



Development of urban shallow groundwater geothermal systems: how to promote a sustainable approach?

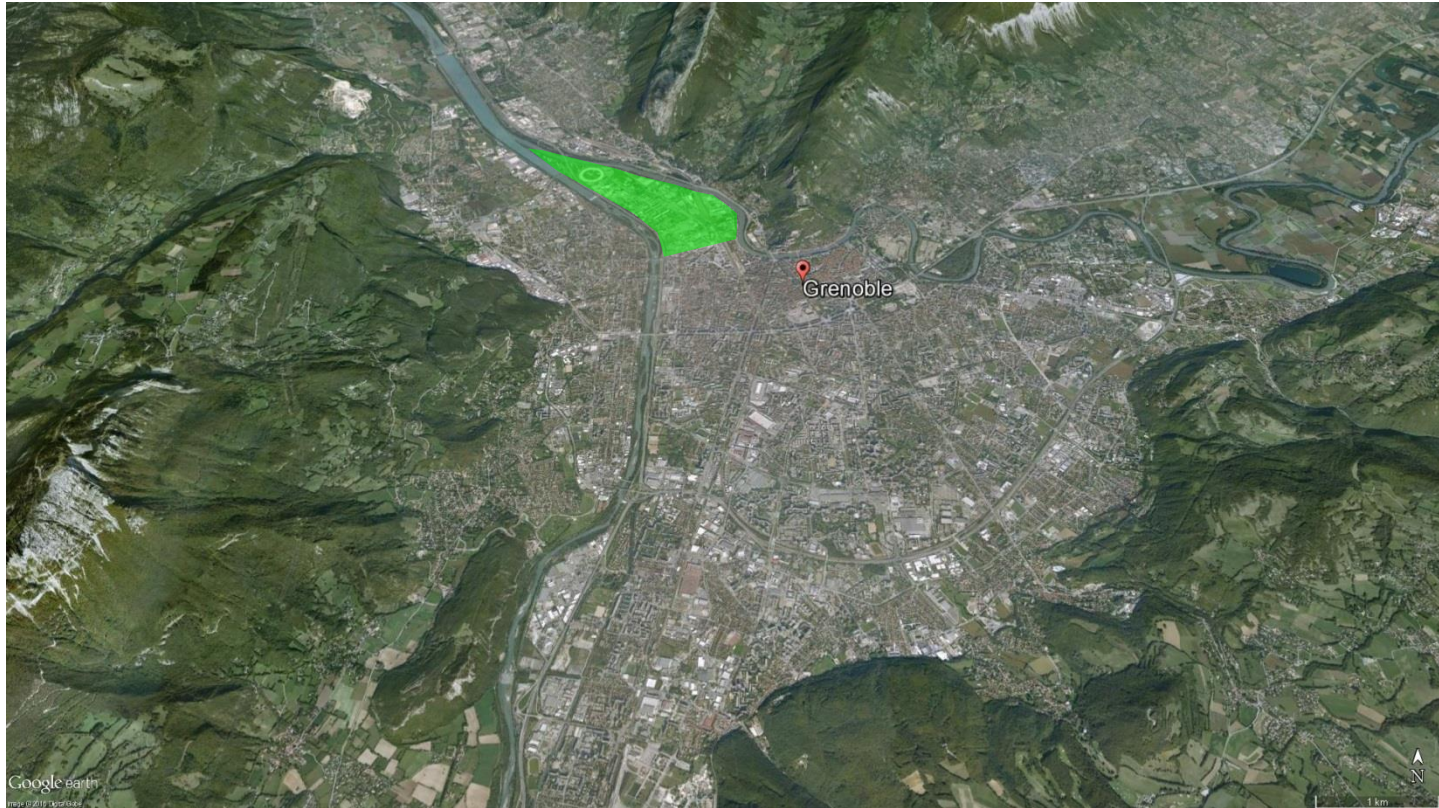
G. Gaultier¹, M. Boisson¹, R. Vigouroux¹ & F. Izoard²

1: *Artelia Eau et Environnement, Echirolles, France*

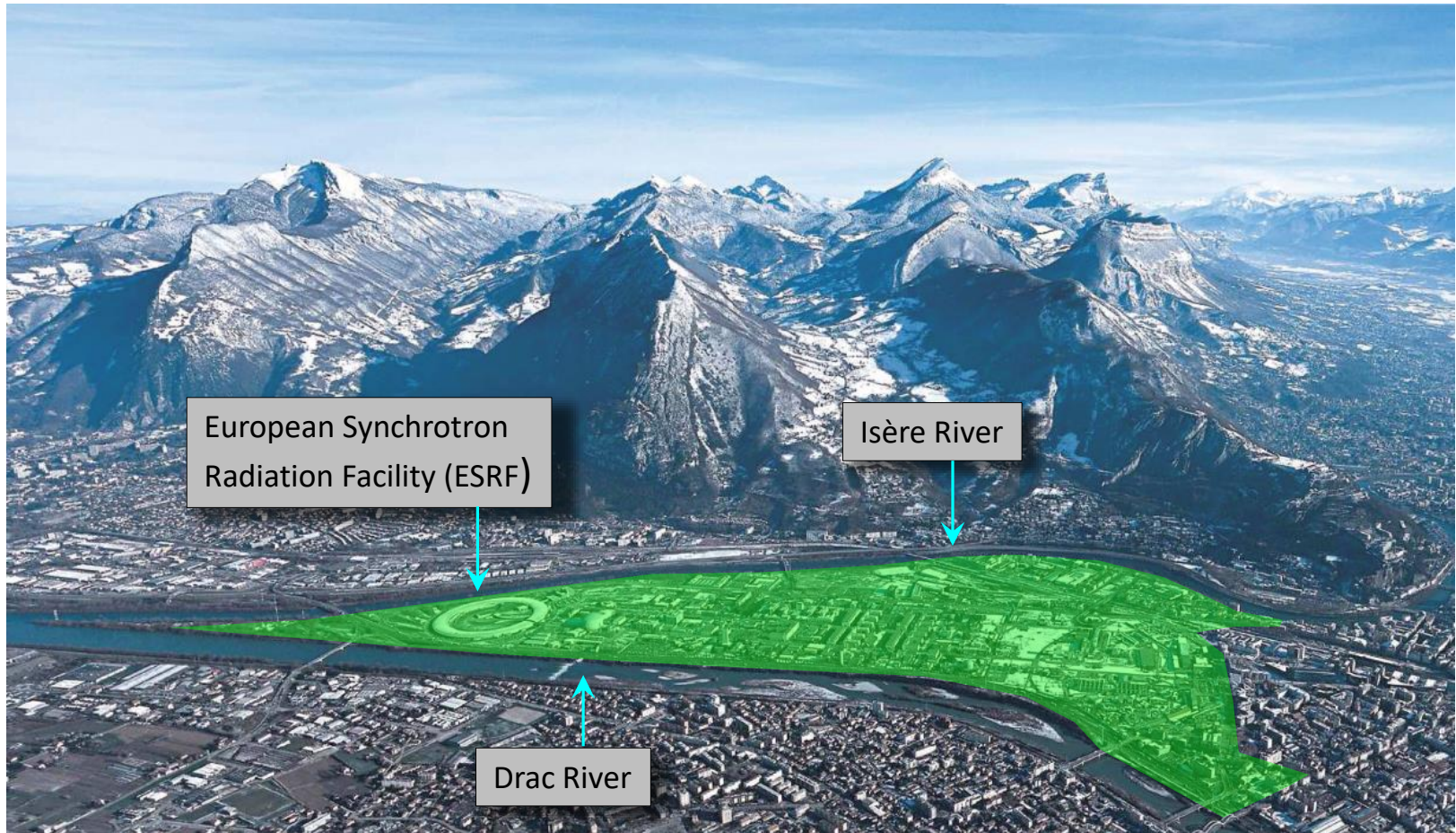
2: *SEM Innovia, Grenoble, France*

GRENOBLE
PRESQU'ÎLE

Urban Redevelopment Project



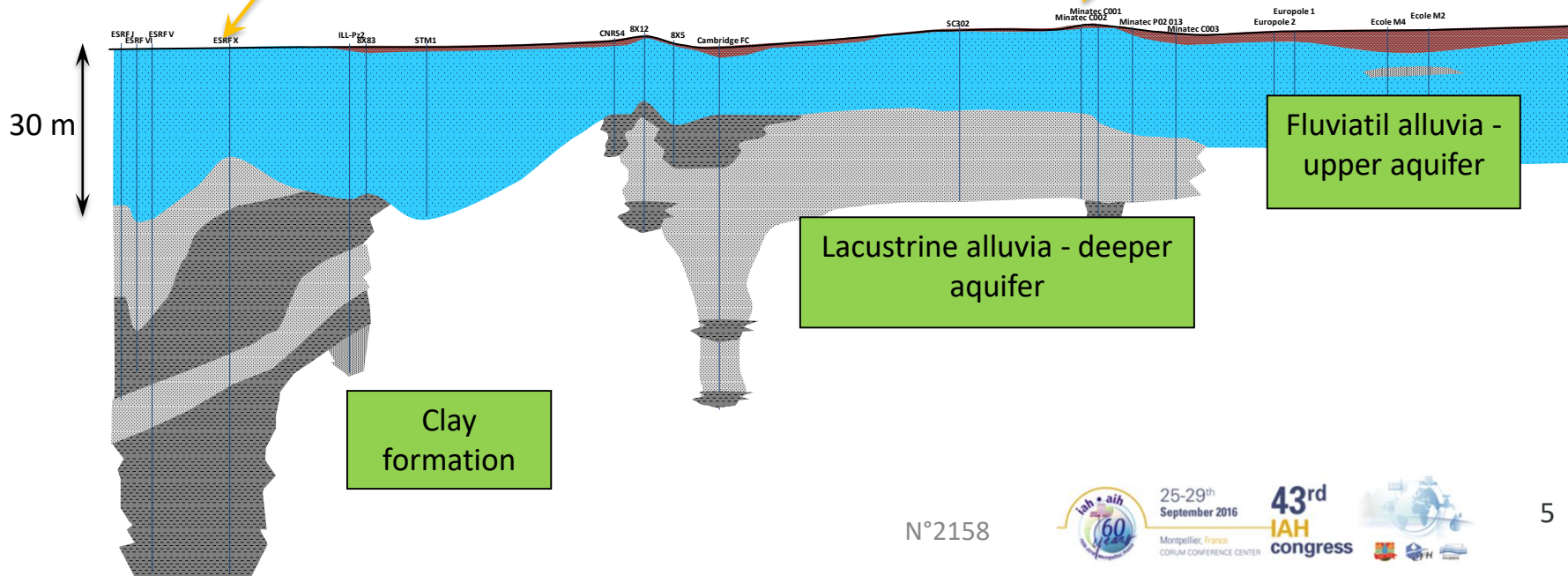
GRENOBLE Urban Redevelopment Project



Area	2.5 km ²
Schedule	→ 2035
Planner	SEM INNOVIA (semi-public development company)
Floor area	790 000 m ²
	<ul style="list-style-type: none">- Research labs- Higher education- Family and student housing- Hotel and service sector, leisure activities and shops- Public facilities



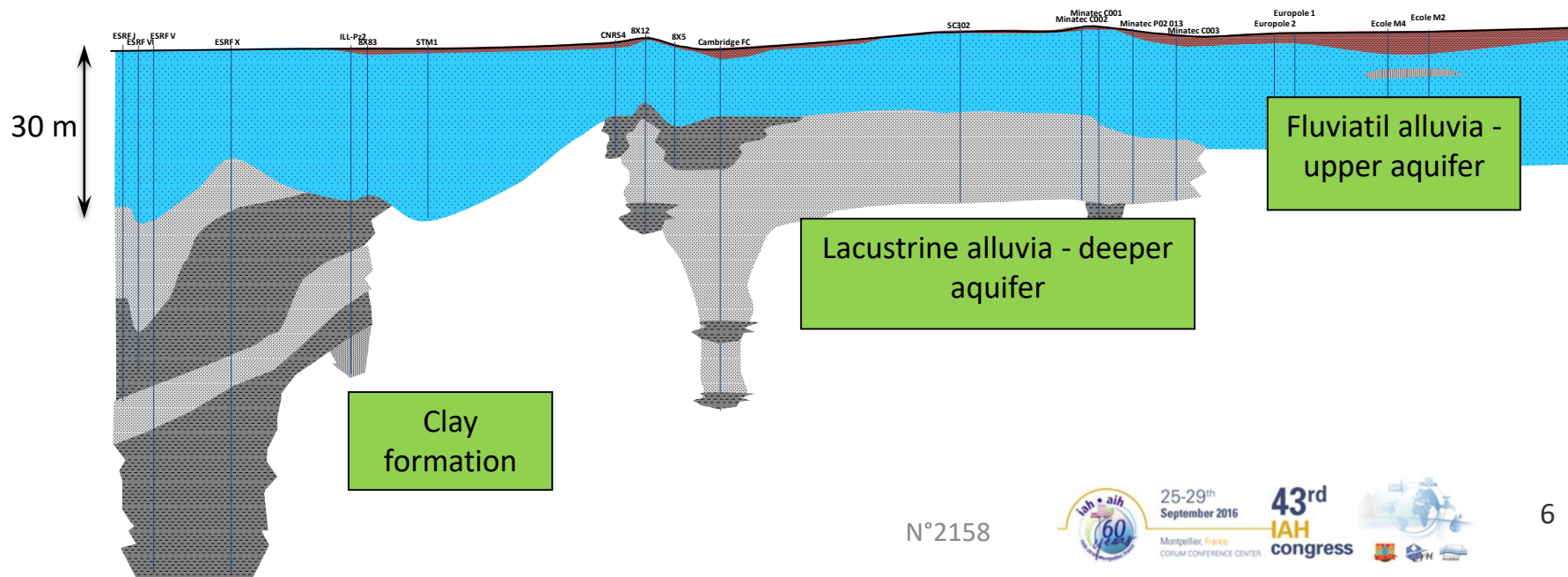
Hydrogeological Context



Two aquifers

- An upper aquifer: fluvial alluvia ($K \sim 4 \cdot 10^{-3} \text{ m/s}$)
- A deep aquifer: lacustrine alluvia

→ Favorable context for the development of shallow groundwater geothermal systems

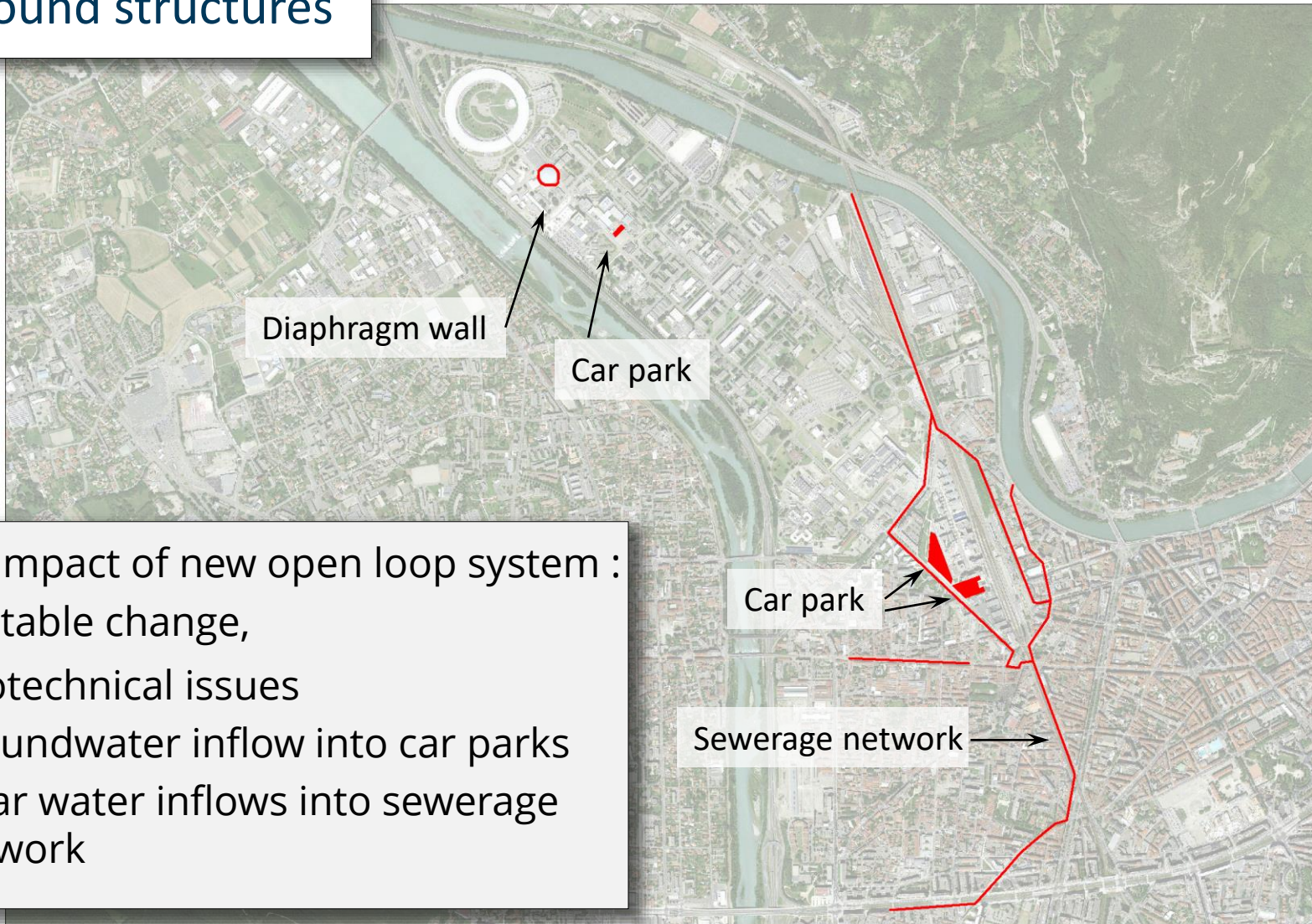


SEM Innovia promotes the use of geothermal energy

- Reduction of greenhouse gases
- Economic benefit

However, many interactions with underground structures or groundwater uses may occur

Underground structures



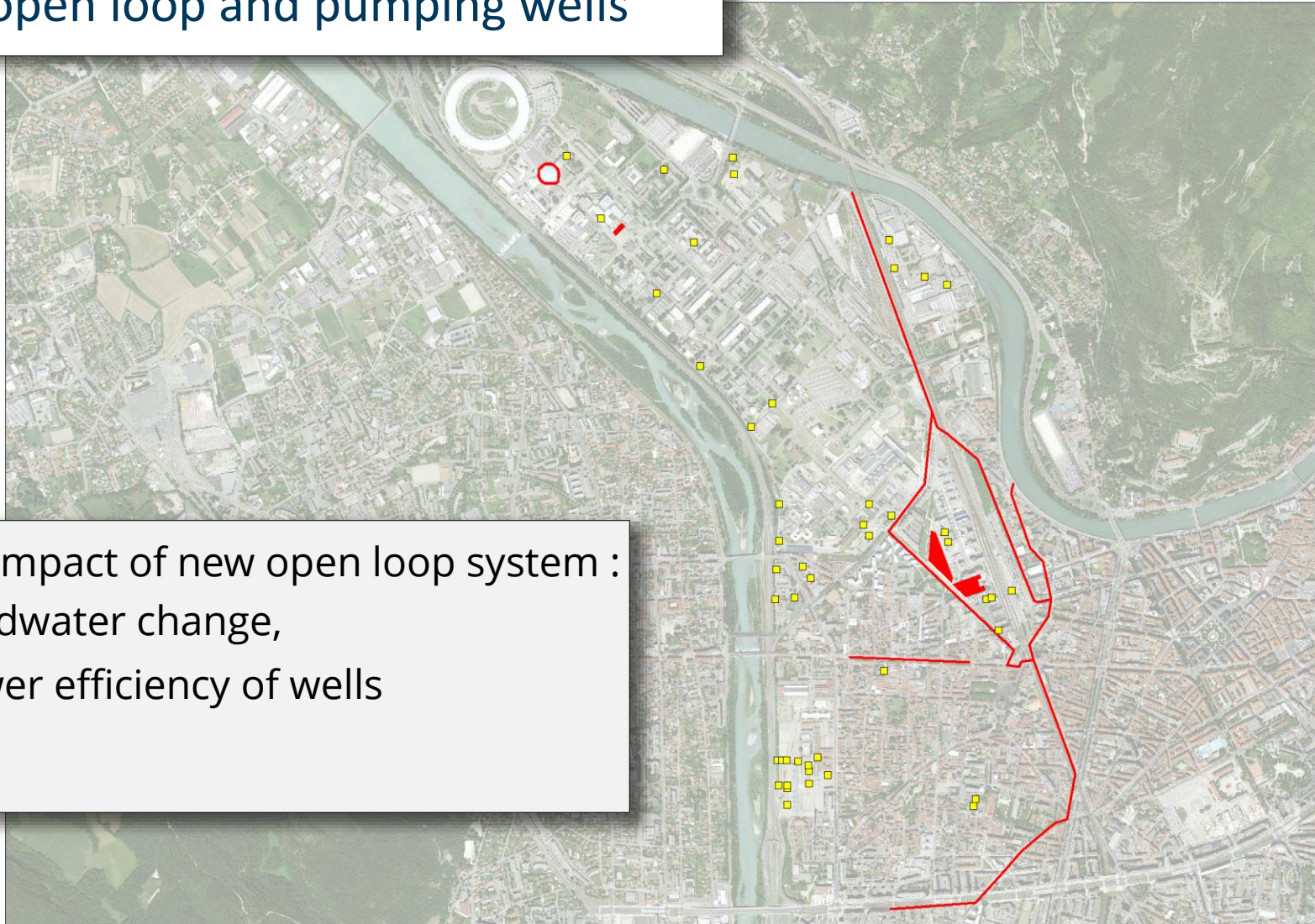
Possible impact of new open loop system :

→ Water table change,

- Geotechnical issues
- Groundwater inflow into car parks
- Clear water inflows into sewerage network

Existing open loop and pumping wells

Possible impact of new open loop system :
→ Groundwater change,
■ Lower efficiency of wells



European Synchrotron Radiation Facility (ESRF)



ESRF:

Very sensitive to ground movements

→ Related to groundwater level changes

European Synchrotron Radiation Facility (ESRF)

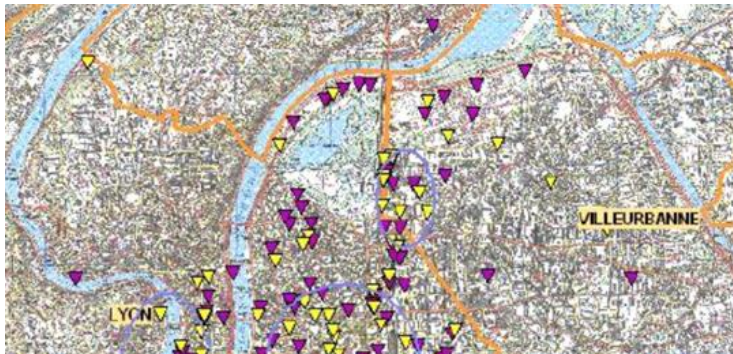
Specific drainage system
to stabilize groundwater
levels

Possible impact of new open loop systems :

- Water level change,
- Ground movement

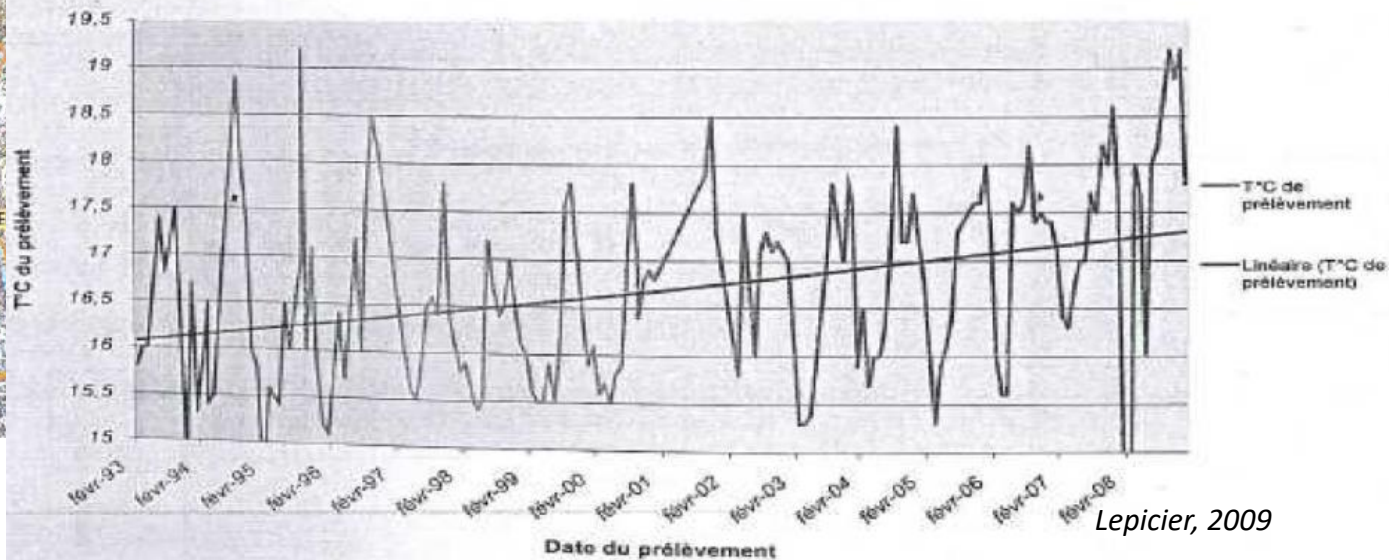
- Recalibration of ESRF
- Operating loss

Lyon



- 150 open loop systems (2012)
- $T^{\circ}_{\text{re-injection}} > 25^{\circ}\text{C}$
- Since 2000:
 - T° issues
 - Bacterial clogging

Evolution de la $T^{\circ}\text{C}$ de la nappe au niveau de Part-Dieu



Lepicier, 2009

How to promote a sustainable approach within a context :

- not yet fully regulated
- with many potential interactions with underground uses?

→ SEM Innovia is developing a twofold approach:

Governance

Decision aid Tool

→ Governance

□ Raising awareness of the use of geothermal energy

GUIDE de la QUALITÉ ENVIRONNEMENTALE dans l'ARCHITECTURE et l'URBANISME

aménagement**s** bâtiment**s** neufs constructions à réhabiliter

édito, introduction
synoptique
table des illustrations
a menagements
b âtiments neufs
C onstructions à réhabiliter
d agnostic environnemental

Grenoble
www.grenoble.fr

Ville de Grenoble

→ Governance

❑ Raising awareness of the use of geothermal energy

❑ Financial leverage

- Consultation with developers
- Pooling of common infrastructure
- Shared cost (Innovia/developer) of common infrastructure
- Innovia support regarding statutory procedures

e.g. Innovia prepared a unique mid-block water legislation dossier (dossier loi sur l'eau) on behalf of developers

→ Governance

❑ Raising awareness of

❑ Financial leverage

❑ “Regulation” leverage

- Urban development zone (ZAC) regulations
- Binding environmental Terms of Reference:
 - Deeds of sale
 - Connection agreements

InnoVia
Grenoble durablement



Cahier des Prescriptions Environnementales
Secteur CAMBRIDGE A & B (périmètre EcoCité1)
Construction des ilots CI1, CI2, CI3, CI4, CJ1, CJ4, CK1, CK2, CK3, CK4 et CE2

→ *Decision aid tool*

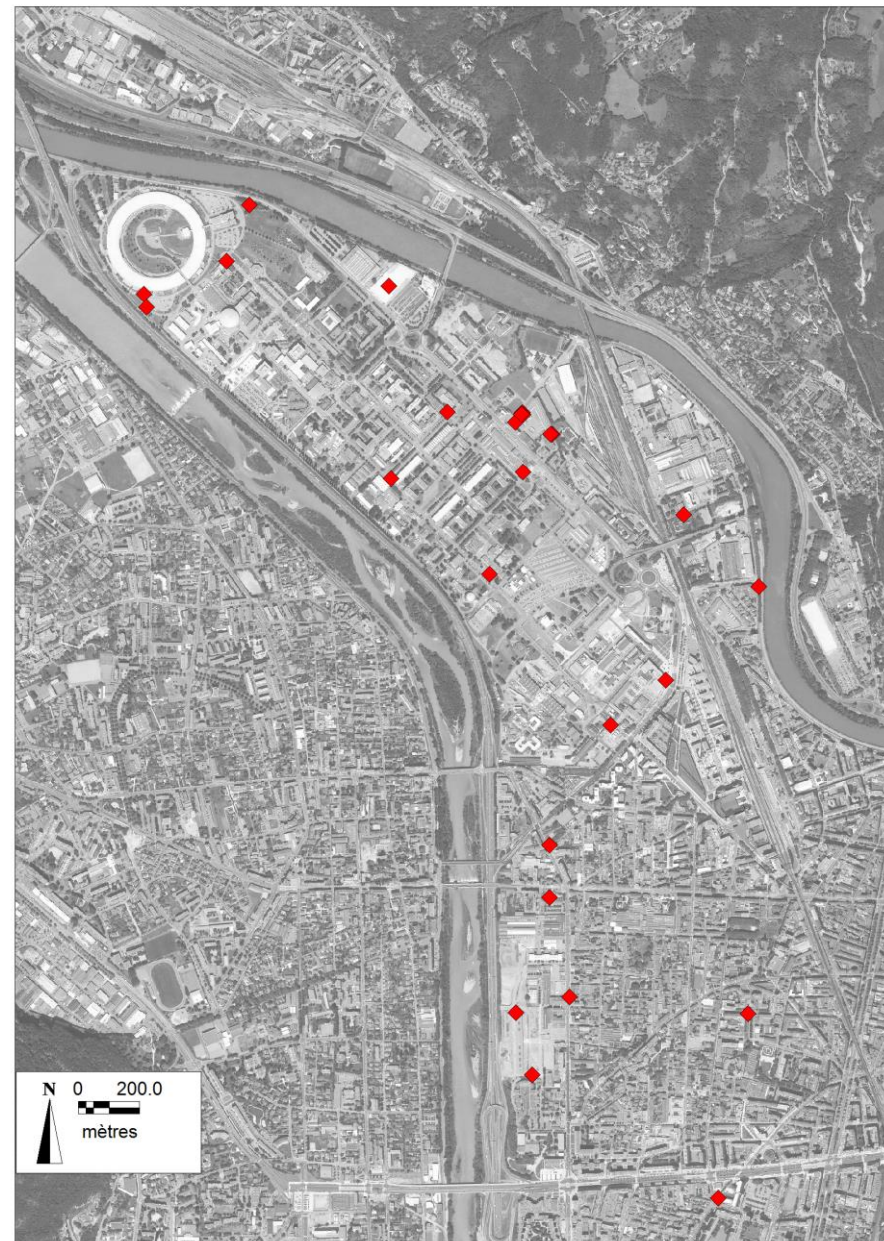
Monitoring

3D groundwater thermal modelling

→ Decision aid tool

□ Monitoring

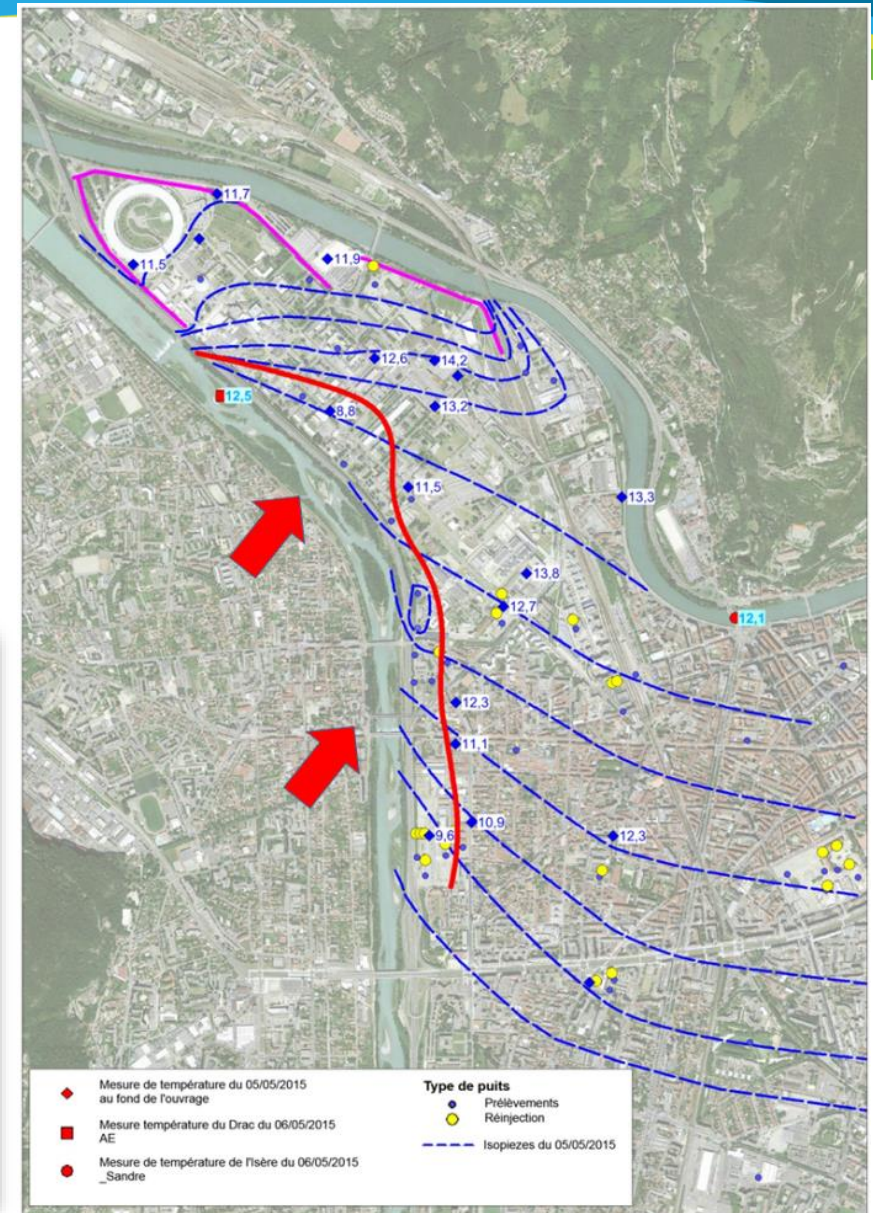
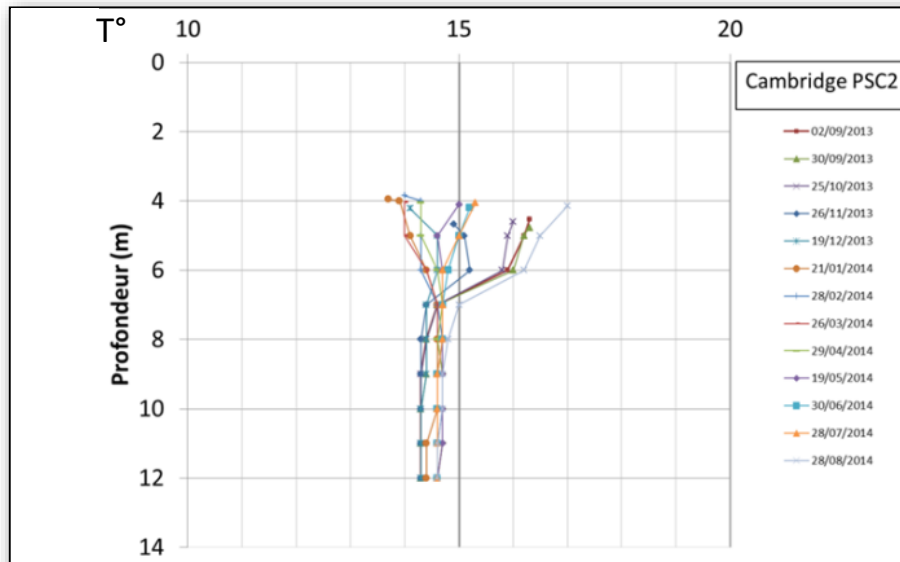
- 23 observation bore-holes
- GW level, T°, Cond.
- Monthly T° log
- Since 2015: automatic recorders



→ Decision aid tool

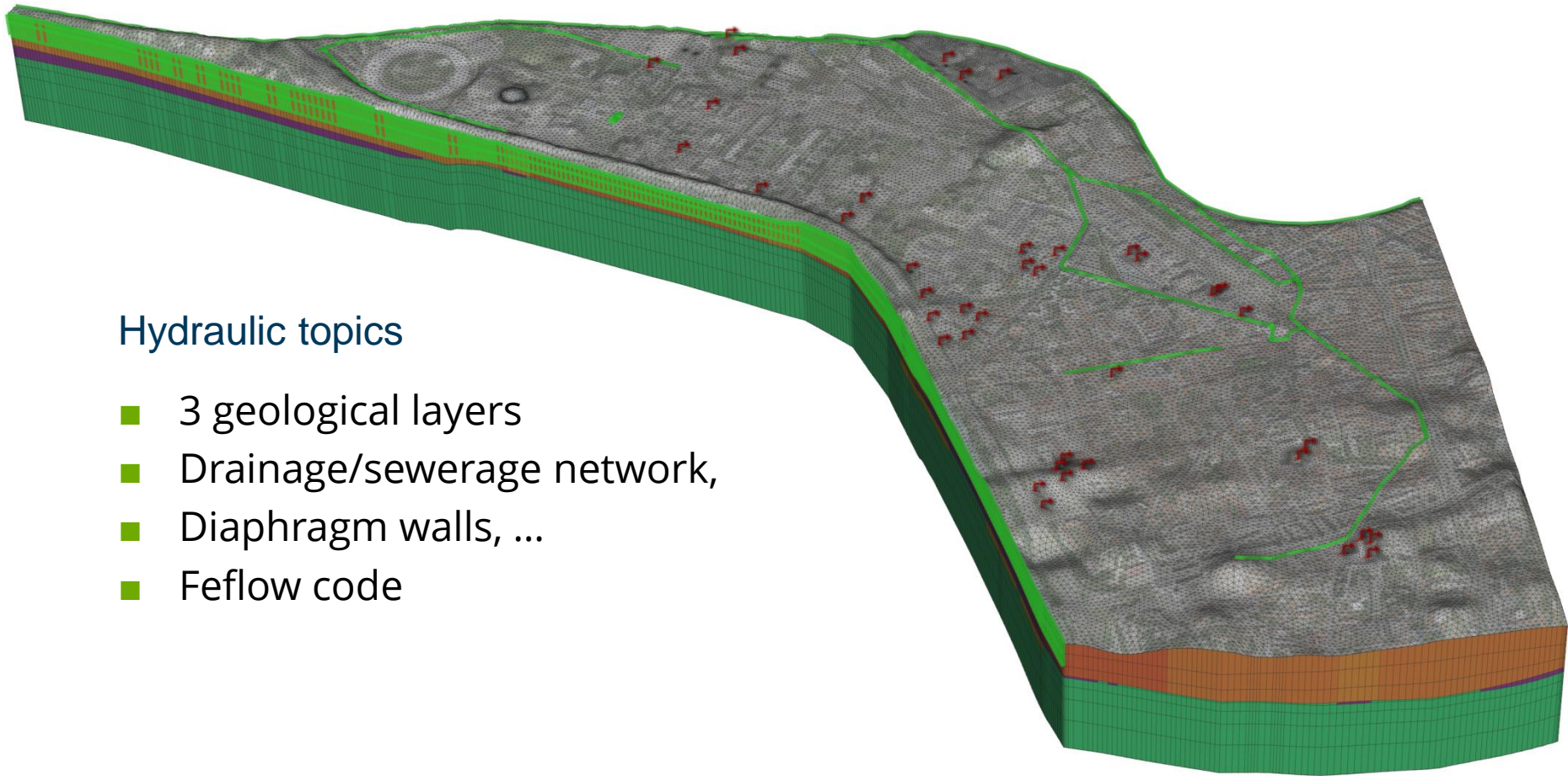
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→ Decision aid tool

3D groundwater thermal modelling

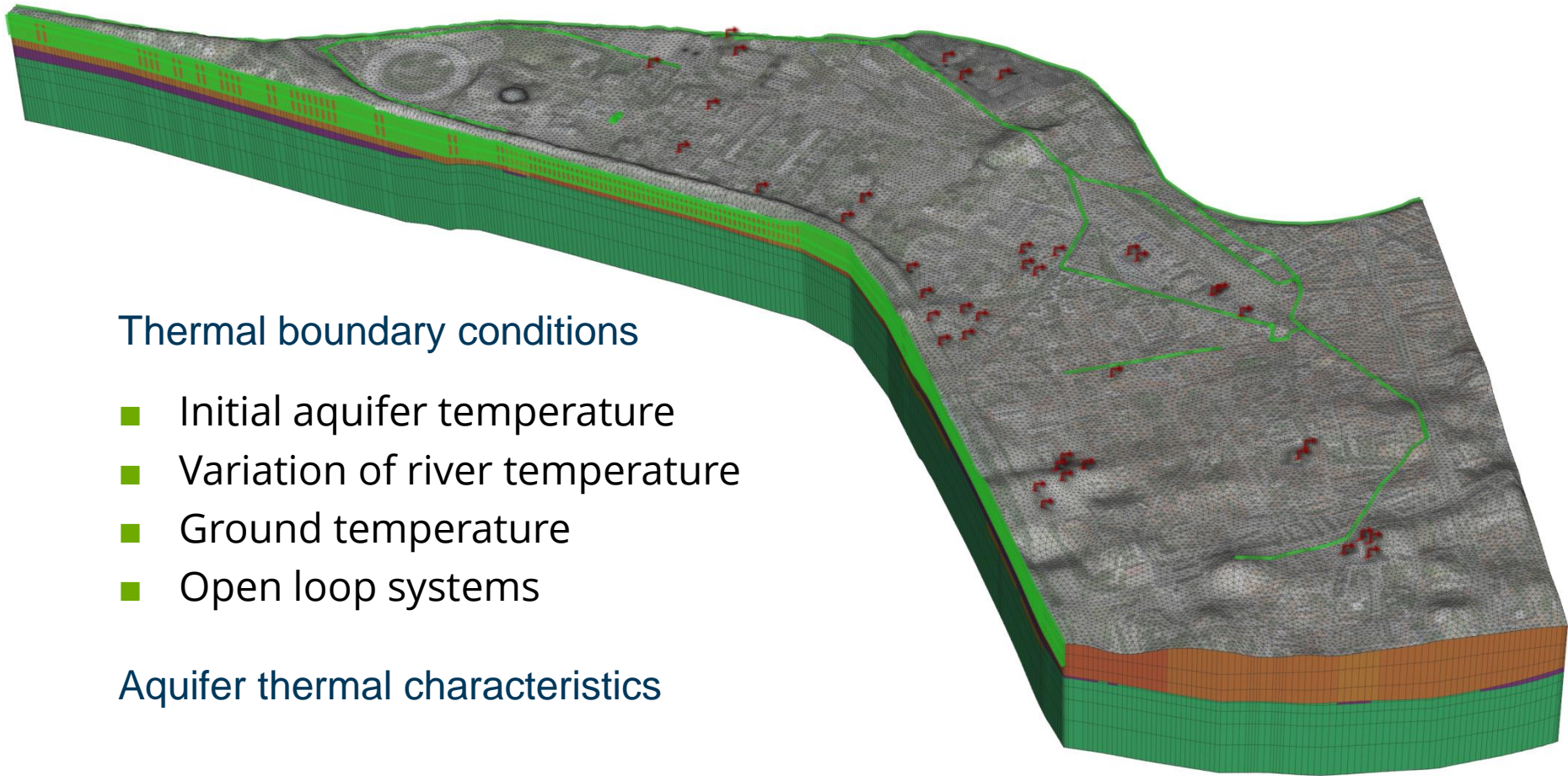


Hydraulic topics

- 3 geological layers
- Drainage/sewerage network,
- Diaphragm walls, ...
- Feflow code

→ Decision aid tool

3D groundwater thermal modelling



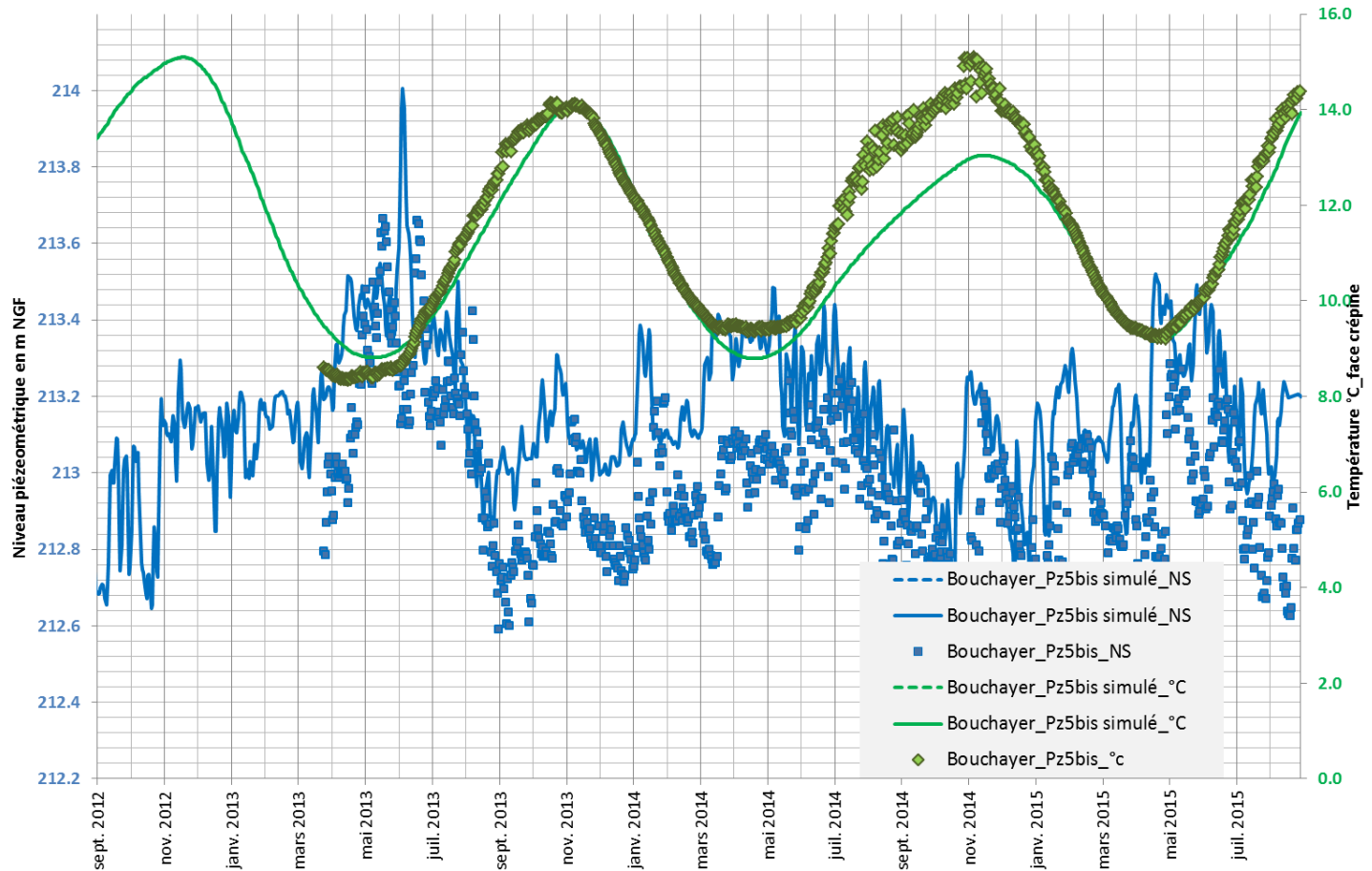
Thermal boundary conditions

- Initial aquifer temperature
- Variation of river temperature
- Ground temperature
- Open loop systems

Aquifer thermal characteristics

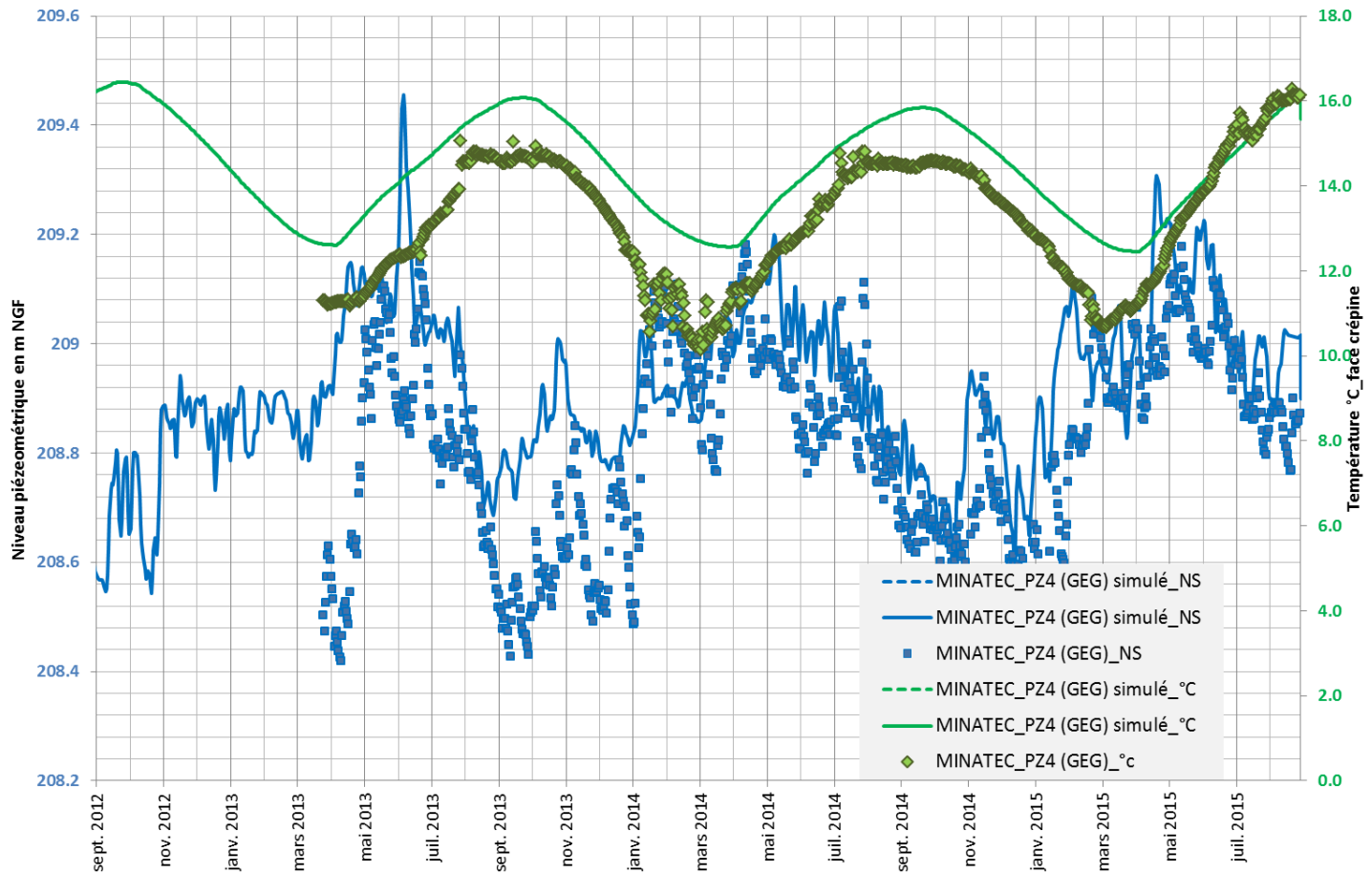
→ Decision aid tool

3D groundwater thermal modelling



→ Decision aid tool

3D groundwater thermal modelling

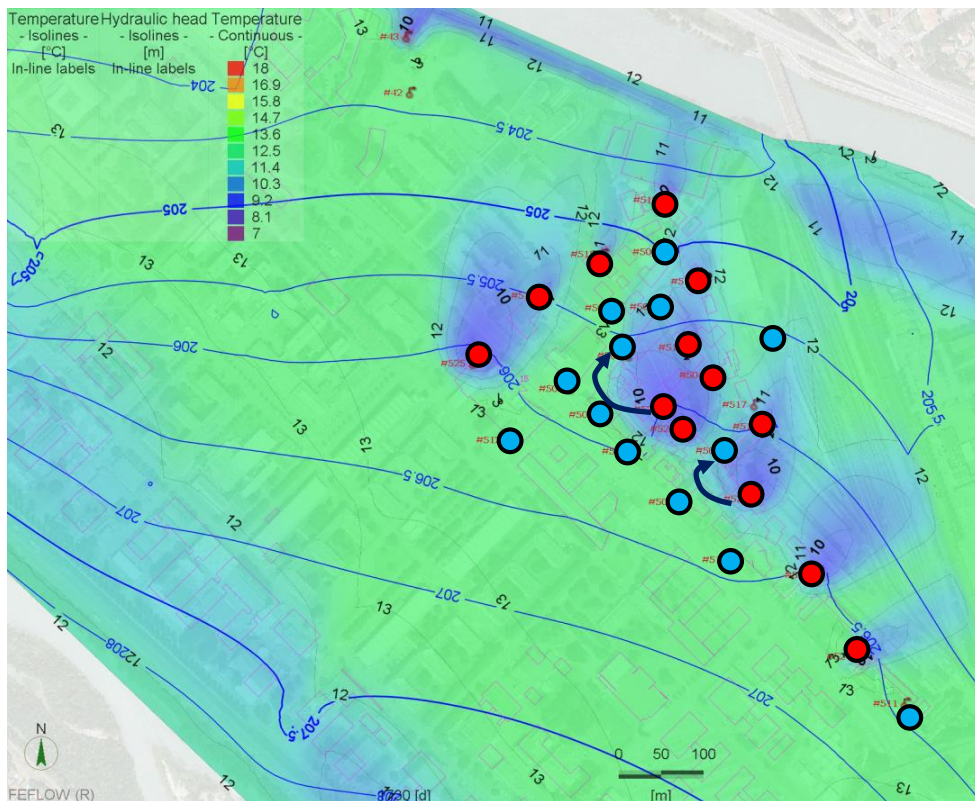


Case Study: Cambridge District



Case Study: Cambridge District

Assessment of several potential solutions



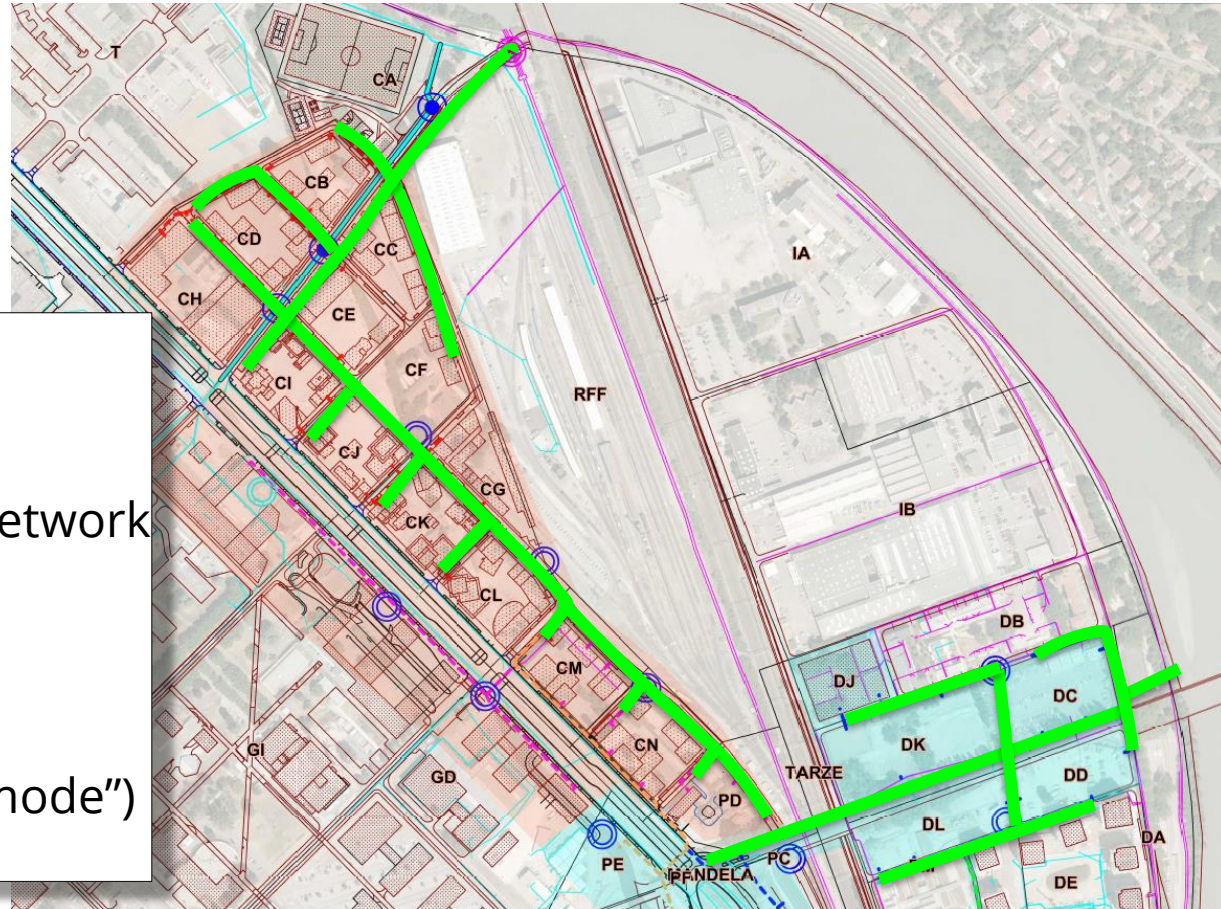
End of summer temperature

- Pumping wells
- Reinjection wells
- ↻ Recirculation of groundwater

Case Study: Cambridge District

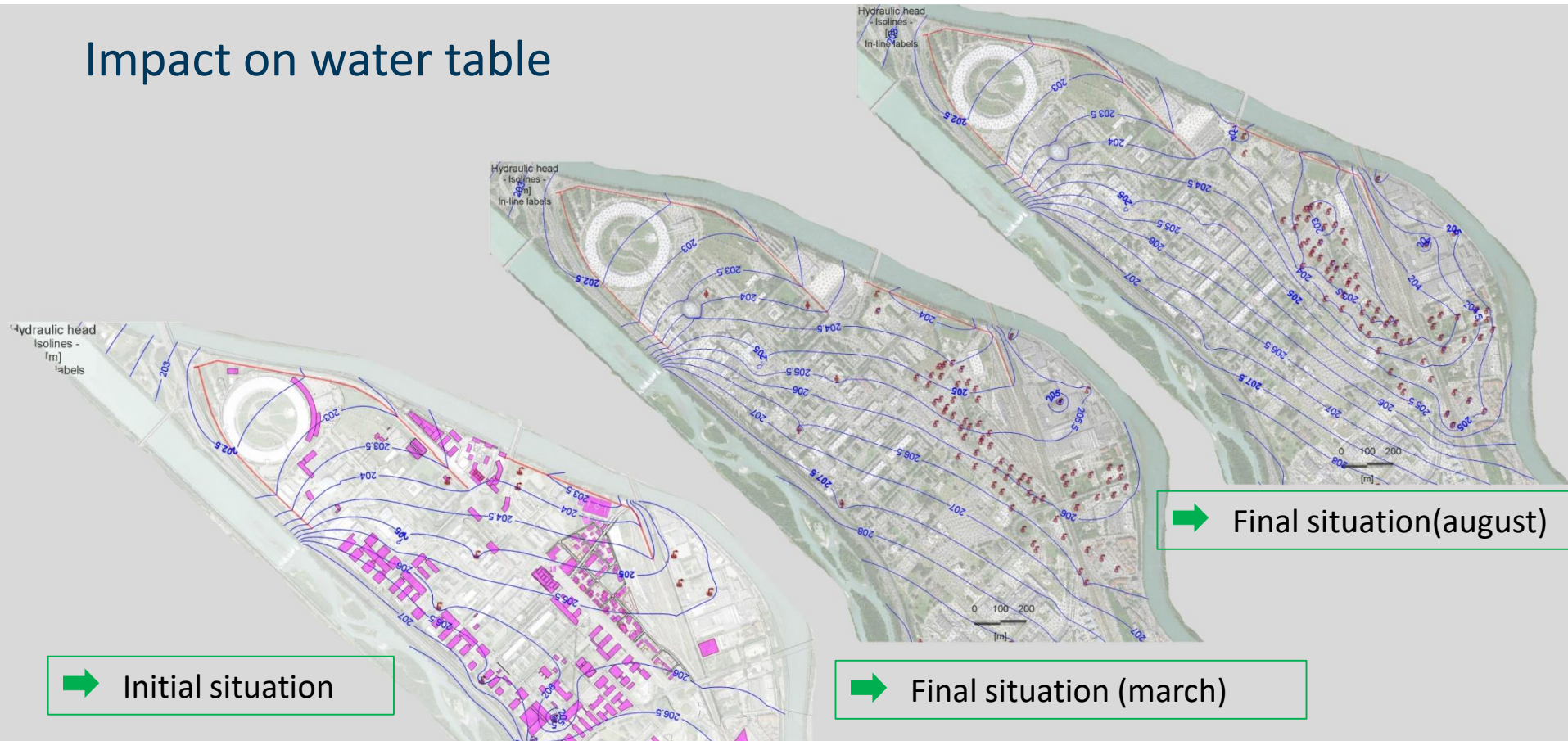
Selected solution:

- 70 pumping wells
- 1 common discharge network
- 2 outlets to Isère River
- Discharge : 1900 m³/h
- Heating + hot water
- Cooling ("free-cooling mode")



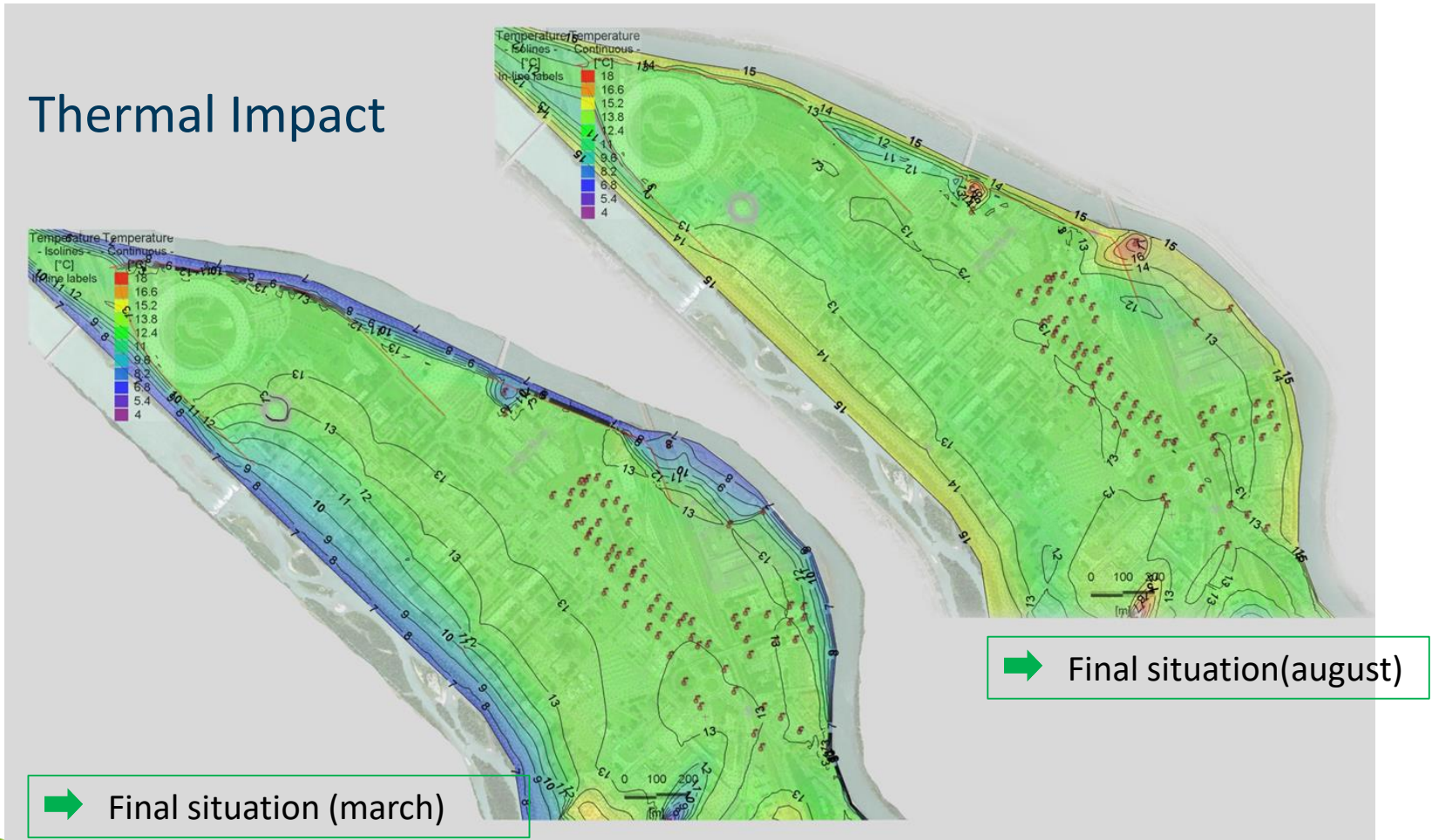
Case Study: Cambridge District

Impact on water table



Case Study: Cambridge District (s.l.)

Thermal Impact



➔ Final situation (march)

➔ Final situation (august)

Development of sustainable geothermal use (within an urban context):

possible with a single player bringing :

- A long term district level vision
- A consistent approach (governance & decision aid tool)
- Motivation

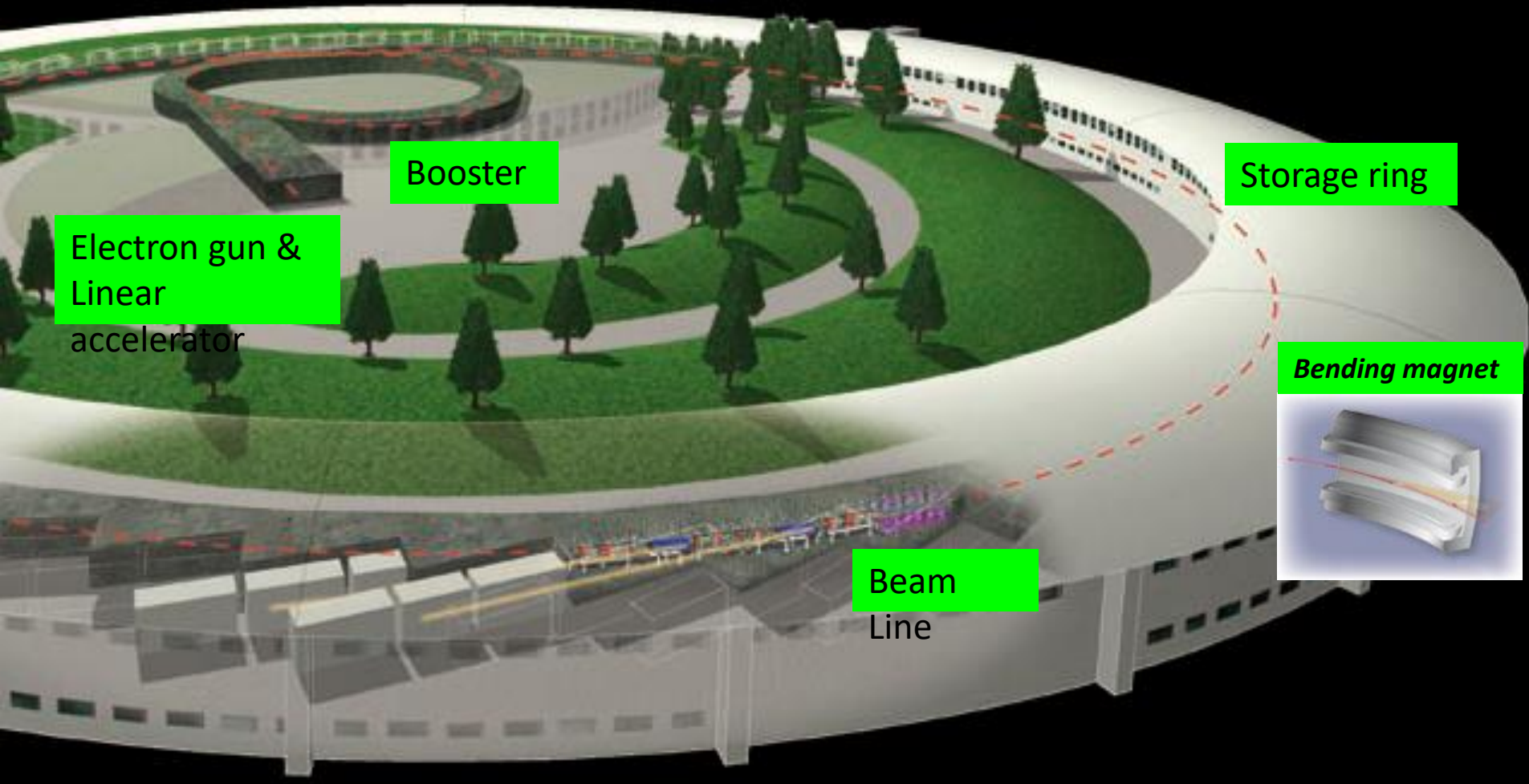


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ESRF is very sensitive to ground movements