The Stillwater Reservoir Conflict

Background to the conflict

A dam is to be built to create a reservoir to increase the water supply to a coastal conurbation. Three possible types of dam are being considered (Figure 1) and these will create a reservoir called the Stillwater Reservoir.

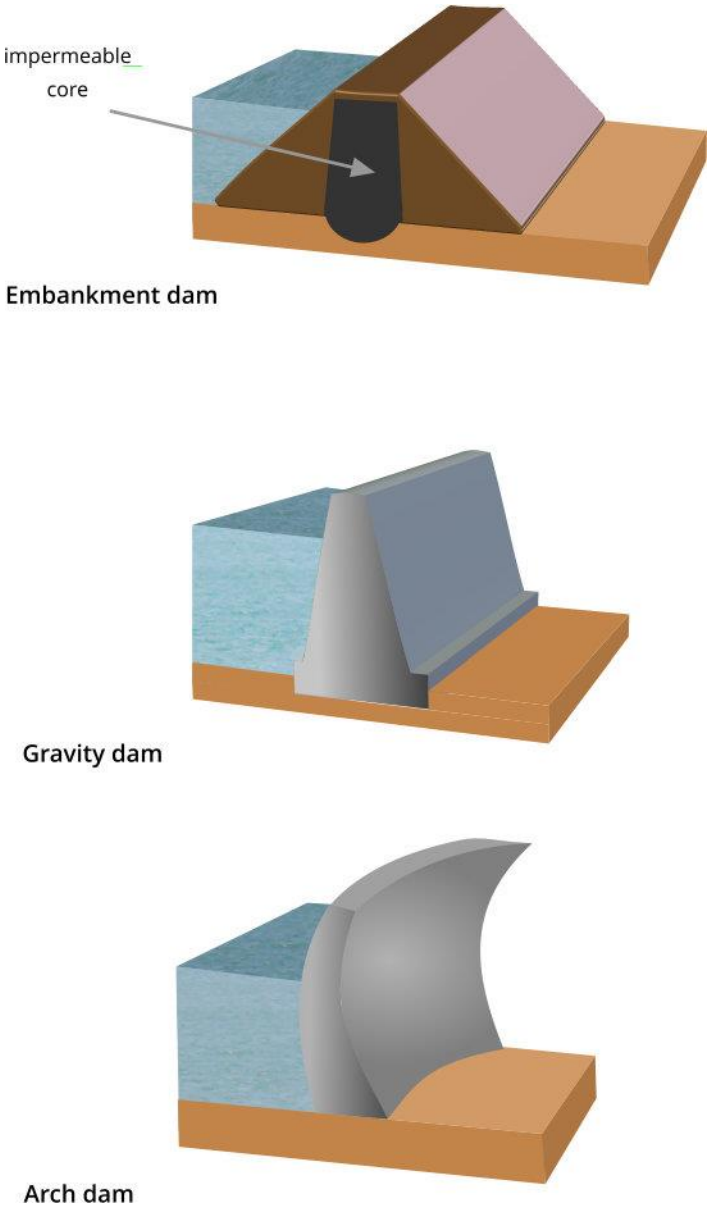


Figure 1. Types of dam considered for the Stillwater Reservoir project

There have been discussions between the six interested parties: hydrologists, hydrogeologists, engineering geologists, conservationists, farmers, and planners from the local water authority.

The list of possible sites has been narrowed down to four. A meeting has now been called to allow discussion between the six interested parties and to select the most suitable site for the Stillwater Reservoir.

The four sites have catchment areas of similar size and have approximately the same reservoir capacity (storage of 25 million cubic metres of water). For each site there is:

- a topographic map,
- a geological map and
- data about the site.

Instructions

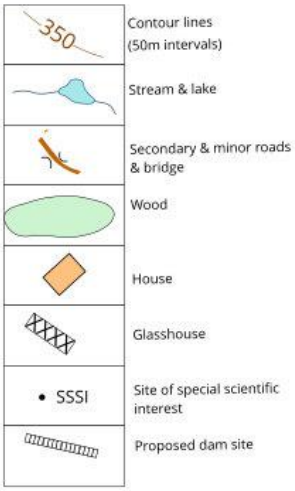
Study Figure 2 which shows information about each of the four potential reservoir sites and Tables 1 and 2 which are guides to the concerns of each of the six interested parties.

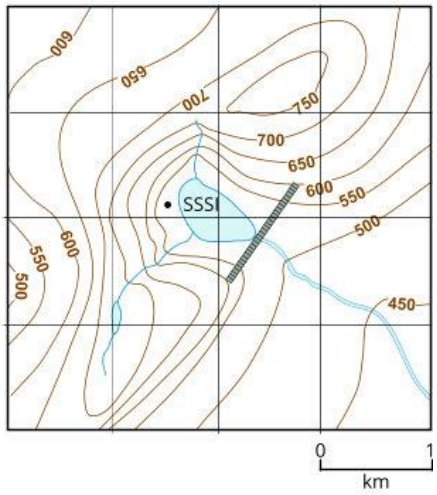
(a) From the point of view of each of the interested parties evaluate the problems and proposed solutions and rank the four sites from the most suitable to the least suitable with reasons. Select the best site from the point of view of the party interests.

(b) Carefully analyse all the data and evaluate all the rankings and reasons. Decide upon the most suitable site and provide data that supports your final choice of site.

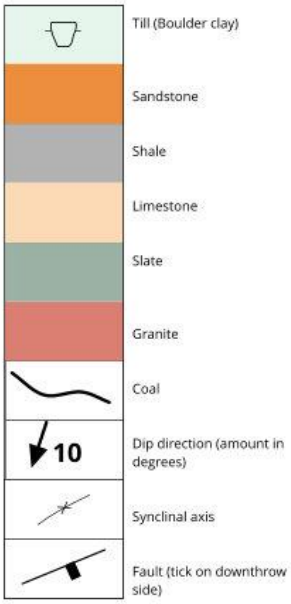
Potential reservoir site A

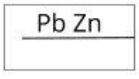
Topographic features

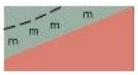


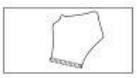


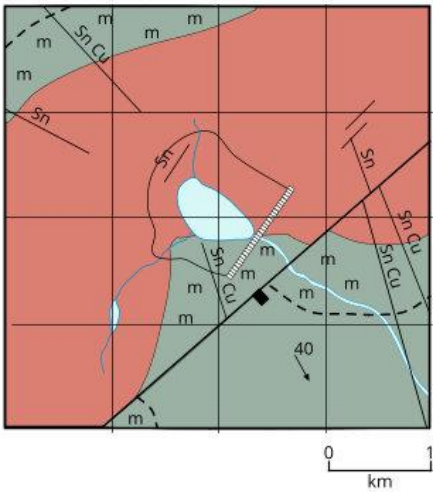
Geological features









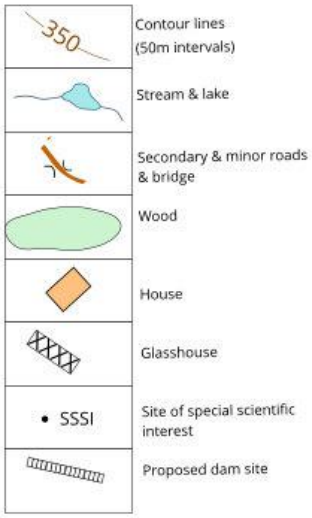


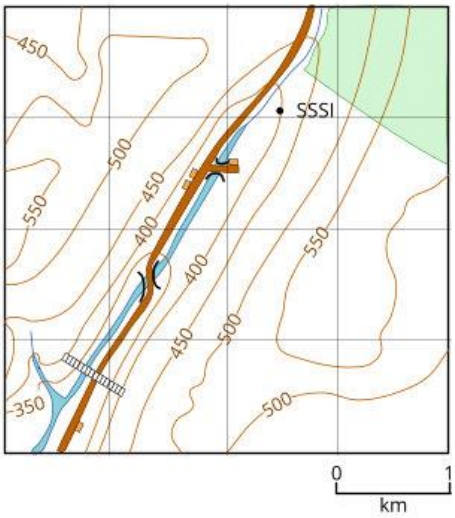
Site A data

Distance from conurbation	112 km
Annual rainfall	2123 mm
Farming types	Sheep. Plan for afforestation held in abeyance.
Geology	Ordovician slates intruded by granite
Points of importance	Rare alpine flora native (i.e. naturally occurring). SSSI - rare flower locality. A 12 km access road will be needed if the reservoir is built on this site.
Reservoir potential	Water supply, hydroelectric.

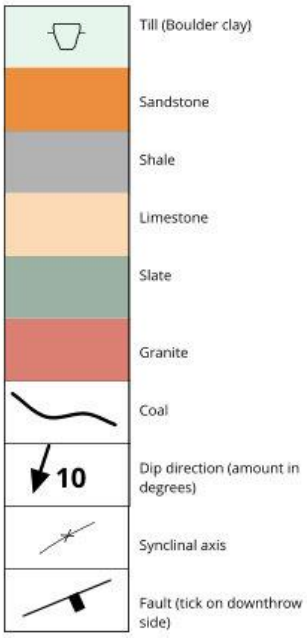
Potential reservoir site B

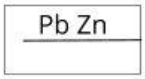
Topographic features

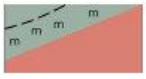


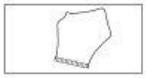


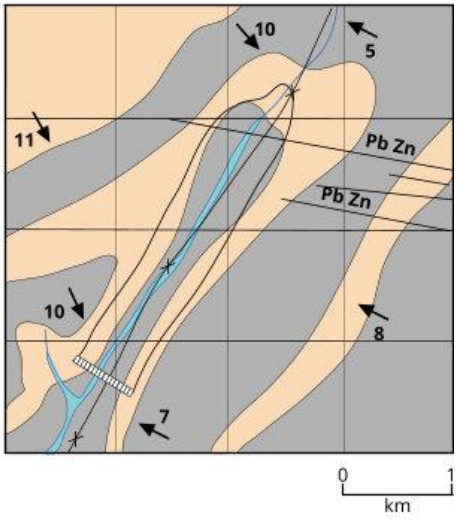
Geological features









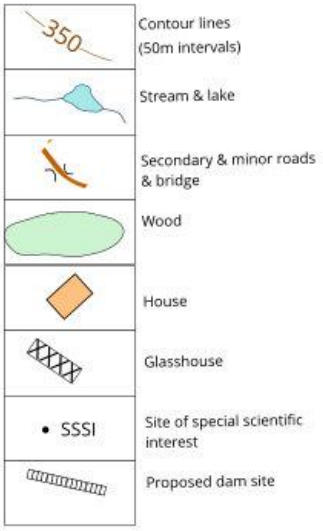


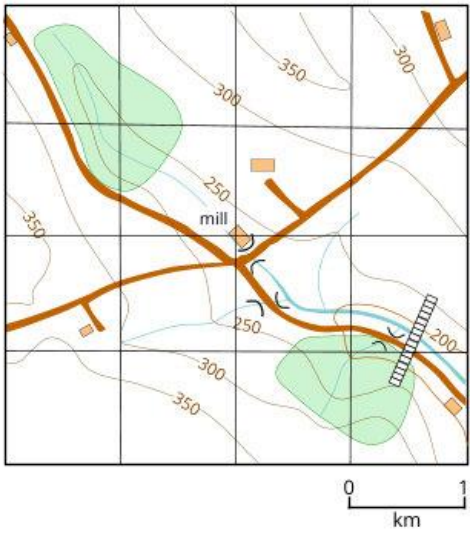
Site B data

Distance from conurbation	77 km
Annual rainfall	1741 mm
Farming types	Sheep on valley sides, beef and dairy cattle on valley floor
Geology	Syncline in Silurian limestone-shale sequence.
Points of importance	Area inside National Park. SSSI - fossil locality.
Reservoir potential	Water supply, tourism (e.g. sightseeing and fishing).

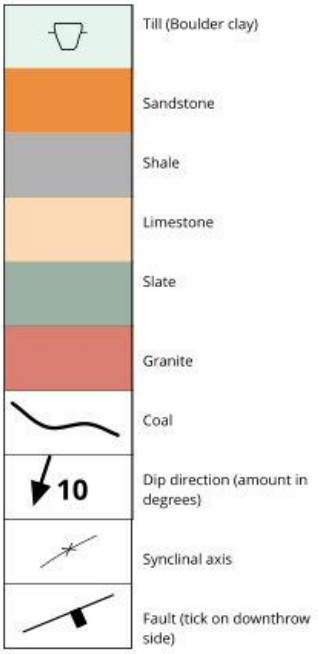
Prospective reservoir site C

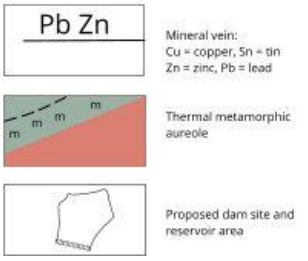
Topographic features

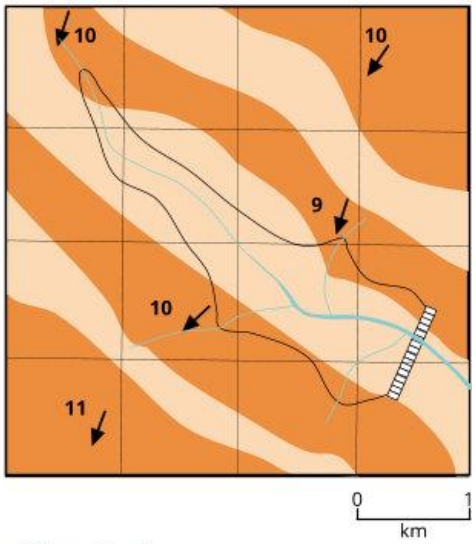




Geological features

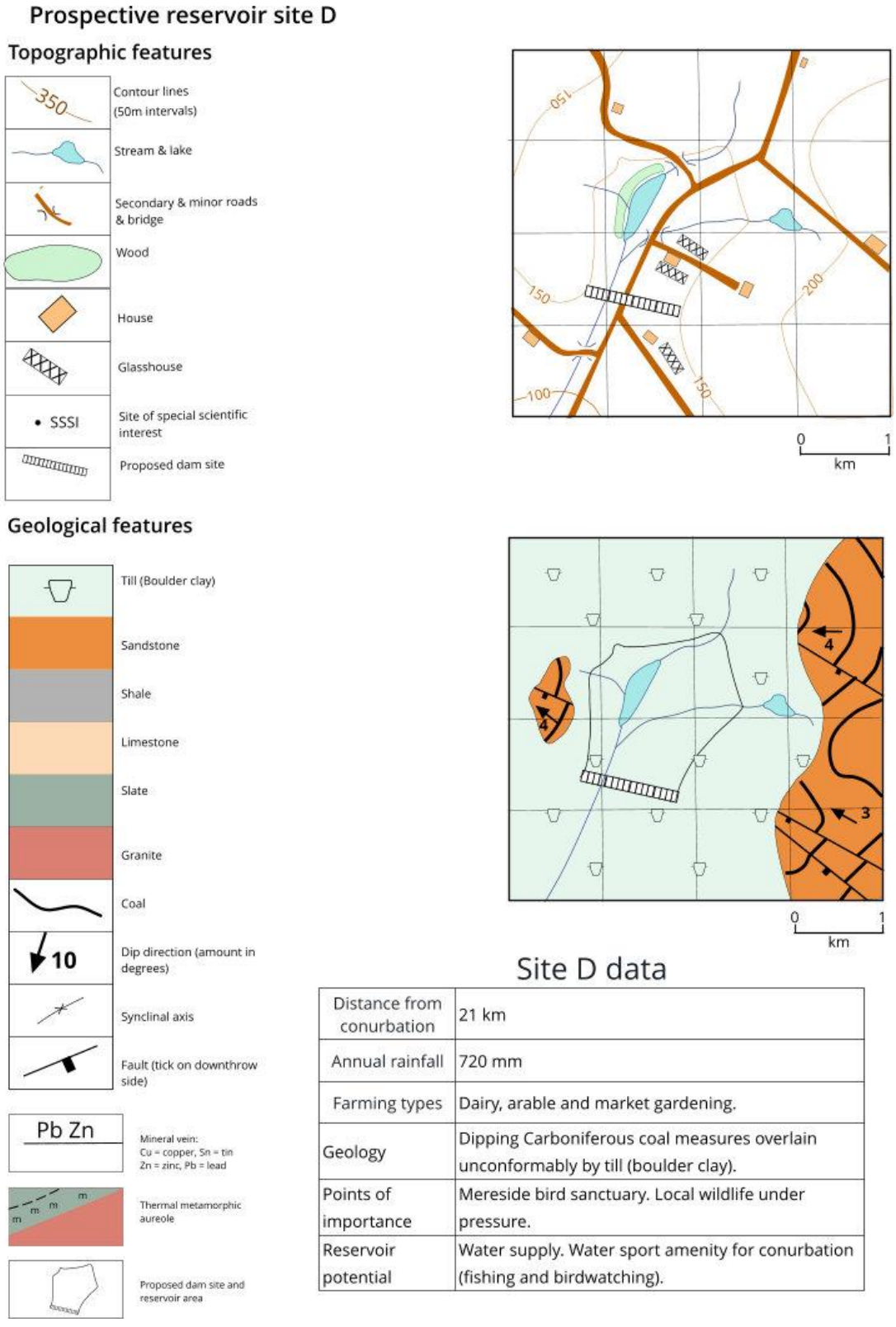






Site C data

Distance from conurbation	45 km
Annual rainfall	1304 mm
Farming types	Beef, dairy and arable farming.
Geology	Dipping Carboniferous sandstone - shale sequence.
Points of importance	Two areas of ancient natural woodland. 15th century mill.
Reservoir potential	Water supply. Water sport amenity for nearby town, fishing, bird watching.



Site D data

Distance from conurbation	21 km
Annual rainfall	720 mm
Farming types	Dairy, arable and market gardening.
Geology	Dipping Carboniferous coal measures overlain unconformably by till (boulder clay).
Points of importance	Mereside bird sanctuary. Local wildlife under pressure.
Reservoir potential	Water supply. Water sport amenity for conurbation (fishing and birdwatching).

Figure 2. Potential reservoir sites

Interested party	Conservationists	Farmers	Planners from the local water authority
Main concerns	Concerned with the preservation of sites of biological, geological, and historical importance, together with the maintenance of ecological balance and the quality of the environment in general.	Concerned with having the reservoir sited to result in the least possible loss of agricultural land to themselves.	Concerned primarily with providing a new, low-cost, pollution-free water supply for the conurbation. However, the reservoir would have additional value if it were to generate hydroelectric power or serve as a water-sport amenity.
Points to consider	A. SSSIs are designated Sites of Special Scientific Interest. B. New reservoirs may prove to be assets to wildlife eg. waterfowl, etc.		A. To generate hydroelectric power a head of water and a large volume are needed, and HEP stations are expensive to construct. B. The best type of reservoir for water sport will have a large surface area. C. The Water Authority will have to divert roads that will be flooded by the reservoir and will have to compensate people if their houses are drowned. This may be expensive - the average house price in 2020 is £315,000.

Table 1. Guide to the main concerns of conservationists, farmers, and planners from the local water authority.

Interested party	Hydrologists	Hydrogeologists	Engineering geologists
Main concerns	Concerned with water supply to the reservoir through tributary streams and surface runoff and with surface water losses.	Concerned with groundwater flow and underground water supply to and loss from the reservoir.	Concerned with the feasibility and cost of building a dam, preferring a simple, low-cost dam.
Points to consider	A. Runoff volume and runoff speed are greater on steep slopes with thin soils than on shallow slopes with thick soils. B. Evaporation rates will be affected by climate (e.g. cloud cover, humidity, temperature, windspeed) and water surface area.	A. Reservoirs which would leak due to the permeability of the underlying. rocks may be sealed by using a clay lining, but this is a very expensive operation, particularly if it is needed over a large area. B. Groundwater flow into the reservoir must be free of pollutants C. The porosities and permeabilities of the major rock types are shown in Table 4.	A. Choice of one of three of the main dam types shown in Figure 1. 1. A gravity dam. The weight holds the dam in position. The foundations must be excavated to sound bedrock. This type of dam needs a large volume of concrete or masonry and so needs a nearby suitable source of rock or sand and aggregate. 2. An arch dam. The curved shape holds the dam in position against walls and floor of gorge-like valleys. It needs solid bedrock: joints and fractures are potential weaknesses. The volume of sand and aggregate needed is small. 3. An embankment dam. Its weight and size hold the dam in position. The foundations must be firm. It has a very large volume and so a large quantity of low-quality fill from a nearby source is needed. B. Primary rock strengths and secondary weaknesses such as joints and faults must be considered.

Table 2. Guide to the main concerns of hydrologists, hydrogeologists, and engineering geologists.

Rock Type	Primary Porosity	Primary permeability	Potential for Secondary Porosity & Permeability
Granite	0%	Low	Fairly high
Thermally metamorphosed slate	0%	Low	Fairly high
Sandstone (after compaction & diagenesis)	10 - 30%	Low to high	Fairly high
Shale (after compaction & diagenesis)	15 - 20%	Low	Low
Limestone (after compaction & diagenesis)	0 - 10%	Usually, low	High
Coal (after compaction & diagenesis)	0%	Low	Low
Clay	50 - 80%	Low	Low

Table 3. Porosities and permeabilities of the major rock types

Acknowledgements
This activity, originally produced by Chris King (King, 1983), was updated by Maggie & Peter Williams(GeoHubLiverpool).

References

King, C. (1983) The Stillwater Reservoir conflict - a simulation game. *Geology Teaching* **8** (3), pp.98– 102.

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