Use of modelling for protecting and improving water quality

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Name Hannah Green
with thanks to Paul Simmons, Neil Murdoch, Paul Davidson

Organisation Environment Agency – Water Quality

Environment Agency

Outline

- Overview of WQ protection role and priorities
- Example of catchment modelling

Breadth of water quality protection

Current Protection Goals and services enabled

Aquatic biology
- Flora, fauna, habitats
- Biodiversity

Drinking Water sources
- Human Health
- Taste, Odour
- Treatability

Recreational waters (e.g. Bathing)
- Human health
- *Recreation*
- *Tourism*

Economically significant aquatic species (e.g. Shellfish)
- Human health

Protected species and habitats
- N2K (SAC, SPA)
- SSSI
- Biodiversity Action Plan species

Amenity and recreation
- Tourism
- Public wellbeing
- Angling
- Water sports
- Boating

Pollutants / water chemistry properties

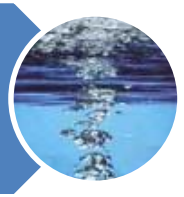
Priority Substances (Very toxic)
- Metals
- Pesticides
- Organics
- …

'Specific' pollutants (toxic)
- Ammonia
- Metals
- Pesticides
- Organics
- …

Emerging issues
- New substances of potential concern

Other types of pollution
- BOD
- Sediment
- Pathogens
- Heat
- Organic carbon / colour

Physico-chemical properties
- Dissolved oxygen
- Nutrients (Phosphate, Nitrogen)
- pH / Acid Neutralising Capacity
- Temperature
- Trace elements



Sources of pollution

Discharges
- Domestic sewage, Trade, Industry, drainage outfalls

Agriculture

Industry

Roads

Urban
- Trading estates, Misconnections, Construction. Airports, etc

Mines

Contaminated land

Ways to apply controls on pollution

Regulation

- Legally enforceable controls, including product / source controls

Enforcement against illegal activity

- Punish / Remedy / Deter

Influencing sectors

- Incentives, Advice & guidance, Partnerships
- Encouraging ownership of problems & solutions
- Encouraging innovation

Influencing development planning and delivery

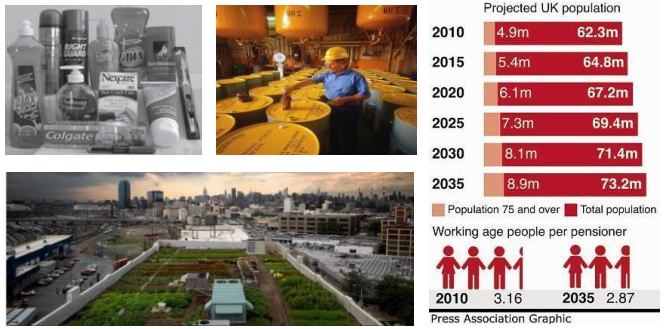
- land-use planning, and infrastructure associated with sectors such as water, energy, transport

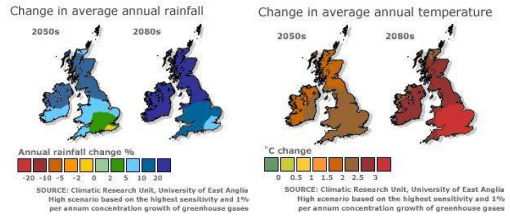
Remediation programmes for legacy issues

- e.g. mining, contaminated land

Managing pollution

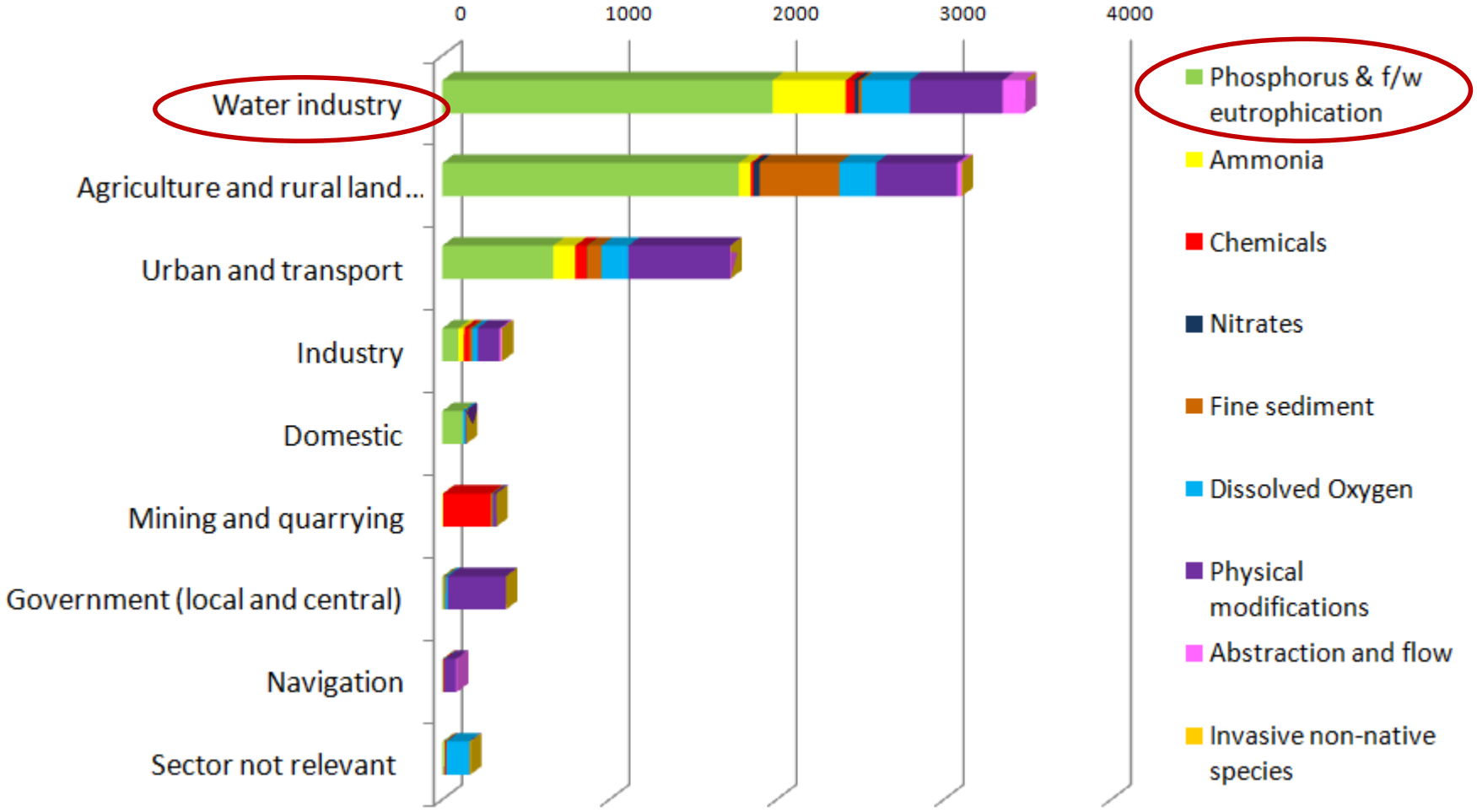
- **Improving** water quality
  - **address current issues – largely a legacy of the past**
    - *Past priorities and choices on what, when and how to control pollution and stringency of environmental objectives*
    - *Phased investment to widen where controls are applied &/or develop and apply more stringent controls*
- **Protecting** water quality
  - address emerging issues
  - avoid deterioration from changing pressures and climate
    - *short, medium and long term issues*
  - continue to apply current controls to new sites
  - ensure compliance with current controls



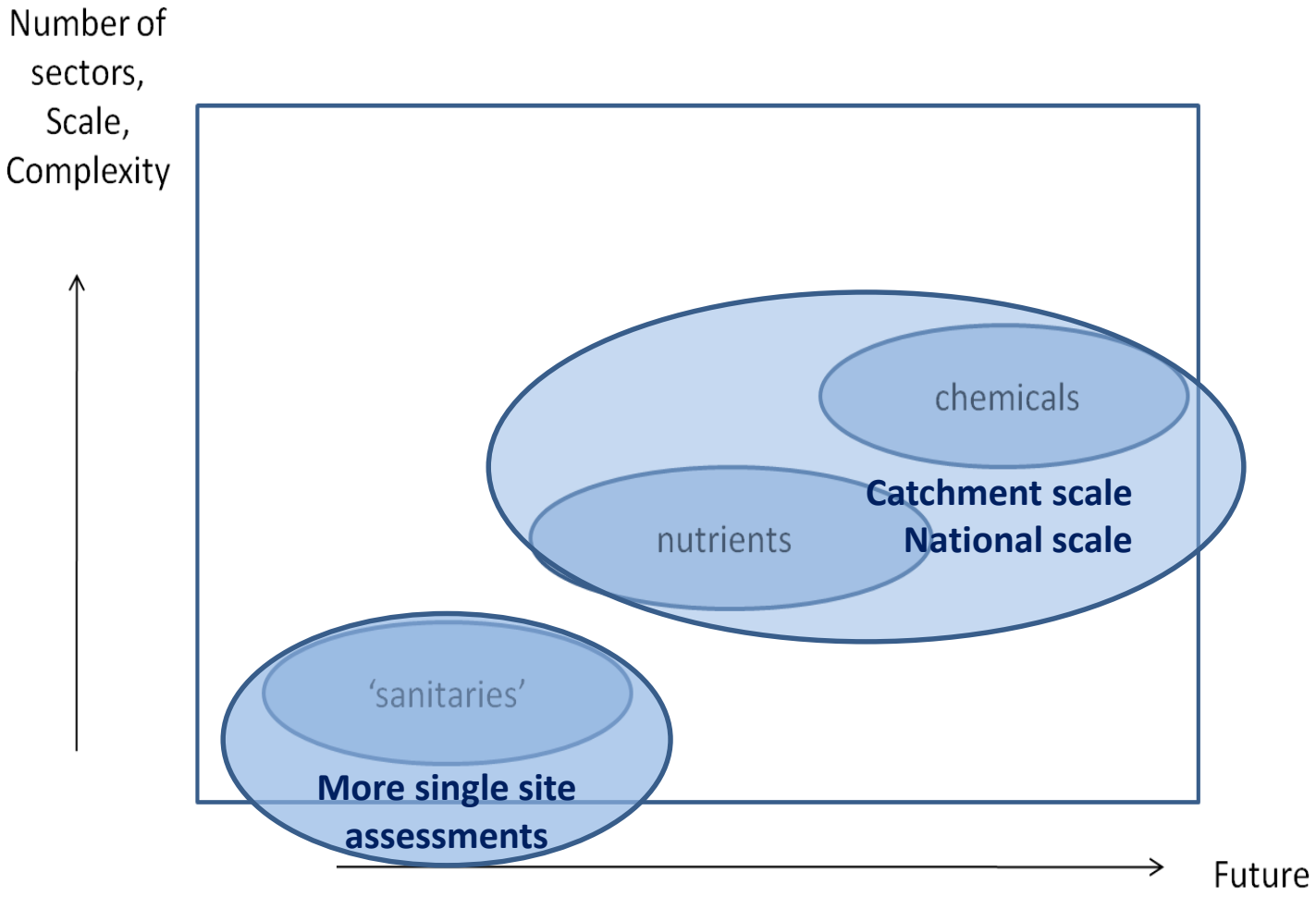


Broad pollution control activities that water quality monitoring and modelling informs

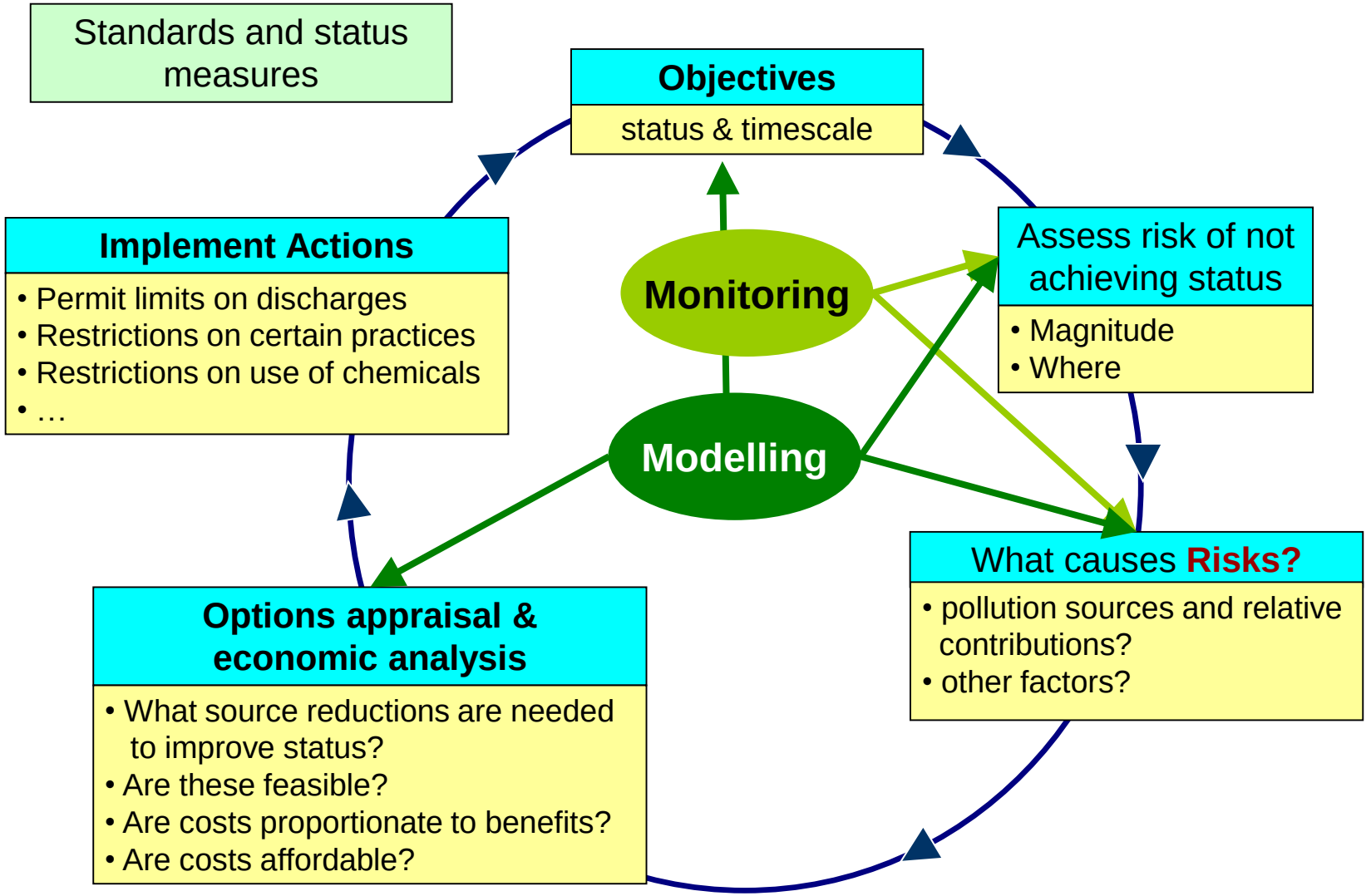
Summary of current reasons for not achieving WFD Good status



Changing pollutants and scale of assessments



Planning cycle for action to protect water quality



2nd cycle RBMPs – investment secured

- **Water Industry** NEP – **£2,300 million** 2015-20
- **Agriculture** 2015-20
  - Countryside stewardship **£400 million**
  - Farmer match-funding £50 million
- **Highways England** – **£110 million** 2015-20 (for flood risk and polluting outfalls part of Designated Environment Fund)
- Minewater remediation programme - £3 million 2015-16
- EA Environment Programme – £5 million 2015-16
- Govt Catchment Partnership Fund – £5 million 2015-16
- Catchment partnerships and local authorities – £16 million

Example of catchment modelling

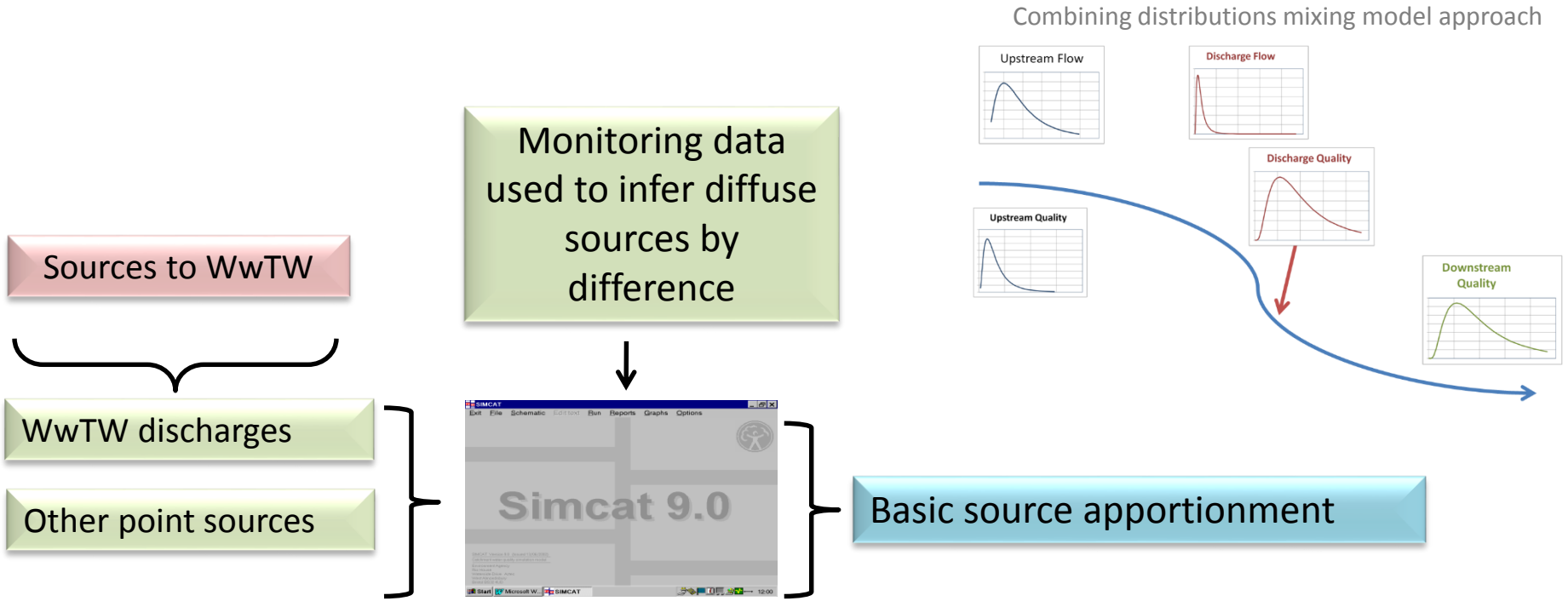
Simcat-SAGIS (Source Apportionment GIS)

Simcat-SAGIS source apportionment model

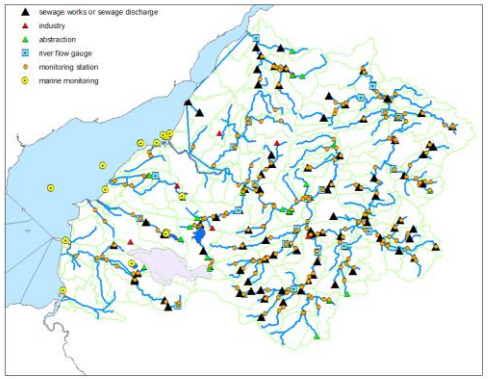
- **Collaborative approach to development and ongoing improvement**
  - Regulators – EA, Sepa, NRW
  - Water Industry
  - Natural England
  - Consultants

Evolution of Catchment Source modelling approach

- SIMCAT developed by EA as catchment model for planning discharge improvement to point source sewage discharges (rivers)
- Largely used for nutrients, especially phosphate
- Non point-source discharges as a single ‘diffuse’ input



The Simcat-SAGIS approach



Sources to sewage works

DISCHARGES
- Sewage works
- Other

AGRICULTURE
- Psychic (ADAS)
- NEAP-N (ADAS)

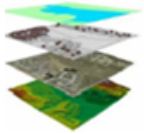
OTHER INPUTS
- Storm sewage
- Non-mains sewage
- Urban runoff
- Highway runoff
- Mines
- Atmospheric
- Background

>17 pollutants

HYDROLOGY
Low Flows (WHS)

Simcat river mixing model

GIS



OUTPUTS

Gauged Flows

Output checks and model refinement

River monitoring

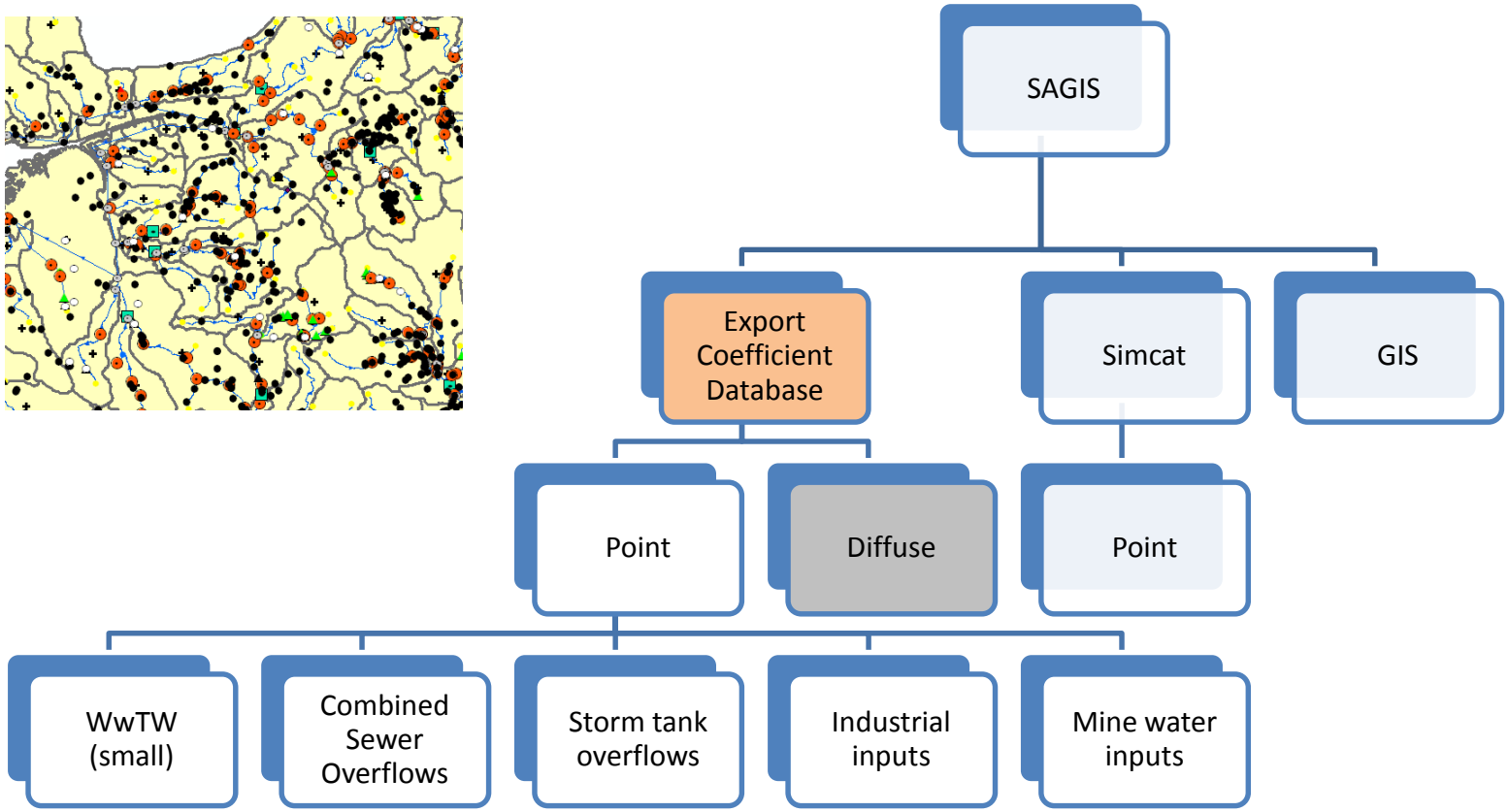
Nutrients – Phosphorus, Nitrogen

Metals – Copper, Zinc, Lead, Cadmium, Nickel, Mercury, Iron

Organics - Di-ethylhexyl phthalate, PAHs (naphthalaene, anthracene, fluoranthene, benzo-a-pyrene, benzo-b-fluoranthere, benzo-k-fluoranthene, benzo-ghi-perylene, indeno-123,cd-pyrene), TBT, Nonylphenol, Triclosan, EE2, BDEs

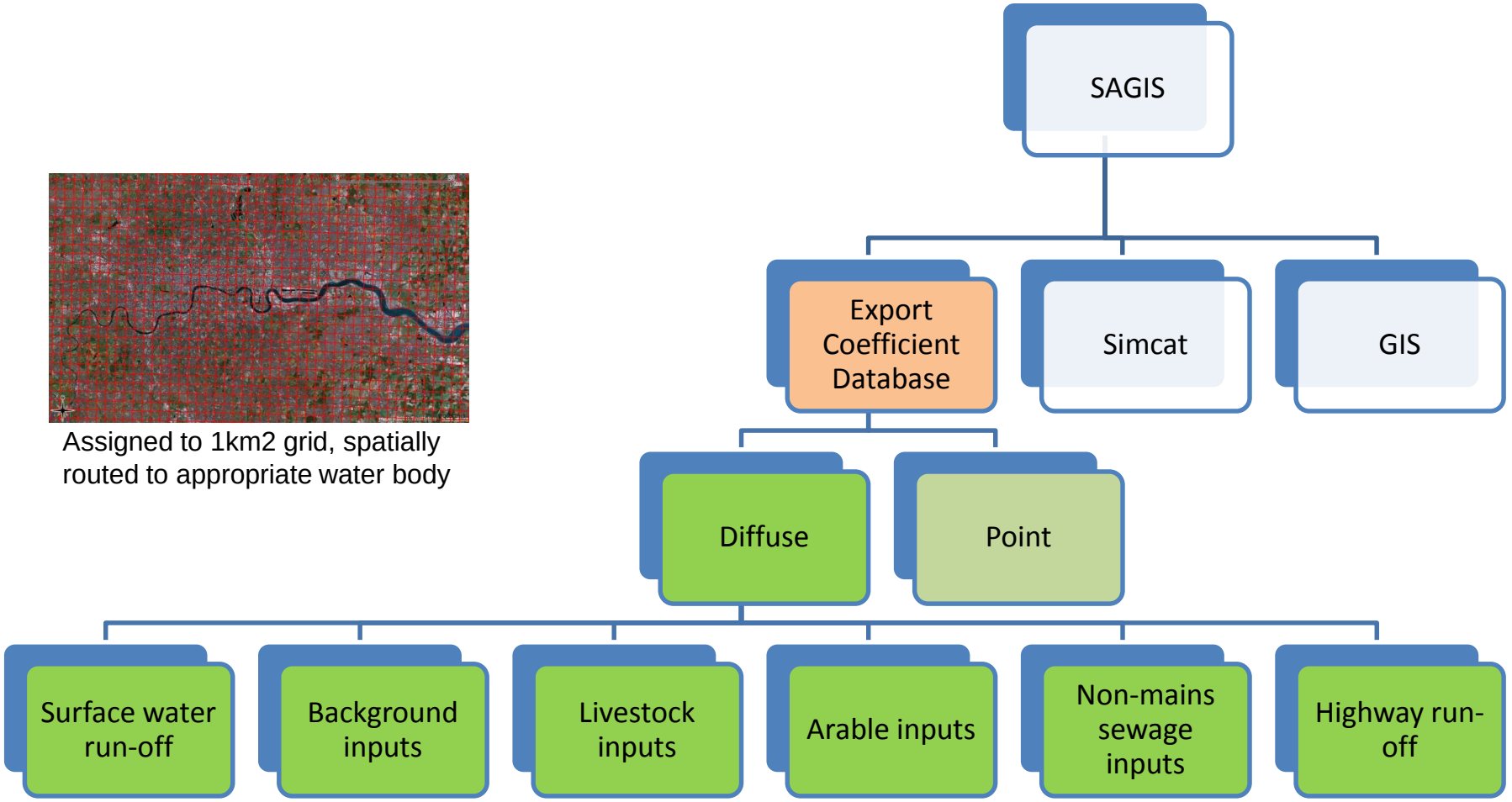
GIS processing of inputs and outputs

Structure of SAGIS – Spatial inputs – Point sources



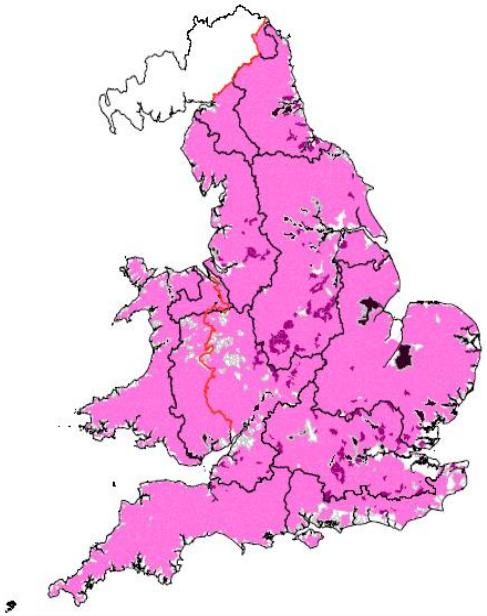
Structure of SAGIS – Spatial inputs – Diffuse sources

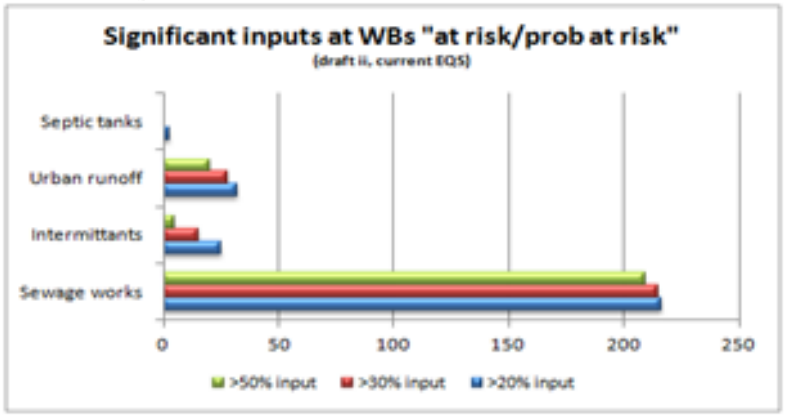
Assigned to 1km2 grid, spatially routed to appropriate water body



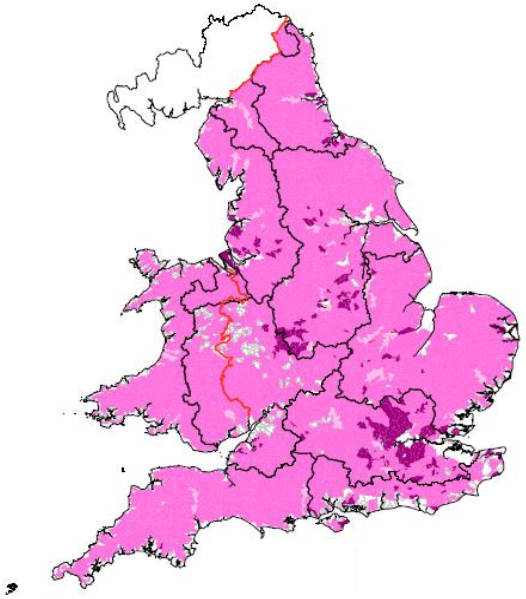
National scale – EQS compliance assessments – chemicals

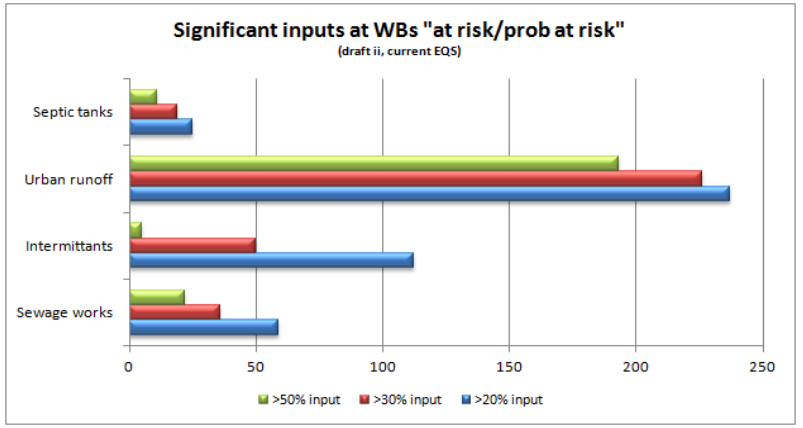
TBT (EQS 0.0002ug/l AA)





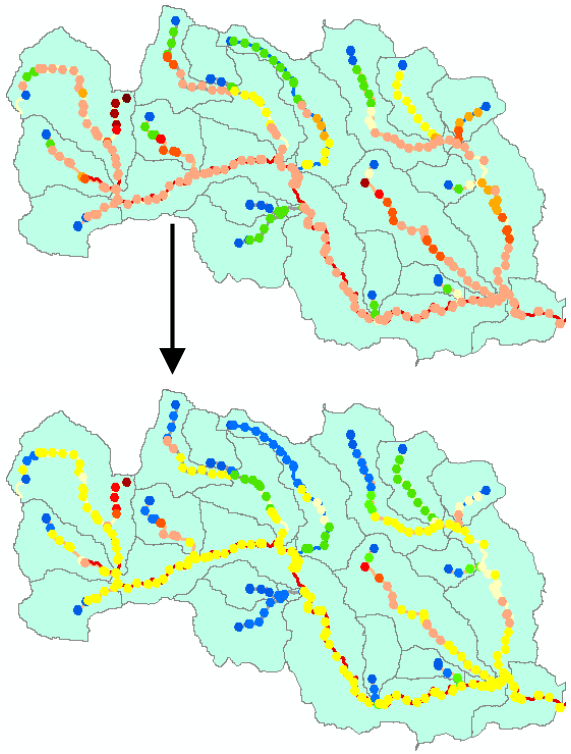
Nonylphenol (EQS 0.3ug/l AA)



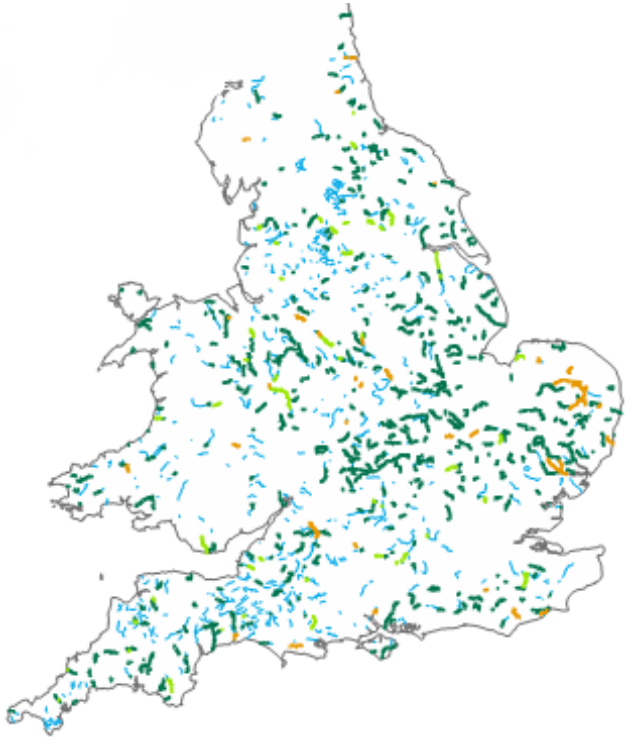


Scenario testing – effect of different levels of phosphate control on river concentrations

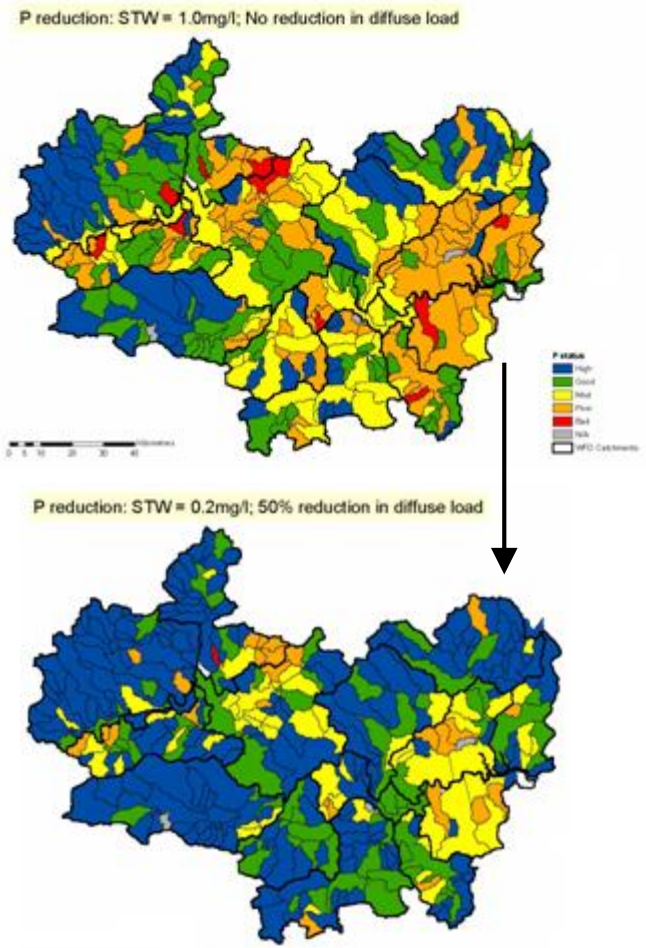
Concentration change expected from actions



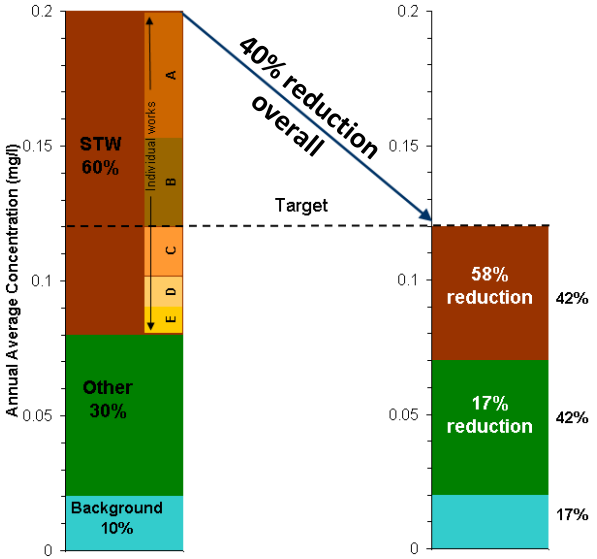
Change in compliance from increasing tiers of actions

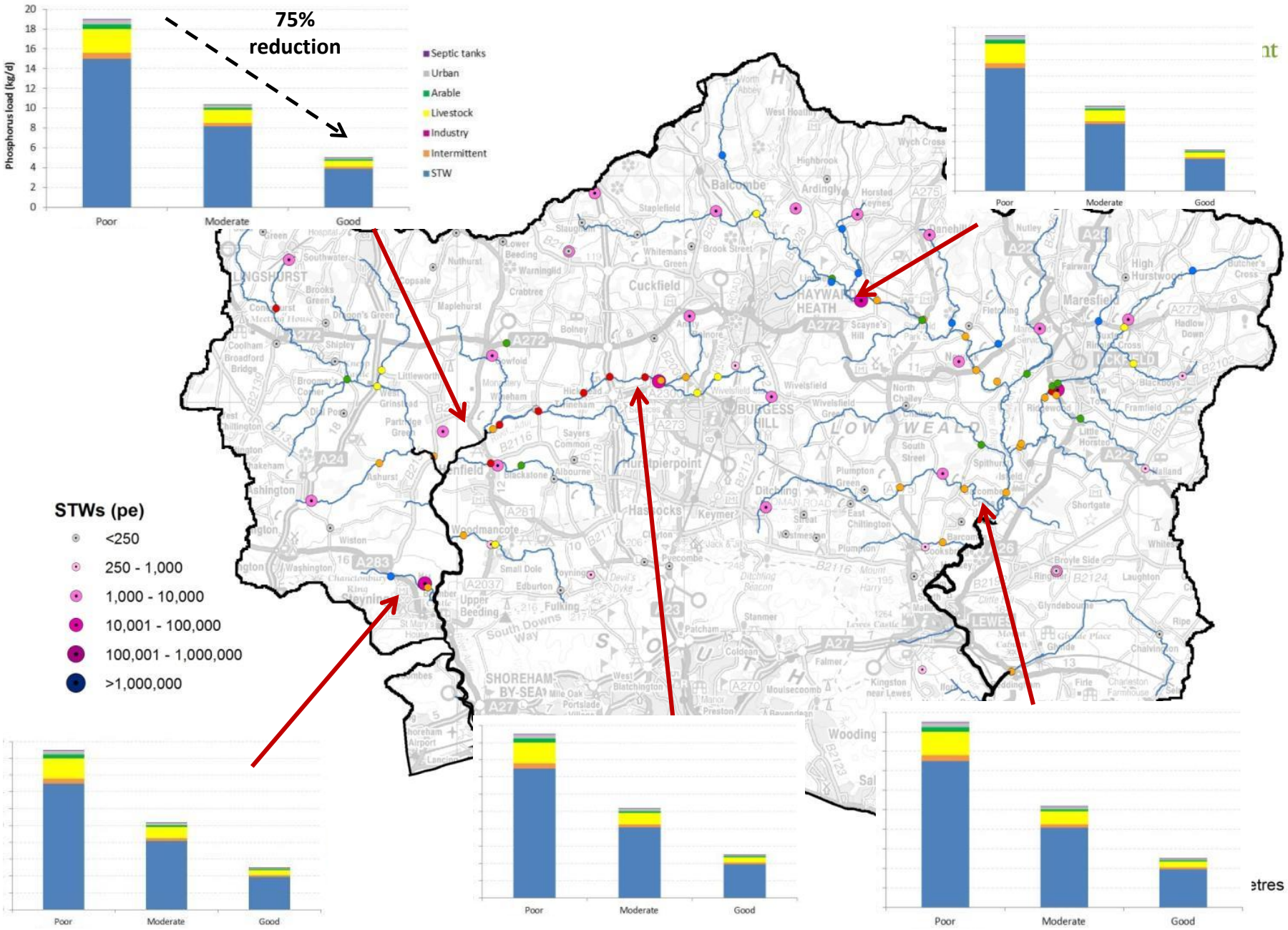


Concentration change expected from actions

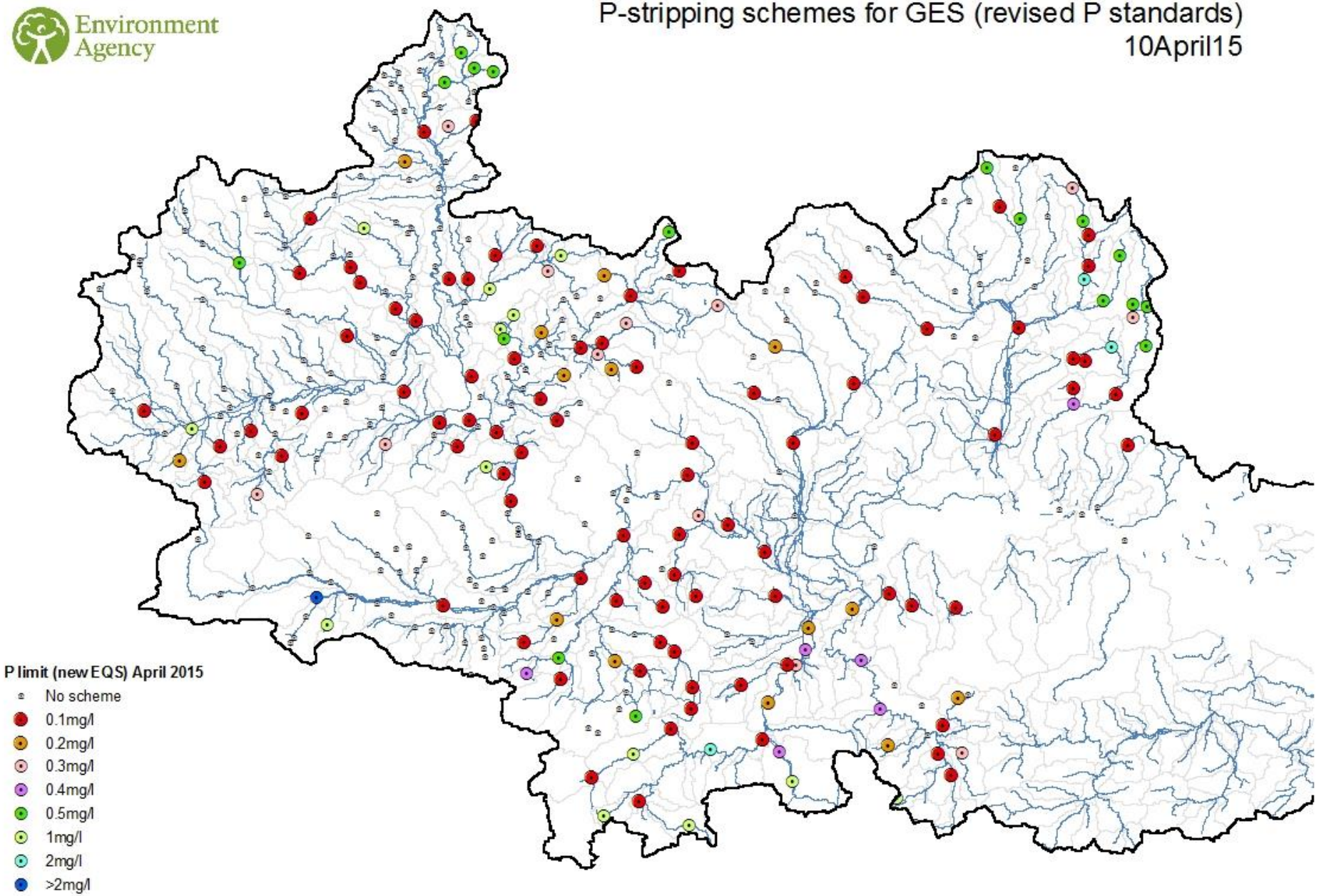


Catchment scale – source reductions needed to achieve phosphate compliance



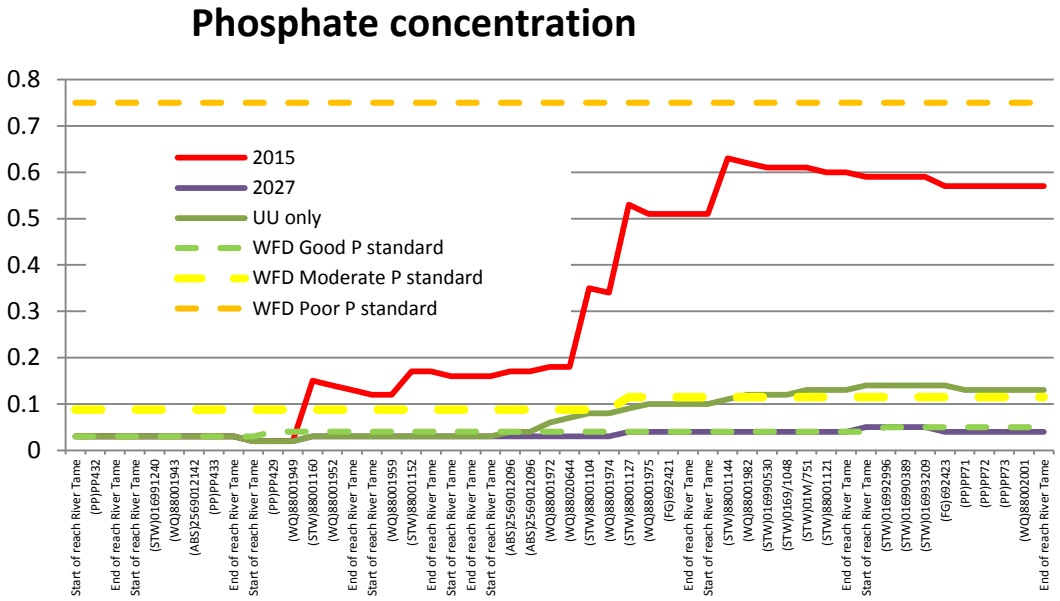


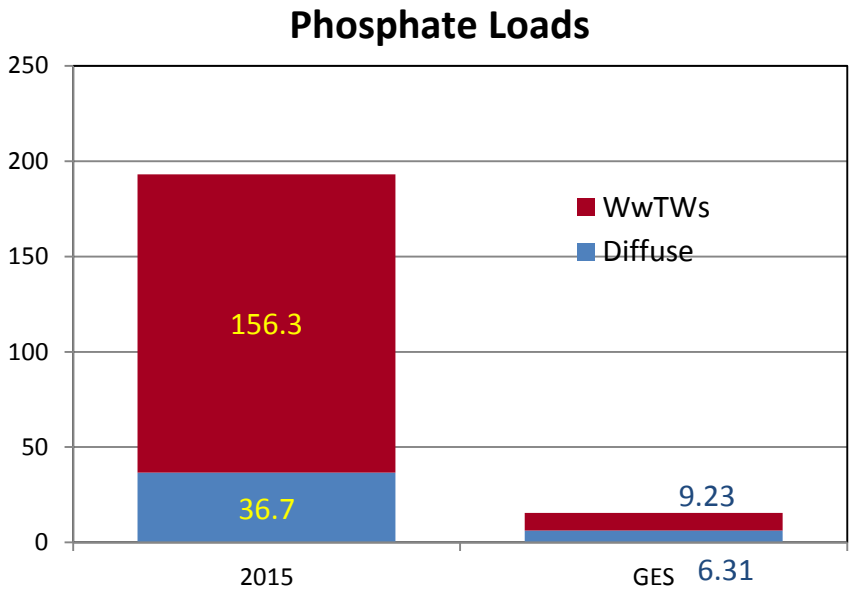
Optimising P permits needed across catchments



Outcomes expected from planned P permits

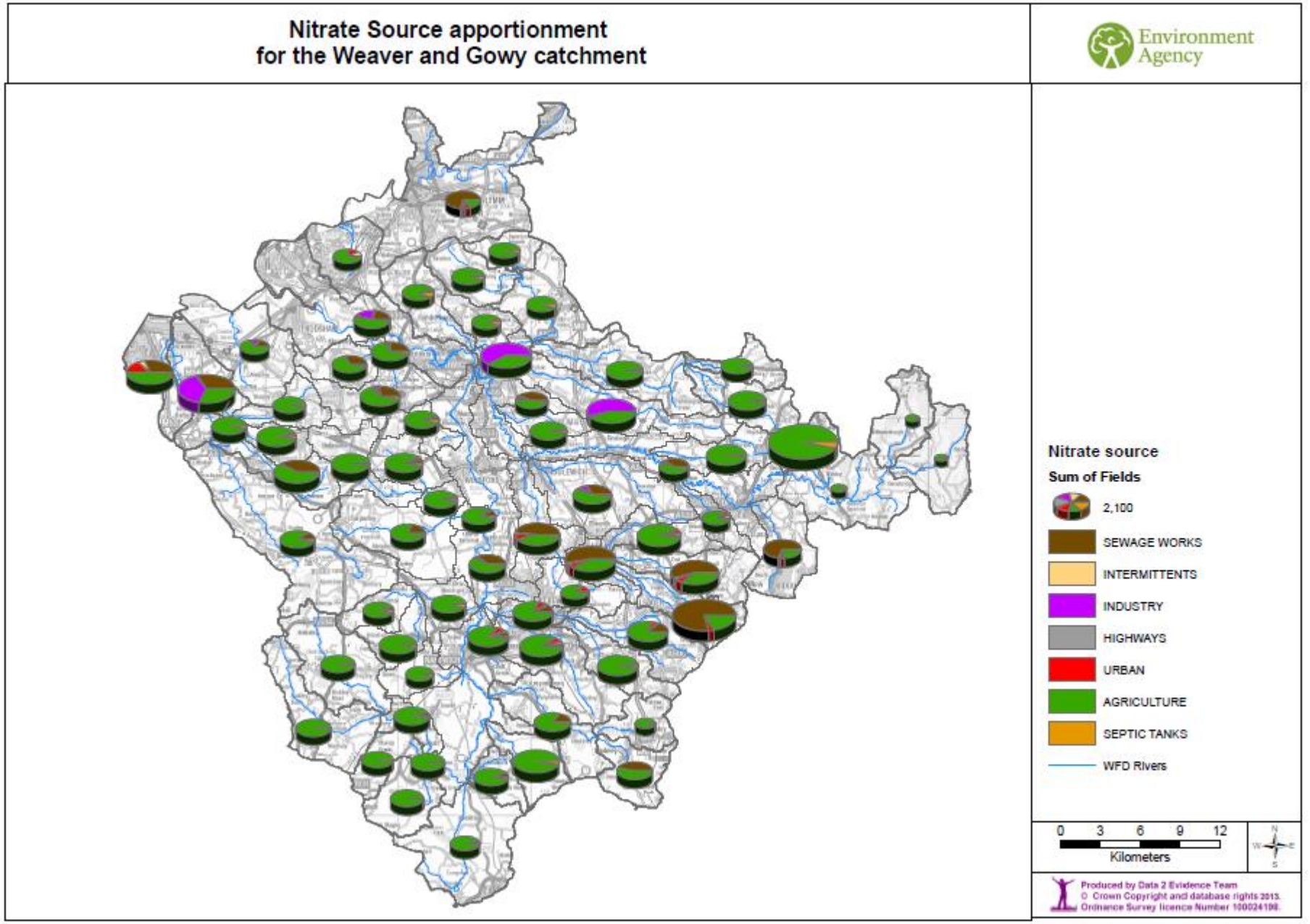
River Thame - phosphate



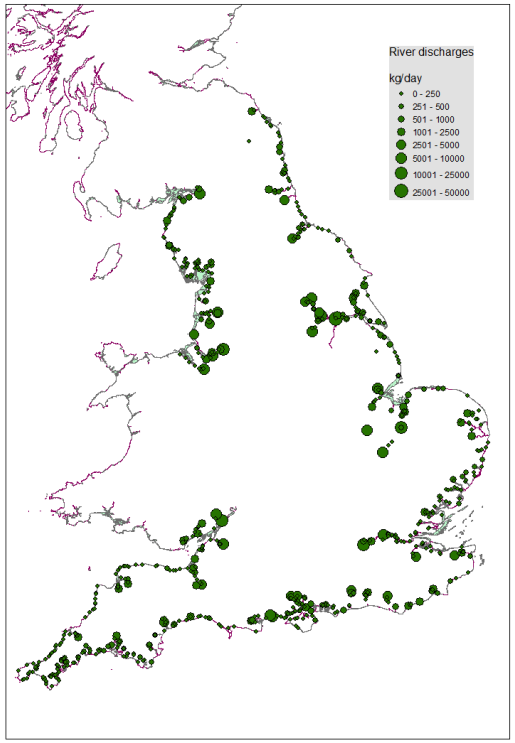


- Used to confirm pathway to good fair share measures
  - P removal at **4 STWs** and **urban** diffuse measures identified
  - Water Industry measures will achieve moderate
  - Improvements to both sources / sectors required to achieve good

Catchment scale Nitrate source contributions



Nitrogen loads to TraC waters



SAGIS-SIMCAT river loads

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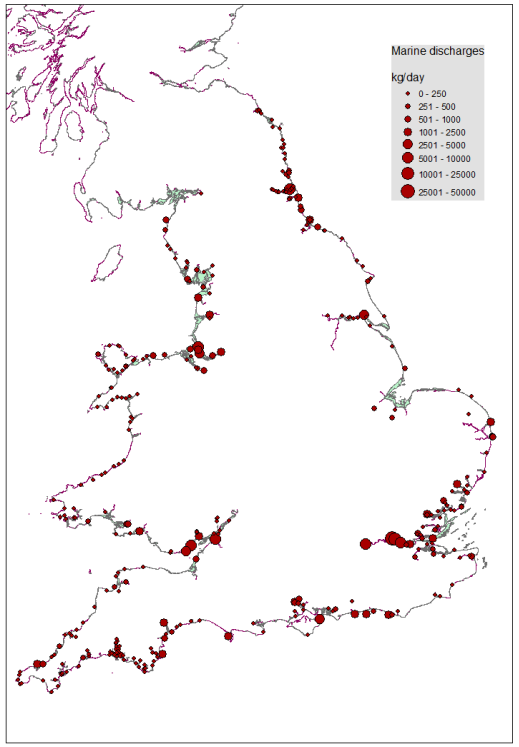

Direct marine discharges

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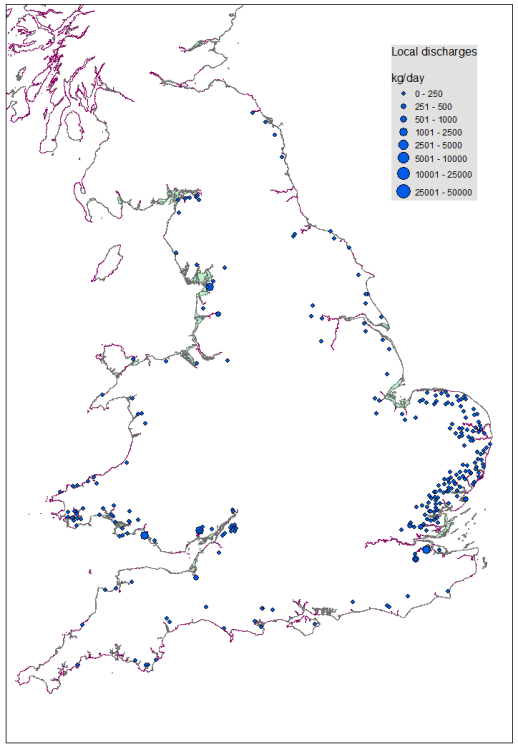

Local discharges (not in SAGIS-SIMCAT rivers)

Other applications for modelling

- Simcat-SAGIS – national coverage catchment planning tool
- Other bespoke models also used for:
  - Permitting (all water categories)
    - Continuous discharges
    - Intermittent discharges (urban pollution spill frequency, sewer modelling)
  - Targeting and evaluating Agricultural intervention programmes (e.g. Nitrates Directive, CSF, Countryside Stewardship)
  - Estimating biological response to nutrients in estuaries
  - Pollution risk forecasting for bathing waters