AVEVA PI WORLD

Mining responsibly and sustainably: BHP's environmental monitoring solution using the PI System with geospatial technology across Australia

BHP

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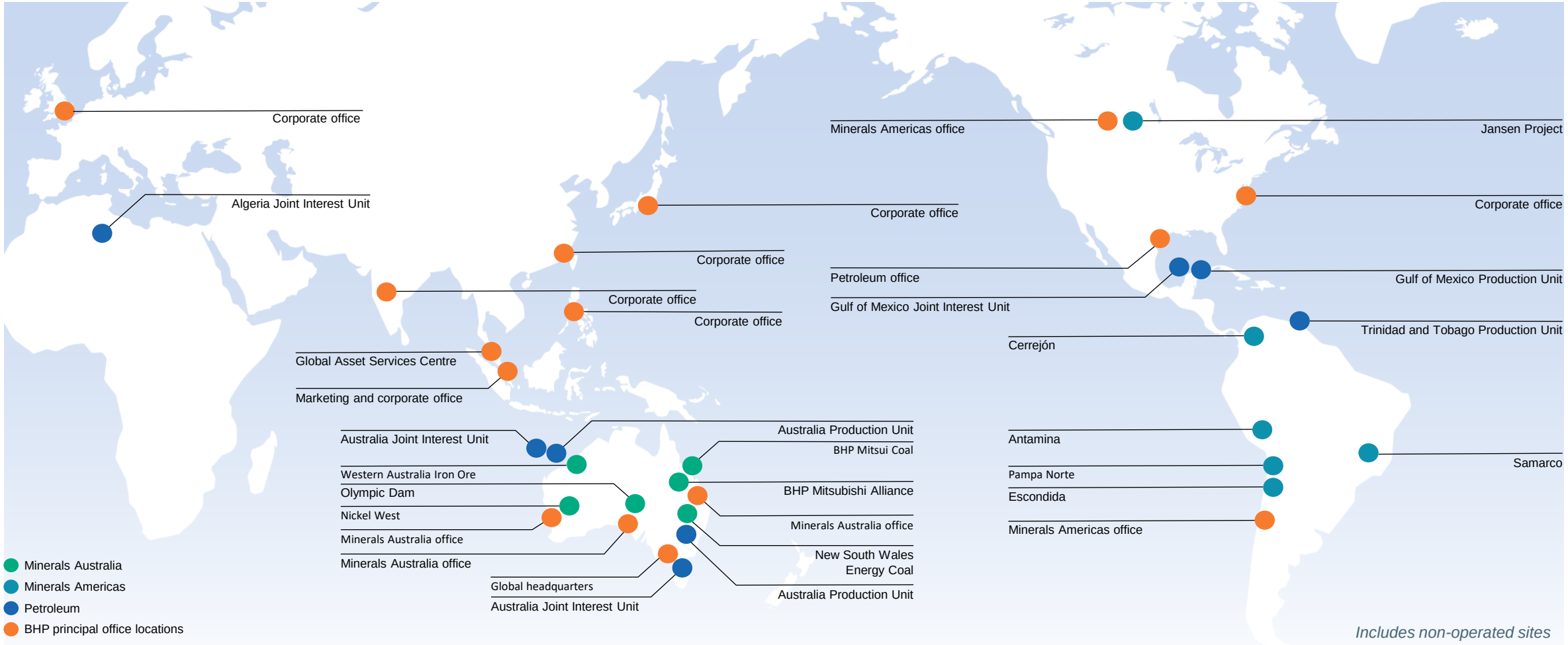
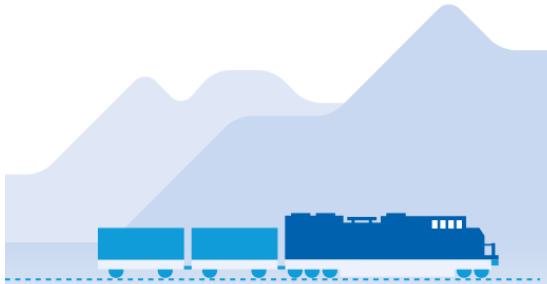
BHP is a world-leading resources company. We extract and process minerals, oil and gas and our products are sold worldwide. Our global headquarters are in Melbourne, Australia.



Includes non-operated sites

BHP’s portfolio of assets

Minerals Australia
Iron ore, copper, nickel, coal



Operated assets

- Western Australia Iron Ore
- Olympic Dam
- Nickel West
- Queensland Coal (BMA and BMC)
- New South Wales Energy Coal

Minerals Americas
Copper, potash, iron ore, coal

Operated assets

- Escondida
- Pampa Norte
- Jansen

Non-operated assets

- Samarco
- Antamina
- Cerrejón

Petroleum
Petroleum

Operated assets

- Shenzi
- Angostura
- Pyrenees
- Macedon

Non-operated assets

- Atlantis
- Mad Dog
- Bass Strait
- North West Shelf

Project initiation / problem statement

BHP must demonstrate environmental responsibility by minimising impacts and contribute to an enduring environmental legacy throughout every stage of its operations. The HSE function supports operations to make sure BHP manages environmental risks and ensures compliance with legislation and internal policies “Our Requirements” (GLDs).

Across Minerals Australia there were six environment systems that operated independently with separate contracts, versions, system capability and database platforms. A current state analysis highlighted the following issues:

- Unreliable data loads and inconsistent data formats. Lack of data governance, controls and standards with inconsistent naming, duplication of sample points. Difficulties analysing long term trends as the same data is stored in multiple ways over time.
- Limited options for displaying, analysing and reporting information. The business are not able to easily combine environmental data with information from other sources.
- Heavy reliance on the vendor. Limited understanding within BHP of how the system operates and how to configure it. Its calculations and output was often not trusted and was being manually verified outside the system.

To address these issues BHP Technology and Environment initiated the Environmental Data Management System project.

Perth corporate office

BMA Coal

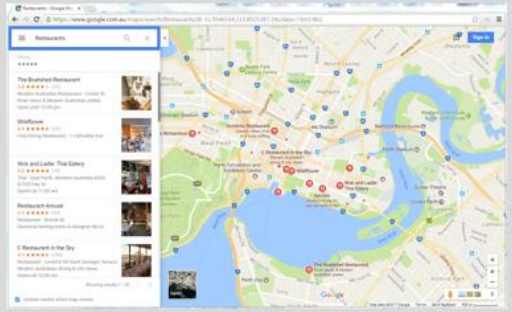
Objective and vision

To have complete and reliable data available in a platform that allows cross-operational reporting and analysis to drive improvements.

Vision - “Support the business to focus on environmental performance by providing environment information efficiently by leveraging technology”

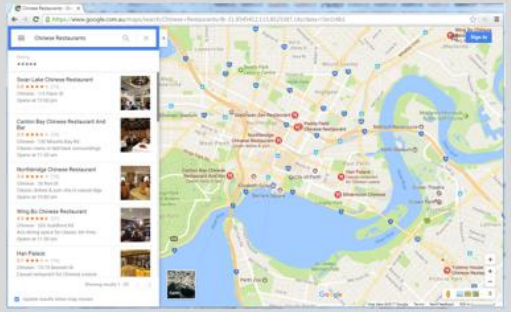
“I want it to work like Google Maps, if you can arrive in a strange city and find out where the nearest open Chinese restaurant is and view the menu, then you should be able to look at a mine site, see where the water monitoring locations are and view the latest readings”

Example: Searching for surface water monitoring points at a mine site and accessing the results for each sample point (e.g. the PH and dissolved metal levels) is analogous with searching for restaurants in a new city and viewing the menus and prices, it should be as simple. The user should not need to care about where the information comes from, just that it is easy to find what they need and they can trust it (it’s accurate and up to date).



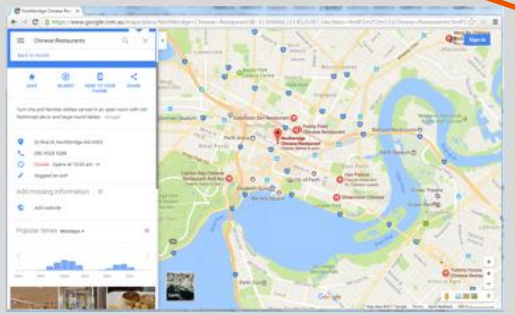
Restaurant
- New to a city, looking for restaurants
- Load Google Maps, type in “restaurants”
- A listing of reports appears with summary info

Surface Water Monitoring
- New to a mine, looking for environment data
- Load the environmental portal, type in “water”
- Results appear showing sample points for water flow, ground water, surface water and dam levels



Restaurant
- Refine the search “Chinese restaurants”
- A listing of reports appears with summary info

Surface Water Monitoring
- Refine search to surface water monitoring points
- Results appear showing sample points and summary data



Restaurant
- Select a restaurant
- Data related to the restaurant appears (details, busy periods, share, send to phone etc)

Surface Water Monitoring
- Select a sample point
- View current and historical trends for analytes of interest (e.g. PH and dissolved metal levels)

Requirements

- To capture repeat measurements taken at specific locations over time to meet BHP's environmental compliance and risk management requirements. A wide range of measurement types need to be captured at different frequencies and through different means, for example:

  - Real time telemetry for monitoring dust levels, noise levels, stack emissions, water quality, river flows, dam levels, groundwater levels and weather; and
  - Manual data entry of field measurements (e.g. water levels and quality) and energy consumption (e.g. diesel and electricity use for greenhouse gas reporting); and
  - Laboratory sampling results covering water quality, soil contamination, etc.

- To be able to trend measurements over time and raise alerts when measurements exceeded pre-defined thresholds or conditions.
- To be able view information geospatially.
- To be able to analyse environmental measurements and combine them with other operational data.
- To be able to produce reports and dashboards.

The project's stakeholders included:

- BHP Environment, who are responsible for managing and reporting on environmental compliance.
- BHP Operations, who are responsible for managing risks while undertaking mining operations.
- BHP NPI, who are responsible for support activities (e.g. water and sewerage treatment plants, water distribution networks and power stations).
- BHP Health & Hygiene, who are responsible for monitoring potable water consumption points across sites and accommodation camps (taps, ice machines, showers, swimming pools).

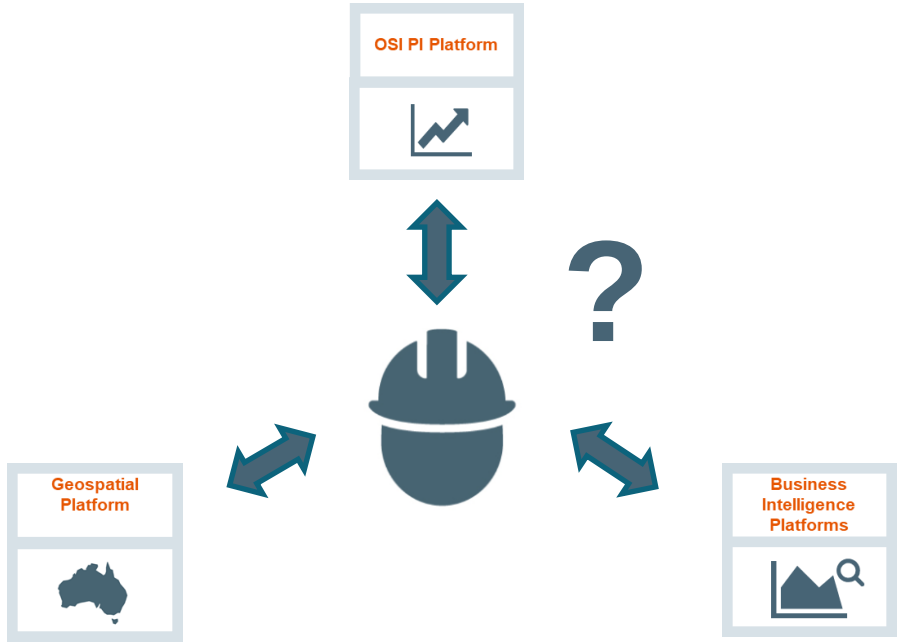
Solution evaluation

We evaluated environmental management systems in the market place

vs

We evaluated whether the existing applications that BHP operated that could provide the required functionality.

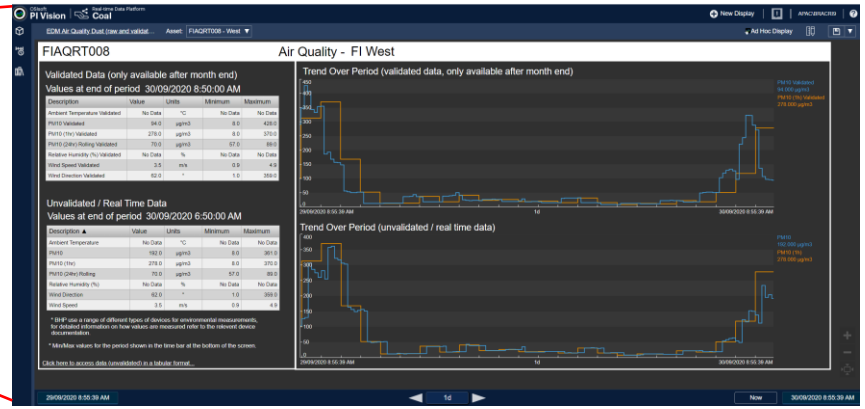
- OSI PI (collection, contextualisation and analysis of time series data streams)
- ESRI ArcGIS (geospatial analysis and mapping software)
- TIBCO Spotfire (analytics solution, to explore and visualize data through dashboards and advanced analytics)



Using these existing applications would also have other benefits:

- The applications were well established within BHP, already supporting a range of business processes.
- There was a large knowledge/skills base both within BHP and the market place.
- Support and training was readily available.
- The project could promote a user development approach to meet ad-hoc requirements.
- The business can combine environmental monitoring data with other operational data within OSI PI. For example, monitoring dust levels against dust suppression system, car dumper / ship loader operation.
- Costs could be shared.

Environmental Data Management (What's been delivered)



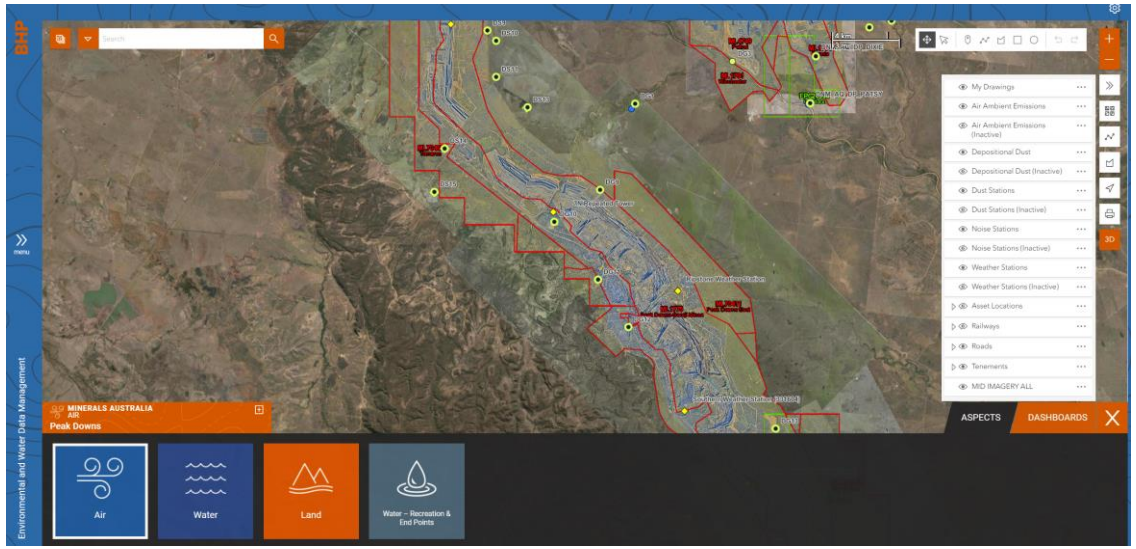
The new Environmental Data Management system covers 35 operational sites across Australia, with data from:

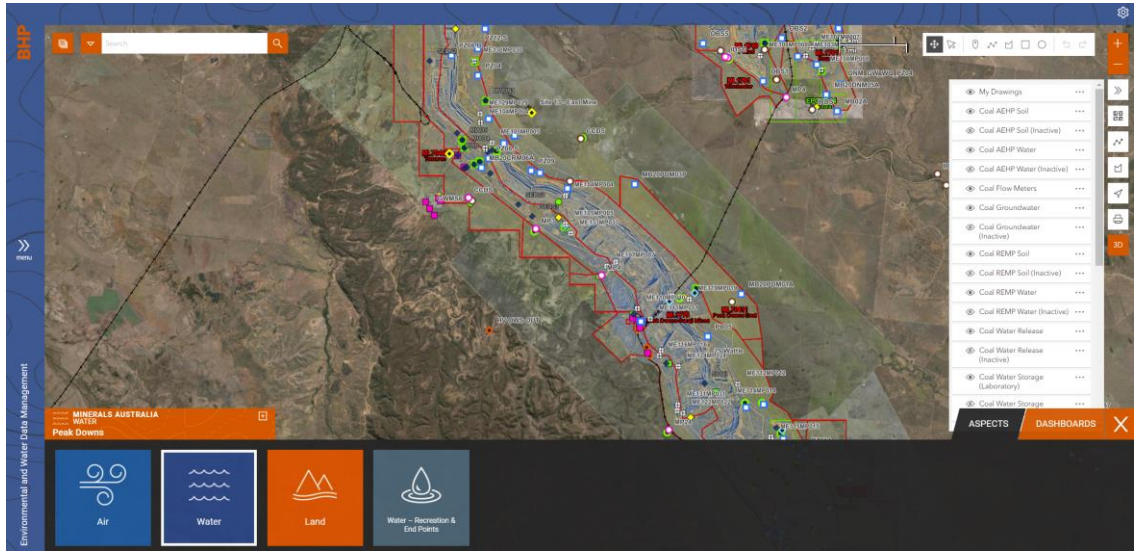
- Telemetry devices (approx. 350 locations)
- Laboratory sampling (approx. 11,000 locations)
- Manual data entry (field measurements)

The new solution provides a modern map interface helping users find the data they are looking for, with functionality for:

- Trending, reporting and analysing data
- Raising alerts based on business defined tolerances
- Calculating green house gas emissions
- Recording water use
- Sample management

Environmental Data Management (What's been delivered)





The Environmental Data Management system presents the different environmental programs as map layers showing the locations where measurements are being taken.

The user can select between different map layer groupings (aspects) relating to the different topics:

- Air
- Water
- Land
- Water (recreation and end points)

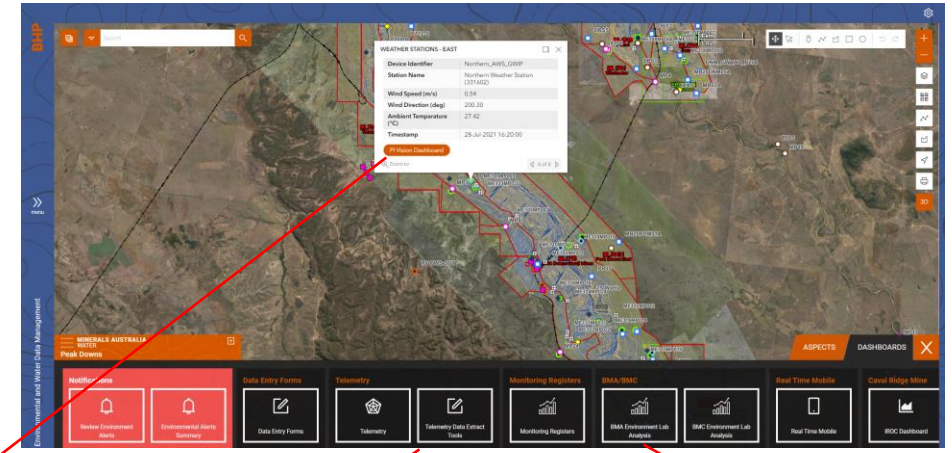
Standard GIS functions are used to:

- Search for locations
- Turn layers on/off to focus on the required information.
- Draw on and mark up the display

Environmental Data Management (What's been delivered)

The user can access measurement readings through

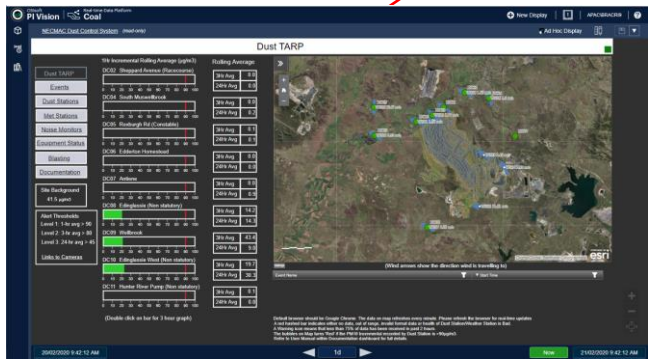
- A map popup
- Location dashboards (showing measurements from one device / location)
- Functional dashboards that combine data from multiple devices / locations
- Spotfire reports that combine data from multiple sources
- Events / Alerts are configured in OSI PI



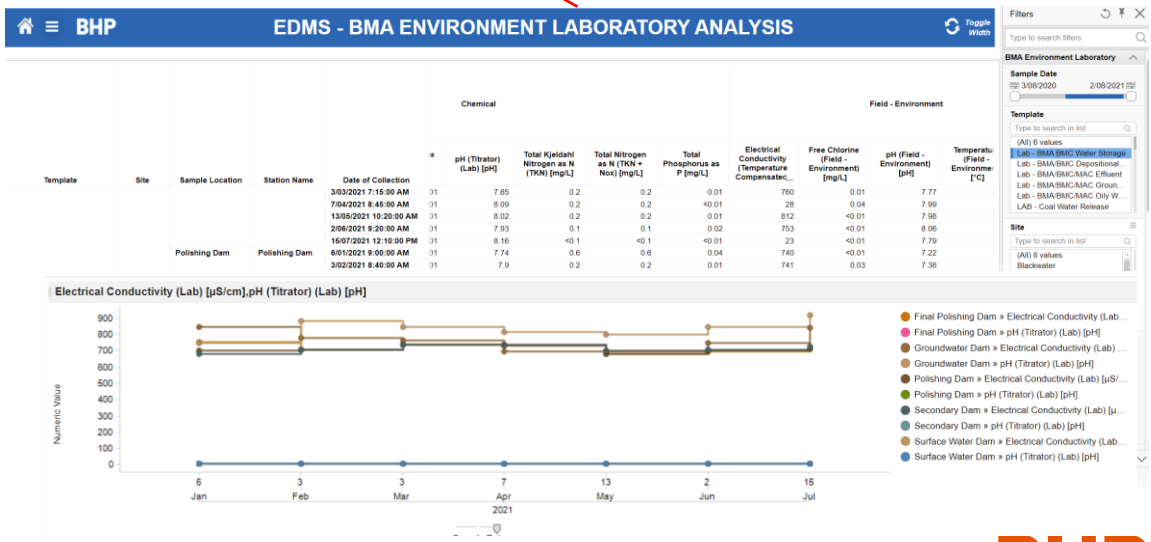
Location dashboards

Functional dashboards

MAC Dust Control System was awarded an Industry Excellence Award by the Clean Air Society Australia and New Zealand



Spotfire dashboards



Environmental Data Management system

Past	Present
It is difficult to find the right data	A modern map driven interface helps everyone find the right data
459 Program/Datatypes, 48,575 sample points & 23,060 attributes	Rationalisation and data governance. 35 standardised telemetry & lab programs, 11063 sample points and 1600 attributes
Monitoring registers maintain manually using Excel (different formats)	Monitoring register is now a report generated from the EDMS configuration (AF attributes)
Telemetry data extracts performed by vendor under a service agreement	< 30 seconds to extract 1 year of weather data (0.75M records)
Previous reliance on the vendor to arrange training	15 in-house training sessions run since Oct 20 attended to by 120 people across the region. The business building their own dashboards.
Missing and inconsistent configuration of alerts	Over 6000 alerts configured to assist in compliance management (and growing!)
Raw telemetry data was replaced by validated data and un-recoverable	Raw and validated telemetry now retained in separate streams
A large number of mouse-clicks and screen refreshes to drill through a greenhouse gas metric creating a *"black box"*	Navigating between a greenhouse gas metric and its source data components is typically viewable on two screens

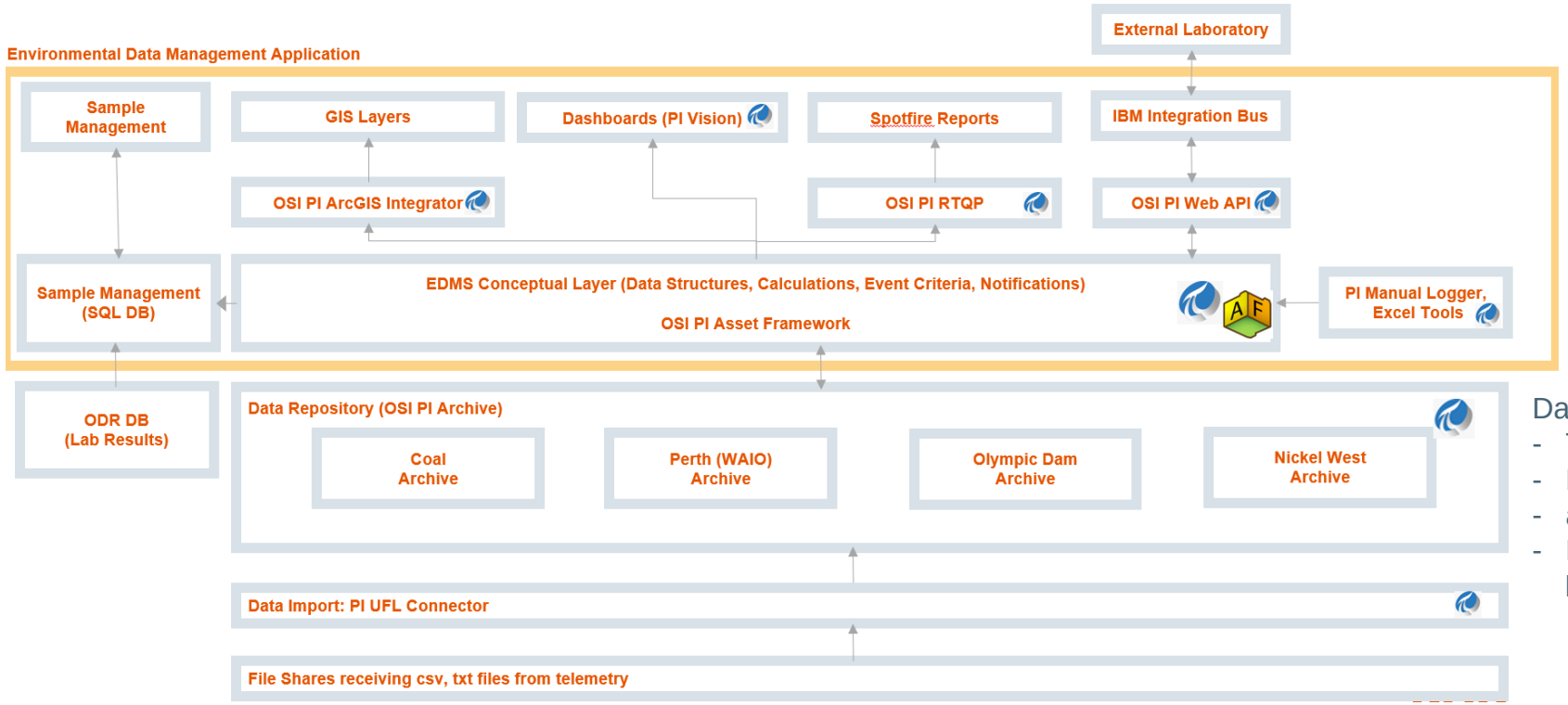
WHY IT'S IMPORTANT?

- Data quality
- Compliance
- Easier to find data
- Standardised
- Intuitive
- Improve performance
- Governance
- In-house support
- Reduced costs
- Mobility
- Collaboration
- Scalable

Solution architecture

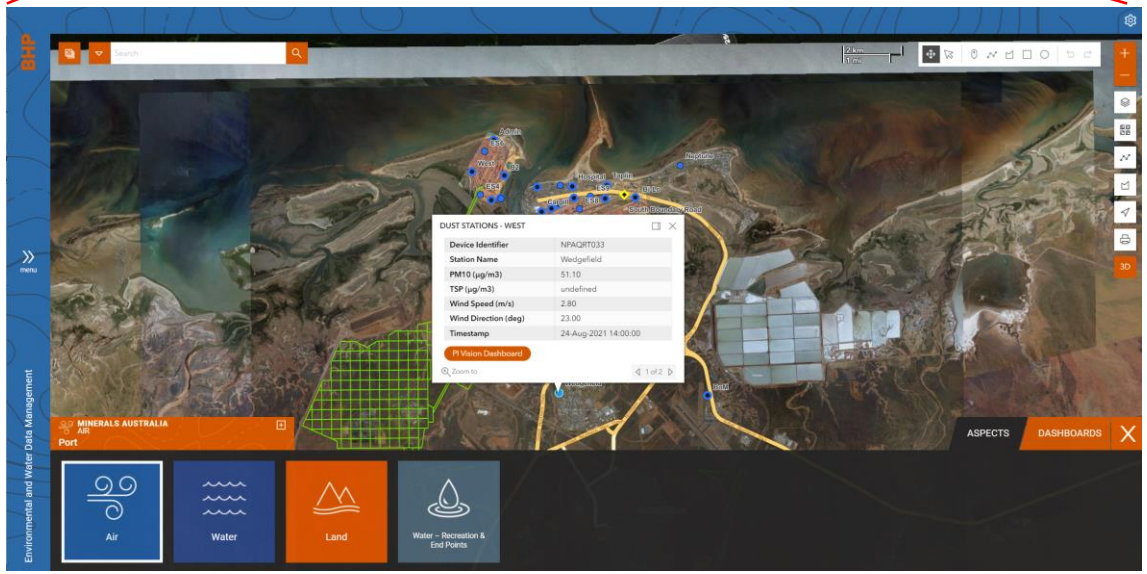
Data published through:
- PI Vision dashboards
- PI ESRI Integrator to GIS maps
- PI RTQP to Spotfire and Sample Management

OSI PI asset framework
- AF templates provide standardised data structures, calculations, event configuration and notifications for each environment program.
- AF Element Hierarchy used to organise sample locations by site and programs.
- Elements customised for specific events, calculations.



Data loads:
- Telemetry through PI UFL connectors
- Laboratory results received by integration
- and loaded through PI Web API
- Manual data loads supported through manual logger and Excel form using PI SDK macro's.

Custom web application (menus and map layers)

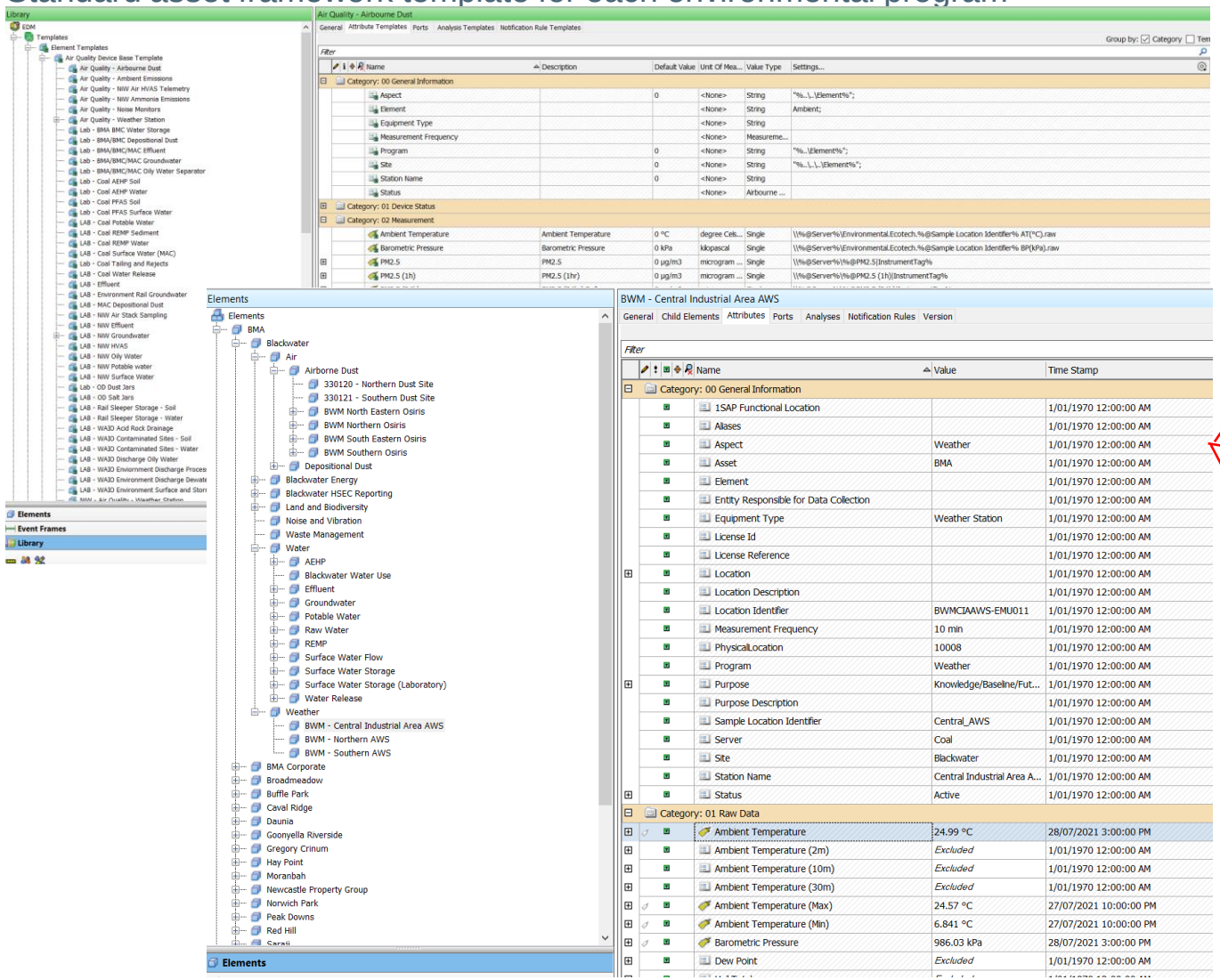


The menu structure is a custom web application to unify and present a geographical representation of environmental data processed by the ArcGIS, OSI Pi and Spotfire platforms.

The custom application was developed using ReactJS and it utilises the ArcGIS JavaScript API and PI Web API to retrieve geographical and environmental data from their respective platforms.

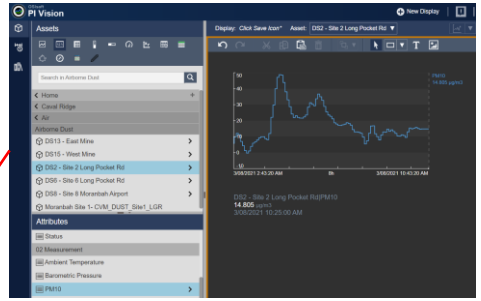
Asset framework contextualisation

Standard asset framework template for each environmental program

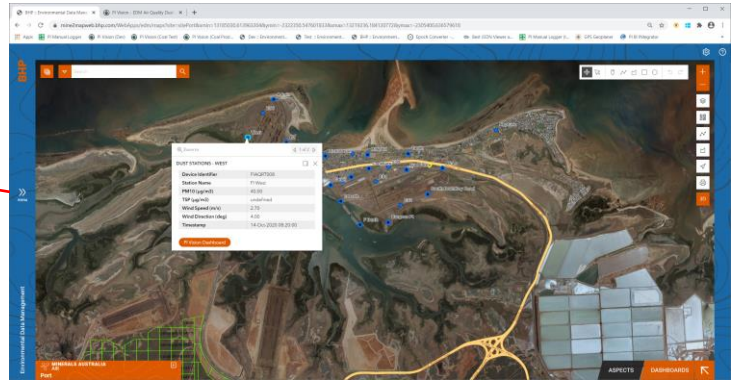


Standard element hierarchy in asset framework for each location across the different sites

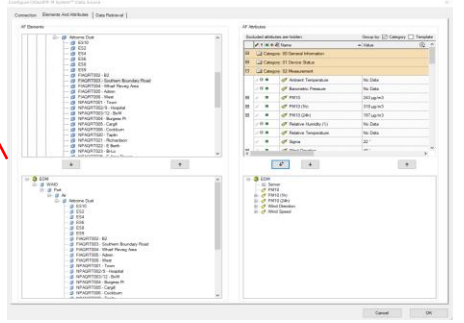
Asset framework exposed through Pi Vision



Asset framework exposed through ArcGIS



Asset framework exposed through Spotfire

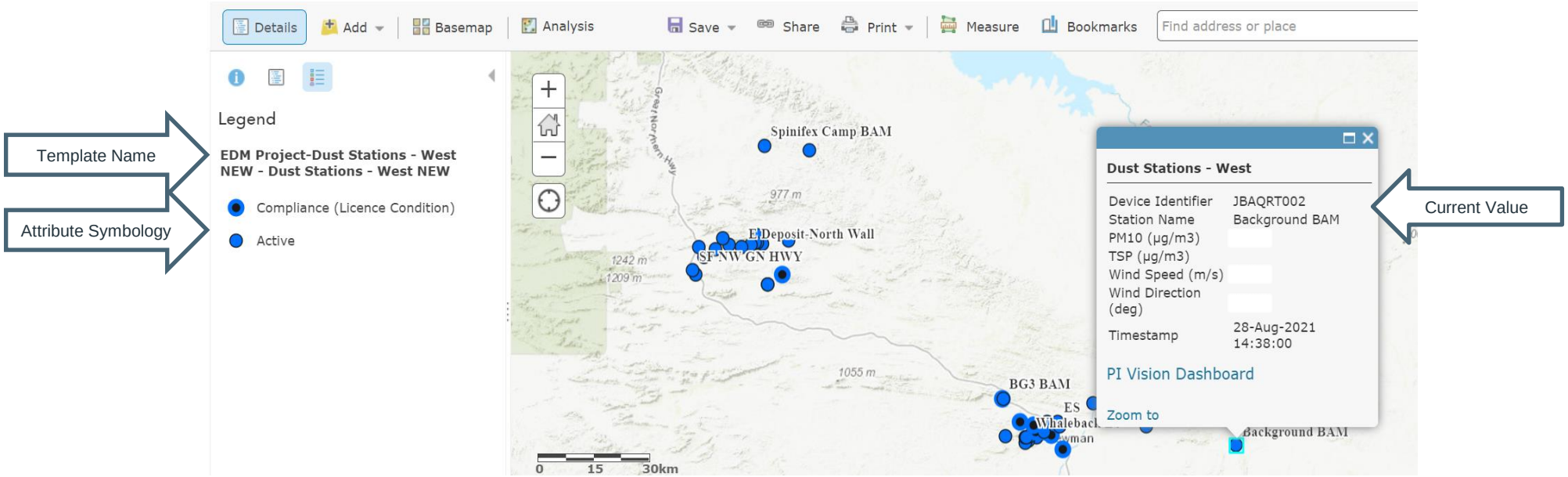


PI ESRI Integrator

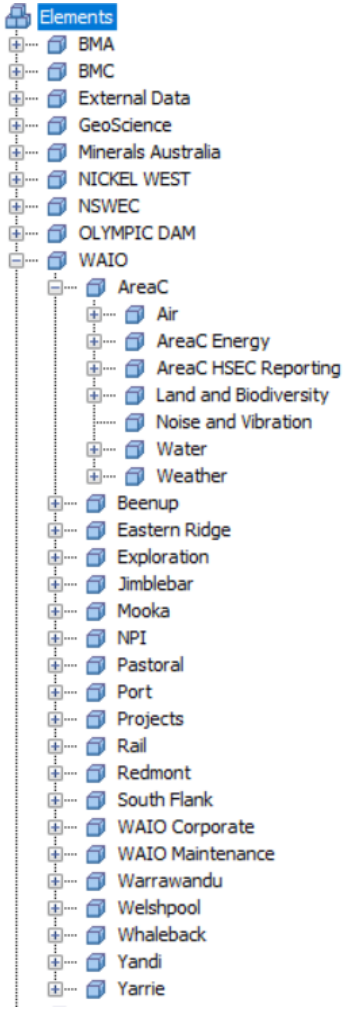
Easy integration of PI System data with GIS web maps to provide current views of data across Minerals Australia sites

Modern map-driven interface to enable users to easily find the data

- The historical data is made accessible via PI Vision Dashboard link
- Over 50 layers/programs, and over 11,000 sample points



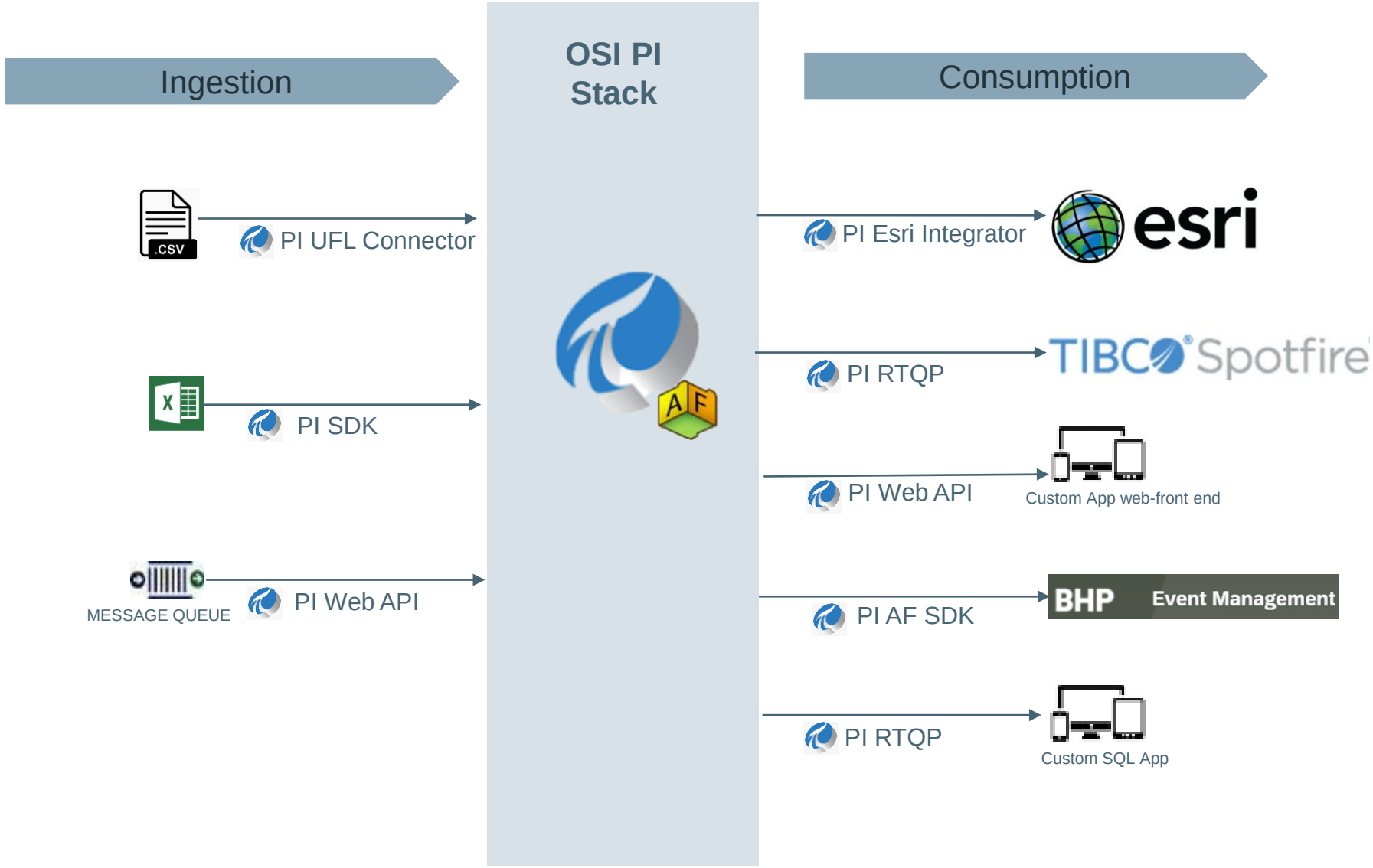
PI system landscape



Architecture

- Redundant PI Data Archives for each asset (4 collective PI Data Archive)
- Redundant PI Vision Server
- Redundant PI Manual Logger Server
- SQL Cluster
- Minerals Australia-level Asset Framework Hierarchy
- Standalone PI UFL Connector
- Standalone PI RTQP Engine

Integration with other systems



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Lessons learnt and things to consider

Chemical Analysis - Water Quality, Soil Contamination, Stack Emissions

Telemetry	Measurements of pH, electrical conductivity, turbidity, dissolved oxygen, dissolved solids from groundwater, dam and river loggers. Measurements of pH, electrical conductivity, turbidity, dissolved solids, chlorine from water treatment plants.	
Field Readings	Measurements of pH, electrical conductivity, turbidity, dissolved oxygen from groundwater, dams and rivers. Measurements of pH, electrical conductivity, turbidity, dissolved solids, chlorine from water and sewerage treatment plants.	
Laboratory Analysis	Complexity of analysis, number of attributes and events/thresholds to manage Non standard numerical results (Limits of resolution and estimated values “<0.01”, “~0.01”)	

Next steps

Stabilisation and improvement

Water	Ground water levels – measuring extraction/injection volumes from production bores and for mine dewatering. Monitoring impact on ground water levels Dam levels – combining telemetry, LIDAR and survey measurements to verify water level readings and calculate water volumes using storage curves
Equipment Monitoring	Improve detection and management of device, communications issues. The EDMS is not showing the latest readings for a device - Leaves on the tree are blocking the communications; or - There is no device, it's been stolen.
Bespoke Dashboards	Using bespoke dashboards / event functionality to improve the management or critical business processes - water releases; - dust management.


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