APPLICATION OF AN INTEGRATED 3-D HYDROLOGICAL HYDRAULIC MODEL, COUPLED WITH A HIGH RESOLUTION DIGITAL ELEVATION MODEL, ON A WETLAND AREA IN THE SOUTH-WEST OF IRELAND

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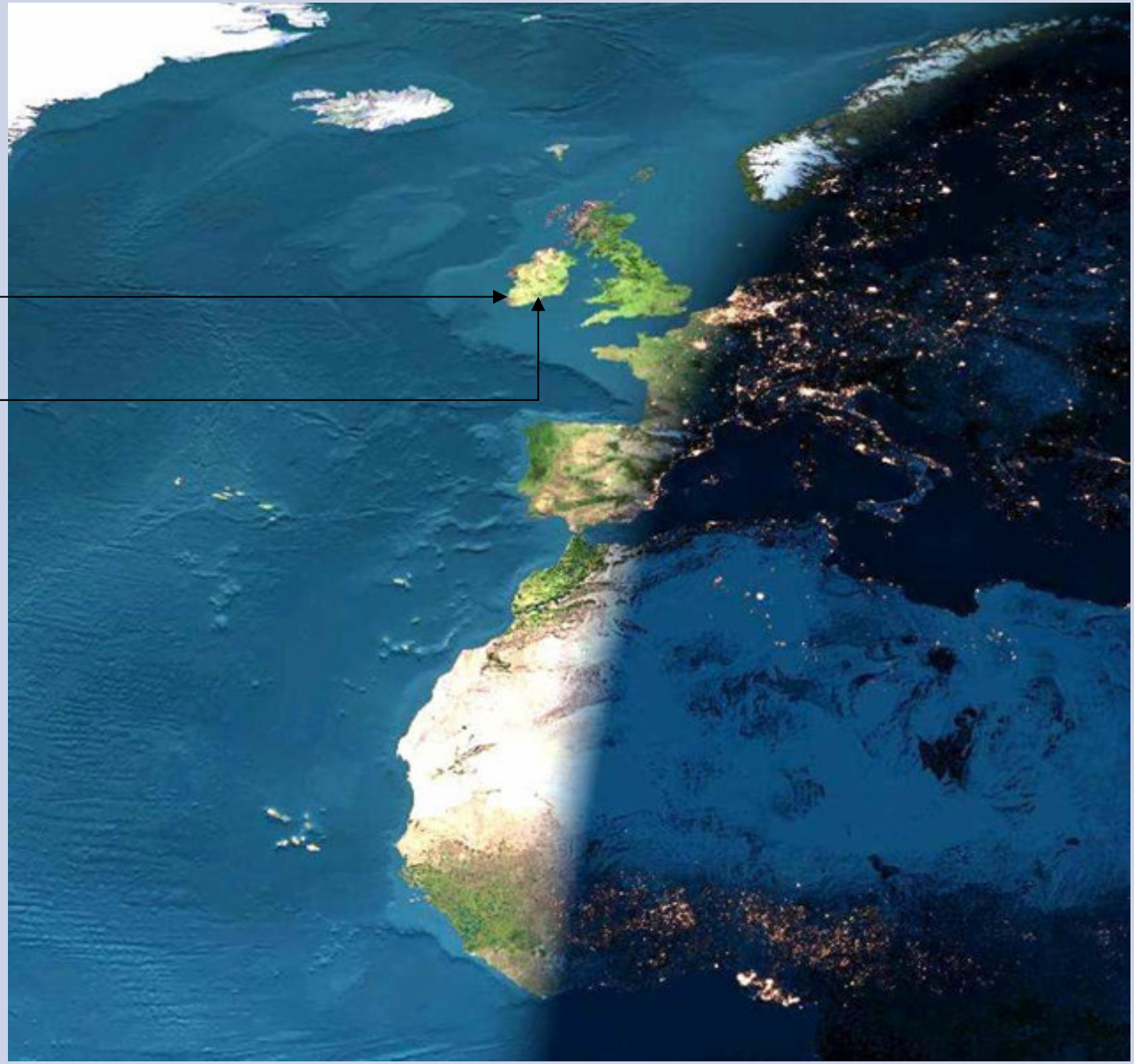
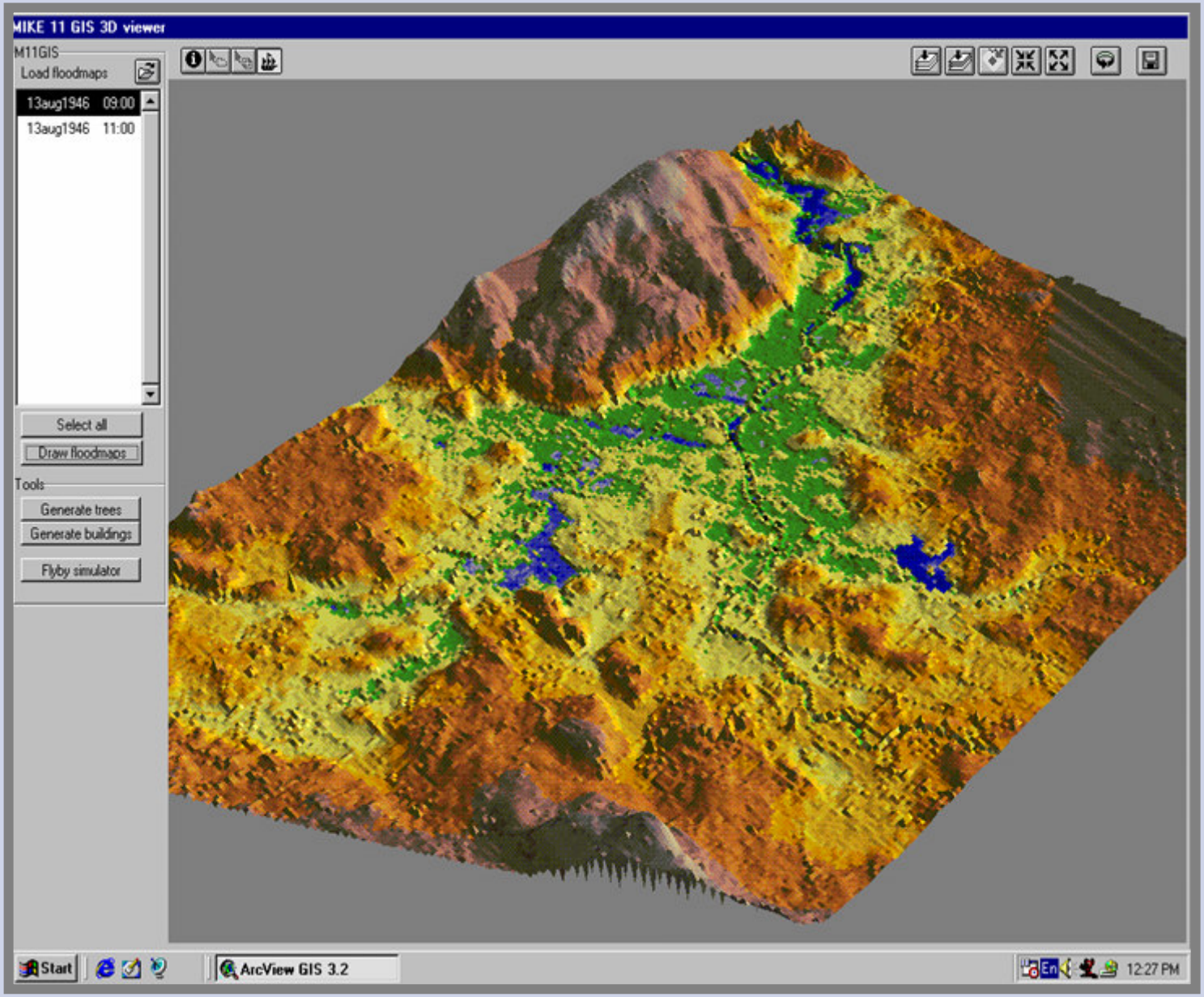
The Lower Feale catchment

Cork



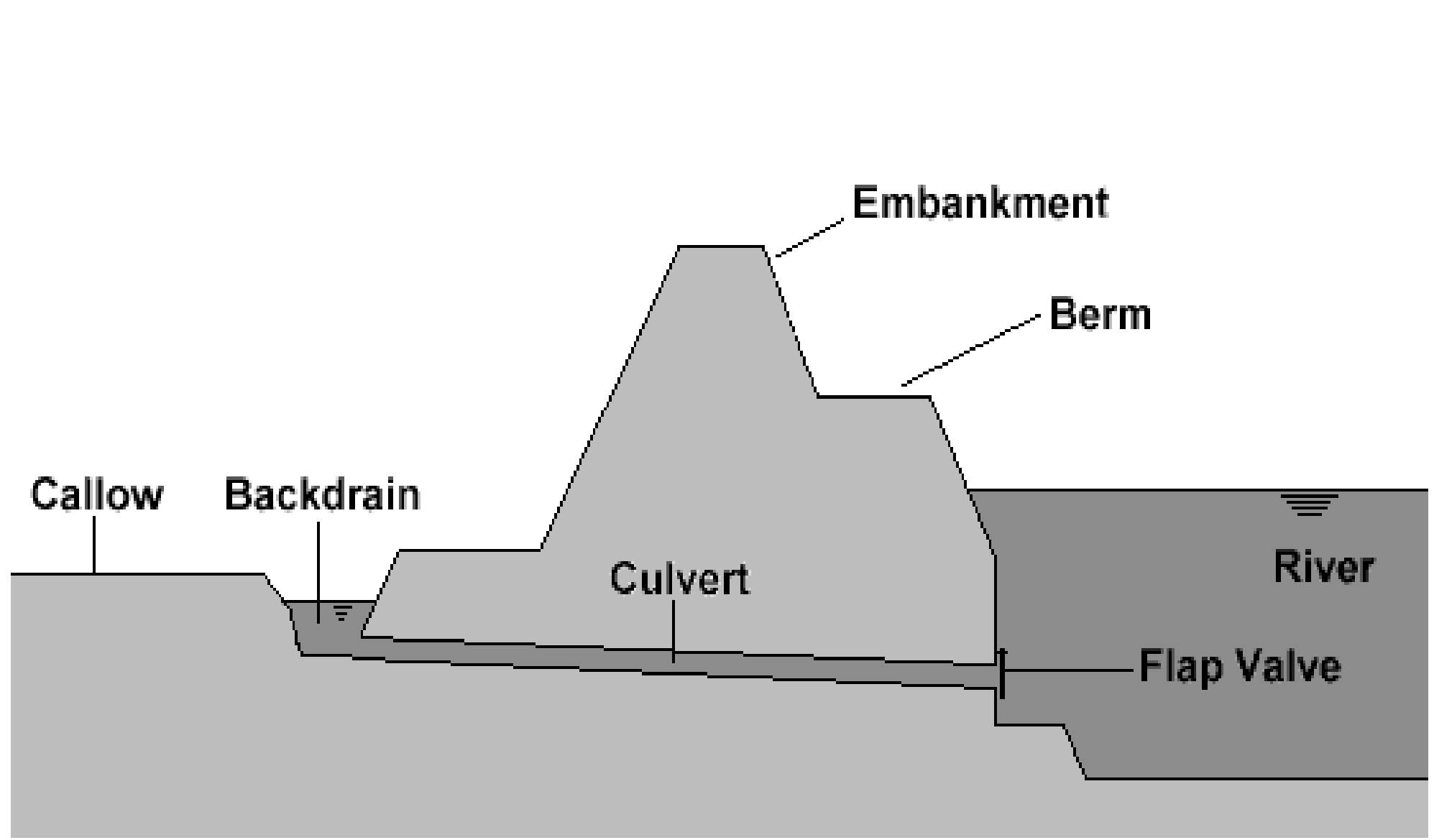
The Lower Feale



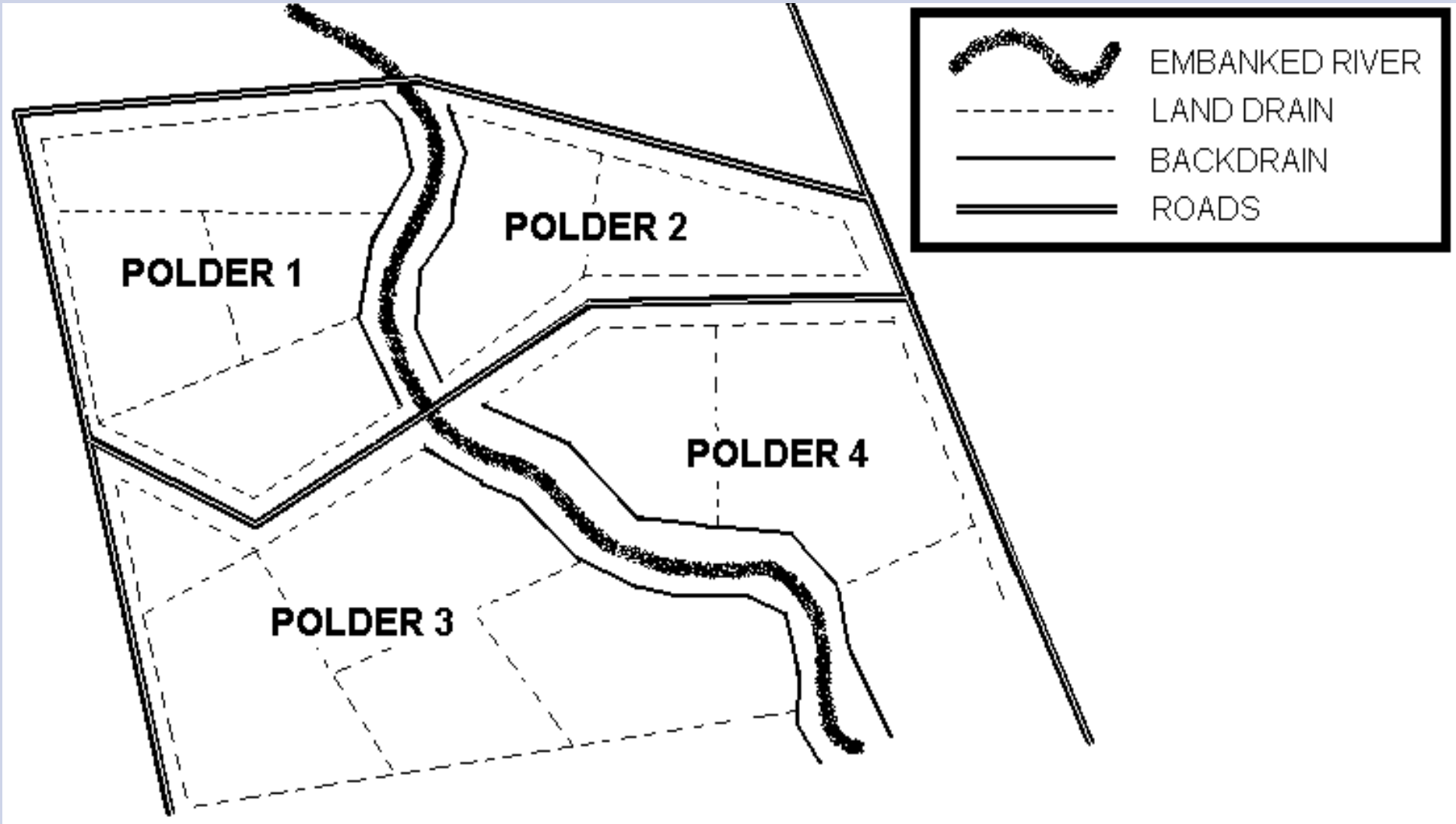
Flooding

Flooding

Sluiced culvert



Polder system - year 1500 in the Netherlands



Polders - 15

POLDER	CATCHMENT AREA (km2)	POLDER	CATCHMENT AREA (km2)
C2R	4.86	C2A	2.23
C4HA	1.0	C5A	3.64
C2K	7.52	C20	1.67
C2U	4.29	C5B	2.41
C3C	5.40	C32A	1
C2M	4.34	C18	1.63
C3A	5.08	C23	0.92
C4H	1.09		

*Areas of the 15 Polders in the Feale Model [**Table 4** in John Martin's, PhD thesis]*

The Feale system in 200 km^2

	NUMBER	*LENGTH (km)*	*STORAGE (km^3)*
MAIN TIDAL CHANNELS & TIDAL TRIBUTARIES	**6**	**49**	**-**
NON TIDAL (SLUICED) TRIBUTARIES	**6**	**16**	**0.55**
BACK-DRAINS & LAND DRAINS	**45**	**66**	**0.53**
EMBANKMENTS	**-**	**107**	**-**
SLUICED CULVERTS	**55**	**1.3**	**-**
SLUICED BARRAGES	**4**	**-**	**-**
WEIRS	**4**	**-**	**-**

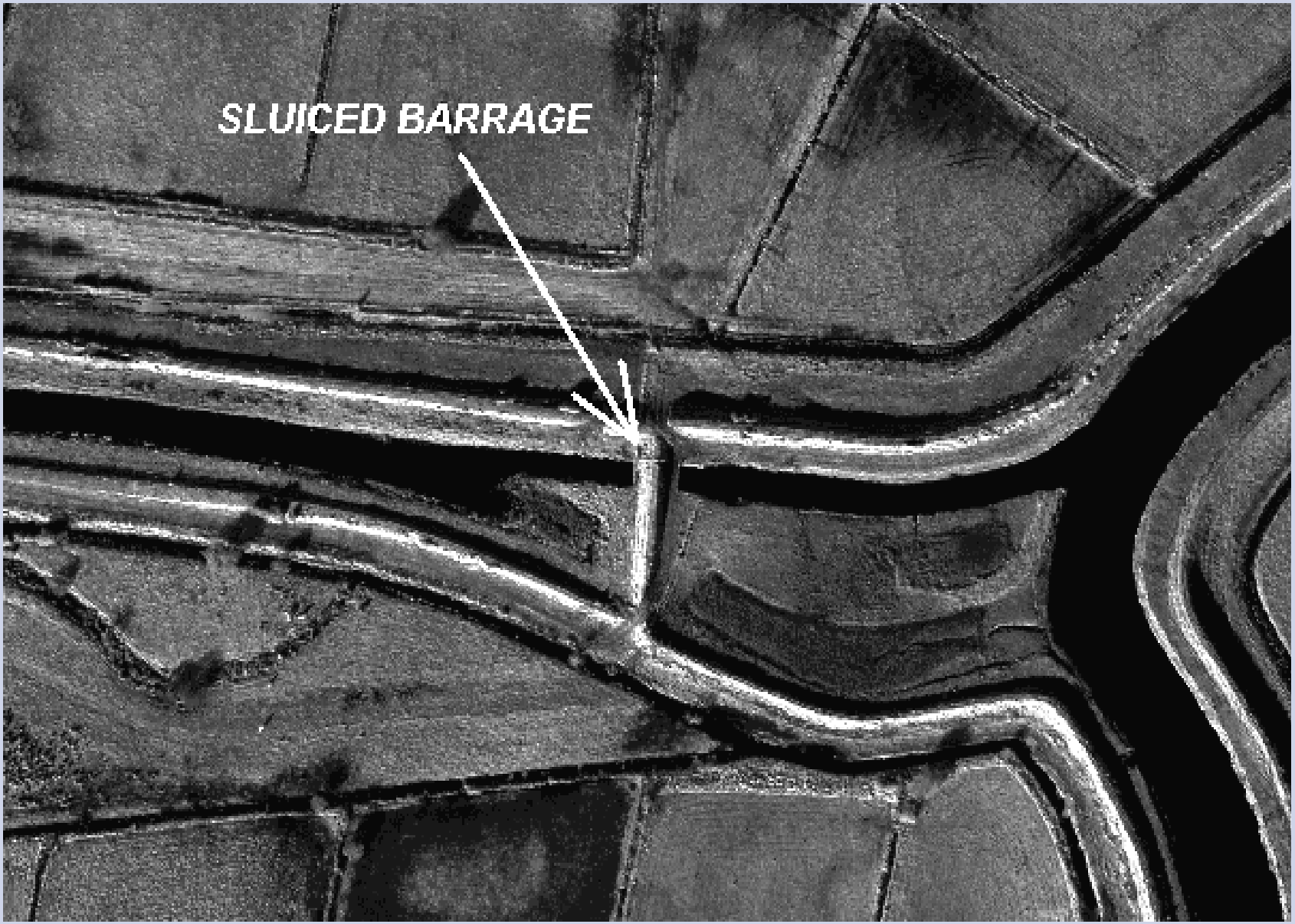
Arterial drainage scheme – 1950

worked then

not working now!

Flap valve

Sluiced barrage - Crompaun/Brick

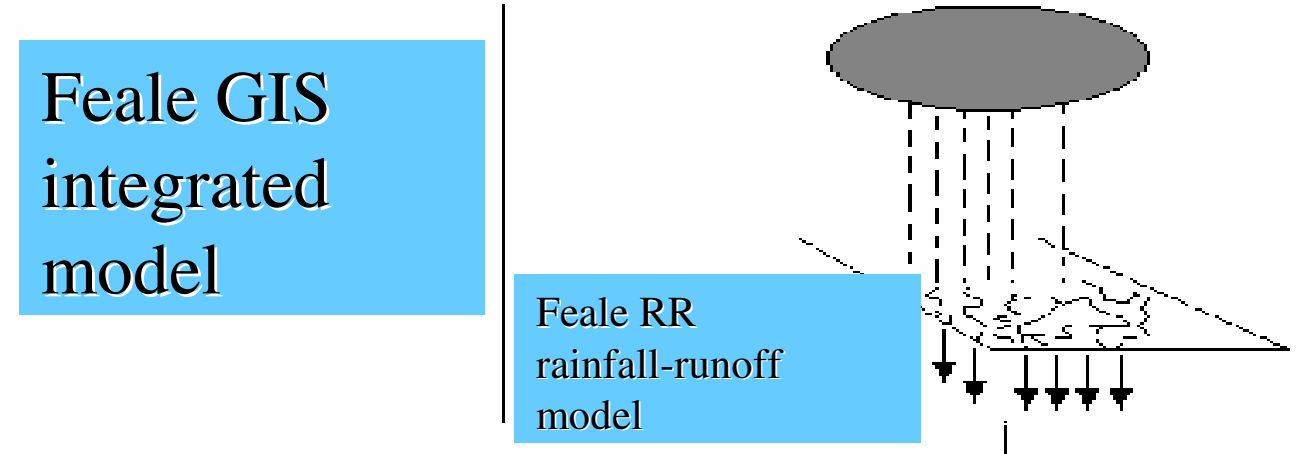


Gate - 5’x4’ teak

Models

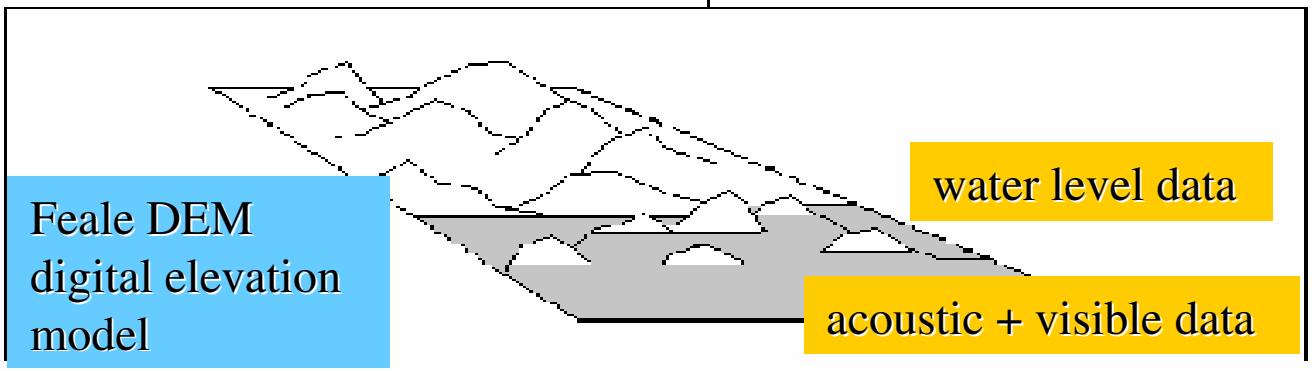
Feale GIS integrated model

Feale RR rainfall-runoff model



Feale NET hydrodynamic network model

Astronomical tide and surge [C3] model



Feale DEM digital elevation model

water level data

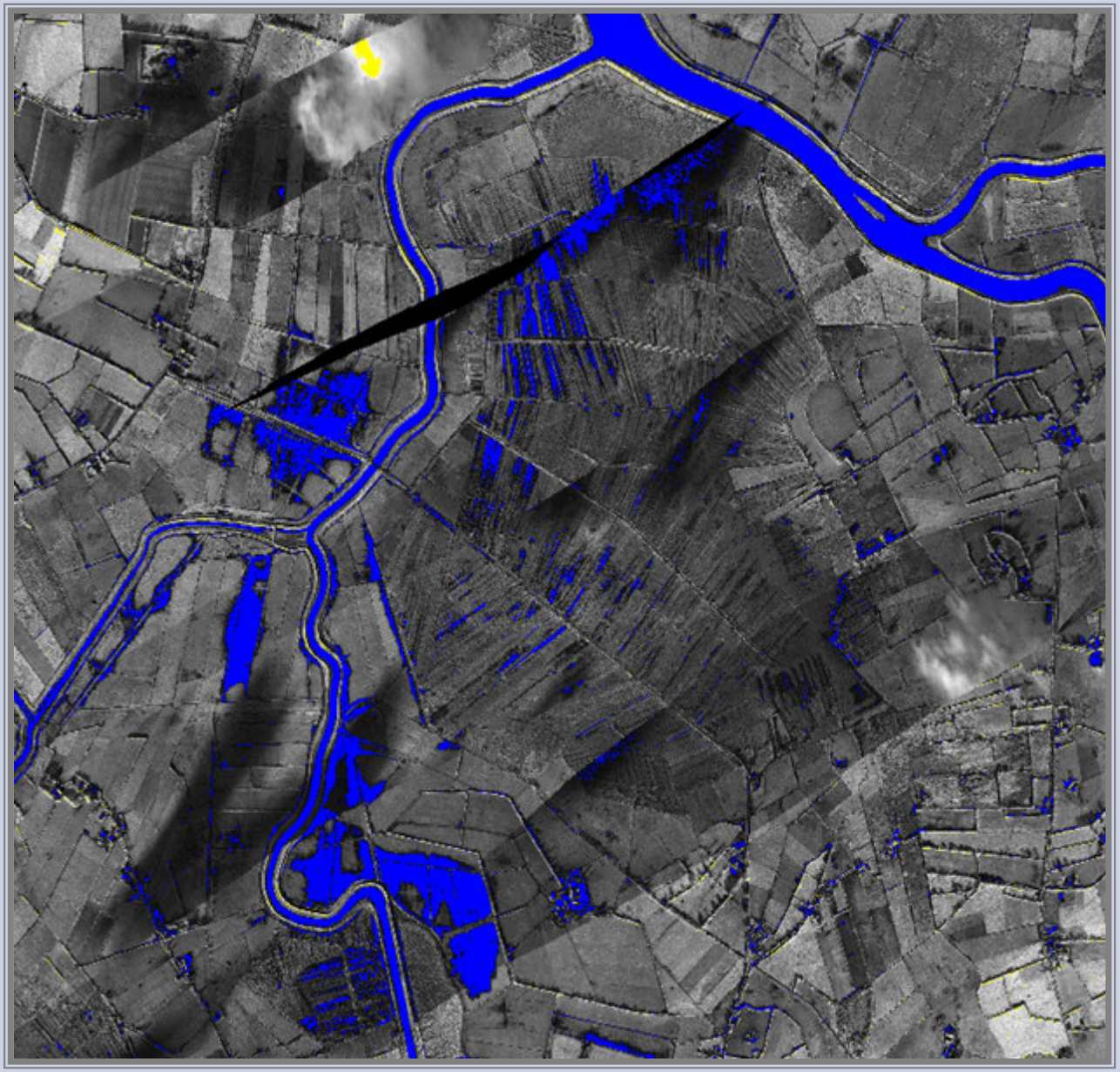
acoustic + visible data

Software

MODEL	*SOFTWARE PACKAGE*	*FUNCTION*	*DATA REQUIRED*
Feale_NET	*Mike11 (2000b)*	To compute Hydrodynamics and Water Levels	Discharge Data, Water Level Data, Cross-section Data, Sluiced Culvert & Hydraulic Structure Data, Feale_RR Results
Feale_RR	*Mike11 NAM (2000b)*	To compute magnitude of Rainfall Run-off Flux	Rainfall Data, Soil data
Feale_DEM	*ERMapper5.5, ArcView 3.2a*	Digital Representation of Topography of the Floodplain	Digital Image Data, Results of Processing of Digital Image Photogrammetry
Feale_GIS	*Mike11, ArcView 3.2a, Mike11-GIS (2000b)*	To integrate Hydrodynamic Water Level Data with Topography to generate Floodmaps	Digital Elevation Model (Feale_DEM), Results of Feale_NET, Data about Floodplain Control Features
Feale_EVAL	*Microsoft Excel 97*	Analysis of Feale_NET Model Results to compute benefits of Flood alleviation measures (in terms of reduction in water level and flood inundated area	Results of Feale_NET, Area Elevation Curves

RGB, nIR, panchromatic visible data 20cm pixel

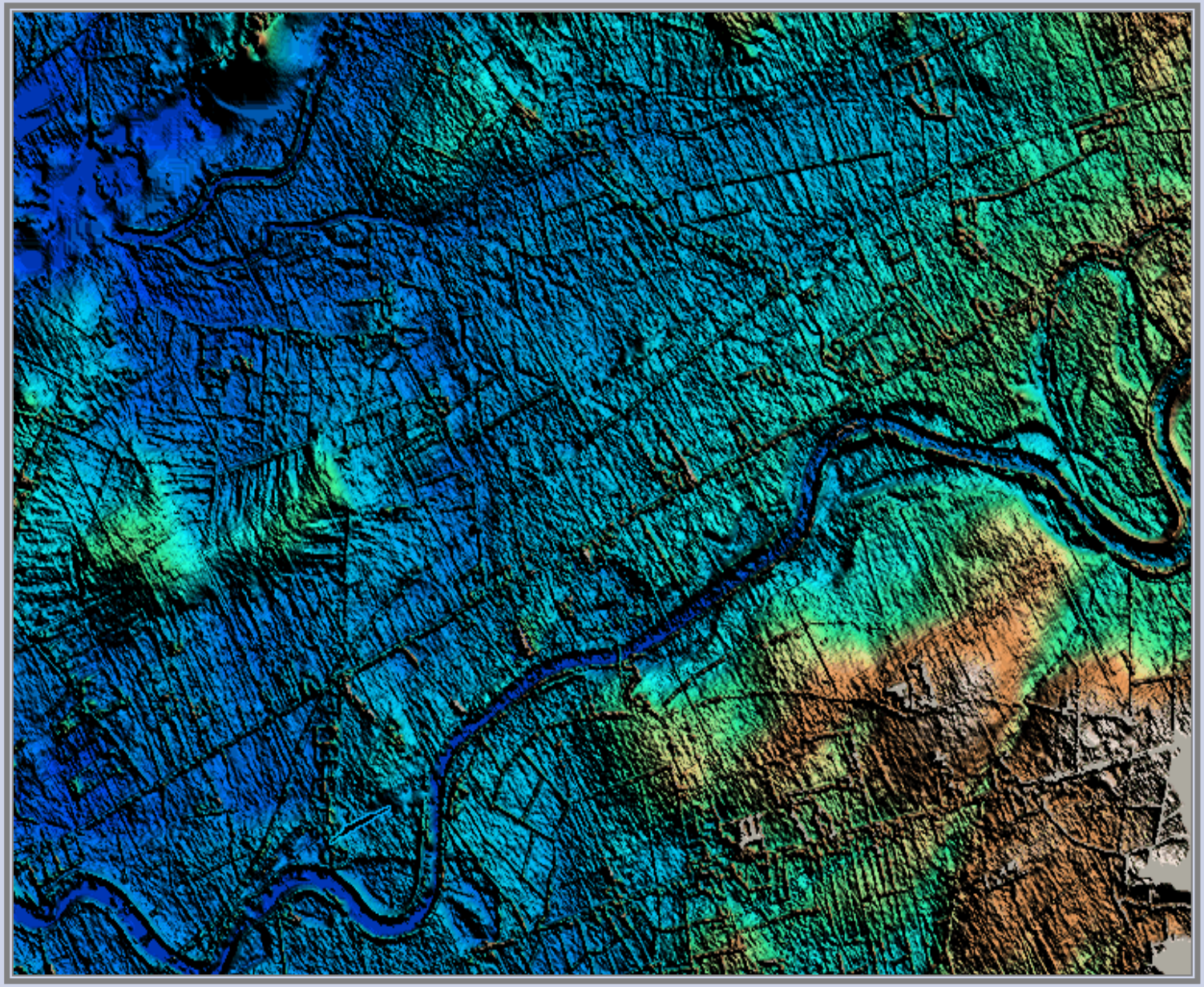
Merged over-flights missing data



ERmapper algorithm identifies wet and dry areas

DEM 20cm vertical resolution - 1m horizontal grid

Each pixel (x,y,z) geo-referenced to national grid +/- 20cm



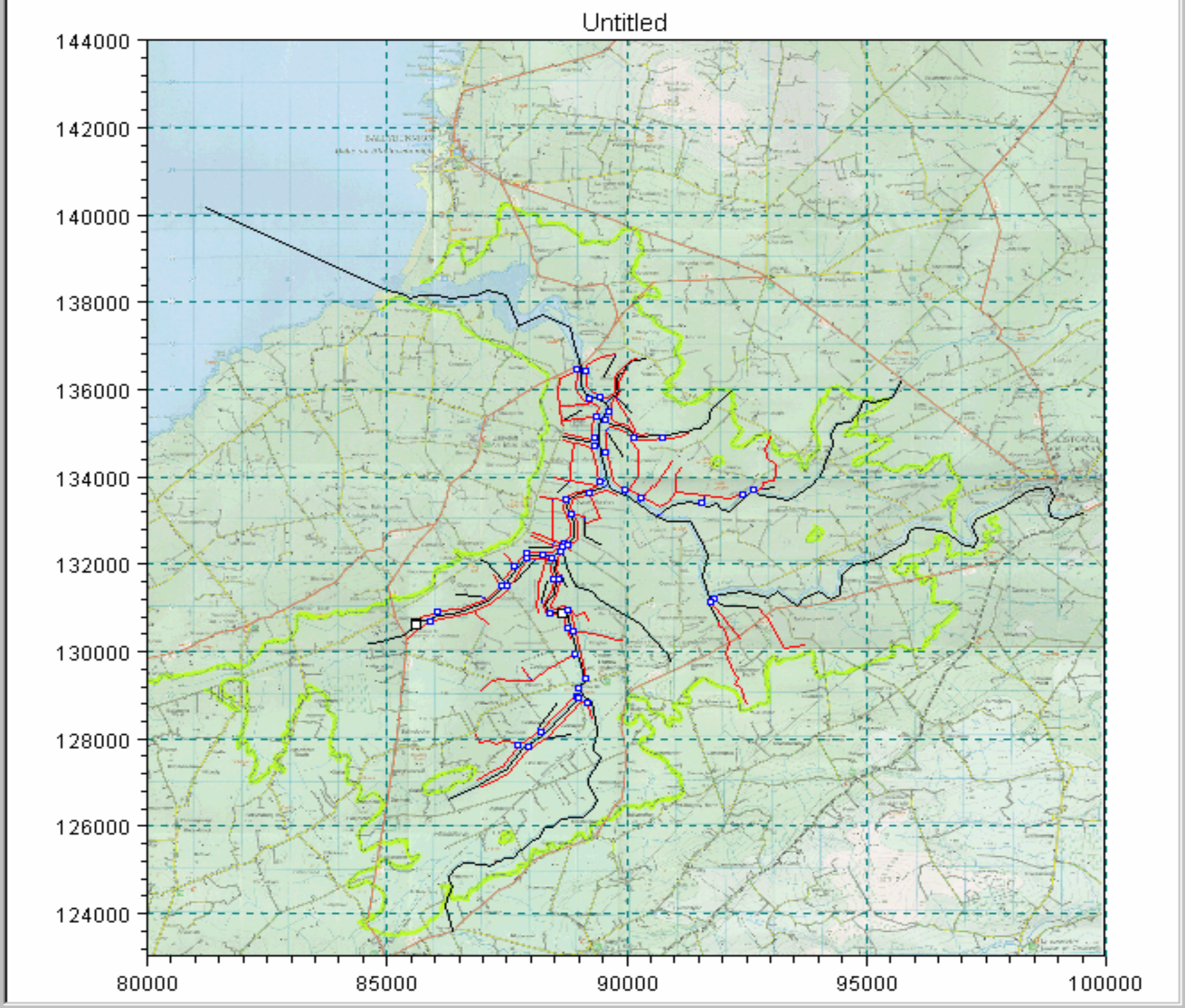
Contour map

Feale NET at 1:50,000

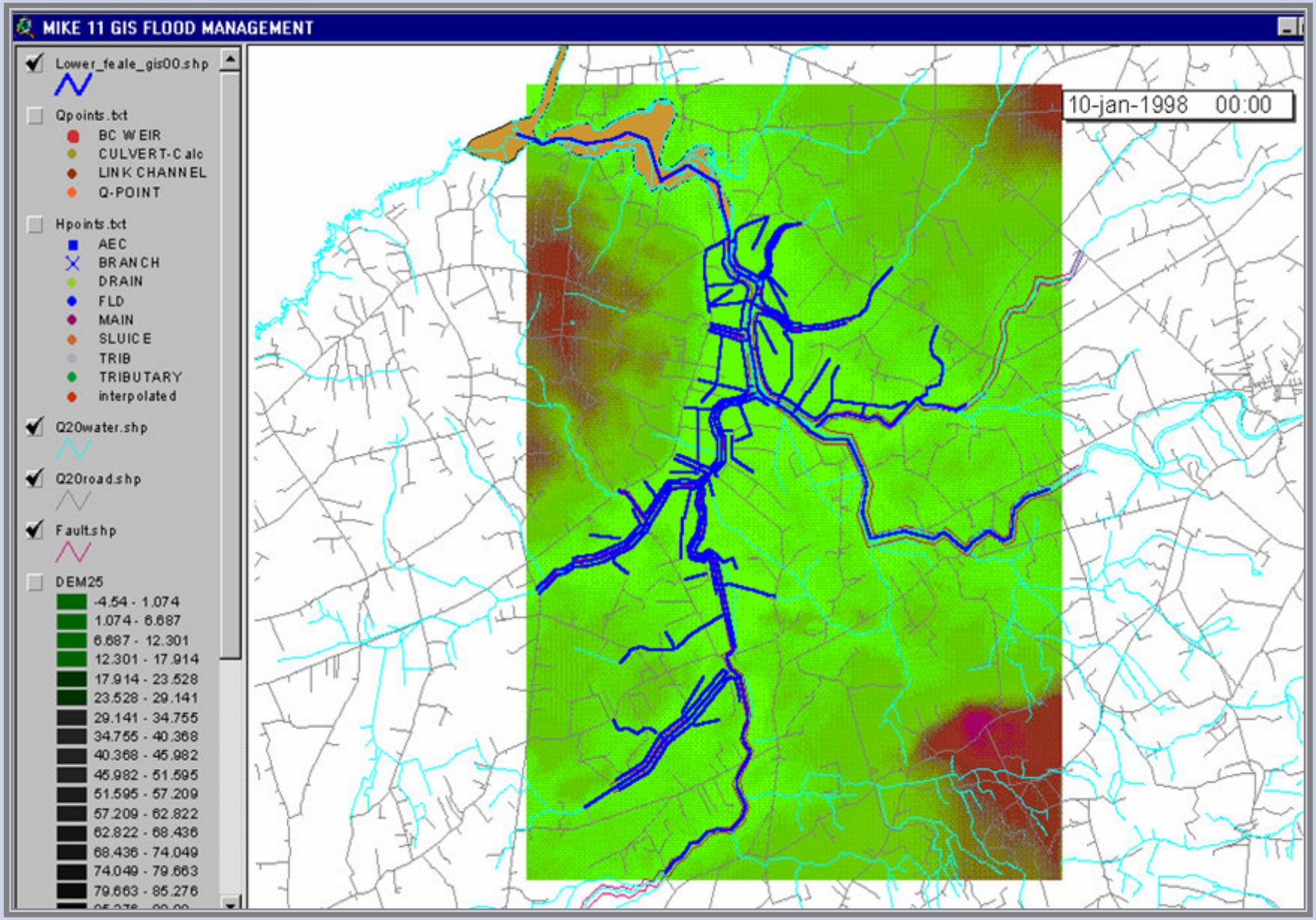
10m contour shown in yellow

backdrains in red

embanked channels in black

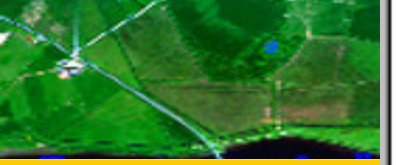


Integrated flood model



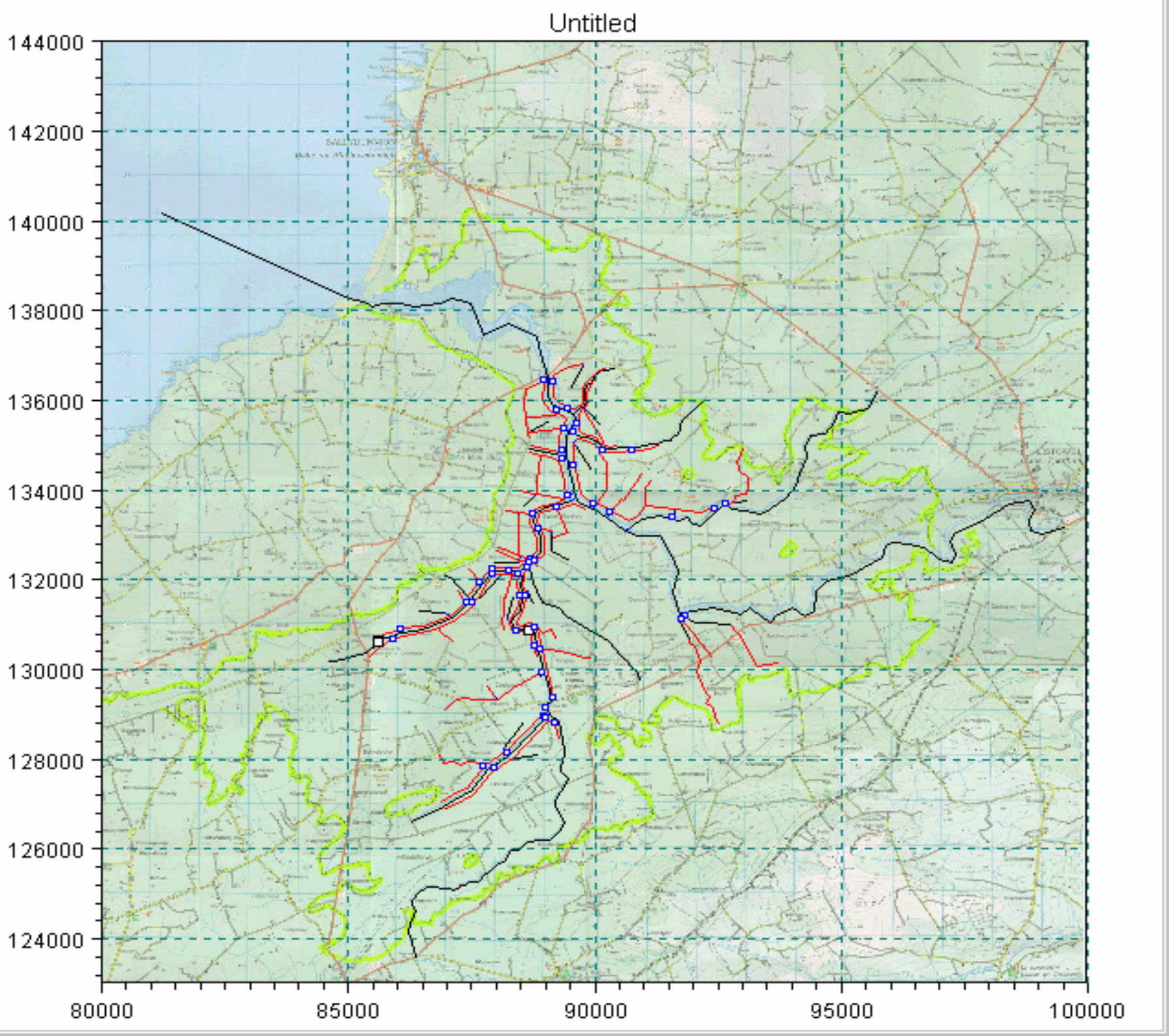
Feale_NET


MIKE 11 GIS FLOOD MANAGEMENT
Lower_feale_gis00.shp
Qpointx.txt
BC WEIR
CULVERT-Calo
LINK CHANNEL
Q-POINT
Hpointx.txt
AEC
BRANCH
DRAIN
FLD
MAIN
SLUICE
TRIB
TRIBUTARY
interpolated
Q20water.shp
Q20road.shp
Fault.shp
DEM25
-4.54 - 1.074
1.074 - 6.687
6.687 - 12.301
12.301 - 17.914
17.914 - 23.528
23.528 - 29.141
29.141 - 34.755
34.755 - 40.368
40.368 - 45.982
45.982 - 51.595
51.595 - 57.209
57.209 - 62.822
62.822 - 68.436
68.436 - 74.049
74.049 - 79.663
79.663 - 85.276

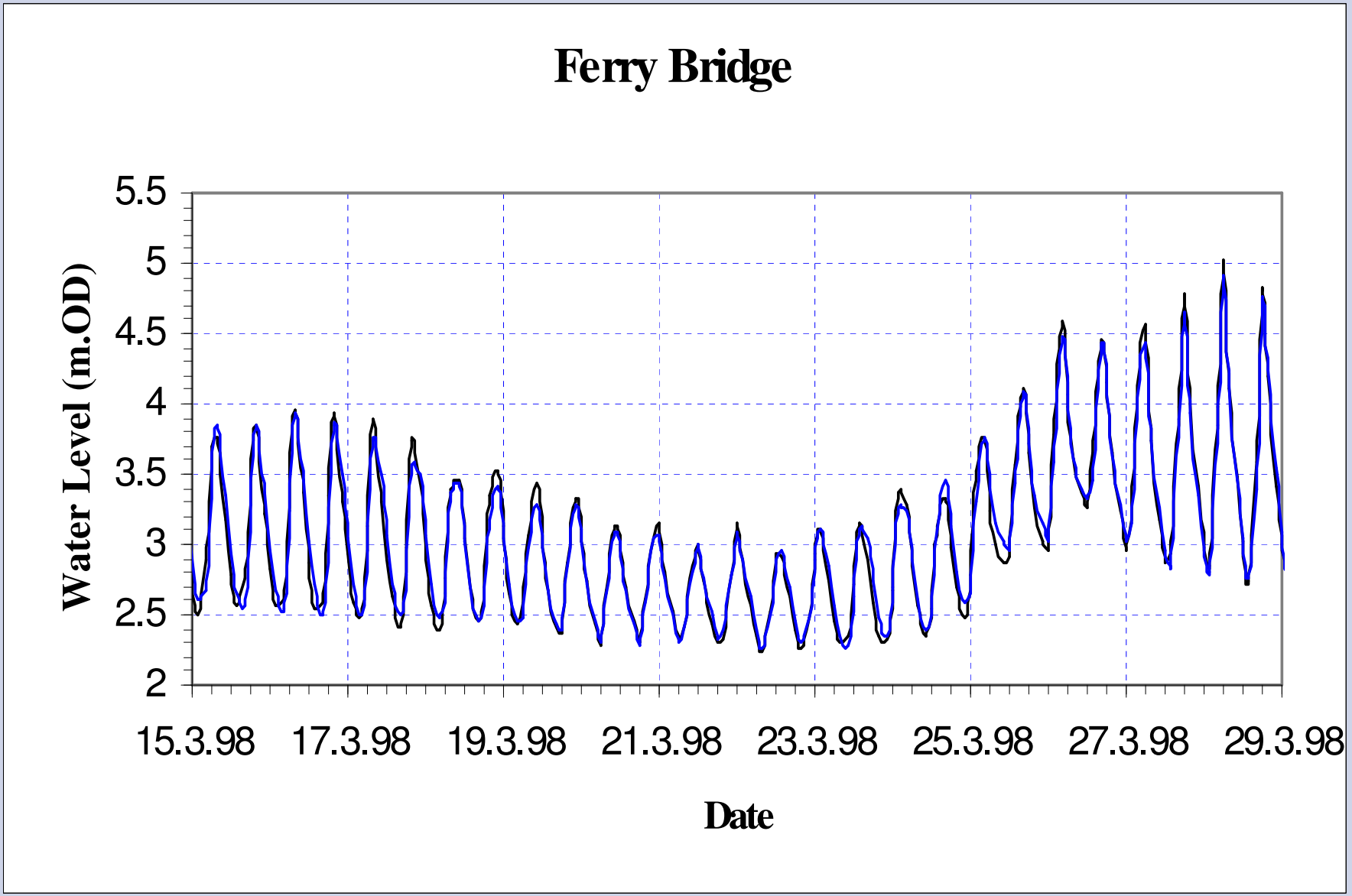


Water level data

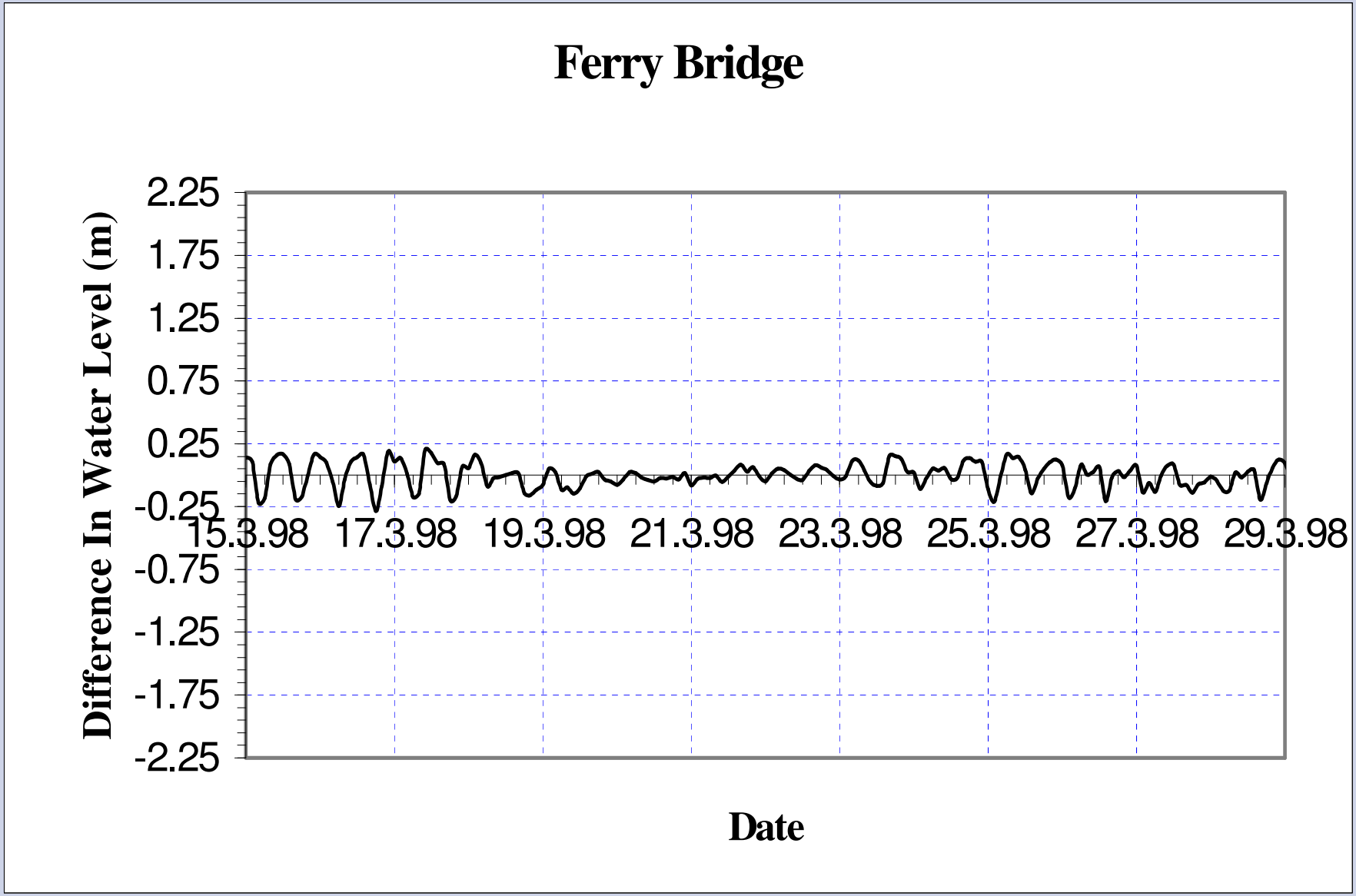
Water flow data



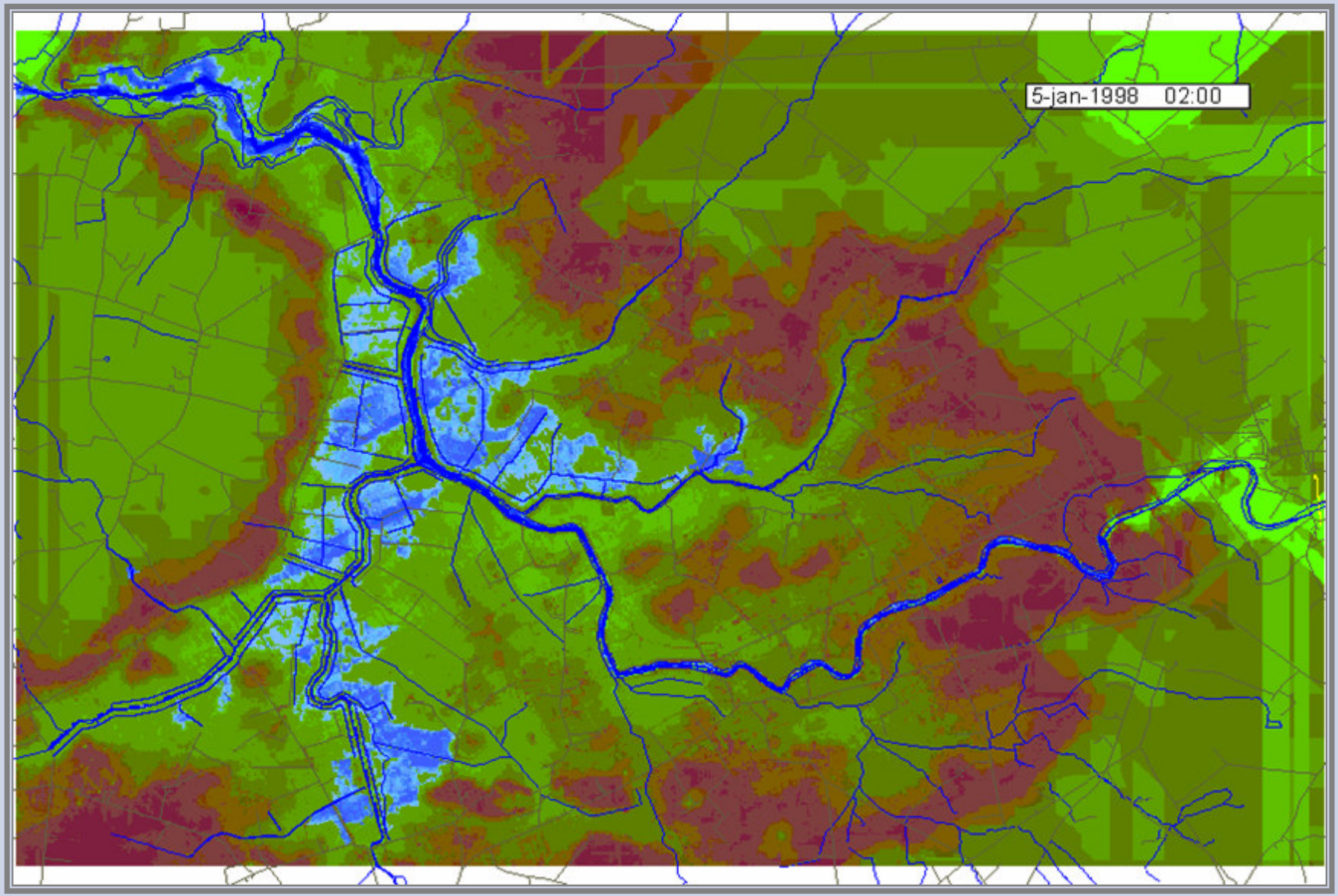
Calibration



Residual error



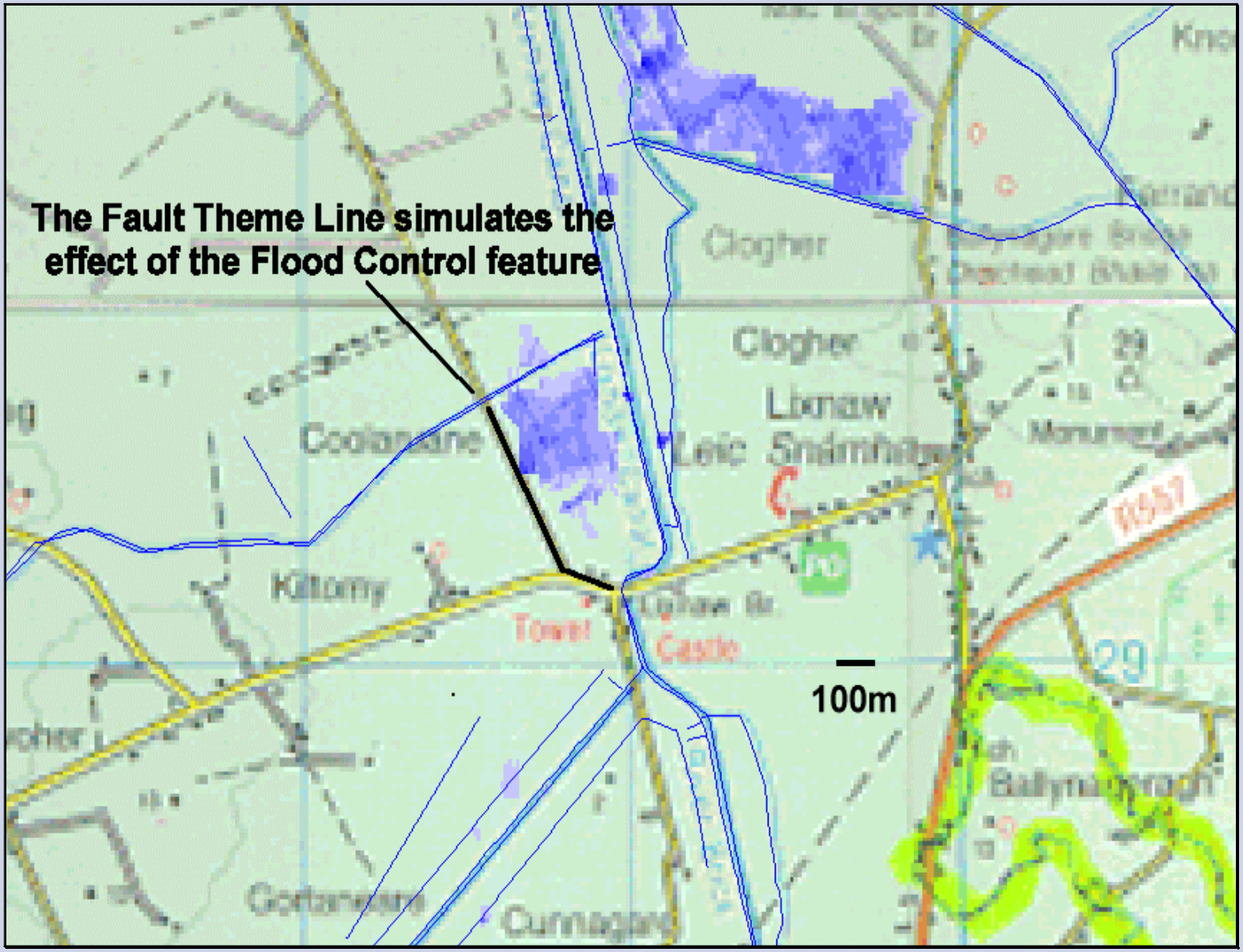
Flood maps



Verification

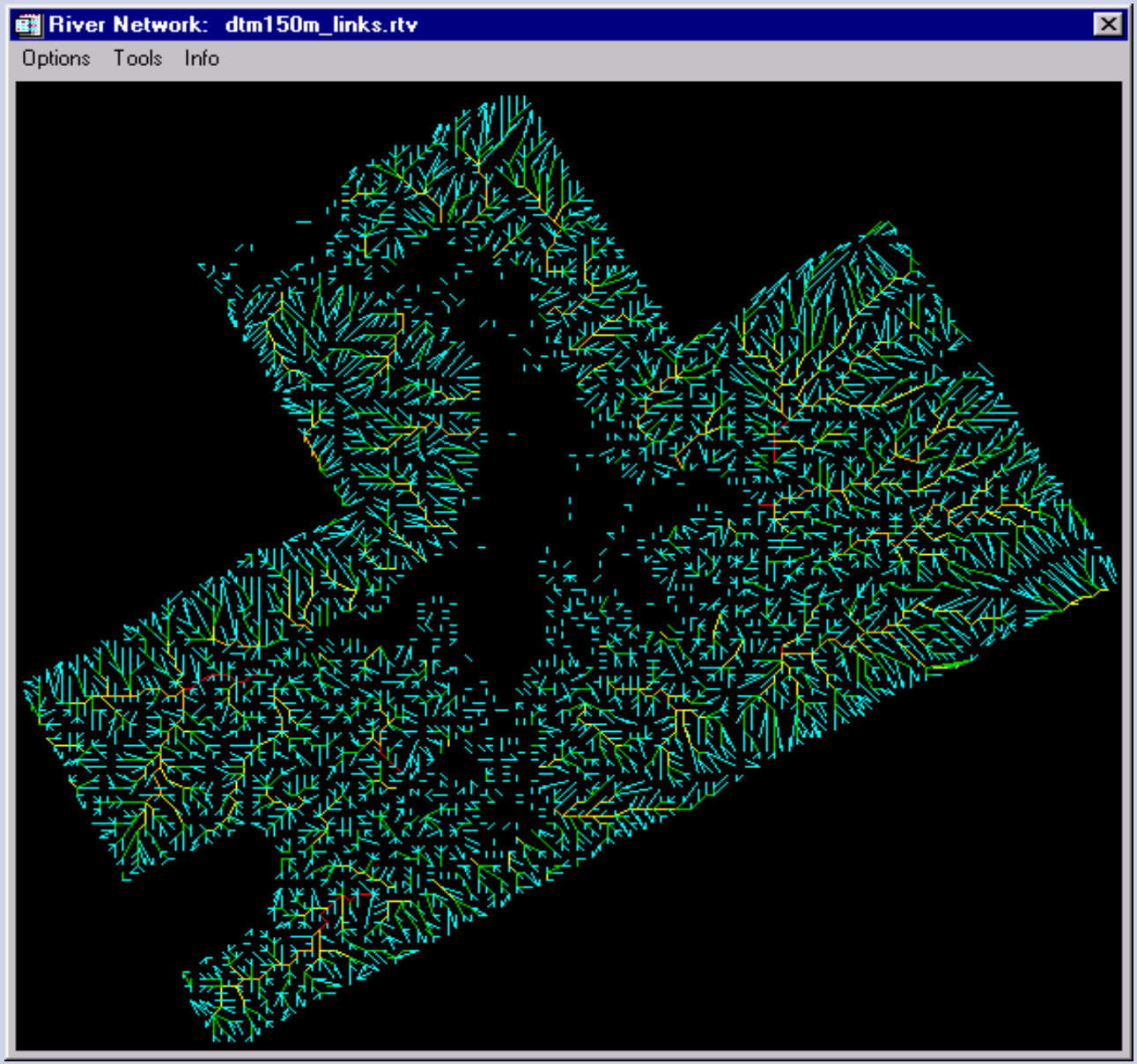
Social calibration

Social calibration



Gradient vector field

Pause for flood animations



Historical analysis

- Remove the hydraulic infrastructure
- restore the land to 12’ OD (ordnance datum)
- simulate - - -

* result: large inundation

Historical analysis

- Insert the 1950s scheme
- place the land at 12’ OD (ordnance datum)
- place the inverts of all culverts at 6’ OD

- simulate --

*result: no flooding

Historical analysis

- Why has the performance of the system deteriorated?

Hydraulic head through the culverts has declined in

magnitude

frequency

duration

Historical analysis

- Why has the performance of the system deteriorated?

River sediment

no longer floods onto callows

confined to the embanked channels

Historical analysis

- Why has the performance of the system deteriorated?

Settlement of the landscape

Lower water level in the fields

Removes buoyant support

Consolidation of soil

Bio-oxidation of the peat

Historical analysis

- Confirmation of hypothesis?

Historic maps

Alexander Nimmo 1815

…

Reference to similar landscapes

The Netherlands

The Fens

Alternatives

- Re-engineer the hydraulic system

Alternatives

- Re-engineer the hydraulic system
  - individual sluiced culverts
  - all culverts in a polder
  - all polders together

Minor improvement
Not credible with stakeholders

Alternatives

- Storm gates in the mouth of the estuary
  - to keep out storm surge and spring tides

traps river floods

Alternatives

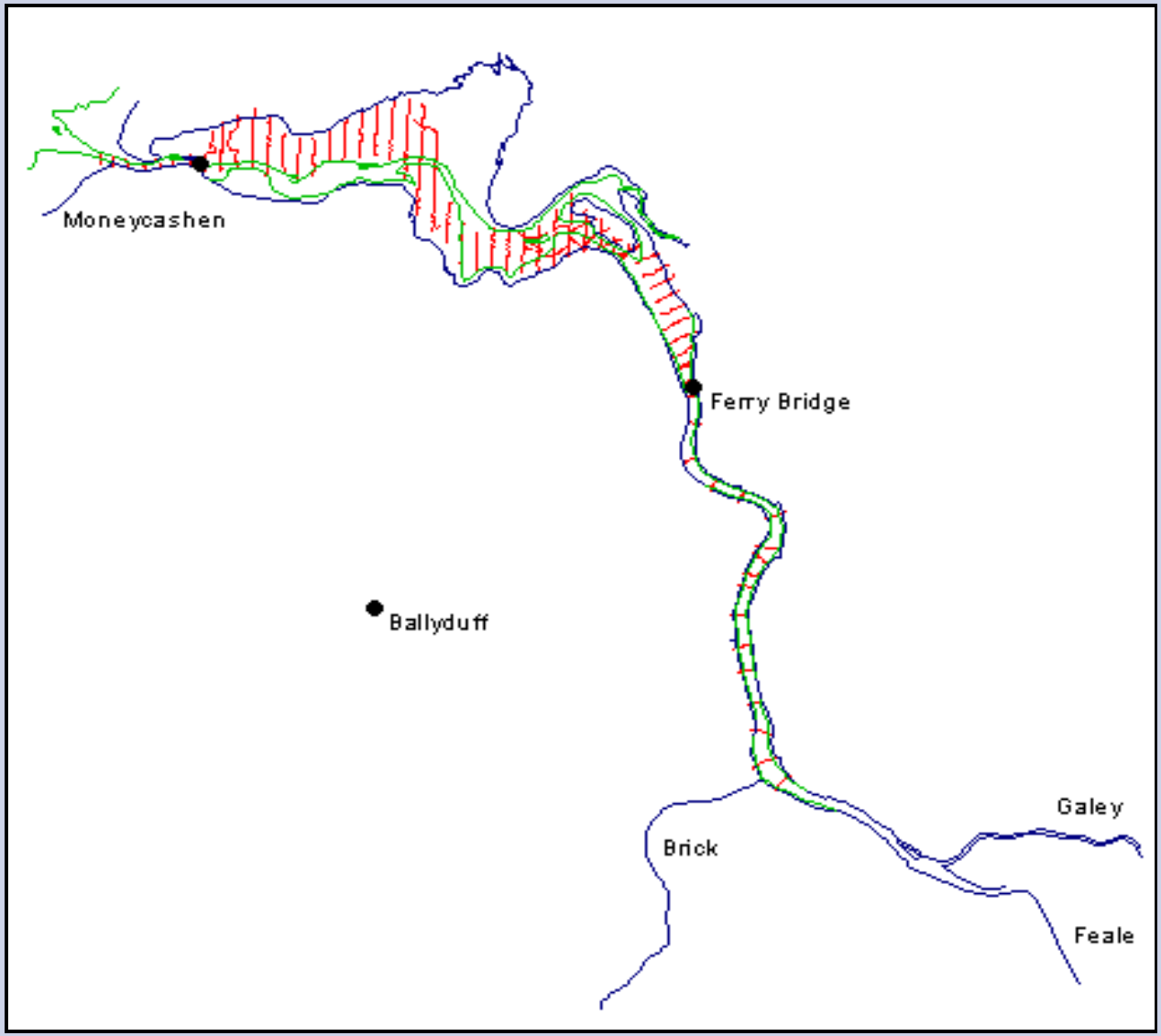
- New interceptor drains
  - to divert runoff away from the polders

purchase of way leave
expensive

Alternatives

- Dredging

Is the estuary blocked?



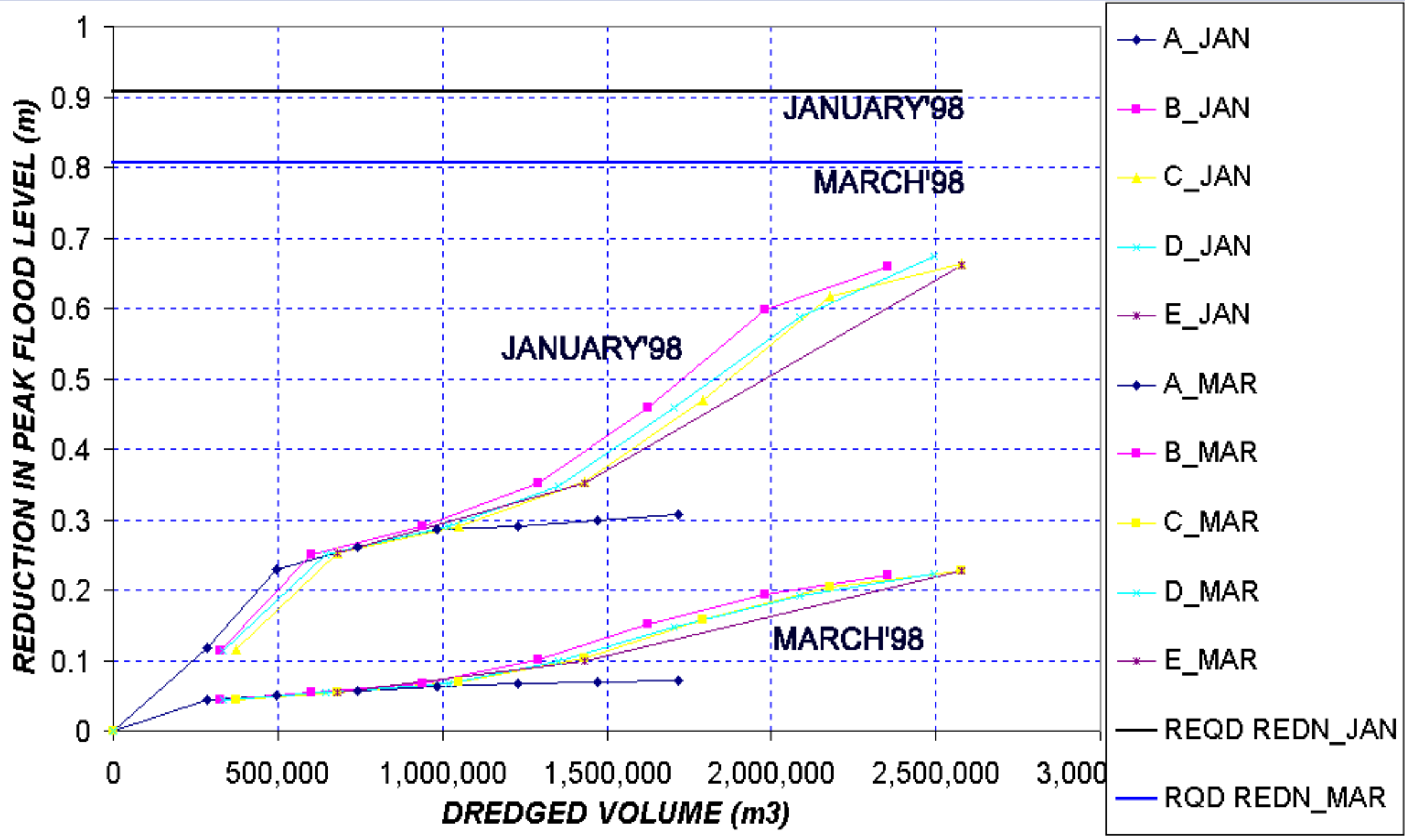
Dredging

- Depth
- Shape
  - side-slopes less than 1:1.5
- Path
  - start at the mouth
  - different end points in the network
    - one
    - many

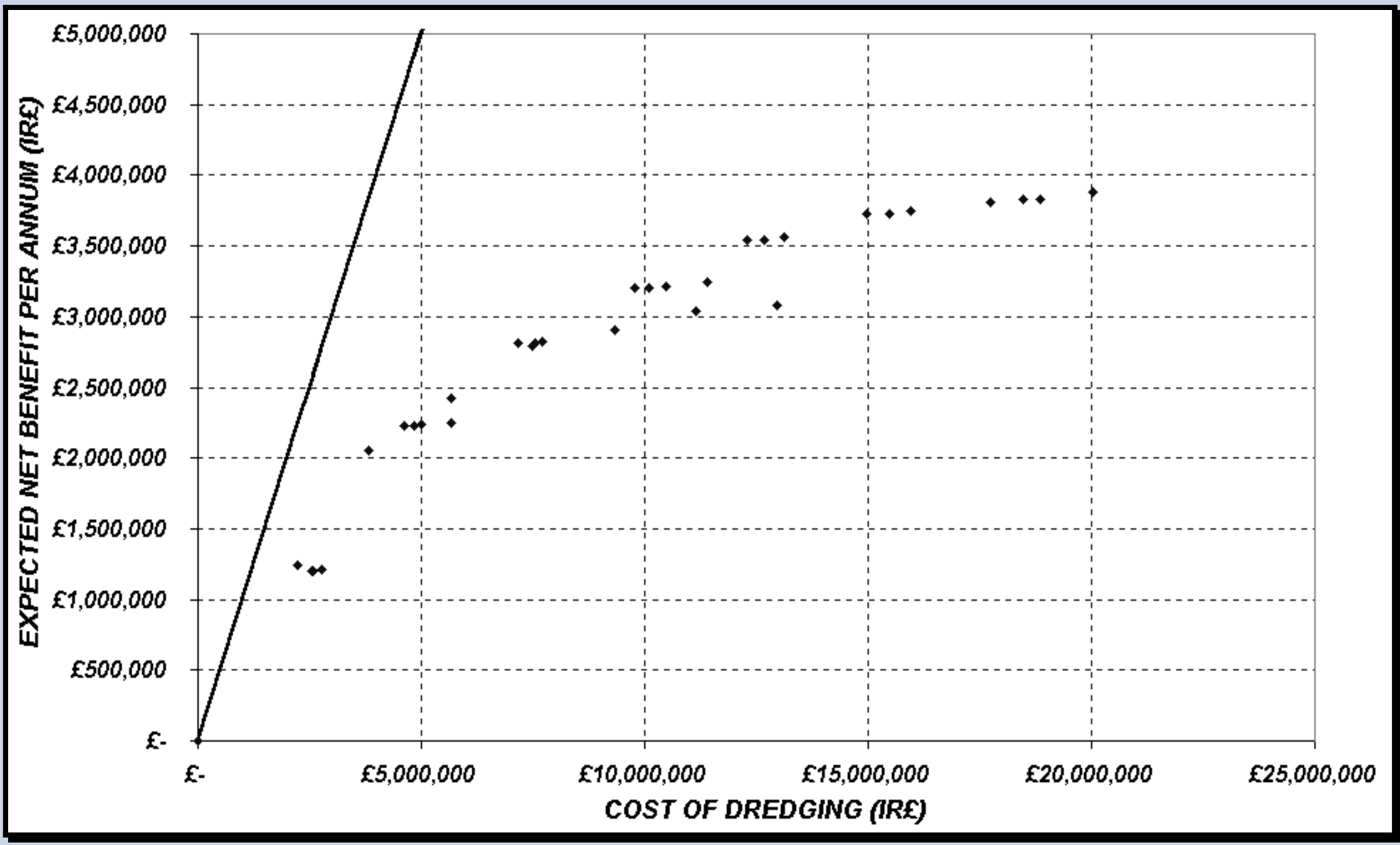
Two reference floods at Listowel

- 50 years of flows
  - December 1997 - January 1998 minor floods, return period 2 years
  - March 1998, return period 9 years

Dredging


REDUCTION IN PEAK FLOOD LEVEL (m)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
3,000
DREDGED VOLUME (m3)
JANUARY'98
MARCH'98
JANUARY'98
MARCH'98
A_JAN
B_JAN
C_JAN
D_JAN
E_JAN
A_MAR
B_MAR
C_MAR
D_MAR
E_MAR
REQD REDN_JAN
RQD REDN_MAR

Benefit/cost analysis of dredging



Alternatives

- Pumping
  - very flexible
  - comparable costs and benefits
  - response of farmers unknown
    - best agricultural use
    - water table in the fields
    - water level in field- and back-drains
    - set-point of the pumps
  - pilot experiment underway!

Pumping station to dewater a test polder

Raised peat bog with active cutting of peat

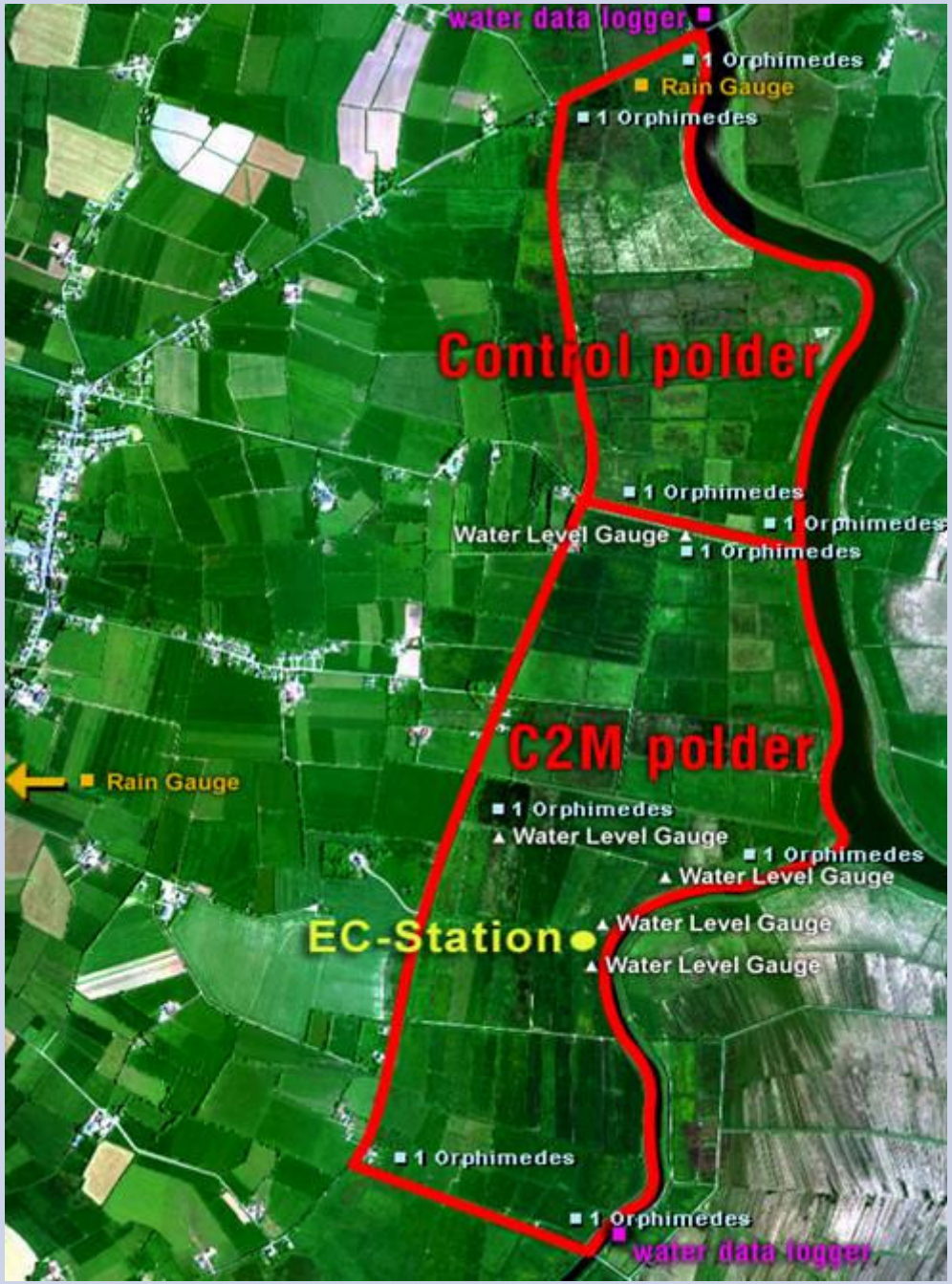
Pumps:

- 3 submersible pumps
- 170 l/s discharge each

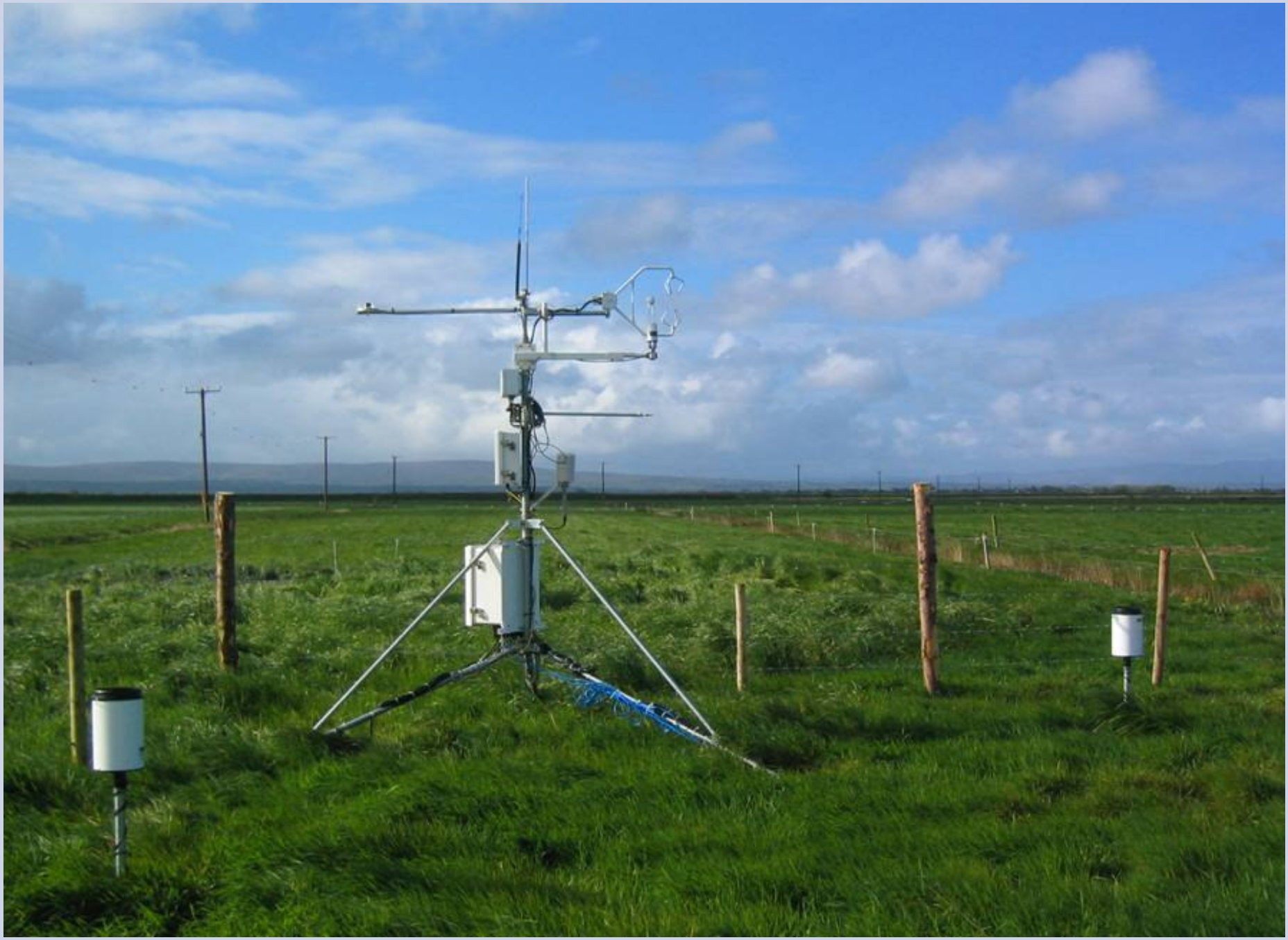
The Study Case:

C2M Polder and the Control Polder

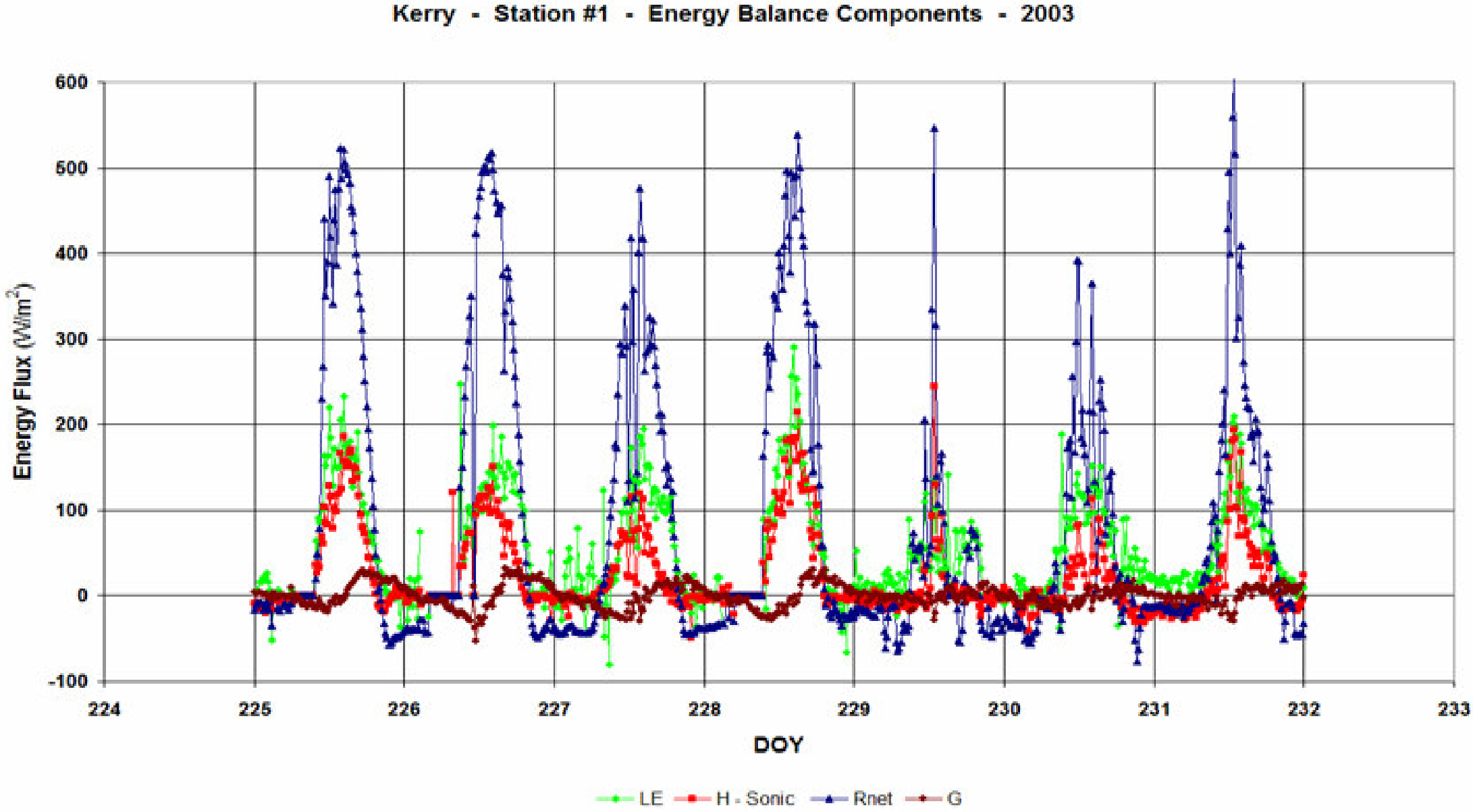
Instruments installed on site



The EC Station

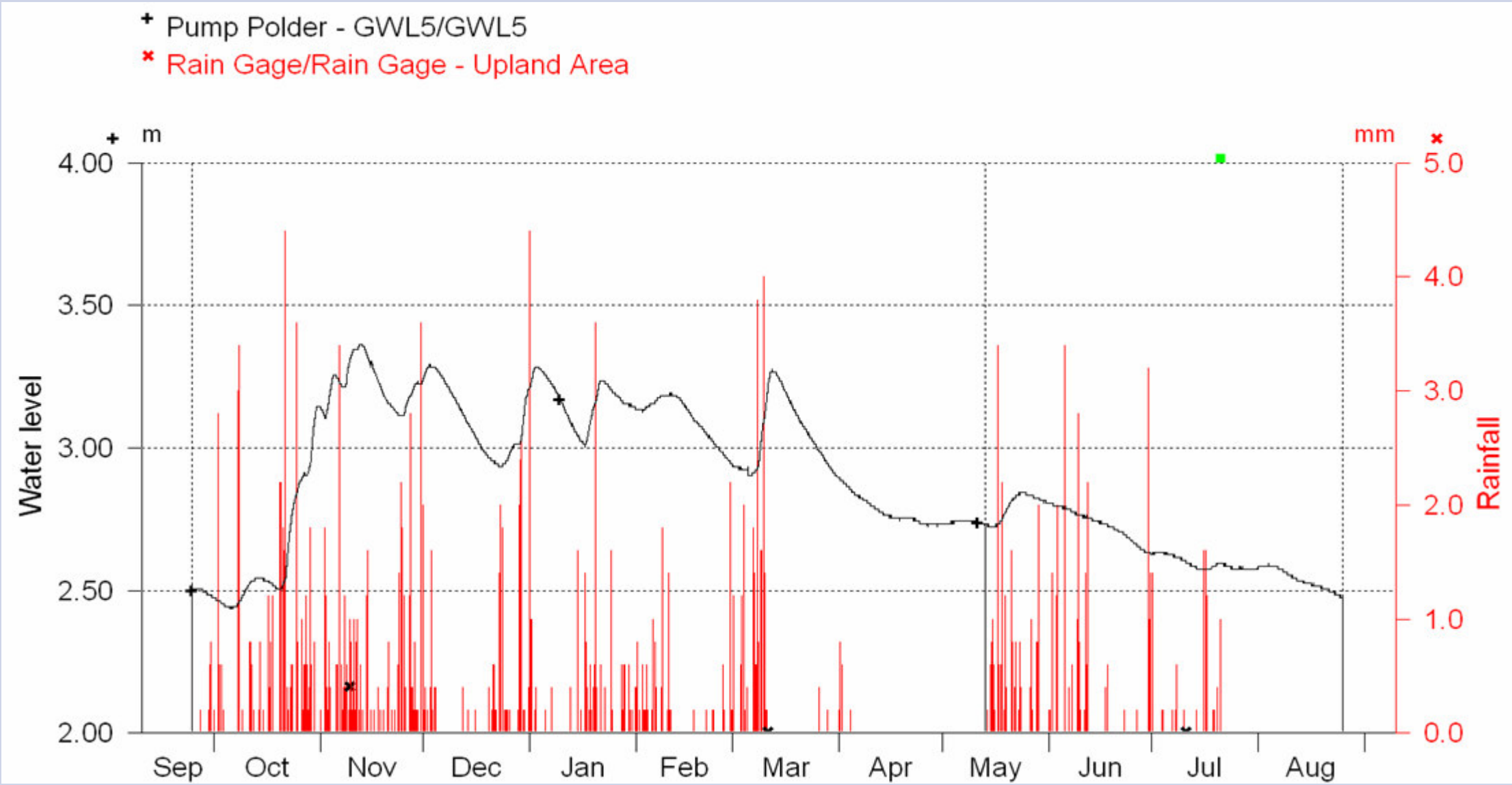


Eddy Covariance Station - Energy Fluxes

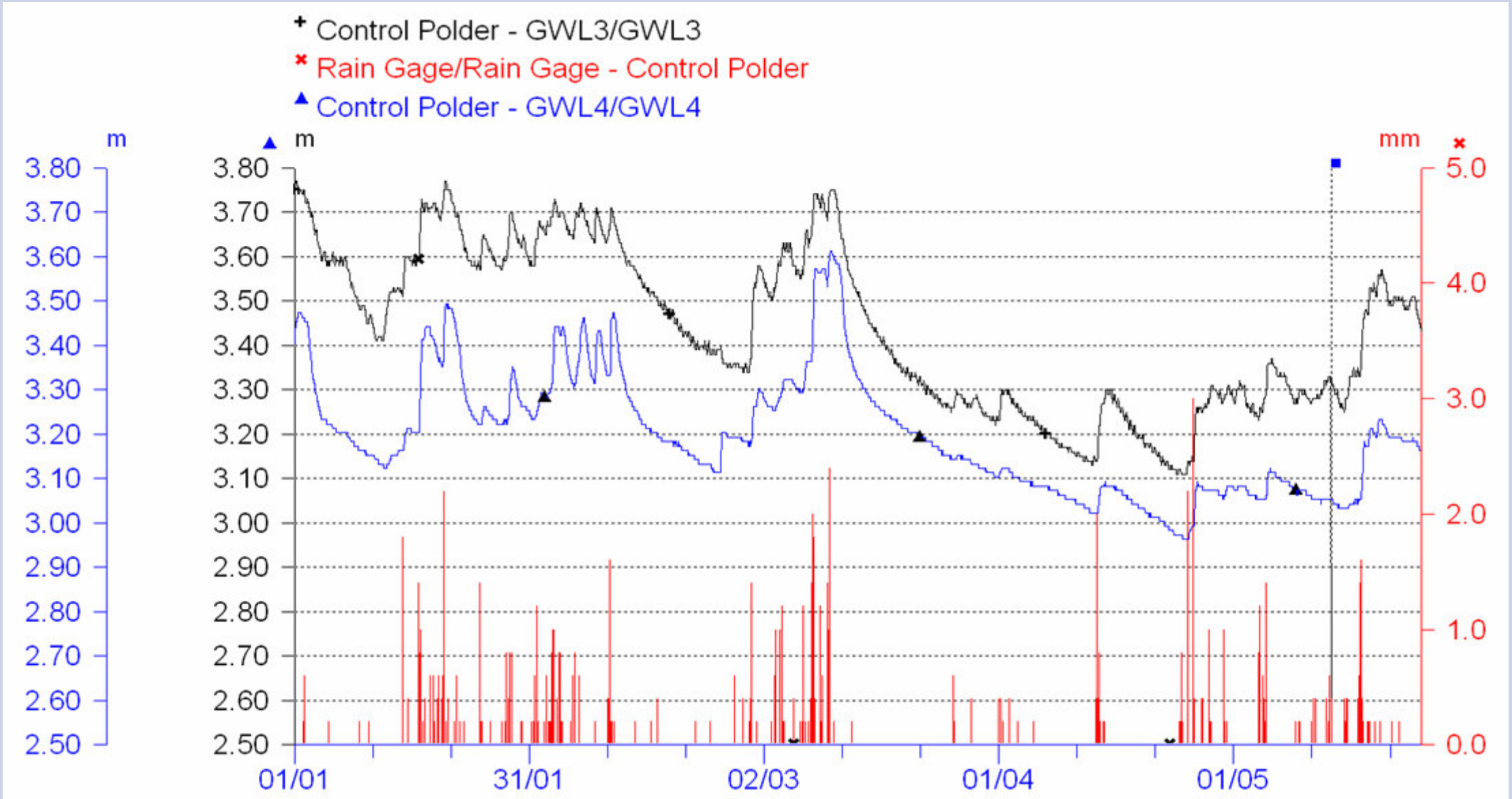


OTT-Orphimedes Water Level Gauge

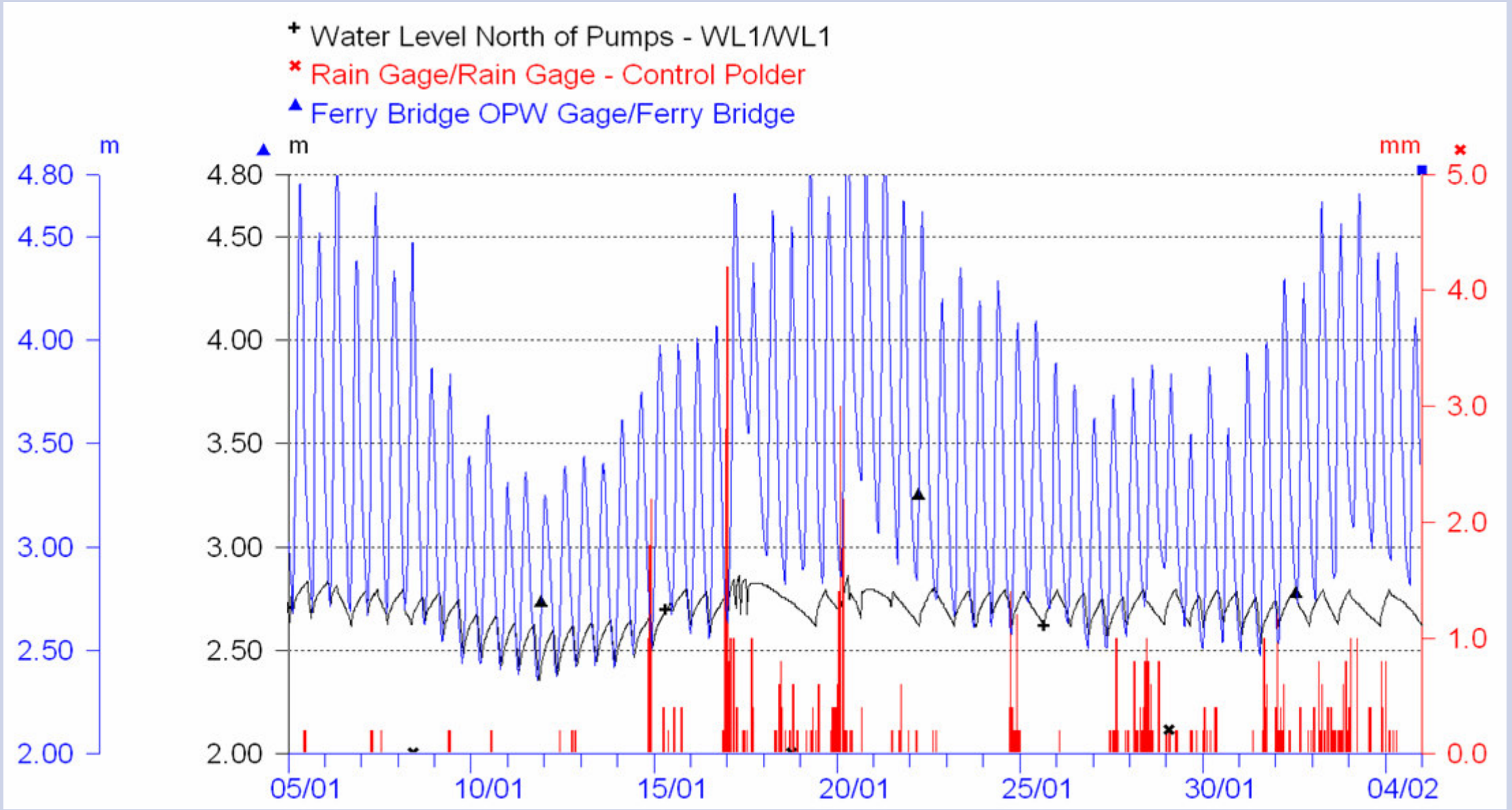
Ground Water Levels recorded



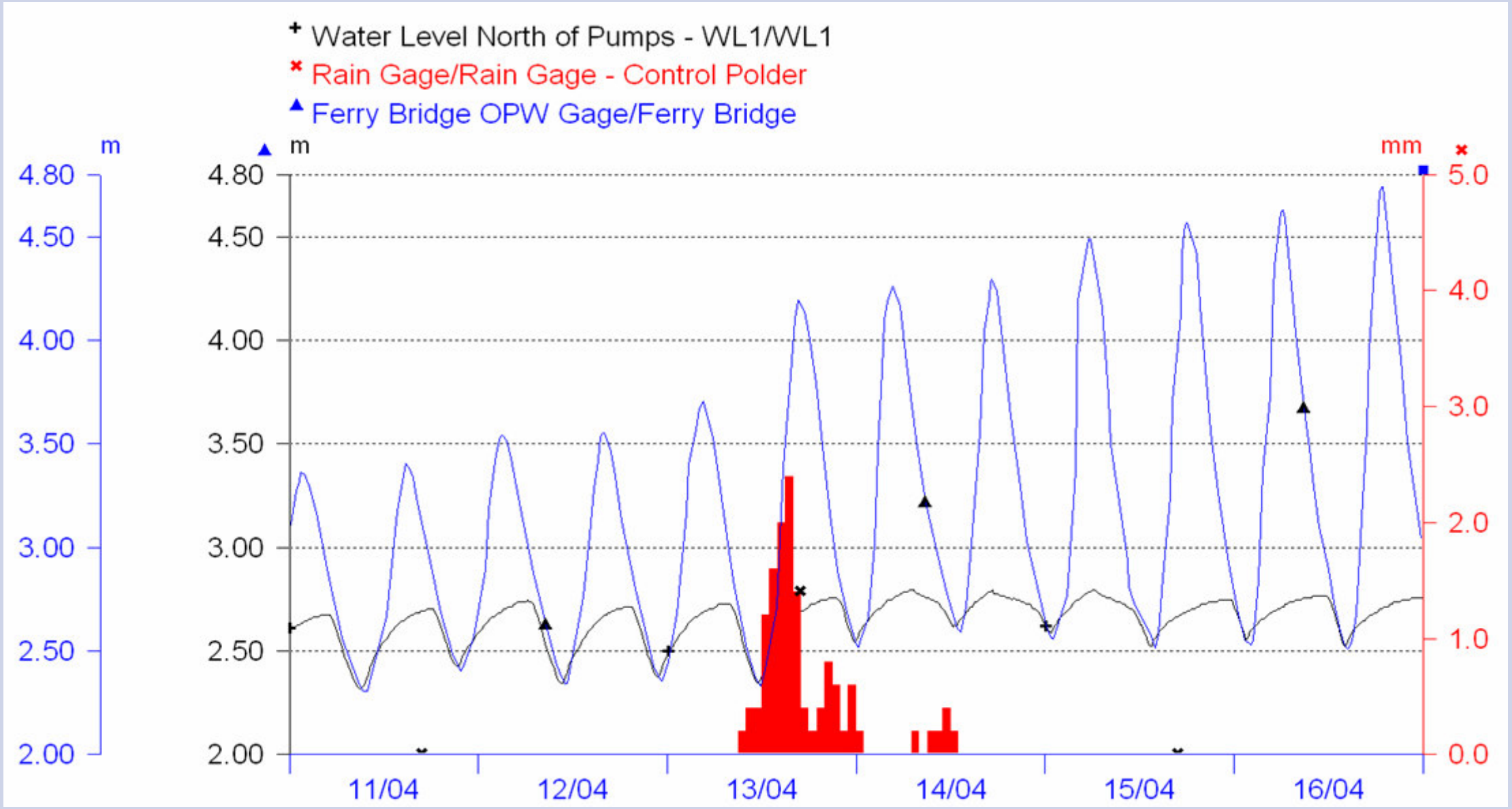
Ground Water Levels recorded



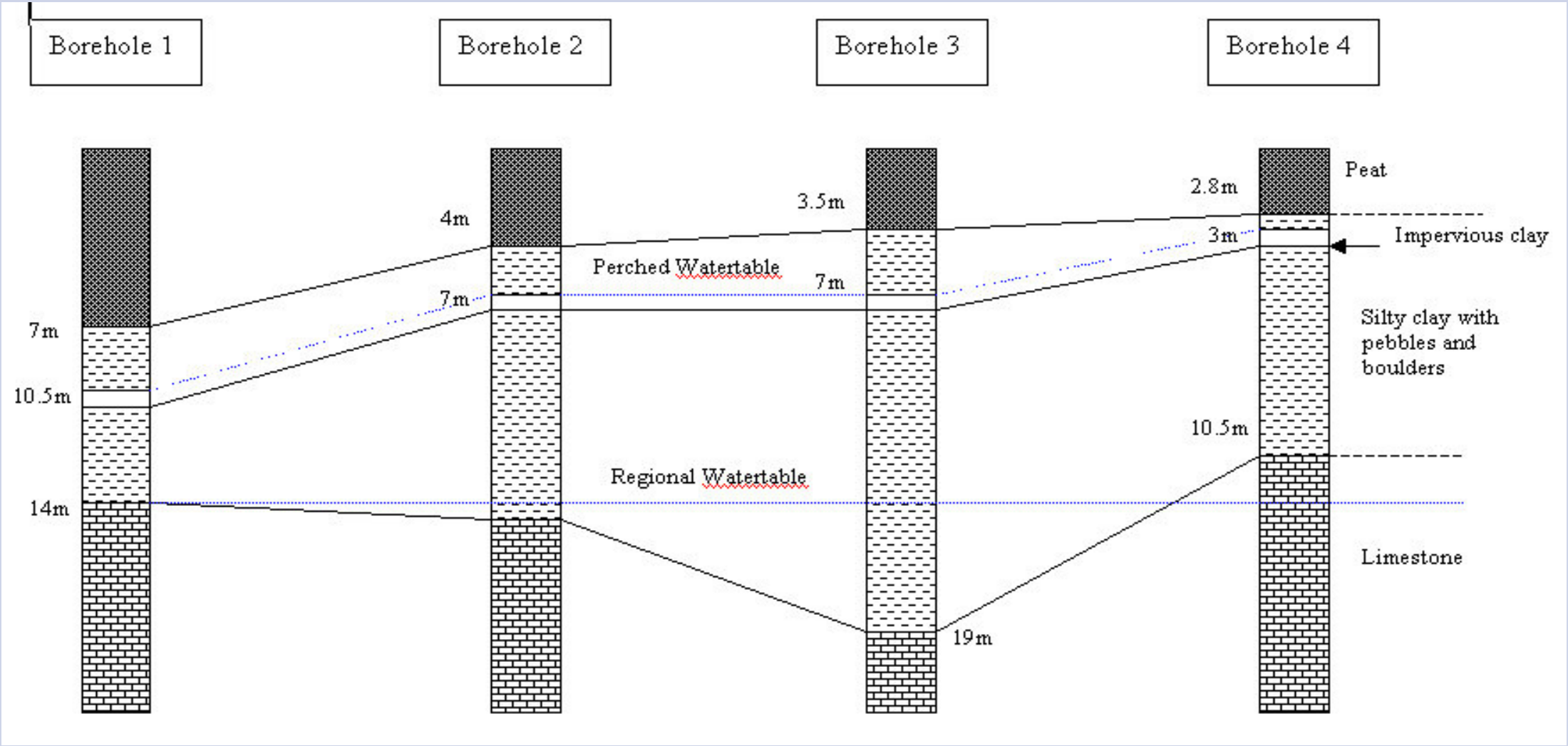
Water Levels recorded



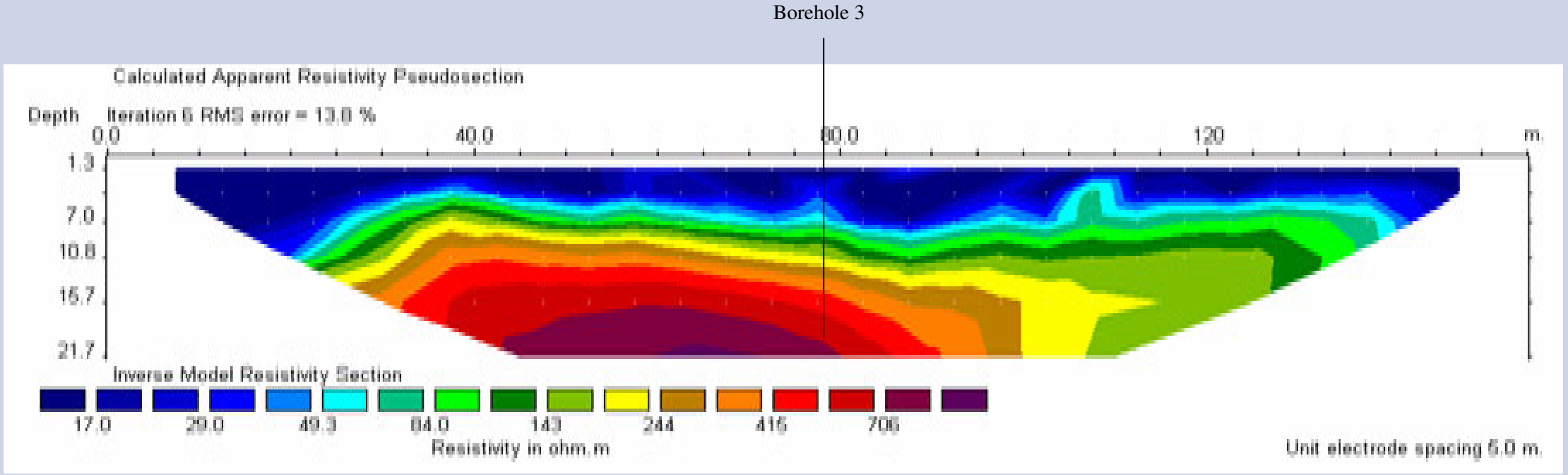
Water Levels recorded



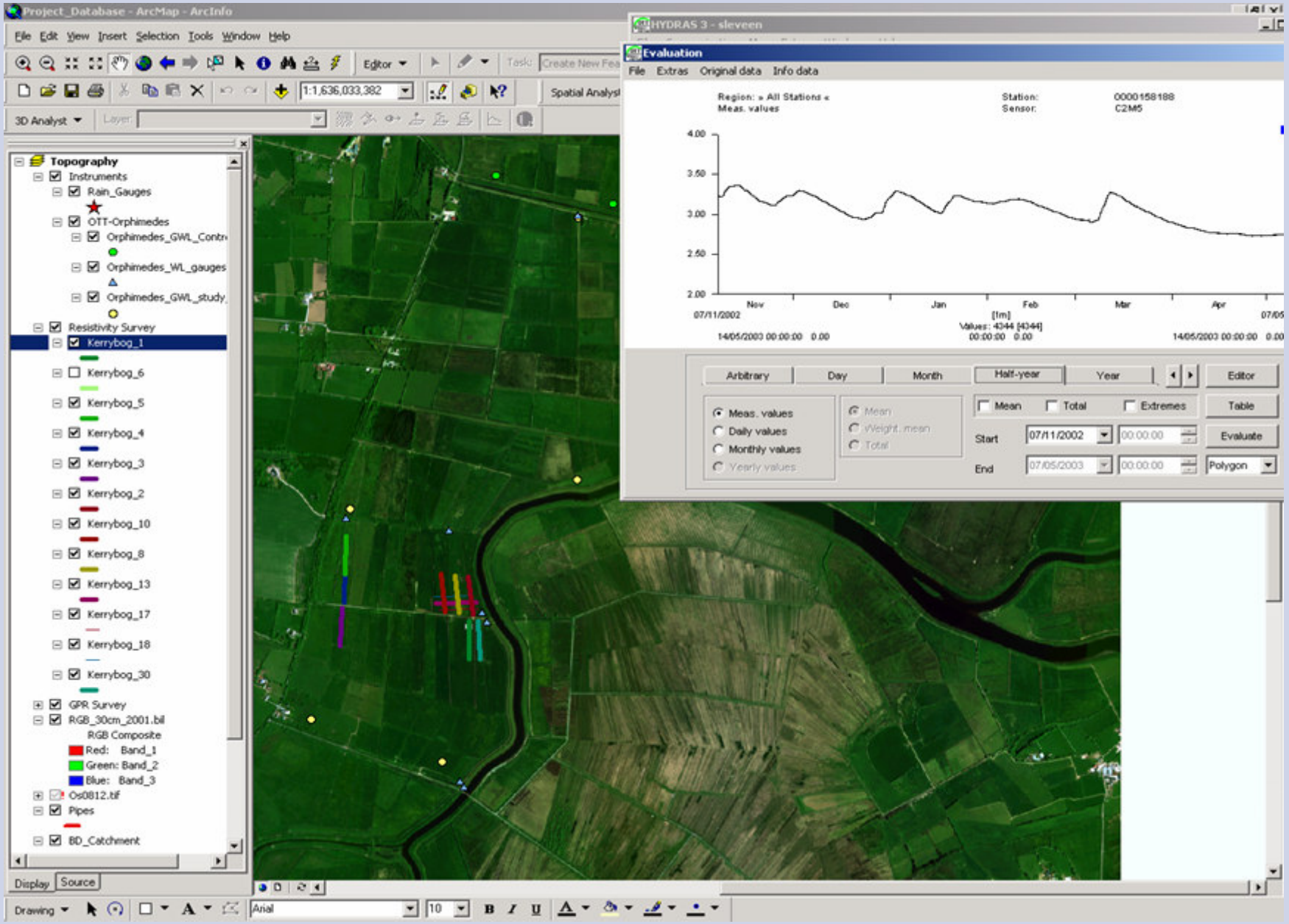
Boreholes logs



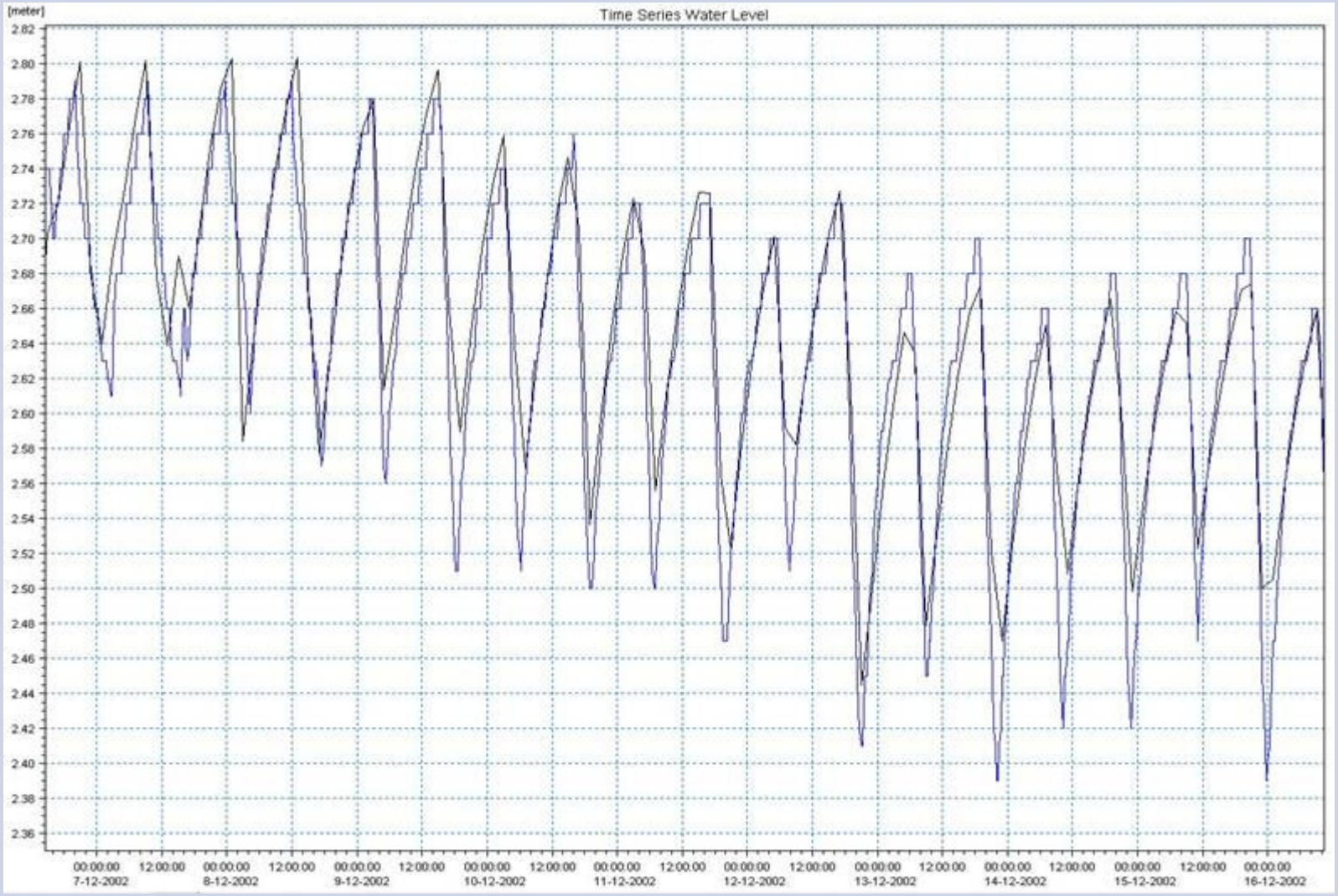
Resistivity Survey



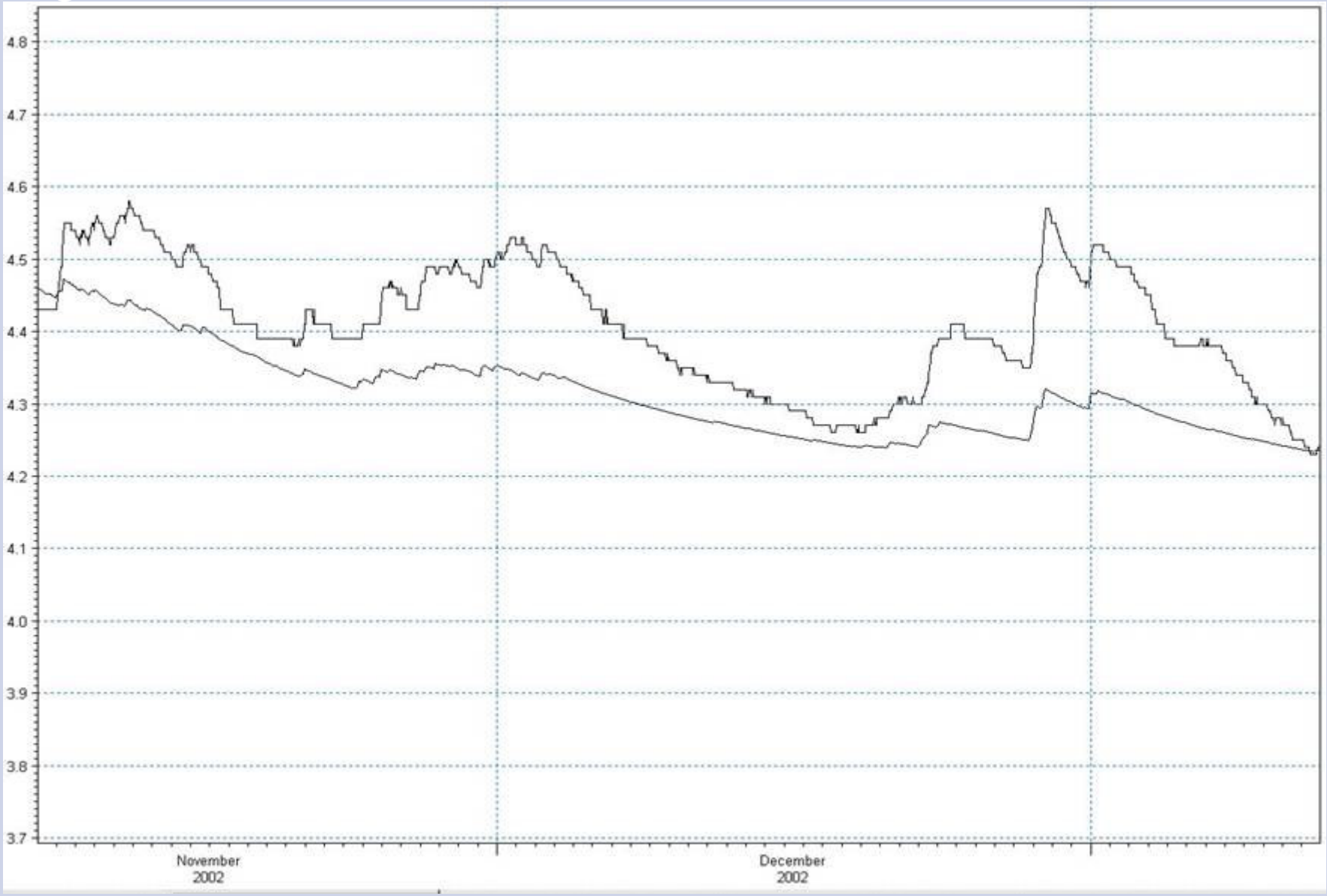
ArcGIS Database



Coupled model: 3D groundwater (SHE) + network model preliminary results – Water level in the drains



Coupled model preliminary results – ground water level



Conclusions:

- Further calibration of the coupled model, not easy

- Mismatch between data and prediction raises the question: Why? and leads to insight into models, data and processes.

- Waiting for flood events to test the effectiveness of pumps (One major and several minor floods)

The Future

- Conservation and development plan
  - proposed Special Area of Conservation
  - restore wet-lands
  - eco-tourism
  - wind mills
  - best sustainable use of natural resources
- e-cooperative for farmers
  - local multi-national food company

Feale website ?

- http://www.rocketmedia.ie/feale/site