Big Swamp Rehabilitation Project: Hydrologic Study

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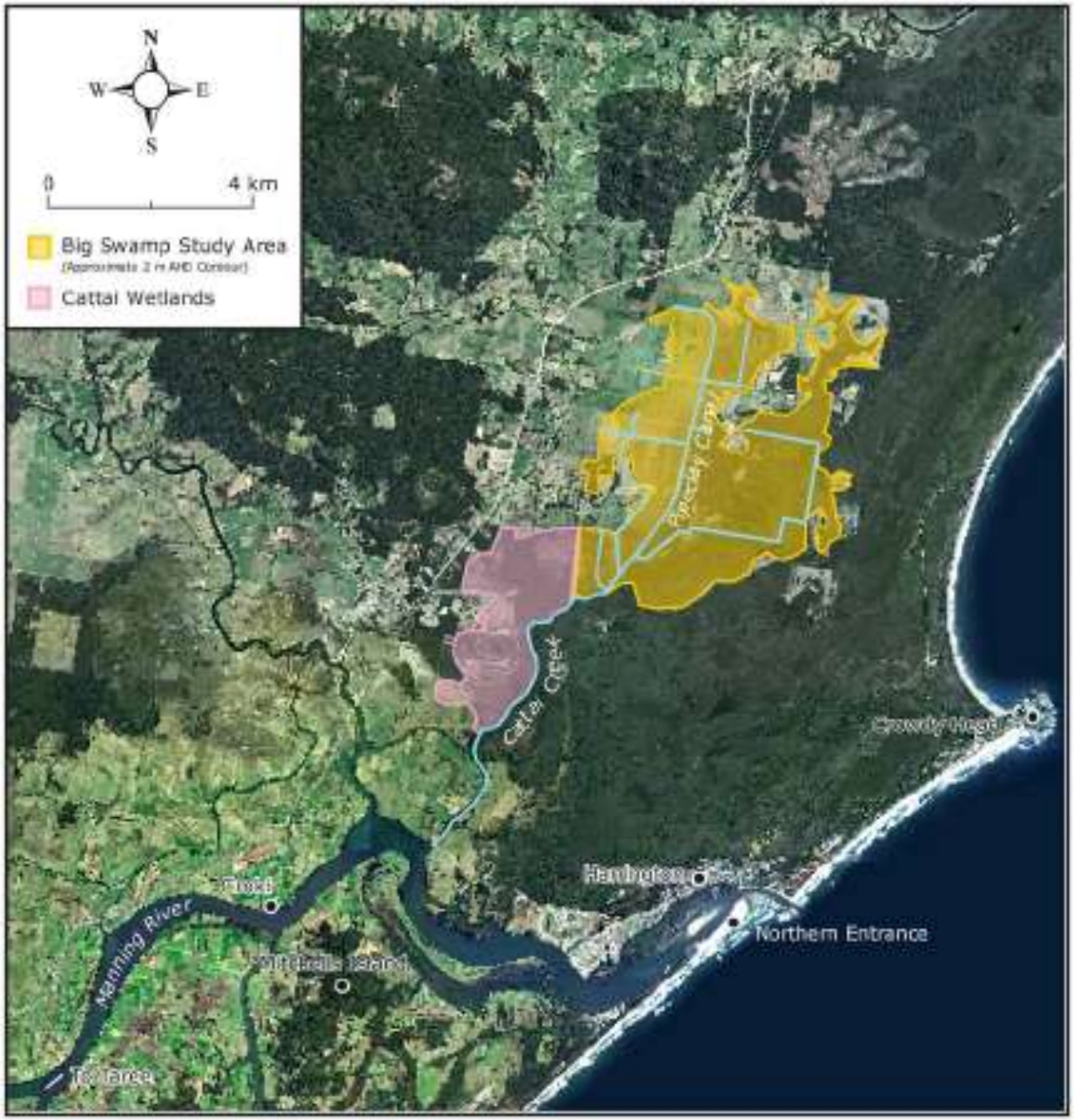
Introduction

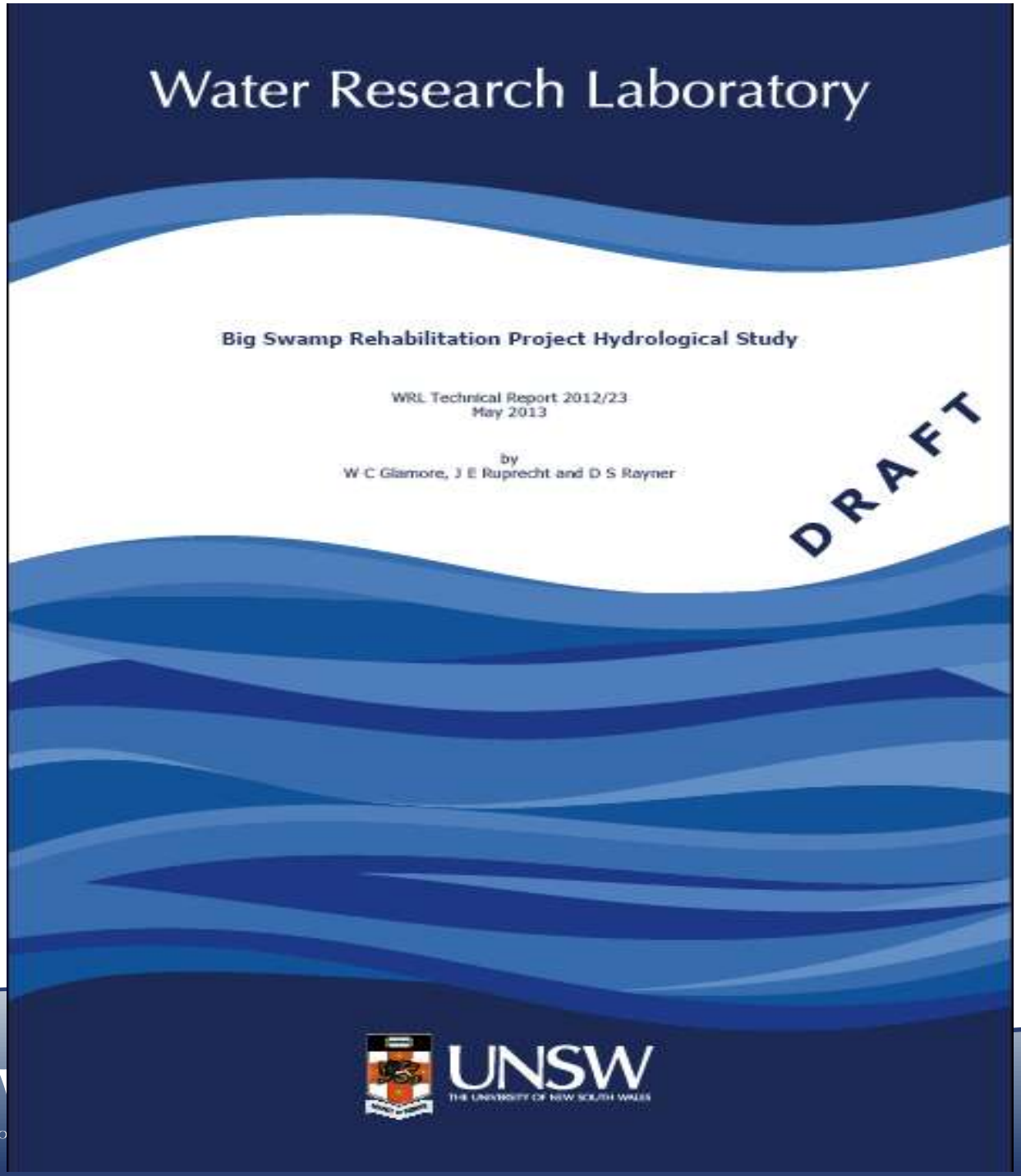
Definitions:

- Big Swamp
- Pipeclay Canal
- Cattai Creek

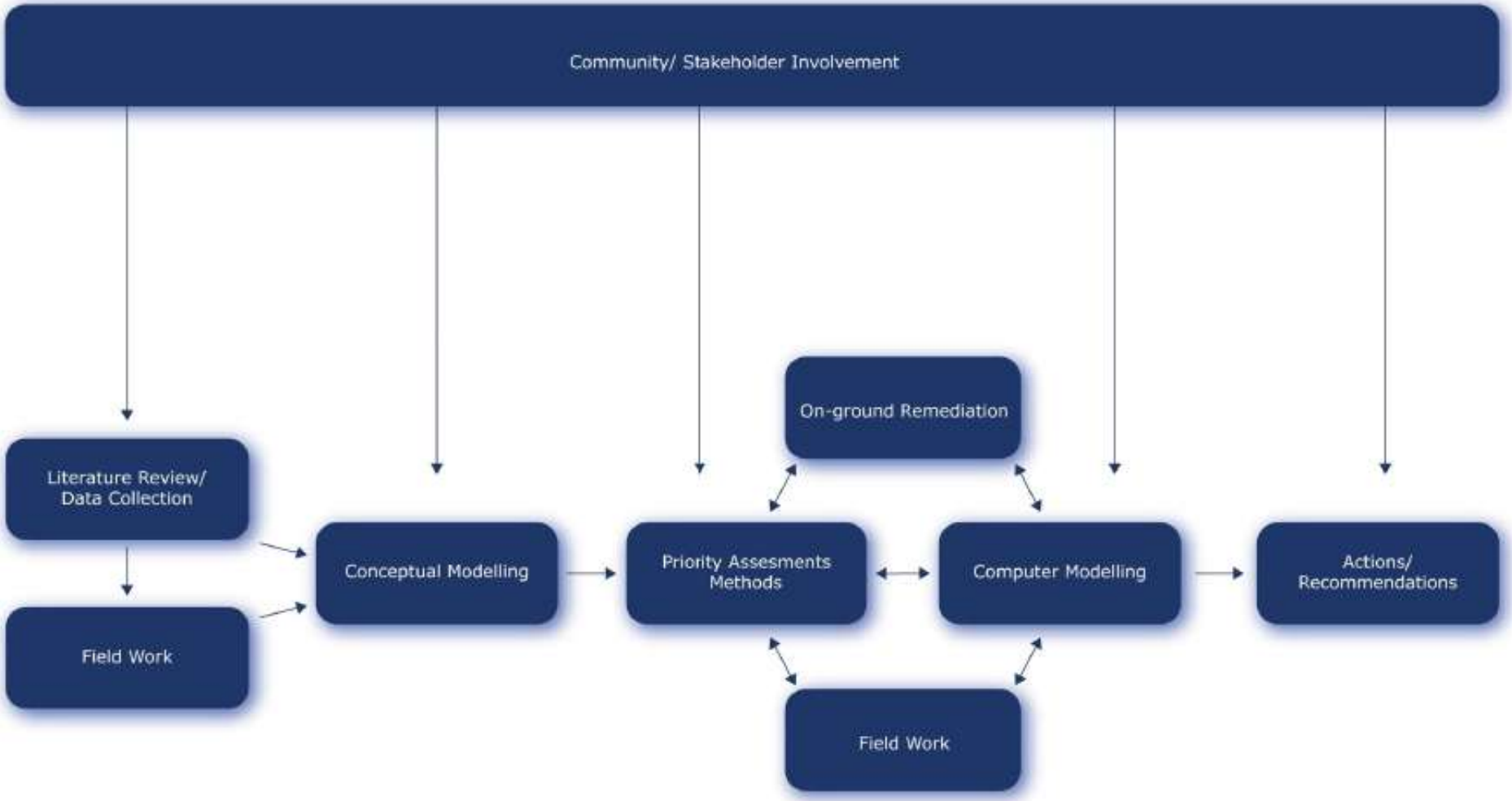
Technical Terms:

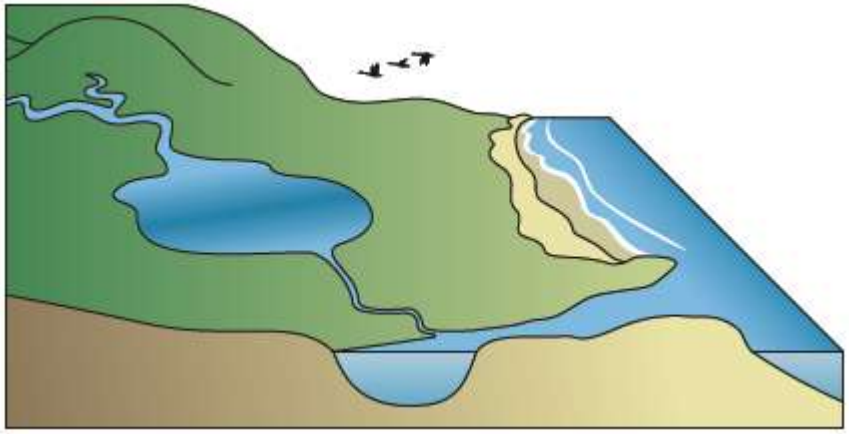
- Hydrology
- Hydrodynamics
- Groundwater
- Hydraulic Head
- Acidity (pH)
- Modelling




Water Research Laboratory
Big Swamp Rehabilitation Project Hydrological Study
WRL Technical Report 2012/23
May 2013
by
W C Glamore, J E Ruprecht and D S Rayner
DRAFT
UNSW
THE UNIVERSITY OF NEW SOUTH WALES

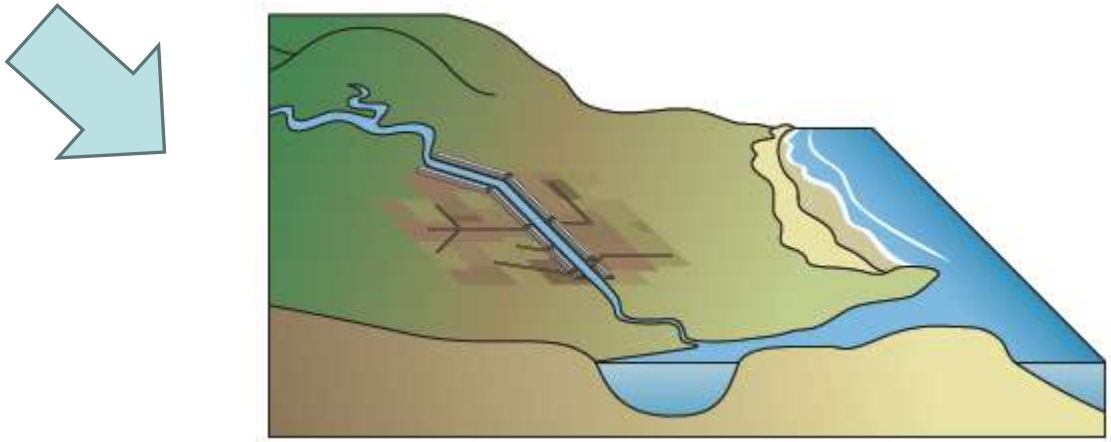
Introduction

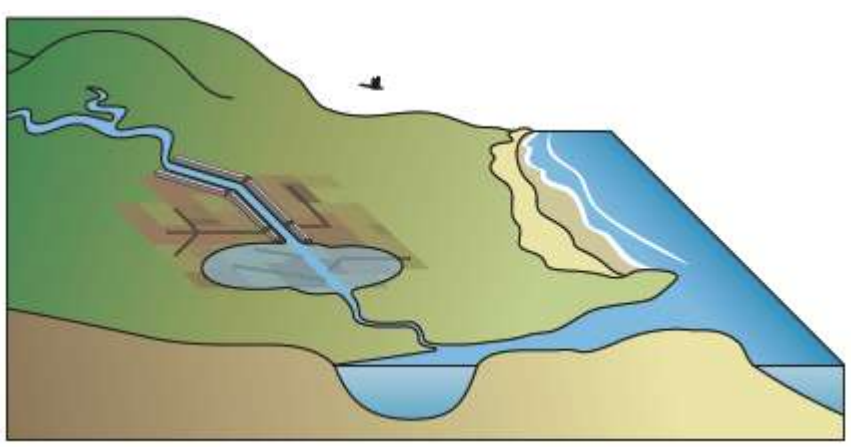




Logic of Study and Report

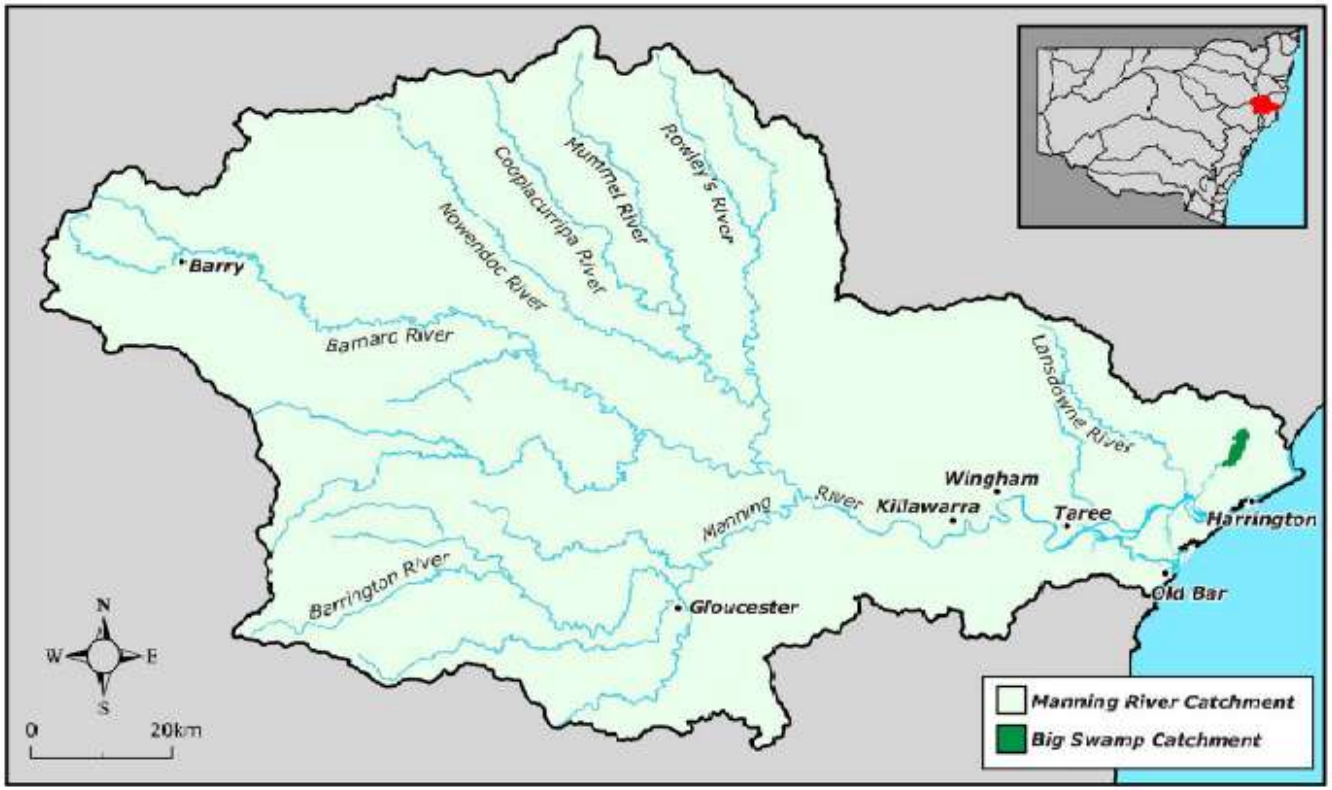
1. How did we get here?



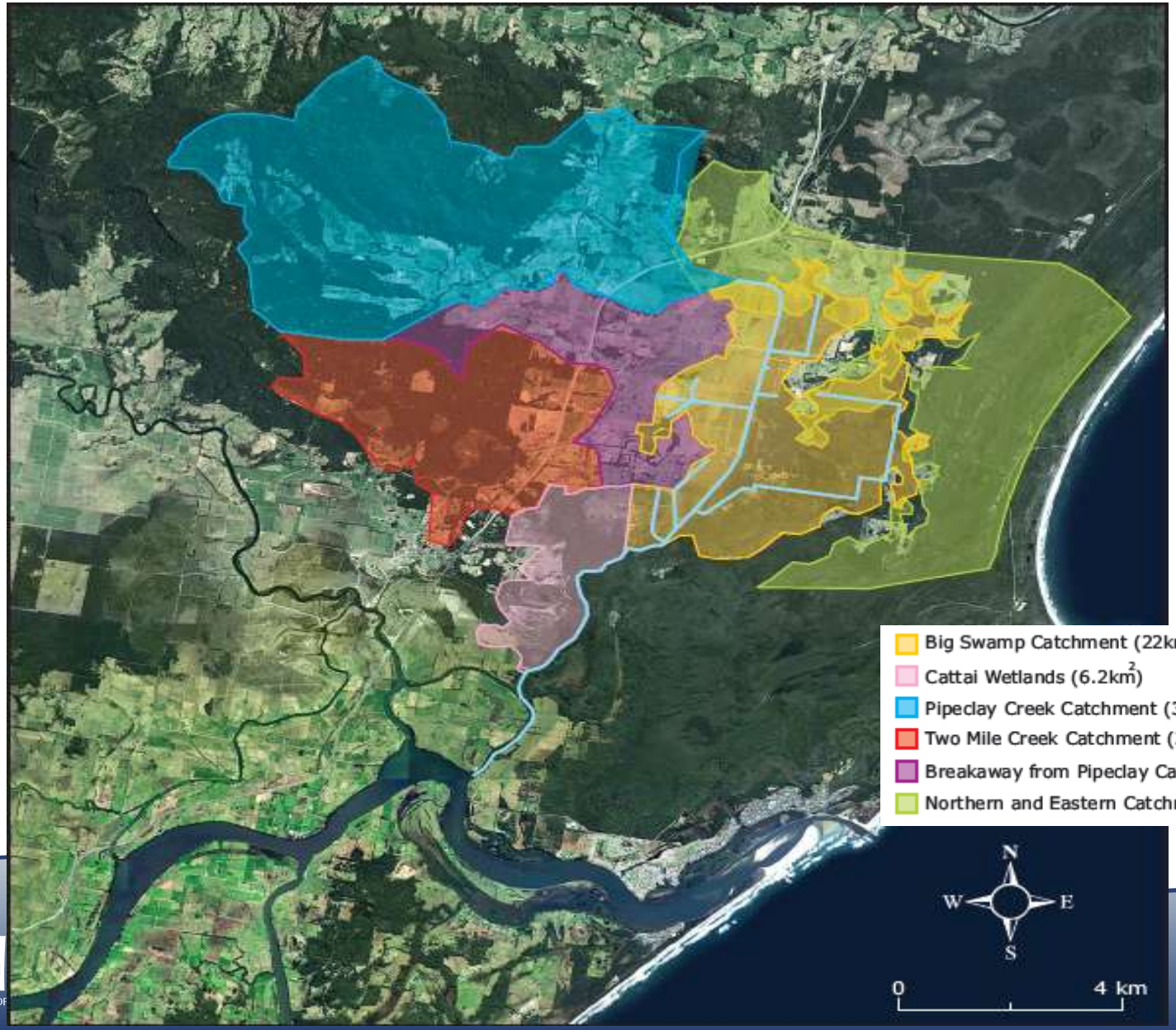


Conceptual Understanding

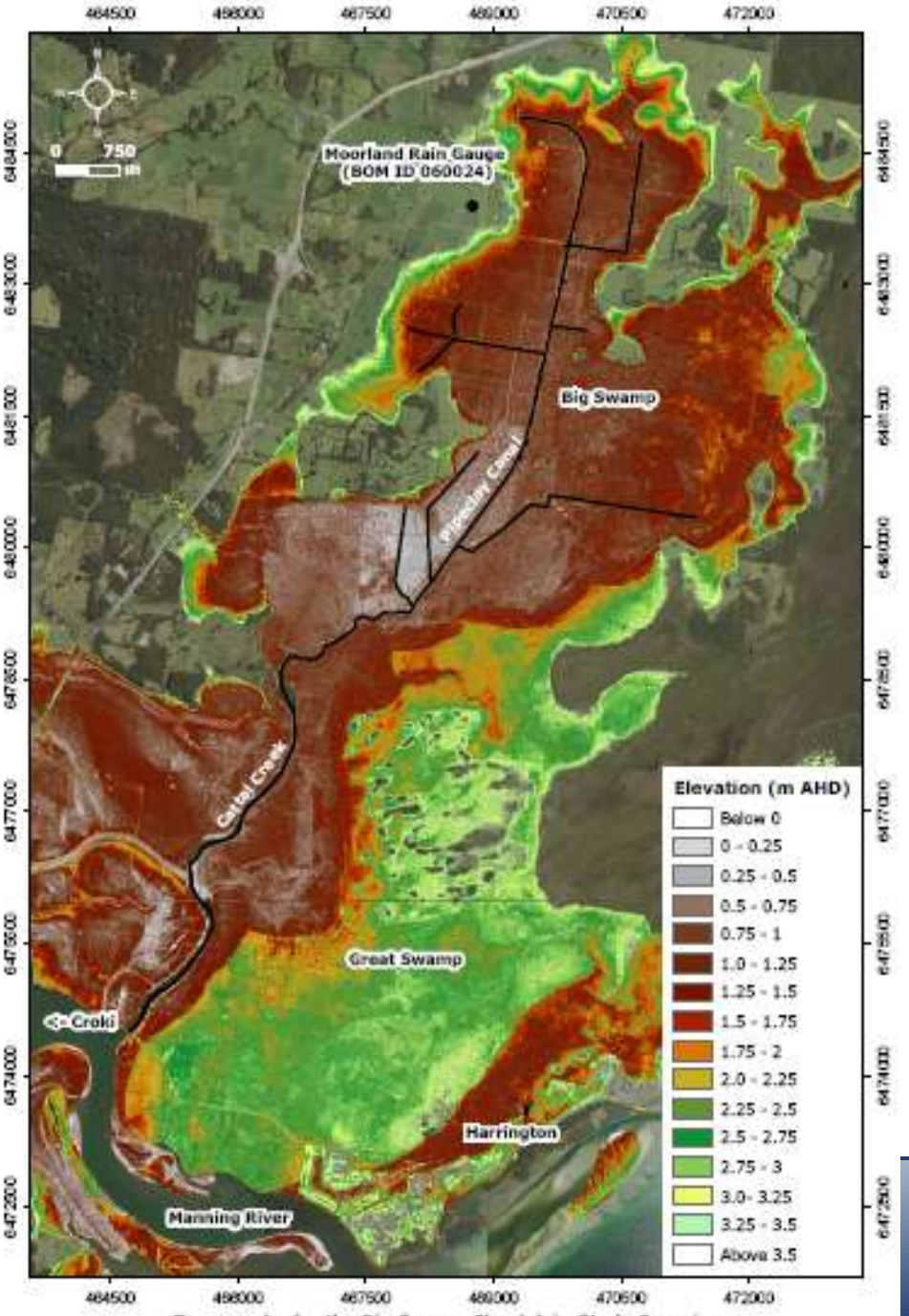
- Manning River catchment is 8,420 km^2
- Big Swamp-Pipeclay catchment is 113 km^2 or ~1% of total.
- Average annual rainfall at Moorland gauge is 1,436 mm but seasonal.
- ~2000 hectares below 0 m AHD (mean sea tide)



Conceptual Understanding

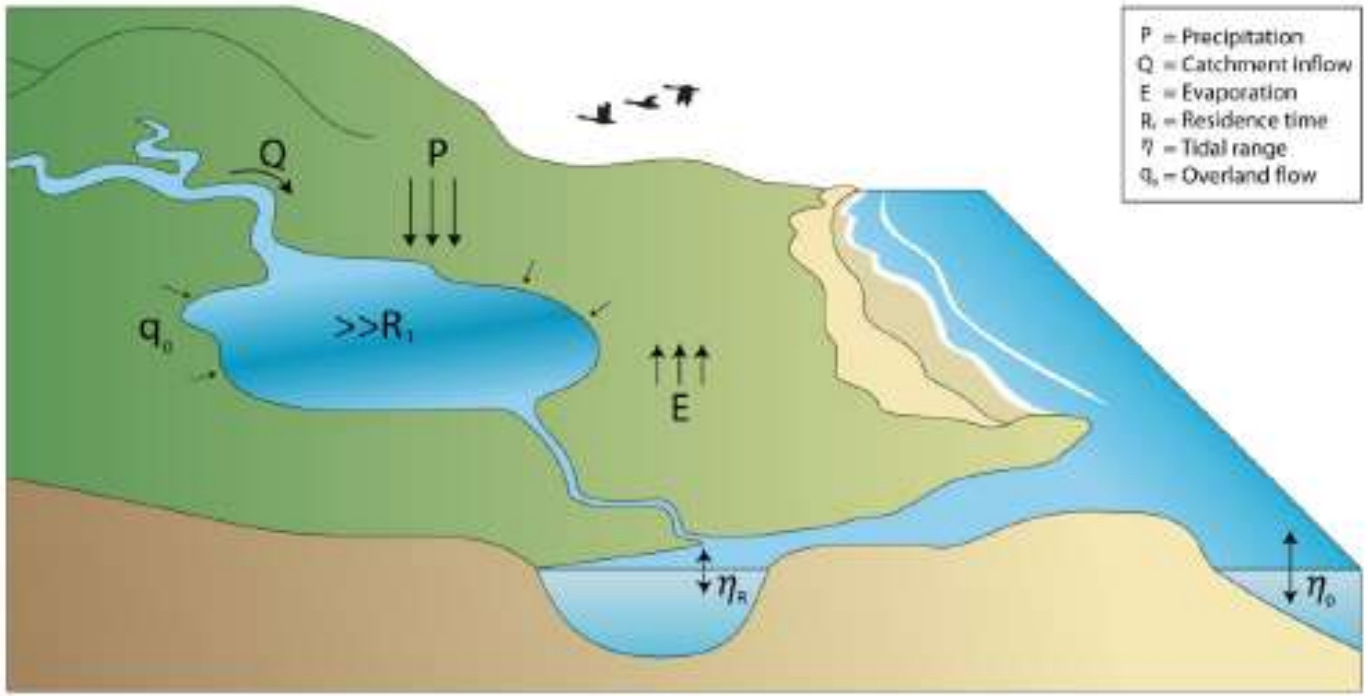


Location and Place Names



Topography for the Big Swamp Floodplain Study Domain.

Conceptual Understanding



Historical Site
- Natural water balance, drainage paths and surface water-ground water interactions
- High residence time (R_t) with natural organic decomposition of floodplan sediments
- Natural geomorphological change with estuare evolution

Conceptual Understanding

Drainage History

- 1899 Big Swamp Drainage Scheme Approved
- 1905 completed
- Designed to pass upland catchment directly to Cattai Creek
- Big Swamp drainage was secondary issue
- Expanded in 1960s and 90s.

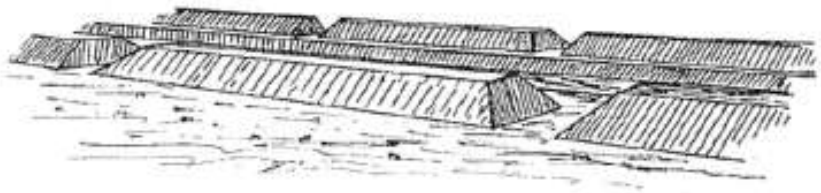
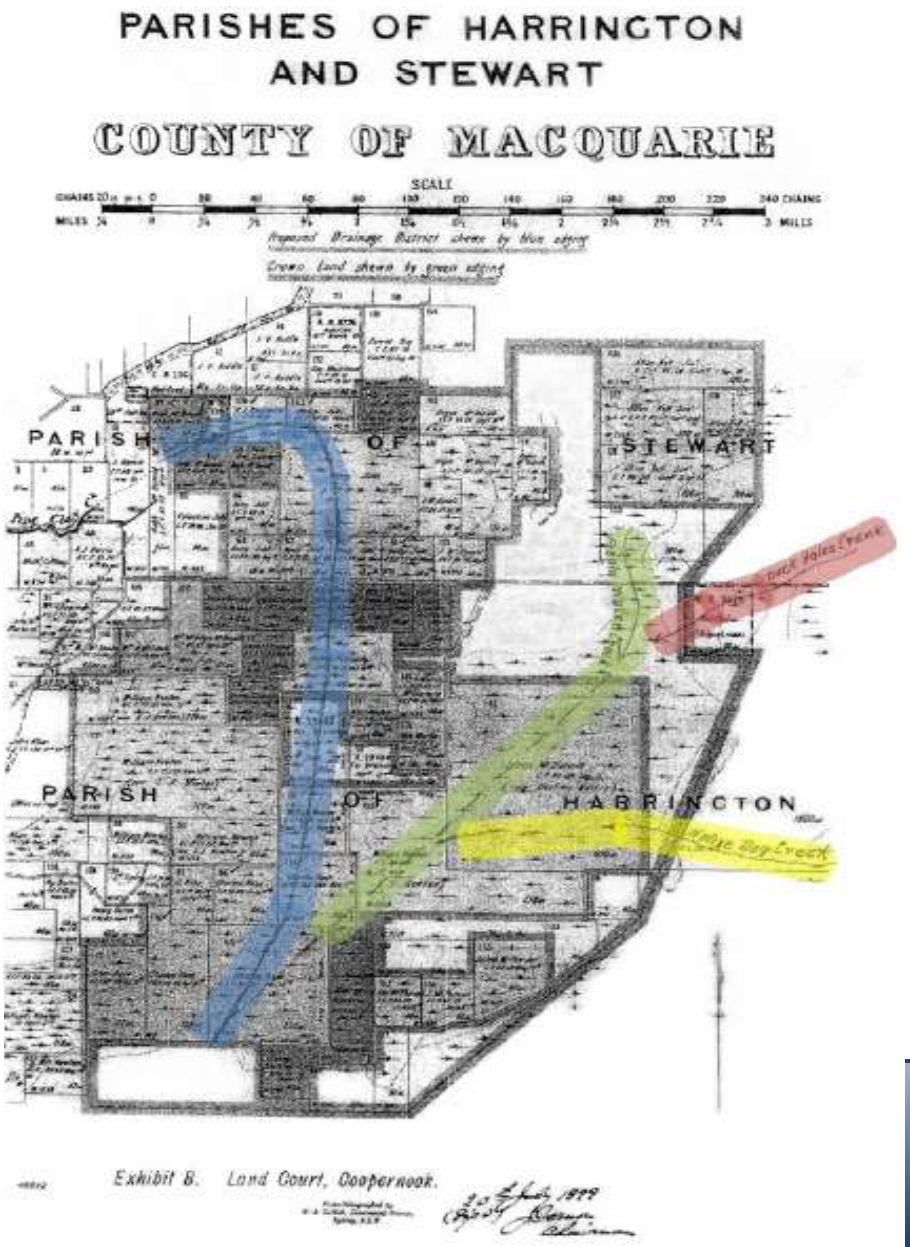
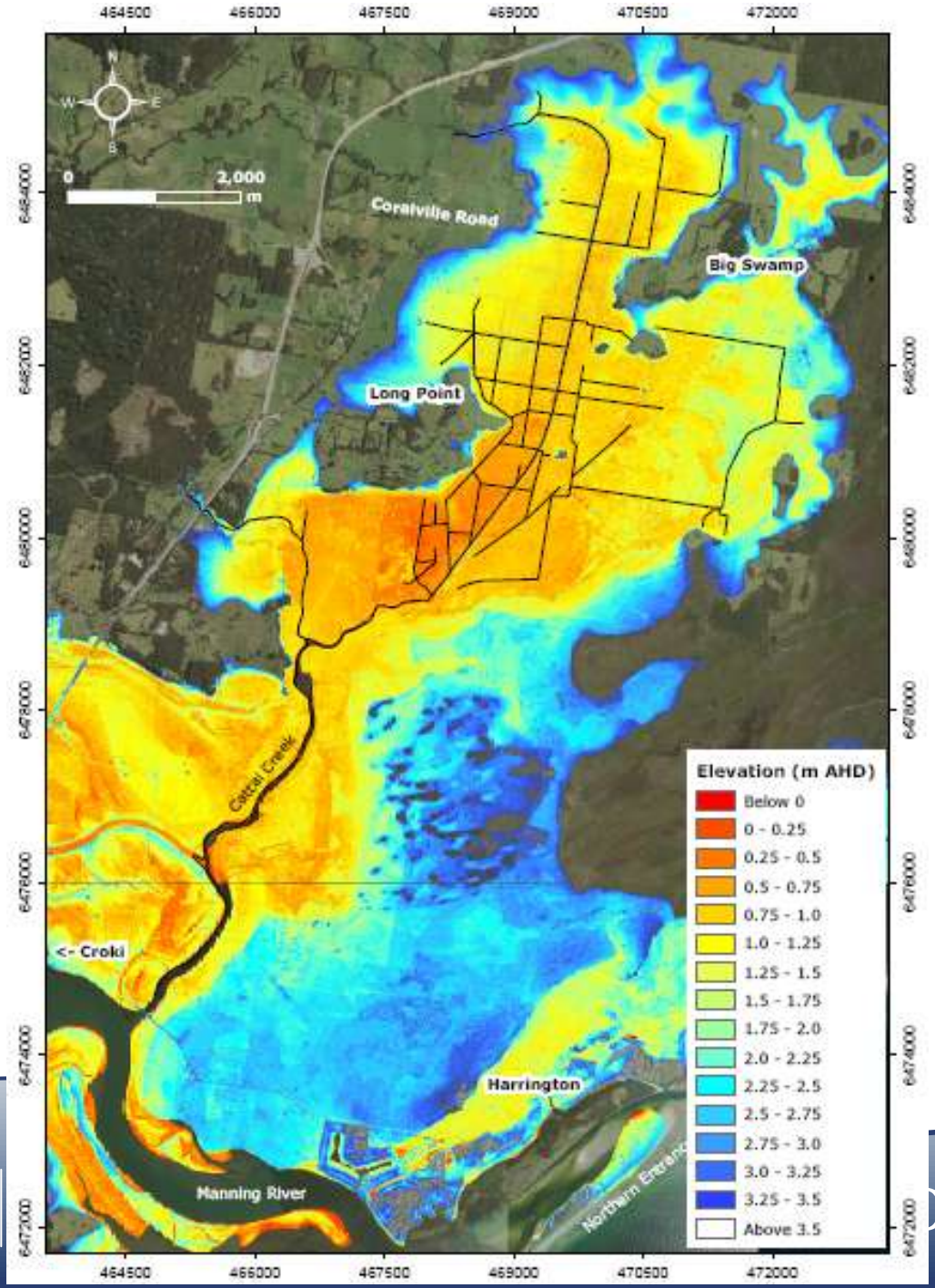
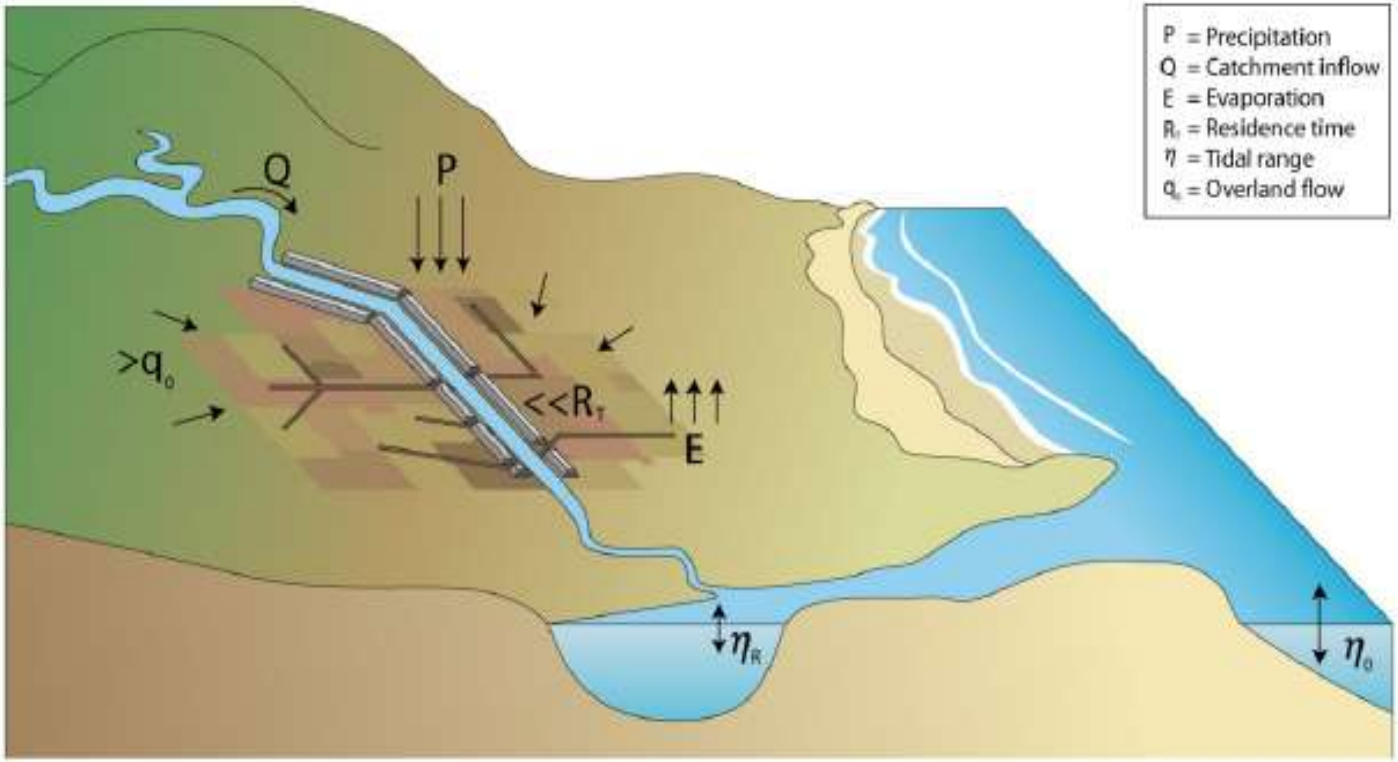


Fig 3.



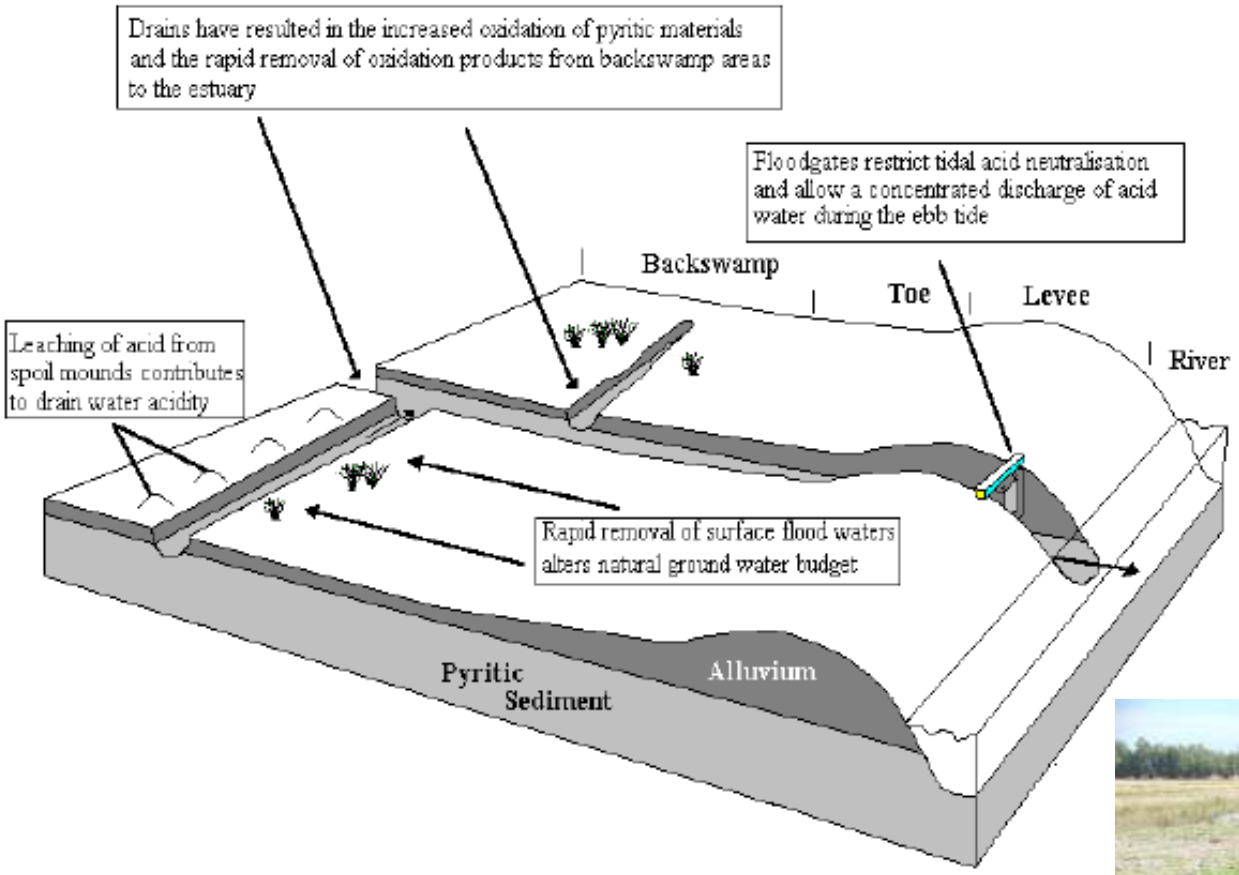

464500
466000
467500
469000
470500
472000
6484000
6482000
6480000
6478000
6476000
6474000
6472000
N
W
E
S
0
2,000
m
Coralville Road
Big Swamp
Long Point
Cattai Creek
<- Croki
Harrington
Manning River
Northern Entrance
Elevation (m AHD)
Below 0
0 - 0.25
0.25 - 0.5
0.5 - 0.75
0.75 - 1.0
1.0 - 1.25
1.25 - 1.5
1.5 - 1.75
1.75 - 2.0
2.0 - 2.25
2.25 - 2.5
2.5 - 2.75
2.75 - 3.0
3.0 - 3.25
3.25 - 3.5
Above 3.5

Conceptual Understanding



Post 1905 (Pipeclay)

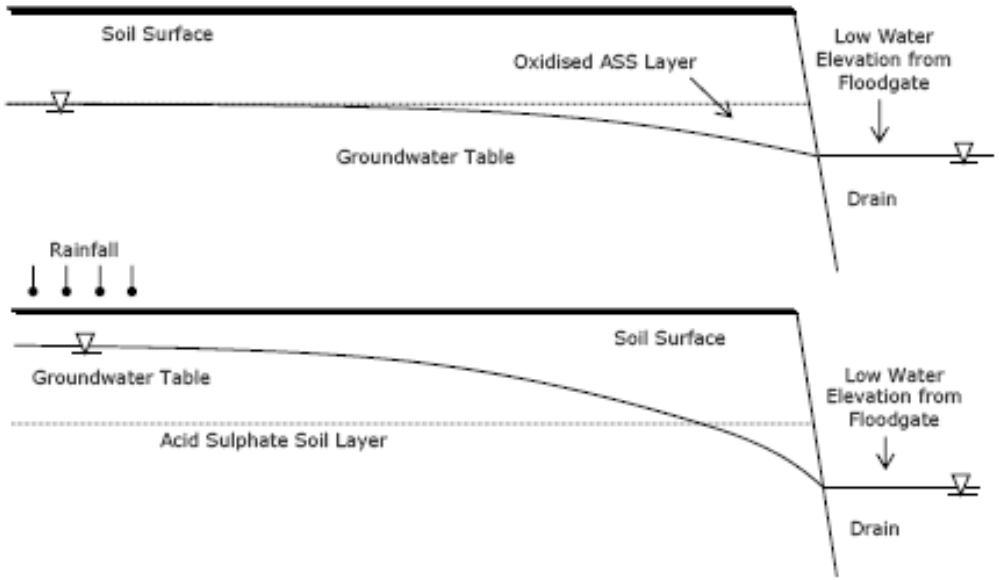
- Rapid removal of surface flood waters altered natural groundwater budget and site hydrology
- Drainage increased oxidation of pyritic material with rapid export from backswamp to esturay
- Flow control structures restrict tidal acid neutralisation and allow a concentrated discharge of acid water during ebb tide

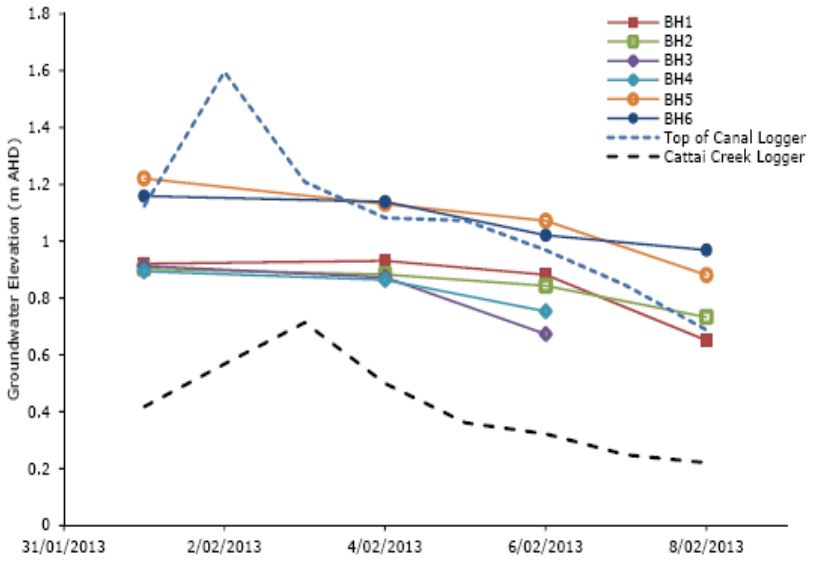

Drains have resulted in the increased oxidation of pyritic materials and the rapid removal of oxidation products from backswamp areas to the estuary
Floodgates restrict tidal acid neutralisation and allow a concentrated discharge of acid water during the ebb tide
Backswamp
Toe
Levee
River
Leaching of acid from spoil mounds contributes to drain water acidity
Rapid removal of surface flood waters alters natural ground water budget
Pyritic Sediment
Alluvium

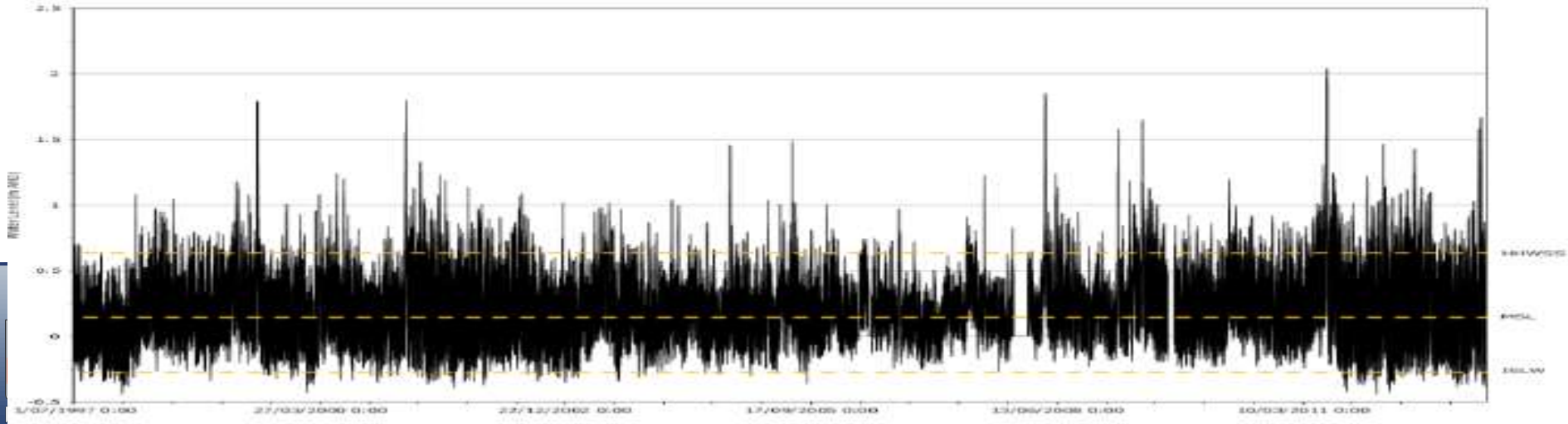

B

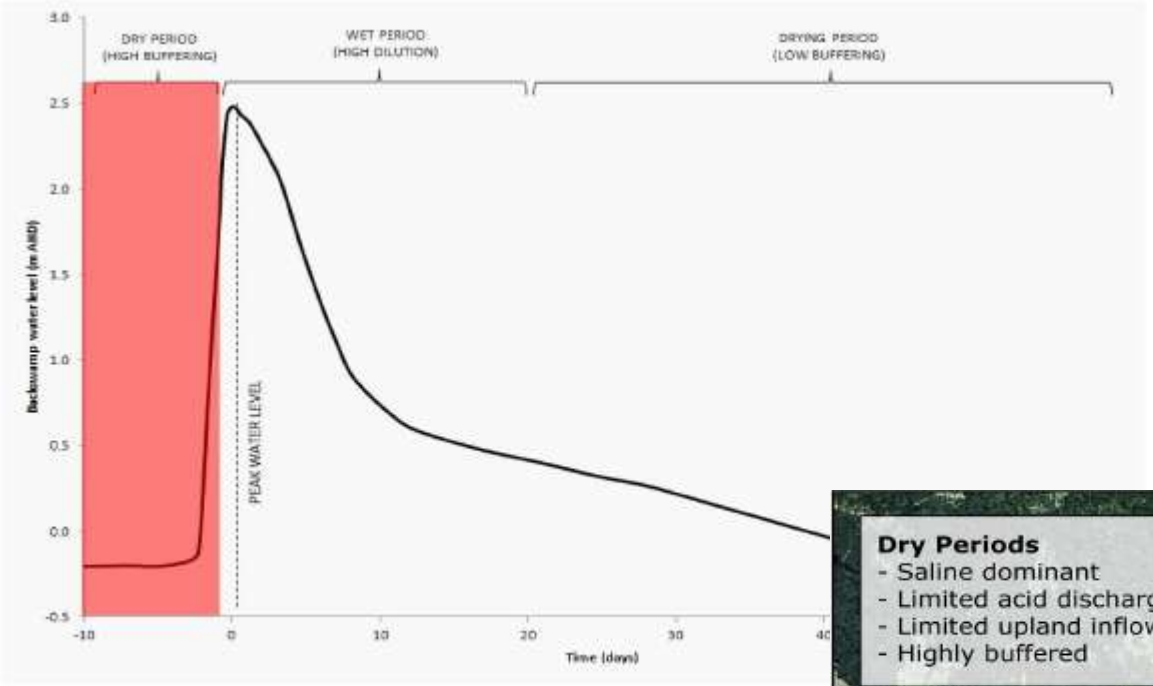

C

Tide, Drains and Acid Sulfate Soils



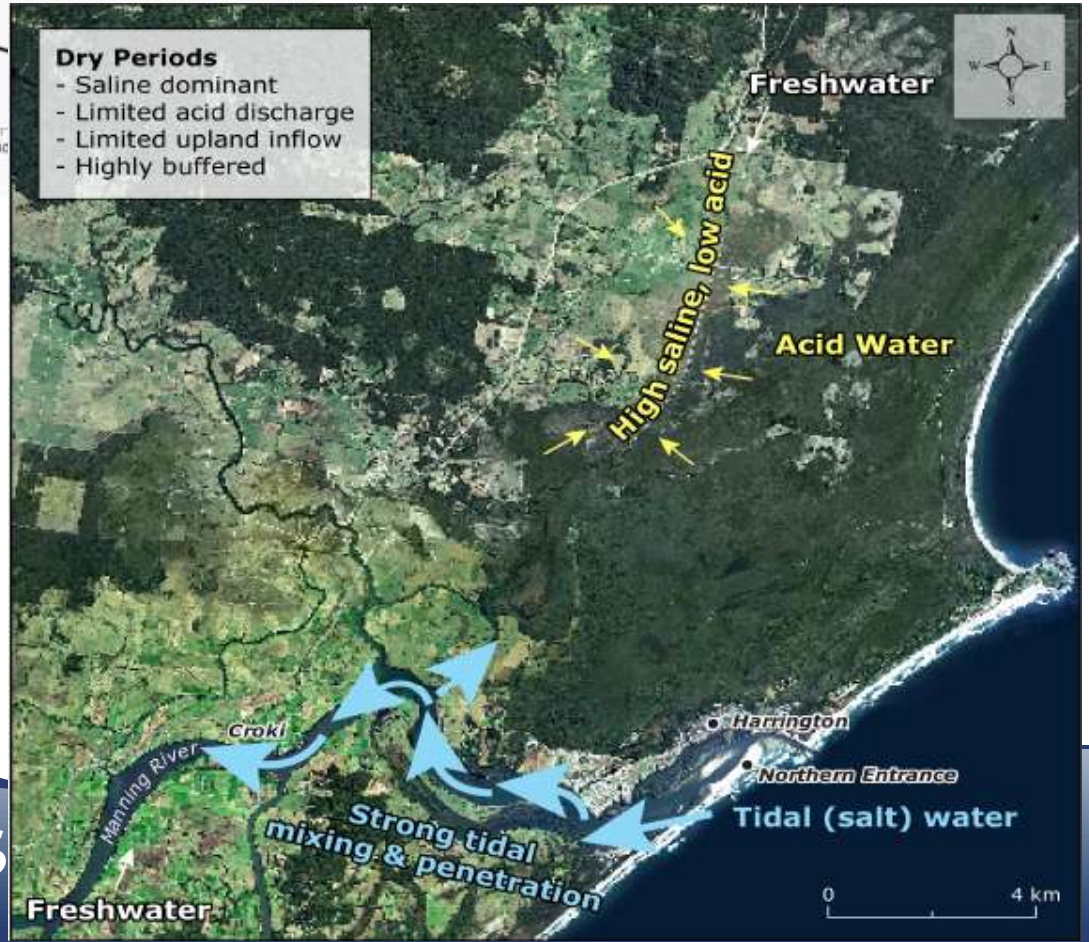


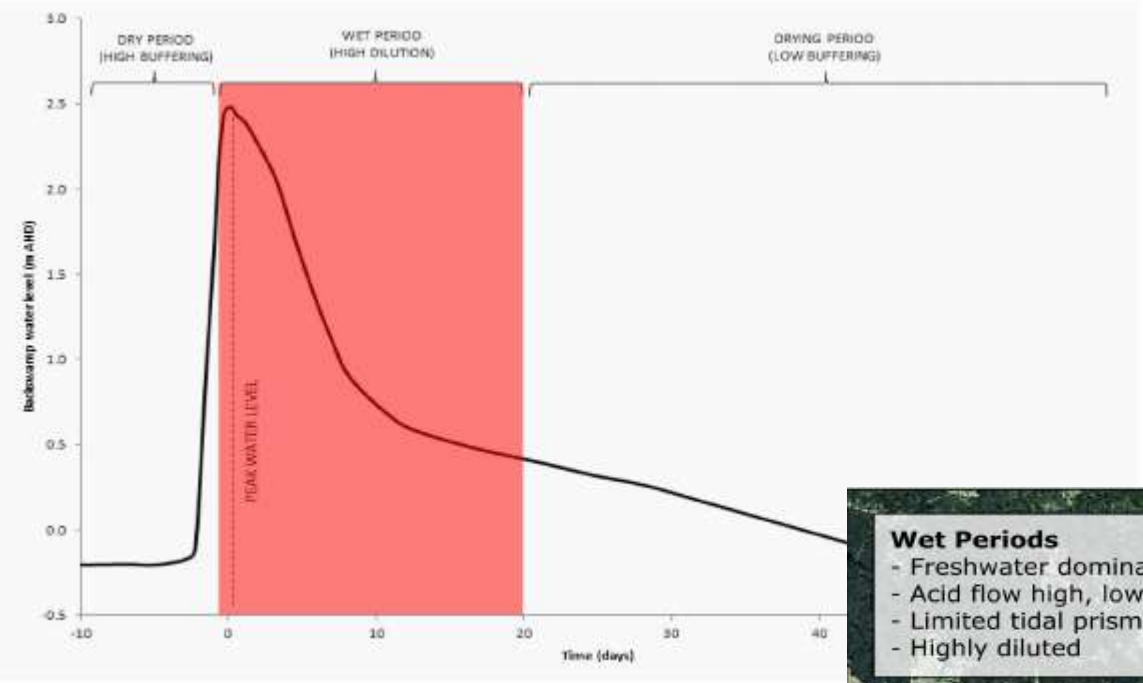




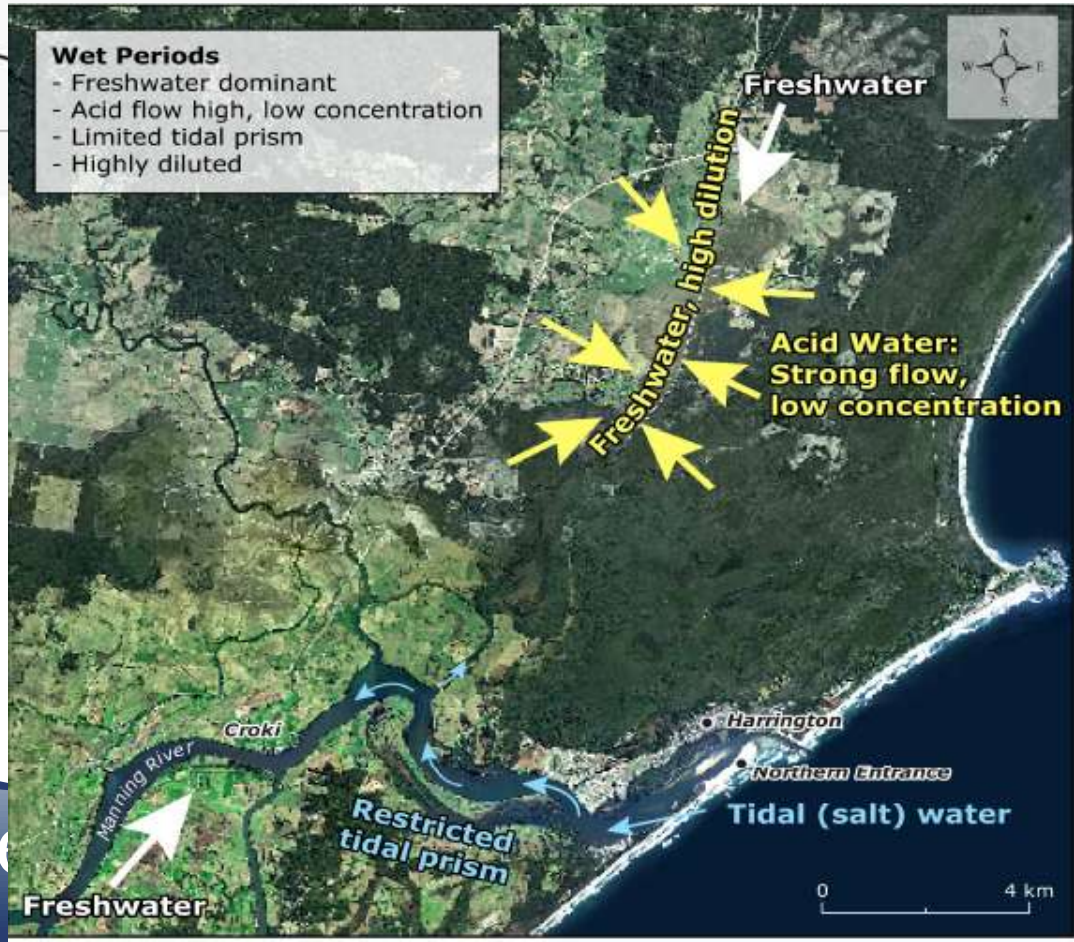
DRY Conditions

Site ID	Mean Annual Spring Tidal Amplitude (m)
Ocean	0.65
Harrington	0.47
Croki	0.25

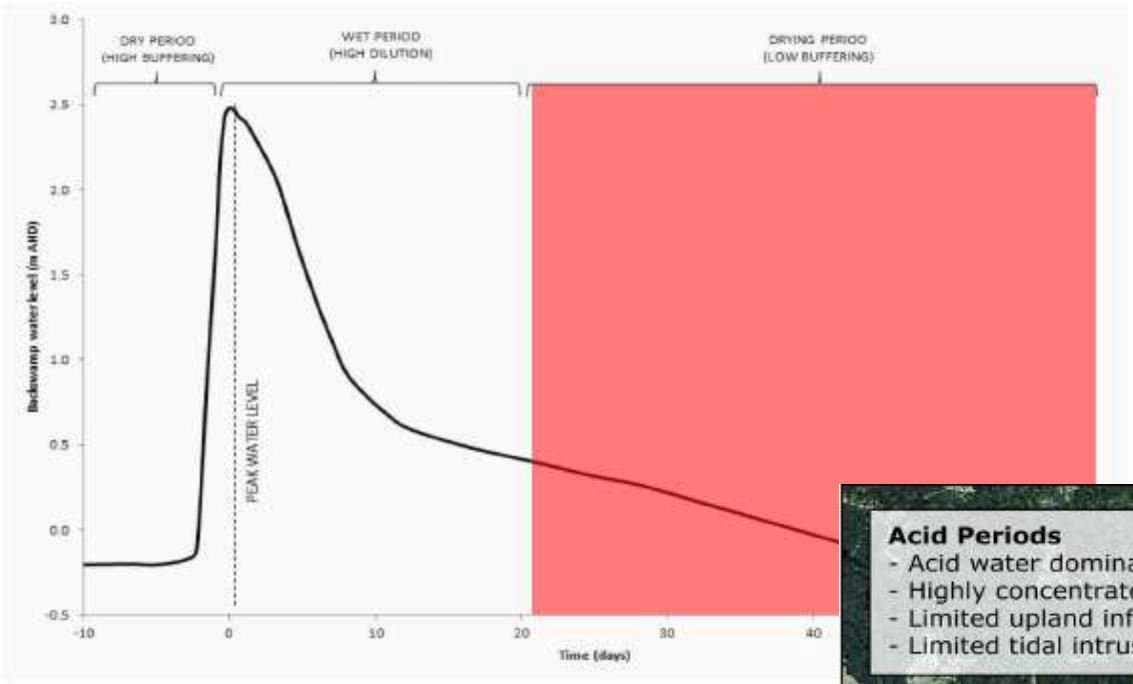


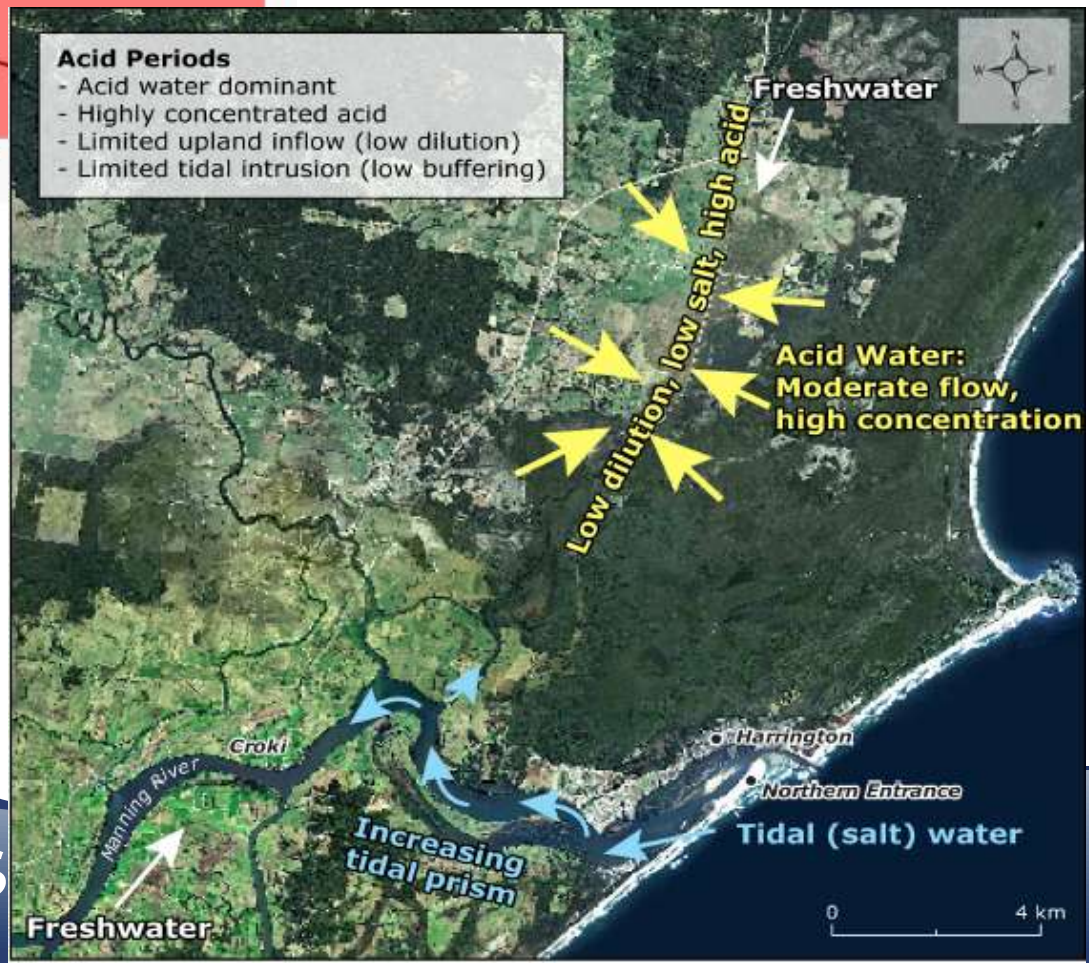


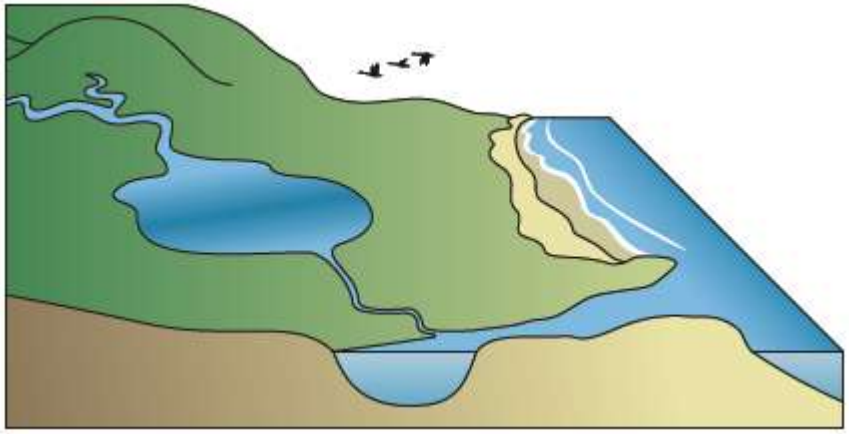
Flood Conditions

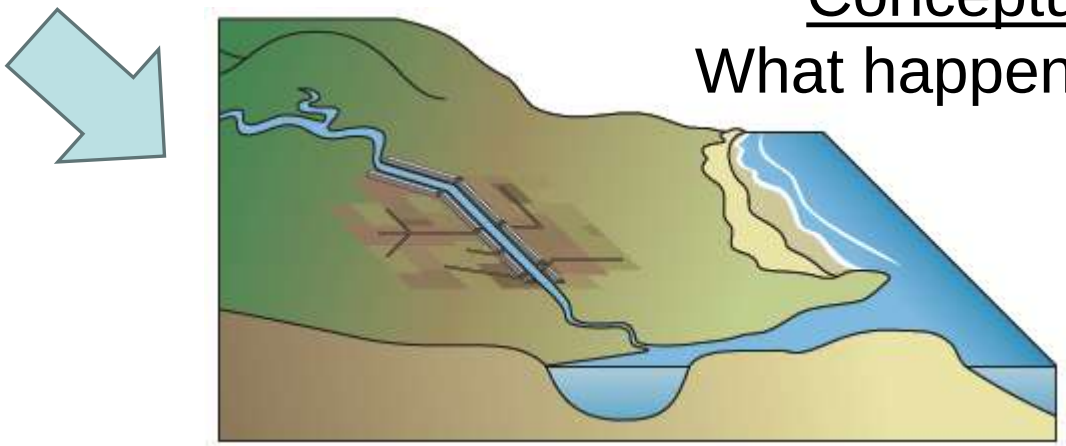


Draining Conditions



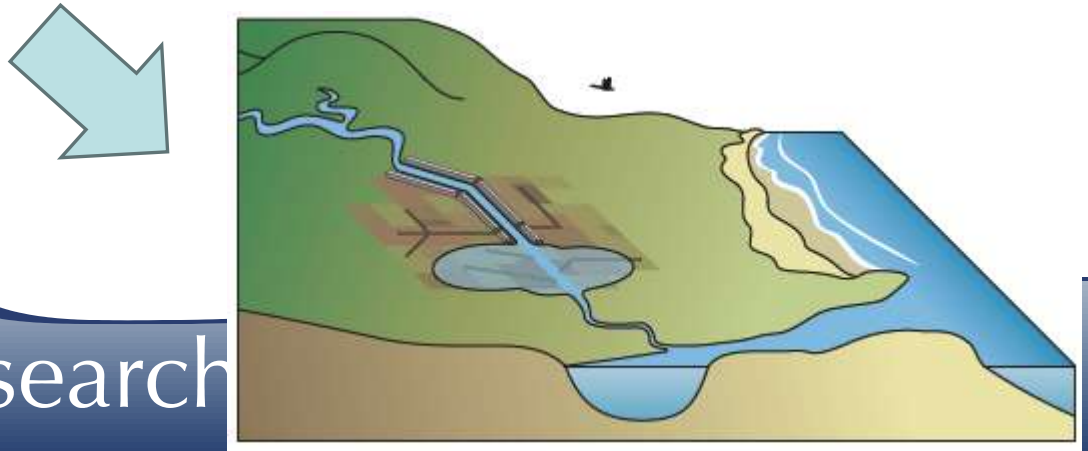




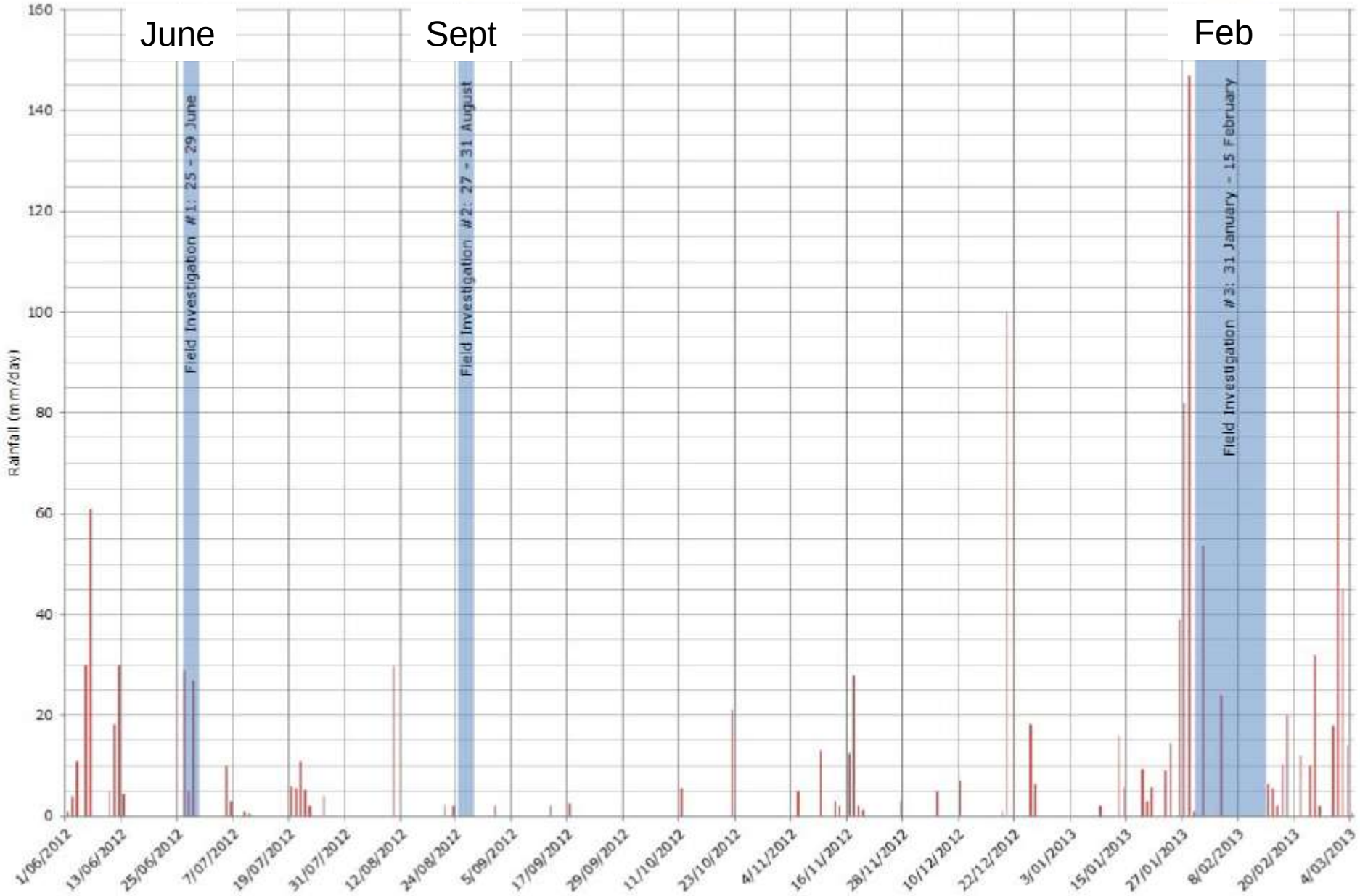


Conceptual into Actual

What happens at Big Swamp?



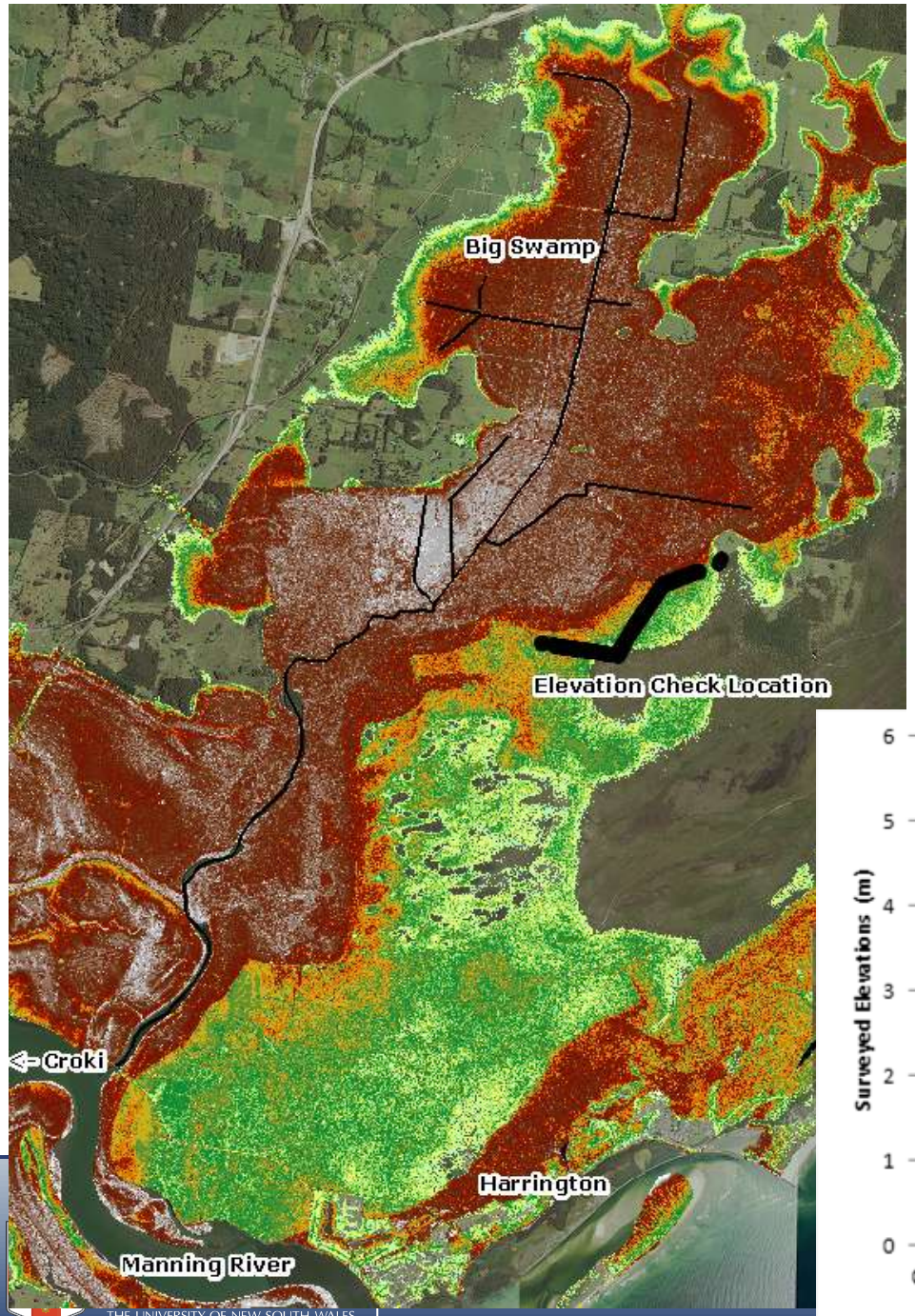
Field Data Collection

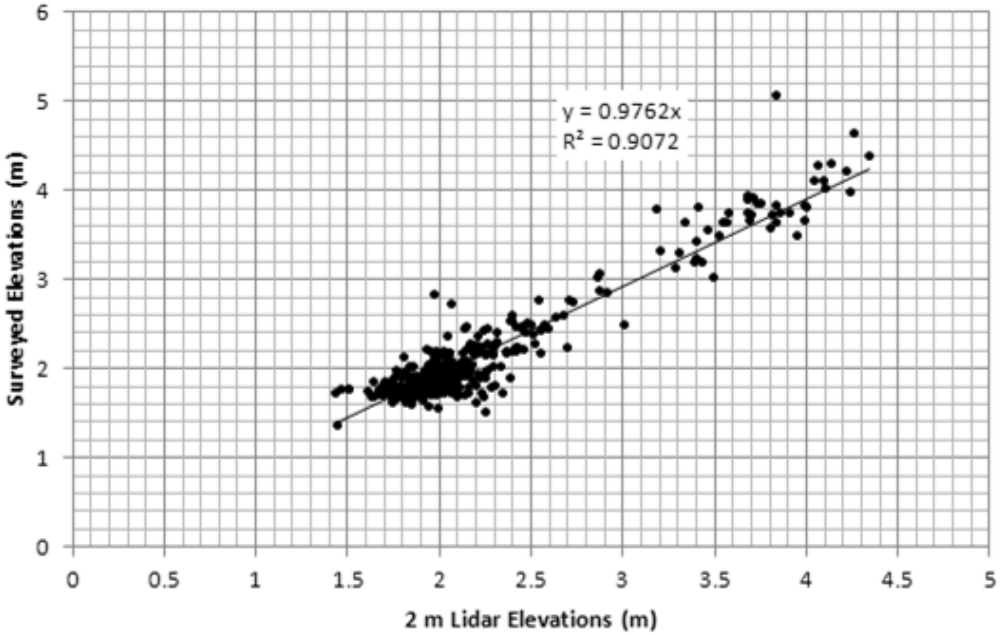


Field Data Collection Program

Field Data Collection Program

Elevation Data Check

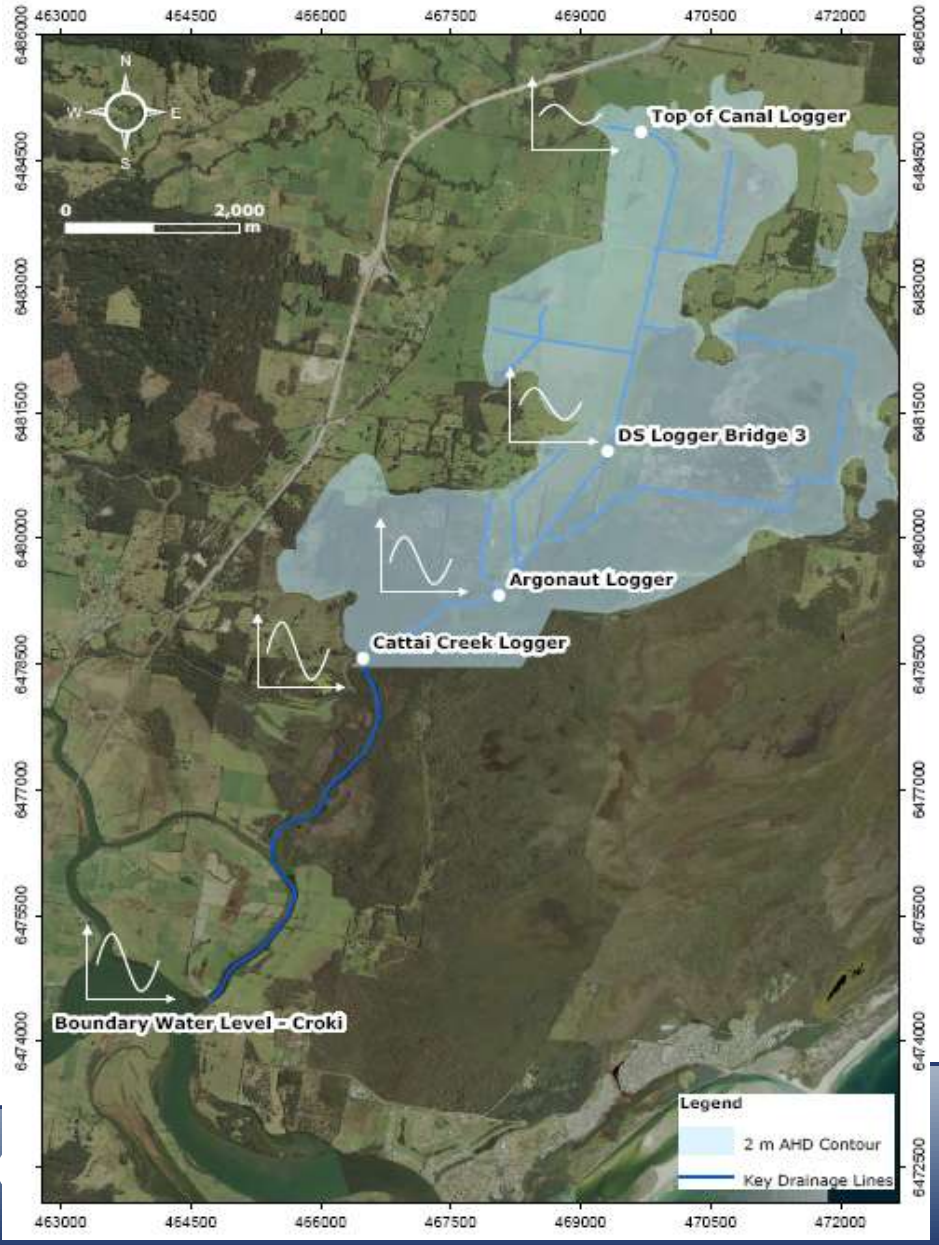




Cross-Sections and Culverts

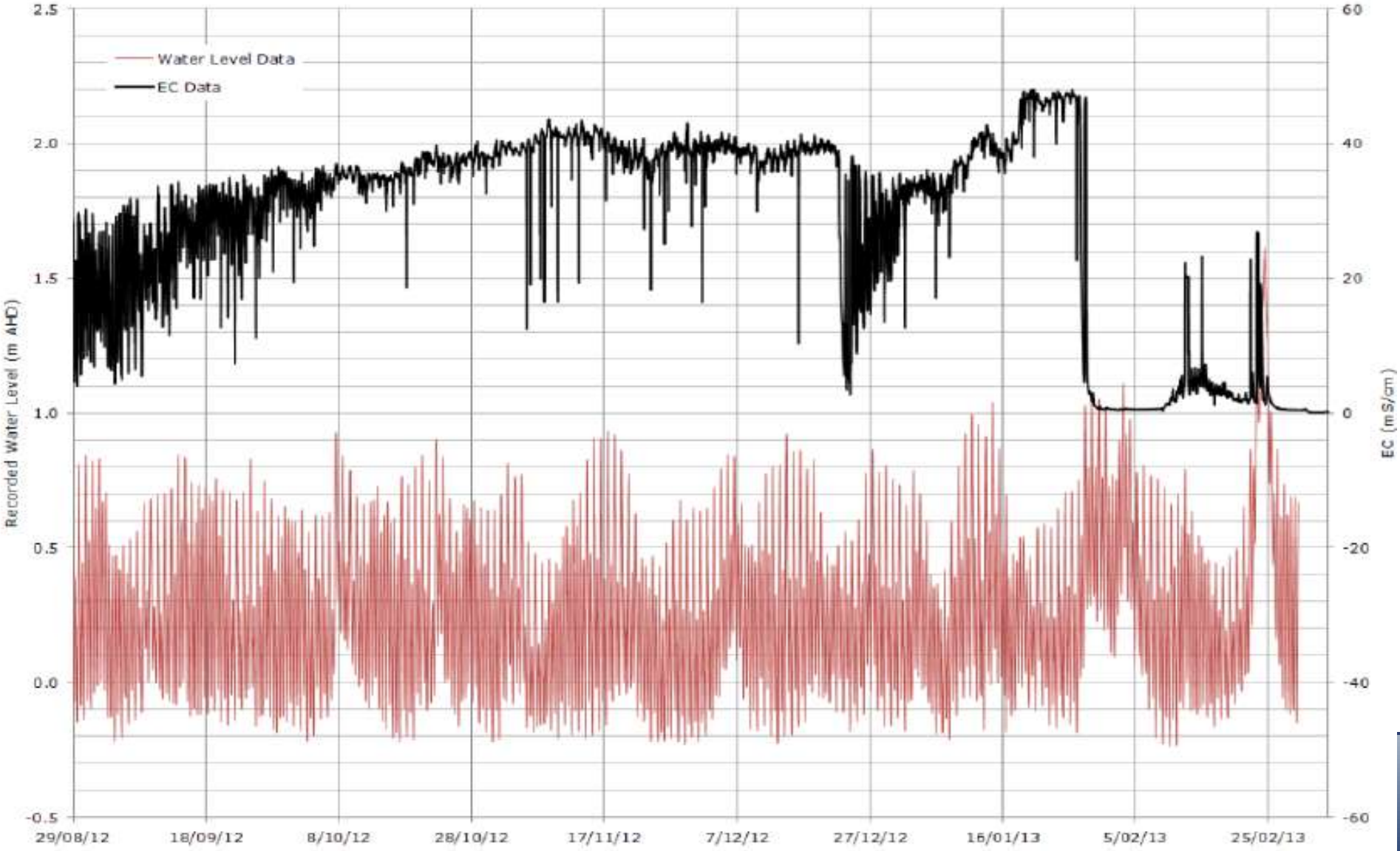
- 33 Cross-sections taken from upstream of Pipeclay canal to bridge near Harrington.
- Plus every known culvert/structure
- All based on high precision RTK-GPS positioning.

Field Data Collection Program

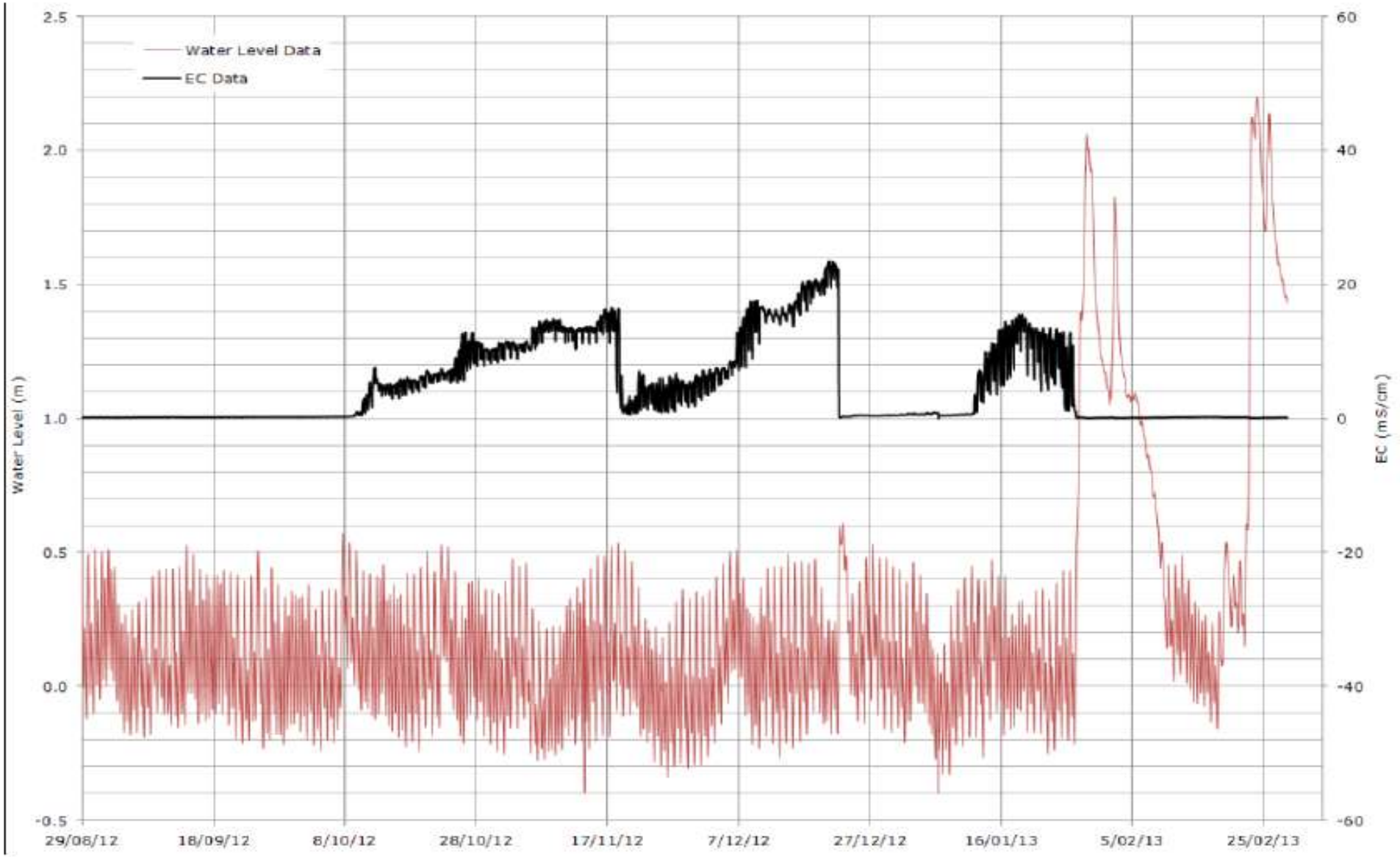


New Instruments Installed

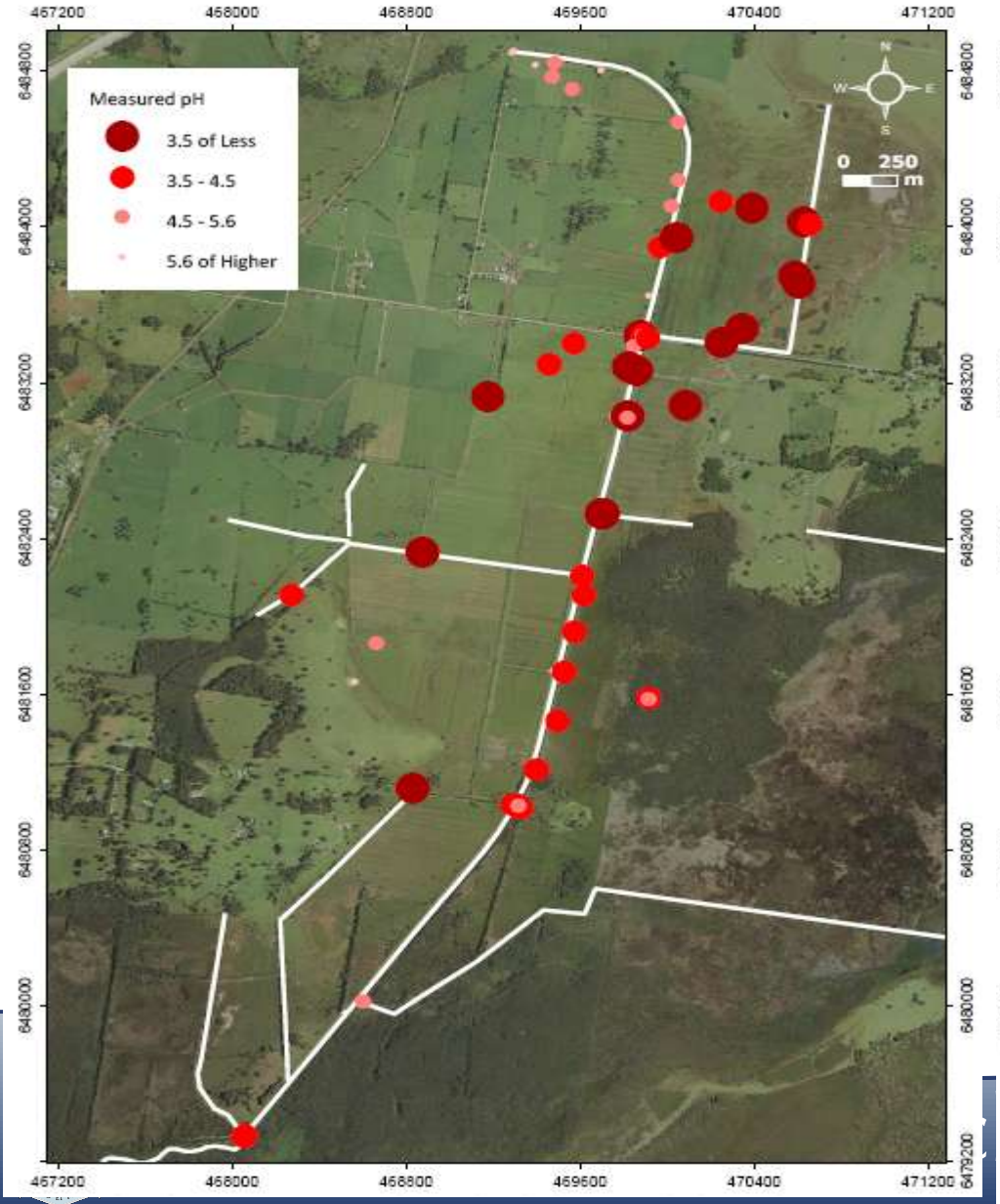
Cattai Creek Logger

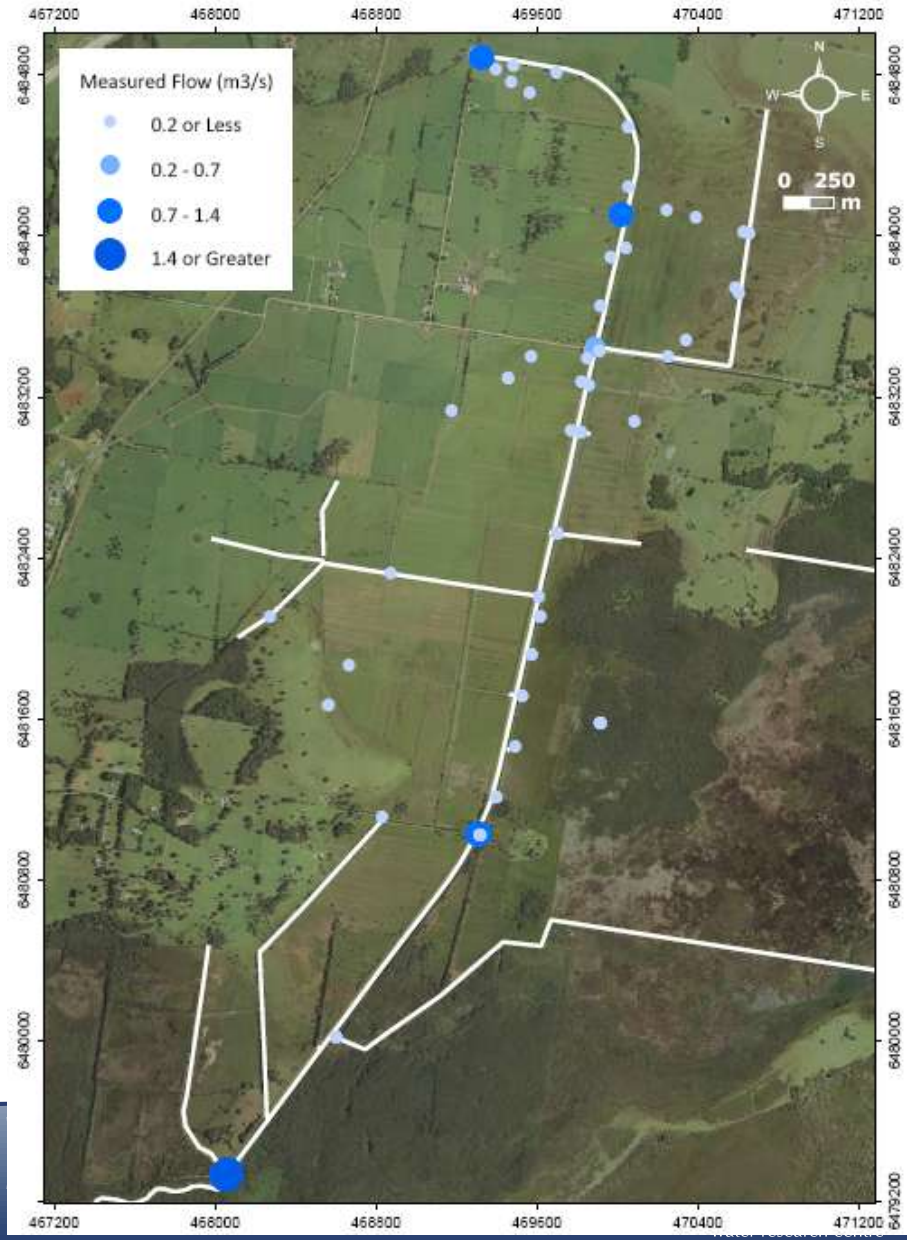


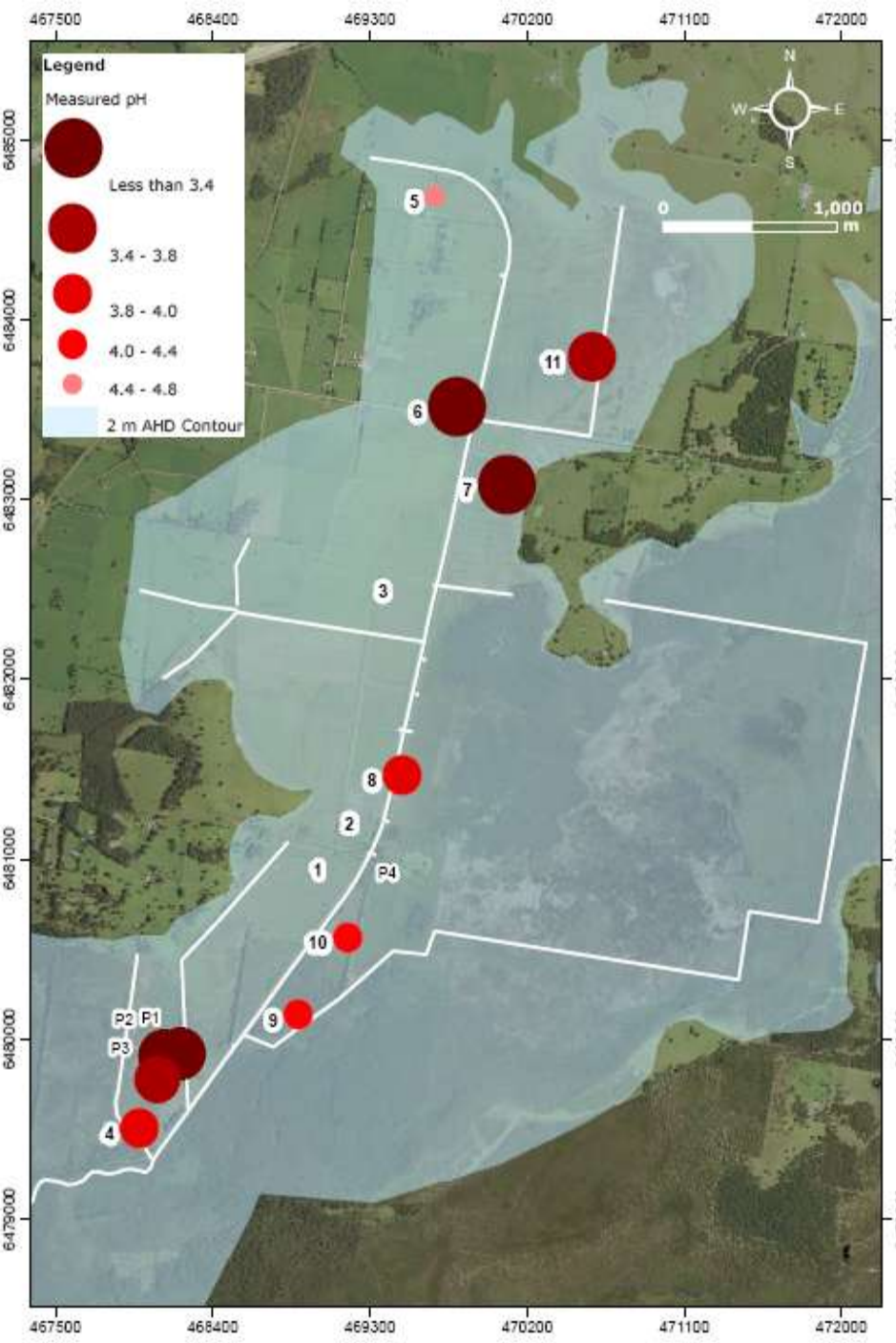
Upper Pipeclay Canal Logger



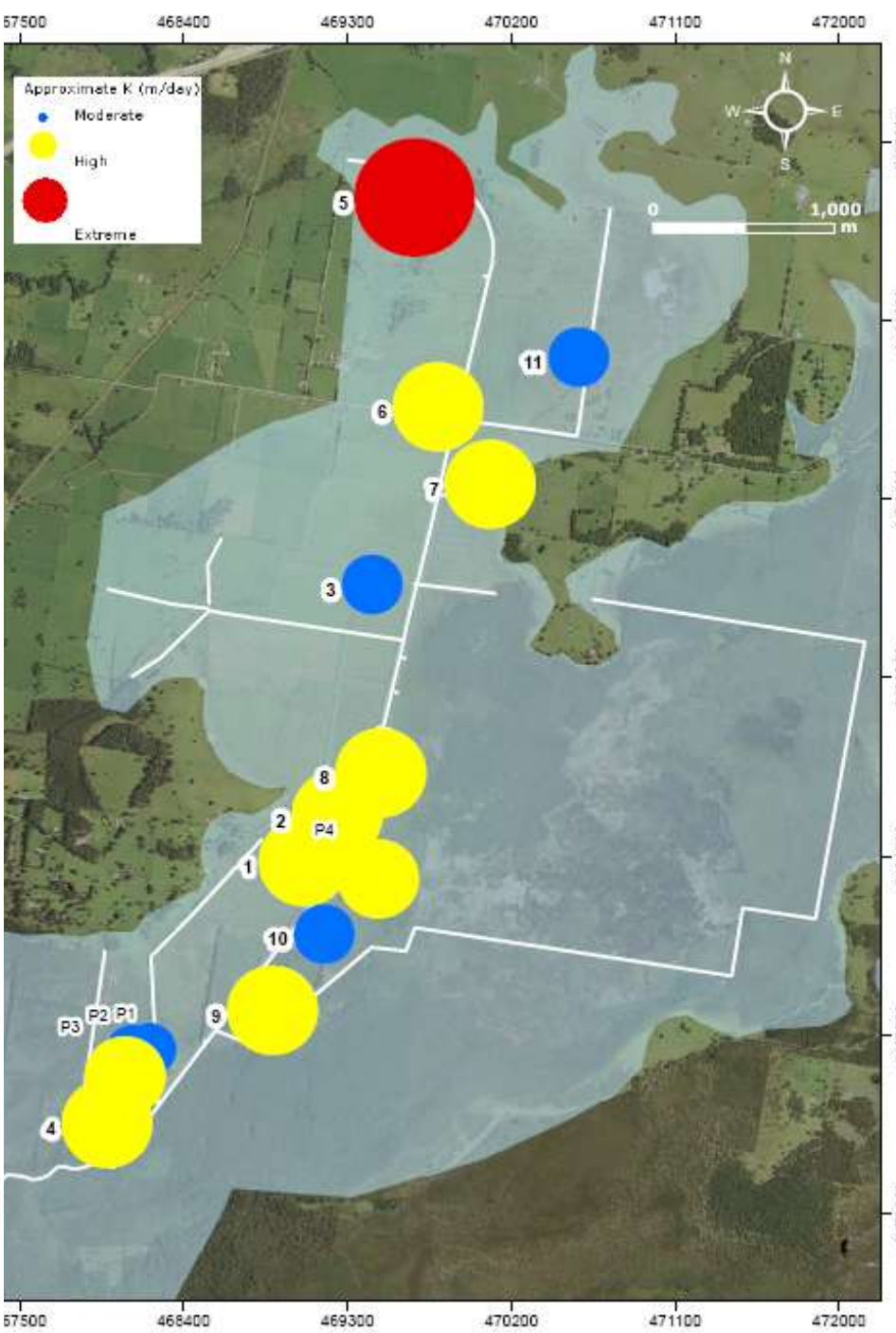
RESULTS: Dry Conditions







Measured pH of Groundwater at Big Swamp Including WRL and Jonston (2007) Test Pits.

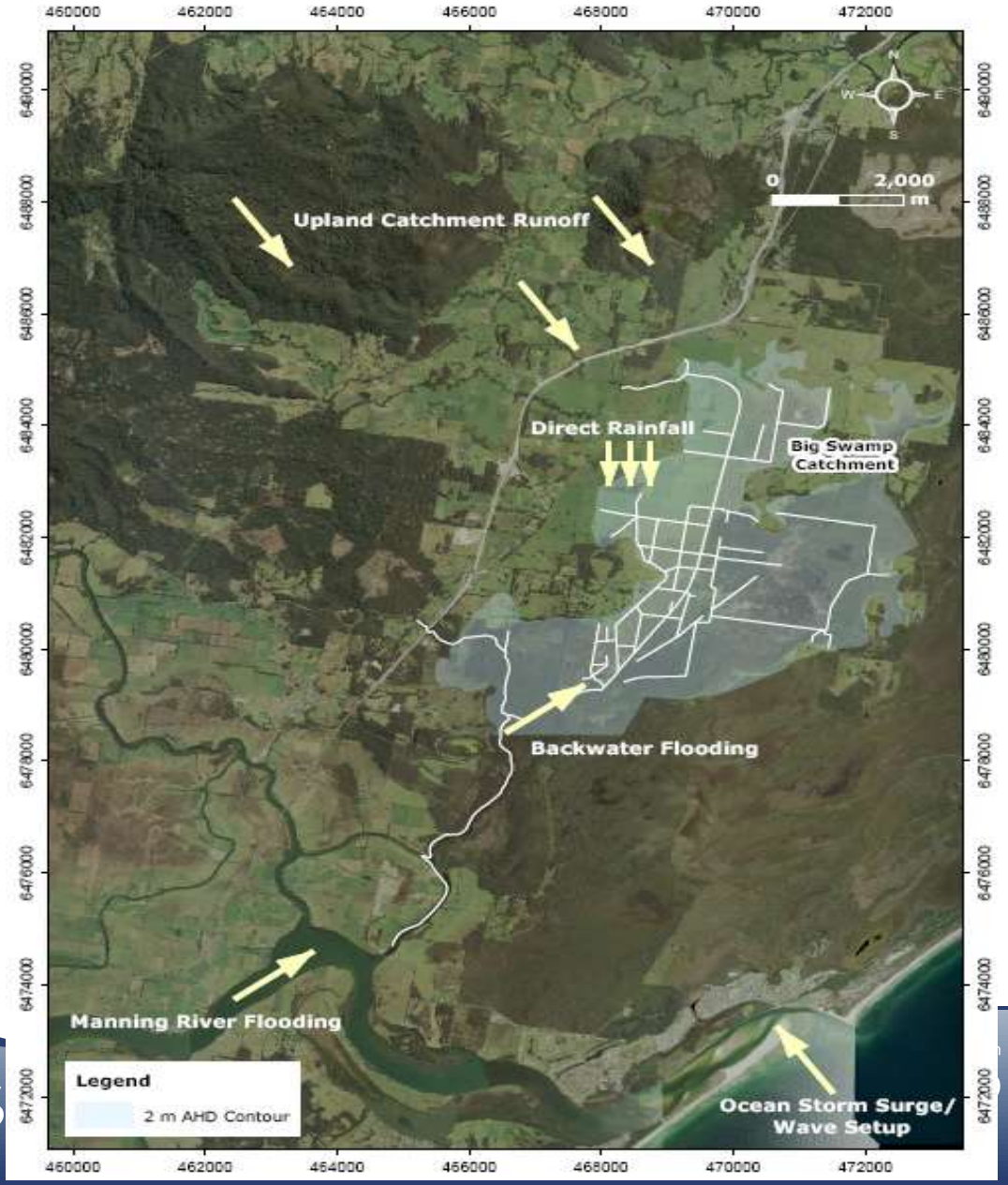


Approximate Hydraulic Conductivity of the Groundwater at Big Swamp.

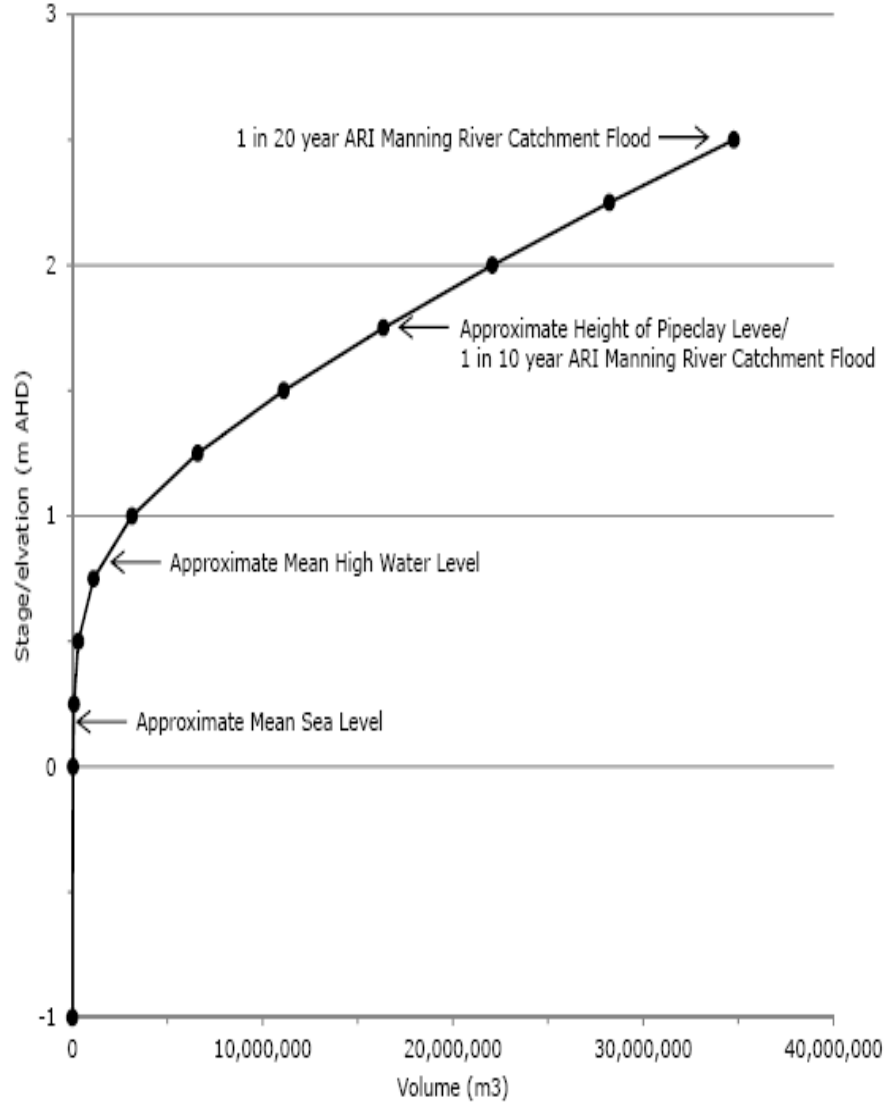
Wet Conditions- Flooding on Big Swamp

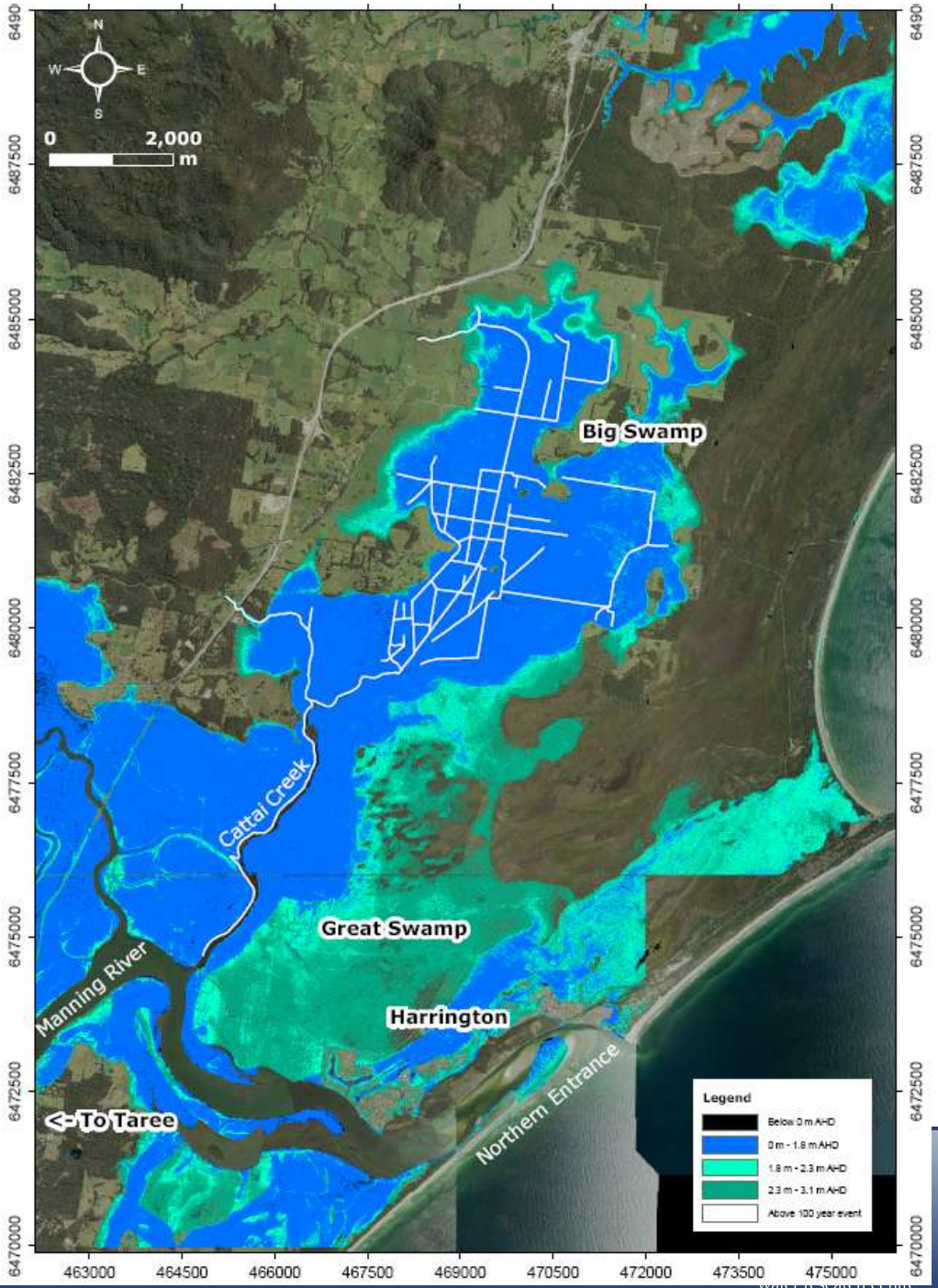
- Levee Bank at 1.8m AHD
- 1% ARI = 3.1 m AHD

- A 100 year event is required to flood Big Swamp over the levee banks from local catchment runoff
- Levee banks overtop from back-flooding of Manning River at ~10 yr event.

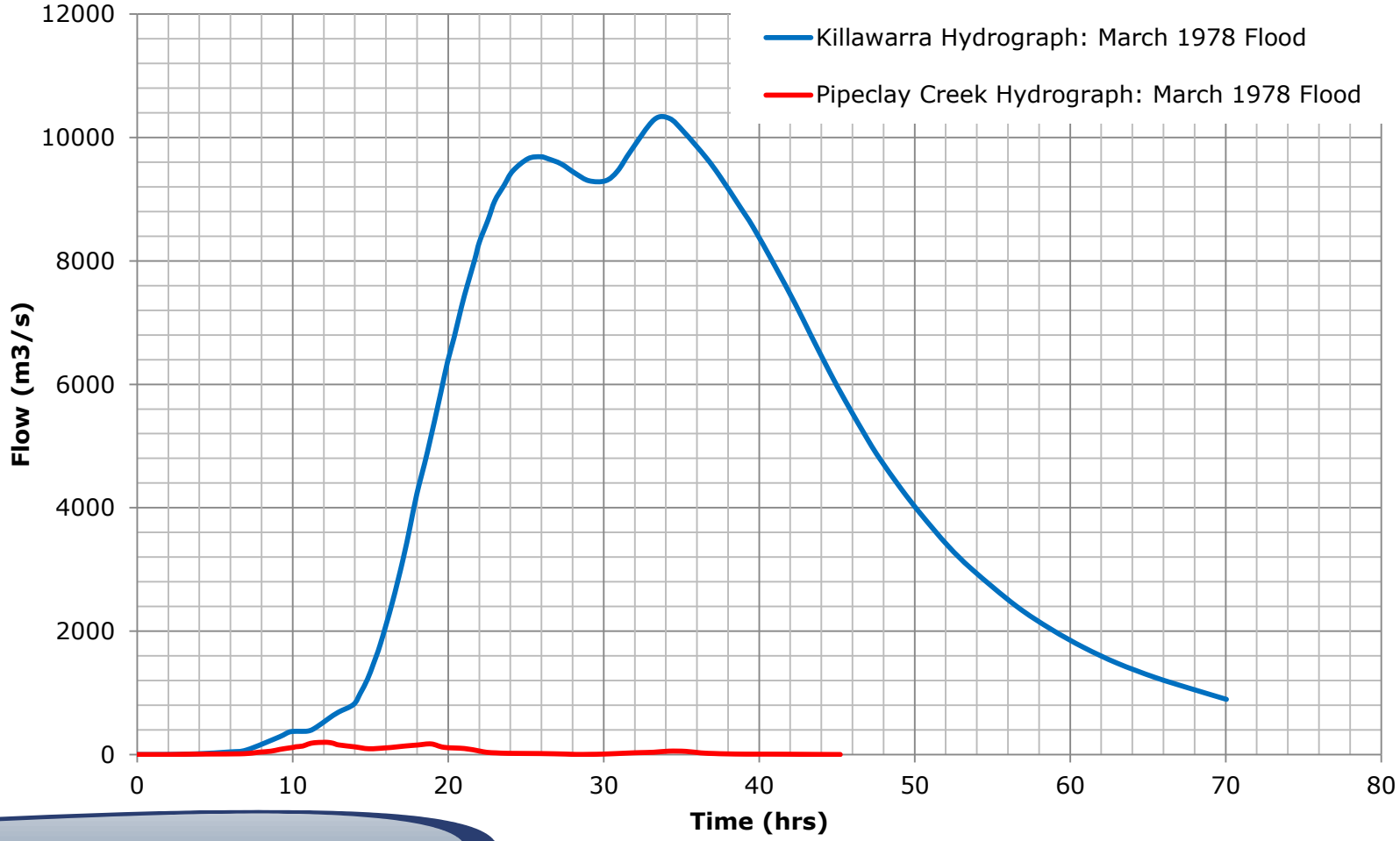


Flooding

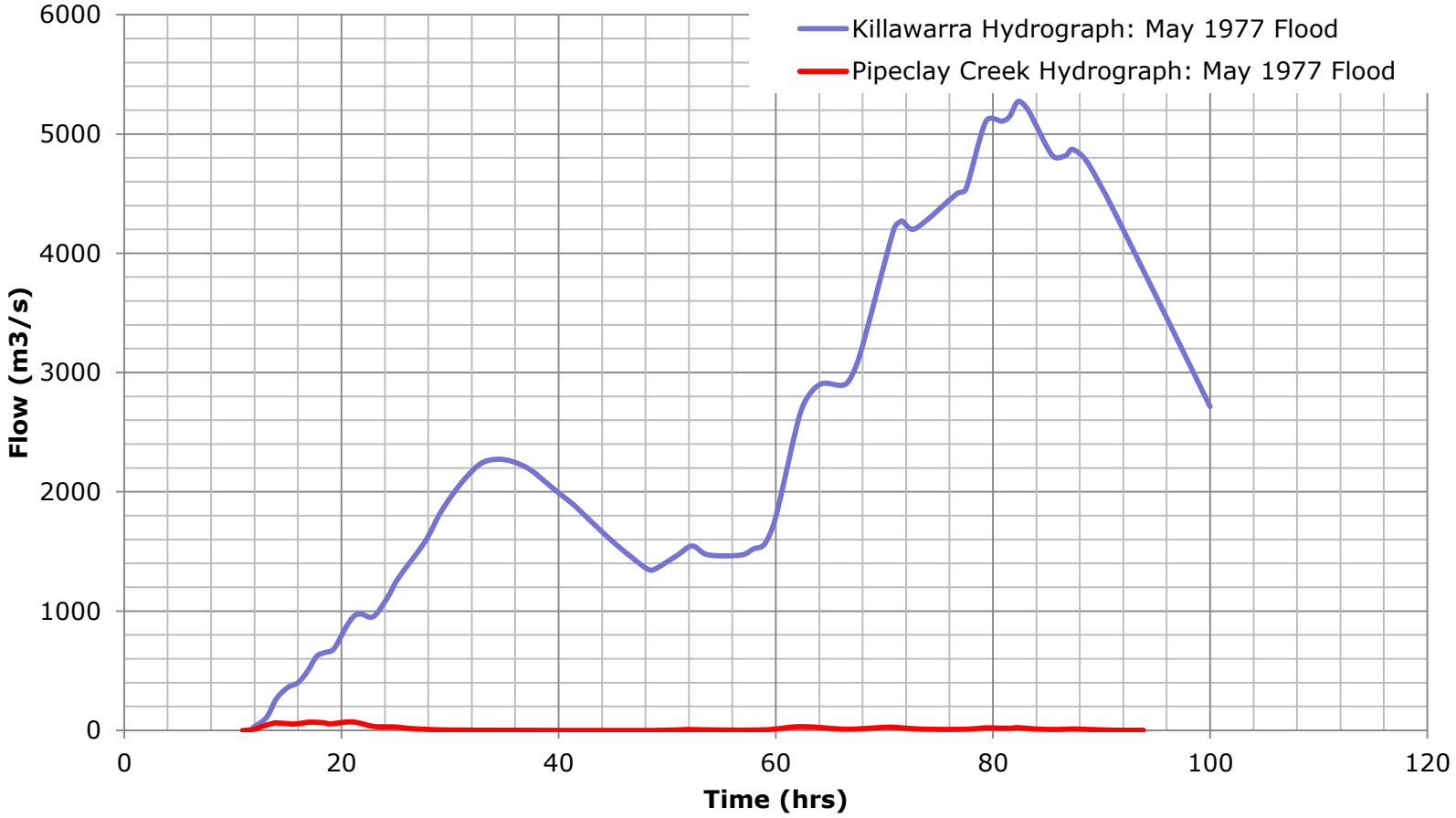

1 in 20 year ARI Manning River Catchment Flood
Approximate Height of Pipeclay Levee/
1 in 10 year ARI Manning River Catchment Flood
Approximate Mean High Water Level
Approximate Mean Sea Level
Stage/elvation (m AHD)
3
2
1
0
-1
0
10,000,000
20,000,000
30,000,000
40,000,000
Volume (m3)

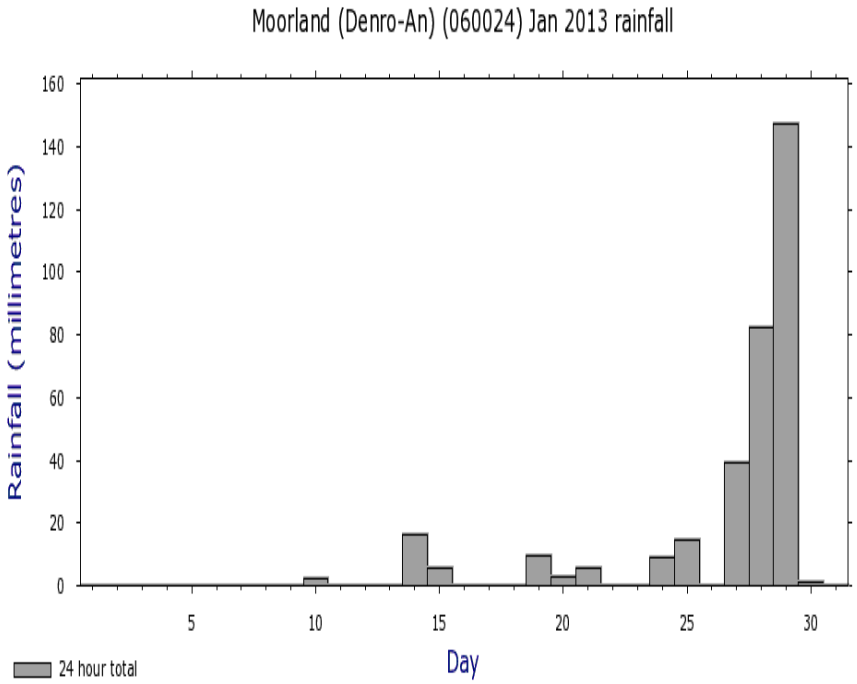

N
W
E
S
0
2,000
m
Big Swamp
Cattai Creek
Great Swamp
Manning River
Harrington
<- To Taree
Northern Entrance
Legend
Below 0 m AHD
0 m - 1.8 m AHD
1.8 m - 2.3 m AHD
2.3 m - 3.1 m AHD
Above 100 year event
6490
6487500
6485000
6482500
6480000
6477500
6475000
6472500
6470000
463000
464500
466000
467500
469000
470500
472000
473500
475000

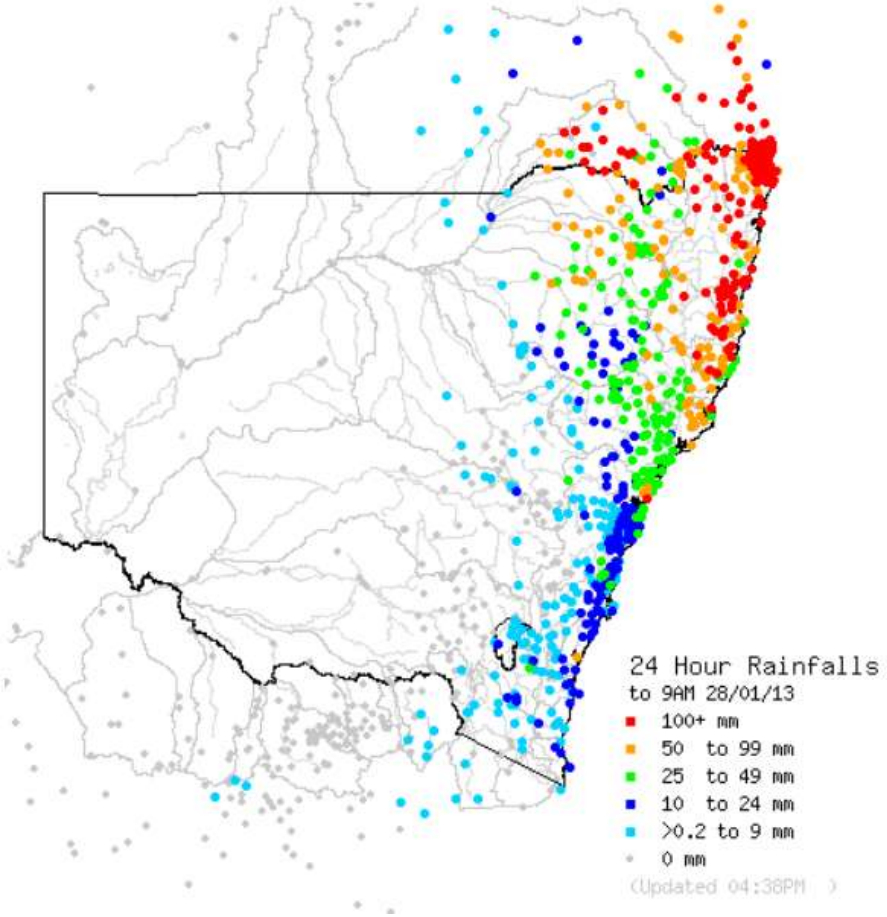
Flood Event: March 1978 (1.3% AEP)



Flood Event: May 1977 (15% AEP)

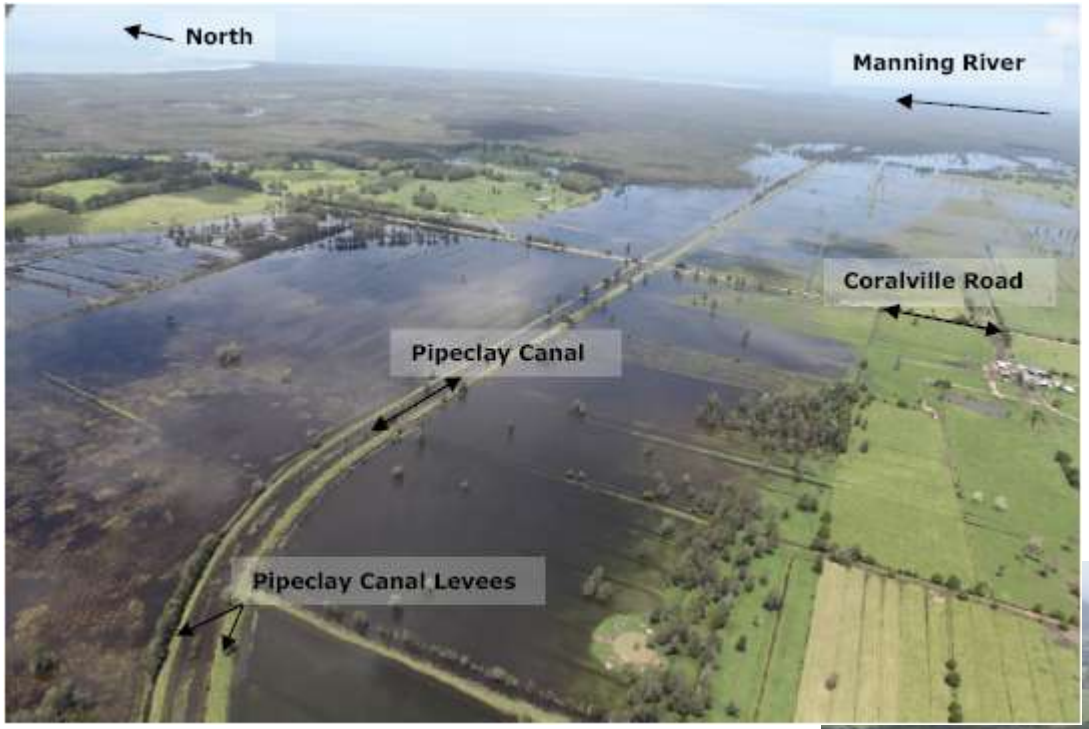


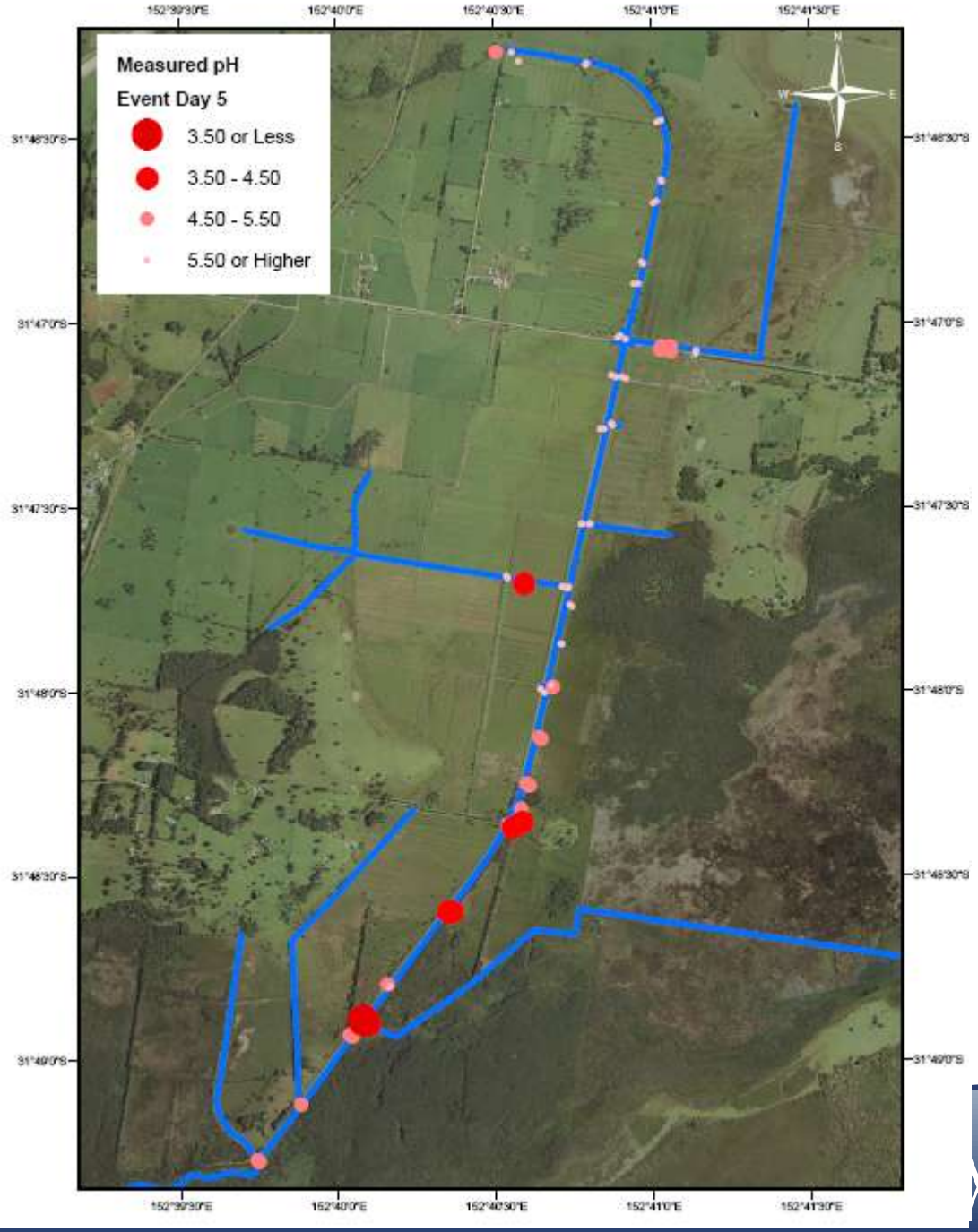


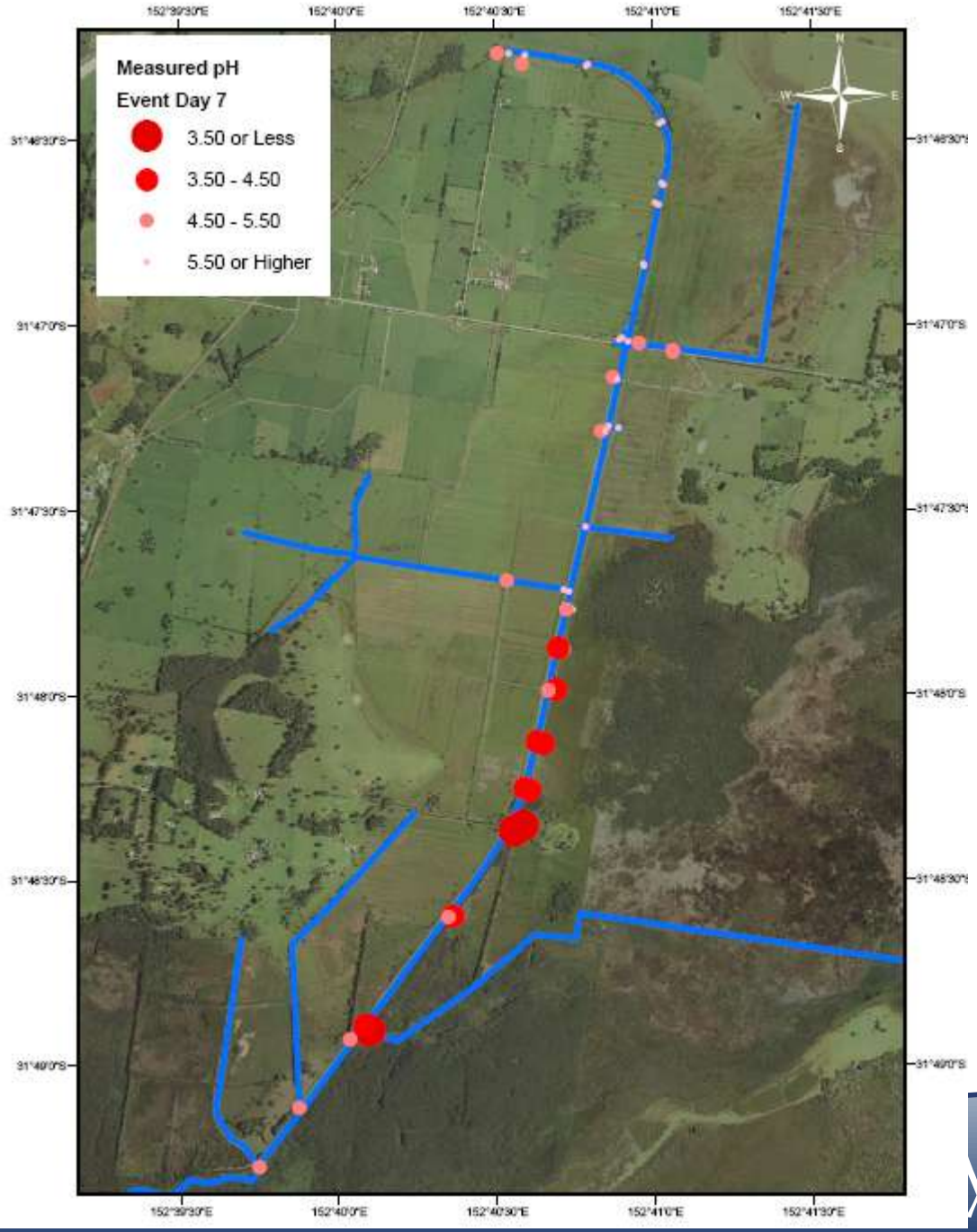


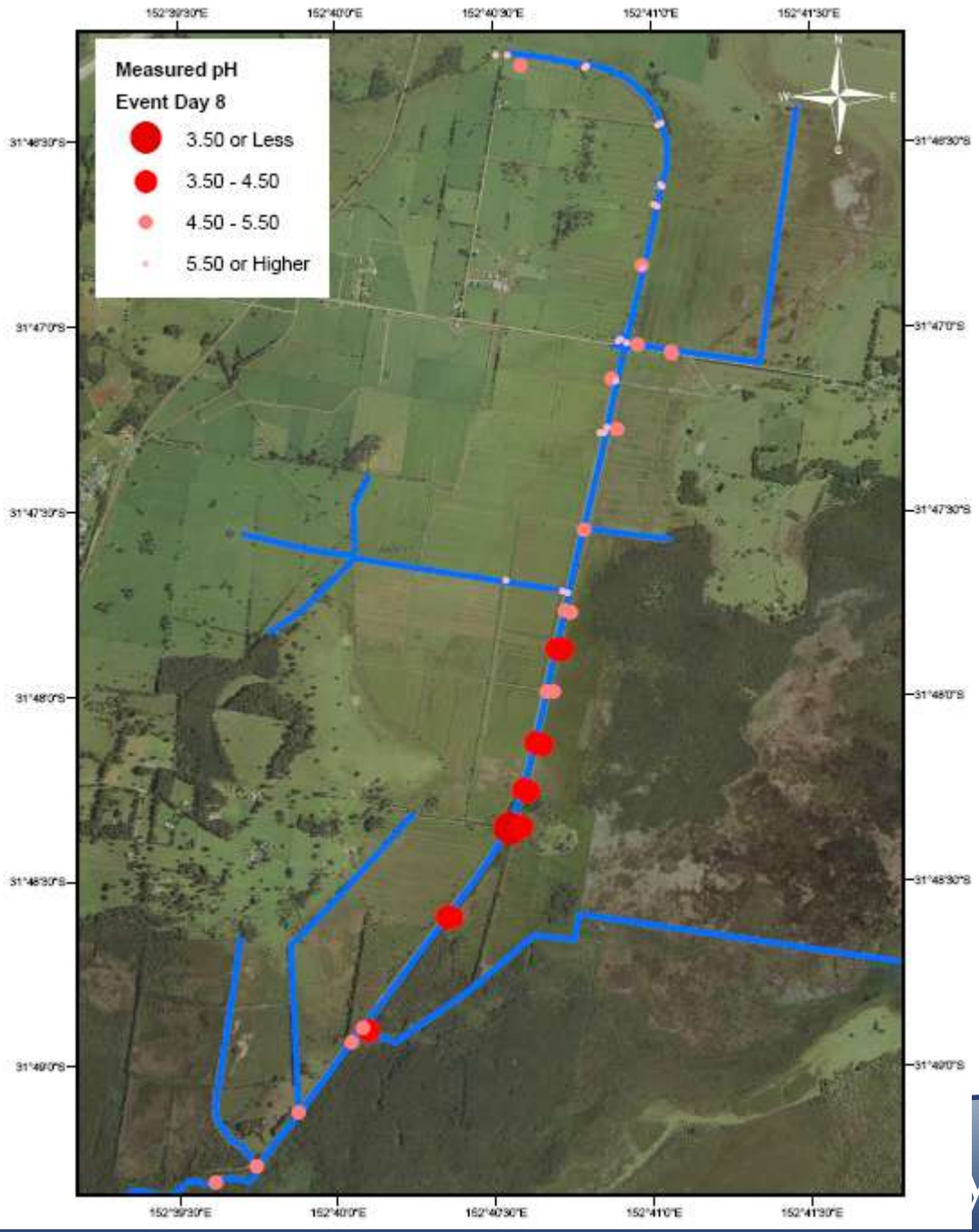
>200 mm of rainfall was recorded at the site in 3 days in late Jan 2013

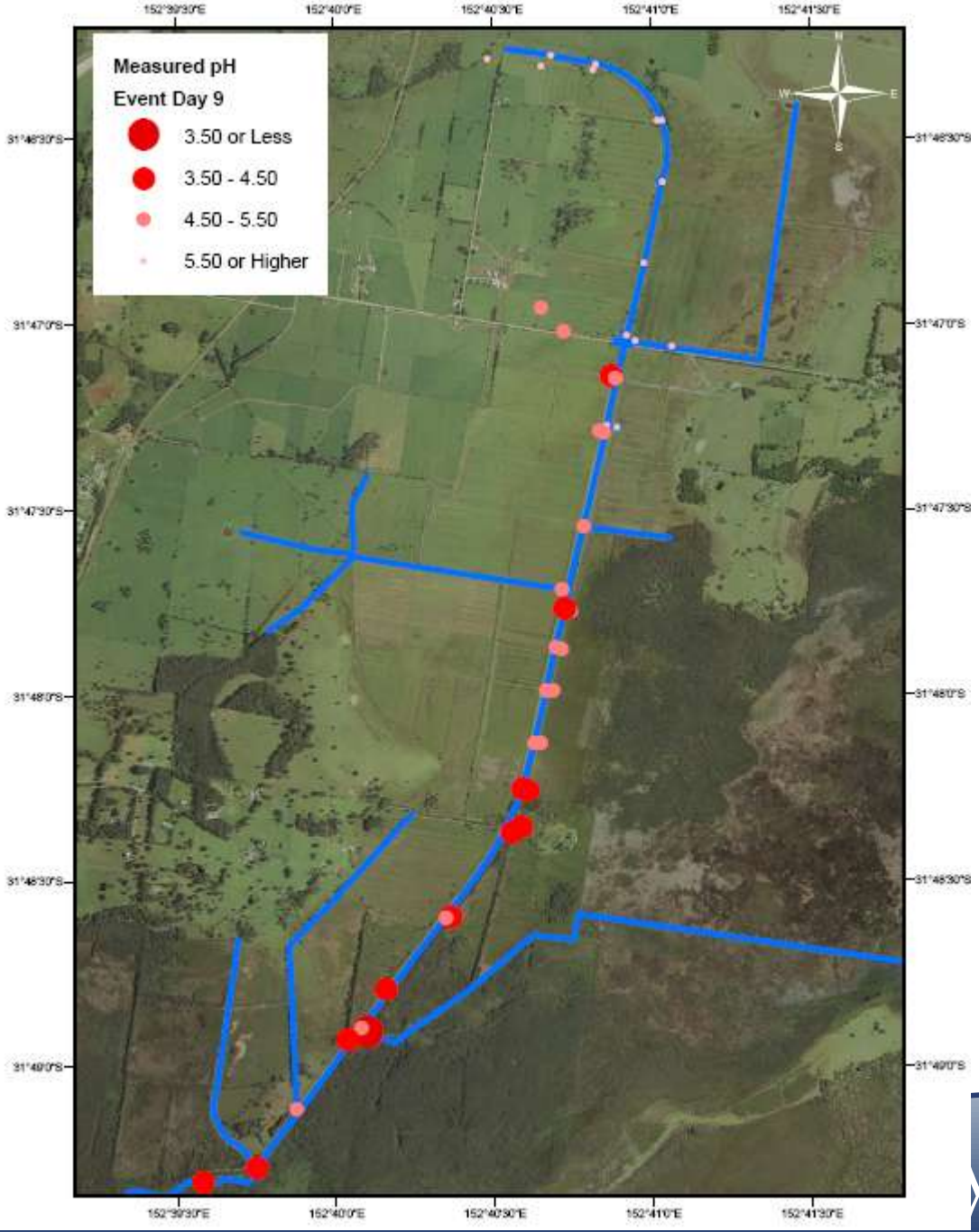
Wet Conditions: Jan-Feb 2013

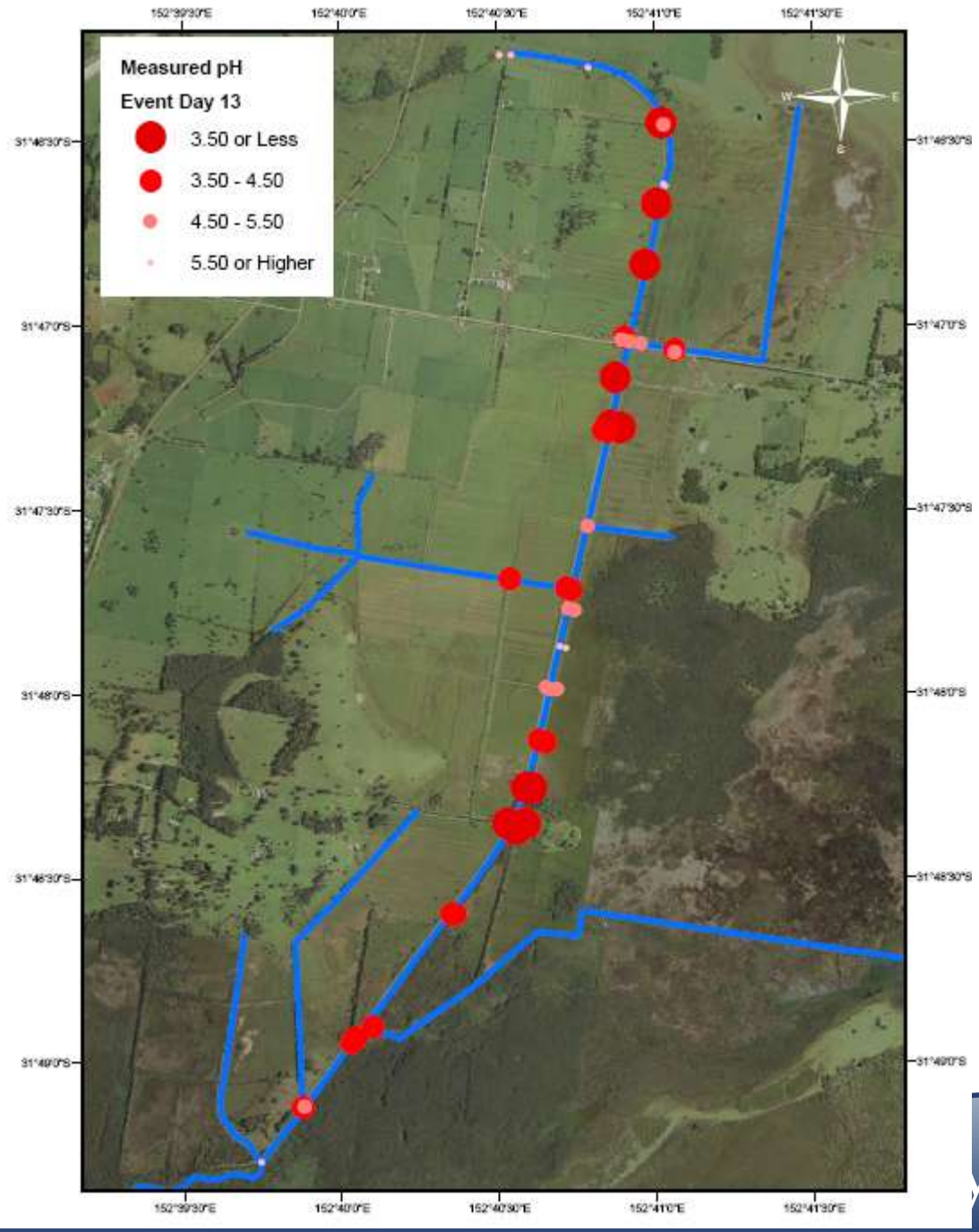



Measured pH
Event Day 5
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°39'30"E
152°40'0"E
152°40'30"E
152°41'0"E
152°41'30"E
31°46'30"S
31°47'0"S
31°47'30"S
31°48'0"S
31°48'30"S
31°49'0"S
N
S
E
W


Measured pH
Event Day 7
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°39'30"E
152°40'0"E
152°40'30"E
152°41'0"E
152°41'30"E
31°46'30"S
31°47'0"S
31°47'30"S
31°48'0"S
31°48'30"S
31°49'0"S
N
S
E
W


Measured pH
Event Day 8
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°39'30"E
152°40'0"E
152°40'30"E
152°41'0"E
152°41'30"E
31°46'30"S
31°47'0"S
31°47'30"S
31°48'0"S
31°48'30"S
31°49'0"S
N
W
E
S


Measured pH
Event Day 9
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°39'30"E
152°40'0"E
152°40'30"E
152°41'0"E
152°41'30"E
31°46'30"S
31°47'0"S
31°47'30"S
31°48'0"S
31°48'30"S
31°49'0"S
N
S
E
W


Measured pH
Event Day 13
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
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152°40'0"E
152°40'30"E
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152°41'30"E
31°46'30"S
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31°47'30"S
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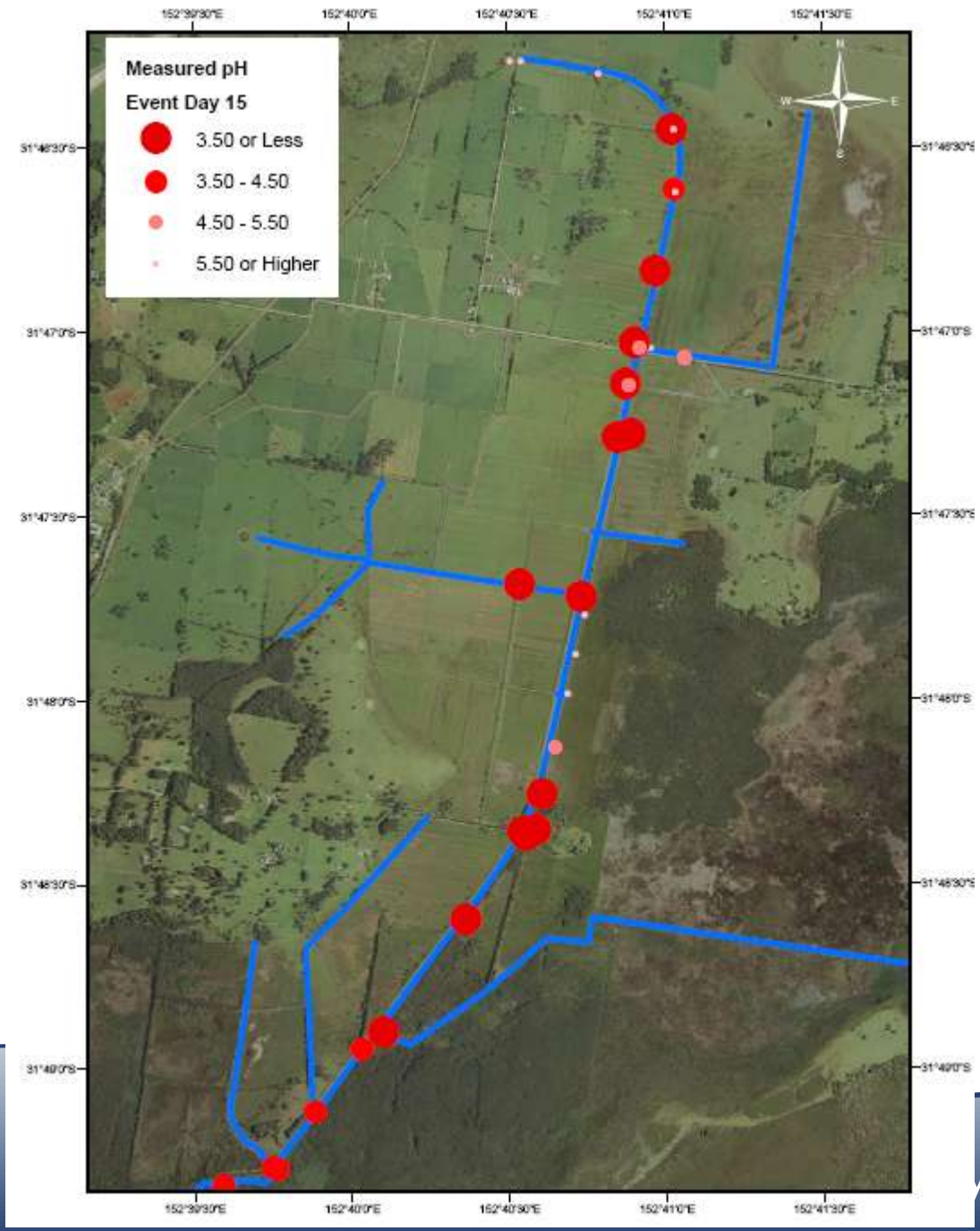
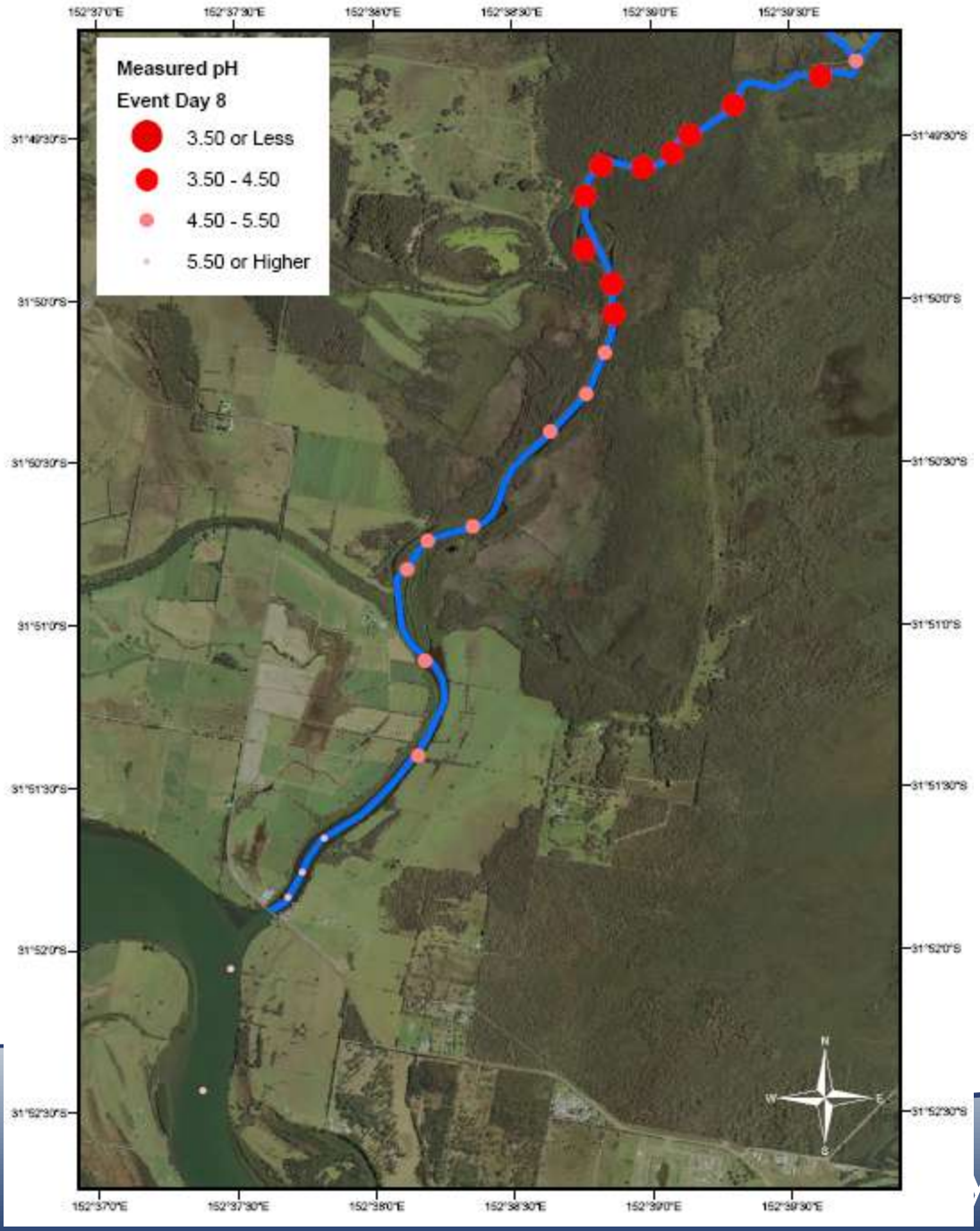
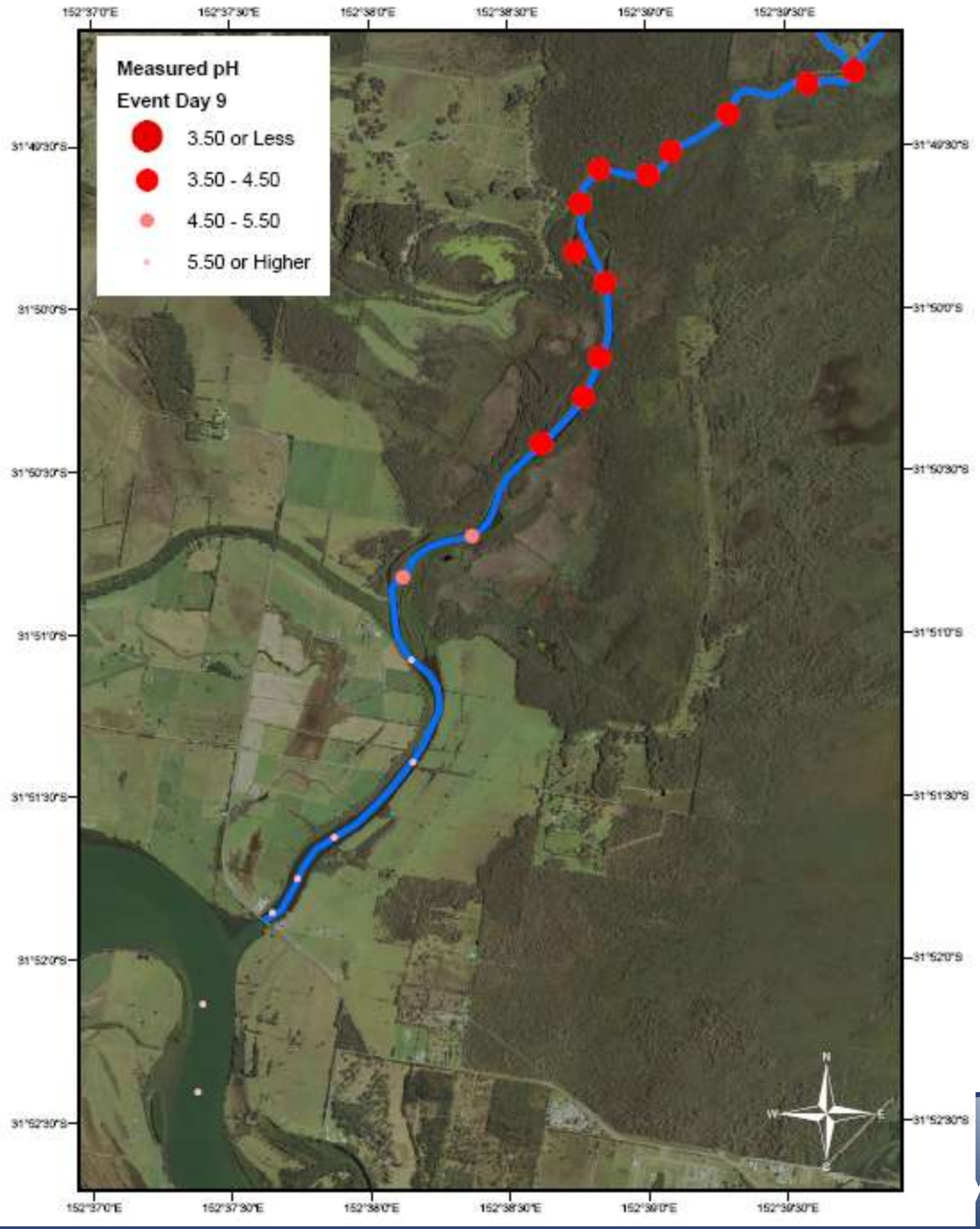
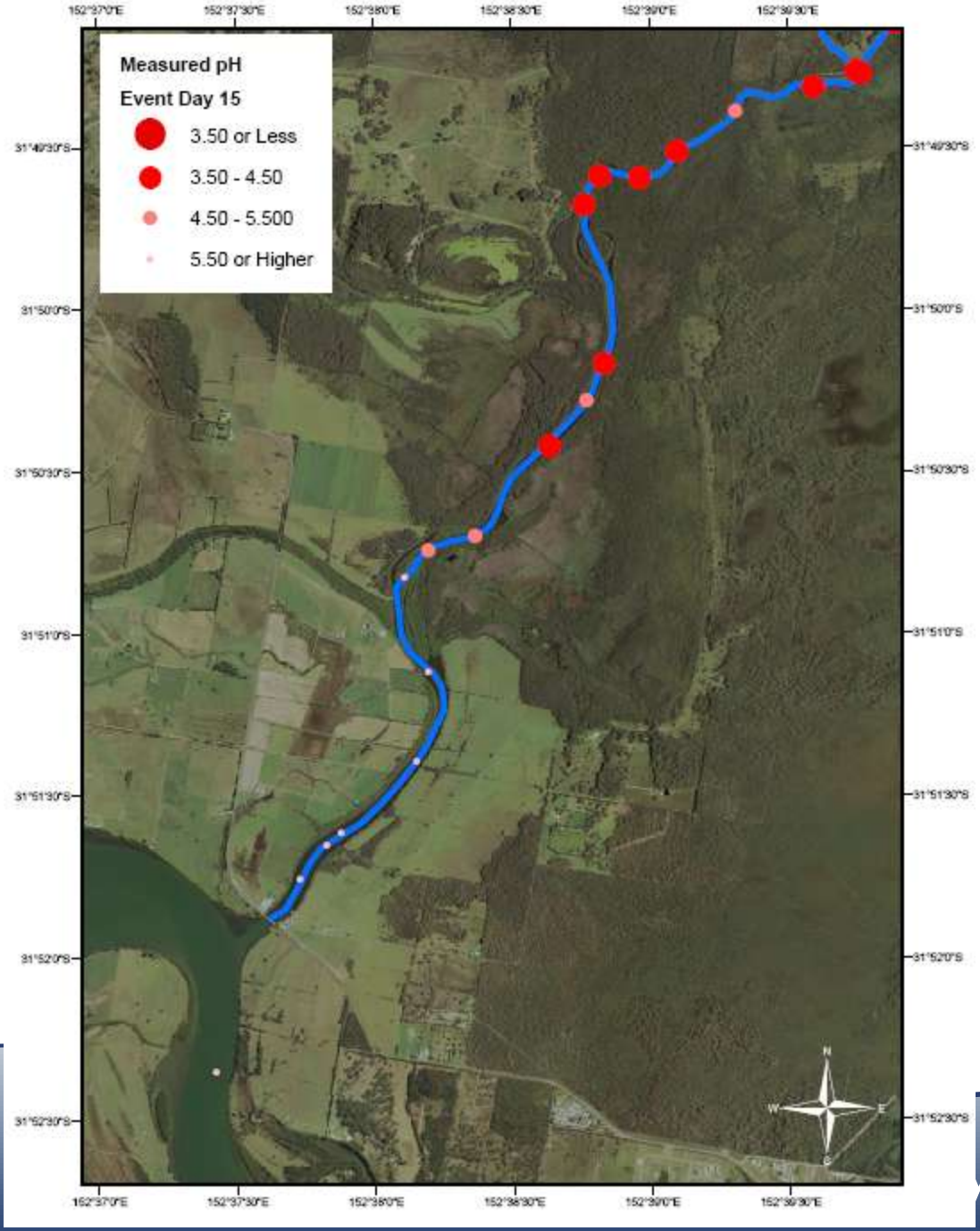
31°48'30"S
31°49'0"S
N
W
E
S


Measured pH
Event Day 15
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°39'30"E
152°40'0"E
152°40'30"E
152°41'0"E
152°41'30"E
31°48'30"S
31°47'0"S
31°47'30"S
31°48'0"S
31°48'30"S
31°49'0"S
N
S
E
W


Measured pH
Event Day 8
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°37'0"E
152°37'30"E
152°38'0"E
152°38'30"E
152°39'0"E
152°39'30"E
31°49'30"S
31°50'0"S
31°50'30"S
31°51'0"S
31°51'30"S
31°52'0"S
31°52'30"S
N
W
E
S


Measured pH
Event Day 9
3.50 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
152°37'0"E
152°37'30"E
152°38'0"E
152°38'30"E
152°39'0"E
152°39'30"E
31°49'30"S
31°50'0"S
31°50'30"S
31°51'0"S
31°51'30"S
31°52'0"S
31°52'30"S
N
S
E
W


Measured pH
Event Day 15
3.50 or Less
3.50 - 4.50
4.50 - 5.500
5.50 or Higher
152°37'0"E
152°37'30"E
152°38'0"E
152°38'30"E
152°39'0"E
152°39'30"E
31°49'30"S
31°50'0"S
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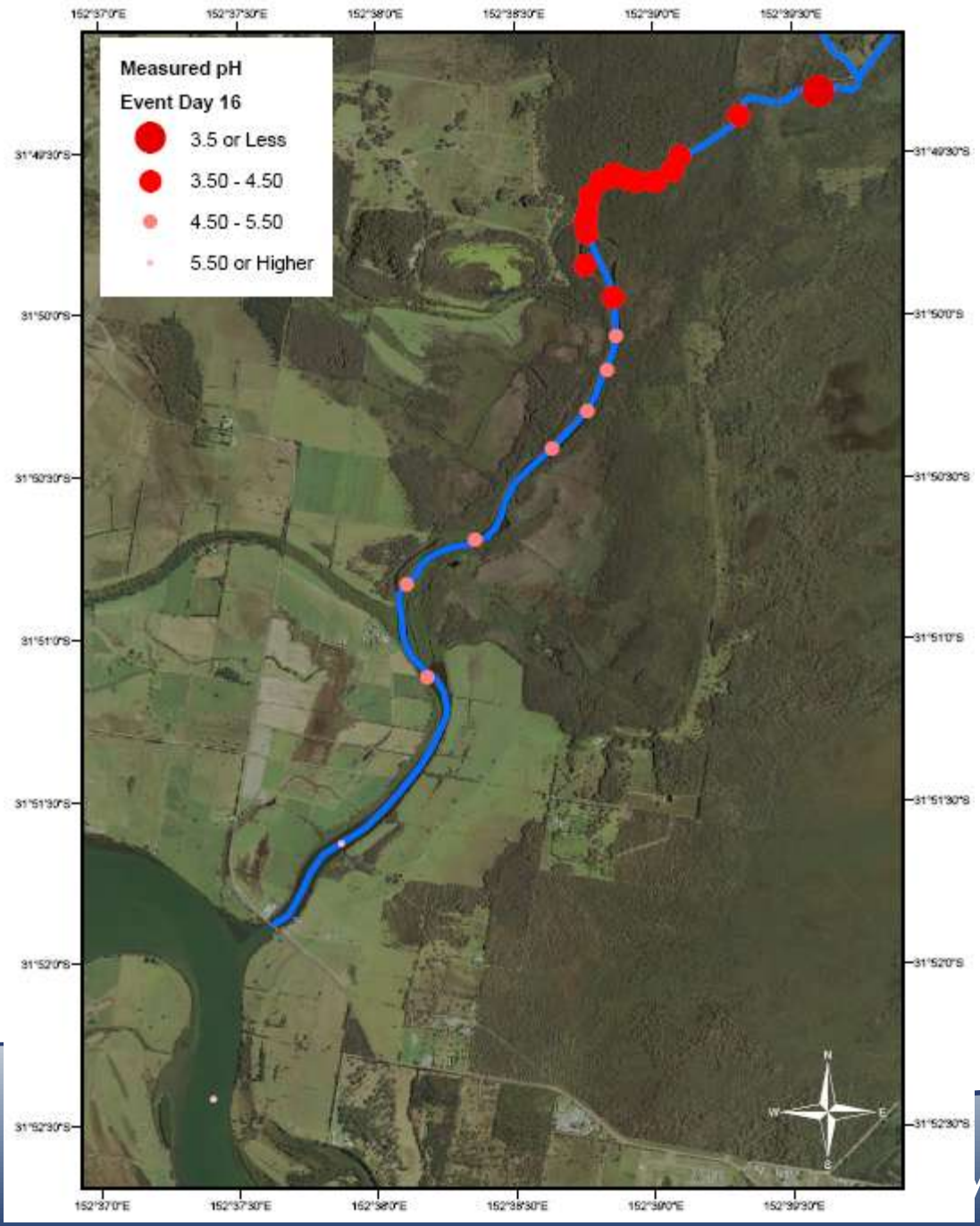
31°51'30"S
31°52'0"S
31°52'30"S
N
W
E
S


Measured pH
Event Day 16
3.5 or Less
3.50 - 4.50
4.50 - 5.50
5.50 or Higher
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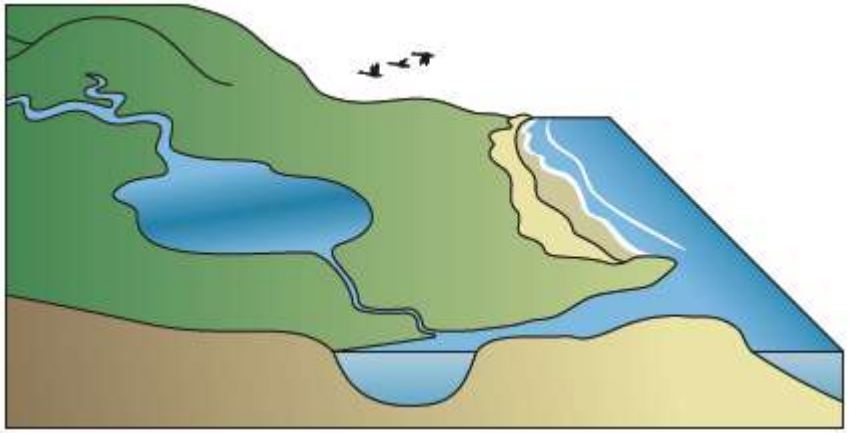
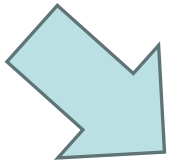
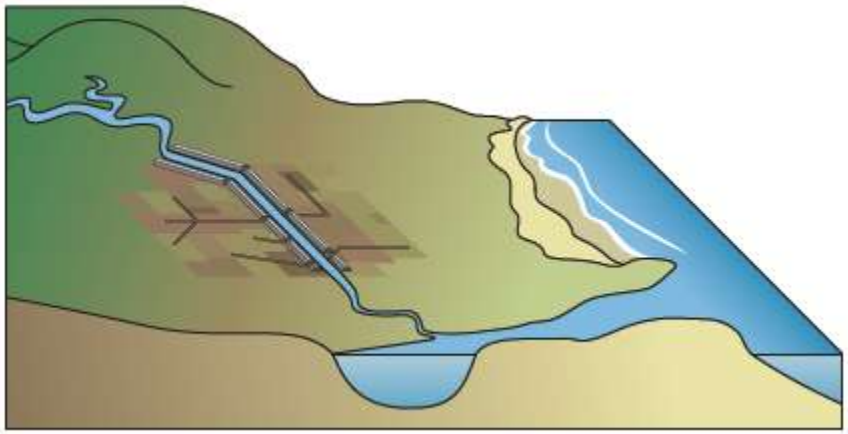
152°38'30"E
152°39'0"E
152°39'30"E
31°49'30"S
31°50'0"S
31°50'30"S
31°51'0"S
31°51'30"S
31°52'0"S
31°52'30"S
N
W
E
S

On-ground Impacts

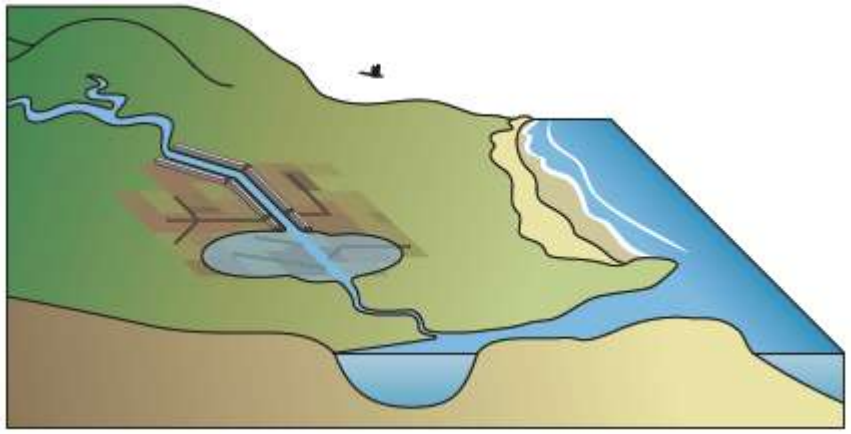






Remediation Options

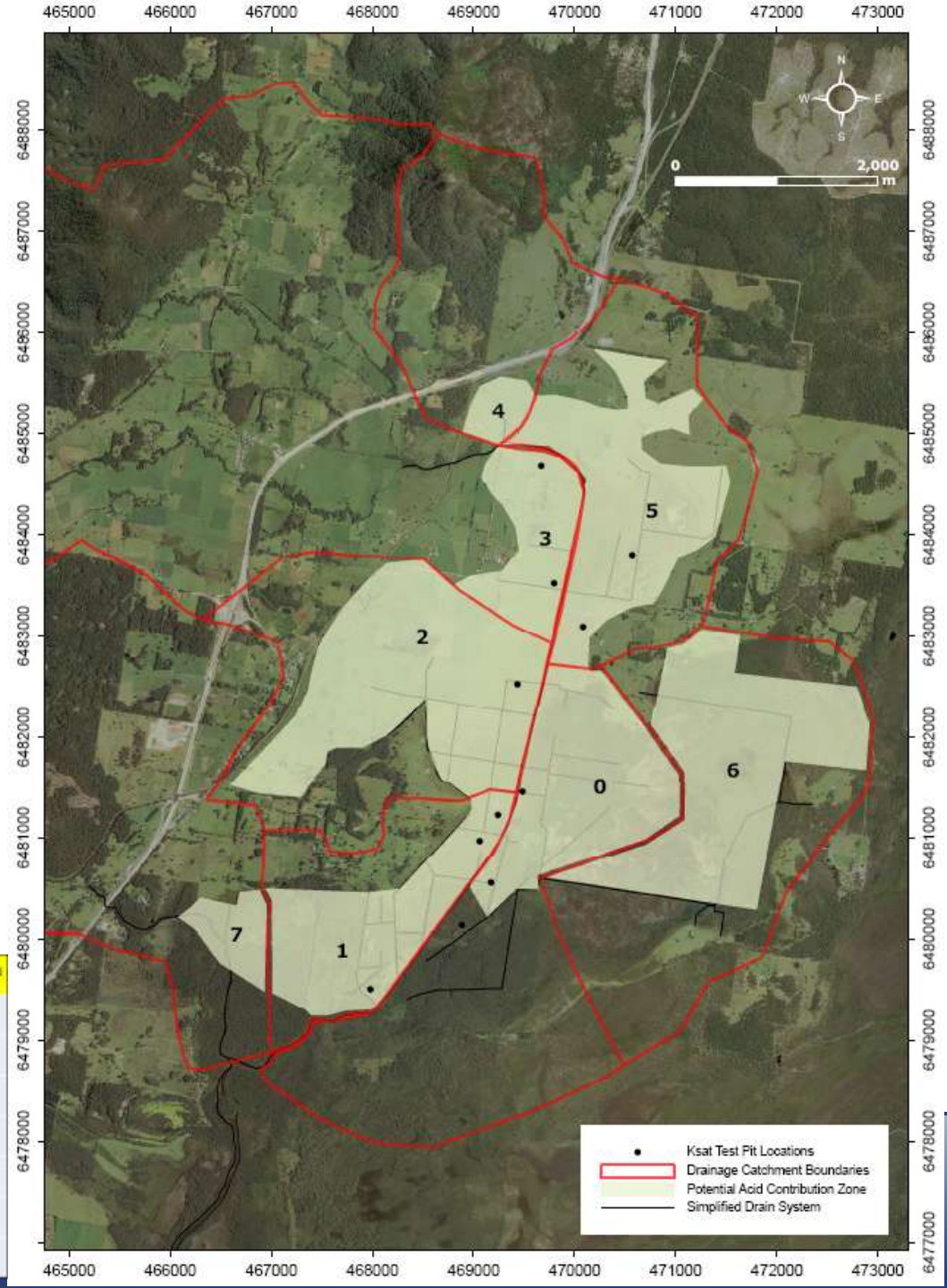
What can we do?

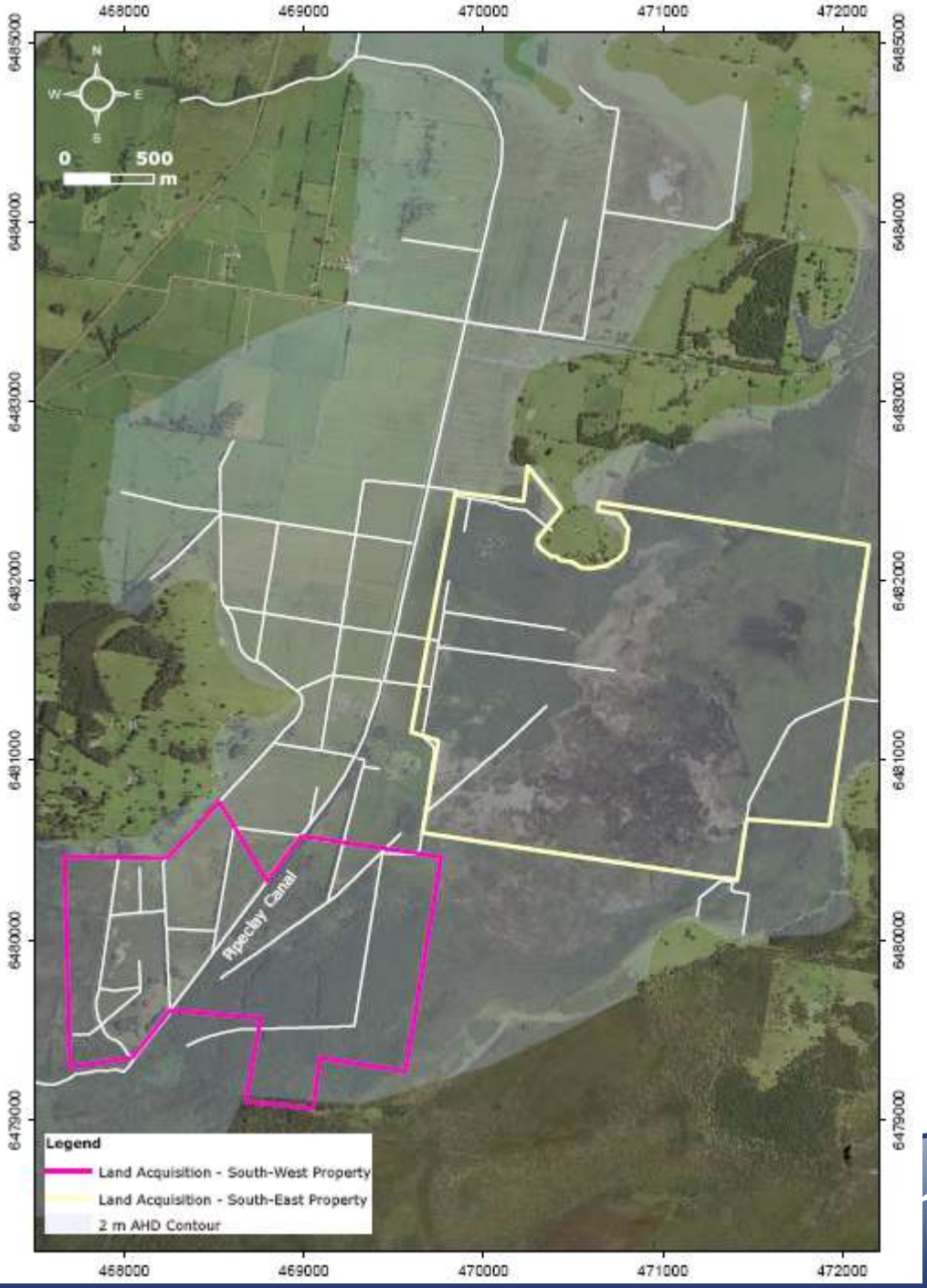


Priority Assessment

- Developed Method to determine which areas are highest priority and should be remediated.
- Based on:
  - Groundwater/Soil
  - Acidity
  - Surface water
  - Total discharge
- Areas 1/7 and 0/6 were highest priority

ID	Normalised Area	Catchment/ Drained	Catchment Area	Drained Catchment Area	Drain Length	Drainage Density	Ksat	pH	GW Factor	Score	Normalised Score
0	1.00	0.11	7,895,356	889,420	4637.5	0.0052	80	4.1	328	19%	19%
1	0.45	0.49	3,544,246	1,747,100	12021	0.0069	23	4.0	92	31%	14%
2	0.86	0.60	6,768,403	4,065,520	14730	0.0036	15	4.0	60	13%	11%
3	0.45	0.38	3,544,246	1,354,922	1542	0.0011	80	4.0	320	14%	6%
4	0.56	0.08	4,453,367	334,414	1800	0.0054	35	4.7 5	166	7%	4%
5	0.70	0.55	5,517,827	3,037,332	9213	0.0030	8	3.6	29	5%	3%
6	0.97	0.02	7,636,533	148,978	1	0.0000	19	3.5	67	0%	0%

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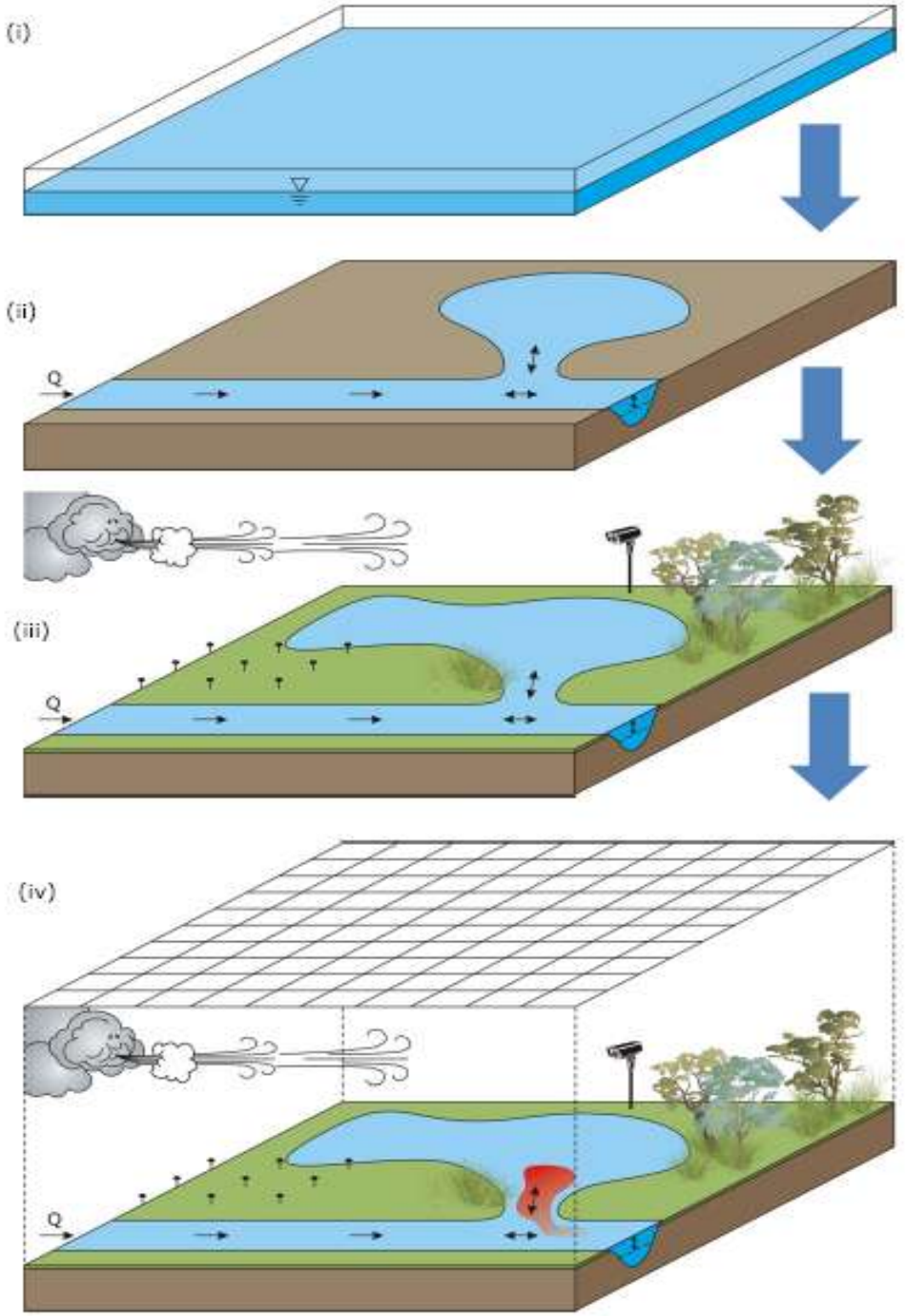
469000
470000
471000
472000
6485000
6484000
6483000
6482000
6481000
6480000
6479000
N
W
E
S
0
500
m
Pipeclay Canal
Legend
Land Acquisition - South-West Property
Land Acquisition - South-East Property
2 m AHD Contour

Restoration Options

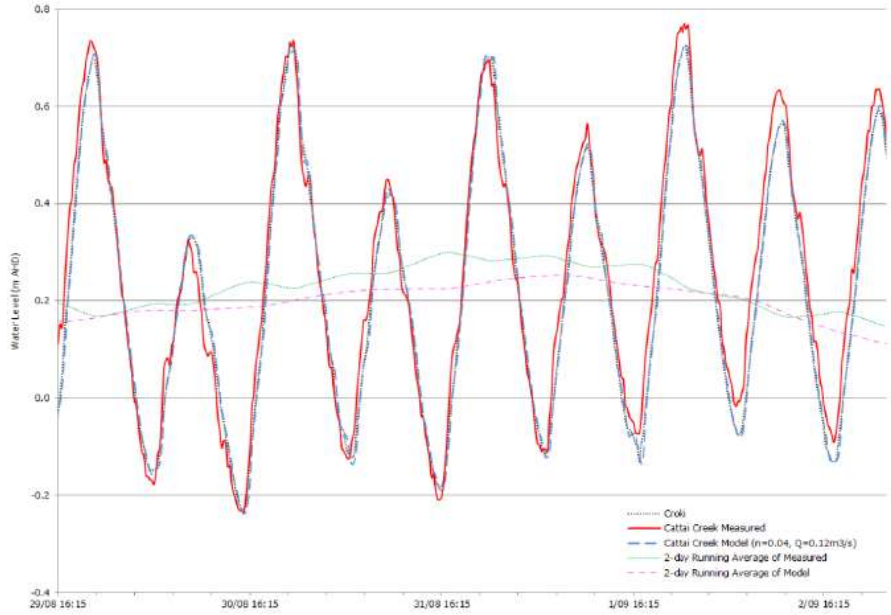
- Objective is to remediate acid problem by:
  - Dilution
  - Neutralisation
  - Reduction
- Aim is to:
  - Improve water quality
  - Reduce acid ponding
  - Improve ecology
  - Decrease acid discharges from soil
- On-ground works:
  - Encourage neutralisation at source by removing floodgates and levee sections
  - Prevent further acid creation by infilling drains and keeping wet
  - Reduce acid transport by removing floodgates and filling drains
  - Encourage reduction of existing acid
  - Ensure no impact to flooding and limit stagnant water.

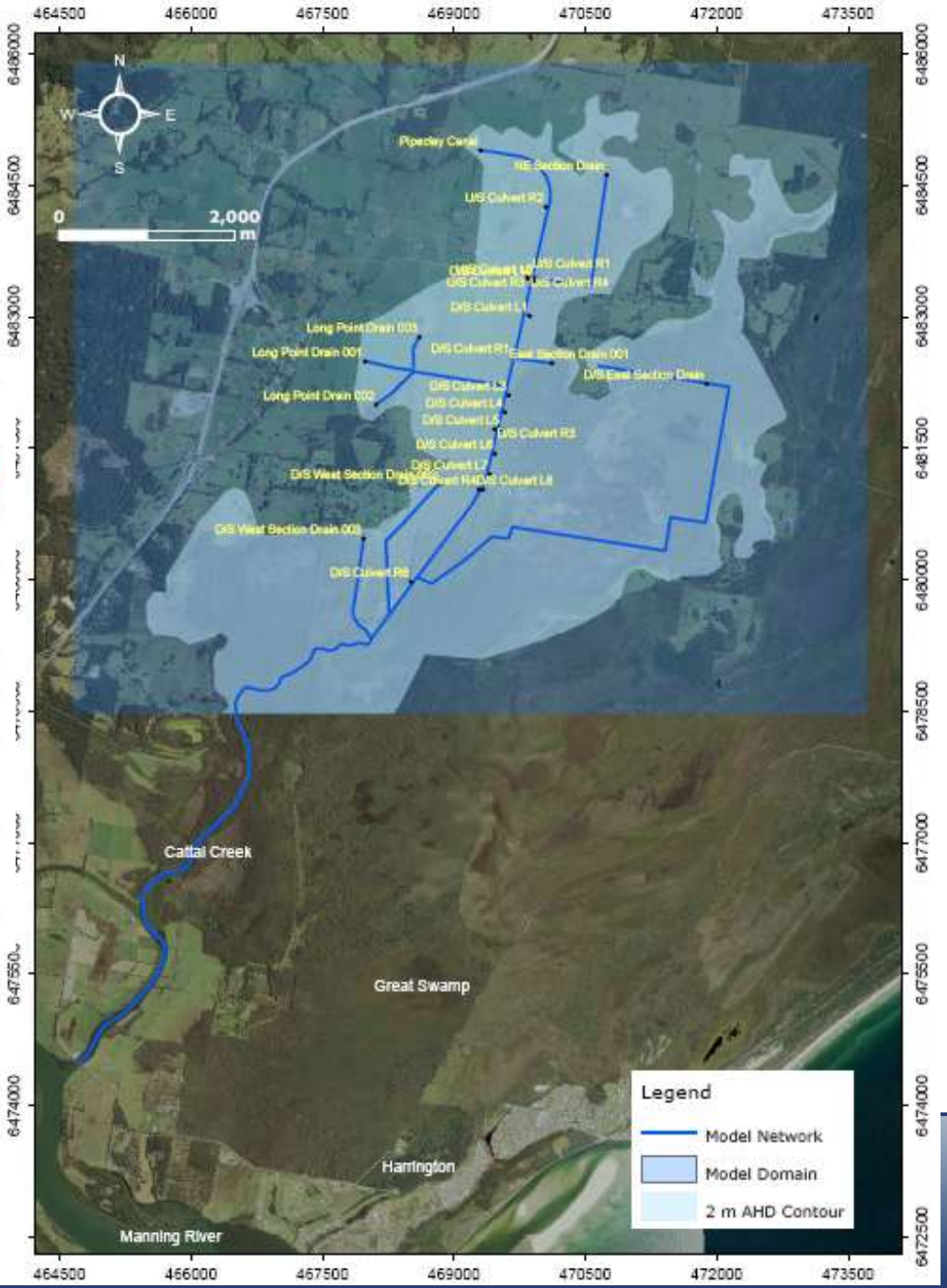
Computer Model

- Computer model developed using the field data to:
  - Assess conceptual model
  - Simulate existing scenaro
  - Modify model to test:
    - No floodgates anywhere
    - Selected restoration options
    - Dry versus wet scenarios
    - Plan for on-ground works

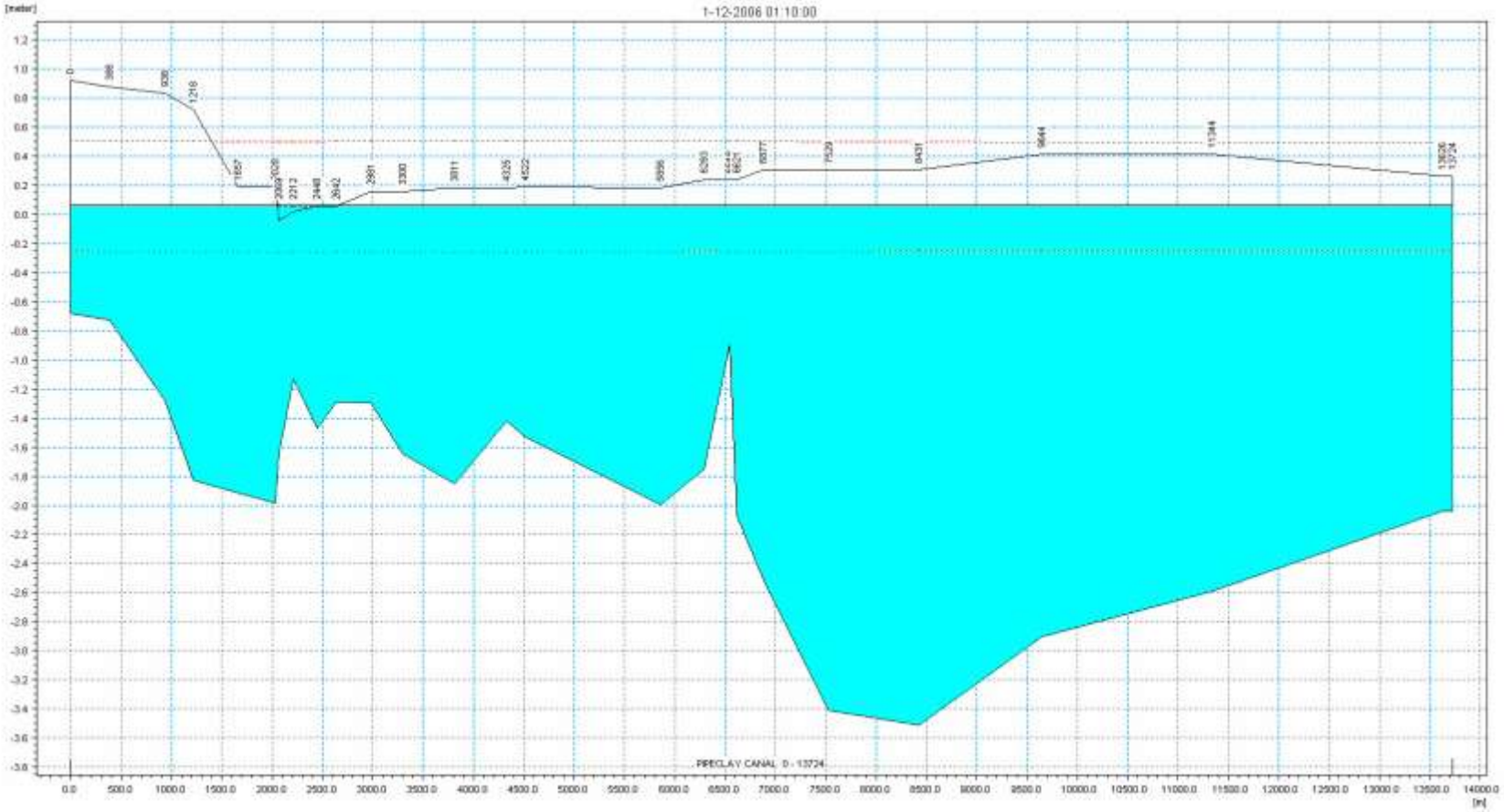


Computer Model

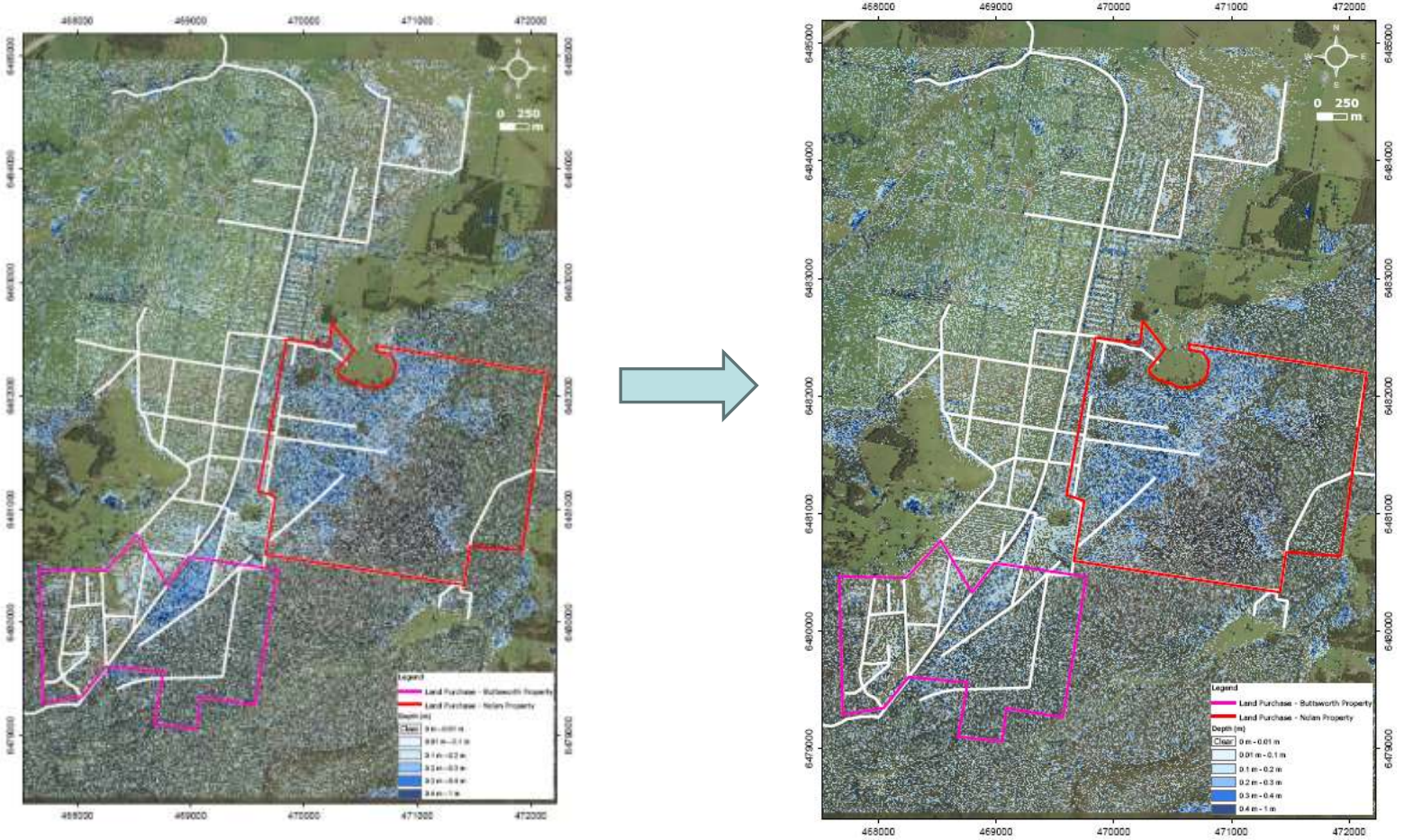




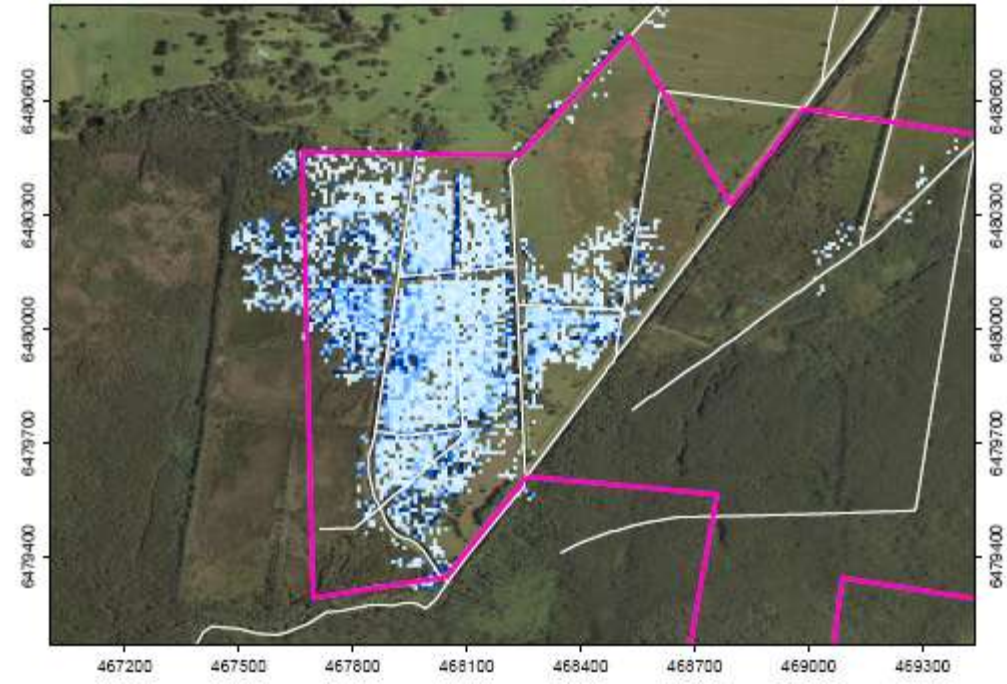
Model Results



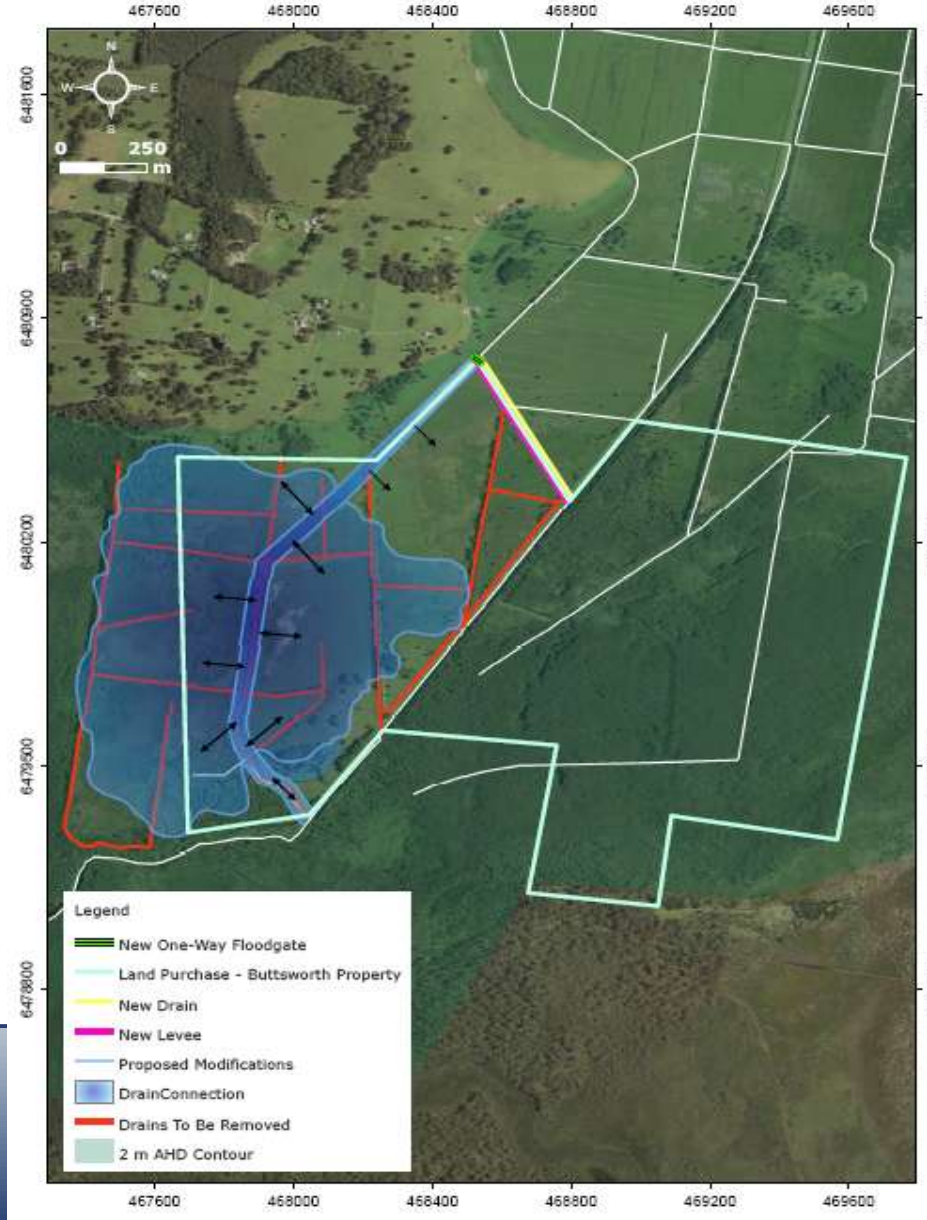
Existing Site Drainage



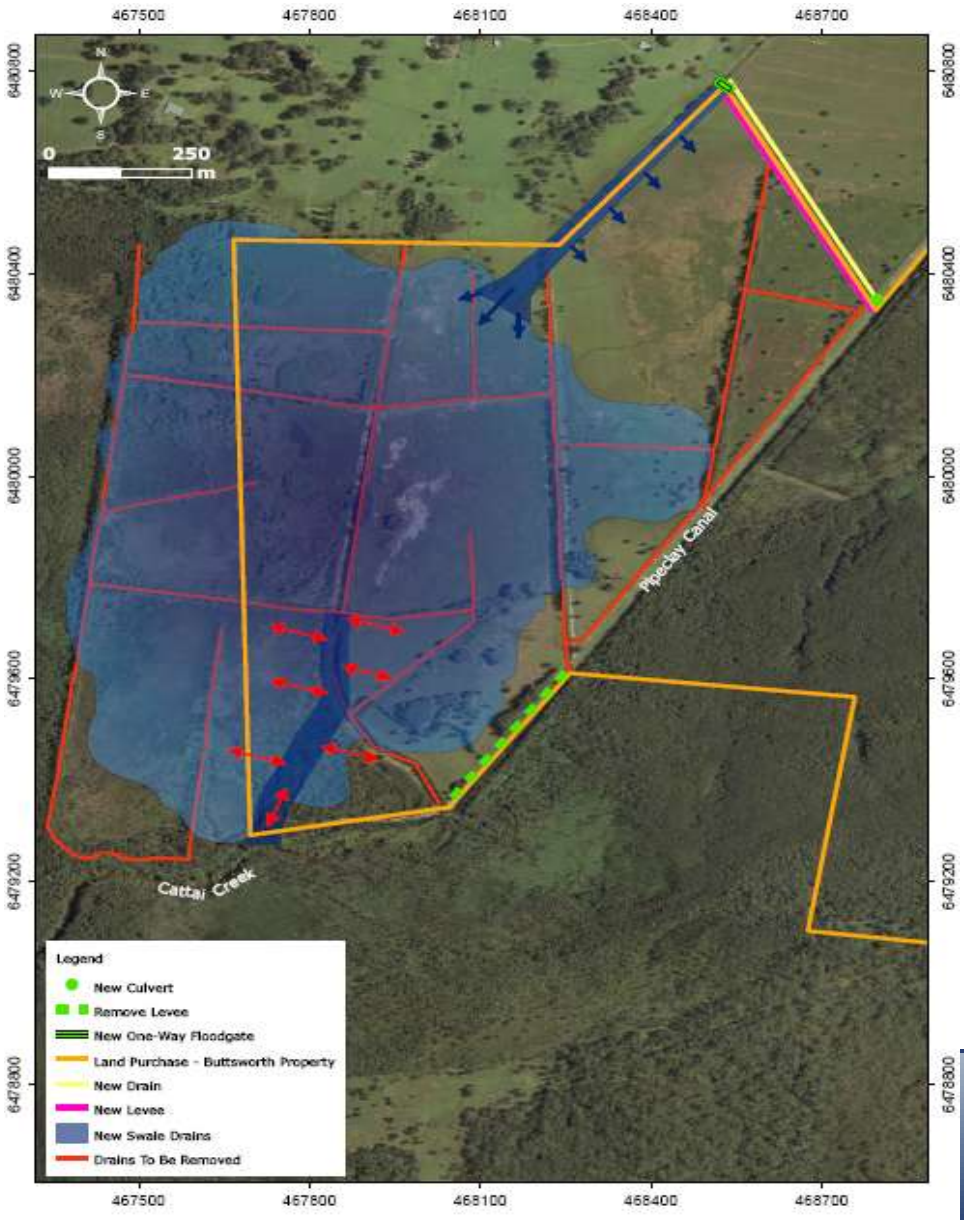
Scenario: No Floodgates



S-W Remediation Options

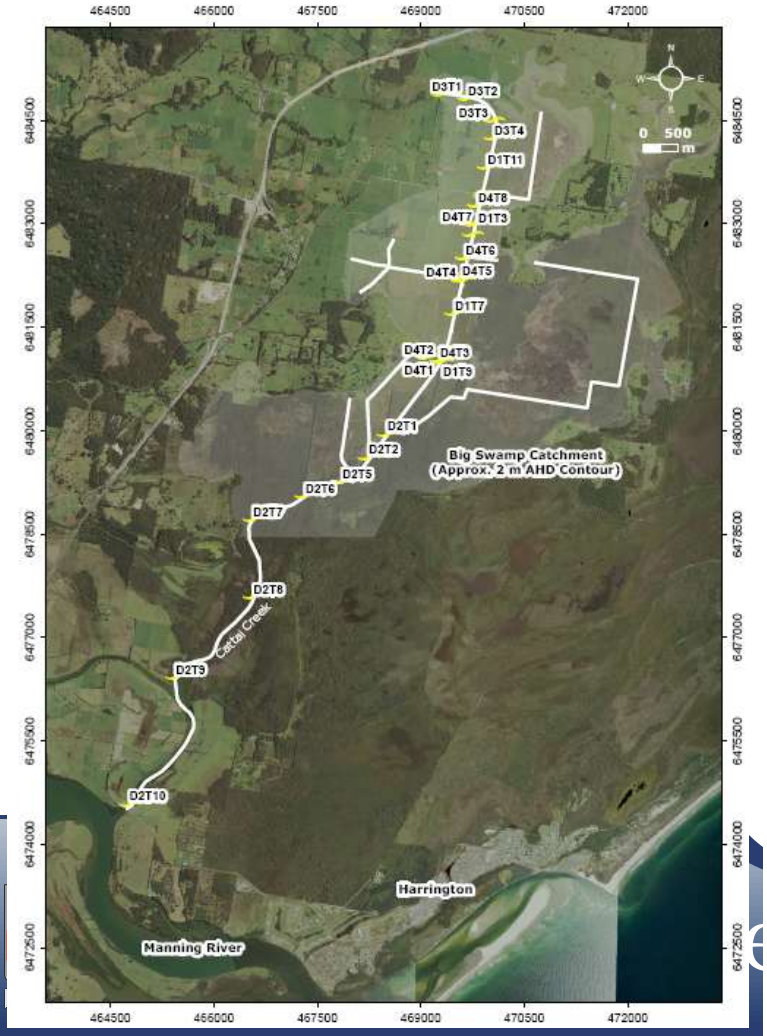


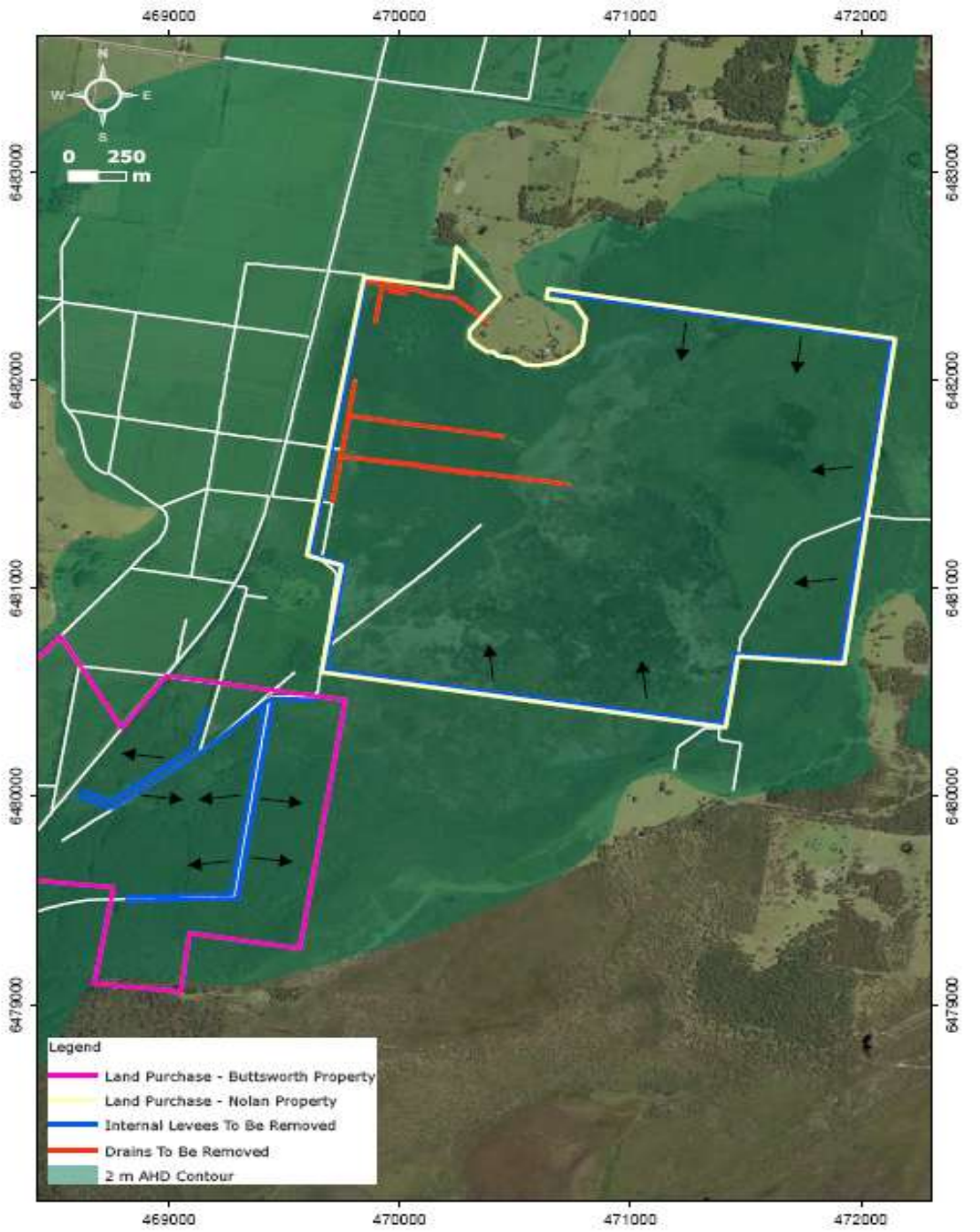
Conceptual Restoration Option 1 - South-West Property



Conceptual Restoration Option 2 - South-West Property

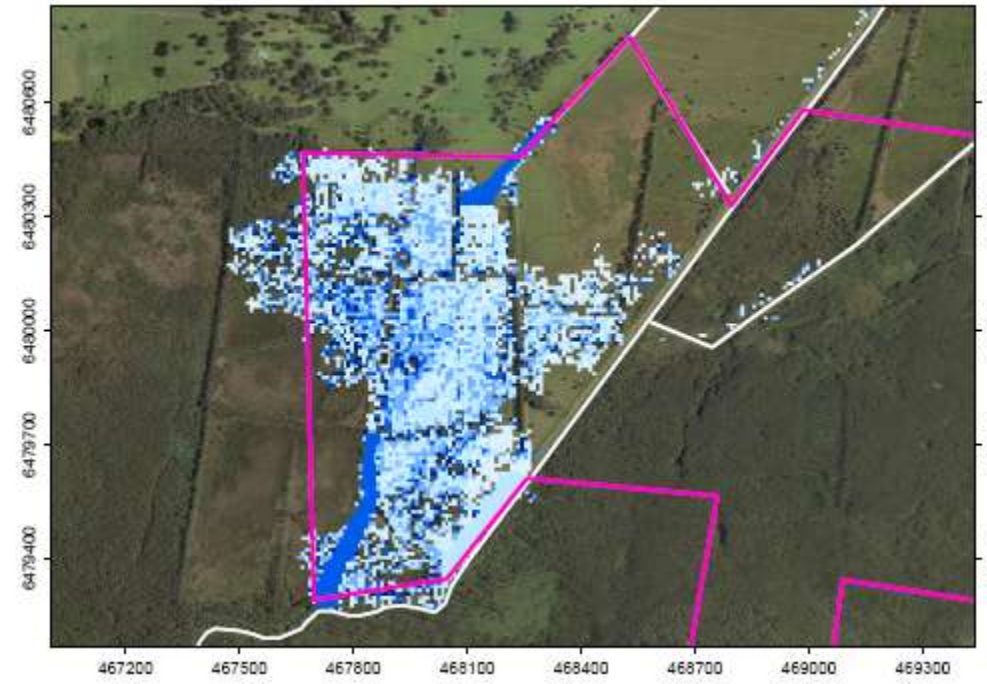
S-E Remediation Option





Conceptual Restoration Option 1 - South-West Property.

Restoration Options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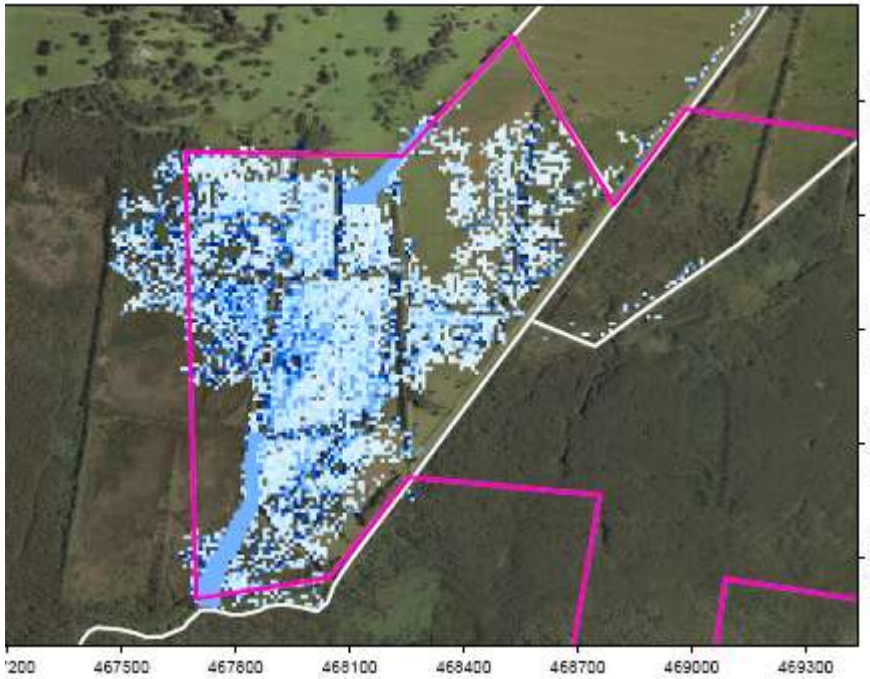
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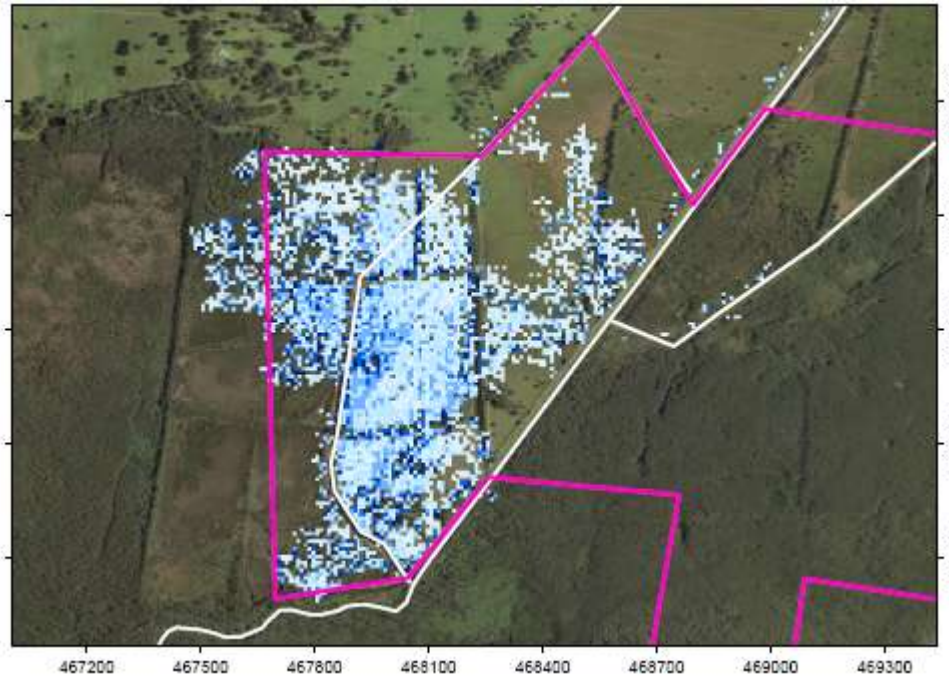
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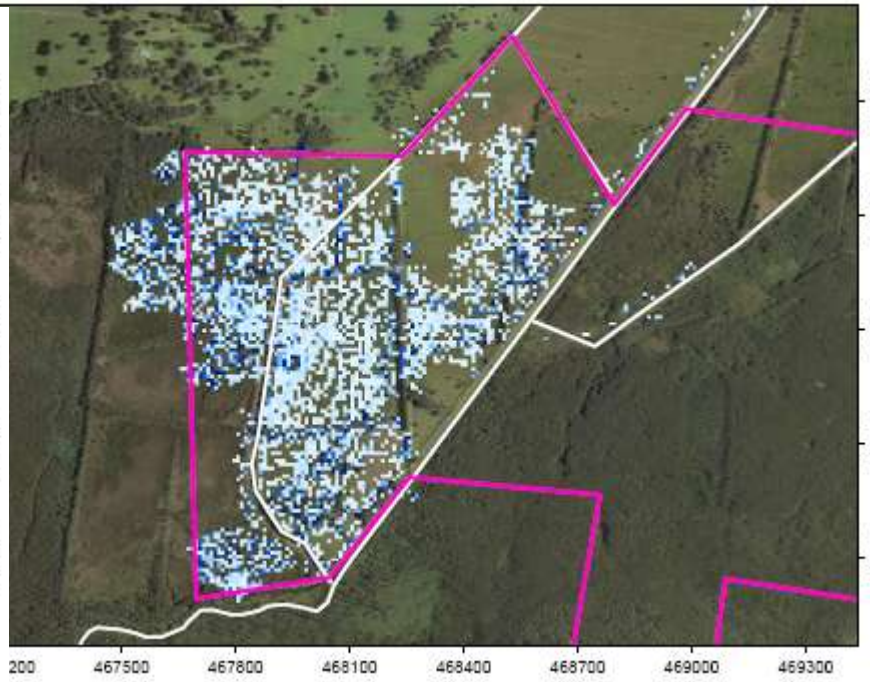
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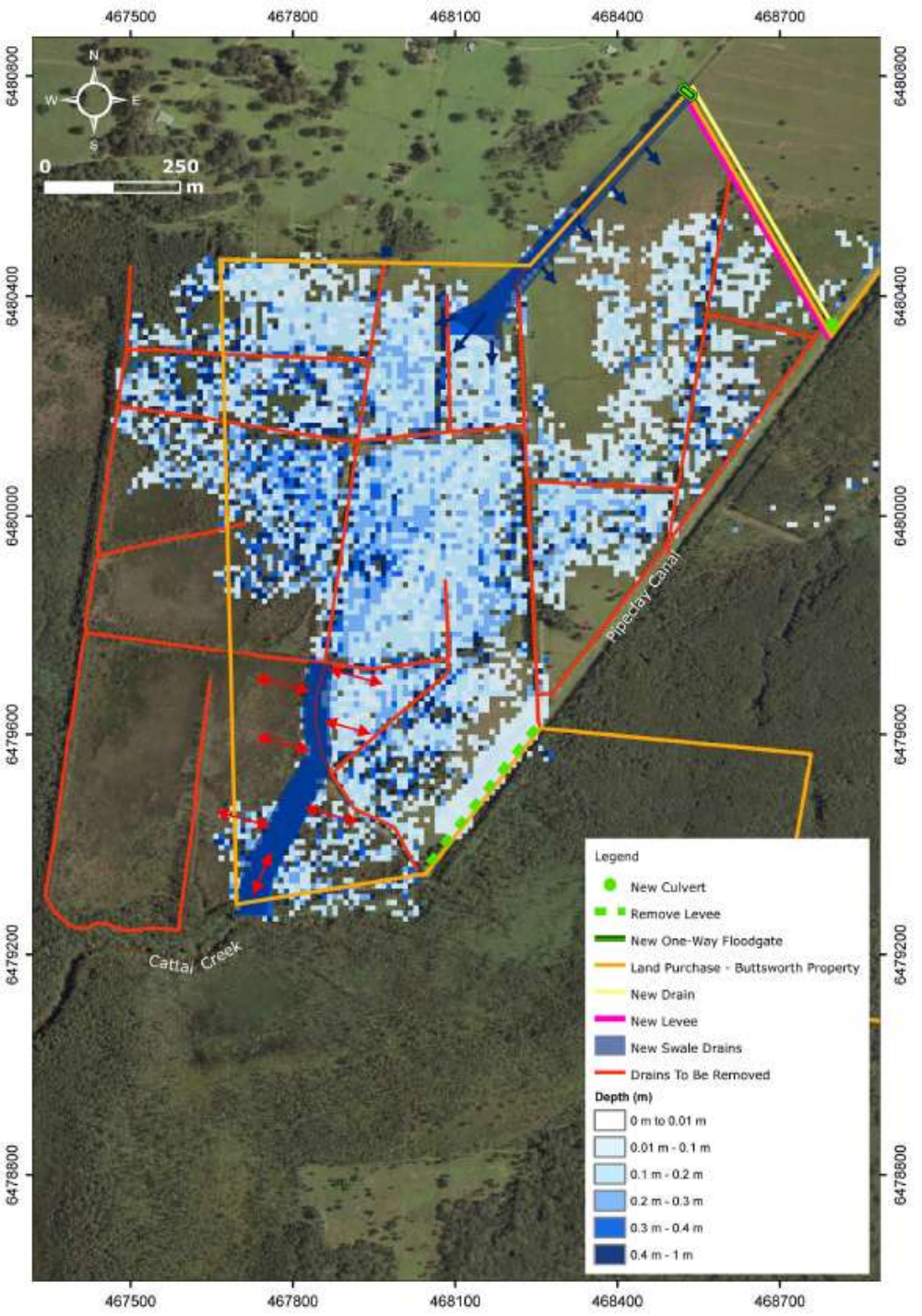
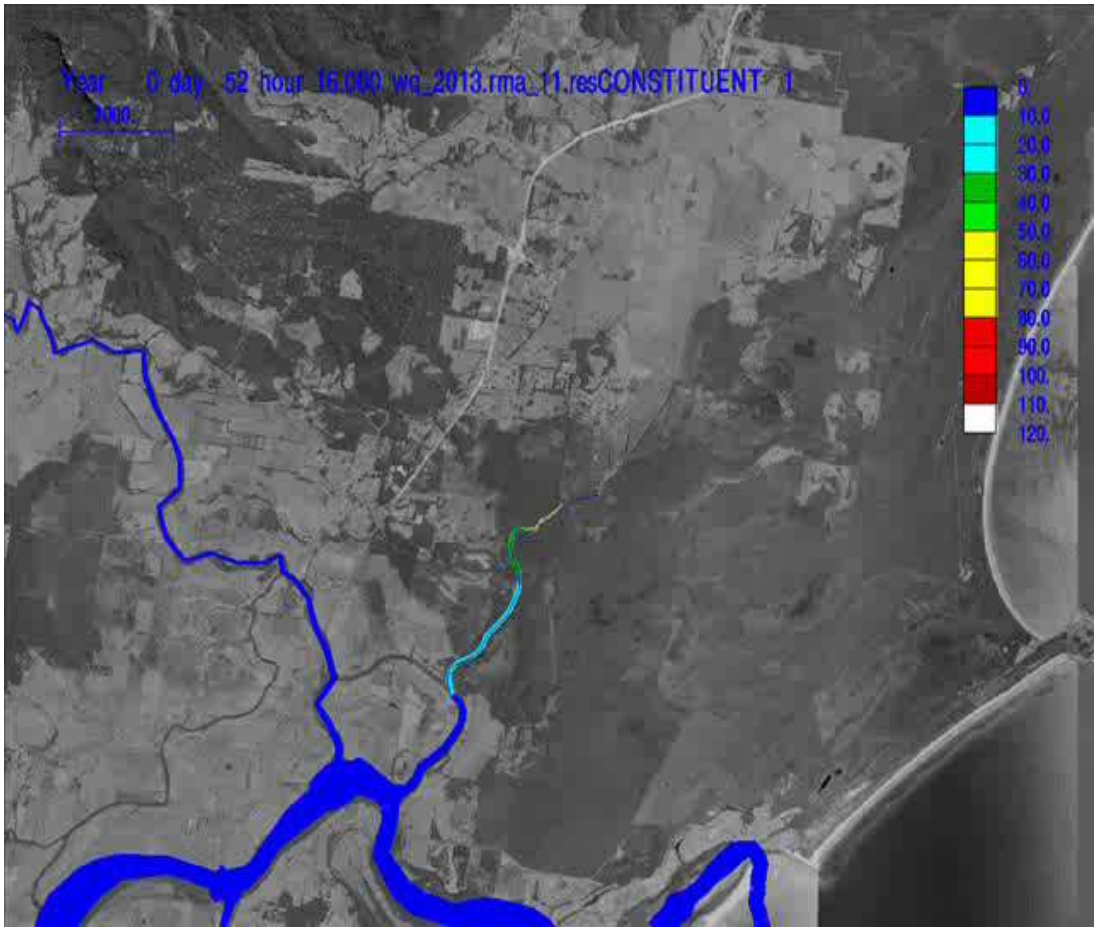
Summary

- Restoring S-W and S-E areas will remove large high priority acid zones.
- The S-E zone will not be fully restored as it still requires drainage.
- The remediation works will not impact flooding elsewhere.
- Any overland inundation will be shallow and intermittent.



Recommendations

- On-ground works
  - Floodgates
  - Levees
  - Drain modification and construction
  - Land grading
- Future Monitoring
  - Continuous sampling
  - Before-After sampling
  - Photo points
- Proceed with Additional Restoration Sites
- Proceed with Plan of Management



Acknowledgments

- Greater Taree City Council
  - Mr Dave Hopper
  - Various field support staff
- Wetland Care Australia
- Various stakeholders and volunteers
- Landholders for Access to Monitoring Stations