CHAPTER 18

TEMPORARY WATER MANAGEMENT

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18.1 Introduction

This chapter provides information for the planning, design, and construction of temporary water management (TWM). This effort is expected to standardize designs and approaches, create workable and understandable designs, provide guidance for local agencies and contractors, and compliance with environmental regulations. Also, the quality of project TWM plans and specifications will improve by looking at TWM in detail during project design.

Photo examples of Temporary Water Management facilities

Temporary water management is the flow and sediment control of surface water and groundwater seepage during construction activities to be performed within bodies of water such as streams, creeks, rivers, wetlands, estuaries, or lakes. Temporary water management also provides a safe working area for construction within a waterbody utilizing a variety of barrier isolation options, materials, and equipment while meeting regulatory requirements related to water quality and fish passage when necessary. These flow and sediment control measures are temporary, usually utilized during the in-water work period, and installed/removed with coordination between the contractor and engineer.

Note that TWM can be utilized along most water bodies such as streams, creeks, rivers, wetlands, estuaries and lakes. ODOT implements many TWM plans along channel settings such as streams, creeks, and rivers, therefore, the guidance within this chapter will focus on channel work applications.

Typical construction activities that require temporary water management during installation or repair work include but are not limited to:

- bridge demolition or construction
- culvert removal or replacement
- embankment construction for roadway alignments

- stream channel modification
- habitat restoration
- streambank repairs

Compliance with the guidelines, criteria and the recommendations within this chapter does not guarantee that the proposed concept design will pass review by all permitting agencies. The guidance in this chapter, however, may reduce the number of regulatory review comments and the time needed for regulatory review and approval. Planning and designing for the temporary water management "Concept Plan" needs to be done early in project development.

The considerations for selecting and recommending an isolation option include worker safety during construction, water quality, aquatic life protection, fish passage, flow conditions, and constructability. Depending on the specific situation, temporary water management includes, but is not limited to, these activities:

- routing streamflow around or through the work area
- isolating the work area from streamflow or surrounding water
- removing water within and entering the work isolation area
- reduceing sediment levels from water pumped from work area prior to releasing this water back into the main water body
- preventing fish and other aquatic creatures from entering the worksite during construction
- providing fish passage during or after working hours

Three isolation options of managing water during construction can be implemented:

- partial isolation
- full isolation
- working in the wet

Additional detail on these isolation options is presented in the remaining sections of this chapter.

18.2 Policies and Practices

General policies of the Federal Highway Administration (FHWA) and ODOT pertaining to hydraulic design are discussed in Chapter 3.

Agency practice specific to temporary water management design include:

- coordination with other federal, state, and local agencies concerned with water resources,
- safety of the general public, construction workers, and inspection staff.

18.2.1 Responsibilities

Many individuals within the ODOT Regions or individuals outside of the agency are involved with temporary water management. The responsibility of these individuals are as follows:

- The hydraulic designer coordinates the TWM concept development with the appropriate design team members through the design and permitting process, and prepares the:
  - TWM concept plan(s),
  - project hydraulics report with TWM recommendations, and
  - project specifications
- Environmental personnel apply for project permits. Getting the TWM information to the environmental personnel in a timely manner, allows for discussions with the regulatory agencies.
- The project manager assures the TWM is implemented and administers those aspects of the project construction.
- The contractor implements the TWM. The TWM concept plan and specifications allows for revisions based on site conditions. A stamped working drawing(s) is developed by the Contractor based on either the Agency's concept plan or and independent plan.

18.3 Definitions

Definitions of important terms are provided in this section. These and other terms defined in the manual glossary will be used throughout the remainder of this chapter in dealing with different aspects of temporary water management.

Isolation Barrier - A temporary barrier used to isolate the work area and turbidity from the actively flowing stream. Barriers can be created using sandbags, pre-cast concrete barriers, water-filled impervious barriers, and sheet piling; also known as a cofferdam.

Diversion - An activity that removes surface water or groundwater from the basin of origin to another watershed where this water would not normally flow.

In-water work period - A list of time periods created by the Oregon Department of Fish and Wildlife (ODFW) for construction activities within Oregon water bodies. These time periods are based on the times in which anadromous and/or game fish are least likely to be present.

http://www.dfw.state.or.us/lands/inwater/

Ordinary high water (OHW) – Generally defined as the mark on the bank or shore to which the high water ordinarily rises in any given season, excluding exceptionally high water levels caused by large flood events.

Rerouting - A pipe or constructed channel that conveys streamflow around the construction area, outside of the existing streambed and discharging the flow back to the same water body; also known as *bypass.*

Suspended solids - Particles floating in the water column. These may be organic or inorganic particles that can be trapped on a laboratory glass-fiber filter.

Turbidity - The refraction of light due to suspended solids in the water column. Turbidity is measured by a turbidimeter in nephelometric turbidity units (NTU) and by visual inspection.

Water body - A generic term to describe waters such as streams, creeks, rivers, lakes, estuaries, and wetlands.

18.4 Types and Selection of Isolation Options

The following section provides an overview of a few waterbody work isolation practices for highway-related construction activities.

18.4.1 Common Isolation Option Elements

Each temporary water management option has common elements as listed below:

- **Removing fish from the work area:** Nets are placed outside of the construction limits to exclude fish from the isolation work area and trap fish for removal. After nets are installed, the work area is surveyed for fish; detected fish are recovered and released back into the main water body outside of the work area. The fish removal process is mandatory and can only be done by ODFW approved biologists.

- **Installing a barrier to isolate the work area:** A barrier is needed between the work area and active channel or surrounding water body. The application goal is for the barrier to keep water out of the work area and to withstand pressures and forces exerted by the surrounding water. Sandbags, precast concrete barriers, and water filled impervious membranes are several common products that could be used to form an isolation barrier.

- **Dewatering the work area:** The work area is dewatered after fish are removed from the work area and the barrier is placed and secured as recommended by the project TWM plan. Water left remaining inside of the work area is removed by pumping it toward and into a temporary sediment control facility for treatment before it is released downstream of the project site. Dewatering can also occur throughout the construction phase to remove groundwater or water that may be seeping under or through the isolation barrier(s).

- **Sediment control:** The placement of barriers and other related construction activities tends to stir up sediment throughout the work area. Releasing turbid water into the adjacent water body could violate water quality regulations. Note that this is the primary reason sediment control measures are used during temporary water management. The most common BMPs to remove sediment during partial isolation of water bodies include filter bags, dispersion areas such as filter strips, sediment traps, and swales. Use of any one of these sediment control measures removes low-to-medium levels of sediment. A combination of these measures should be used if high levels of sediment are encountered during the dewatering and construction process. The temporary sediment control facility is removed after work has been completed and the disturbed area(s) restored as recommended by the project restoration plan.

- **Rewatering the work area:** All isolation plan features need to be removed after work is completed and accepted by ODOT. The goal at this stage is to allow water to reclaim the work area by removing the isolation features. The ideal approach is to rewater the disturbed area slowly to minimize erosion and turbidity. This is to be done in such a manner as to not strand fish and to regain the pre-construction flow conditions.

There are three isolation options outlined below. The site constraints for these isolation options may include right-of-way limits, water rights issues, and environmental concerns just to name a few.

18.4.2 Partial Isolation

Photo example of Partial Isolation

Partial isolation is typically implemented when work will occur along or near the bank of a stream, river, lake, or estuary. The example provided utilizes a barrier that is placed next to and along the bank of a stream to establish a work area. Partial isolation allows for varying flow conditions to continue downstream through the non-isolated channel, maintains upstream and downstream fish passage, and minimizes affects to an aquatic ecosystem by dewatering small portions of the waterbody.

Partial isolation is intended to isolate an area to allow work in dry conditions and is typically implemented during projected low-flow conditions. The process and main features of this approach are:

- Removing fish from the work area to be isolated[1]
- Installation of the isolation barrier[1]
- Dewatering the isolated work area[1]
- Sediment control throughout the construction process[1]
- Removal of the isolation barrier and re-watering the work area[1]

The partial isolation option is the combination of these features. Each of these features has specific limitations and requirements that need to be considered when developing a partial isolation plan. Additional information to guide the concept plan design is detailed throughout the remaining sections of the chapter. Figure 1 shows a general configuration of a work area using the partial isolation option.

Partial isolation could be considered and applied when:

- work will be performed within creeks, rivers or lakes
- work will be performed during the in-water work period
- upstream and downstream fish passage is required during work activities
- water is present and the work requires dry conditions
- there is no water present but highly probable
- staging is feasible or necessary during repair or construction activities

Activities that could require partial isolation include but are not limited to:

- bridge abutment maintenance and construction
- pier maintenance and construction (e.g., spread footings, bents)
- embankment protection

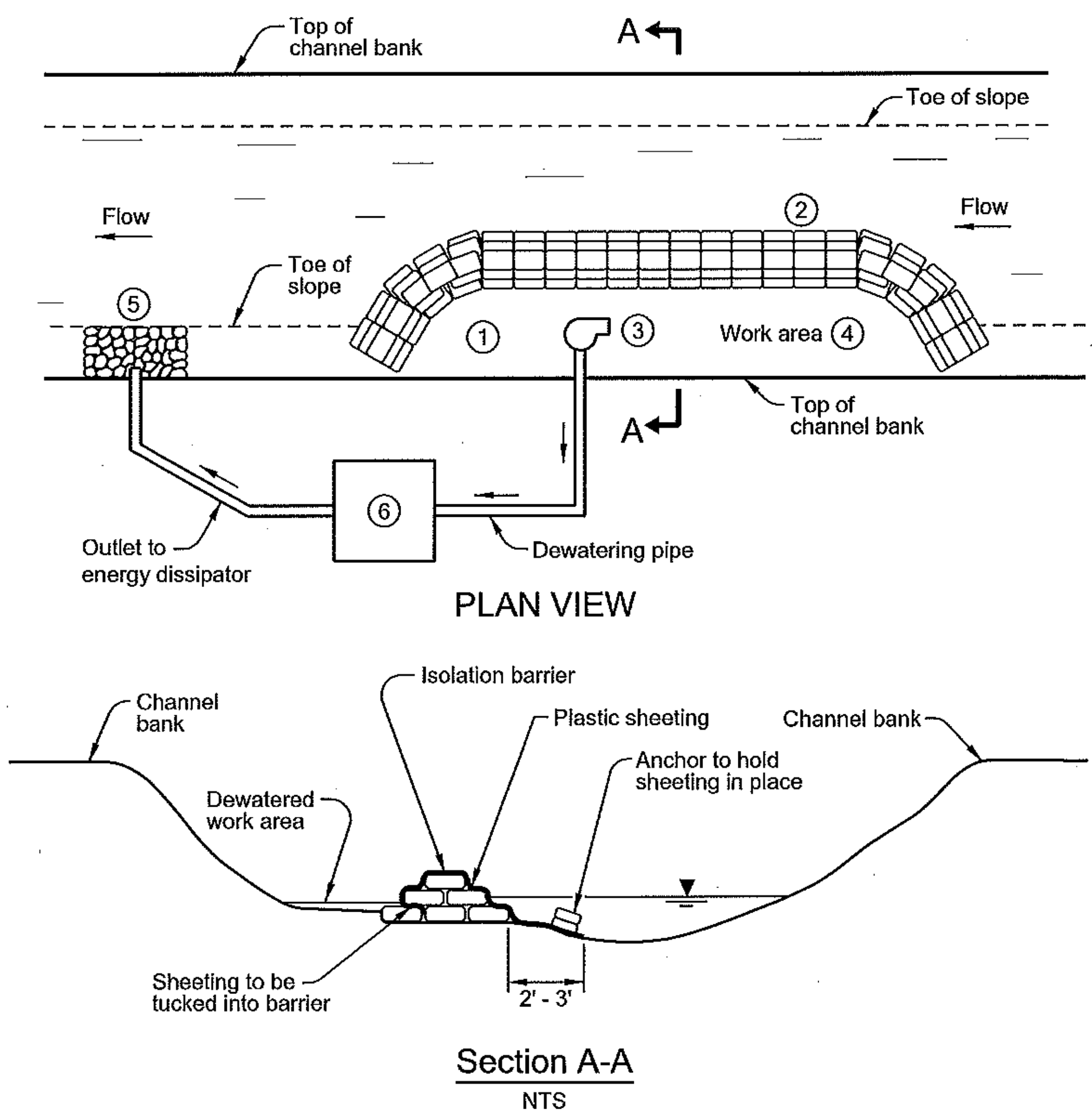
[1] Refer to Section 18.4.1 Common Isolation Option Elements for full descriptions of the elements that are common between the three listed isolation options.

- streambank restoration
- streambed repair or restoration
- bridge demolition
- installation of temporary work platforms

Partial Isolation limitations:

- Typically applied during low flow conditions within creeks or rivers. When temporary water management is needed beyond low flow conditions appropriate engineering would be needed to withstand the greater forces, pressures and flows.

- Typically applied along one side or the other of creeks or rivers. May need to consider full isolation when work is necessary within or across a stream channel.



LEGEND

1. Fish recovery is required.
2. Isolation barrier. See section 18.5.1
3. Dewatering pump with fish screening. See section 18.5.3.
4. Dewatered work area
5. Energy dissipator. See section 18.5.4
6. Temporary sediment control facility. See section 18.5.5

Pump

Figure 18-1 Partial Isolation

18.4.3 Full Isolation

Photo example of Full Isolation

Full isolation is typically implemented when work will occur from bank to bank of a stream. The example provided uses barriers that are placed upstream and downstream of the work area and span the width of the active channel. The barriers keep streamflow out of the work area while a temporary bypass system is used to reroute streamflow through or around the work area.

Full isolation is intended to isolate an area to work in dry conditions and is typically implemented during projected low-flow conditions. The process and main features of this approach are:

- Removing fish from the work area to be isolated:[2]
- **Installation of the isolation barrier:[2]** A barrier is needed between the work area and active stream channel upstream to block the natural flow and downstream of the work area to block backwater conditions. The application goal is for the barrier to keep water out of the work area and to withstand pressures and forces exerted by the retained streamflow.
- **Routing streamflow through a pipe, pump, or combination of these features:** A stream flow conveyance feature or features needs to be installed and available for the duration of construction to convey flows around or through the work area and release flow back into the waterway. The two most common conveyance options are gravity (e.g., a temporary pipe) or pump bypass. The installation of the conveyance features and barrier should be coordinated at the same time.

[2] Refer to Section 18.4.1 Common Isolation Option Elements for full descriptions of the elements that are common between the three listed isolation options.

- **Dewatering the isolated work area:**[2] Note that the purpose of the gravity bypass pipe is used for streamflow rerouting and not for dewatering. Water pumped from the work area must be transported to a temporary sediment control facility for treatment before it is returned to the stream channel.

- Sediment control:[2]

- Removal of the isolation barrier and re-watering the work area:[2]

Each of these features has specific limitations and requirements that need to be considered when developing a full isolation plan. Additional information to guide the concept design of each of these features is detailed throughout the remaining sections of the chapter. Figures 2 through 4 illustrate general configurations of a work area implementing the full isolation option along a stream channel.

Full isolation should be considered and applied when:

- work will be performed within creeks, rivers or lakes,
- work will be performed during the in-water work period,
- upstream and downstream fish passage is not required,
- water is present and work requires dry conditions, and
- channel bottom and/or bank to bank access is needed to perform work

Activities that could require full isolation include but are not limited to:

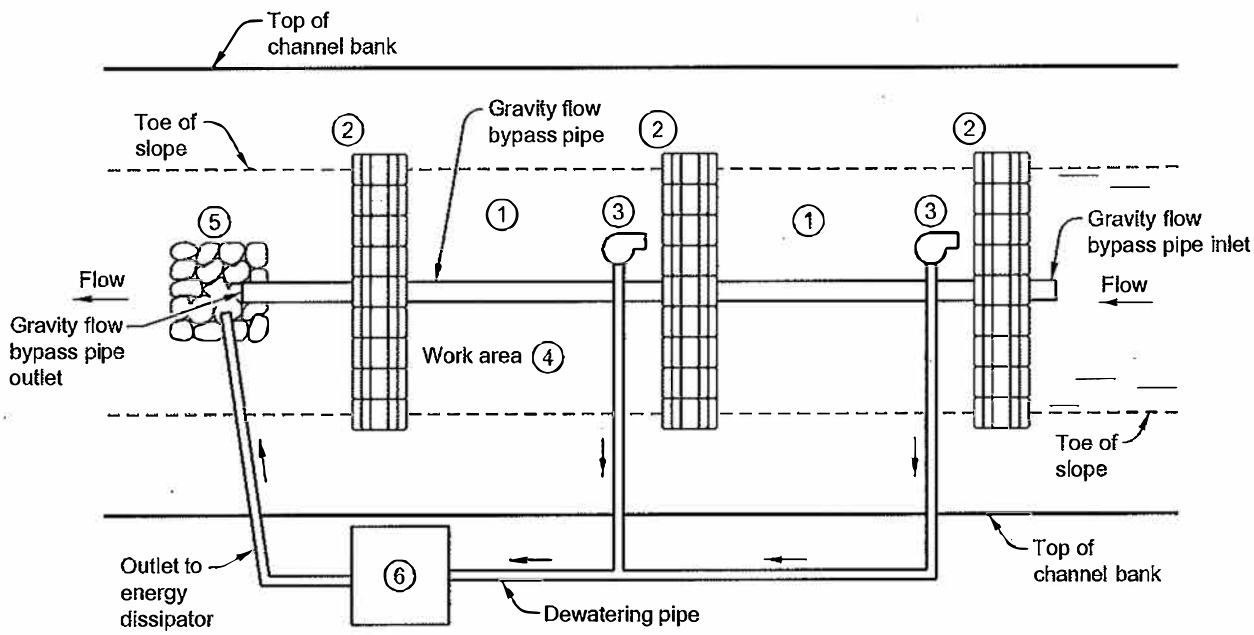
- bridge abutment maintenance and construction
- pier maintenance and construction (e.g., spread footings, bents)
- embankment protection
- streambed repair or restoration
- streambank restoration
- bridge demolition
- installation of temporary work platforms

Full Isolation limitations:

- Typically applied during low flow conditions within creeks or rivers. When temporary water management is needed beyond low flow conditions appropriate engineering would be needed to withstand the greater forces, pressures and flows.

- Fish passage (downstream and/or upstream) in a gravity system may not be possible due to depth/velocity requirements. Designers may want to consider partial isolation when fish passage is necessary.

- Fish passage is not possible when pumps are used for re-routing stream flows.



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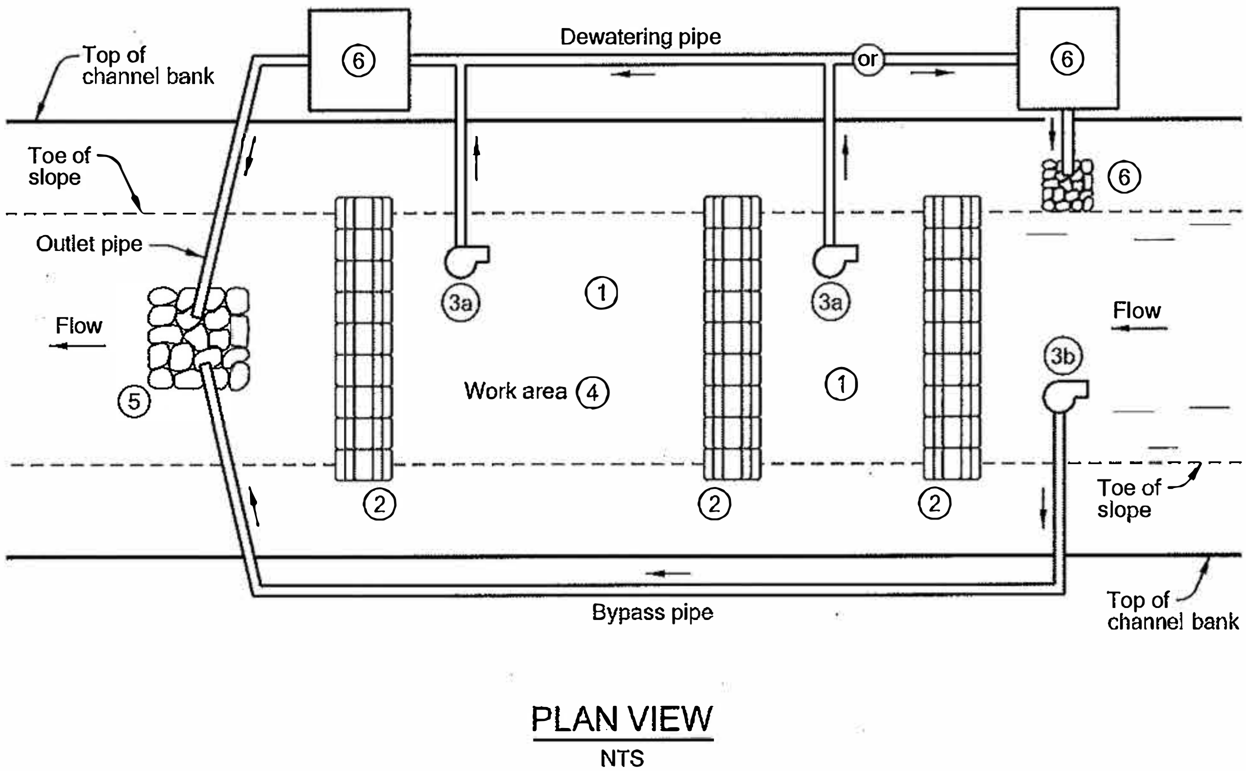
LEGEND

1. Fish recovery is required.
2. Isolation barrier. See section 18.5.1
3. Dewatering pump with fish screening. See section 18.5.3
4. Dewatered work area
5. Energy dissipator. See section 18.5.4
6. Temporary sediment control facility. See section 18.5.5

Pump

Figure 18-2 Full Isolation — Piped Gravity Bypass

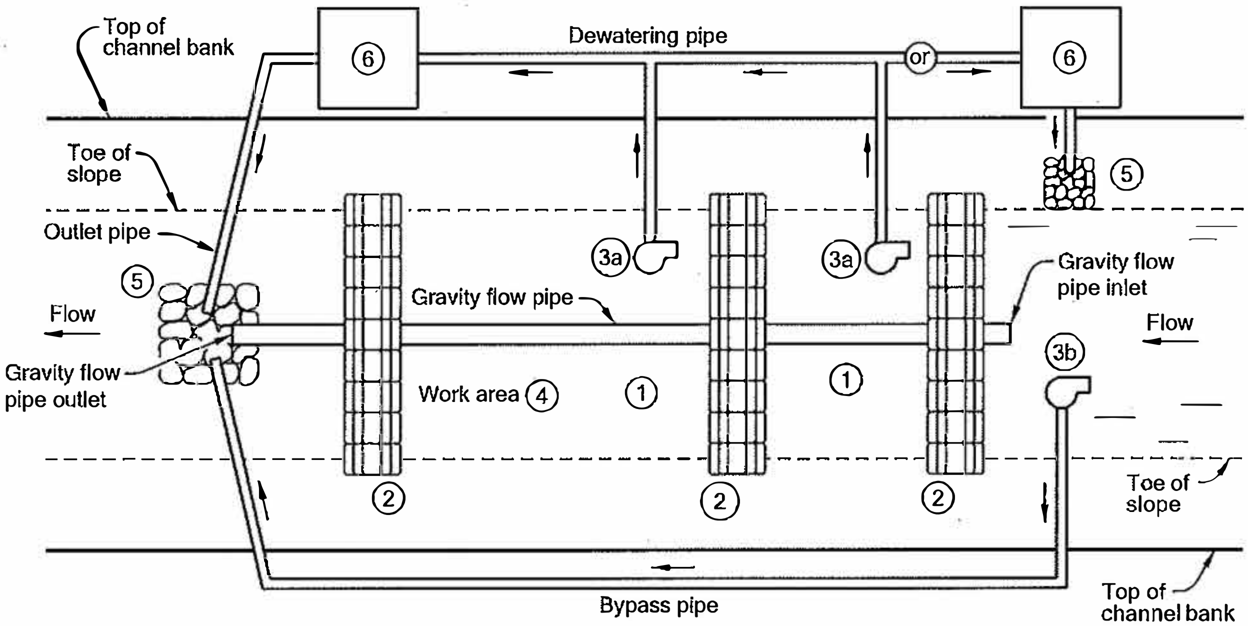


LEGEND

1. Fish recovery is required.
2. Isolation barrier. See section 18.5.1
3. Dewatering pump with fish screening. See section 18.5.3
4. Dewatered work area
5. Energy dissipator. See section 18.5.4
6. Temporary sediment control facility. See section 18.5.5

Pump

Figure 18-3 Full Isolation — Pump Bypass



PLAN VIEW

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LEGEND

1. Fish recovery is required.
2. Isolation barrier. See section 18.5.1

3a. Dewatering pump with fish screening.
See section 18.5.3

3b. Bypass pump with fish screening.
See section 18.5.3

4. Dewatered work area
5. Energy dissipator. See section 18.5.4
6. Temporary sediment control facility. See section 18.5.5

Pump

Figure 18-4 Full Isolation — Combined Pump/Gravity Bypass

18.4.4 Working in the Wet

Photo example of Working in the Wet

Working in the wet allows for the completion of certain construction activities while water is present in the work area. It uses a barrier that is placed between the work area and the remaining portion of the active channel.

Working in the wet option is used when equipment does not need to enter the channel and sediment can be managed within the identified work area. The benefits of working in the wet include lower costs and decreased disturbances to aquatic resources.

The process and main features of this approach are:

- **Removing fish from the work area:**[3] Nets are placed outside of the intended work area to exclude fish from the isolation work area and trap fish for removal. After nets are installed, the work area is surveyed for fish, and detected fish are recovered and released back into the main water body. The fish removal process is mandatory.

- **Installing a barrier to isolate work area:**[3] A barrier is needed between the work area and active channel or surrounding water body. The application goal is for the barrier to contain turbid water and prevent it from spreading into the waterway. Silt fences and silt curtains are a few common products that could be used to form a working in the wet isolation barrier.

[3] Refer to Section 18.4.1 Common Isolation Option Elements for full descriptions of the elements that are common between the three listed isolation options.

- **Sediment Control:**[3] The most common approach to deal with sediment during wet isolation is to allow sufficient time for sediment to settle before removing the barrier. The barrier should remain in place until significant settlement has occurred throughout the isolated area.

- **Activate the work area:** The isolation barrier needs to be removed after all work is completed. Barrier removal should be done slowly to prevent re-suspension of sediment and reduce turbidity.

Each of these features has specific limitations and requirements that need to be considered when developing a working in the wet plan. Additional information to guide the design of each of these features is detailed throughout the remaining sections of the chapter. Figure 5 is a general configuration of working in the wet isolation area.

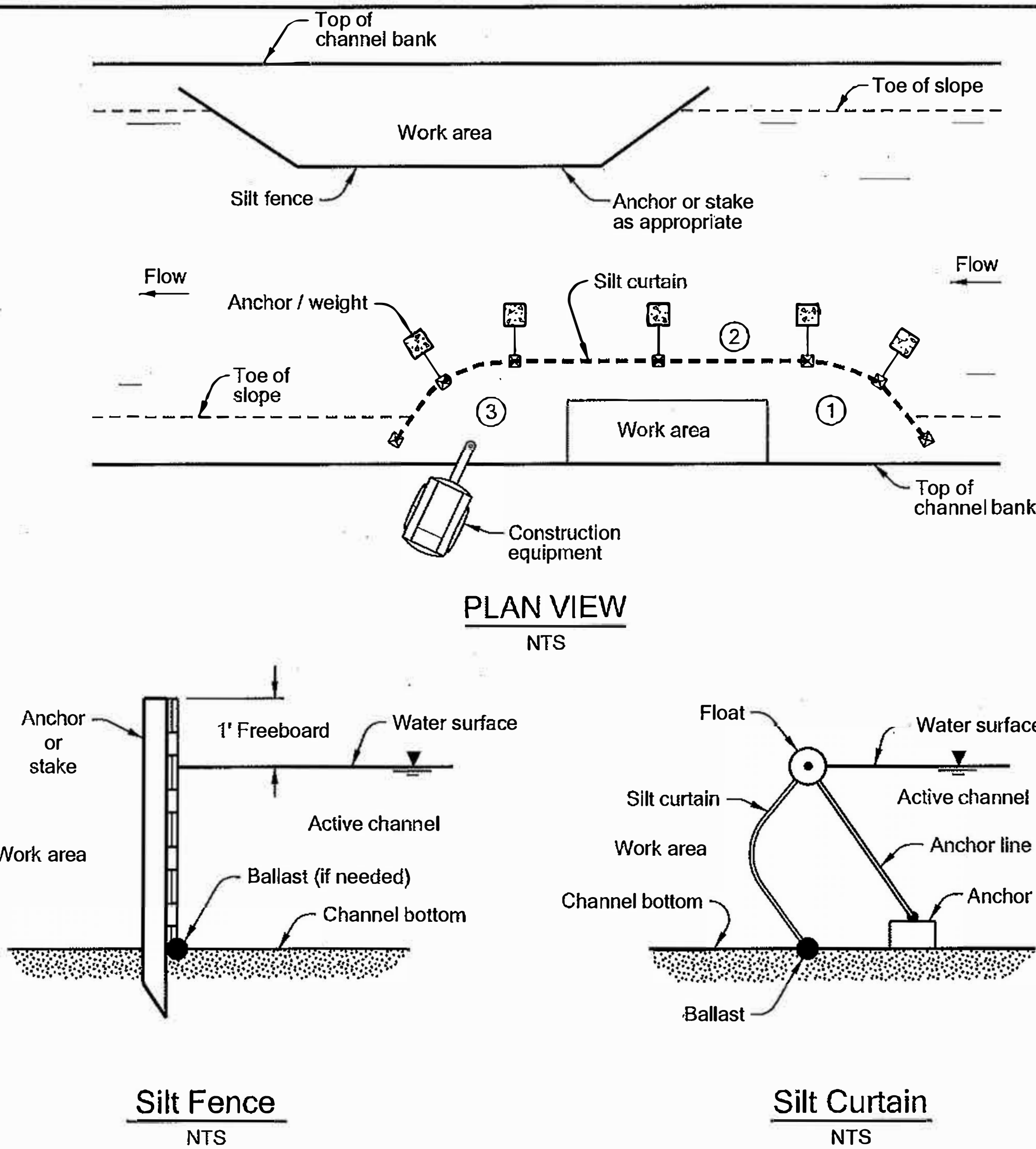
Working in the wet should be considered and applied when:

- work will be performed during a short time frame
- low to moderate water depth is anticipated
- water is present and work does not require dry conditions
- construction equipment does not need to be placed within the channel
- Impacts to fish and habitat would be greater by installing isolation
- streambanks that are not susceptible to erosion or failure and would allow equipment to work along the top of bank

Activities that could require working in the wet include but are not limited to:

- streambed restoration
- streambank stabilization or restoration
- placement of canisters (drilled shafts)
- pile driving

[3] Refer to Section 18.4.1 Common Isolation Option Elements for full descriptions of the elements that are common between the three listed isolation options.



LEGEND

1. Fish recovery is required.
2. Isolation sediment barrier. See section 18.5.1.4 for design guidance.

Figure 18-5 Working in the Wet

Working in the wet limitations:

- Sediment control may not be possible without violation of water quality standards, such as elevated turbidity. May want to consider partial isolation when turbidity conditions cannot be maintained below the standard.

- Equipment cannot be placed in the stream channel or waterway.

- Typically applied during low flow and low velocity conditions within creeks, rivers, and lakes.

18.5 Temporary Water Management Components

Temporary Water Management (TWM) components are discussed in this section. TWM components are used to establish an isolation barrier between the active channel/waterway and work area, convey stream flows through or around the work area, and control erosion and sediment produced from construction activities.

Partial Isolation consists of the following components:

- Isolation barrier
- Dewatering pump
- Energy dissipator
- Sediment control feature

Full Isolation consists of the following components:

- Isolation barriers
- Bypass pipes and/or pumps
- Dewatering pump
- Energy dissipator
- Sediment control feature

Working-in-the-Wet consists of the following components:

- Isolation/Sediment barrier

Table 18.5-1 provides a selection process for TWM components based on the various site conditions that may be present.

Table 18.5-1 TWM Components Selection Table

Temporary Water Management – Component Type Matrix	Temporary Water Management Site Conditions: Flow Conditions		Soil Type and Conditions				Surface Slope/Grade				Depth of Flows				Site Accessibility		
TWM Component Type	Low flow s < 0.5 cfs	Moderate flow s < 6.0 cfs	Soft silts, muds or loose sands *	Stiff clays or Dense sands and gravels	Large gravels or cobbles	Cobbles or boulders	Flat or slopes <3%	3% to 8%	8% to 15%	Slopes > 15%	0 to 2 feet	2 to 4 feet	4 to 6 feet	6 to < 20 feet	No access for equipment	Limited access for equipment	Easy access for equipment
Sandbags	■	■	○	■	■	■	■	■	■	○	■	■	-	-	■	■	■
Precast Concrete Barriers	■	■	-	■	○	○	■	○	-	-	■	■	○	-	-	○	■
Water Filled Membrane	■	-	○	○	○	-	■	○	-	-	■	■	○	-	○	○	■
Silt Curtain and Fences	■	-	■	○	-	-	■	○	○	○	■	■	○	○	■	■	■
Proprietary Structures	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***

■ *= Component is recommended for use under site condition*

○ *= Component may have limitations under site condition*

\- *= Component not recommended for use under site condition*

* *= soft or loose soils are defined as easily penetrated (>12”) by ½” rebar pushed by hand. Consult with project Geotechnical Engineer if soft soils are encountered.*

*** *=Proprietary components shall be designed and installed as recommended by the manufacturer*

18.5.1 Isolation Barriers

An isolation barrier is needed and used when construction work is to be performed within a waterbody. The primary use of isolation barriers is to:

- isolate the worksite from the adjacent waterbody
- keep water out of the isolated area
- mark isolation limits
- contain sediment laden water
- keep fish out of the isolated area

There are several products available for barrier isolation. A few of the barrier types that will be briefly discussed in the following sub-sections include:

- Sandbags
- Precast concrete barriers
- Water-filled impervious membranes
- Silt curtains and fences

Refer to the various manufacturers for more detailed information on the products discussed to assist with proposing the most appropriate barrier(s) for a given application and anticipated site constraints.

18.5.1.1 Sandbags

A barrier constructed of sandbags has been historically used as a means of holding back floodwaters and successfully used to prevent overtopping of levees. This type of barrier relies on its self-weight to resist overturning and sliding.

Sandbags are rectangular, durable, weather resistant, tightly woven bags sufficient to prevent leakage of filler material. They are commonly filled with dry sand or fine gravel.

A sandbag barrier is constructed by stacking them atop one another, in an alternating brick-like fashion, and topped with a plastic sheeting to form a water tight seal. See Figure 6.

Advantages:

- Can accommodate long lengths of barrier protection
- Simple to design
- Easy to construct
- Materials are inexpensive and readily available
- Can be installed at various heights
- Flexible enough to accommodate terrain slope changes
- Reusable
- Damage can be repaired during use
- Can be utilized with other barrier types to add additional resistance to movement or used to help form a water tight seal

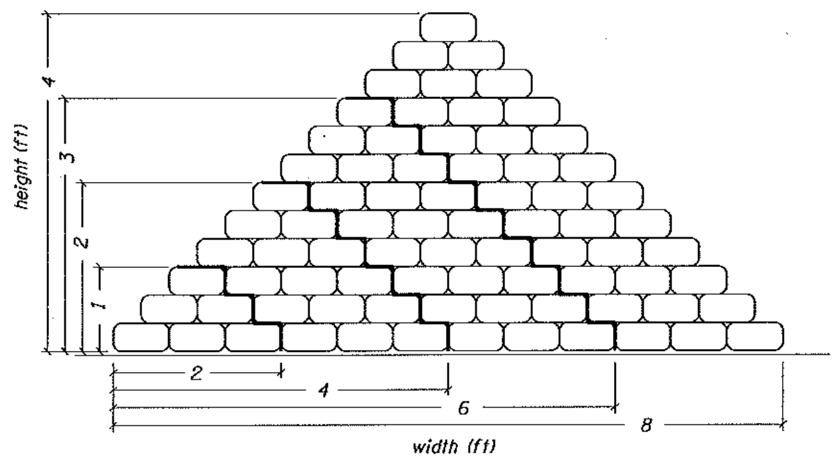
Disadvantages:

- Manual labor needed to install and remove
- Footprint increases with barrier height
- May not seal completely if placed on larger gravels and cobbles

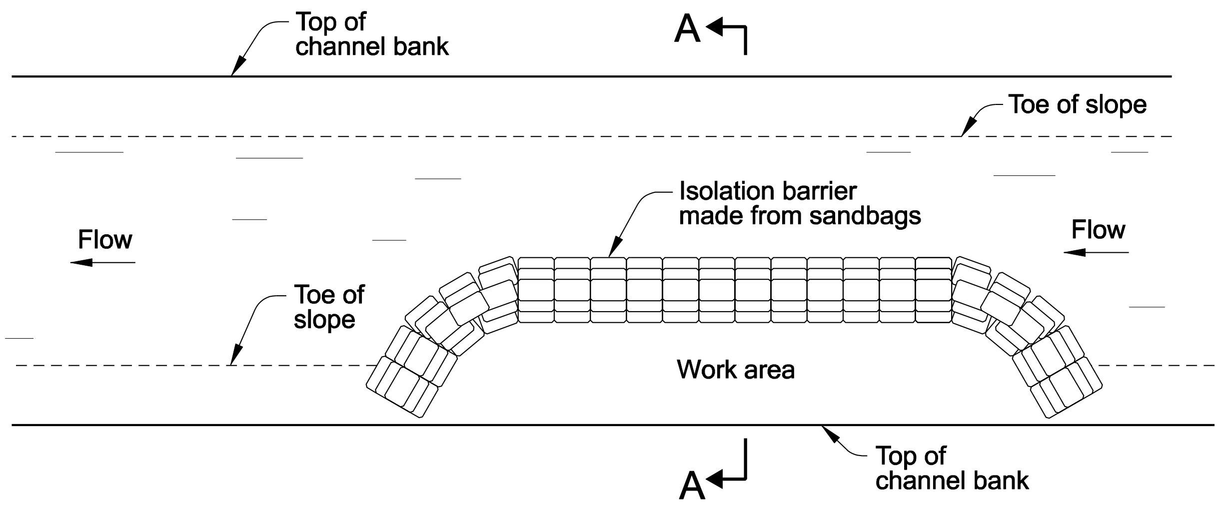
Implement into the concept plan utilizing a few common guidelines:

- A height to width ratio of 1:2 (e.g., a 1 foot high wall would have a base width of 2 feet). This is the minimum width-to-height ratio that should be used to construct a sandbag barrier. See footprint detail below.
- Sand bag weight can vary. The sandbag dimension noted below is for a 30 pound bag of dry sand. These are the ideal size and weight of a bag because they are easier to transport around the job site and easier to mold and form into place.
- A plastic sheeting cover will improve water tightness. Do not utilize plastic sheeting underneath the bags since that will increase the potential for the barrier to slide.
- Likely stability failures: sliding, excessive seepage under barrier, and collapse.
- Sand bag dimensions can vary. The estimated number of bags needed for a 1:2 ratio is noted in the following table. This is based on each bag having placed dimensions of about 4 to 5 inches high by 9 to 10 inches wide by 14 inches long.

Height of sand bag barrier (feet)	Approximate number of bags used per 100 lineal feet of barrier
1	600
2	1700
3	3000
4	5500



Sandbag footprint detail



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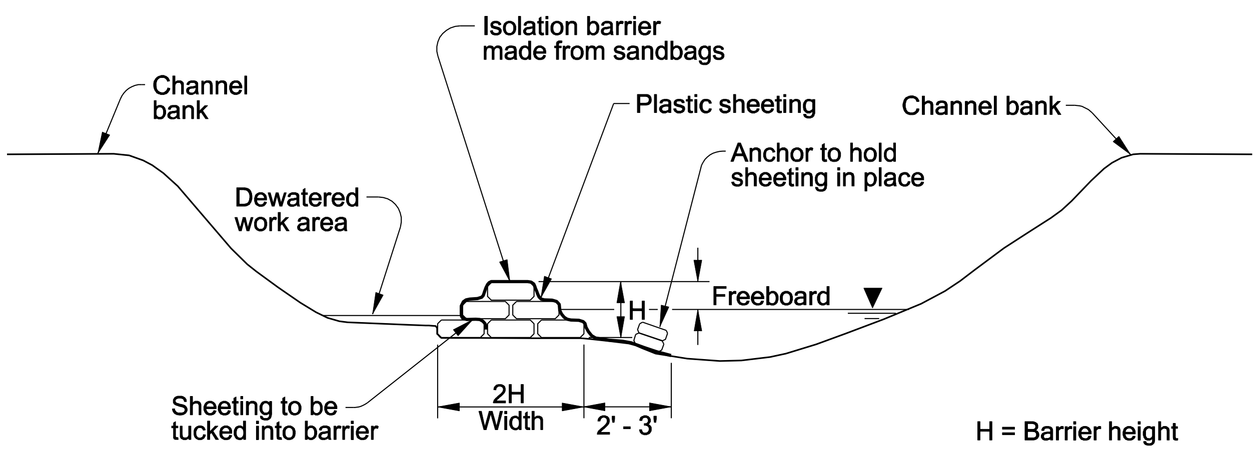

Section A-A

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Figure 18-6 Sandbag Barriers

Photo example of Concrete Barriers with Sandbags

18.5.1.2 Precast Concrete Barriers

A work isolation barrier could be created using pre-cast concrete traffic barriers or eco-blocks. These barriers are gravity structures depending on their weight for stability. Common TWM application is to position concrete barriers end-to-end and topped with plastic sheeting to form a water tight seal. See Figure 7.

Advantages:

- High resistance to lateral forces and pressures from high water velocities
- Form an immediate wall because of their inherent height
- Durable
- Reusable
- Barrier height can be increased by stacking

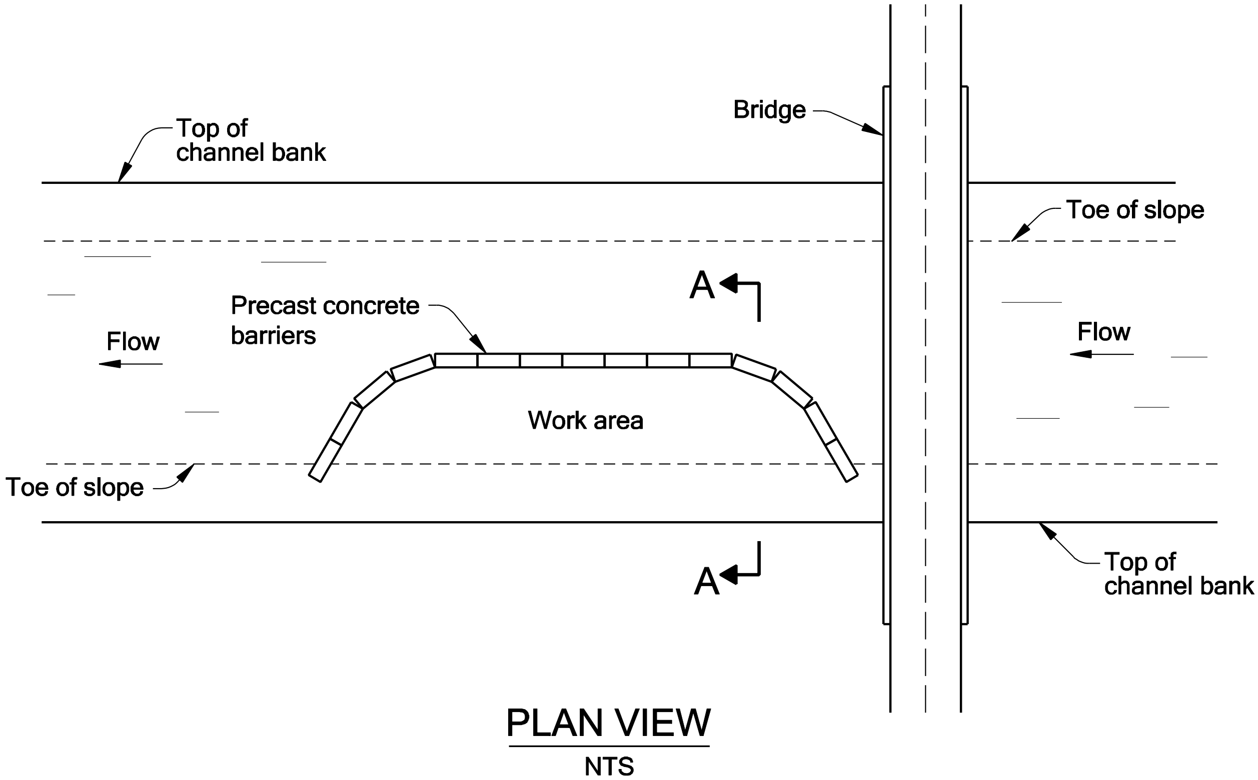
Disadvantages:

- Requires construction equipment capable of heavy lifting
- Need a lot of storage area during construction staging
- High seepage under barrier is likely
- High bearing pressures on soil

Implement into the concept plan utilizing a few common guidelines:

- Standard concrete traffic barriers are available in heights of 32 or 42-inches:
    - 32-inch high barrier:
        - single section is 12.5 ft. long and 2 ft. wide at the base
        - weighs 5,710 lbs.
        - See Standard Drawing RD500
    - 42-inch high barrier:
        - single section is 12.5 ft. long and 2’-2” wide at the base
        - weighs 7,970 lbs.
        - See Standard Drawing RD545
- Recommended use along mild slope channels
- Adequate site accessibility is needed for heavy equipment to install and remove concrete barrier
- A plastic sheeting cover will help form a water tight seal
- Likely stability failures: sliding, excessive seepage, bearing capacity, and possible overturning

Photo example of Partial Isolation with Concrete Barriers



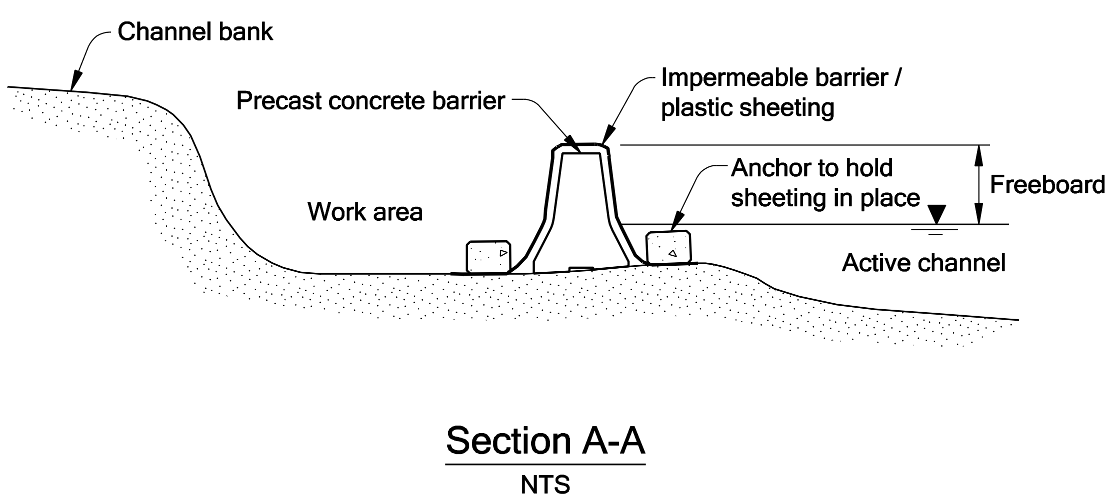


Figure 18-7 Precast Concrete Barriers

18.5.1.3 Water-filled Impervious Membrane

Geo-membrane tubes are available that can be filled with water to form a dam. See Figure 8. These water filled tubes are gravity dams using the weight of water to provide stability.

Advantages:

- Can accommodate long lengths of barrier protection
- Low bearing pressure on the bedding surface
- Quick and easy to install
- Tears can usually be repaired while in use
- Flexible enough to accommodate minor terrain slope changes
- Reusable

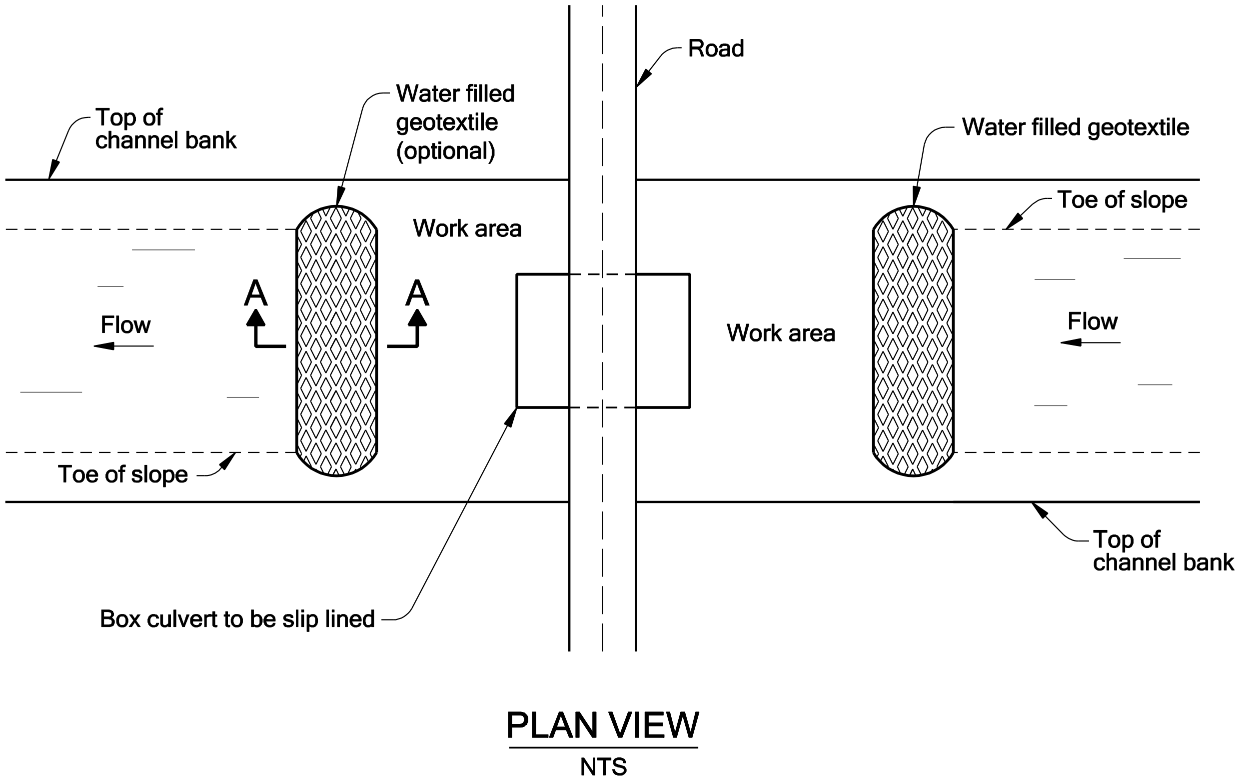
Disadvantages:

- Limited to relatively flat terrain
- Susceptible to tears that could lead to barrier failure
- High seepage under barrier is likely if used along gravel or cobble channel bottoms
- Low resistance to sliding in most water current conditions

Implement into the concept plan utilizing a few common guidelines:

- Appropriate along level sections of ground
- Appropriate for sandy channel bottoms
- Can be ordered in custom sizes up to 72 inches in height
- Likely stability failure: sliding

Photo example of Water Filled Impervious Membrane



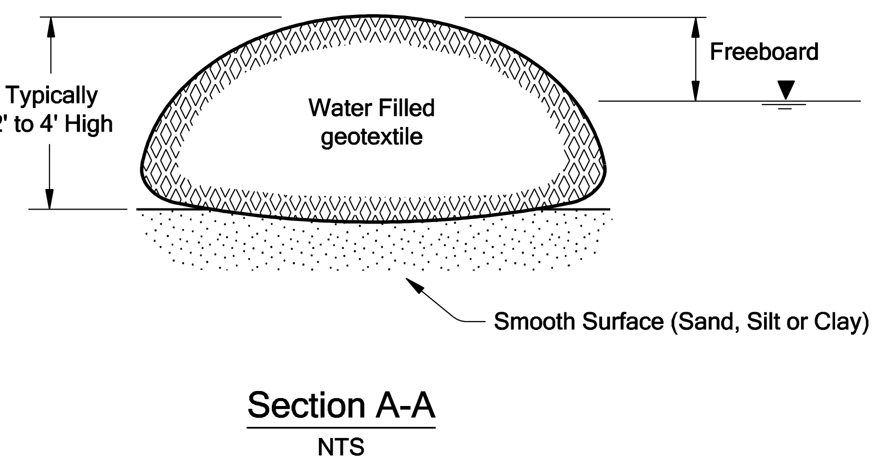


Figure 18-8 Water-filled Impervious Barriers

18.5.1.4 Silt Curtains and Fences

Silt curtains and fences are used for working in wet applications. A curtain or fence is installed around the work area to contain the sediment laden water. The curtain or fence barrier allows suspended soil particles to settle out of suspension and stay in the immediate area.

Silt curtains are suspended between the water surface with a float on top and ballast in the bottom. See Figure 9.

Photo example of Silt Curtain

Advantages:

- Can accommodate varying lengths of barrier protection
- Flexible barrier that can be installed around a work area

Disadvantages:

- Limited to calm water conditions
- Susceptible to tears that could lead to barrier failure

Implement into the concept plan utilizing a few common guidelines:

- Limit installation configuration to a semicircle or U-shaped (Figure 9)
- Spanning a curtain from bank to bank is not recommended unless negligible flow
- Limit use to velocity conditions less than 0.5 ft/sec

- Water depth limits: greater than 2.5 feet but less than 20 feet
- Wave height limits: less than 0.5 feet
- Likely stability failure: sliding

Silt Fences are staked in place and the barrier fabric is anchored to the stakes with staples or nails. The bottom of the barrier fabric is ballasted to create a seal against the stream bottom. See Figure 9.

Advantages:

- Can accommodate varying lengths of barrier protection
- Flexible barrier that can be installed around a work area

Disadvantages:

- Limited to calm water conditions
- Challenging to install when water is present
- Susceptible to tears that could lead to barrier failure

Implement into the concept plan utilizing a few common guidelines:

- Limited to shallow depth conditions and low water current/velocity
- Spanning a silt fence from bank to bank is not recommended unless negligible flow
- Limit use to velocity conditions less than 0.5 ft/sec
- Water depth limits: 4 feet or less
- Wave height limits: less than 0.5 feet
- Likely stability failure: overturning, sliding

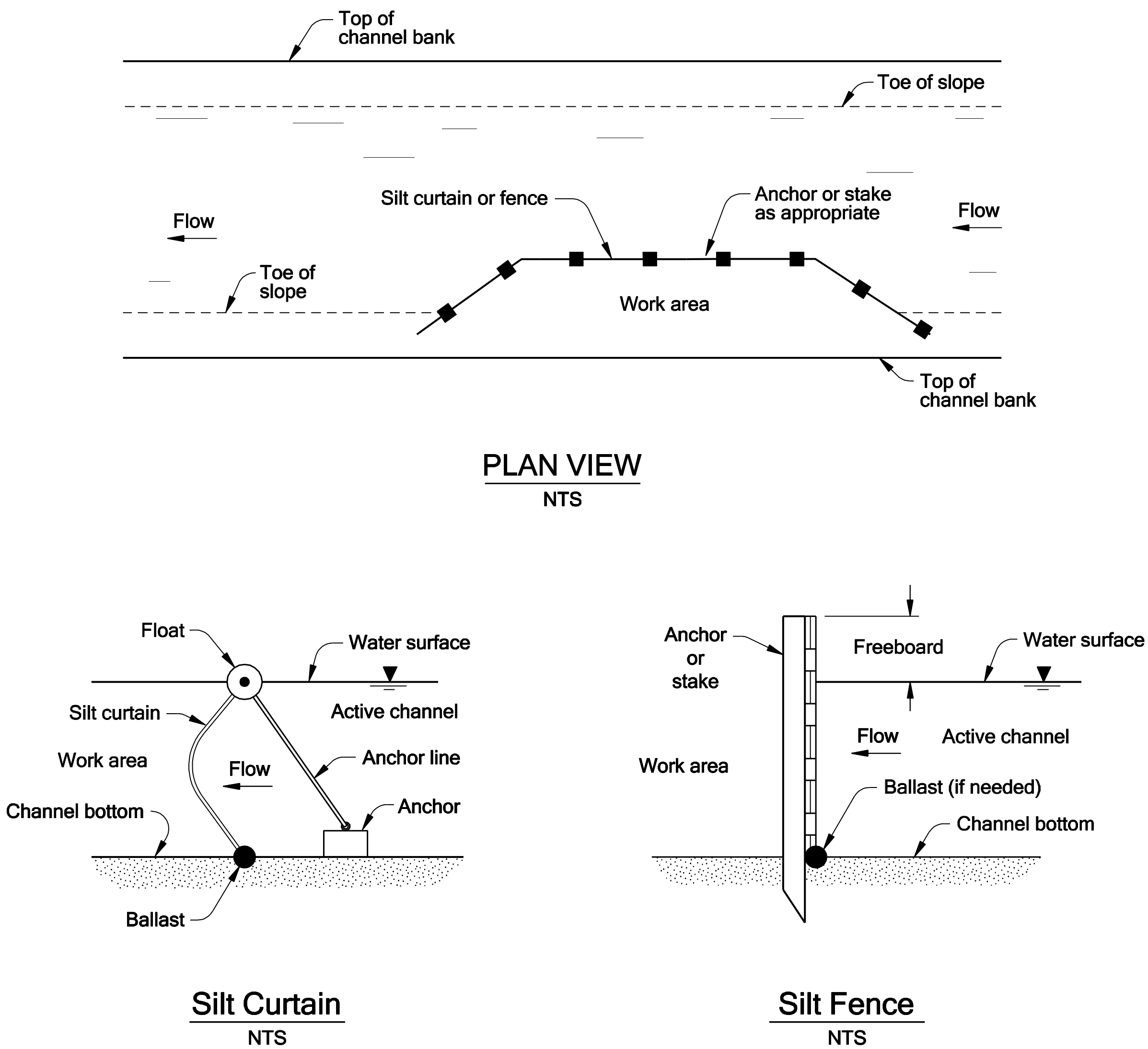


Figure 18-9 Silt Curtain and Fence Barriers

18.5.1.5 Sheet Piles

Sheet piles can be used by driving it into the ground to form an enclosed area (also known as a cofferdam) around the excavation site. Sheet piles are a manufactured construction product with a mechanical connection "interlock" at both sides of the section. These mechanical connections interlock with one another to form a continuous wall of sheeting. Sheet pile applications are typically designed to create a rigid barrier for earth and water, while resisting the lateral pressures of those bending forces. The shape or geometry of a sheet pile section lends to the structural strength. Also, the soil in which the section is driven has numerous mechanical properties that can affect the performance.

In some cases an underwater concrete seal may be needed along the channel bottom within the cofferdam to seal off water and resist its pressure, and also to act as a slab to brace against the inward movement of the sheet piles in order to mobilize their resistance to uplift under the hydrostatic pressure. Figure 10 illustrates sheet pile cofferdams to isolate the center pier of a bridge.

Advantages:

- Sheet piles are easily installed and removed
- Materials can typically be reused

Disadvantages:

- Requires special equipment (impact or vibratory hammer) and access for installation and removal

TWM concept plans do not apply to coffer dam installations. The Contractor's Engineer will need to submit plans, calculations, and working drawings that must comply with ODOT's Bridge Design and Drafting Manual. The most current Bridge Design and Drafting Manual can be viewed at the following website:

http://www.oregon.gov/ODOT/HWY/BRIDGE/Pages/standards_manuals.aspx

Also keep in mind:

- An ODFW Fish passage plan (application) may be needed for this type of work. The project environmental coordinator or biologist will be requesting design drawings and assistance with stream crossing information. A link to view the fish passage plan application is provided below:

  http://www.dfw.state.or.us/fish/passage/

- The design may need to meet ODFW's requirement of at least one clear span of 35 feet within the channel for channels wider than 35 feet.

Cofferdam designs must comply with Standard Specification 00510 and the checklist outlined in Special Provision SP510. Special Provision SP510 can be viewed and downloaded at the following website:

http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008_special_provisions.aspx#Part_00500

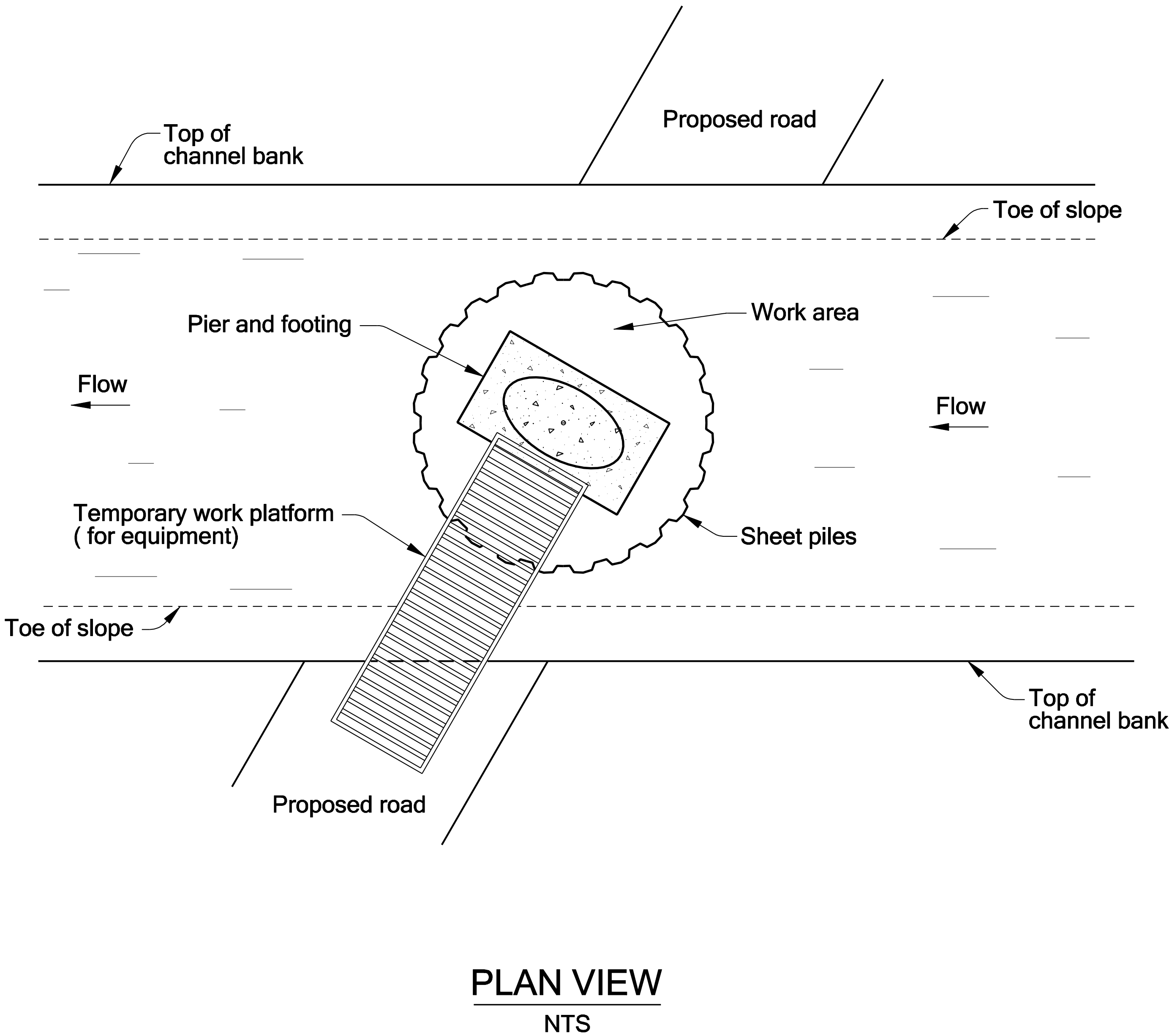


Figure 18-10 Sheet Pile Barriers

18.5.2 Soil Stability Analysis

The site soil conditions should be considered for the varying TWM component options. Soil conditions may be a controlling factor in the determination of which type of components may be suitable for the site. There may be numerous forces that a barrier would have to withstand when installed to separate a work area from an active stream or creek channel. Hydrodynamic forces are exerted during times when streamflow is present around the barrier. Among the forces are positive frontal pressure forces against the barrier and/or drag effect along the sides. Hydrostatic forces can induce horizontal forces against a barrier, especially when water levels on different sides of the barrier are not equal. It can even cause vertical buoyant forces or flotation. Therefore, proper stability analysis and barrier design must be sought for forces related to sliding, overturning, and settlement.

TWM facilities are usually short term structures and may need very minimal design evaluation to provide adequate and safe isolation of the work area. Sound engineering judgment should be used when determining the level of evaluation needed for the individual site conditions.

The project Geotechnical Engineer should be consulted for the soil stability analysis with hydraulic input parameters provided by the hydraulic designer. The hydraulic parameters that will need to be provided are as follows:

- Maximum water pressure acting on the base of the structure
- Horizontal force of water acting on the structure
- Vertical uplift force of retained water acting on the structure
- Total nominal effective force on the base of the structure

Factor of safety against sliding

Sliding or the movement of TWM barriers is due to moving water exerting pressure forces greater than inherent resistive forces.

The factor of safety against sliding is calculated using basic fluid mechanics pressure-related equations:

Maximum water pressure, acting at the structure's base is calculated using the following equation:

$$p_w = H_w \gamma_w \qquad \text{(Equation 1)}$$

Where:

P_w = maximum water pressure at the base of the structure
H_w = height of the retained water
γ_w = unit weight of the water

Horizontal force of the water acting on the structure is calculated using the following equation:

$$F_w^h = \frac{1}{2} p_w H_w = \frac{1}{2} \gamma_w H_w^2 \qquad \text{(Equation 2)}$$

Where:

F_w^h = horizontal force on the structure due to the pressure of retained water
H_w = height of the retained water
γ_w = unit weight of the water

Vertical uplift force of retained water acting on the structure is calculated using the following equation:

$$F_w^v = \frac{1}{2} p_w \frac{B}{B+L} B = \frac{1}{2} \gamma_w H_w \frac{B^2}{B+L} \qquad \text{(Equation 3)}$$

Where:

F_w^v = vertical uplift force on the structure due to the pressure of retained water
H_w = height of the retained water
γ_w = unit weight of the water
B = base width of retaining structure
L = length of the impermeable blanket

Total normal effective force on the structure’s base is calculated using the following equation:

$$N' = W - F_w^v \qquad \text{(Equation 4)}$$

Where:

N' = vertical effective force on the base of the structure
W = total weight of the structure (may include the vertical water pressure, acting downward, if the wet face of the structure is not vertical)
F_w^v = vertical uplift force on the structure due to the pressure of retained water

Factor of safety against sliding in terms of total forces on the base is calculated using the following equation:

$$F_S = \frac{N' \tan \delta}{T} \qquad \text{(Equation 5)}$$

Where:

F_S = factor of safety against sliding
N' = vertical effective force on the base of the structure
δ = angle of friction of the soil/structure interface. **Coordinate value with project geotechnical designer.**

Substituting N’ and T = F_w^h; (the horizontal force on the structure due to the pressure of retained water). The resultant factor of safety is expressed as:

$$F_S = \frac{(W - F_w^v) \tan \delta}{\frac{1}{2} \gamma_w H_w^2} \qquad \text{(Equation 6)}$$

Where:

- F_S = factor of safety against sliding
- W = total weight of the structure (may include the vertical water pressure, acting downward, if the wet face of the structure is not vertical)
- F_w^{v} = vertical uplift force on the structure due to the pressure of retained water
- δ = angle of friction of the soil/structure interface. Friction angles vary depending on soil type. **Coordinate value with project geotechnical designer.**
- H_w = height of the retained water
- γ_w = unit weight of the water

Factor of safety against overturning

Overturning is an action, due typically to external forces, whereby a structural element rotates from its original position, or further, to the point where it fails or falls over completely.

Factor of safety against overturning obtained by expressing moment of equilibrium with respect to the structure's downstream toe is calculated using the following equation:

$$F_O = \frac{Wr_w}{F_w^h \frac{H_w}{3} + F_w^v \frac{2}{3} B} \qquad \text{(Equation 7)}$$

Where:

- F_O = factor of safety against overturning
- W = total weight of the structure (may include the vertical water pressure, acting downward, if the wet face of the structure is not vertical)
- r_w = moment arm length
- F_w^{v} = vertical uplift force on the structure due to the pressure of retained water
- F_w^{h} = horizontal force on the structure due to the pressure of retained water
- H_w = height of the retained water
- γ_w = unit weight of the water
- B = base width of retaining structure
- L = length of the impermeable blanket

Or, substituting for the moments of F_w^h and F_w^v:

$$F_O = \frac{Wr_w}{\frac{1}{6}\gamma_w H_w^3 + \frac{1}{3}\gamma_w H_w \frac{B^3}{B+L}} \qquad \text{(Equation 8)}$$

Where:

- F_O = factor of safety against overturning
- W = total weight of the structure (may include the vertical water pressure, acting downward, if the wet face of the structure is not vertical)
- r_w = moment arm length
- H_w = height of the retained water
- γ_w = unit weight of the water

B = base width of retaining structure

Settlement

Related to civil engineering and this discussion on TWM, settlement is more associated with soil mechanics, foundation and geotechnical engineering. It is often facilitated by groundwater seepage from outside of, toward and beneath a structural barrier. The upward force of water beneath the barrier, or the transfer of fines and consolidation of soils, resulting from groundwater movement may cause a TWM barrier to settle. TWM barriers are most often small, short term structures in which settlement would not be of much concern for the functionality of the structure nor for the safety of workers within the isolated work area. In situations where taller or multiple layers of barrier components are needed, possible settlement should be analyzed. Foundation settlement is commonly calculated in accordance with AASHTO Article 10.6.2.4 and Chapter 6 and Chapter 8 of the GDM. See the ODOT GDM, Section 15.4.3.6.2.

A soil evaluation and subsoil exploration of the streambed materials should be performed as part of the project geotechnical investigation and gathering of data, and should be reviewed to determine the effect it will have on stability analysis and barrier placement. See the ODOT Geotechnical Design Manual (GDM), Chapters 3 and 15, for information related to performing a geotechnical investigation. Also see GDM Chapter 16, Tables 16.2, 16.3 and Figure 16.2, pertaining to soil types and information about the angle of internal friction. Also, review the ODOT Hydraulic Design Manual (HDM), Chapter 6, Section 6.4.4.10 and Appendix A for further discussion of bed materials.

Design concerns with varying soil types:

- Certain types of bed material could cause the barrier to settle. This could occur when soft clays or silts are present at the site of interest.

- Channels lined with bedrock material tend to have a low coefficient of friction. Barrier anchoring may be needed when the bed material is bedrock.

- Channels lined with large gravel, cobbles and/or boulders tend to have an irregular bed surface. This condition makes it challenging to use a barrier that can prevent or control surface water intrusion into the construction area. Channel bed preparation may be needed to provide a suitable foundation to place the barrier.

18.5.3 Stream Flow Control

There are several functional requirements that have to be satisfied when implementing stream flow control. The first requirement is to utilize a stream flow feature that can be implemented with the type of work proposed while maintaining a dry construction area. For example, a bypass pipe and/or pump are needed when implementing full isolation. The second requirement is that it must be able to convey streamflow through or around the work area for the duration of the project to maintain a continuous flow condition that prevents the downstream channel from drying up causing injury to or killing aquatic life.

ODOT has utilized existing stream channel, pipes, and pumps to route streamflow through or around the work area. The use of any one or a combination of these stream flow features depends on site conditions (topography, debris, and access limitations), channel characteristics (such as width, depth and channel slope), flow velocity conditions, duration of work, and the type of work. Additional discussion in the followings sections is intended to help with implementing the best stream flow control approach according to the anticipated challenges of a project site.

18.5.3.1 Existing Channel

The use of the existing stream channel is the ideal approach to convey water around the work area. It can be used for stream flow conveyance when the work occurs along the bank or work is staged so that an isolation barrier does not span the entire width of the channel. See Photo 1 and 2.

Photo 1

Photo 2

Advantages:

- Can accommodate varying flow and velocity conditions
- Upstream and downstream fish passage is provided for the duration of the project
- Bypass pipe and/or pump is not needed to convey water around the work area

Disadvantages:

- Cannot be implemented when work occurs in the channel from bank to bank (full isolation)

Implement into the concept plan utilizing a few common guidelines:

- Channel conditions along the active channel needs to be able to convey the concentrated flow
- Only implement during non-flood periods

18.5.3.2 Gravity Bypass Pipes

A gravity bypass pipe system is another option to route water through or around a work site. The pipe would begin at the upstream isolation barrier and be placed along the channel bottom. The bypass pipe would extend through the work area and end at a point downstream of the work area.

Photo A

Photo B

Photo C

Photo D

A bypass pipe can be used during stream crossing structure (culverts and bridges) repairs and replacements (see photos A, B and C above), or for channel work downstream of a culvert (see photo D, above).

The bypass configuration approach depends on the construction or repair activities. Here are a few examples for reference:

- *Stream crossing culvert replaced with a new culvert (see photo A above):* **Option 1** is that the new culvert will be placed at the same location and is utilizing a bottomless structure approach. An option to maintain stream flow is to drain water through a bypass pipe. The bypass pipe would be placed along the existing culvert and channel bottom and span the entire length of the work area. The bypass pipe would begin at the upstream barrier and end far enough downstream to maintain a dry work area. **Option 2** is that the new culvert will be placed adjacent to the existing culvert to improve channel alignment. This option would allow for the existing culvert to function as the bypass pipe or a pipe can be placed inside of the existing pipe.
- *Stream crossing culvert replaced with a new bridge example (see photo B above):* In most cases the new bridge will be placed at the same location as the existing culvert. One construction option would be to build the bridge over the existing culvert. The existing culvert would be removed as soon as the bridge can support traffic loading. An option to maintain streamflows through the project site is to drain water through a bypass pipe. The bypass pipe would begin at the upstream barrier and then be routed through the existing culvert structure during construction. The end of the bypass pipe would be located far enough downstream to maintain a dry work area.
- *Channel reconstruction to install a roughened channel (see photo D above):* A roughened channel is a construction option to raise and restore the streambed downstream of a stream crossing structure such as a culvert or bridge when a headcut has proceeded upstream

through the crossing site or a scour hole has evolved influenced by the erosive forces of streamflows exiting the structure. A barrier is placed at the culvert outlet. The bypass pipe would be installed into the barrier to direct stream flows into it and extend through the work area during construction. The end of the bypass pipe would be located far enough downstream to maintain a dry work area. Note this option is primarily used when the existing crossing structure will remain in-place.

Photo examples of piping the stream flow through the existing structure

Advantages:

- Flexible enough to accommodate minimum terrain slope
- Can accommodate short or long conveyance distances between pipe inlet and outlet
- Reusable
- Quick and easy to install

Disadvantages:

- It is typically located along the work area and may need to be relocated to avoid equipment or construction work
- Upstream fish passage is difficult because low water depth and high velocities can occur

Implement into the concept plan utilizing a few common guidelines:

- Site conditions must provide moderate slope installation to generate adequate velocity to move water through bypass pipe

- Discharge point must be able to accommodate an energy dissipator. See section 18.5.3

- An oversized pipe is desirable to accommodate varying streamflows and would allow for sufficient bypass flow to maintain aquatic life downstream

- Upstream fish passage through a bypass pipe may not be possible because of higher velocity conditions due to confining the flow in a pipe

18.5.3.3 Pumps

There are pumps suited for the construction industry. These pumps typically are able to quickly move a high volume of water (performance), have the ability to pass debris without clogging (low downtime), and can withstand harsh work environments (durability). TWM work could utilize these pumps to dewater work areas (i.e., between barriers) or route streamflows around the work area or to a sediment control facility for sediment removal treatment.

Photo examples of pumped bypass

There are generally two types of water pumps in the construction industry. The first type of pump is the centrifugal pump. This type of pump uses a rotating impellor to draw water into the pump and pressurize the discharge flow. Common centrifugal rental pumps include standard, trash, submersible models. The second type of pump is the positive displacement pump. The most common displacement pump is the diaphragm pump. These pumps deliver a fixed amount of flow per cycle through the mechanical contraction and expansion of a flexible diaphragm.

Standard centrifugal pumps

Standard centrifugal pumps provide an economical option for general purpose dewatering. The most common models are in the 2 to 4-inch range with flows up to 500 gallons per minute (gpm) and heads in the range of 90 to 115 feet. These pumps should only be used in clear water applications as they have limited solid handling capability of only 10 percent by volume.

High-pressure centrifugal pumps

High pressure centrifugal pumps are designed for use in applications requiring high-discharge pressures and low flows. These pumps will discharge around 145 gpm and produce heads in excess of 300 feet. These pumps should not be used when water contains any solids or even sandy water. Silt, sand or debris would almost immediately clog the pump. A mesh net would need to be used over the suction strainer if the pump is being used in dirty water.

Trash centrifugal pumps

Trash pumps are a type of self-priming centrifugal or submersible centrifugal pump designed to handle dirty water containing rocks, mud, stone, and other debris while dewatering. A key feature is open or non-clog enclosed impellers designed to pass rocks and other debris. Trash pumps are commonly used to dewater construction sites, mines, and utility pits. The most common pump sizes are in the 2 to 6-inch range producing flows from 200 to 1,600 gpm and total head (pressure) ranges of 25 to 150 feet.

The rule of thumb is that a trash pump will handle spherical solids up to ½ the diameter of the suction inlet. Solids such as sticks, stones, and debris flow through without clogging. Trash pumps can handle up to 25 percent suspended solids by volume.

Diaphragm pumps

Diaphragm pumps use positive displacement rather than centrifugal force to move water through the casing. In other words the pump will deliver a specific amount of flow per stroke, revolution or cycle.

Diaphragm pumps are commonly referred to as mud hogs, mud hens and mud suckers. Their names reflect their popularity for use in applications where shallow depths and slurry water render centrifugal pumps ineffective.

A diaphragm pump provides the lowest rate of discharge and head by comparison of any contractor pump. The most common pumps are the 2 and 3-inch gasoline powered models producing flows in the range of 50 to 85 gpm. They have the ability to handle air without losing their prime and of handling water with a solid content greater than 25 percent by volume.

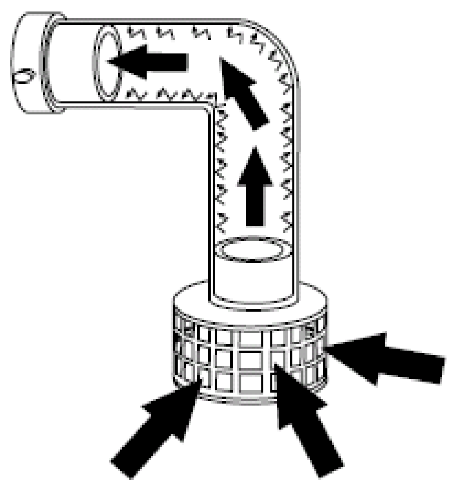
Slow-seepage applications are the most common uses for diaphragm pumps. These conditions exist in any trench or excavation where groundwater seeps slowly into the work site and in areas with high water tables. In these environments centrifugal pumps are unable to perform effectively because their high-discharge volumes combined with low water levels would cause the pumps to quickly lose their prime.

Pump terminology

- Pumps lift water with the aid of atmospheric pressure then pressurize and discharge it from the casing. The practical suction lift (also known as maximum suction lift) is 25 feet (at sea level and for cold water [60°F]).

- Pump performance is measured in volume as ***gallons per minute*** and in pressure as ***head***. In general a trade off occurs between head and flow with an increase in head causing a decrease in flow or vice versa.

- Head refers to gains or losses in pressure caused by gravity and friction as water moves through the system (see figure below). It can be measured in lbs/in^2 (PSI) but is most commonly listed in feet of water.



Friction loss

For example, a 3-inch trash pump is rated with a maximum head of 90 feet. A pump must produce 1 psi to push a column of water vertically 2.31 feet. Therefore dividing the maximum head rating of a pump 2.31 will provide the maximum pressure capacity of the pump:

90 (ft/head) / 2.31 (ft/head) = 38.96 psi

or

Multiplying 2.31 by the maximum pressure capability of the pump will provide the maximum head rating of the pump.

2.31 (ft/head) x 38.96 psi = 90 (ft/head)

Suction lift and head may also be referred to as static or dynamic. Static indicates the measurement does not take into account the friction caused by water moving through the hose or pipes. Dynamic indicates that losses due to friction are factored into the performance. The following terms are usually used when referring to lift or head:

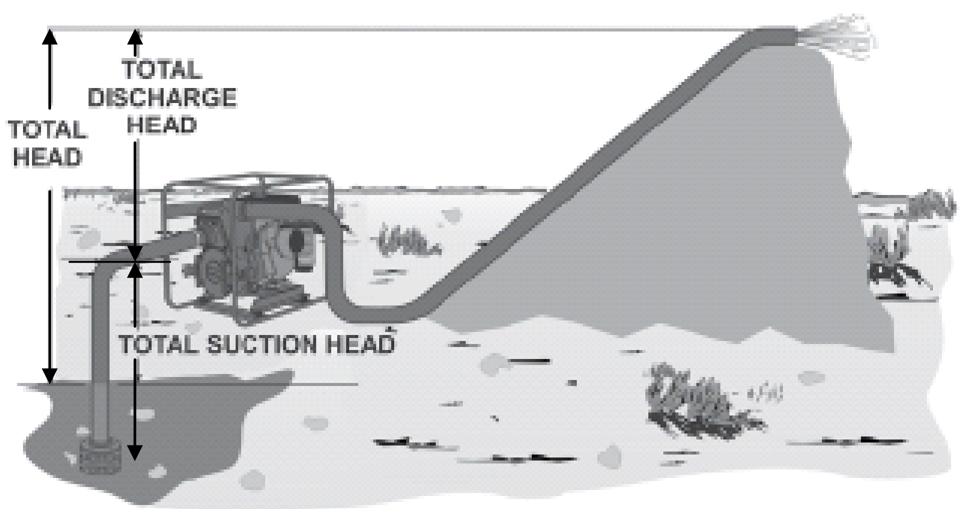
- Static suction lift – the vertical distance from the water line to the centerline of the impeller.

- Static discharge head – the vertical distance from the discharge outlet to the point of discharge or liquid level when discharging into the bottom of a water tank.

- Dynamic suction head – the static suction lift plus the friction in the suction line. Also referred to as total suction head.

- Dynamic discharge head – the static discharge head plus the friction in the discharge line. Also referred to as total discharge head.

- Total dynamic head – the dynamic suction head plus the dynamic discharge head. Also referred to as total head.



Pump implementation guidelines:

- Pump size estimation is based on the design and check discharges determined in design procedure step 3.

- Suction lift is reduced at higher elevations because atmospheric pressure decreases. For example, a pump is capable of a suction lift of 25 feet at sea level compared to 19 feet of suction lift at an altitude of 4,000 feet. Refer to manufacturer's literature for additional information.

- Altitude affects engine performance as well. A rule of thumb is that gasoline and diesel engines will lose 3 percent of their power for every 1,000 feet of elevation. This is due to the lack of oxygen at higher altitudes.

- Fish passage cannot be provided during pumping operations. Pumps should only be considered when gravity flow conditions cannot be provided or as temporary backup to convey stream flow around the work area.

- Fish screen attached to the intake pipe is required during pumping operations. Incorporate when necessary the fish screen detail and notes onto the concept plan as discussed in the drafting standards at the end of this chapter.

- Pump motors with 150 feet of any stream shall be placed within a contained area in the case of a fuel or oil spill.

- The table below details the ideal pump based on water conditions at the work site:

Application	Standard Centrifugal pump	Diaphragm pump	Trash pump
Clear water	X		
Slimy water	X	X	X
Muck water	X	X	X
Mud water	X	X	X
Silt water	X	X	X
Slow seepage water		X	

Water Intake/Fish Screening

When pumps are used in TWM operations, fish screens shall be installed, operated, and maintained for each water intake, including pumps used to isolate in-water-work areas. Fish screening needs to meet NMFS fish screen regulations.

https://www.fisheries.noaa.gov/west-coast/habitat-conservation/west-coast-federal-energy-regulatory-commission-licensed

When pumping water from any body of water, pump intakes shall equipped with fish screens having a minimum open area of 27% and meet the following requirements:

- Perforated plate openings shall be 3/32 inch or smaller.
- Mesh or woven wire screen openings shall be 3/32 inch or smaller in the narrowest direction.
- Profile bar screen or wedge wire openings shall be 1/16 inch or smaller in the narrowest direction.

18.5.4 Energy Dissipators

Energy dissipators are used to reduce the velocity and, consequently, the erosion potential of flowing water. Their most common use is to reduce the outlet flow velocities from conduits that discharge onto embankments, into natural or unlined channels, or into drainage swales. They are typically permanent installations designed to withstand a design flow without experiencing any damage. The design of permanent application of energy dissipators at the outlets of open-channels or closed conduits such as culverts or storm sewers is discussed in Chapter 11.

Energy dissipators used for TWM need to be simple, easy to install, temporary or removable, have a small footprint, reusable, be able to be installed along the channel bank or bottom, and be able to move or relocate. A few types that provide these features are discussed below.

TWM energy dissipators are often used where:

- erosion may occur
- right-of-way is limited
- a low-cost and easily constructed dissipator is needed
- flow from the outlet of the conduit has moderate to low velocity and depth

18.5.4.1 Temporary Pad using Wood Sheeting

An energy dissipator can be formed using plywood with mounted wood weirs. An example of this temporary dissipator placed downstream from a conduit is shown in Figure 10. When this dissipator is used the flow crosses over the mounted wood weirs before it enters the downstream channel. The energy is dissipated as turbulence when the flow from the upstream conduit collides with the wood weirs mounted to the plywood.

Photo example of Wood Sheet Energy Dissipator

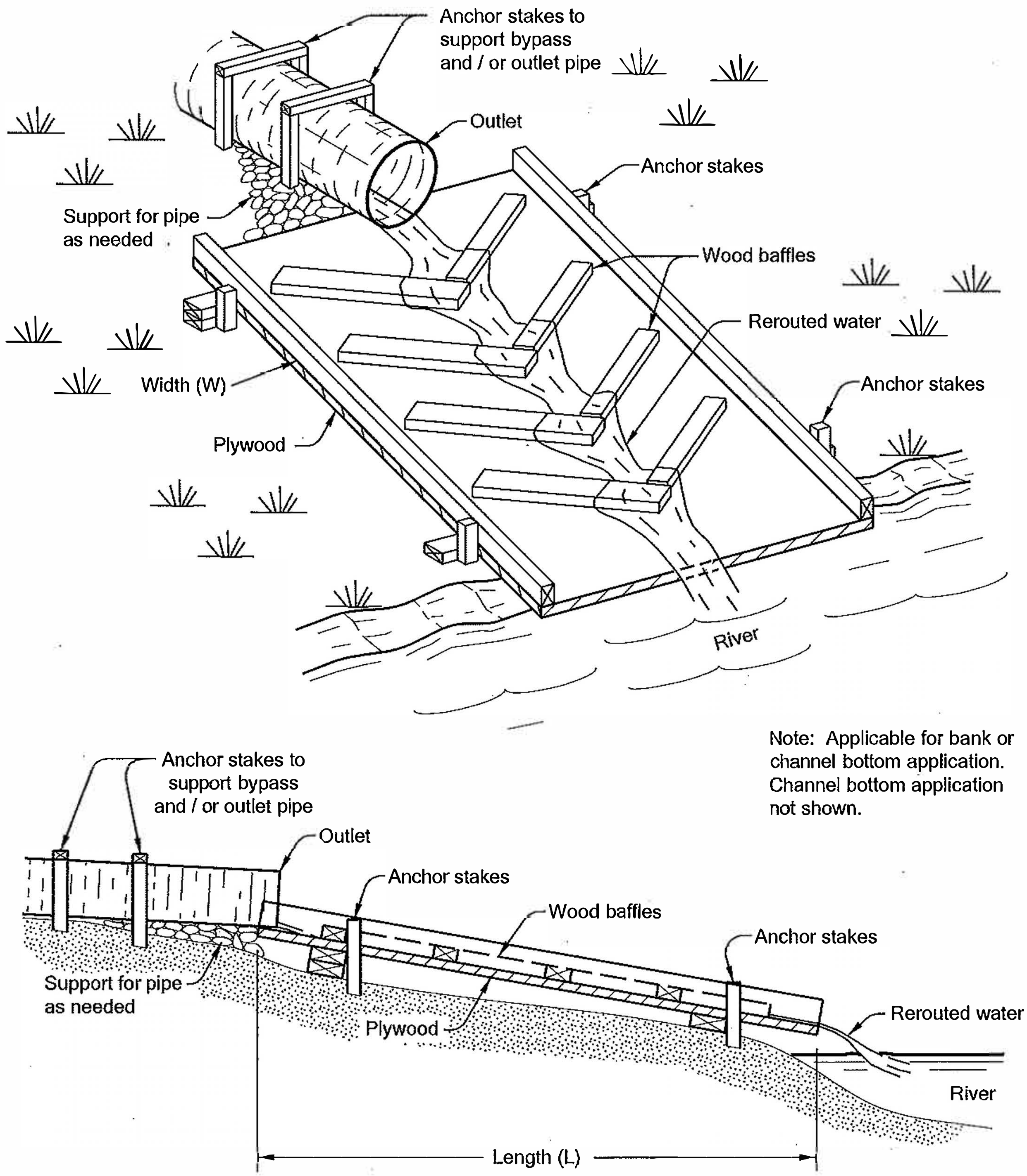


Figure 18-11 Wood Sheet Energy Dissipator

Implement into the concept plan utilizing a few common guidelines:

- Limit the use of this dissipator to bypass or outlet pipes equal to or less than 24-inches in diameter or span.

- Lumber material: must be free of any preservative treatment and coating.

- The minimum surface area needed to accommodate this dissipator:
    - length: 8 feet
    - width: 4 feet

18.5.4.2 Temporary Riprap or Gabion Pads

A riprap pad is the most common permanent type of energy dissipator for smaller conduits or channels. When this dissipator is used the flow crosses over the riprap before it enters the downstream channel. The roughness of the riprap creates turbulence in the flow and energy is dissipated.

A riprap pad to dissipate energy could be used during TWM work. The implementation objective is the riprap pad can be removed at the end of the waterway work. An alternate approach is creating a dissipator pad using a gabion basket filled with riprap. Examples of these temporary concepts are shown in Figures 11, 12 and 13.

Implement into the concept plan utilizing a few common guidelines:

- Riprap and gabion basket: rock must be durable and meet the requirements in the ODOT Standard Specifications for Construction.

- The minimum surface area needed to accommodate this dissipator:
    - length: 4 times the diameter or span of the bypass/outlet pipe
    - width: 2 times the diameter or span of the bypass/outlet pipe

- Riprap size: most temporary applications would utilize Class 50 or 100.

- Pad thickness: 24 inch minimum

Note: Riprap pad design is discussed in Chapter 11

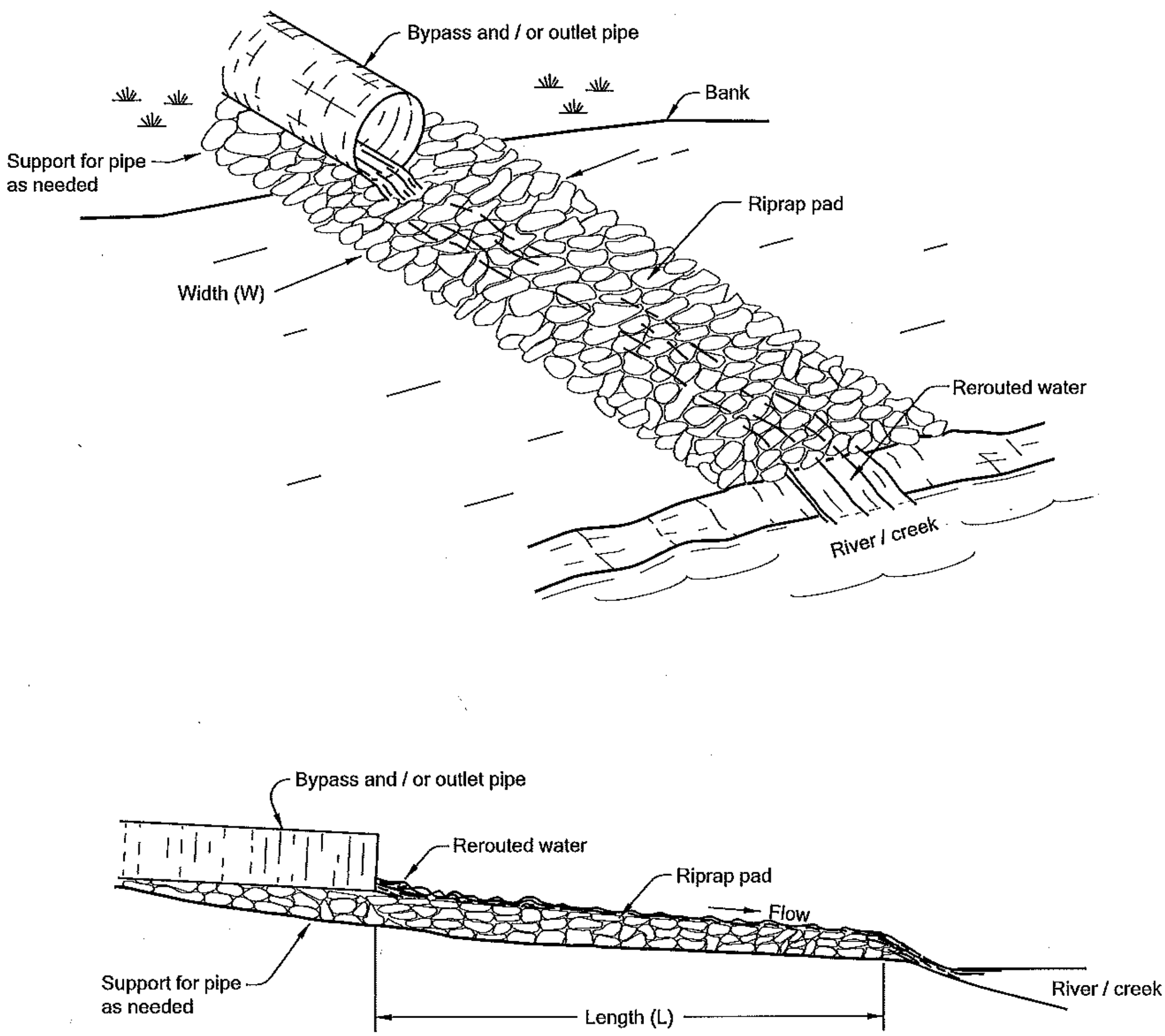
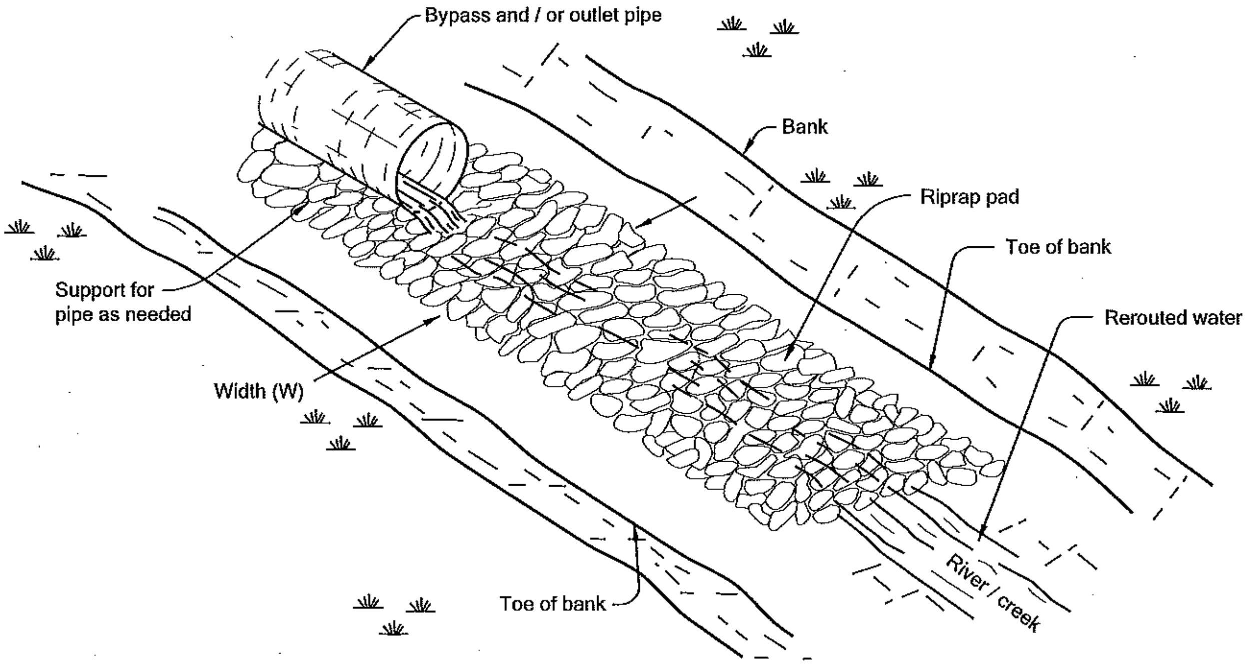


Figure 18-12 Temporary Riprap Energy Dissipator (channel bank application)



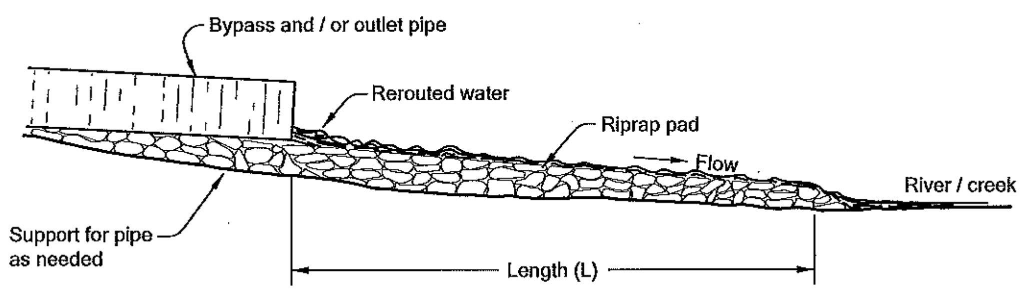


Figure 18-13 Temporary Riprap Energy Dissipator (channel application)

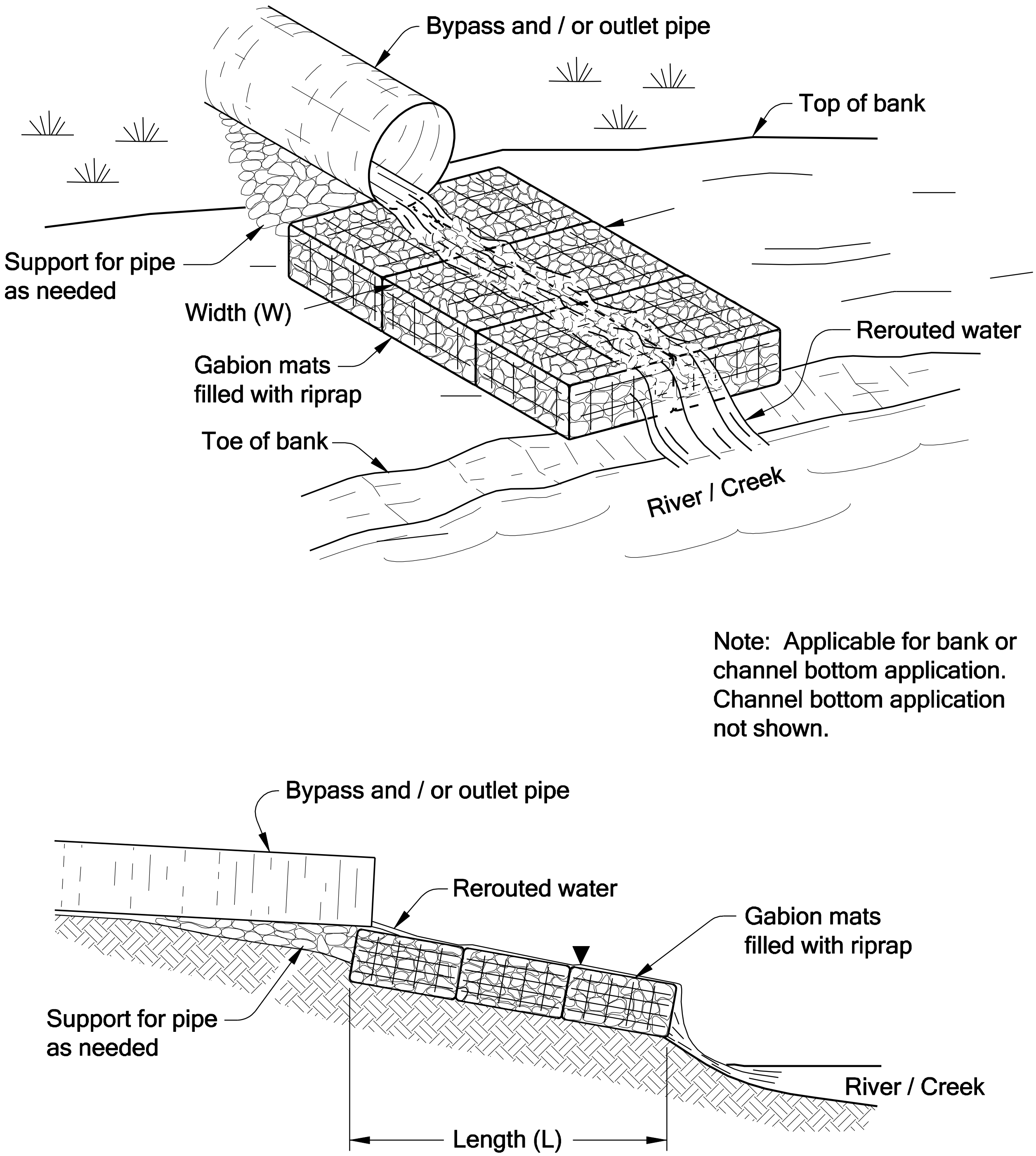


Figure 18-14 Temporary Gabion Energy Dissipator

18.5.4.3 Temporary Concrete Pads

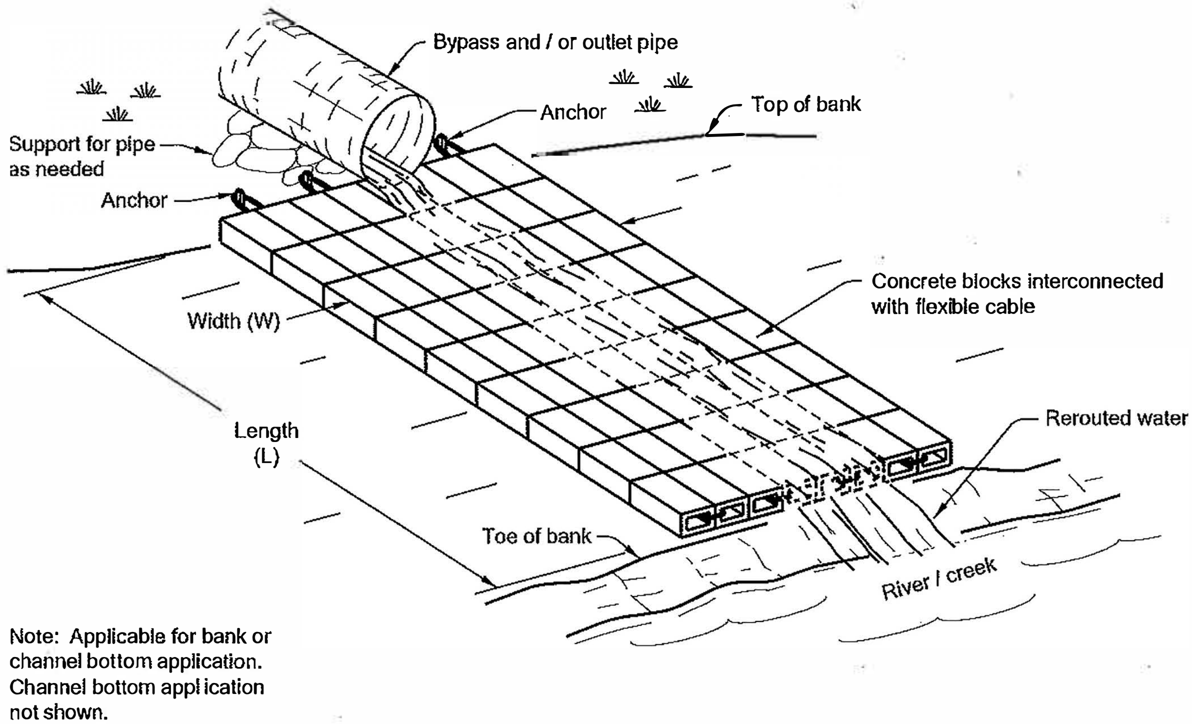
An energy dissipator can be formed using a precast cable concrete block system. It consists of concrete blocks interwoven with stainless steel cable. The cable feature allows this pad to contour to the channel bottom or side slope. Note that a cable concrete pad would have to be placed and moved using heavy equipment. Examples of this temporary dissipator option are shown in Figure 14.

Implement into the concept plan utilizing a few common guidelines:

- The minimum surface area needed to accommodate this disspator:
    - length: 8 feet
    - width: 2 times the diameter or span of the bypass/outlet pipe

- Blocks must have surface roughness

- Concrete block cable system would simplify installing, relocating, and removing



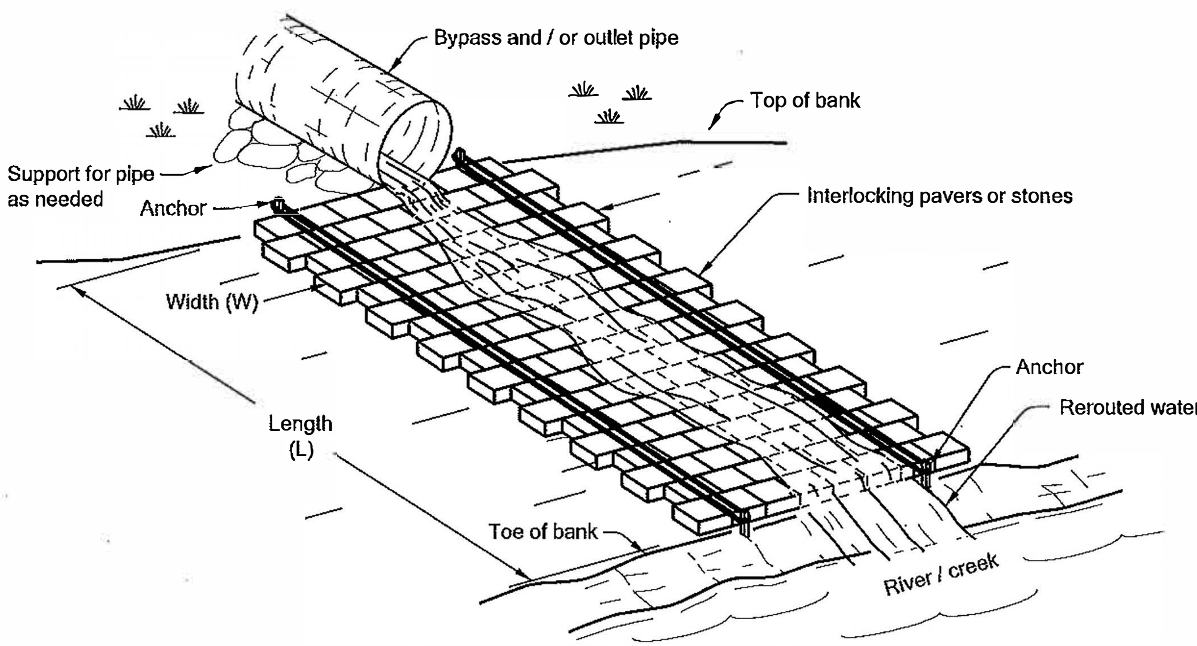


Figure 18-15 Concrete Pad Energy Dissipator

18.5.5 Sediment Control Facilities

Sediment control measures must be implemented if turbidity in the dewatering discharge has the potential to exceed the allowable standard. This allowable standard is set by the regulatory agencies in permits and other approvals. The most common standard is that turbidity cannot be increased more that 10 percent between upstream and downstream reaches, except for nominal periods of time (e.g. 2 hours). Suspended solids trapped in water are the primary water quality issue of concern in all TWM situations.

Sediment control is commonly needed when dewatering the construction work area. These flows are generally pumped to a TWM treatment facility before releasing back into the waterway. It may also be necessary to route water pumped from the waterbody to a TWM treatment facility if sediment levels are high.

Use of any one of these sediment control measures removes low-to-medium levels of sediment. A combination of these measures should be used if high levels of sediment are encountered during dewatering and construction.

Note possible facility locations on the TWM plan. Flat to mild slope areas provide the best conditions for pollutant removal performance.

Note possible treatment option(s) on the TWM plan. The treatment options must remove sediments by settling or filtering. A few sediment control measures that are effective at removing sediments by settling or filtering are discussed below.

18.5.5.1 Filter Bags

Filter bags are large rectangular or square bags made of heavy-duty needle punched filter fabric that provides high permittivity pore structure that allows filtered water to pass through the fabric while sediments are captured in the bag. These bags are commonly used during water pumping applications. These bags are generally known as dewater bags or sediment filter bags. See Figure 15.

These filter bags are rugged but not indestructible. Proper performance depends on maintaining a reasonable pump rate and ensuring concentration of sediment is not excessive otherwise the filter bag will fail.

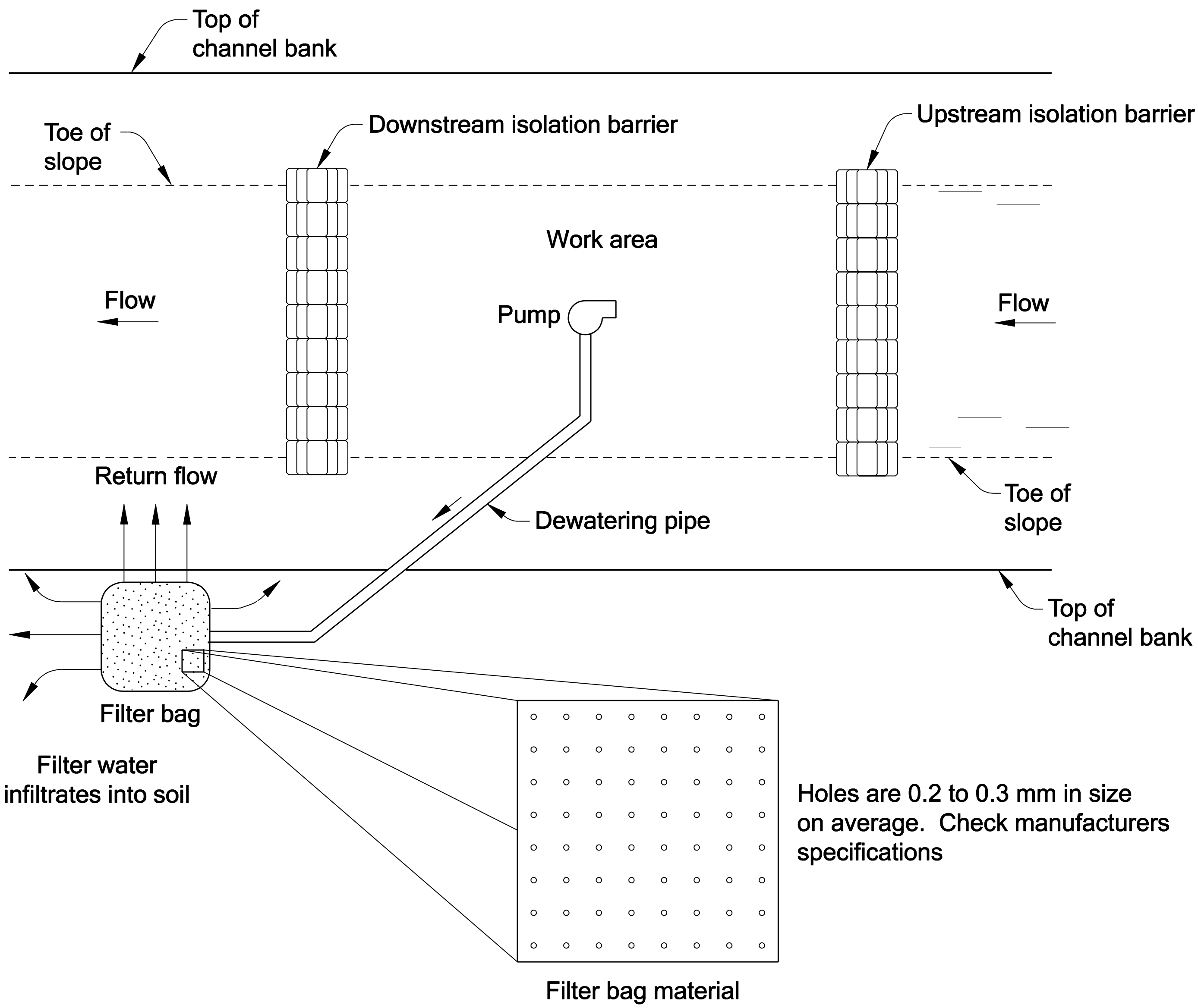


Figure 18-16 Filter Bag

Photo example of a Filter Bag

Implement into the concept plan utilizing a few common guidelines:

- Limit use to on the ground or on a trailer. The area needs to be stable and relatively level. Steep slope areas are not recommended as the bag may roll.
- Bags come in various sizes and recommended flow rates. Refer to manufacturer's literature for more detailed information.
- Bags can be connected to a 2, 3, 4, or 6 inch discharge hose

18.5.5.2 Rock Filter Berms

Rock filter berms utilize a mound of clean gravel that creates a settling chamber for the turbid water. A rock filter berm should be placed onto an impervious geotextile to discourage water from undermining the rock filter and to help contain the collected sediment. Rock filter berms are easy to install and are effective. This method is illustrated in Figures 16 and 17. Refer to ODOT's Erosion Control Manual for guidance.

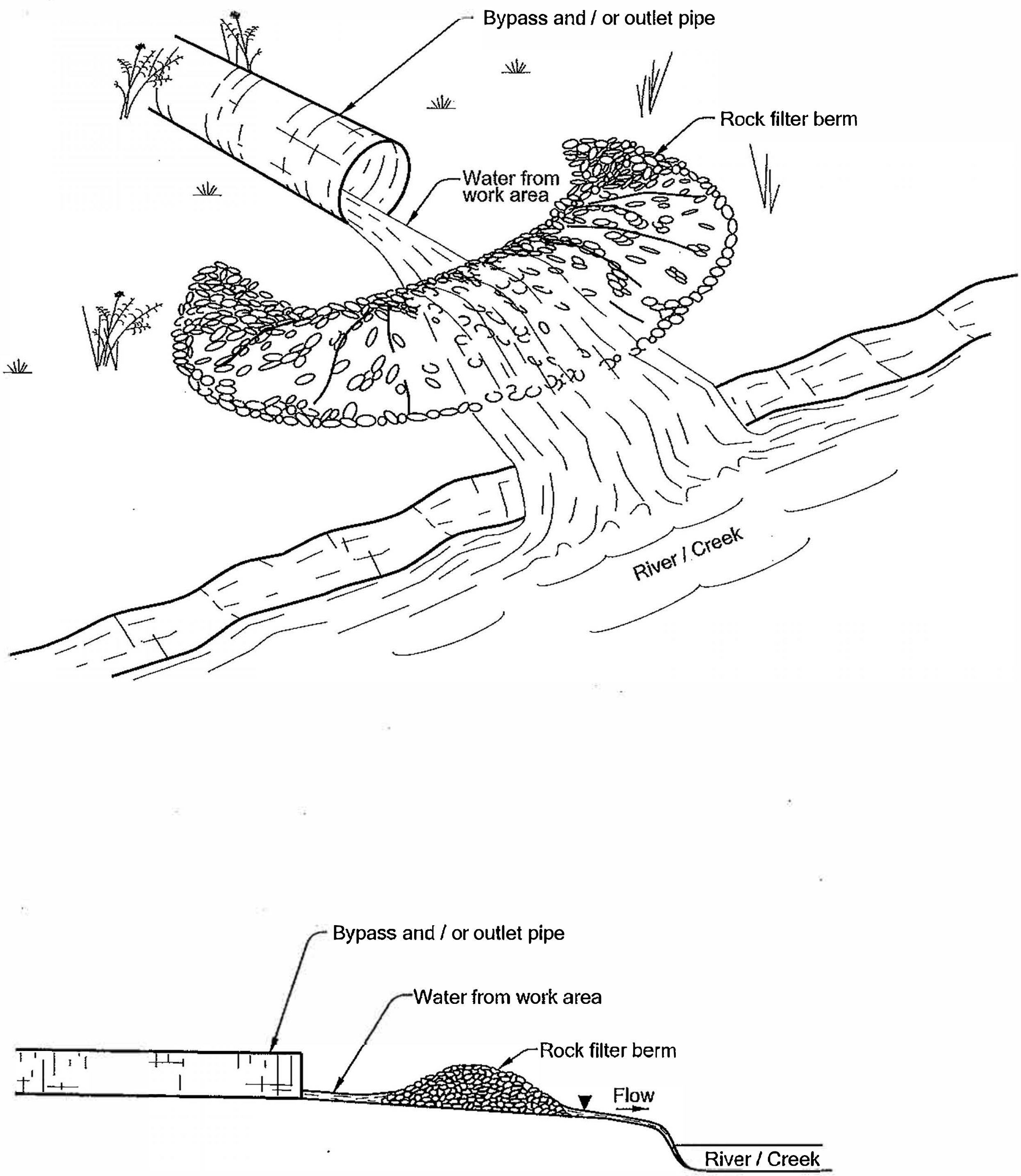
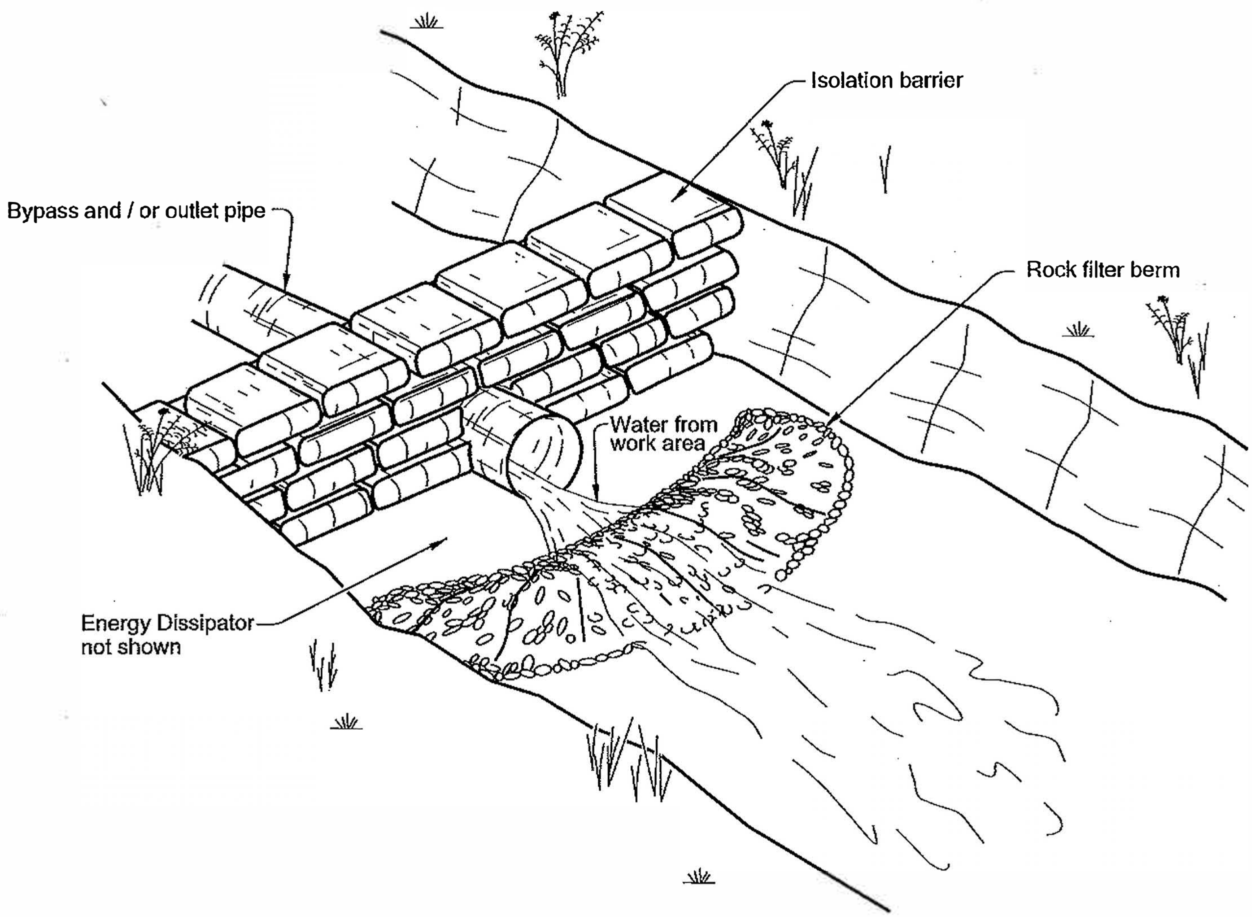


Figure 18-17 Rock Berm (channel bank installation)



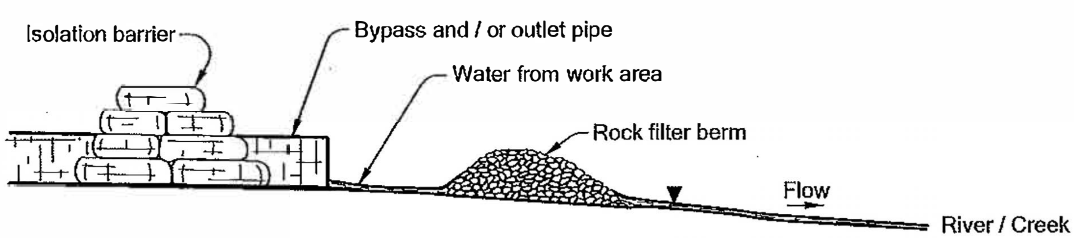


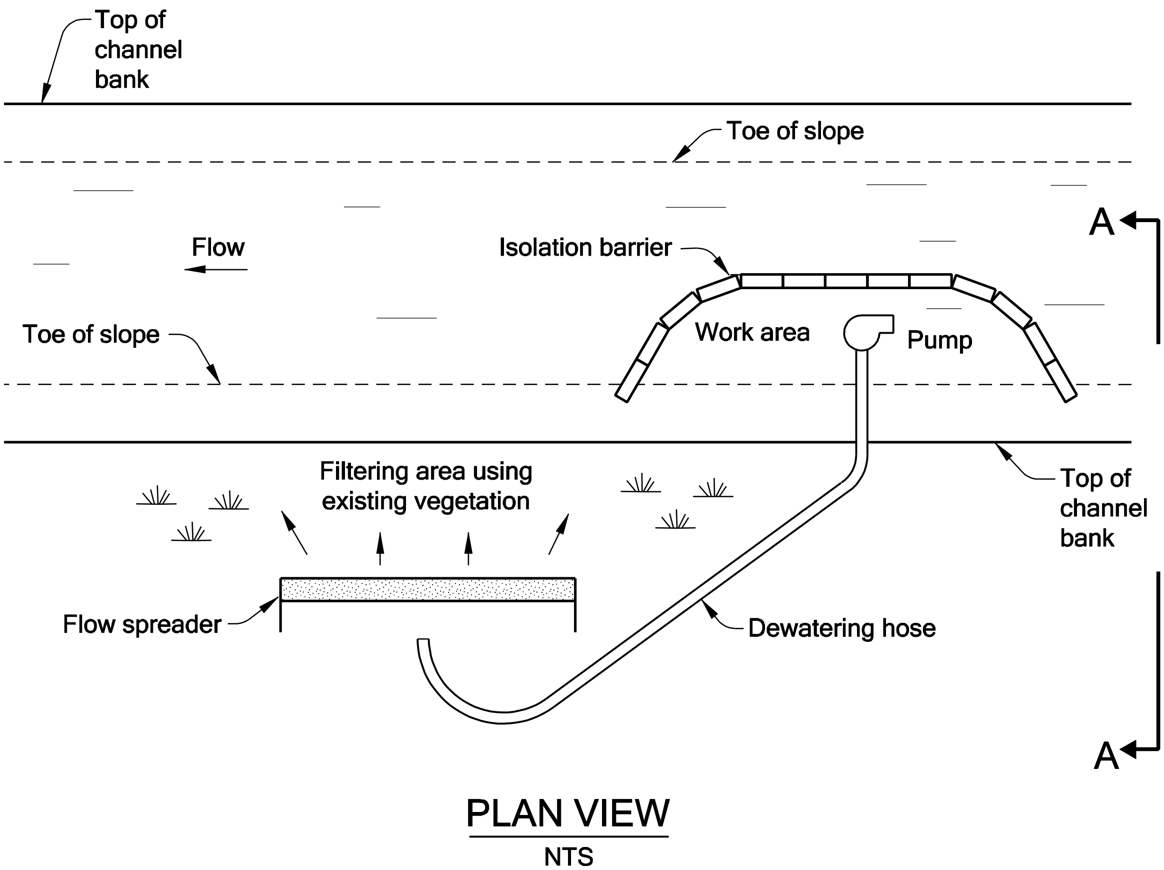
Figure 18-18 Rock Berm (channel installation)

18.5.5.3 Dispersion

Mild sloped areas adjacent to the waterway can be used as a temporary dispersion spot to remove sediments from pumped water prior to draining back into the waterway. Concentrated flows from pumping may be dispersed with a flow spreader to achieve sheet flow conditions. Sheet flow across vegetated ground maximizes water contact with vegetation and results in optimal filtration performance. This method is illustrated in Figures 18 and 19.

Implement into the concept plan utilizing a few common guidelines:

- Vegetated areas along the project site or imported turf could be utilized to disperse pumped water. Imported turf should be anchored to prevent it from sliding down the side slope. The minimum surface area needed to accommodate this approach:
    - length: 6 feet or equal to flow spreader length; whichever is greater
    - width (flow width): 10 feet
- The maximum dispersion area slope: 33 percent
- Flow spreader: 6 foot minimum length



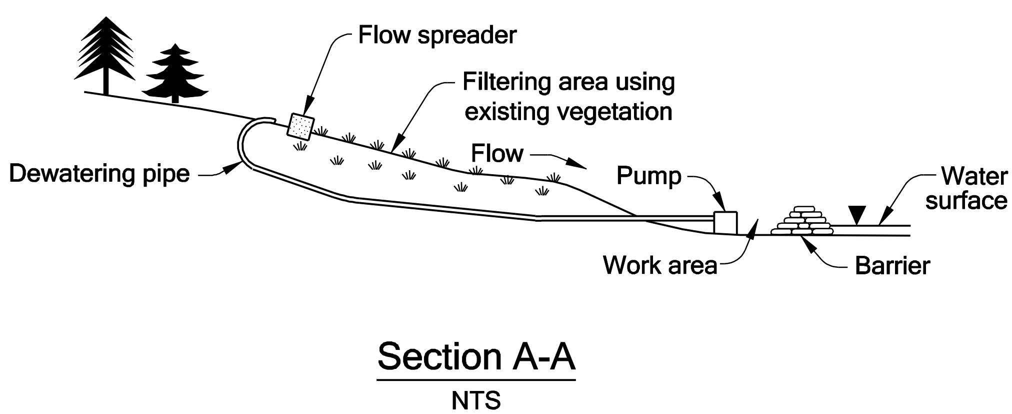


Figure 18-19 Dispersion using Filter Strip with rock berm flow spreader

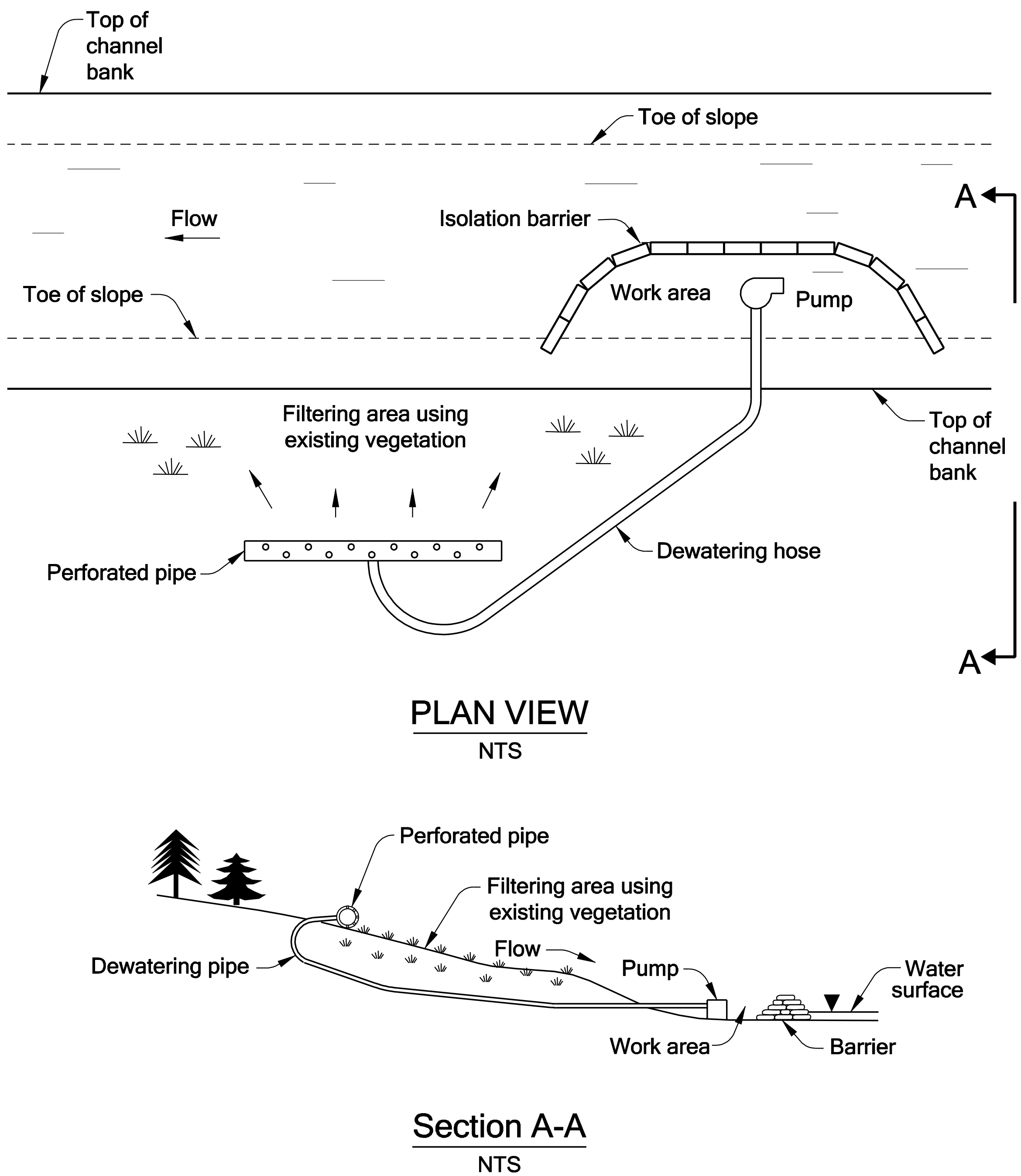


Figure 18-20 Dispersion using Filter Strip with perforated pipe flow spreader

18.5.5.4 Sediment Trap

TWM sediment traps are temporary ponding areas used to remove sediments through settling. Sediment traps can be constructed using sandbags and impervious liners, inflatable pool kits, an excavated hole with a liner or a portable truck or trailer mounted tank. The trap requires an outlet feature to convey the water back into the waterway channel. A sediment trap is illustrated in Figure 20.

Implement into the concept plan utilizing a few common guidelines:

- The surface area needed to accommodate a sediment trap:
  Volume = (5%) (50 percent exceedance discharge) x 16 = cubic feet storage
  Area = cubic feet storage /estimated storage depth.

- An outlet pipe from sediment trap to energy disspator is necessary. Elevate invert of pipe above bottom of sediment trap to allow for detention time and sediment storage.

- An energy dissipator is necessary. Refer to Section 18.5.3

Photo example of Sediment Trap

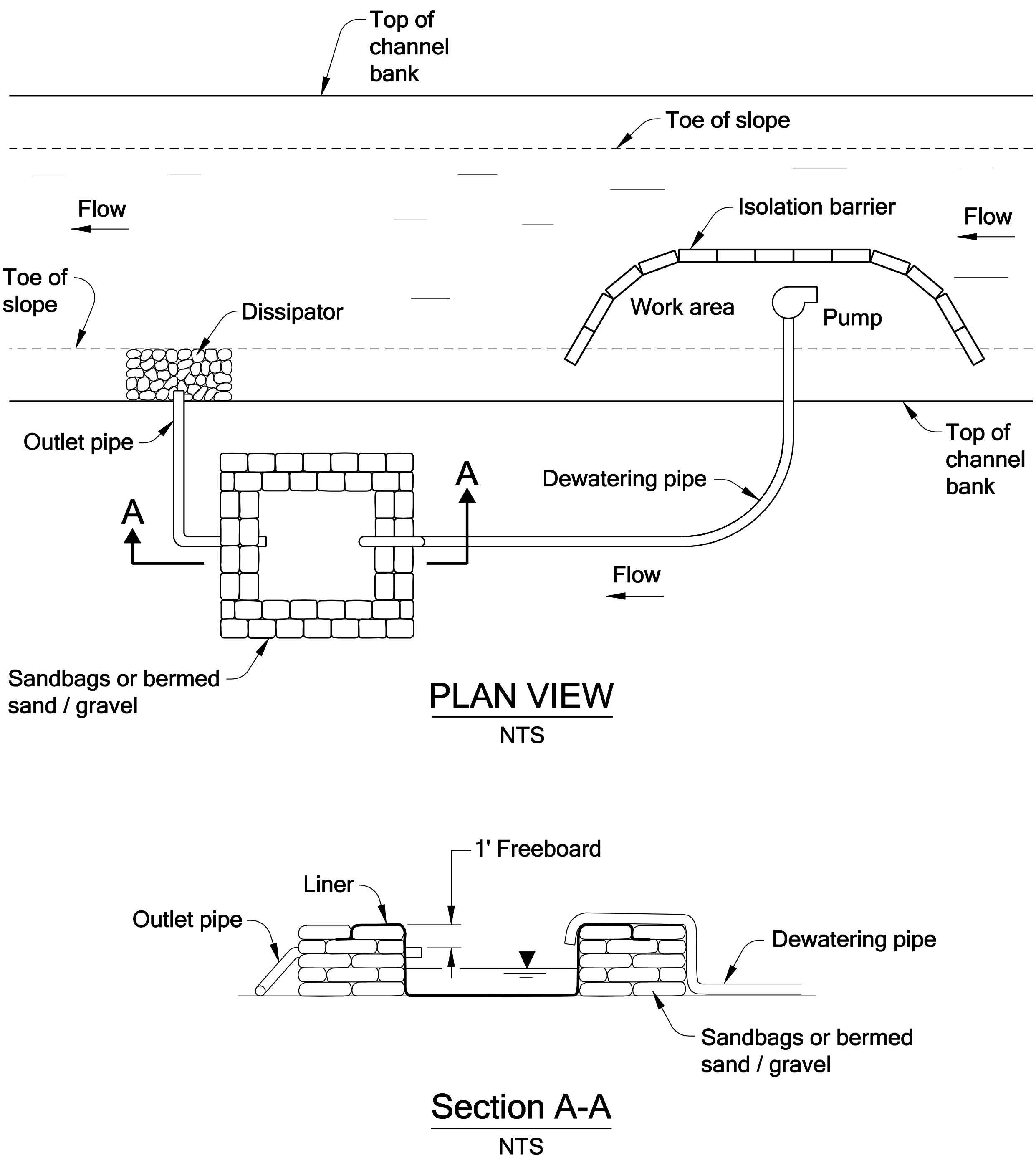


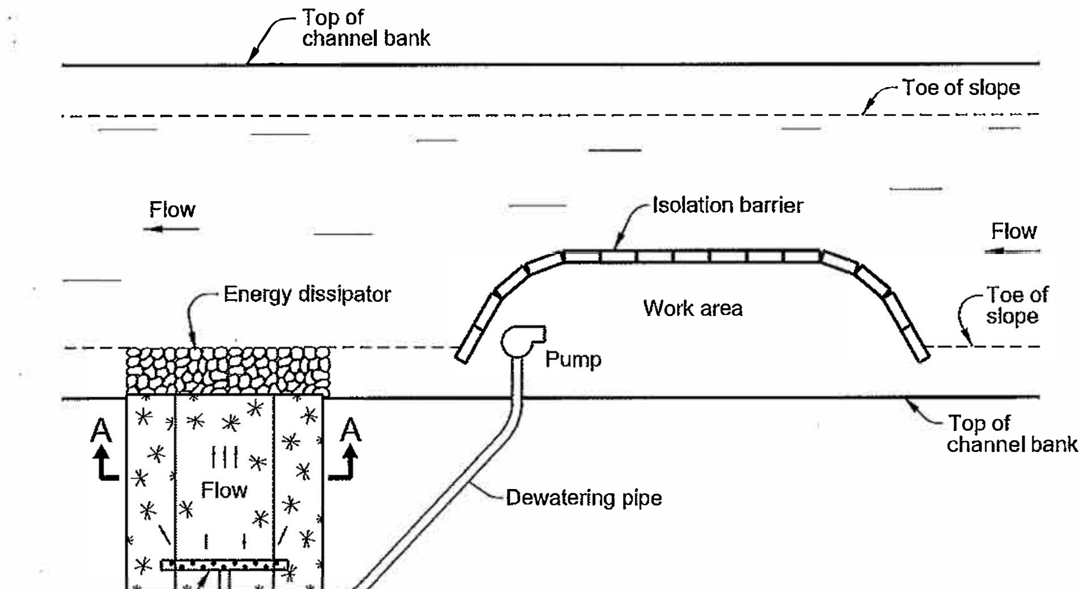
Figure 18-21 Sediment Trap

18.5.5.5 Swales

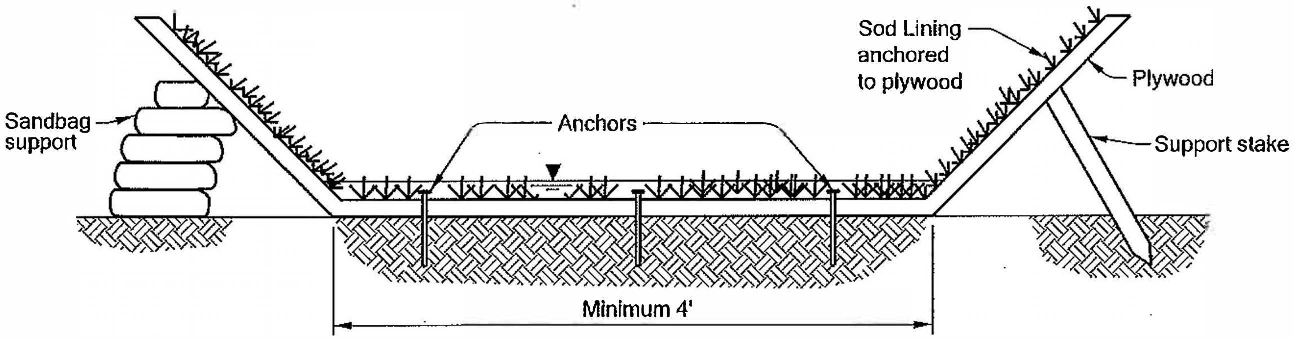
TWM swales are temporary constructed grass lined channels used to remove sediments by filtration through vegetation. A trapezoidal swale cross-section is illustrated in Figure 21. It is the ideal shape for temporary applications because the raised side slopes would help contain the flow along the grass channel and trap sediments.

Implement into the concept plan utilizing a few common guidelines:

- Utilize a temporary and mobile application such as constructing the trapezoidal channel using plywood and lining with sod. Other applications could be utilized as long as sheet flow conditions can be achieved for varying flow conditions. The **minimum** surface area needed to accommodate this approach (not including side slopes):
  - length (flow length): 25 feet
  - width: 4 feet
  - slope: 6 percent maximum
- Use in areas with mild slopes to promote slow velocities and increase retention time
- Use a flow spreader to reduce velocity of water exiting dewatering pipe before discharging onto swale



PLAN VIEW
NTS



Section A-A
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Figure 18-22 Swale

18.6 Design Procedure

The temporary water management concept design procedure involves many tasks. The typical concept design includes many, if not all, of the following tasks. Keep in mind:

- The goal is to prepare a TWM "Concept Plan" that is included with project plans and can be implemented based on site conditions. A stamped working drawing(s) is developed by the Contractor based on either the Agency's concept plan or an independent plan.

- The concept plan should allow for construction or repair tasks to be accomplished under stable and safe conditions and minimize as much as possible environmental effects such as fish passage and disturbance of fish habitat, wetlands, and riparian areas.

- Redesigns can be minimized by coordinating the concept design of TWM with other project team members such as the biologist, environmental coordinator, permit specialist, project leader, and roadway designer early and throughout the development process.

Step 1 – Project task kick-off

Notify the project biologist, environmental coordinator, permit specialist, construction office, roadway designer, and bridge designer you will be the temporary water management designer on the project.

Step 2 – Determine Project Scope

- Determine and note the activities requiring temporary water management.

- Months of the year the temporary water management will be in place (usually the in-water work period)

- Requirements for temporary water management due to the chosen environmental permitting method. Coordinate with the project environmental coordinator or biologists.

- Available right-of-way

- Floodplain use regulations:

  The Federal Emergency Management Agency (FEMA) regulations are discussed in Chapter 2, Chapter 3 and Chapter 6, Section 6.4.1. When work is to occur within a floodway, it is necessary to comply with applicable regulations and consult with the local FEMA coordinator to discuss the concept design and incorporate any issues that result from this effort.

- Water Right Issues:

The objective of using isolation methods along rivers and creeks is to allow for continuous flow through or around the work area. This is the most desirable approach because this should lessen habitat impacts. Quite often no additional permits are required when rerouting methods are used for the duration of the project.

Water rights to neighboring property owners should not be interrupted throughout the duration of the project. Storage, diversions or water uses are determined using Oregon Water Resources Department (OWRD) information. Identify nearby surface water withdrawal points using data available from OWRD. Visit the project site to verify the conditions that need to be maintained when surface water withdrawal points are in the immediate vicinity of the project. Care is needed during project temporary water management to allow for any surface water withdrawal points to operate for the duration of the project. There are two design options:

(1) The preferred approach is to work around the withdrawal point(s) without having to temporary relocate during construction activities, or

(2) Temporarily relocate withdrawal point(s) during construction. Coordinate relocation and restoration of withdrawal point(s) and easements with project leader, property owner, and right-of-way specialist.

Locate these points and note applicable provisions to maintain access to water on the temporary water management plan. A description of water right issues should be included in the project hydraulics report.

The removal of all or a portion of flow from a river or creek is known as diversion. This approach may have significant biological impacts; affect the scope of hydraulic work and the total project costs. Coordinate with project environmental staff and regulatory agencies for site requirements when this option is being considered during temporary water management. Regulatory requirements and supporting narrative comments should be documented in the project hydraulics report.

- In-water work period: In-water work guidelines have been developed by ODFW to assist the public in minimizing potential impacts to important fish, wildlife and habitat resources. These guidelines apply to Oregon rivers, tributaries, associated reservoirs and lakes, bays, and saltwater estuaries.

  The ideal TWM approach is to prepare the concept plan assuming the work will be implemented during the in-water work period. The in-water work period can be determined by going to ODFW's website, (http://www.dfw.state.or.us/lands/inwater/), or asking the project biologist.

- Fish Passage: Fish passage is the ability for fish to travel freely up and down the waterway they occupy.

  Maintaining upstream and/or downstream fish passage during the time the temporary water management structure will be in place is a concern to regulators and may be a permit requirement for any given project. Therefore, this is a very important issue and must be considered, evaluated, and coordinated with the project team on all projects that require temporary water management.

  Note:

  - It is common not to have any fish passage concerns during partial isolation and working in the wet installations because water is allowed to continue flowing downstream through the non-isolated channel without any significant changes in water depth and velocity.

  - Fish passage cannot be provided during a full isolation installation using pumps to route streamflow around the work area.

  - Fish passage through a bypass pipe depends on diameter/span, slope, and flow conditions which will vary throughout the duration of a project. Downstream passage during any flow condition is not difficult to accommodate because fish traveling downstream would be moving in the direction of flow. Upstream fish passage is limited to when flow conditions are reasonable for fish to make the journey through the pipe. The slope, diameter/span and length of the bypass pipe will impact velocity conditions due to confining the flow from the stream channel to a pipe barrel.

Step 3 – Determine Hydrology

Temporary water management designs require discharge estimates for a portion of the year when construction will take place. These discharges are used to estimate the need for isolation barriers, bypass piping and/or pumps, energy dissipators, dewatering pumps, and sediment control features as outlined in the concept plan. Then the design of these features would be based on the actual flows observed on the jobsite by the Contractor’s Engineer preparing a working drawing based on the ODOT prepared concept plan or an independent plan that meets water quality and environmental requirements, and does not affect neighboring properties and water rights.

Mean daily exceedance discharges are used in temporary water management. Exceedance discharges are estimated surface water discharges throughout the construction period and are used in temporary water management design. The exceedance discharge is the mean daily discharge that is expected to be exceeded for a specified number of days during the subject month. Usually this is expressed as a percentage of the days in the month. The discharges most often used are the 5, 10, 25, 50, and 95 percent exceedances.

General steps to determine hydrology include:

- determine the months of the year temporary water management will be in place (usually the in-water work period established by Oregon Department of Fish and Wildlife). See Chapter 3 for additional guidance on installations used within and outside of the flood season.

- follow the steps outlined in **Chapter 7**, Appendix J to estimate exceedance discharges for the months TWM will be in place or utilize the USGS software program named National Streamflow Statistics (NSS). The NSS program is not part of ODOT's Hydraulics overlay. It would need to be installed onto your computer by contacting the Computer Support Desk. Others can download this software from the following website: http://water.usgs.gov/software/NSS/

  Note: A cooperative study between the USGS and the Oregon Department of Transportation resulted in developing methods for calculating flow duration quantiles for the 5, 10, 25, 50, and 95 percent exceedances from streamflow records and developed regression equations that relate basin physical and climatic characteristics to flow statistics. These equations provide estimates of unregulated flow conditions at locations where streamflow data are unavailable (ungaged sites). This data has been incorporated into the NSS program. The study can be viewed at the following website: http://pubs.usgs.gov/sir/2008/5126/

- determine the maximum predicted discharge when necessary. This discharge would be necessary for critical facilities such as coffer dams, bypass pipes or temporary bridges on critical roadways, or work bridges. Follow the steps outline in **Chapter 7**, Appendix K to estimate the maximum predicted discharge.

- use the calculated exceedance and maxmimum predicted discharges to prepare the discharge table in the hydraulics report and concept plan. Example of a discharge table included in the hydraulics report is provided below. Example of a discharge table included in a TWM concept plan is provided in Figure 23.

Note:

The objective of temporary water management is to provide for uninterrupted streamflow through the project site and it is almost always required by the permitting regulatory agencies. This continuous flow prevents the downstream channel from drying up and killing aquatic life and may require fish passage upstream, downstream, or both. Coordinate with project environmental staff and regulatory agencies for site requirements.

Discharges less than or equal to 0.5 cubic feet per second (224 gpm) are almost a trickle in most streams and can be difficult to convey with gravity flow systems. The streamflow sometimes percolates under the barriers and flow through the bypass pipe ceases or is reduced to a trickle. Often the solution to manage upstream flows less than 0.5 cubic feet per second is to pump the water through the worksite. The pump must be small enough to operate continuously and deliver an uninterrupted flow.

Discharges greater than 0.5 cubic feet per second (224 gpm) are often impractical to pump through the work site because multiple portable pumps or a single trailer mounted pump would be required. Gravity flow systems or other methods would be used to manage upstream flows greater than 0.5 cubic feet per second. The gravity system would be sized to convey water during the wettest construction month. Quite often it is possible to use a combined system: pumping during work hours and gravity flow during off hours.

DRY CREEK AT HWY 99W
ESTIMATED DISCHARGES FOR
TEMPORARY WATER MANAGEMENT

	AVERAGE DAILY DISCHARGE IN CUBIC FEET PER SECOND (GALLONS PER MINUTE)		
NOTE	**1**	**2**	**3**
JULY	3.1 (1,400)	2.0 (900)	1.4 (630)
AUGUST	2.0 (900)	1.1 (490)	0.77 (350)
SEPTEMBER	2.5 (1,100)	1.3 (580)	0.68 (310)
OCTOBER	11.0 (5,000)	3.3 (1,500)	1.4 (630)

1) Average Exceedance Discharge (Average daily discharge expected to be exceeded 2 days each month.)
2) Average Exceedance Discharge (Average daily discharge expected to be exceeded 8 days each month.)
3) Average Exceedance Discharge (Average daily discharge expected to be exceeded 16 days each month)

In-Water work period extends from 1 July through 15 October

Listed discharges are surface water from the upstream watershed. The estimated discharges are based on nearby gaged basins. Discharges in the subject watershed may differ.

TWM Discharge Table included in Hydraulics Report and concept plan

Step 4 – Visit the project site

- Take Photos. At a minimum, photos should be taken of:
  - highway, looking toward increasing milepoint
  - highway, looking toward decreasing milepoint
  - scour or erosion problems when a stabilization or repair task
  - upstream and downstream of crossing structure when applicable
  - possible areas to place sediment control features

- Prepare a photo log and include in the project design file
- Verify Hydrology calculations are reasonable. It is important to remember that the calculated discharges are for flows for an average year and are almost always based on gage records on nearby streams. This prediction method cannot predict discharges during the TWM period with absolute certainty. Therefore, the TWM design should have some flexibility to handle unexpected discharges.
- Document site characteristics such as:
  - Debris concerns
  - Cross-sections and approximate bank slopes
  - Neighboring structures
  - Any nearby water withdrawal features
  - Ground cover conditions (e.g. trees, boulders, erosion)
  - Channel stability concerns
  - Approximate bed material size and gradation
  - Utilities within project boundaries

Step 5 – Coordinate additional data (as needed)

Assemble additional data such as streambed profiles, channel and overbank area cross-sections, OHW elevation mark elevation, existing structures, utilities, etc. as discussed in Chapter 6.

Step 6 – Verify survey

The type, source, and complexity of data for a temporary water management design will vary depending on the location and type of construction activity. It is important to verify accuracy and completeness at this stage of the design process.

Step 7 – Determine the isolation approach

There are almost always several alternatives that could be implemented at any given project site. Select what appears to be the best option. Discussion on the isolation approaches and components are discussed in Sections 18.4 and 18.5.

Step 8 – Develop a TWM Concept Plan

Develop a temporary water management concept plan. This plan will be included with the final design plans. Distribute for review and comment as noted in the design step below.

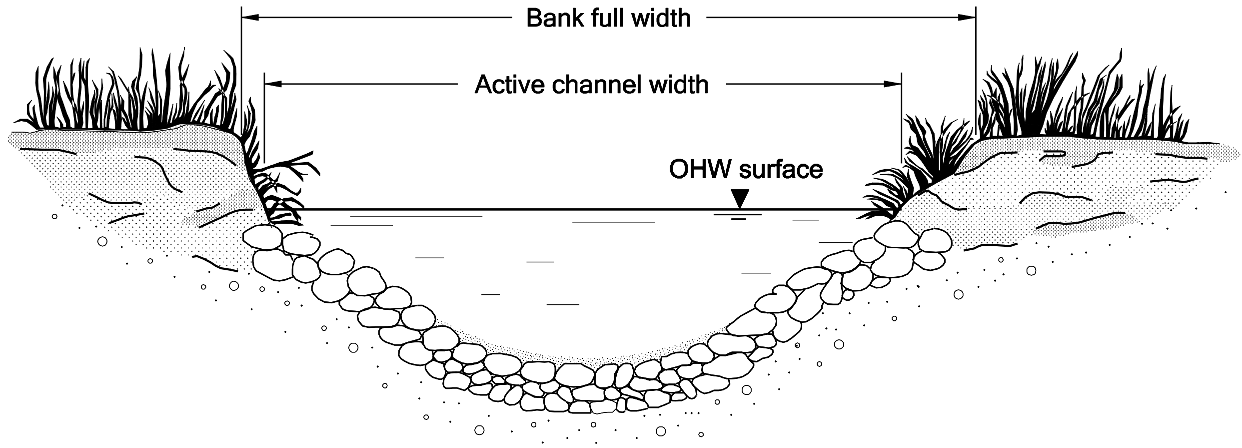
- Note on the plan the selected option to control water during construction.

- Include any constraints on plan such as highway and road locations, right-of-way boundaries, existing structures, utilities, etc.

- Include ordinary high water mark (OHW) to establish the regulated work area (See Chapter 6). Work within the regulated work area is allowed only during the in-water work period. The Hydraulic Engineer and Biologist field locate the ordinary high water marks. The active channel width is determined by the distance between the ordinary high water marks. The requirements for field assessment, flagging, and documentation of the ordinary high water mark are outlined in ODOT Geo-Environmental Technical Bulletin GE09-07(B). A link to this bulletin is provided below:

  http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/GE09-07b.pdf

- Typical temporary water management components included on plan:
  - Limits of isolation (see step 10)
  - Construction limits (see step 10)
  - Isolation barriers (see Chapter section 18.5.1)
  - Bypass pipe or other bypass features when applicable (see Chapter section 18.5.2)
  - Pumps when applicable (see Chapter section 18.5.2).
  - Pump screening detail and notes when applicable - incorporated into the standard templates (see template examples below)
  - Energy dissipater (see Chapter section 18.5.3)
  - Sediment control facility (see section 18.5.4)
  - Temporary water management discharge table. Add hydrology data according to Step 3.
  - Specific notes
  - Temporary construction easements



Active channel width and bankfull width

Step 8a – Coordinate TWM Concept Plan Drafting

A template is available for preparing partial or full-isolation concept plan sheets. The name of the template file is Seed_TWM.dgn and is located with other seed files in ODOT's MicroStation workspace. The file contains a ready-made plan sheet (or template). The template contains instruction on use and includes general notes, details, a fillable discharge table, and an area for laying out the TWM concept plan.

Step 9 – Distribute the TWM plan for review and comment

Distribute the plan to the project team and project manager's office. Modify concept design as needed based on review comments.

Then meet with environmental and permitting staff and review the proposed concept plan. Verify the concept plan can obtain a permit. It is necessary to work out permitting issues at this early stage of design.

Be prepared to repeat this step more than once.

Step 10 – Verify there is adequate right-of-way for temporary water management

No temporary construction easements are necessary if adequate right-of-way is available. If adequate right-of-way is not available, coordinate temporary construction easements with the project leader and right-of-way agent.

A project's temporary water management construction limits is the area or boundary needed to accommodate project isolation features (such as barriers, bypass piping, pumps and hoses, fish isolation netting, and sediment control measure), construction materials, equipment, mobility, and other activities. The construction limits should be estimated early and accurately during the design process to allow adequate time to negotiate and purchase project construction easement(s) when applicable and may be referenced in project environmental documents.

The following procedure outlines the typical steps in estimating temporary water management construction limits and coordinating construction easements when necessary.

- Estimate the limits of isolation.

The construction limit for temporary water management is determined by the hydraulics designer by first estimating the limits of isolation. Limits of isolation marks the area needed to perform the work within the waterway. All three isolation method limits are marked with the barriers used to isolate the work area. For example, a full isolation project would place a barrier upstream and downstream of the work area. The limits of isolation would be the distance between these barriers. The limits of isolation for partial isolation and working in the wet would be from waterway bank to the isolation barrier.

- Estimate the TWM construction limits.

The TWM construction limit would then be estimated beyond the isolation limits to allow for adequate area for mobility and construction activities.

Always try to minimize the TWM construction limits. This is recommended and desirable because this approach should lessen habitat impacts. This is important because it is typically the number one priority of regulators. Also, this may ensure a shorter review from regulators if the isolation plan demonstrates impacts are minimized to only what is needed to perform the work.

- Submit construction limits to the project roadway designer.

The estimated construction limits for temporary water management is submitted to the roadway designer for consideration of the overall project construction limit. Construction limits for other highway features would also be submitted by other project team designers to the roadway designer for consideration of the overall project construction limit. The construction activity requiring the greatest area would establish the construction limits for the project. Any project construction limit area needed beyond the highway right-of-way would require construction easements. The roadway designer most often coordinates all project construction easements with the right-of-way specialist.

Note:

- *A Construction easement is an agreement between ODOT and a neighboring property owner(s) that allows access to the construction site through private property to perform temporary construction activities on private property such as staging of equipment, stock piling of materials, temporary water management or other temporary construction activities when applicable.*
- *All permanent highway facility features should be limited to within the regulated waterways or highway right-of-way unless permanent easement(s) or additional right-of-way has been purchased as needed from neighboring property owners.*

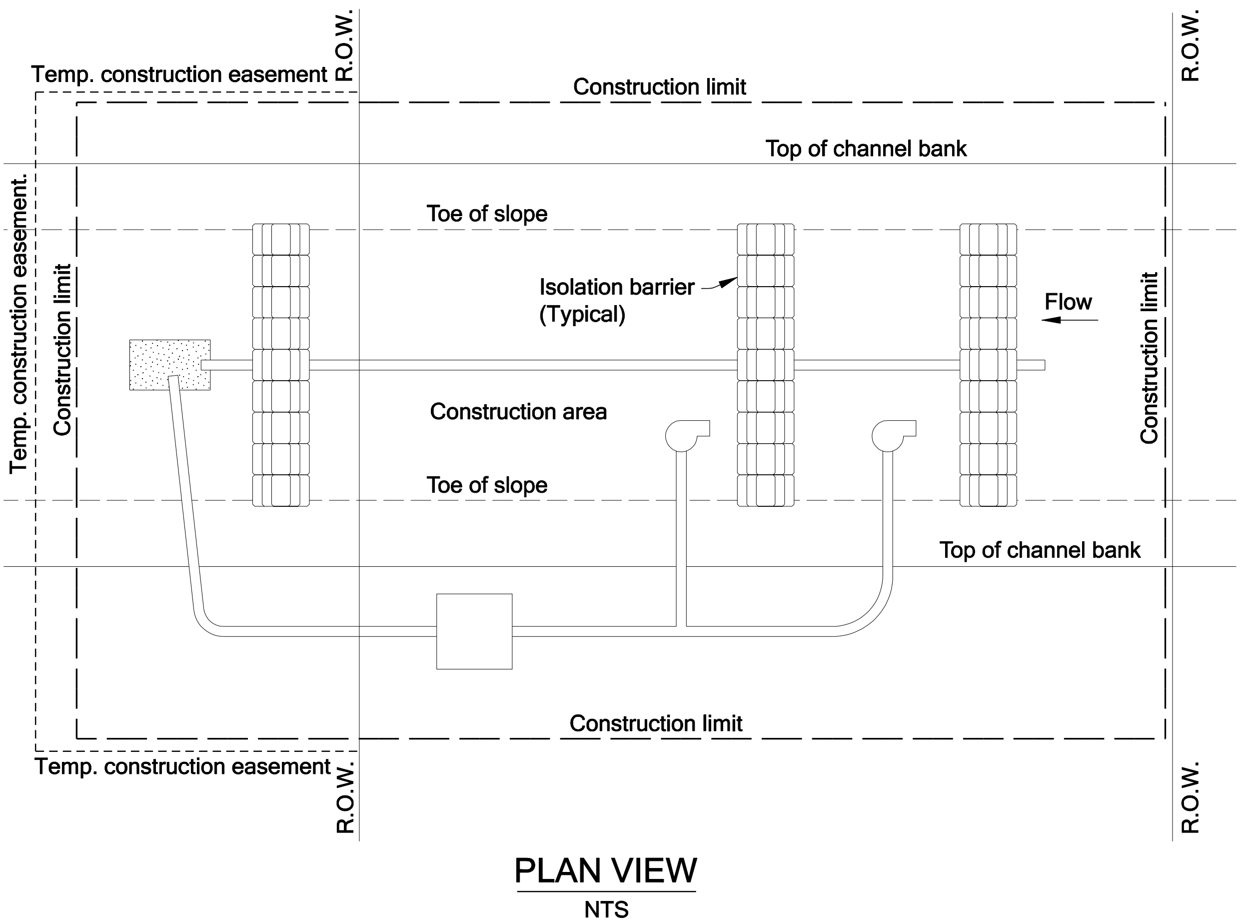


Figure 18-23 Example Temporary Construction Limits and Extent of Work Area Isolation

Step 11 – Preliminary Plans (or DAP) review comments

Distribute the concept plan to project team designers, project manager's office, environmental staff and project permit specialist. Comments from the project team, regulators and other interested parties are used to prepare the detailed hydraulic recommendations and revise the temporary water management plan.

Step 12 – Prepare TWM section of the Hydraulics report

Prepare recommendations for temporary water management and include in the project hydraulics report according to Chapter 4.

Step 13 – Advanced plans review comments

When applicable, revise and submit temporary water management concept plan.

Step 14 – TWM plan and Permit Coordination

Coordinate with environmental staff and project permit specialist to verify permit is consistent with temporary water management plan. Changes to permit or plans are usually required to bring these documents into agreement.

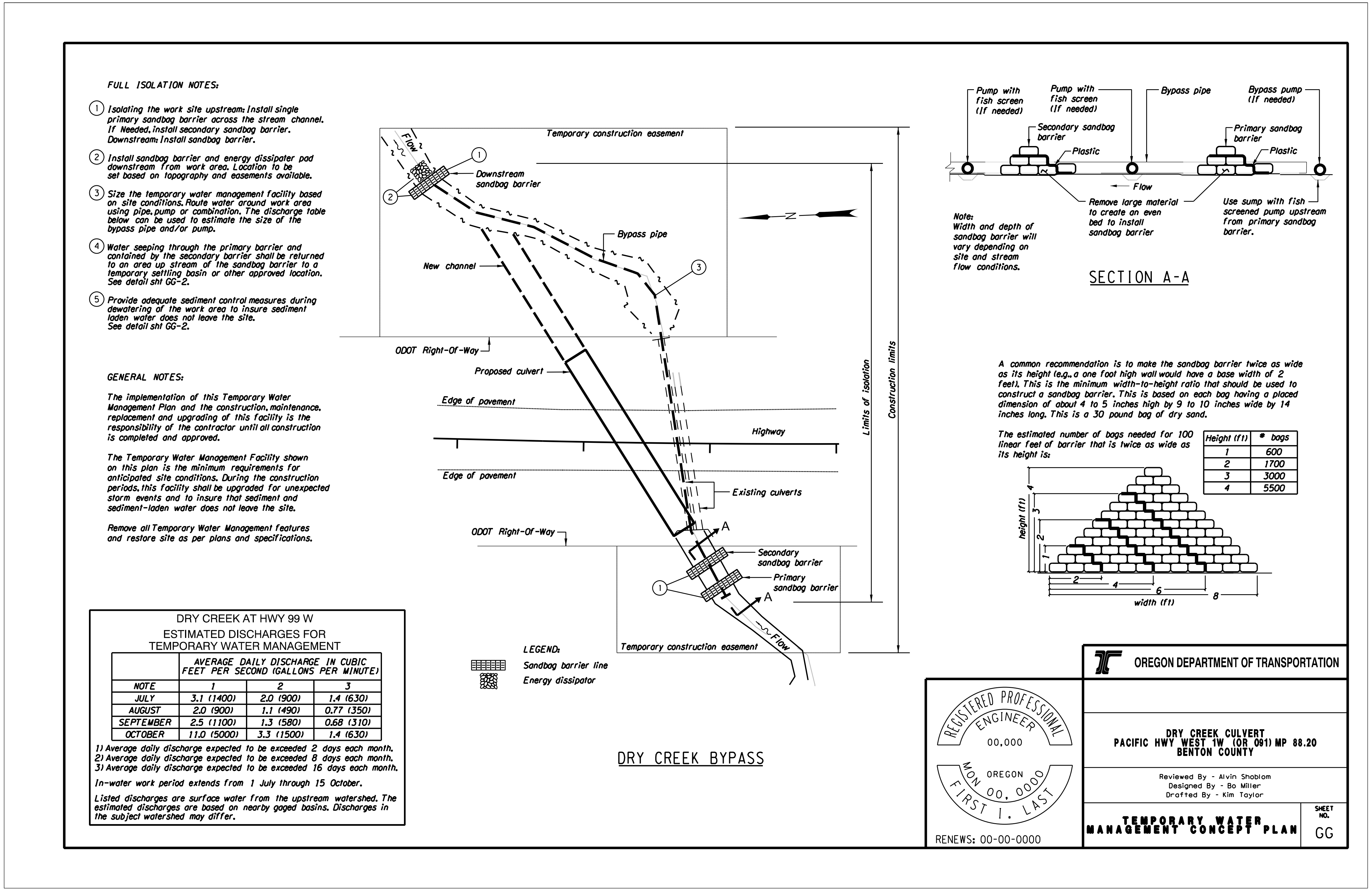
Step 15 – Plans-in-hand review comments

Collect comments from plans-in-hand meeting. Revise plan as necessary. Submit plan with final design plans. Figure 22 is an example of a TWM plan "concept only".

Step 16 – Prepare Special Provision

Utilize Special Provision SP00245. This provision can be viewed and downloaded at the following website:

http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008_special_provisions.aspx#Part_00200



DRY CREEK AT HWY 99 W
ESTIMATED DISCHARGES FOR TEMPORARY WATER MANAGEMENT

	AVERAGE DAILY DISCHARGE IN CUBIC FEET PER SECOND (GALLONS PER MINUTE)		
NOTE	1	2	3
JULY	3.1 (1400)	2.0 (900)	1.4 (630)
AUGUST	2.0 (900)	1.1 (490)	0.77 (350)
SEPTEMBER	2.5 (1100)	1.3 (580)	0.68 (310)
OCTOBER	11.0 (5000)	3.3 (1500)	1.4 (630)

1) Average daily discharge expected to be exceeded 2 days each month.
2) Average daily discharge expected to be exceeded 8 days each month.
3) Average daily discharge expected to be exceeded 16 days each month.

In-water work period extends from 1 July through 15 October.

Listed discharges are surface water from the upstream watershed. The estimated discharges are based on nearby gaged basins. Discharges in the subject watershed may differ.

Height (ft)	# bags
1	600
2	1700
3	3000
4	5500

Figure 18-24 Example Drawing of a TWM Concept Plan (Full Isolation)

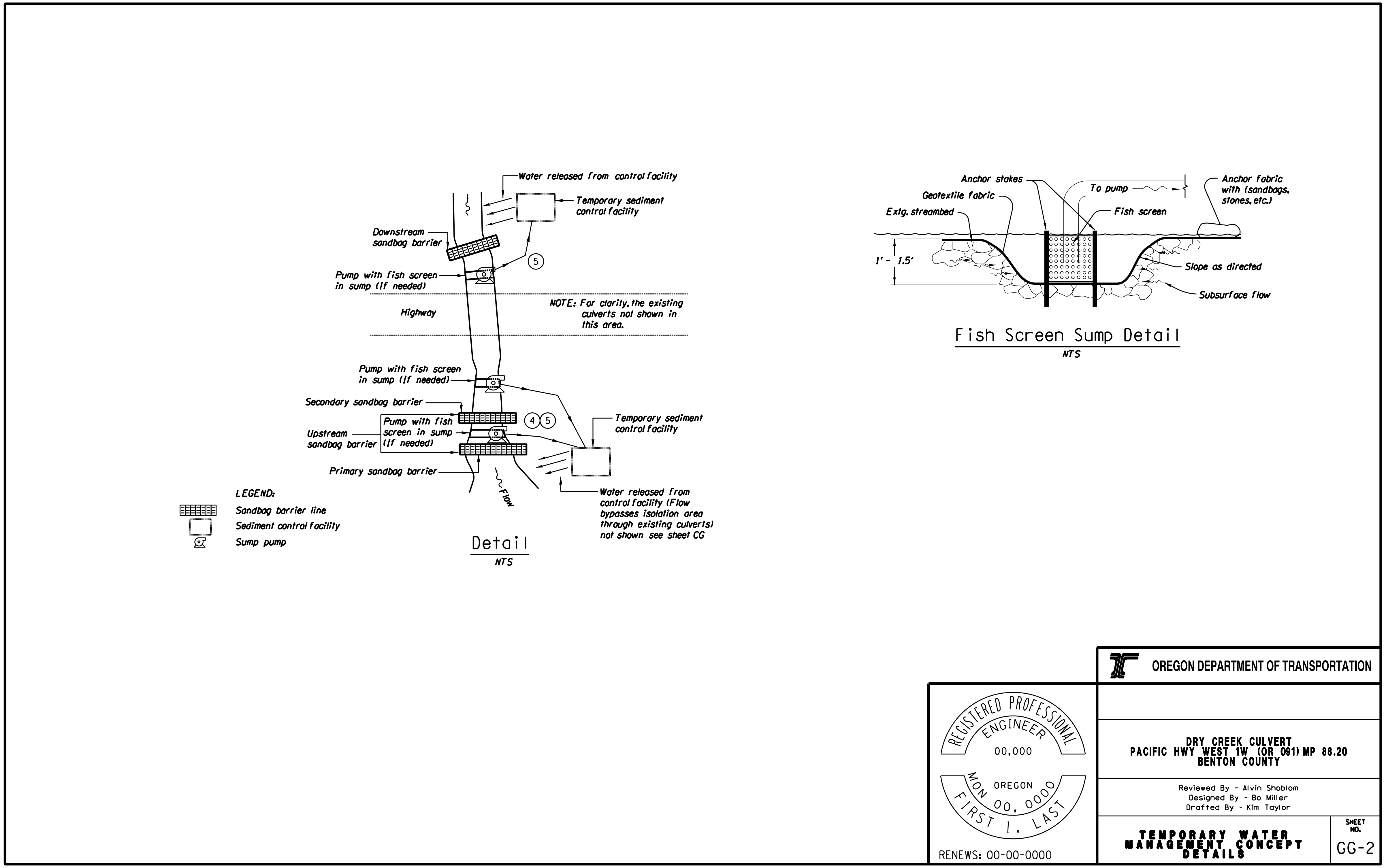


Figure 18-25 Example Drawing of a TWM Concept Plan (Full Isolation Page 2)

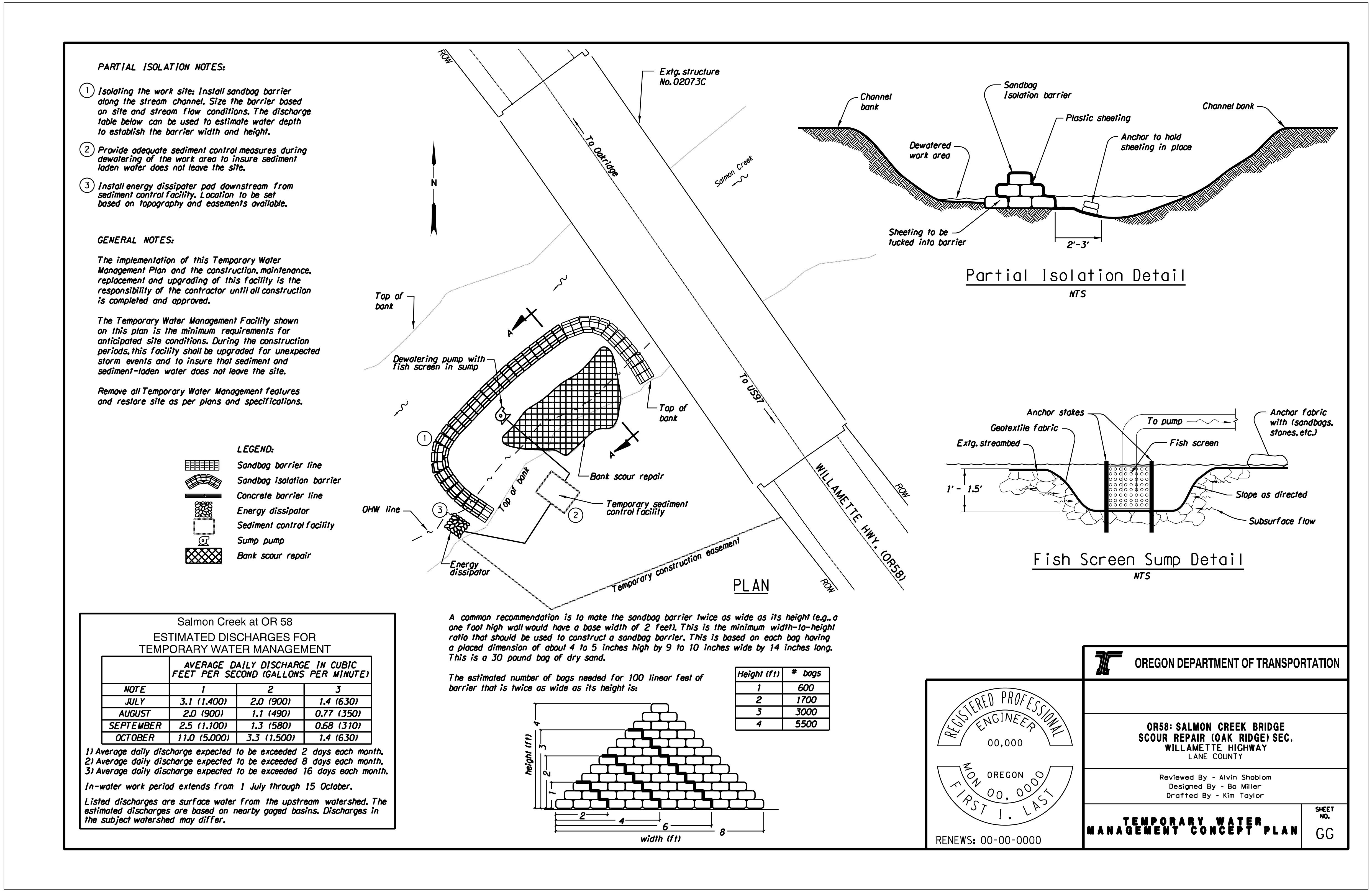


Figure 18-26 Example Drawing of a TWM Concept Plan (Partial Isolation)

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