Drain and Dewater Civil Construction Site

Learner Guide

Table of Contents

Select Plant, Tools and Equipment

Once you have confirmed your job requirements you need to choose the right equipment and attachments to get the job done.
When choosing equipment and attachments you need to think about:

- The task requirements, specifications and goals.
- The appropriateness of the equipment for the completion of the task.
- The characteristics, correct use, operating capacity and limitations of each item.
- The potential risks to yourself and others in the intended use of the equipment.

Commonly used tools during drainage and dewatering could include plant or hand tools such as:

- Shovels.
- Crowbars.
- Picks.
- Hoses.
- Pumps.
- Graders and levelling equipment.
- Excavators.

Information about technical capabilities and limits can be found in the operator manuals supplied by the manufacturer of each item.

It is not safe to operate plant, equipment or attachments outside site procedures and the manufacturer's specifications. This may cause the machinery to break and could also cause an accident or injury.

Pumps

Pumps are essential items of drainage and dewatering equipment. They may range from small low volume through to high capacity units.
It is important to ensure that the correct type of pump is used for the appropriate application. For example, using a pump that is too small can be slow and may not be able to move the correct volume of water to achieve the task.
When selecting a pump, there are three main considerations:

1. The amount of water to be moved.
2. The height and distance from the water level to the discharge point.
3. The placement of the pump to allow for safety to the operator and to give maximum efficiency in operation.

In civil construction the three common types of pumps that are used to drain and dewater are:

- Centrifugal pumps.
- Diaphragm pumps.
- Submersible pumps.

Position Sedimentation Controls

Sediment, or sedimentation, is the name given to soil products, which have been swept into water during the process of erosion.
Sediment controls are those actions that capture the soil particles contained in water.
To ensure successful sedimentation control, you will need to be able to identify both the correct control measure and the most effective location for that measure.

Each worksite will have a comprehensive plan for sedimentation control contained within the environmental management plans. These plans give exact details about the establishment of sediment control measures, i.e. where they are to be positioned and how they are to be constructed.

Sedimentation Controls

The two main methods of sedimentation controls are:

Slowing	***Slowing the flow of water*** **to allow the sediment to settle out of the water.**
Treating	***Treating water*** **that is full of sediment to remove the particles within the water.**

Sedimentation control measures could include:

- Earthen windrows.
- Sediment control perimeter banks.
- Stacked rock and geo-textiles.
- Check dam sediment traps.
- Geo-fabric filter fabrics.
- Sandbags.
- Sediment traps.
- Gully pit traps.
- Sediment retention basins.
- Flocculation systems.

Construct Sedimentation Control Barriers

The methods for constructing and maintaining sedimentation control barriers are detailed in the overall environmental management plan.

This plan will include sedimentation and erosion control plans and drawings, which outline common construction methods such as:

- Sediment traps.
- Gully pits.
- Sediment retention basins.

Sediment Traps

Sediment traps are used to slow the flow of water in capturing the sedimentation material. They should never be used in large watercourses.

Sediment traps are constructed from materials that are heavy enough to slow the rate of flow, such as:

- Rocks.
- Logs.
- Sandbags.
- Gabions.

The maximum depth should be between 0.6 to 1.0 metres high. For correct construction, the centre of the sediment trap needs to be 0.15 metres lower than the edges to allow for a spillway.

When maintaining a sediment trap, watch for signs of scour at the edges of the trap. This occurs when the water 'rips' around the edges of the trap causing erosion issues.

Gully Pits

Gully pits are primarily used to stop sediment escaping into a stormwater system.

These sediment control measures require regular monitoring as they can fill with sediment very quickly, becoming ineffectual and sometimes causing localised flooding.

Sediment Retention Basins

This is a permanent or semi-permanent measure that is only used in specific situations where the water catchment is large or the expected flow is rapid and other measures are unsuitable.

Sediment retention basins are best positioned in depressions below the construction site and are often constructed using graders or excavators.

Regular maintenance of these basins is required to remove silt and sediment.

Position Geo-Fabrics and Woven Wire

Geo-fabrics and woven wire are used to provide additional stability to earthworks structures. They may be used either together or independently of each other.

Geo-Fabrics

Geo-fabrics (or "geo-fab") are materials that are used onsite for stabilisation, sediment catchment and erosion control.

They can be used to line trenches or drains, to cover large areas, or to create dams and sediment traps.

Geo-fabrics come in rolls ranging from 300mm to six metres wide, in a variety of sizes and weights. The higher the weight of the fabric, the less sedimentary materials will be allowed through.

Laying the Geo-Fabric

To lay the geo-fabric, the required lengths are rolled out and then cut. When laying out geo-fabric, you must ensure a good overlap where two pieces of material meet to ensure a watertight join.

Depending on the plans and specifications for the sediment control measure you are creating, the geo-fabric may be laid with the run of the water or it may be at right angles to the flow of the water.

Before starting to lay geo-fabric, ensure you have double-checked the plans and specifications and are aware of the alignment required.

When using geo-fabrics under a rock mattress or other materials, ensure the geo-fabrics is adequately secured to ensure de-lamination does not occur. This is particularly

important if you are laying a geo-fabric layer then a rock mattress in front of a culvert with an anticipated high flow rate of water.

If the geo-fabric is not securely attached to the underlying layers of soil, the rock mattress can become a floating obstacle which may cause significant damage to the culverts, roads or other structures in the path of the water.

If geo-fabric is used to create coffer dams or sediment traps, ensure the grade or weight of the materials is adequate for the tasks you will be undertaking.

The correct grade is recommended based on the amount of water it will hold.

When cleaning or maintaining a sediment trap that has been created using geo-fabric, it is possible to drain the water, roll the geo-fabric into a bundle by folding from the sides and removing the silt as well as the geo-fabric.

The way this silt is treated after it is removed will depend on the site environmental management plans and what, if any, contaminants may possibly be contained within the silt.

Geo-fabric is heavy but does not require special handling techniques other than an awareness of manual handling issues.

Woven Wire

Woven wire comes in sheets and is used to give additional stability to earthwork structures such as contour banks or high flow trenches.

Working with Woven Wire

Due to the nature of the material, woven wire does have specific handling requirements. It is heavy and when cut it has razor sharp edges.

To cut the woven wire, bolt cutters are used on the heaviest of the wires, while carton knives can be used for the lighter materials. When using a carton knife, ensure you have adequate spare blades, as the woven wire will break or quickly blunt them.

While each manufacturer will have different requirements for working with woven wire, they normally include:

- Use of gloves.
- Eye protection.
- Team lifts or other approved manual handling methods.

Woven wires are difficult to reposition, so ensure you have double-checked the plans, drawings and specifications and know the area where they need to be laid before you start.

Establish Temporary Drainage Systems

Temporary drainage systems are established early in the construction process to enable control of sediment and to minimise erosion during activities such as land clearing.

They may also be used where there is insufficient space to place more permanent measures on the site.
Temporary controls are also often used if the work may be short term or due to mobile works.
These temporary drains are used as stop-gap measures while the construction of the permanent drains are installed.
Temporary drains are focused at moving any water into an existing storm water drainage system.
This existing system may be natural or man-made.
Temporary drains could consist of:

- Temporarily constructed drains.
- Temporarily constructed contour banks to isolate water.
- Permanent contour banks.
- Temporarily installed culverts or diversion pipes which must be installed in accordance with site plans and manufacturers' specifications.

The focus of temporary drains is to ensure adequate control of water during the construction phases.

Free Water

Free water is often defined as water that is not contained by tanks, dams, pipes or other vessels.
This also applies to water that flows freely through or around the site.

Clean water (i.e. water that has been treated or had sediments removed, or clean storm water that has not picked up sediments or contaminants from the worksite) may also be referred to as free water.

Remove or Direct Slab and Surface Water

Water that is present on the surface or in work areas has the potential to form sheet flows and must be controlled.

Large open areas, such as concrete slabs or cleared ground, can allow water to sheet off, leading to severe erosion.
Controls need to be in place to cater for these sheet water flows to minimise the risk of damage to the works.
Slab and surface water is often controlled in the same way, i.e. the sheet flows are diverted into temporary drainage control systems which may be in the form of:

- Silt fences.
- Contour banks.
- Check dams.
- Basins or other suitable measures.

It is necessary to prevent the water from the surface or slabs from picking up too much velocity and potentially causing huge erosion areas that can carry large amounts of sediment or cause severe damage to other work areas.

This prevention is done by using multiple, smaller sized drainage devices rather than one large device that will allow water to move quickly.

Fill Surface Holes and Depressions

It is essential to fill any surface holes and depressions that have developed during your dewatering activities.
This will ensure the levels in the area are of a similar dimension.
Holes or depressions in the area near or in the path of the water flow could lessen the effectiveness of the sedimentation control measure you have implemented, possibly causing them to fail in the long term.
Filling in the holes and depressions also stops water ponding in areas other than the intended drainage or water management controls.
When filling holes, ensure you are using the correct equipment and are following appropriate manual handling procedures and processes.
If you are unsure about the correct materials needed to fill surface holes and depressions or how correct compaction is achieved where required, talk to your supervisor and/or check the site specifications and management plans.

Drain Surface Water

The slope or grade of the site can be used to channel or divert surface water flows, thus allowing for more effective control measures to be implemented.
It is much easier to construct dewatering and drainage devices that work with the fall of the ground, rather than to create a system that works against the environmental conditions because water will always find the easiest path in flowing down a hill.
Also be aware that surface water flows can be controlled more easily in a concentrated format rather than in sheet flows by using devices such as sediment fences and contour banks.
These devices would then be used to drain surface water to controls such as sediment basins or check dams where the water could be pumped or otherwise dewatered.
Upon reading the environmental management plan, diagrams or specifications you may discover that they require the construction of a drainage system that works against the environmental conditions (such as expecting the water to flow up hill to get into the drainage system).
This is when you need to apply diagnostic procedures and/or speak with the site environmental manager.

Locate and Construct Sumps and Wells

Sometimes it may be necessary to create a sump or a well to allow the water to drain from a site or area.

Sumps

In simple terms, a sump is a hole or a depression where water can be held to allow a pump to sit below the natural surface level.
Sumps are not usually very deep and are filled in as necessary.
They may be temporary or permanent, depending on the works.

Wells

A well is generally a more defined hole, often constructed by boring a large diameter hole to the required depth.
Wells may be stabilised with rock around the sides, or may have steel casing put into the hole.
They are more likely to be used where water seepage occurs.

Locate Sumps and Wells

When deciding on the location of sumps and wells in a drainage and dewatering system, it is essential to ensure they are constructed in the lowest point of the system.
This allows for maximum efficiency when removing the water from the area, normally by using a submersible pump.
Sumps and wells that are located in positions other than the lowest point mean that the water will never be completely removed from the area or site.
If the plans specify a location that is not at the lowest point, speak with the environmental manager to determine if the location needs to be moved to the lowest position.

Constructing Sumps and Wells

The general terrain of the worksite will determine the type of sumps and wells required. While site plans, and your work instructions will determine where they should be located.
he sumps and wells must be located where water will flow in.
Some workplaces use the sumps to collect the water so that it may be used in other construction processes or for treatment prior to leaving the worksite.
Check with the supervisor to ensure the correct size and type of wells or sumps are used for the work activities.
Sometimes wells are constructed in areas where natural springs or underground water flows are present. The wells must be securely constructed and are usually lined to ensure the sides do not collapse. Different methods of lining will occur depending on the intended purpose of the well.
Sumps are usually just low points designed to allow water to collect so it may be pumped out or treated. These may be naturally occurring depressions in the ground; small holes dug with a shovel or may be mechanically excavated or constructed.
Always check the relevant drawings, plans, and work specifications before starting construction. In many cases, it is necessary to obtain the appropriate licences or permits before installing wells.
Additionally, the correct environmental controls must be implemented to minimise contamination to the underground supply.

Install Surface or Submersible Pumps

The type of pump required for the task will determine how the pump needs to be installed.
Some pumps may be vehicle-mounted, so access to the sump or well may be a consideration. Other pumps are portable.
Some may require flat and level surfaces for the body of the pump to sit on, while other types may be placed directly in the water or have suction attachments.
The three common types of pumps that are used to drain and dewater sites are:

Pump Type	Description
Centrifugal Pumps	Centrifugal pumps are usually light weight, portable and easy to maintain. They have a suction hose attached that must be filled with water before pumping can occur – this is called priming the pump.
Diaphragm Pumps	These are bigger and heavier than centrifugal pumps and can handle large volumes of water and some solids. They are often used to move a large volume of water quickly to drain an area, e.g. pumping out a coffer dam or basin.
Submersible Pumps	Submersible pumps may be electric, air or fuel motor-driven and may have a flex drive head. Excavations, trenches, wells and sumps are common places for these pumps to be used. The head of the unit is generally attached to a delivery hose that is used to move the water away from the original location.

Pumping Requirements and Procedures

Pumps should always be installed and used in accordance with manufacturer's directions and site procedures.
These documents cover factors such as:

- Safety aspects.
- Refuelling procedures.
- Water management instructions.
- Other specific criteria relevant to the workplace.

Pumping requirements and procedures may include the following:

Requirements and Procedures	Description
Training and Instruction	Before using a pump for the first time, operators should be given training or instruction in the correct use. Training may be provided by the supplier, manufacturer or a person on the site who is familiar with the operation of the unit. Some pumps may be easy to operate while others may have specific features.
Checking Pump Limitations	Operators should always be familiar with how much and how far water or other fluids can be moved using a particular unit without overloading the machine. This also includes knowing the limitations of the equipment that you are using. If in doubt, talk to your supervisor or seek further training.
Checking Pump Location	The pump or drive motor should be located on firm, level ground wherever possible.

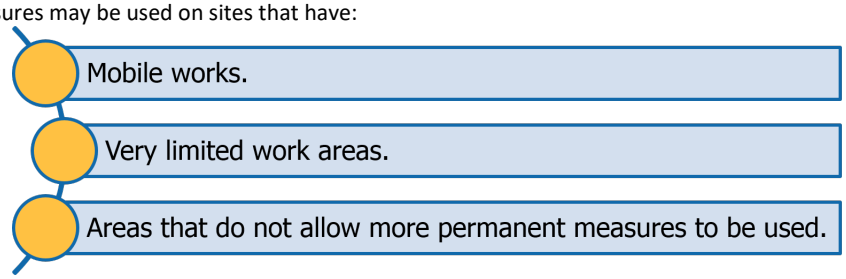
	Care should also be taken to ensure that the pump is not likely to vibrate or roll into the water or sustain damages during operation. This does not apply to submersible units, which, as their name suggests, are designed to operate underwater.
Connecting Hoses	Delivery and suction hoses, where applicable, should be correctly connected. Where required, pumps should be primed.
Maintaining Pump Units	Pump units should be checked and maintained frequently to ensure that they are in peak running condition.

Locate Surface Pumps

Make sure you select the correct type of pump for the task required.
You then need to locate the pump as close as possible to the point of origin, i.e. the well, sump or basin, without putting the operator or equipment at risk.
The delivery point should also be considered when locating the pump, to avoid putting unnecessary strain on the pump motor.
Be aware of other aspects such as power source, suitable space for drive motor units or refuelling of motors when locating and positioning pumps.

Pump Water into Temporary Drains

In some cases it may be necessary to pump water into temporary drainage systems such as basins, ponds or check dams.
These temporary measures may be used on sites that have:



It is important to know the relevant site procedures for temporary controls.
These will be outlined in the project/site environmental management as well as the erosion and sedimentation control plans.
Sometimes water may need to be pumped from the work areas to temporary drainage controls to allow the sediment to settle out of the water.
In this case the water is then pumped out after the sediment has settled and the remains can be disposed of in line with the site waste management procedures.

Disperse Discharged Water

When dispersing discharged water, it is essential that you understand the main construction principles of draining and dewatering a site, i.e. ensuring that water is controlled and transferred correctly to avoid damage to the project and the environment.
These principles are reinforced in the requirements of the environmental management plan, and it is vital that you strictly adhere to the outlined procedures.
This will ensure that no dirty or contaminated water or pollution leaves the site, thus minimising any negative impacts on the environment including stormwater drains and natural watercourses.

Dispersal requirements and procedures can cover such factors as:

Dispersal Requirement and Procedures	Description
Parts Per Million	How many parts per million of sedimentary materials.
Discharge or Delivery Points	Pumping into particular areas may be limited or not be allowed at all, for example directly into a watercourse.
Discharge Amounts	It is not uncommon for amounts of discharge to be specified over a set period of time. This is particularly applicable to areas with low rainfall, as a high discharge rate could upset environmental balances.

All procedures used during the dispersal of discharged water will require approval before they are applied.

Clean Up After Work

Once all your tasks are finished, you will need to clean up the site. This includes removing any tools and equipment that have been used.

Whether you have to remove small amounts of water or have to control large quantities of water in deep excavations, you will need to consider a wide range of dewatering methods and techniques.

In many construction works, such as building foundations and basements, you will have to deal with groundwater and surface water management. They should be controlled to ensure easy and safe accomplishment of the work on the construction site.

That's when dewatering comes into play.

Dewatering, as its name suggests, is the process of removing surface and subsurface water from a construction site.

Whether you have to remove small amounts of water in case of shallow excavations (up to 1.5 m deep) or have to control large quantities of water in deep excavations (over 3 m deep), you will need to consider a wide range of methods to make sure adequate precautions have been taken.

Why dewater?

Dewatering provides dry and stable conditions for excavations, allows to increase the stability of the soil, and ensures workers' safety.

If for some reason surface and sub-surface waters are not properly collected and disposed of, they can pose significant hazards during construction site preparation and, later on, during the building's life cycle.

Image source: HSI Services, Inc

The damage may be of different types:

- The conditions of the soil may undergo variations that can affect the structure of the building.
- It may become a reason for surface flooding.
- If you don't pay proper attention to the place where water is discharged, you may run the risk of witnessing erosion and other related problems.
- Dampness may lead to unhealthy conditions and attract termites.
- Flooding may damage adjacent properties.

Builders, designers and other specialists involved in the construction process should make sure the site preparation is done professionally so that groundwater is removed as required and surface water always runs away without the risk of being banked up.

What to consider before choosing a dewatering method?

You should base your decision on a number of information sources.

Refer to the geotechnical and groundwater site investigations and risk assessments accomplished in the scope of your construction project and, if needed, consult with the information provided by local authorities.

In most cases, you will need specialist engineering services to take care of soil stabilisation and successful control of groundwater.

The common process of dewatering involves the following phases: *collection of water, pumping, filtering/removing silt*, and *discharge*.

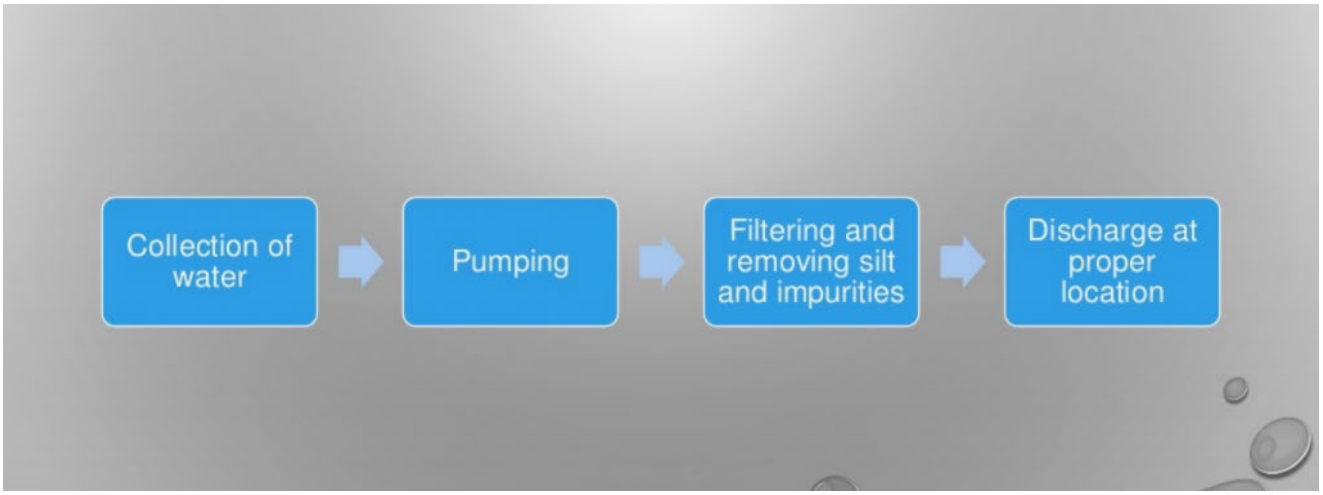


Image source: SlideShare

Methods of dewatering

We have singled out four commonly used methods: sump pumping, wellpoints, deep wells, and eductor wells. These techniques can be employed singularly or in combination depending on the nature of the soil and groundwater conditions.

Dewatering by Open Sump Pumping.

It's a reliable choice in a wide range of situations, and it's also referred to as the simplest, cheapest, and most effective dewatering method.

A sump is a hole or an area in the ground (deeper than the basement floor) where water is collected and then pumped away for disposal.

How it works.

Drains and sumps are constructed at one or more sides or corners of the foundation pit. The drains collect the groundwater and convey it into the sump. From the sump, the water is continuously evacuated (either manually or mechanically).

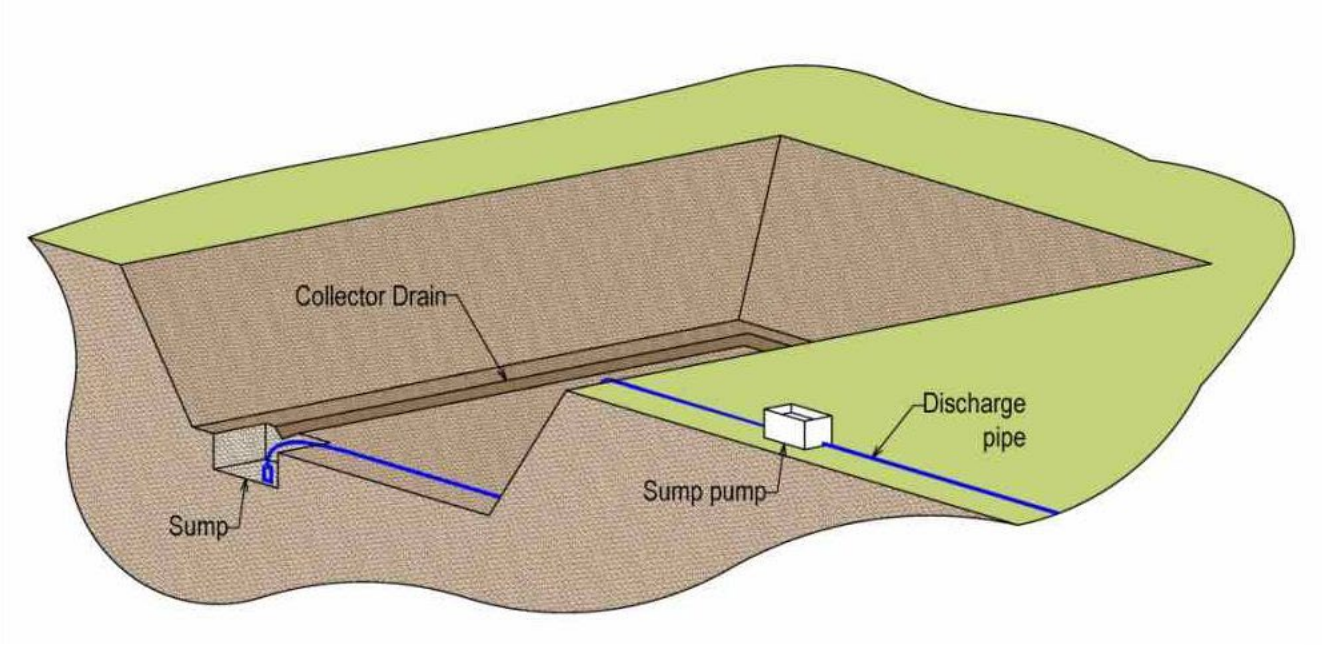


Image source: Gharpedia

This method works well for most soil and rock conditions (can be applied in well-graded coarse soils or in hard fissured rock).

Consider scenarios when you should be cautious. When using this technique, there is a risk of collapse of the sides as "the groundwater flows towards the excavation with a high head or a steep slope". In fine-grained soils, such as silts and fine sands, there is also a risk of instability which may result in ground movements and settlement.

Dewatering by a Well Point System.

This method features easy installation, and it's relatively cheap and flexible, being practical and effective under most soil and hydrologic conditions. Wells are drilled around the construction area and pumps are placed into these wells.

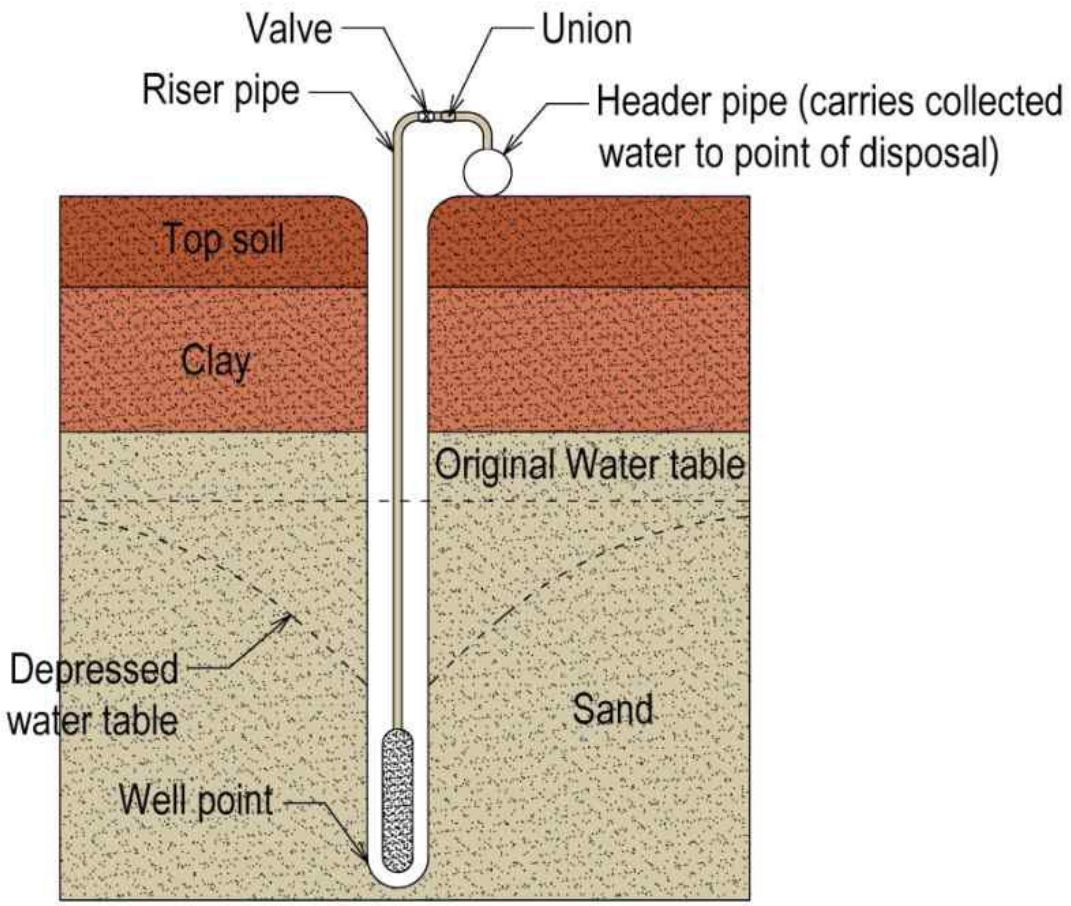


Image source: Gharpedia

Wellpoint systems consist of a series of small-diameter wells, connected by a header pipe to a centrally located suction pump. Groundwater is abstracted via the wellpoints from a vacuum generated by the pump.

The perforated pipe has a ball valve to regulate the flow of water (the ball valve also prevents the mud from entering into the pipe). Groundwater can be lowered about six metres by this method.

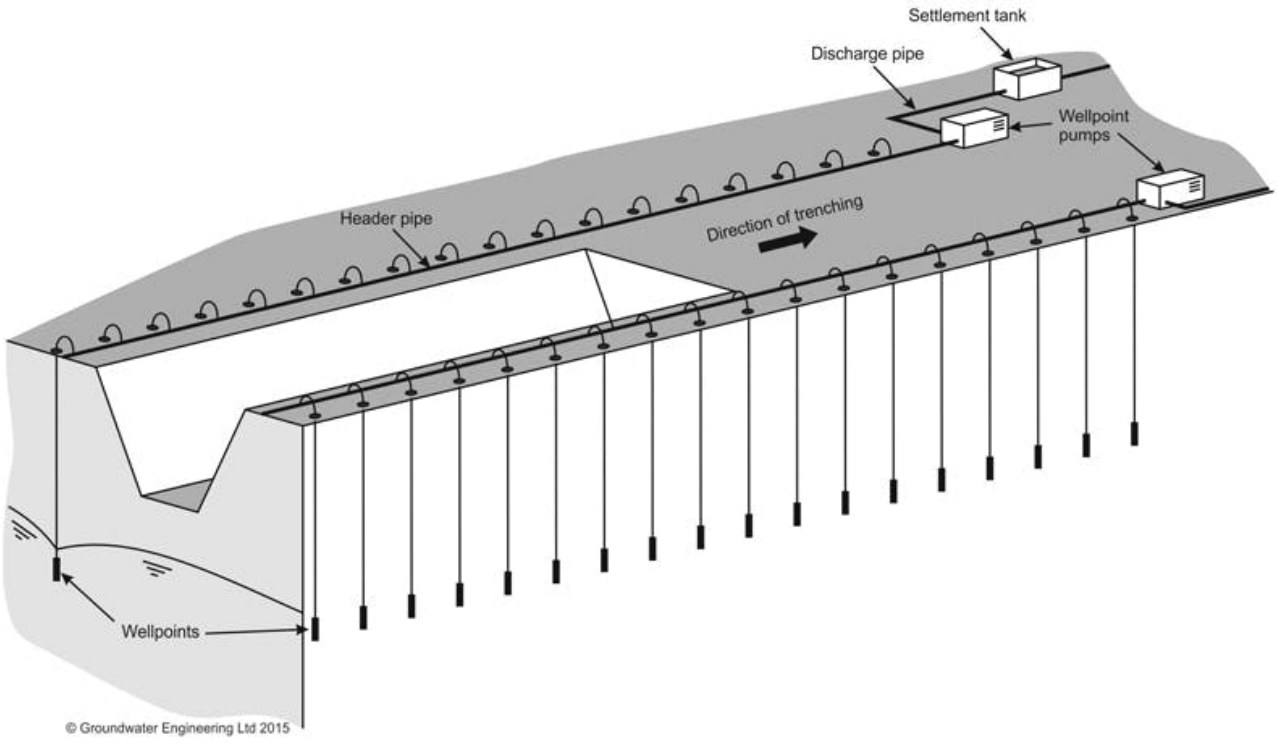


Image source: Groundwater Engineering

This method is ideal for buildings with deep basements and is effective in sands and sandy gravels.

Image source: GEOQUIP

Dewatering by Constructing Deep Wells.

When a deep excavation is needed and a large quantity of groundwater is required to be removed, dewatering may be done by constructing deep wells in soils or rocks where permeability is between moderate (e.g. sands) to high (e.g. gravels).

Image source: The Constructor

Deep well dewatering system can drain out water up to 24m depth. The capacity of the pumps as well as the number, depth, and spacing of deep wells may vary depending on the site conditions.

In cases when wellpoints and deep wells are not suitable methods for dewatering, the use of eductors can be considered.

Dewatering Using the Eductor System

The eductor system (also known as the ejector system) is a specialist technique used in low permeability soils such as very silty sands, silts, or clays. Eductors are typically used to help stabilise the side slopes and soil in the excavation area.

Unlike the wellpoint dewatering system, it uses high-pressure water in the riser units. The eductor system works in the following way: “Ejector supply pumps located at ground level feed high-pressure water to the ejector nozzle and venturi located at the base of the wells. The flow of water through the nozzle generates a vacuum in the well and draws in groundwater”.

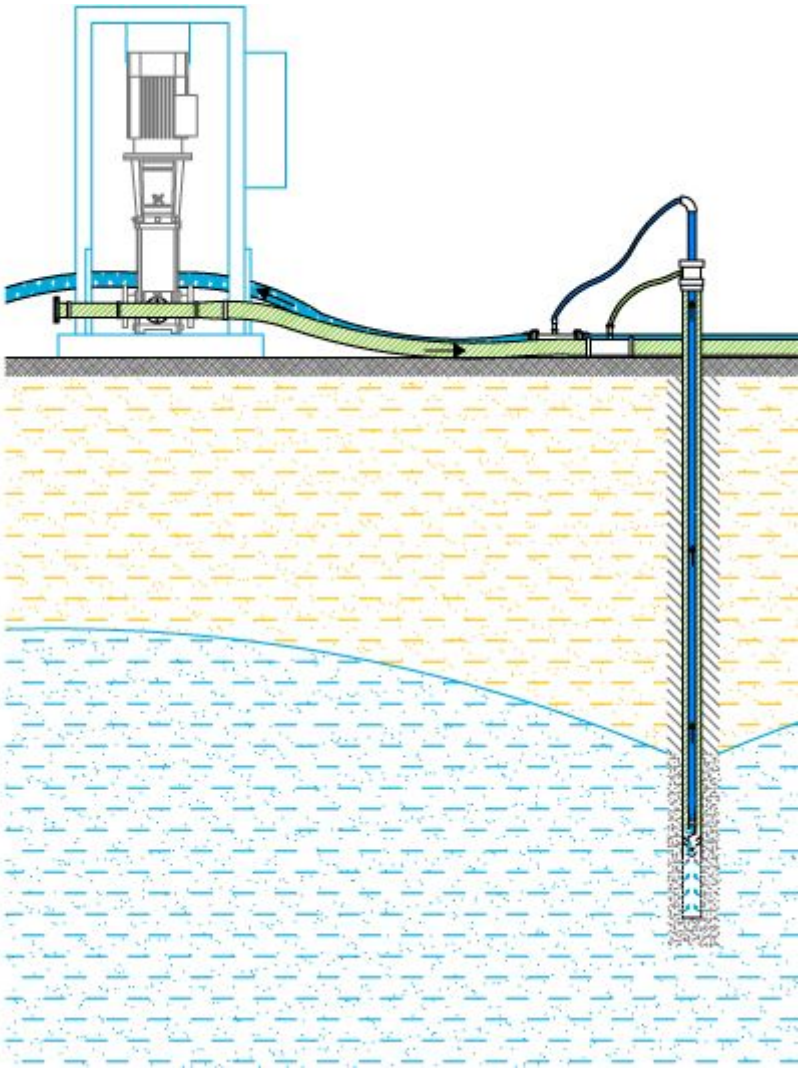


Image source: WJ Middle East

Wrapping up!

To survive and thrive in an environment where more and more buildings are designed and built, construction specialists have to be knowledgeable in the industry laws and regulations and competent to accomplish construction projects – from demolition to excavation, from glazing to maintenance.