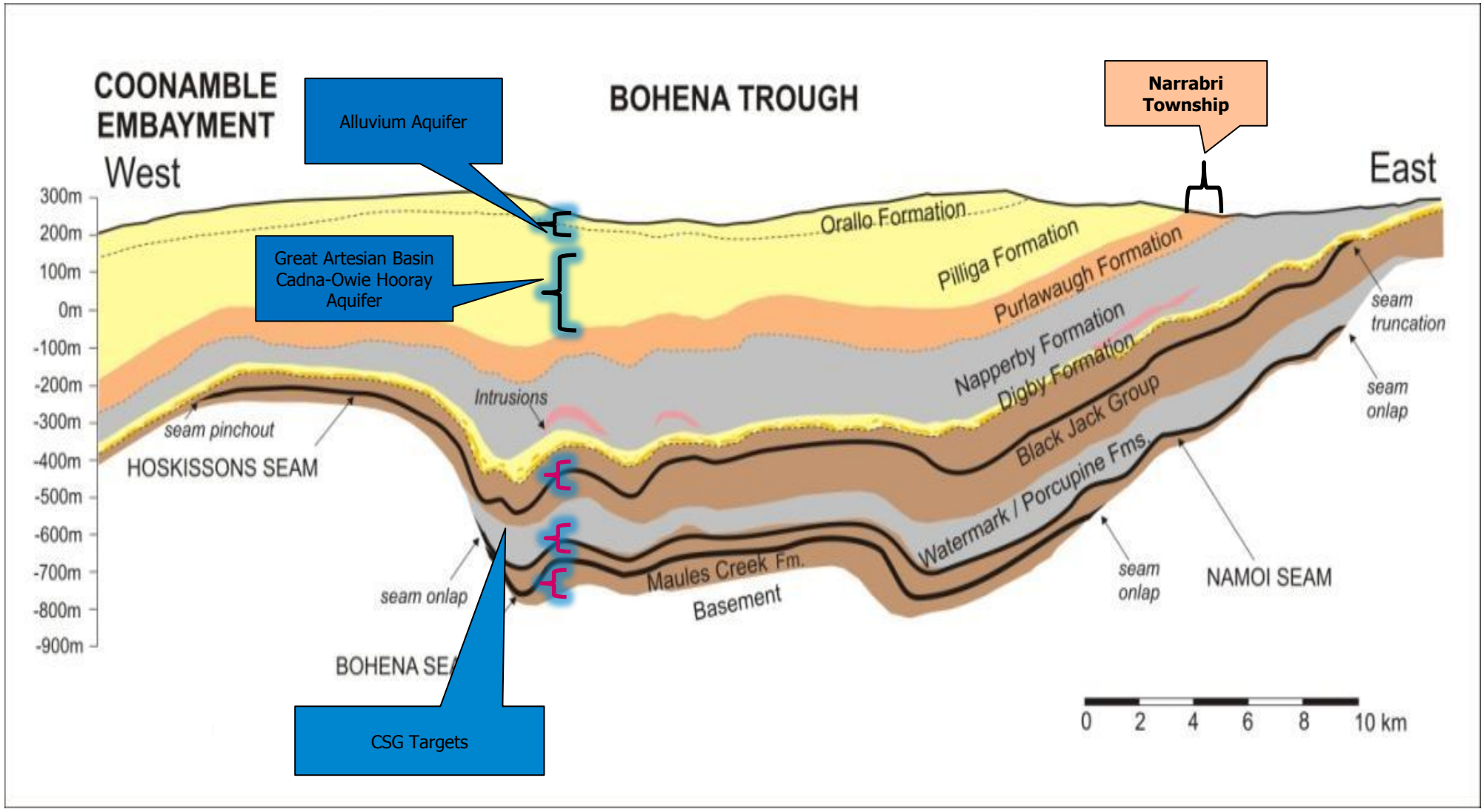
Santos

Surface Water Management

09 October 2012

Narrabri – hydrogeological overview



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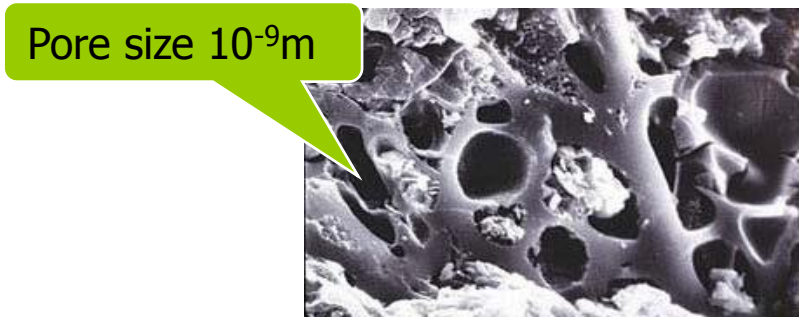
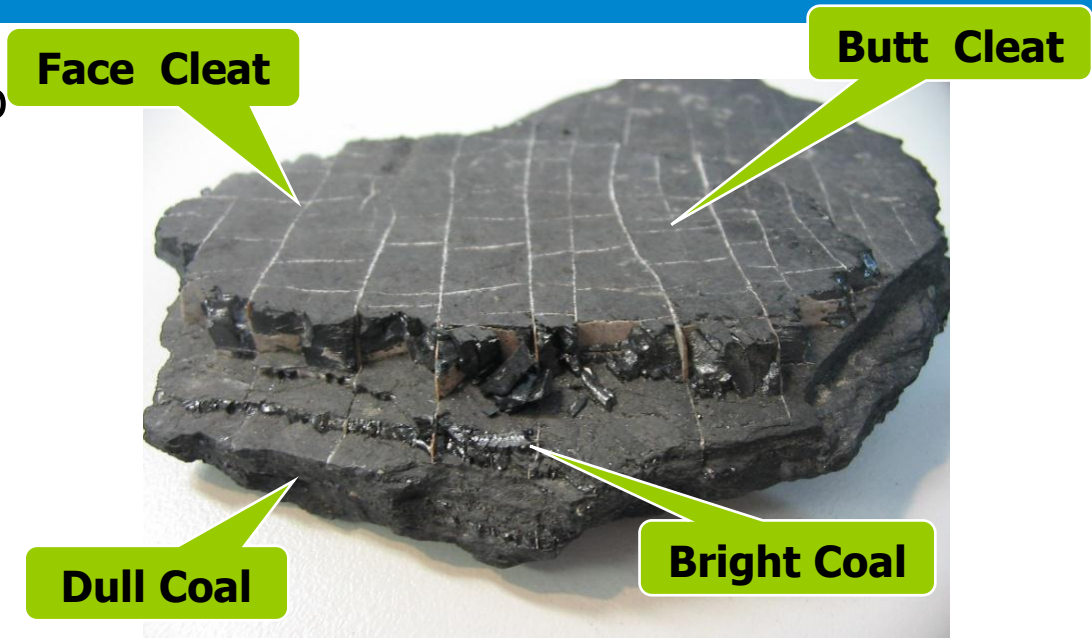
Why is CSG water produced?

- CSG trapped in coal is adsorbed onto the coal surface in cleats or micropores and held in place by reservoir and water pressures





- To extract the CSG it is necessary to reduce the pressure by removing water
- The extraction process involves drilling wells into the coal seams
- Water is pumped out of the coal seams to reduce the pressure in the seam. This allows gas to flow through the well to the surface

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Surface facilities

- Once the water reaches the surface it goes through a separator and then is transferred by pipelines to water treatment facilities.
- The water we produce is from the coal seam, ***not*** from the aquifers used by the community and farmers.
- Coal seam water is typically **brackish**, but can be treated and used for a range of uses.

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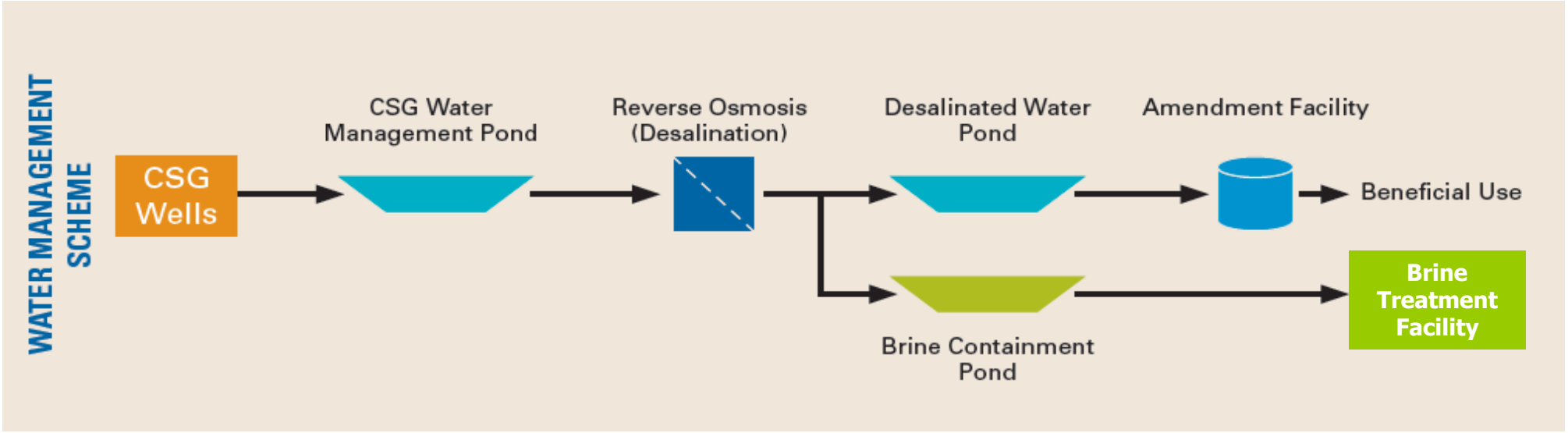
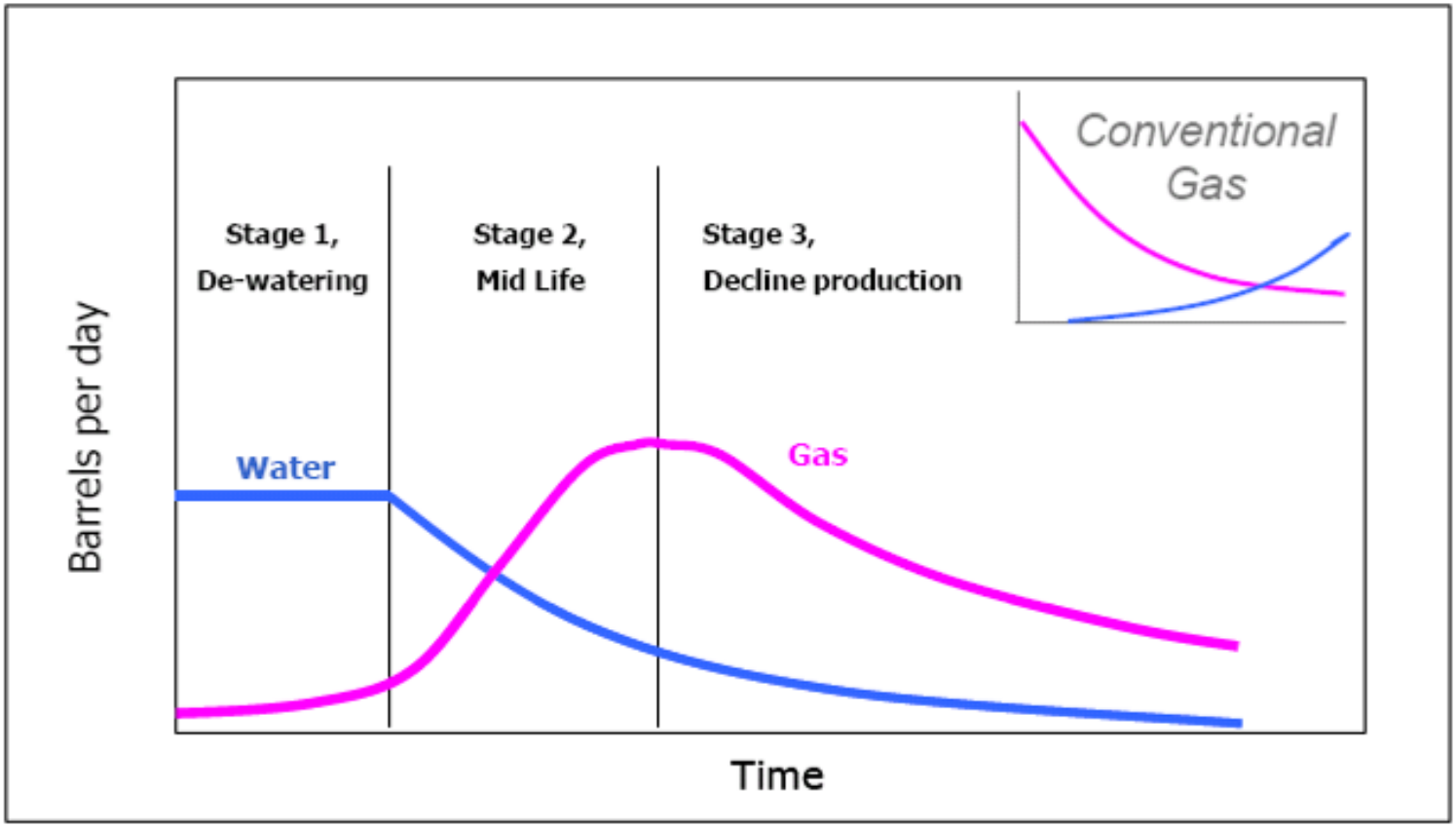
CSG water process

- The gathering system transfers CSG water from wells to the CSG water management ponds and treatment plants



How much water is produced?

- CSG water production is typically higher earlier in the life of a CSG well and then declines as gas production increases



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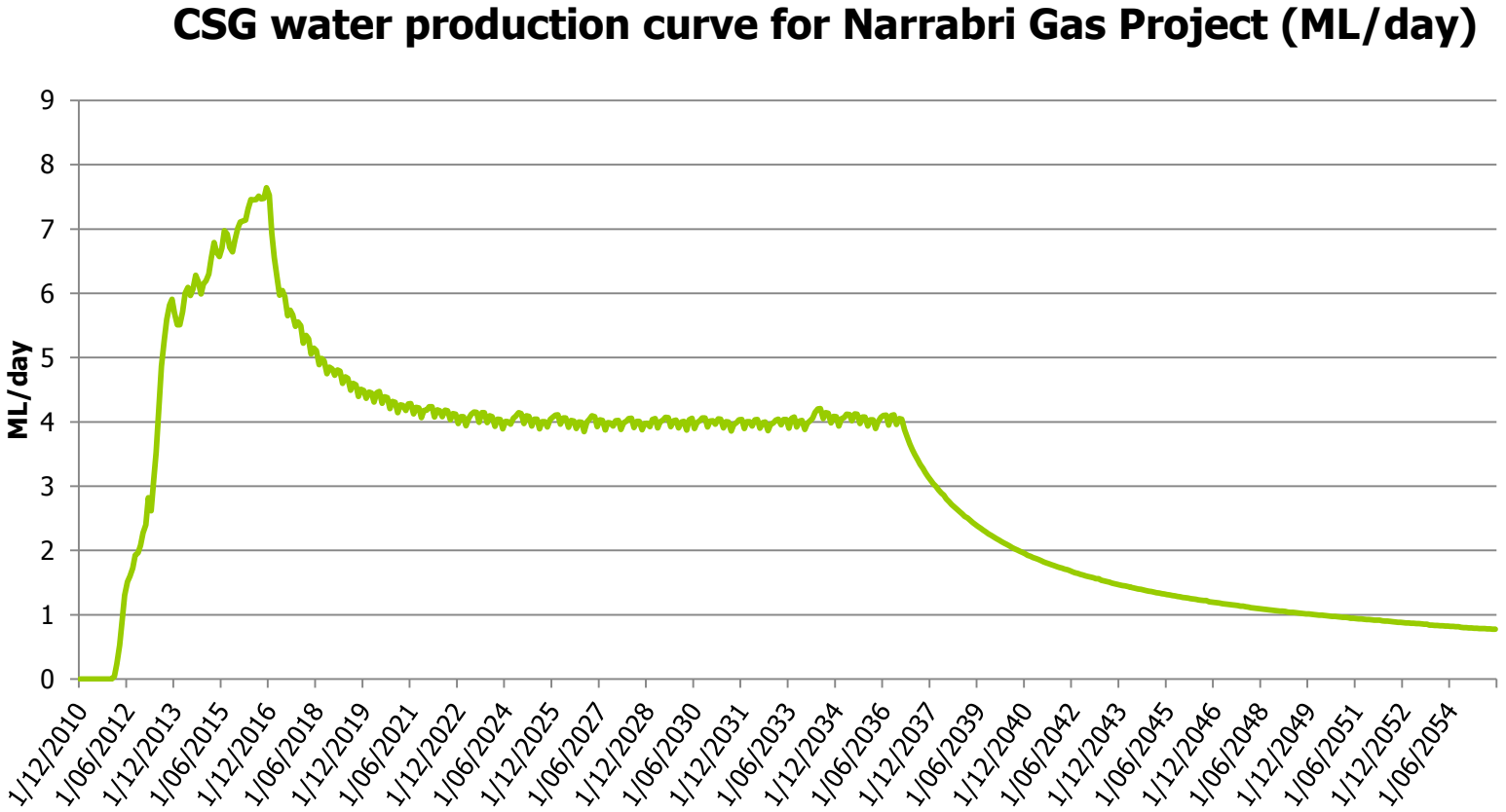
Groundwater abstraction – likely volumes



- Project life: 2012 to around 2055 (~49 GL of CSG water could be produced)
- Peak production of approximately 7.6 ML/day (1.5ML/Avg) – capacity of an Olympic size swimming pool is around 2.5 ML

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How do we treat CSG water?

- The typical CSG water treatment processes are:
  - Desalination; and / or
  - Amendment
- Desalination uses the process of reverse osmosis (RO) to separate salt from the water
- Amendment alters the chemical balance of the water
- The actual treatment process used to achieve the target water quality depends on the original quality of the water, and its intended beneficial use

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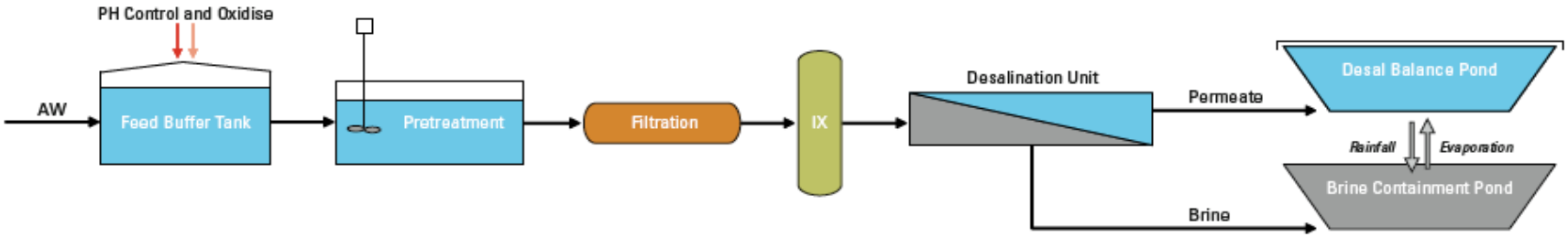
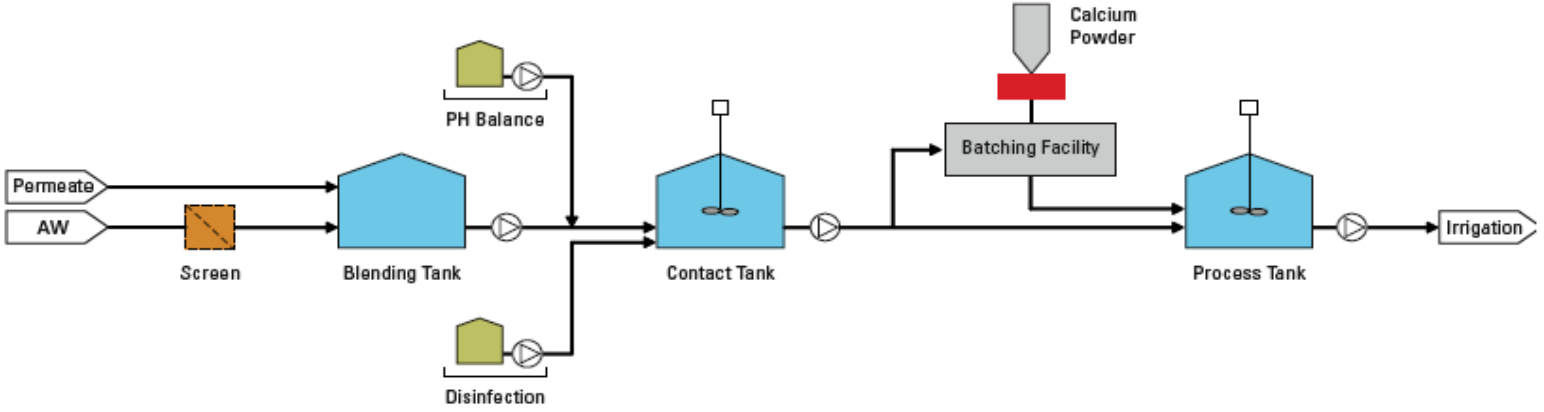
How do we treat CSG water?

Desalination Process



Amendment Process



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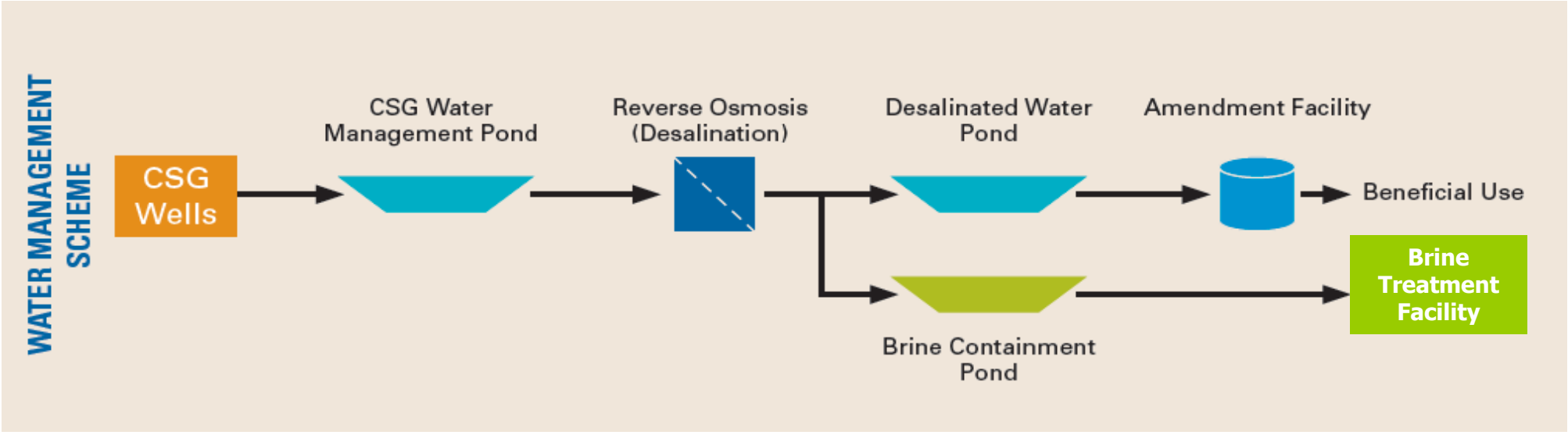
CSG water quality

- Raw CSG water is 'brackish', which limits its direct use
- Treatment of CSG water takes into consideration produced water quality and quantity, and existing land uses
- After treatment CSG water can be used for various applications
- Santos therefore is turning raw CSG water, not suitable for drinking or agriculture, into a water resource for use within the community



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Santos water management philosophy

Santos water management philosophy:

- Bring benefits to the local community
- Protect the environment
- Develop a sustainable approach to water management

Substantial work to determine appropriate water management strategy

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Potential uses of treated water

- Uses can include:
  - Injection of treated CSG water to aquifers
  - Irrigation of crops
  - Stock watering
  - Dust suppression
  - Coal washing
  - Discharge to surface waters

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Groundwater Monitoring – How we sample

Parameter	ALS Method/ Package Code	Technique/ Method Reference	Limit of Reporting (mg/L) (or as indicated)	Holding times	Bottle Type / label colour
Bromide	ED009X	APHA 4110	0.01	28 days	500ml plastic / green
pH	EA005P	APHA 4500-H+ B	0.01 pH units	6 hours	
Conductivity	EA010P	APHA 2510 B	1 µS/cm	28 days	
Total Dissolved Solids	EA015H	APHA 2540 C	10	7 days	
Alkalinity Total Alkalinity as $CaCO_3$ Bicarbonate as $CaCO_3$ Carbonate as $CaCO_3$ Hydroxide as $CaCO_3$	NT-2A	APHA 2320 B	1	14 days	
Sulphate -(turbidimetric)as SO_4		APHA 4500 SO4-E	1	28 days	
Chloride		APHA 4500-Cl- -B	1	28 days	
Fluoride		APHA 4500 F- -C	0.1	7 days	
Silica	EG052	APHA 4500-SiO2	0.1	28 days	
Residual Alkali (calc)	EA161	In House	0.01	-	
Ionic Balance	EN055-DA	APHA	-	-	
Major Cations - Ca, Mg, Na, K	NT-1B	APHA 3120 Ca, Mg, Na -A	1	28 days	
SAR					
Total Hardness (calc)	EA065	APHA 2340 B	1	7 days	
Reactive Phosphorus	NT-8A	APHA 4500 P - G	0.01	2 days	
Nitrite		APHA 4500-NO_2- I	0.01	2 days	
Nitrate		APHA 4500-NO_3- I	0.01	2 days	
Ammonia as N		APHA 4500 NH_3- H	0.01	28 days	125ml plastic / purple
Total Nitrogen (inc TKN/NOx)		APHA 4500 Norg/NO3	0.1	28 days	
Total Phosphorus as P		APHA 4500 P - H	0.01	28 days	
Total Organic Carbon	EP005	APHA 5310B	1	28 days	40ml vial/purple
Dissolved Organic Carbon	EP002		1	28 days	40ml vial/purple field filtered
Standard Plate Count (21°C & 36°C)	MW002	AS 4276.3.1	<1cfu/mL	24 hours	600ml plastic / grey (sterile)
Sulfate reducing bacteria**	SRB-WAT	Subcon Baseline *(NOT NATA ACCREDITED)*	MPN/100mL	24 hours	600ml plastic/ grey (sterile)
Dissolved Metals As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Pb, V, Zn	W-3	USEPA 6020 ICP/MS	Cd-0.0001 Zn - 0.005 Others -0.001	180 days	60ml plastic / red field filtered
Hg		CV/FIMS	0.0001	28 days	
Additional Metals - Fe, Se, B, Sr, Al, Mo, Sn, U, Li	EG020F	USEPA 6020 ICP/MS	Fe, B - 0.05 Al, Se - 0.01 Others -0.001	180 days	
Total Metals (including digest) As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Pb, V, Zn	W-3T	USEPA 6020 ICP/MS USEPA 3005	Cd-0.0001 Zn - 0.005 Others -0.001	180 days	60ml plastic / red
Hg		CV/FIMS	0.0001	28 days	
Additional Metals - Fe, Se, B, Sr, Al, Mo, Sn, U, Li	EG020T	USEPA 6020 ICP/MS	Fe, B - 0.05 Al, Se - 0.01 Others - 0.001	180 days	
Ethanol	EP117	In-House GC/MS	50 µg/L	14 days	2 x 40ml vial/purple
TPH(C6-C9) & TRH (C6-C10)/BTEX	W-7	GC/FID, P&T-GC/MS, GC/MS-SIM	TPH/TRH: 20 - 100 µg/L BTEX:1-2µg/L, PAH:0.5-1µg/L	14 days	2 x 40ml vials/purple
TPH (C10-C36) & TRH (C10-C40)/PAH				7 days	100ml amber glass /orange

- We endeavour to obtain baseline data from surrounding landholder water bores who are happy to participate.
- A water sampling expert from an external provider leads the sampling on site – (collects the sample)
- Samples are securely transported to a NATA Authorised laboratory for analysis
- Analysis is undertaken on a wide variety of analytes

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Water studies work programme

- Participation in the Namoi Catchment Water Study
- Water Demand Study
- Regional Bore Inventory
- Groundwater modelling and impact assessment
- Feasibility studies for beneficial uses (e.g. irrigation, MAR, stock, dust suppression etc)
- Managed Aquifer Recharge Feasibility Study
- Brine management studies
- Incidental water management strategy and water balance modelling
- Environmental monitoring

Questions

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Upcoming Work & Pilliga Rehabilitation

09 October 2012

Exploration program

- We suspended exploration activities until release of the Namoi Catchment Water Study and the Strategic Regional Land Use Policy
- Licence renewal offers now made by the NSW Government
- Exploration program for the next two to three years to commence in early 2013
- We aim to drill 50 wells over that time with the majority of work planned around the Narrabri area
- Before work commences - community consultation will take place to ensure understanding of what is planned

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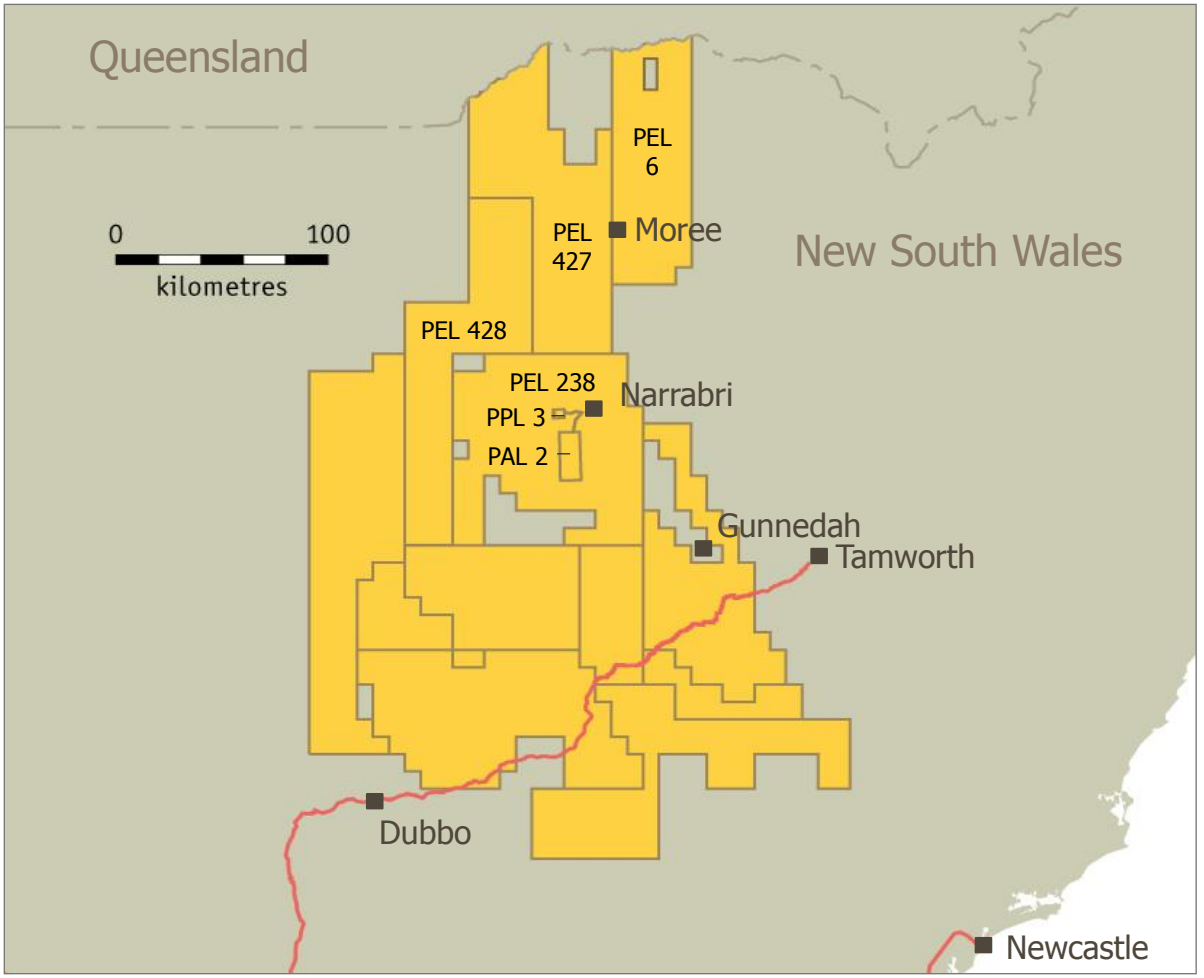
Exploration 2013-2015 Narrabri area

- PEL 238
  - 7 pilots (28 wells)
  - 14 core holes
- PEL 428
  - 1 core hole
- PEL 427
  - 2 core holes
- PEL 6
  - 2 core holes



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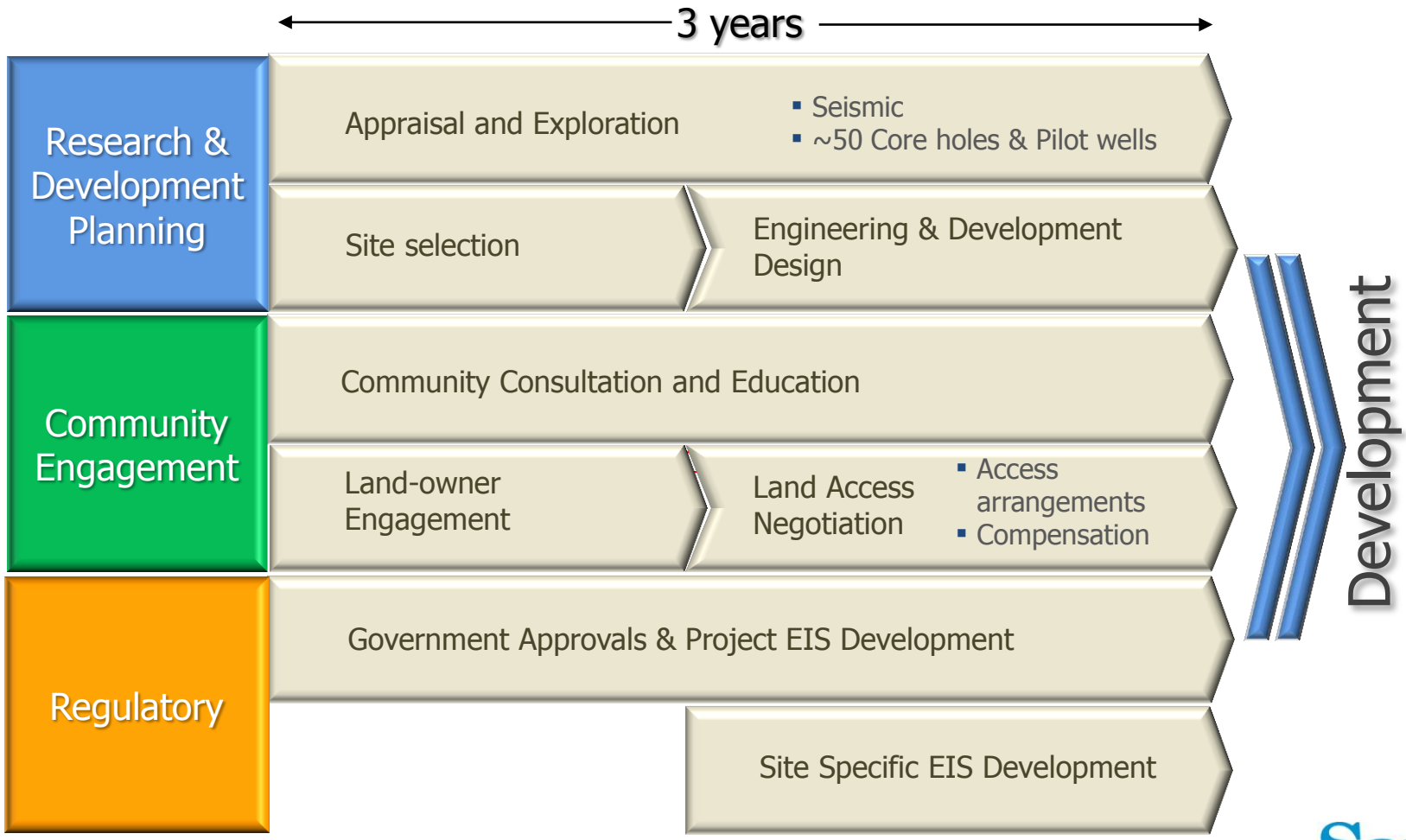
We have the energy.

Research program

Demonstrate that Santos can extract the gas and operate sustainably



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We have the energy.

Review of Environmental Factors (REF)

A Review of Environmental Factors (REF) is an ecological assessment of a location and includes mitigation measures to ensure the ecology is not impacted by our activities.

- A REF is required for a Part 5 approval under the Environmental Planning & Assessment Act administered by the Department of Resource & Energy
- Part 5 REF approval is the required approval for exploration and appraisal activities in New South Wales
- Part 5 REF is lodged with DRE and reviewed and signed off on by Department of Planning, New South Wales Office of Water and Office of Environment & Climate Change and ORE
- Department of Planning review from the perspective that it is compliant with Part 5 and not Part 4
- New South Wales Office of Water from the perspective of compliant with Water Act and any water bore licences have been applied for
- Office of Environment & Climate Change to review Cultural & European Heritage compliance

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What to look for in a REF

Step	Action
1. Water	Water may be used during the operations by obtaining water from a licensed Council or a landholder who has a licensed bore which is licensed for other than stock and domestic purposes
2. Farm Management Plan	A Farm Management Plan (FMP) should be developed for a location with the landholder informing the exploration and appraisal operator of activities on the land
3. Safety Management	The FMP should contain information on farm safety and petroleum activities safety. Santos is required to lodge a Safety Management Plan and Emergency Response Plan with the regulator and FMP should convey to the landholder relevant information
4. Ecological assessment	The ecological scout is used to identify koala habitat, endangered species and water sources. Information obtained on the land can be shared with the landholder. Santos must have in place koala habitat management plans, mitigation measures to avoid endangered species and mitigation to avoid water sources and overland flow.
5. Chemical use	The REF must contain information on chemicals used at the location, together with plans as to how drilling cuttings etc. will be removed to a licensed facility. This information will be provided to the landholder as part of the FMP
6. Noise and light	Santos has a policy which states that it will not undertake drilling activities within 1km of an occupied residence. Santos also has a policy of directing light so as not to affected an occupied residence. If a landholder wishes to have noise and/or light monitoring undertaken at their property Santos will provide a third party expert to take these measurements and report back to the landholder
7. Personal information	Any information collected by Santos of a personnel nature with regard to the landholder will be managed in accordance with the Privacy Act
8. Regulator visits	Santos will invite the regulator to attend at a location to review the activities in progress however, under legislation the Regulator has the right to undertake "spot checks" of the location

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Pilliga rehabilitation update

- Thorough review of all existing facilities carried out this year
- Improved upkeep of all sites – signage, fencing, general appearance
- Remediated banks of the water storage ponds located at Bibblewindi
- Rehabilitated the equipment storage yard located at Wilga Park
- Completed field soil plot trials to assess most effective means of remediated impacted soil across operational areas

Wilga Park clean up

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Pilliga rehabilitation update

- Decommissioning of four existing Bohena wells and Bohena water storage ponds has commenced as instructed by a Notice of Direction received from Department of Resource & Energy by ESG in November 2011. Sites to be rehabilitated.
- Regulatory approval has just been received to commence rehabilitation works on the remainder of existing drill pads in the Pilliga. Work to commence in October/November.
- Former ESG drilling ponds are scheduled for removal and rehabilitation with work to commence this month.
- Santos is proposing to carry out work on approximately 45 existing wells in the Pilliga. A number of these will be decommissioned and rehabilitated as they are no longer required following Santos revision of ESG's exploration and appraisal plans.

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Pilliga rehabilitation – water

- Former ESG Bibblewindi water treatment plant has been shut down since mid-December last year, shortly after Santos acquired ESG
- Santos review found facilities:
  - do not meet Santos standards
  - had insufficient capacity for future pilot appraisal activities
  - had questionable long-term reliability
- Solutions being investigated, but construction of a new purpose built facility likely to emerge as the best solution
- In the interim:
  - consolidating all water facilities to one location – Bibblewindi
  - will enhance an existing groundwater monitoring system at the water storage ponds at Bibblewindi, Bohena South and Wilga Park

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Pilliga rehabilitation - water

- Consolidation to begin this week with the decommissioning of the Dewhurst ponds and rehabilitation of the well sites.
  - Local landholders have been notified
  - Trucking of water from Dewhurst to Bibblewindi will commence next week
  - Take approximately 8 weeks
  - Will allow for removal of water storage tanks at Dewhurst
  - Rehabilitate the area and Dewhurst ponds
  - In the longer term a water flowline will be constructed from Dewhurst to Bibblewindi to handle eventual output from the Dewhurst pilot

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