Latest Meteorological Office climate predictions indicate that UK storm events will increase in frequency and intensity

Stormwater Management

With storm events increasing in frequency and intensity, a well-designed, well-maintained water-treatment system can ensure a compliant discharge and improve the environmental performance of a quarry

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No one wants to pay more than they have to for waste treatment; so with this in mind, when did you last review your stormwater management scheme? How much has your quarry changed since the stormwater management scheme was designed?

The fact is that rainfall cannot be controlled and the latest Meteorological Office climate predictions indicate that within the UK there will be increased storm events. This will lead to more frequent demands on stormwater management schemes and potential changes in capacity requirements due to increases in storm intensity.

With regard to stormwater management, SRK work on the philosophy of first understanding the water catchment and seeking to identify ways to keep non-contact waters away from disturbed land. In this way, these waters do not pick up any sediment from excavations and so do not need treating. This has the potential to create savings on several levels:

1. Less water to treat means less treatment chemicals;
2. Reduced pumping costs, if required, both in terms of the capital cost, as less water potentially requires a reduced pump size, and the associated operating costs;
3. Potential reduction in the size of the downstream water-treatment facility. Less water to treat leads to a smaller treatment facility.
4. Keeping water flow to a minimum across the site reduces the cost of ongoing road maintenance. Roadway erosion from water is an ongoing cost that can be controlled.

The other advantage of separating non-contact waters is that these waters are often cleaner, when compared with contact waters, and their mixing results in some dilution of the overall water to be treated. From a water-treatment perspective, it is easier to treat a heavily sediment-laden water than it is to polish a water that is near the discharge water quality objectives. Keeping the waters separate reduces the potential for dilution.

The next decision to be made is what level of storm event should the system be designed to cope with? This is often selected through discussions with the local permitting regulators but it should be a function of the length of operation at the site, in conjunction with any downstream considerations. However, there are minimum storm conditions that should be considered, such as a one-in-ten-year event. ➤

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When diverting or capturing non-contact waters, care must be taken in the design of any structures to ensure they have adequate capacity to cope with the storm event. It is, however, probably more advantageous to over-design the non-contact water-diversion structures in order to minimize the downstream risk of a storm impacting an operation. In addition, the diversion and collection of non-contact waters also provides the potential for some water storage for site operations. As well as predicting a higher frequency of storm events, the Meteorological Office is also predicting longer drier periods, so some water storage could have operational advantages.

Once as much non-contact water as possible has been diverted, the next decision to be made is how to collect and treat the contact waters. Often, quarries require some form of dewatering ahead of operations, the collection system being a simple sump excavated into the base of the quarry. Here, the use of a floating pump, in conjunction with flocculant reagents, can provide a primary treatment for the water. The floating pump ensures that the water is drawn from the treated water horizon and minimizes the transfer of sediment out of the mining void. This can result in a reduction in pumping operating costs, as pumping a sediment-rich slurry has a higher cost than pumping just water. This sump will, however, require ongoing maintenance as the settled sediments will build up over time, eventually minimizing the volume of treated water and leading to reduced capacity and the transfer of solids.

Consideration must also be given to the disposal of these sediments, as with other sediments collected. They are potentially readily mobilized by the action of water and so, rather than being part of the solution, can add to the suspended solids issue. An appropriate long-term storage area should be identified.

Where waters are collected in drainage channels or ditches, these should be sized so that they have the capacity to carry the stormwaters. In addition, consideration should be given to reducing energy within the flows of these structures in order to minimize erosion of the structure while still permitting discharge of the flow. Often, large rocks placed at regular intervals are used to perform this task.

Next, the main sedimentation treatment needs to be appropriately sized. Sedimentation treatment is controlled by rise rate within the sedimentation chamber and is a function of the effective treatment area. The depth of a sediment chamber only provides storage space; a shallow pond with a large surface area will perform the sedimentation task better than a small deep tank.

The settlement of the sediments is a function of their density, specific diameter and the viscosity of the fluid they are settling in; this gives rise to their settling velocity. The rise rate of the sedimentation chamber or pond needs to be less than the settling velocity of the sediments entering in order to achieve sedimentation.

In reality, non-aided settlement of fine particulate (clay) suspensions at a quarry often requires an effective settlement area approaching the size of the disturbed land, as the typical settling rate for these solids is in the order of <1mm/h. Therefore, aided settlement through the addition of flocculation reagents or coagulants is more cost-effective and can improve the settlement rate by two orders of magnitude, as it creates larger particles that settle quicker. These reagents can be added passively through the addition of flocculant blocks to flow channels or, more commonly, by means of a dosing pump. Simple settling trials with a variety of reagents can quickly determine the optimum reagent and settling rate.

In addition to determining the size of the required settlement area, consideration should also be given to the distribution of flow. Distributing the flow along the edge of a rectangular tank and collecting the clarified water from the opposite side is a more effective use of the available settlement area than a single-point entry and discharge. This is because the single-point entry and exit will create dead zones within the settlement chamber and the effective settlement could be reduced by as much as 50%, when compared with the optimized tank. Similar precautions should be considered for sedimentation ponds.

Next, if multiple sedimentation tanks are to be used, they should always be used in parallel and the flow divided proportionately between the tanks. In this way the effective settlement area is equivalent to the sum of all of the tanks. Operating the tanks in series means that the effective settlement area is only as good as the largest sedimentation tank in the system. This is because any smaller or subsequent tanks will not reduce the rise rate to promote further sedimentation.

Finally, sedimentation treatment should be designed for a maximum flow; adding further flow to the system will not only hinder the performance of the treatment, but could even lead to scouring of the previously deposited sediments. This will have a greater impact than not treating the water at all. Scouring is also an issue when the sedimentation chambers are not regularly maintained. If it is not possible to see clear water in a sedimentation chamber or pond, then it is probably full. If the collected sediments can be seen near the surface, it will not be effective in treating the water.

Having a lower flow through the sedimentation treatment system will maintain its performance. To maintain a steady flow through a sedimentation treatment system an attenuation pond is utilized. If the attenuation pond is sized with the storage capacity for the desired storm event while maintaining a maximum discharge to the sedimentation treatment system, this will even out the storm peak flows. Should the storm event be excessive, the attenuation pond should also include a bypass feature such that excess waters beyond the design capacity are discharged without treatment or sent to emergency settlement areas. In this way the designed system will continue to operate and will still treat the majority of the water. This water can then be either blended with the untreated waters, giving a net improved discharge from site, or discharged separately.

Consideration should be given to the discharge point from the site to minimize potential downstream flood risks whilst permitting the discharge of treated waters; ongoing maintenance of this structure will be required. A well-designed, well-maintained water-treatment system can provide a compliant discharge and improve the environmental performance of a site. For help and advice or a review of an existing stormwater treatment scheme, contact SRK Consulting at: watertreatment@srk.co.uk ***QM***