone" (approximately a 20 kilometre radius). It was determined that when close proximity to the hospitals (i.e. the health workers' "comfort zone") is coupled with an employee surpassing a service milestone of three to five years, they are more likely to stay on board until they retire.

Through the use of GIS technology, administrators were able to resolve many previously unanswered questions. Questions such as:

- If the nursing population living within a 10 kilometre radius of our hospitals is projected to retire in 10 years, but the average home price in the area has become far too expensive for entry level clinical professionals, how will we be able to attract new entrants to the workforce to this location?
- If unforeseen circumstances closed a major transport link to the hospital, how would this affect our capacity to appropriately resource our facility?
- Many hospitals around the rest of the country are or will be experiencing a healthcare worker shortage. Do we, or will we, have a shortage in our area?



**"While recruiters have had hunches for decades about what may or may not be attractive recruitment features for nurses... GIS analysis was able to lay the "location" controversy to rest, once and for all."**

## Real savings and stronger planning capabilities

While long-term planning must always be a work in progress, large returns on investment are already being realised.

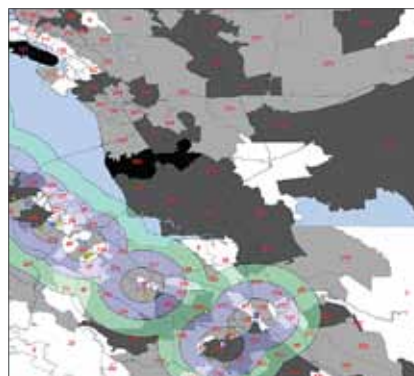
For the Stanford University Medical Centre, the recruitment advertising budget has been reduced by more than 50 percent, a monumental amount considering the San Francisco Bay Area is one of the most expensive advertising regions in the United States. GIS technology enabled the hospitals to identify places where there were too few nurses or too much competition and in turn the HR department stopped wasteful advertising in those areas.

GIS also allowed the hospital to precisely target candidates through direct mail. In addition, mapping and analysis of workforce retention data provided insights into why health workers leave the medical centre to work elsewhere.


For example, when the medical centre's location was compared to latitude-longitude points of all other hospitals on the San Francisco Peninsula, applying a buffer at three, six and ten kilometres (and comparing it to other internal retention data), it became visually obvious that health workers just starting their careers could actually leapfrog from one hospital to another, up and down the peninsula. Further trend analysis showed they would continue to move between facilities until they were able to locate the preferred pay and shifts.

GIS technology and location intelligence has proven to assist hospitals to anticipate and mitigate potential interruptions to continuity of care and to avoid the astronomical costs associated with hiring and retraining replacements.

In the case of the Stanford University Medical Centre it was estimated that this knowledge would save approximately \$22.5 million in recruitment and retraining costs over the following two years.



The entire San Francisco Bay Area external registered nurse population with hospital points buffered at two, four, and six miles up and down the San Francisco Peninsula, showing the ease with which nurses can establish their careers by leapfrogging from one hospital to another.



**“GIS technology enabled hospitals in the San Francisco Bay Area to identify places where there were too few nurses or too much competition and in turn the HR department stopped wasteful advertising in those areas.”**




## Policy Making

Establishing a body of local evidence to support policy and planning positions can be done simply and quickly with GIS technology.

It is commonly believed that 80% of all business data has a spatial element. GIS effectively leverages these elements to provide decision-makers with the ability to analyse data horizontally (e.g. the concentration of health conditions within geographical zones) and vertically (e.g. historical and cultural trends relating to certain health conditions). This enables policy-makers to draw a more complete picture of the effectiveness of current health policies or an emerging trend.

GIS technology provides health professionals and policy-makers with a unique perspective. It is a compelling view and one that has a proven track record of strengthening decision-making practices.



**“Decision making and response times are improved and people and resources are placed where they need to be, when they need to be there – saving lives and protecting property.”**

Mark Wallace,  
Queensland Fire and  
Rescue Service

### Case Study #4:

## Mapping where childhood asthma, schools and pollution sources collide

The South Bronx, New York, has one of the highest asthma rates among school-aged children across the whole of the United States.

By plotting schools against industrial and manufacturing sites, it was discovered that 50% of the region's students went to a school within 13 kilometres of an industrial zone; and that 89% of students went to school within half a kilometre.

This information was used to guide policy makers' decisions around how land use could potentially impact on children's health.

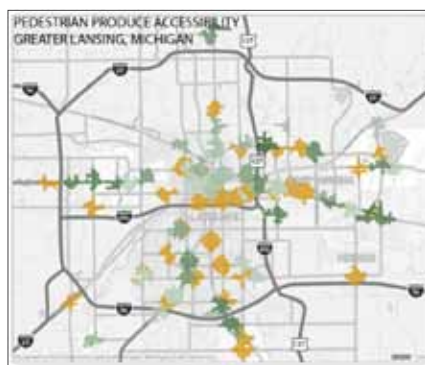
GIS technology was able to combine various types of data to reveal a correlation that had previously gone undetected within the standard tables, graphs and spreadsheets.

## Research

For health researchers and data managers, GIS technology delivers three key benefits:

1. The ability to integrate vast amounts of information, from multiple data sources, into a central repository that can be accessed company-wide;
2. The provision of a single point of truth in an easy to digest visual format that transcends, language, education and technical expertise; and
3. A level of clarity that is unattainable through traditional data management systems.

One of the other benefits provided through an integrated GIS is the time saved collating, qualifying and managing data.



Nutritional Terrain Map

### Case Study #5: Mapping Nutritional Terrain

A food desert is defined as an urban area with little or no access to nutritious foods. Residents living in food deserts are more likely to be overweight and have other diet-related health problems such as diabetes or hypertension.

Unfortunately, food deserts are both detrimental to public health and becoming more common in urban food landscapes increasingly dominated by fast food outlets and less well served by supermarkets and grocery stores.

While it is clear that food deserts are a public health problem, it is less clear how to accurately identify them. Before food deserts can be eradicated, they must first be located. Consequently, there is an emerging need to identify nutritionally at-risk zones and visualise nutritional inequalities within cities.

Although many previous investigations of urban food environments have employed GIS, few studies have taken advantage of the more advanced capabilities of the Esri GIS suite.

A study undertaken by researchers at Michigan State University sought to firstly quantify nutritional accessibility in each urban area; and secondly, visualise complex fresh produce accessibility patterns to reveal nutritional inequalities within these regions.

The results of the analysis has enabled public health officials and legislators to better understand how the interactions of the built environment and retail food landscapes can threaten the collective nutrition of urban neighbourhoods.

As interest in food environments continues to increase, the role of GIS and nutritional terrain mapping should also increase. The results from this project demonstrate that GIS can help public health officials visualise the nutritional terrain and understand the complex relationships between the built environment and access to nutritious foods.

Furthermore, the results indicate that while some parts of a city may enjoy ready access to hundreds of nutritious items, other parts of that city may have no access at all.

## Business Information

Historically, Business Intelligence (BI) and Geographic Information System (GIS) technology have followed separate development and implementation paths.

However, the need for a more complete operational picture and the capacity to plan for changing business conditions have led to the amalgamation of the two technologies.

In addition, workforce diversity within the health sector has seen GIS and BI become a natural pairing. By visually representing BI data on a map, GIS translates even the most complex messages into a universal language.

The value of this universal language extends beyond internal communications. Community expectation has shifted and the demand for up-to-date, easy to access information is driving a new standard in public engagement programs.

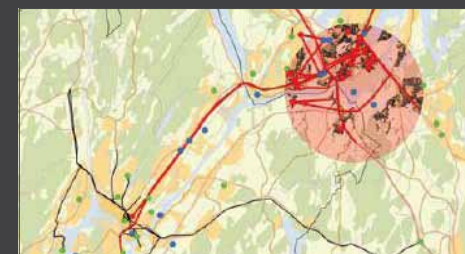
With the maturation of Internet technology, we have seen transformational change in public communication practices, as it has become easier to distribute information via the web.

In terms of the health sector, and its various sources of data, an integrated GIS and BI solution would establish a common platform for the compilation, storage, use, and distribution of data, delivering enhanced information management capabilities and system agility.

### Case Study #6: A Snap shot of Norway's 2005 Legionella epidemic

In May 2005 a Legionella epidemic broke out in Norway. The outbreak was one of the biggest health crisis situations that Norwegian municipalities had dealt with in years.

GIS was employed to help identify the source of the infection. The red lines on the map below traces patients' movements over a 12 day period prior to becoming infected. The blue dots on the map show the location of cooling towers and other possible sources.



Through an analysis of the movements of the infected patients, the authorities were able to identify the most likely origins of infection and managed to quickly locate the source.

One of the strengths of GIS in this type of scenario is the ability to manage very large volumes of data very quickly in a simple and well-ordered manner to health sector and community stakeholders.

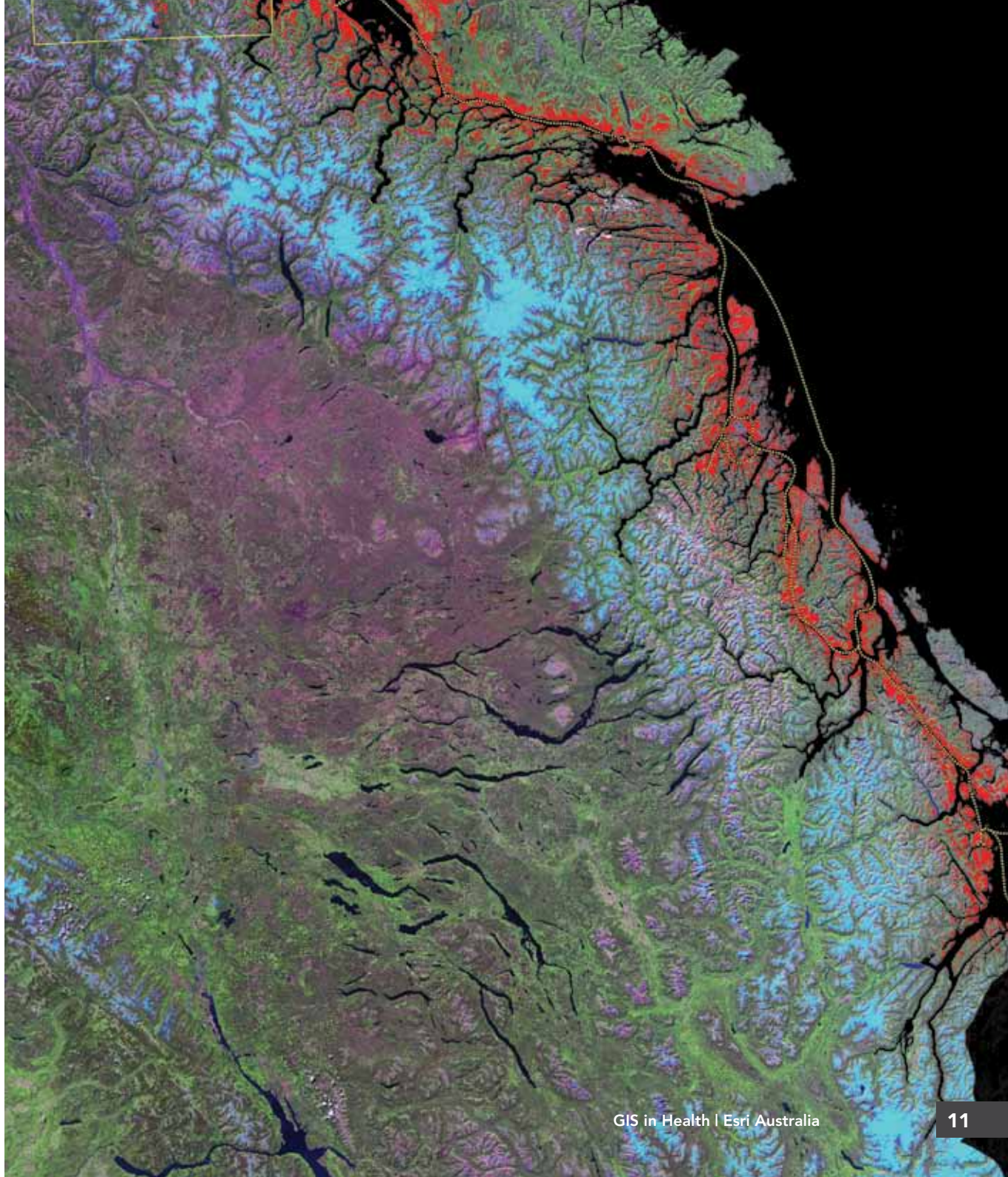
## Seeing is believing

For over 34 years, Australia's most progressive local, state and federal government agencies have been powering their decisions with Esri GIS solutions.

And when it comes to GIS technology, seeing really is believing.

## An Esri GIS solution...

- Predicted the likely impact of the 2011 Brisbane flood for **Brisbane City Council** before the event fully unfolded.
- Reduced the **City of Bayswater's** land reporting requests processing time from 12 days to 5 minutes.
- Helped **Energex** identify \$500 million worth of unregistered assets, returning an additional \$21 million in revenue annually.
- Guarantees **Queensland Fire and Rescue Service** emergency response personnel are in the right place at the right time – saving lives and property.
- Enabled the **SA Department for Families and Communities** to conduct asset auditing of their remote aboriginal communities from out in the field.



A topographic map of Australia is shown in the background, with contour lines and various geographical features. The text is overlaid on the right side of the map.

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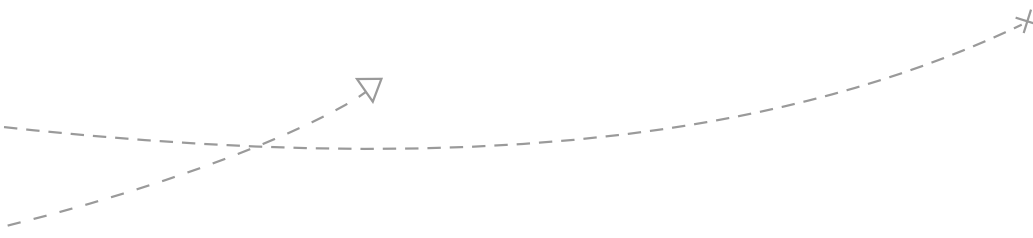
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