



Oversized quarry sumps can be used to store run-off during large events



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Eugene Daly Associates,
Groundwater, Hydrological
and Environmental Consultants.
email: dalywater@edawater.ie
www.edawater.ie



Paved quarry yard with channels routing run-off to attenuation



CSA Group

Eugene Daly Associates,
Groundwater, Hydrological
and Environmental Consultants.
email: dalywater@altracomplc.com
www.edawater.ie

3 The Hydrogeology of Quarry Dewatering

- Extraction below the water table inherently induces drawdown local to the void and will modify the pre-existing groundwater regime.
- Any impacts must be quantified and if the effect is negative then it should be mitigated against.
- Often, it is difficult to estimate the extent of drawdown from a greenfield development. In the case of an extension to a existing quarry then historical data may be available.



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3.1 Potential Direct Impacts

- Direct impact to groundwater quantity by quarry dewatering.
 - wells
 - springs
 - groundwater protection zones
 - river abstractions
 - wetland habitats
- Recovery of groundwater levels post extraction



3.1 Potential Direct Impacts

- Direct impact to groundwater quality by contamination.
- Quarries operating below the water table tend to develop a trough in the groundwater surface. This acts as a hydraulic trap preventing any potential contamination from discharging into the aquifer.
- All potential contaminants must be removed from site post extraction.



3.2 Potential Indirect Impacts

- By stripping the superficial deposits and removal of the bedrock for aggregate, evapotranspiration and recharge are removed from the area of the quarry excavation. All rainfall effectively becomes run-off.
- The removal of recharge areas can lead to reduction in river baseflow and increase in storm flow during events.
- These can be mitigated against with routing and storage of run-off waters to recharge trenches.



The groundwater table



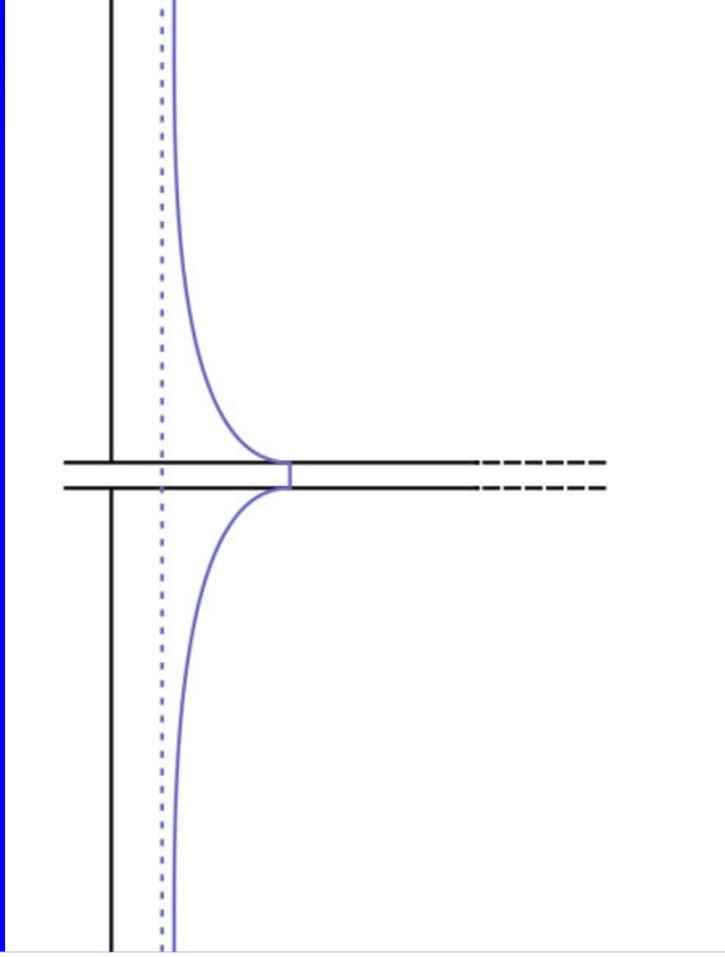
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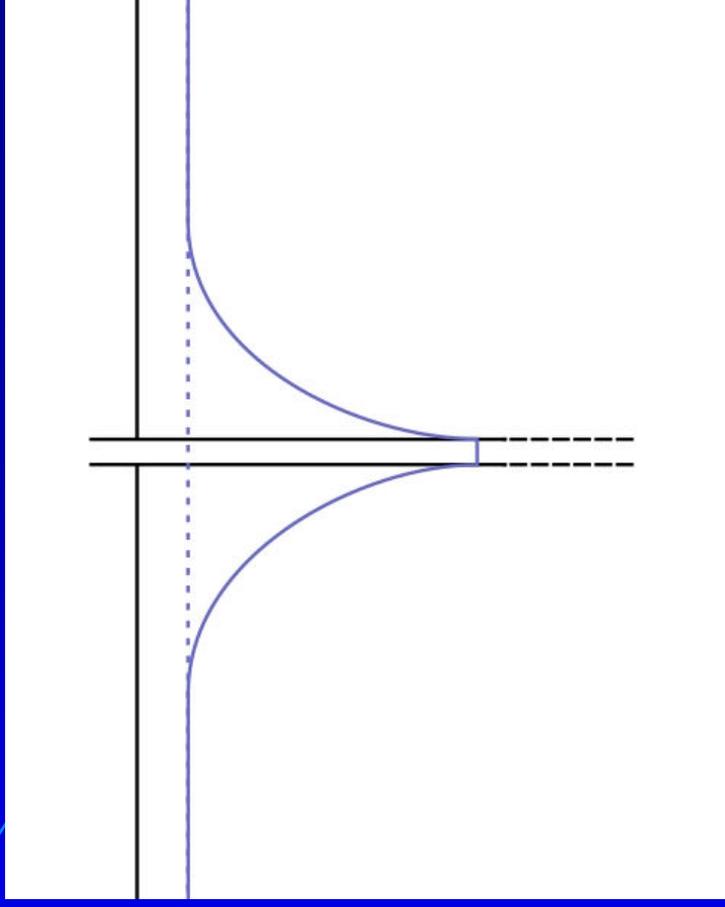
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Schematic Drawdowns Associated with Strata of Different Aquifer Characteristics



High T
High S



Low T
Low S



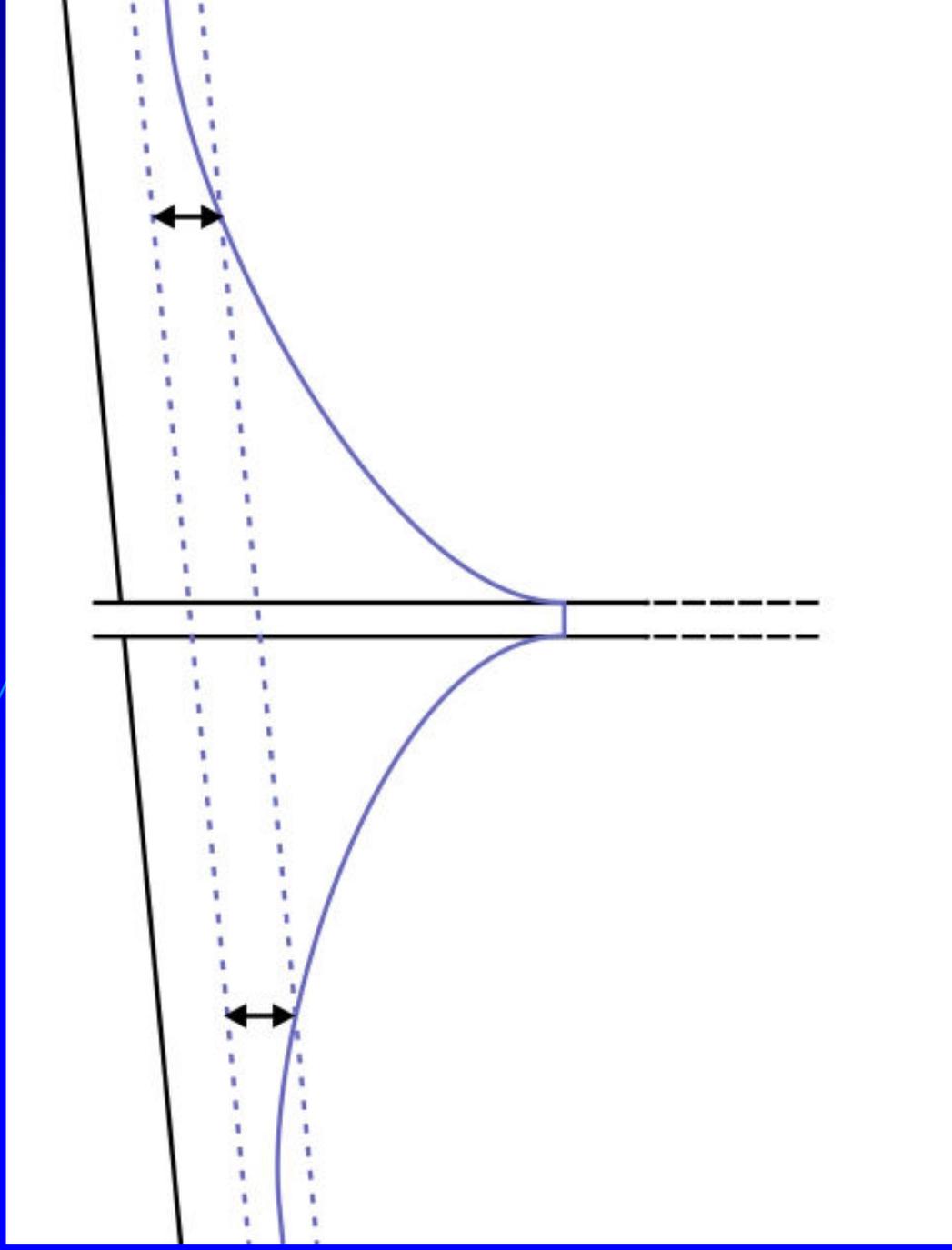
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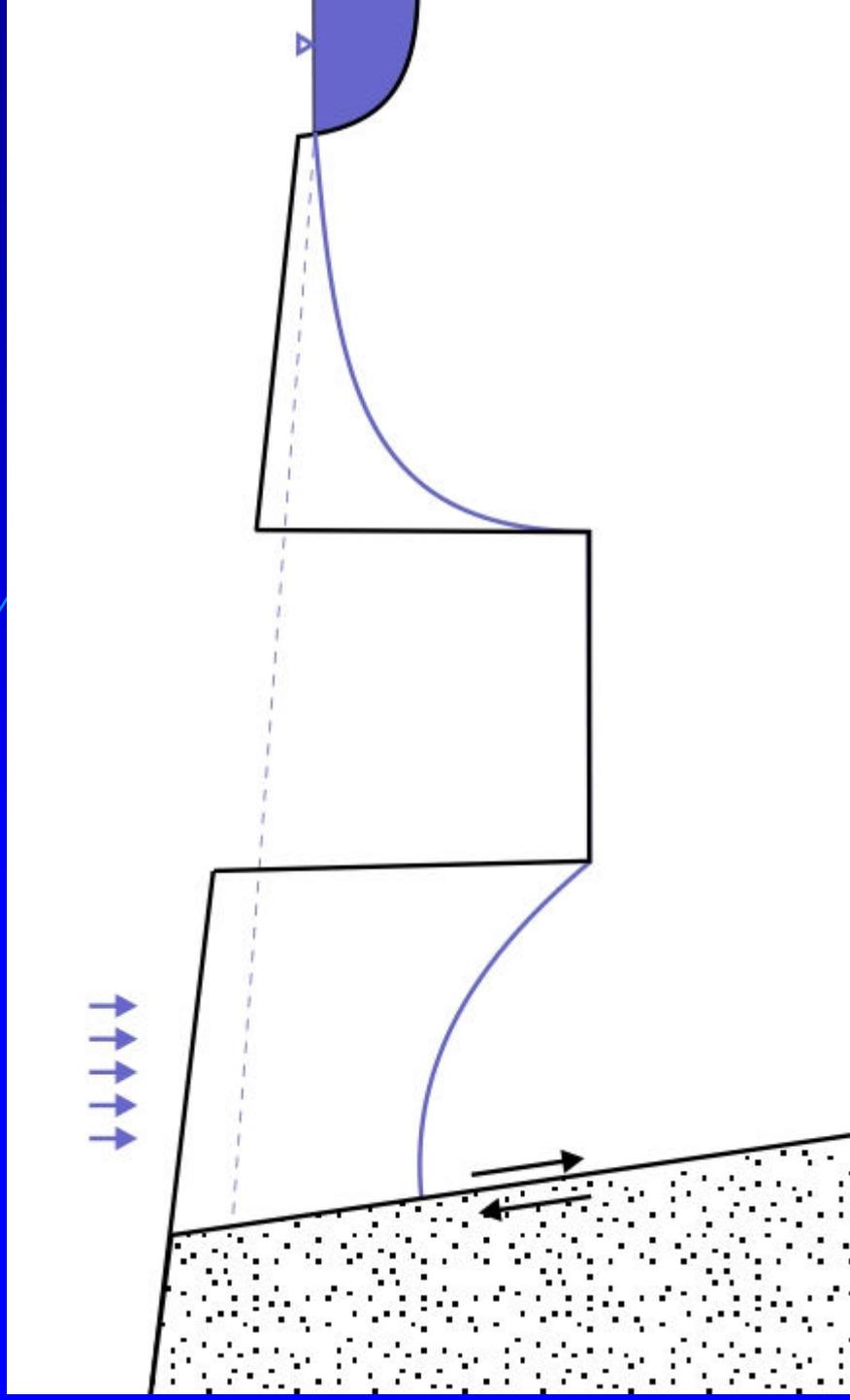
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Relationship between the Cone of Drawdown and the Annual Water Table Fluctuation



Typical Features Affecting the Cone of Drawdown Associated with Quarry Dewatering



Extent of Drawdown

Excavation Type	Strata	Depth below w.t.	Discharge Rate (l/s)	Extent of drawdown (m)	Condition	Comment
Medium sized quarry	Ballyadams Fm Limestone (Major aquifer)	20	50	450	Steady state	Large fault passes through the extraction area
Small sized quarry	Siltstone / dolerite (Poor aquifer)	10	5 (winter)	<50	Extended sump test	14 day test in winter
Medium sized quarry	Greywacke / dolerite (Poor aquifer)	25	<10	<50	Steady state	Hillside quarry
Medium sized quarry	Ballysteen Fm Limestone (Locally imp.)	25	<10	300	Steady state	Hillside quarry
Large sized quarry	Ballysteen Fm (Major Aquifer)	30	15	100	Steady state	



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The principal types of potential water impact

Hydrogeological Classification	Relationship to the water table	Potential impacts during extraction		Potential post-extraction impacts		Examples in Ireland
		Major	Minor	Major	Minor	
Aquifer	Unsaturated Zone	G.W. quality	S.W. quantity (if extensive)	G.W. quality (if extensive and not reinstated properly)	-	Many old limestone quarries
Aquifer	Saturated Zone	G.W. quantity & S.W. quality	-	S.W. quantity (until rebound occurs) and G.W. quality	-	Quarries in moderate and high permeability strata

This table applies to unconfined conditions.

S.W. = Surface Water

G.W. = Groundwater.



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Aquitard	Unsaturated Zone	-	S.W. quantity (if extensive)	-	G.W. quality. S.W. quantity (if extensive)	Many old rock quarries
Aquitard	Saturated Zone	S.W. quality	G.W. quality	-	G.W. quality	Many rock quarries in low permeability material.

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3.2 Tools to Estimate Drawdown Extent

- In the case of an extension to an existing quarry drawdown can be measured from monitoring wells around the periphery of the site relative to water levels in the quarry sump. However, drilling should always be undertaken in the extension area to assess the geology.
- In the case of greenfield development or deepening of quarry below the water table the properties of the aquifer can be assessed by undertaking well testing, which will induce drawdown in the aquifer.
- Numerical modelling can also be used to assist with the prediction of drawdown and groundwater inflows.

Conclusions

- For the majority of quarries the greatest component of water managed on site and discharged to surface water is often rainfall run-off and not groundwater inflows.
- Both direct and indirect potential impacts should be assessed and mitigated against if negative.
- Often, drawdown is difficult to estimate; however, data from aquifer testing can be used to determine extent. Groundwater modelling can be used to help estimate the extent of drawdown.
- The quarry void forms a trough in the groundwater table. This acts as a hydraulic trap so that in the event of contamination originating within the quarry it is unlikely to disperse into the aquifer.



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