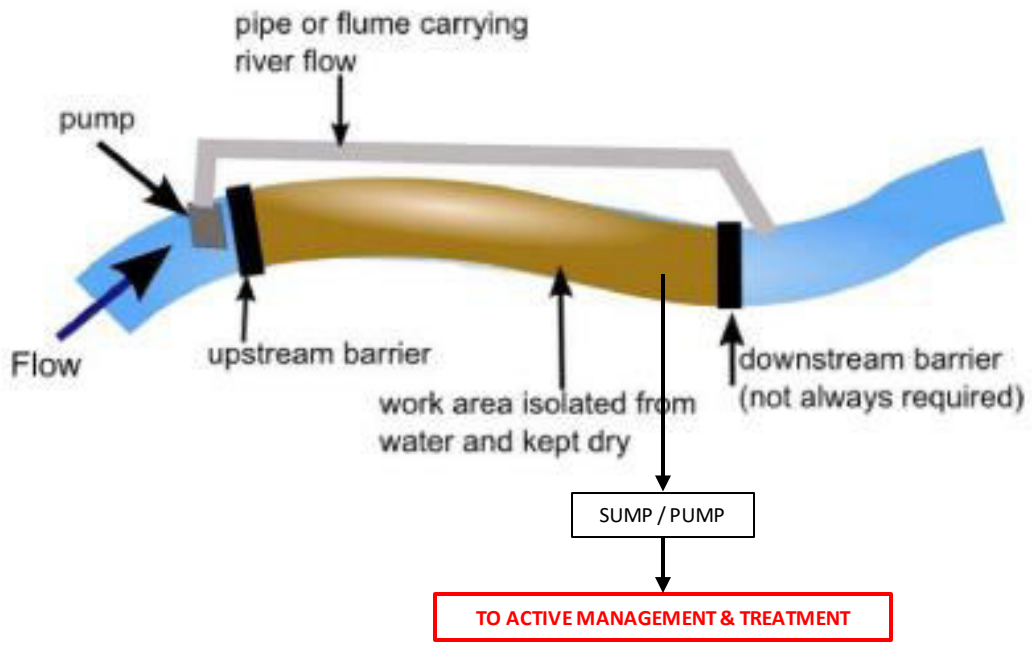
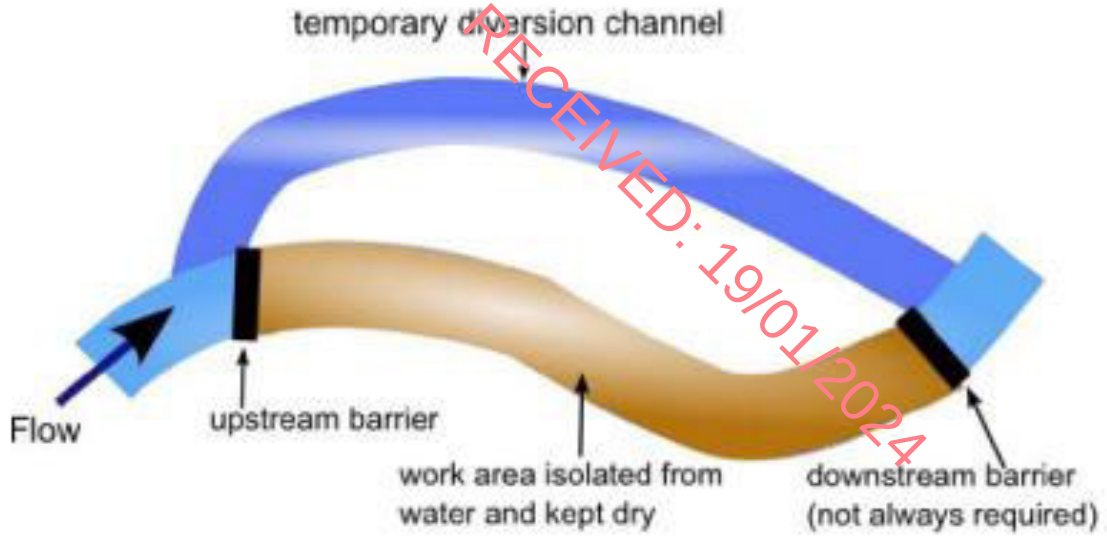
Full Isolation Over Pumping – Plan



NOTES:

- Full isolation over pumping / siphon. A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipework need not be located in the isolated area.
- This method is the preferred method for channel diversion during instream works , for example, during watercourse crossing / culvert construction. However, the pumping equipment deployed must be capable of the surface water feature discharge rate, including back up equipment and fail safe protocols.

Full Isolation by Diversion – Plan



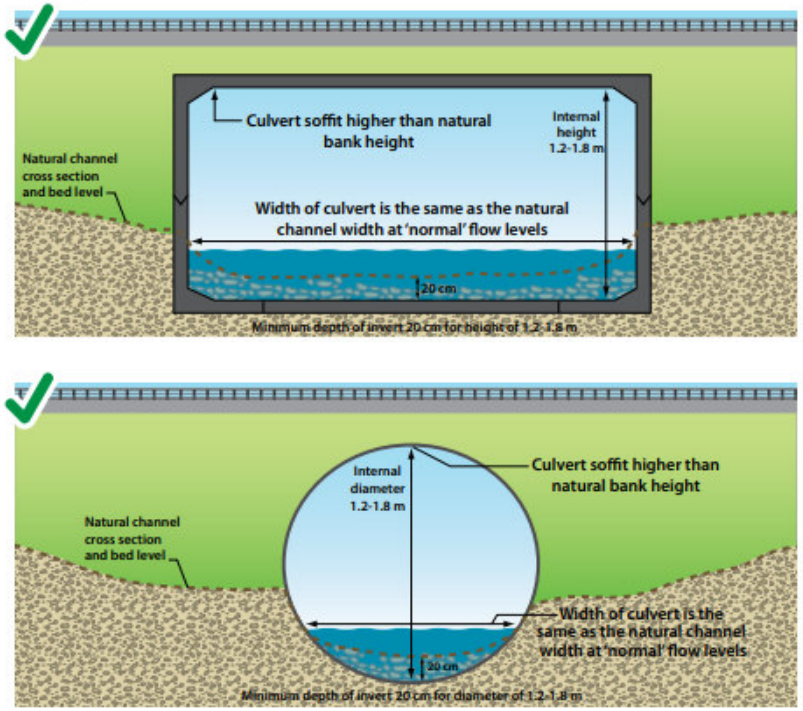
NOTES:

- Full isolation temporary diversion channel. A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel.
- This is the less preferred method due to the destructive nature of constructing temporary diversion channels. However, in some instances where discharge rates are high, this method will negate the requirement for large volume pumping and associated inherent risks.

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 1 Instream Works, Isolation and Over Pumping – General Considerations**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Closed Culvert Good Practice Design Considerations – Section

Figure 40: Good practice, culverts showing invert buried below bed level allowing the natural bed level, slope and material to be maintained. Culvert also maintains natural channel width.



SEPA (2010) Engineering in the Water Environment Good Practice Guide – River Crossings .

Closed Culvert Good & Bad Examples – Section

Figure 41: Good practice, use a single large culvert for crossings that maintains the natural channel width.

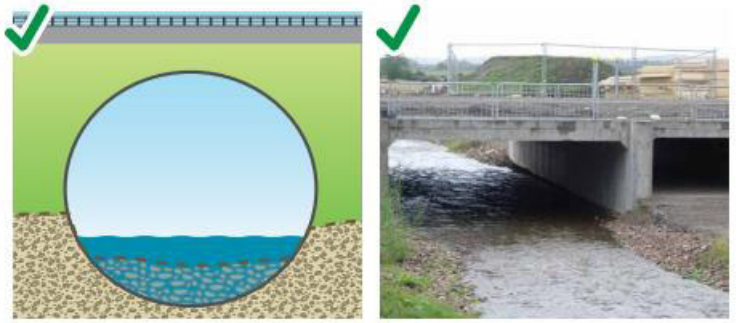


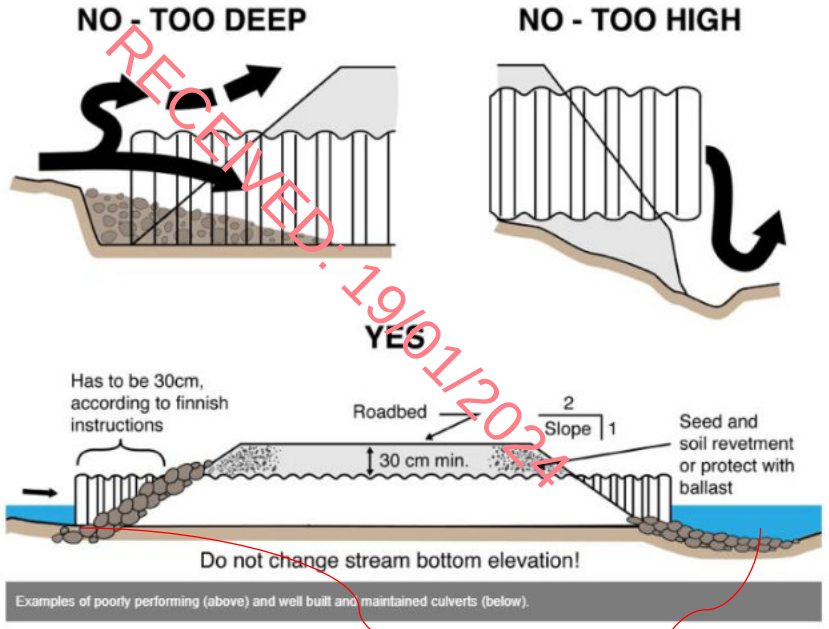
Figure 42: Poor practice, do not use smaller multiple pipes; they can create a barrier to fish passage.

SEPA (2010) Engineering in the Water Environment Good Practice Guide – River Crossings .

NOTE: Coarse aggregate has been used for erosion control. Silt fencing has been used to mitigate against the entrainment and mobilisation of solids during the construction process

TrueNorth Steel (2021)

Closed Culvert Erosion Control Good & Bad Examples – Section



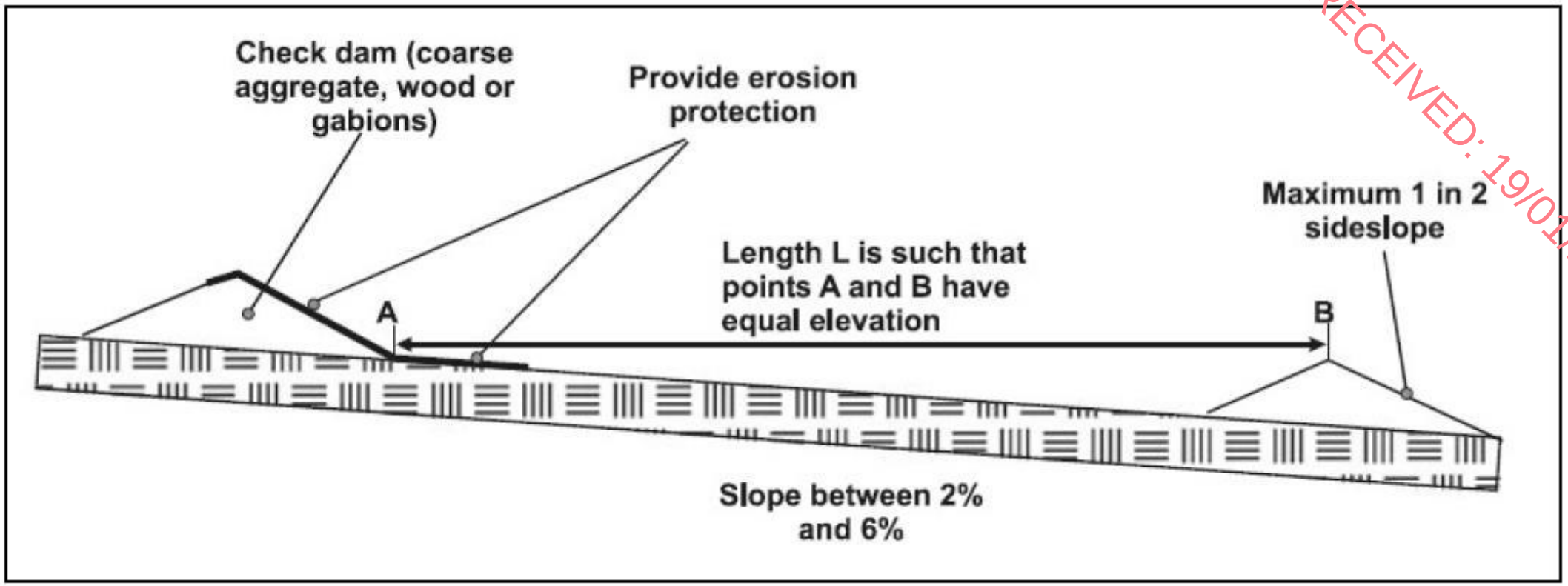
NOTE: Coarse aggregate will be used for erosion control. These areas at the openings of the culvert will also be designed to reduce velocity / discharge rate in turn further controlling erosion and providing additional beneficial impacts such increased attenuation time, increased recharge to ground etc.

Roadex Network (https://www.roadex.org/e-learning/lessons/drainage-of-low-volume-roads/components-of-road-drainage-system/)

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 2** **Culvert Watercourse Crossing – General Considerations**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

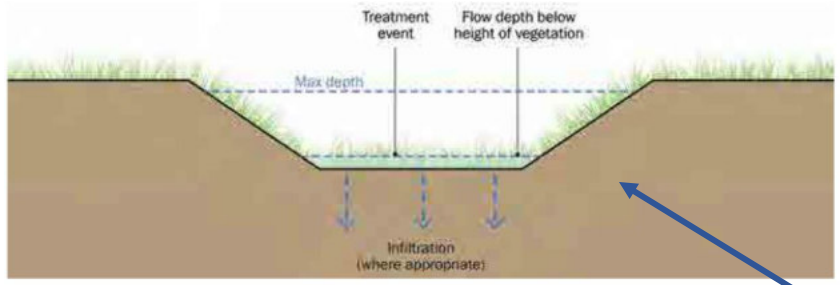
Constructed Drain and Check Dams – Section



Check Dam Design Consideration (CIRIA, 2004)

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	JOD		
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 3 Check Dams – General Considerations**	**Date:**	19/04/2023	**Reviewed By:**	SK
	Revision:	00		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



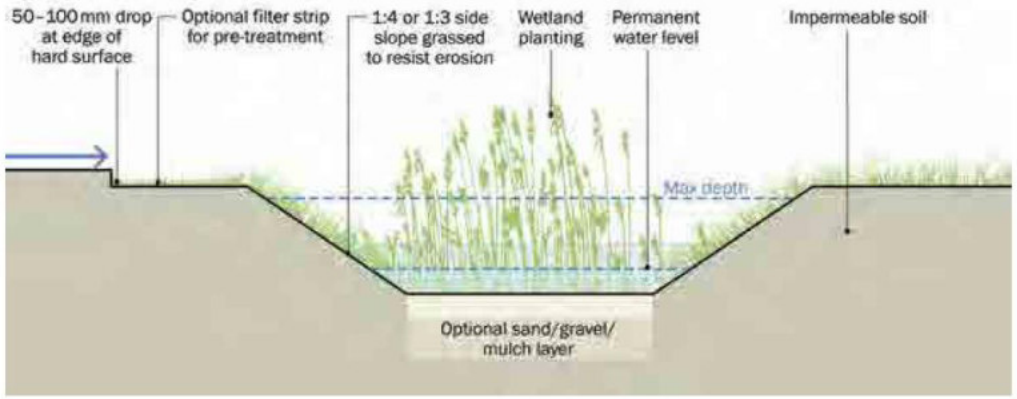
CIRIA SuDS Manual (2015)

A swale can have check dams installed at measured intervals across the flow path, that temporarily pond runoff to increase pollutant retention and infiltration and further decrease flow velocity.

Swale channels are broad and shallow and covered by vegetation, which slows the flow of water and facilitates sedimentation as well as filtration through the roots and soil matrix, evapotranspiration and infiltration into the underlying soil.

Image Source: Massachusetts Department of Environmental Protection (2023) <https://megamanual.geosyntec.com/npsmanual/checkdams.aspx>

Shallow, vegetated, open channel designed to direct, treat and attenuate surface water runoff with a potential for biodiversity benefits.



CIRIA SuDS Manual (2015)

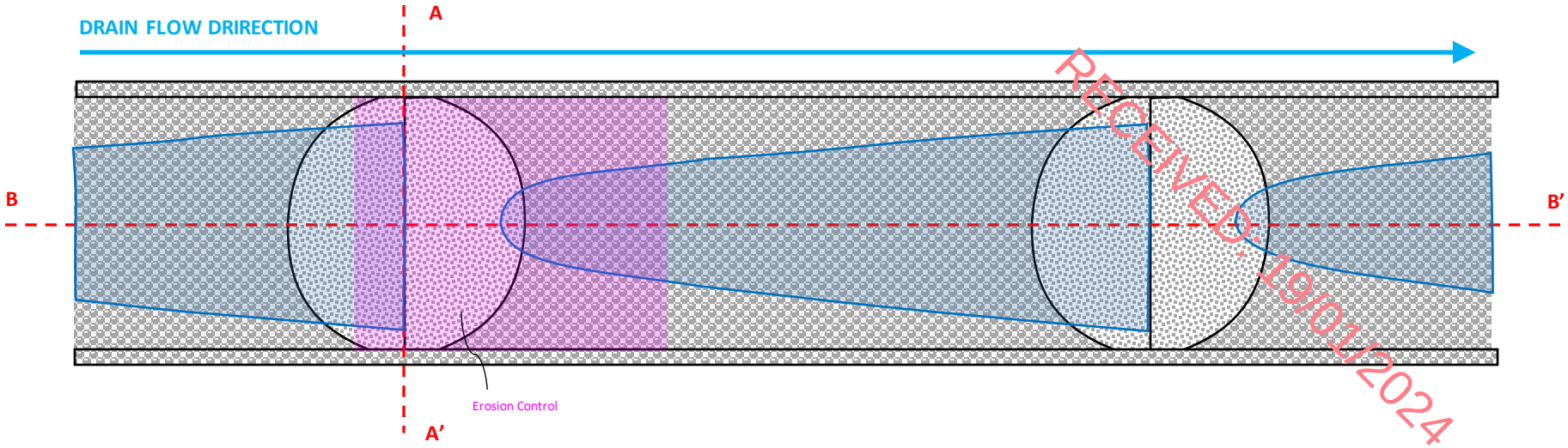
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 3a Check Dams – General Considerations**	**Date:**	19/04/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

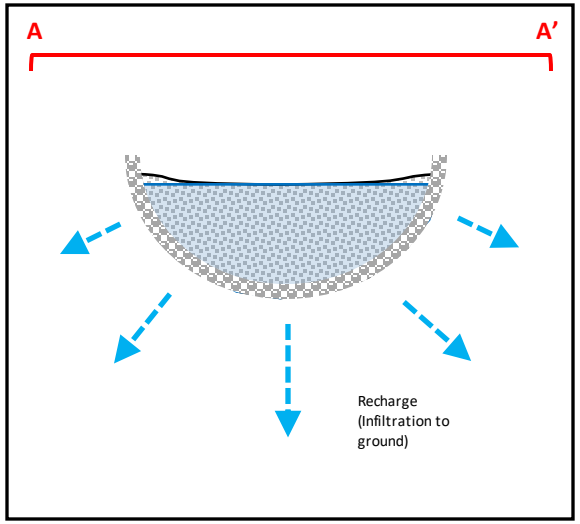
NOTES:

- The extensive use of check dams is recommended for the following reasons:
  - Management of runoff in terms of reducing flow velocity and minimising in channel erosion, or erosion at drainage outfalls.
  - Maximise attenuation of runoff with a view to enhancing runoff quality i.e. settlement of suspended solids.
  - Maximise attenuation of runoff with a view to reducing the hydrological response to rain fall at the site.
  - Maintain or improve the site hydrological/ hydrogeological regime with a view to maximising recharge to ground and increasing groundwater levels locally. This is particularly relevant for peatland areas.
- Check dams will be constructed with the following features and specifications:
  - A low flow pipe or small orifice to allow for low flows through the check dam.
  - Check dams will be permanent (life of development) and will be constructed with crushed rock with appropriate geo-chemistry (local) for example; coarse aggregate (100-600 mm). Wooden boards, gabions can also be used.
  - Erosion protection and energy dissipaters (cobbles / boulder 100-150mm diameter) which will extend approximately 1.2 – 1.8m downgradient of the dam and applied to both the base and side walls of the drain / swale.
  - Erosion control can be enhanced with the in-combination use of geotextile base layers (but consider low flow through).
  - It is recommended that the drainage channels / swales are entirely lined with coarse aggregate / erosion control. This will enhance mitigation in terms of attenuation, erosion control, and recharge to ground. Alternatively, allowing drains / swales to vegetate will achieve similar effects.

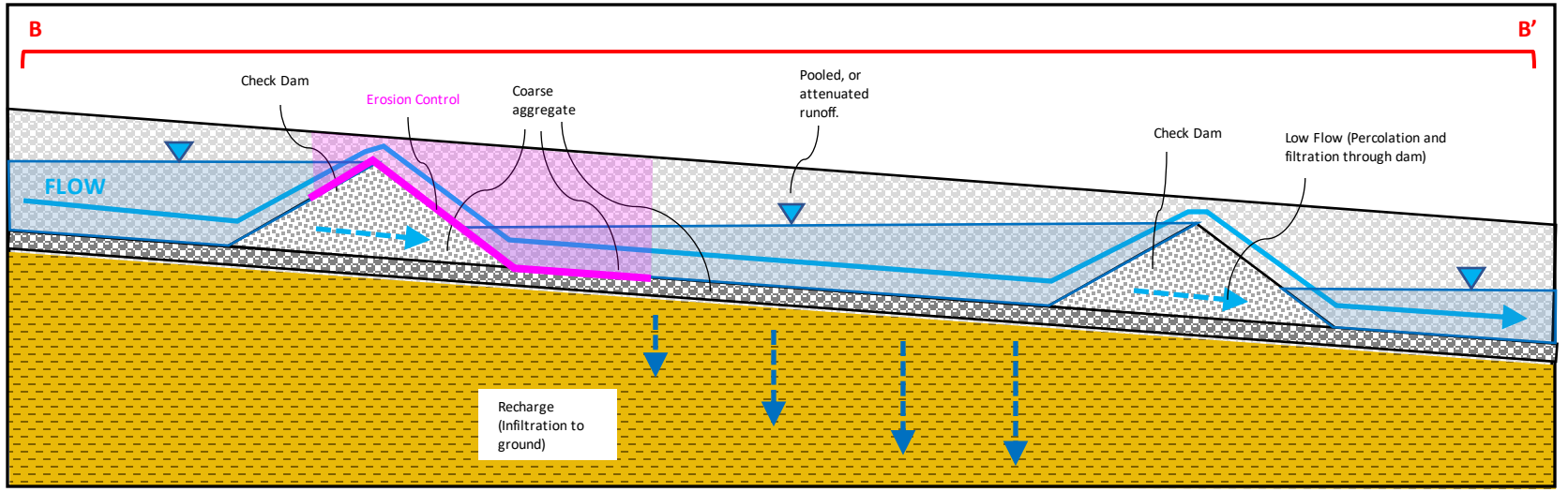
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A'



Constructed Drain and Check Dams – Section B-B'



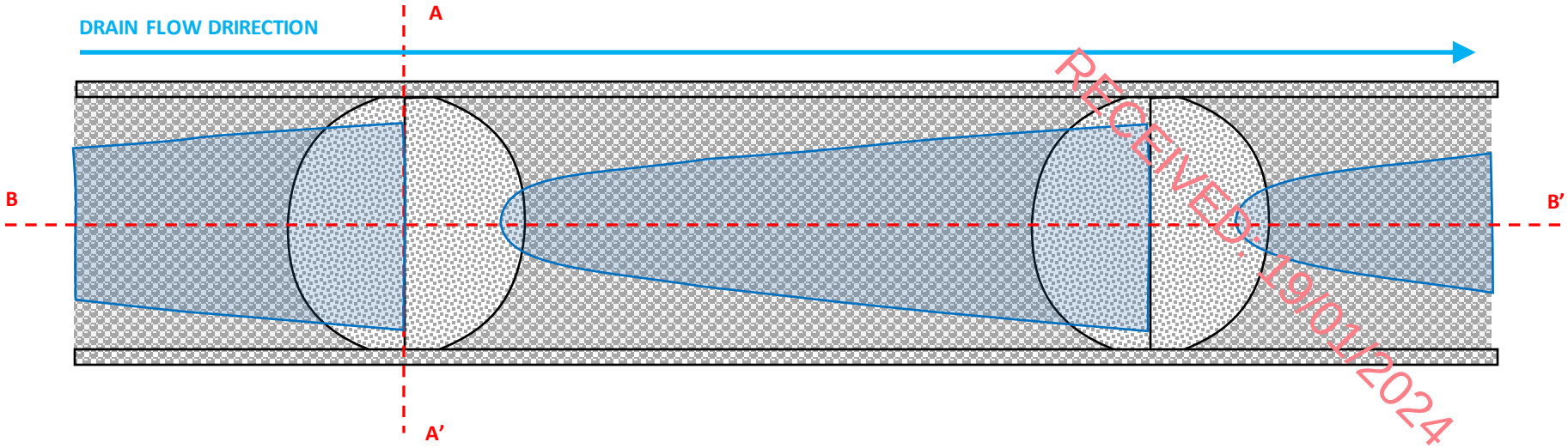
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 4 Check Dams – General Considerations**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

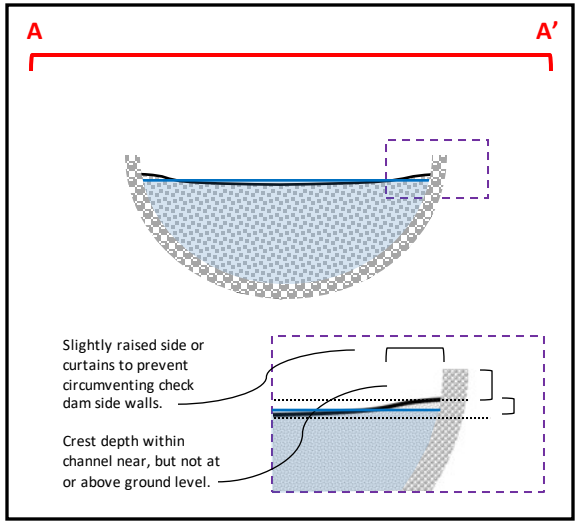
NOTES:

- It is recommended to align the elevation of the upgradient toe and downgradient crest. Therefore the spacing (L) of check dams will be dependent on the on the slope angle of a particular length (L) of drainage, whereby; on shallow slopes check dams will have larger spacing and on steeper slopes (up to 15 degrees *) spacing will be smaller.
- The purpose of aligning the toe and crest of respective check dams is recommended with a view to maximising pooling, or attenuation capacity of the drainage channel. The conceptual section presented here is designed with the downgradient crest (A) higher than the upgradient toe, as opposed to the crest (B) which is aligned with the toe. The purpose of this is to further enhance attenuation capacity at the dam, and to maximise hydraulic head ** and infiltration / percolation of runoff to ground water (recharge). However, this approach has limitations including for the potential to adversely impact undermine the integrity of the upgradient dam through erosion etc. or the downgradient dam through loading / excess weight. Mitigation measures including material selection, erosion control, and variable flow (V-notch) *** will be used where relevant to mitigate such impacts.
- (*) Check dams are recommended for drainage channels with slope angle up to 15 degrees. Drainage and runoff on steeper slopes (>15 degrees) will require different drainage velocity control features, for example; rock ripraps.
- (**) Attenuation of runoff in drainage channels is an opportunity to enhance recharge and reduce the hydrological response to rainfall at the site. However, detailed design will consider environmental and geological constraints, for example; enhanced recharge is not recommended in areas of elevated or high landslide susceptibility or risk.
- (***) V-Notch weirs discussed Conceptual Design – Drainage Infrastructure Check Dams – With Variable Flow Rate / V – Notch Weirs

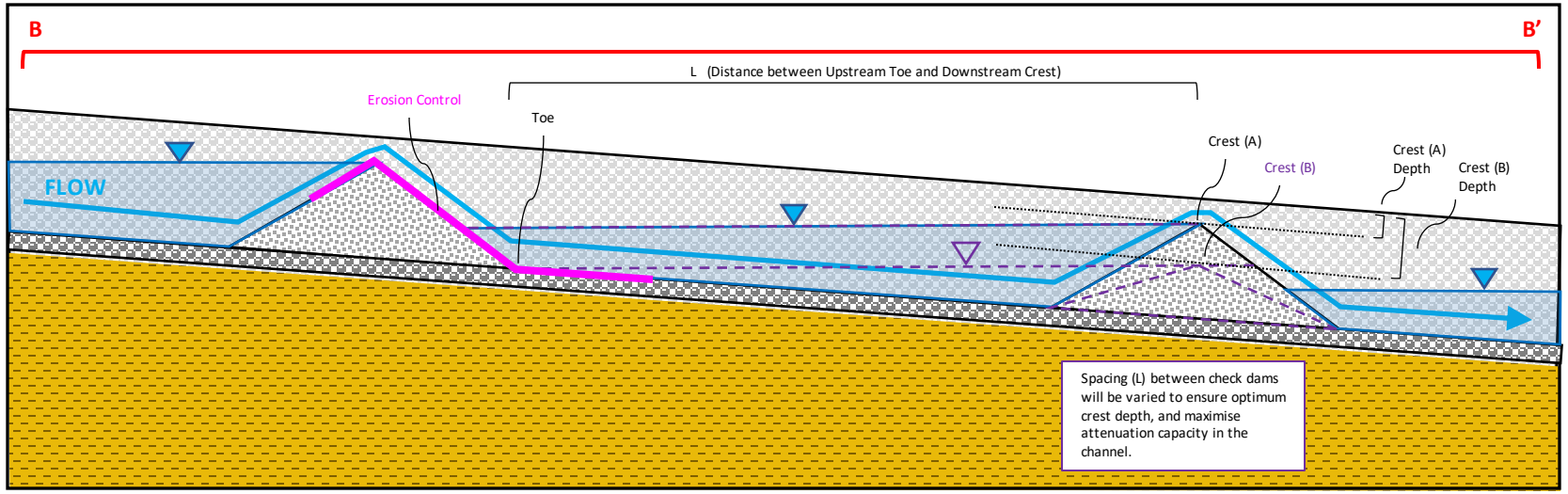
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A'



Constructed Drain and Check Dams – Section B-B'



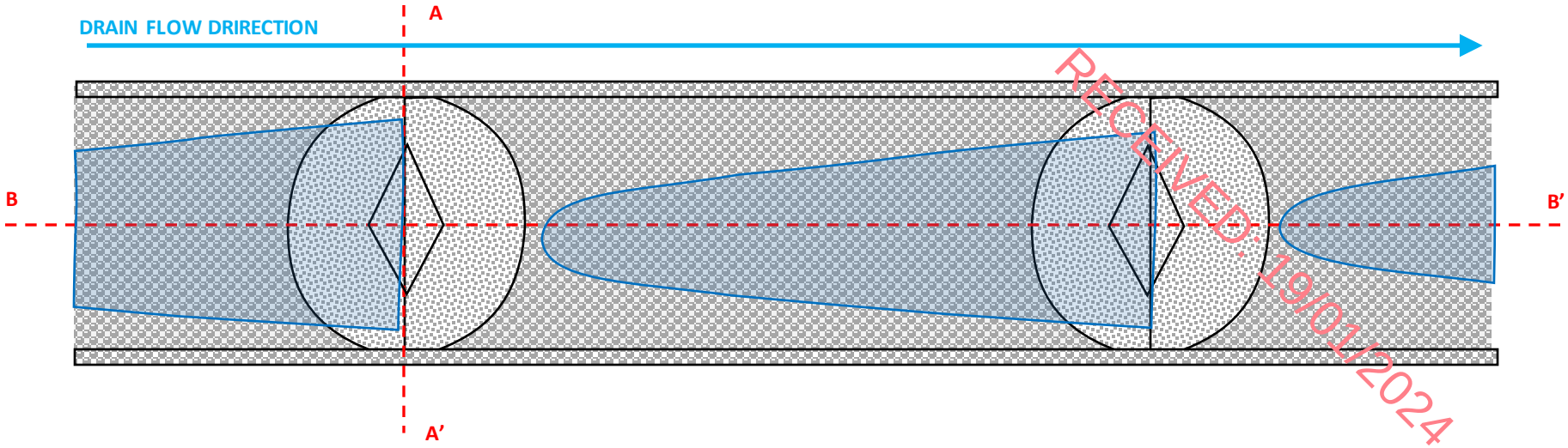
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 5 Check Dams – Design Specifications and Considerations**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

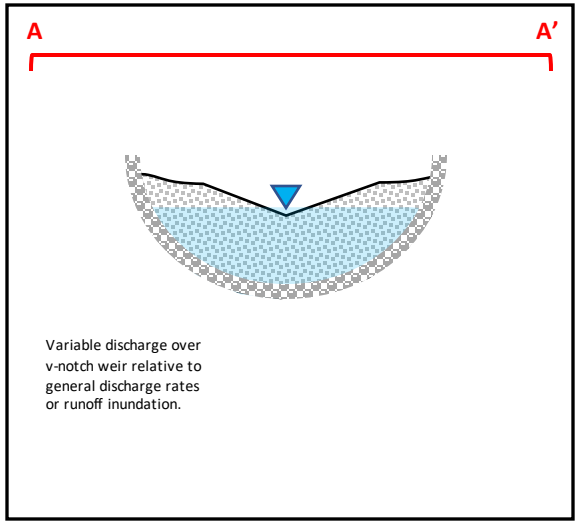
NOTES:

- V-Notch weirs can be included in designs as a control to mitigate against variable or peak flows / drainage discharge rates.
- V-Notch can also be employed to correct the elevation differential (between Toe and Crest) of respective in line check dams.

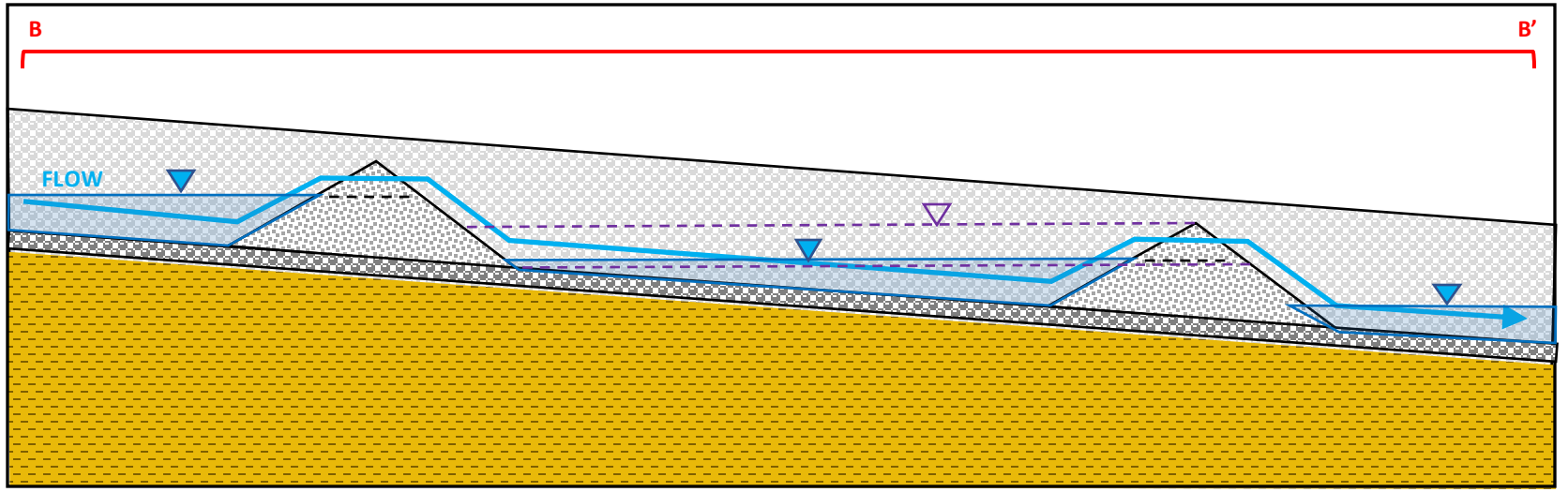
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A'



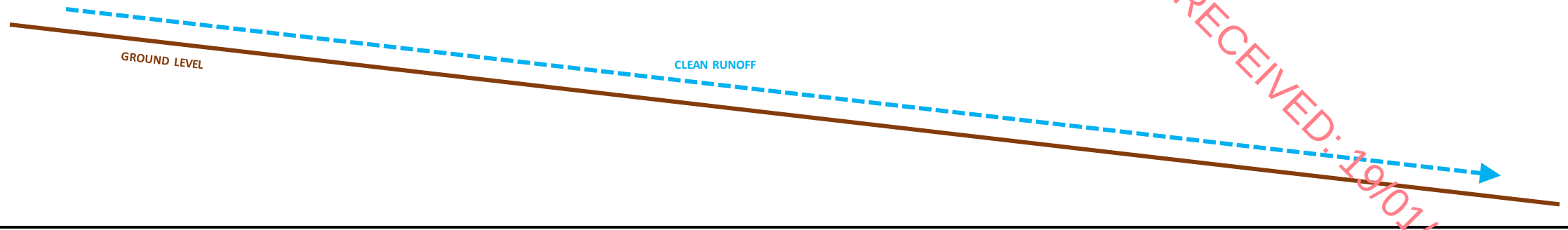
Constructed Drain and Check Dams – Section B-B'



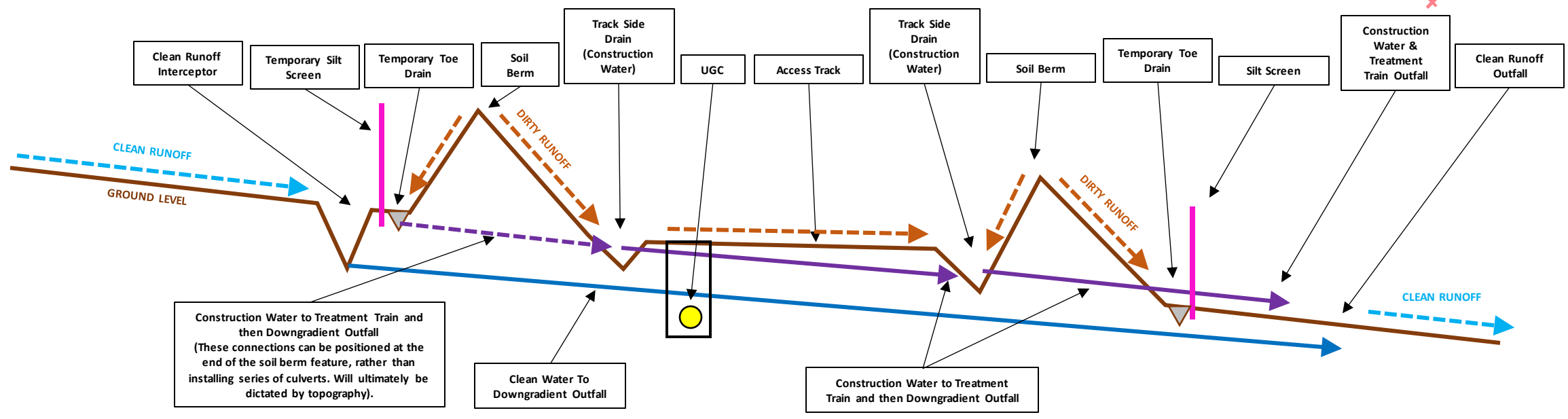
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 6 Check Dams – With Variable Flow Rate / V – Notch Weirs**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Drainage Section – Conceptual – Baseline Runoff



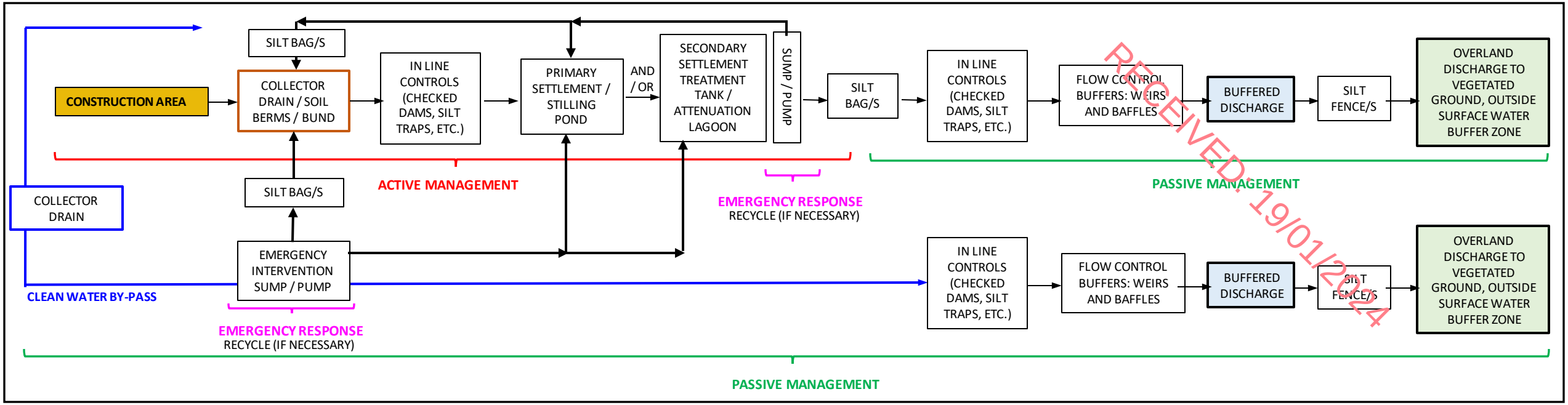
Drainage Section – Conceptual – Development Runoff & Controls



Site Name: **Letter Wind Farm, Co.Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 Conceptual & Information Graphics – Tile 7 Drainage – Track and Drains Section**	**Date:**	05/07/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

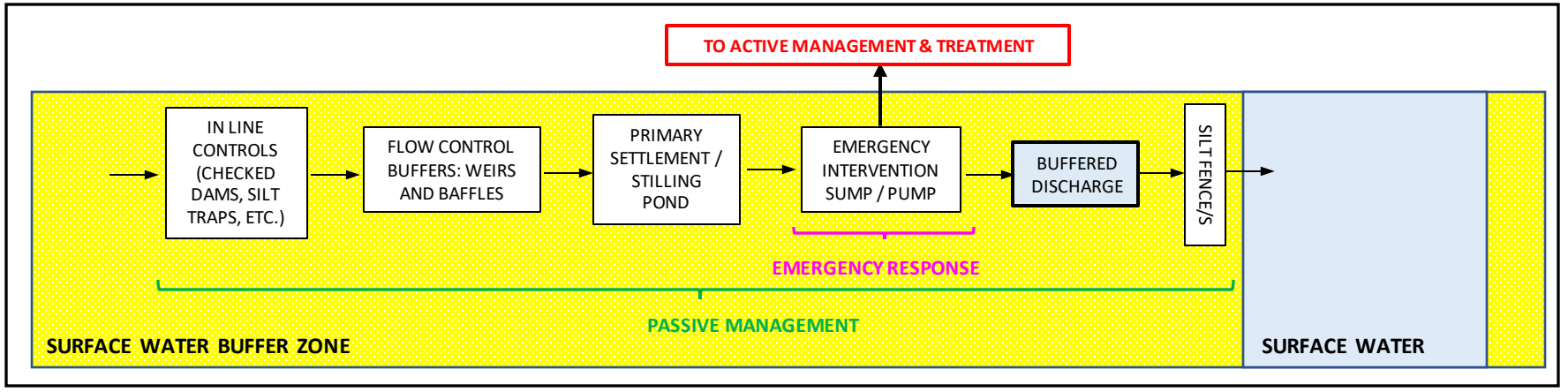
Conceptual Treatment Train Layout for Construction Areas (Access Tracks, Hardstand Areas, Turbine Base, etc.) & Clean Water By-Pass



NOTES:

- Wherever possible, outfalls will be positioned outside of Surface Water Buffer Zones.
- For areas of the development footprint within Surface Water Buffer Zones, in line measures such as silt screens will be over specified e.g. double / triple silt screens, and access to emergency intervention sump / pumps will be facilitated through design and/or emergency response.
- Quality of runoff entering buffer zones will be good i.e. suspended solids <25mg/l. Where runoff quality is poor, emergency response will be to use an intervention sump / pump and pump divert runoff to an area of the drainage network where it will be treated before redistribution and discharge.

Conceptual Treatment Train Layout for Construction Areas & Associated Infrastructure within Surface Water Buffer Zones

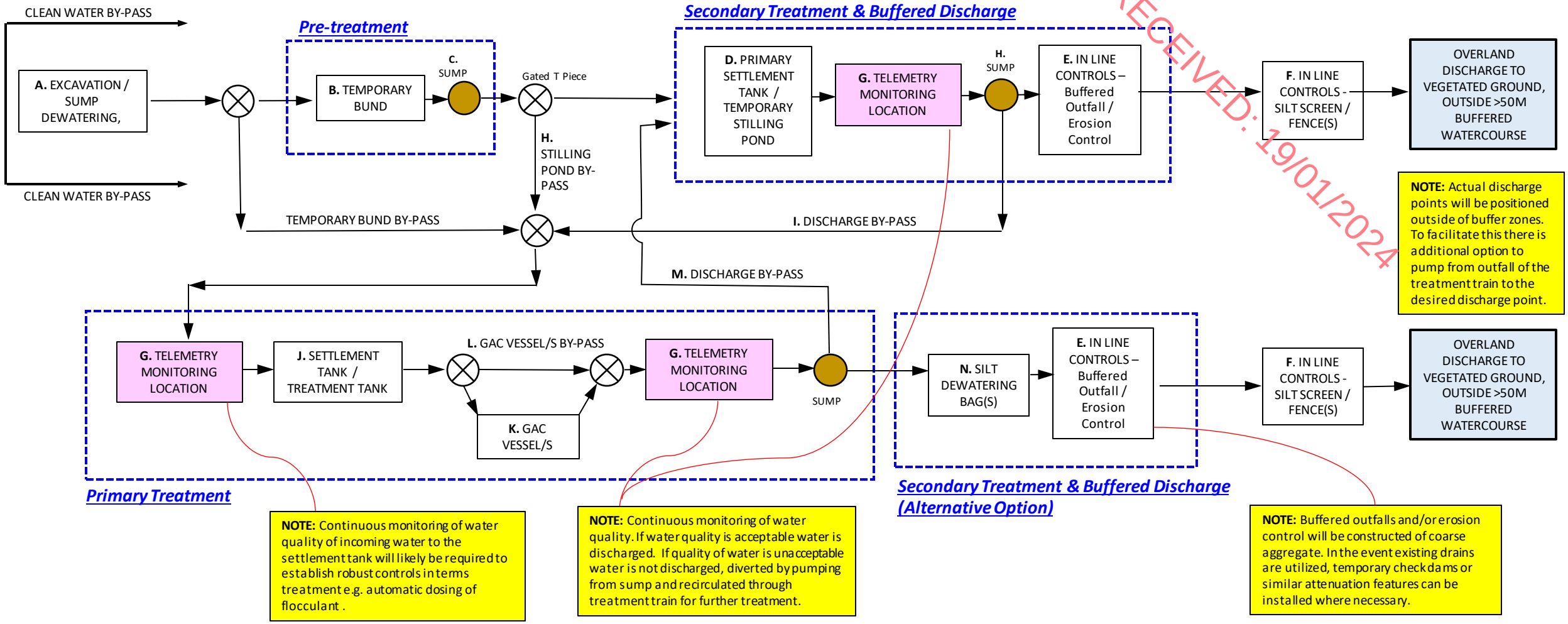


Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 8 Water Treatment Train Layout Flow Diagram**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Conceptual Dewatering and Treatment Train Flow Diagram

Contaminated water arising from construction works, namely; excavations and temporary stockpiling, will be contained and treated prior to release or discharge.
The schematic presented here is a conceptual model of measures implemented to manage arisings and runoff.



Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 9 Conceptual Dewatering and Treatment Train Flow Diagram**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

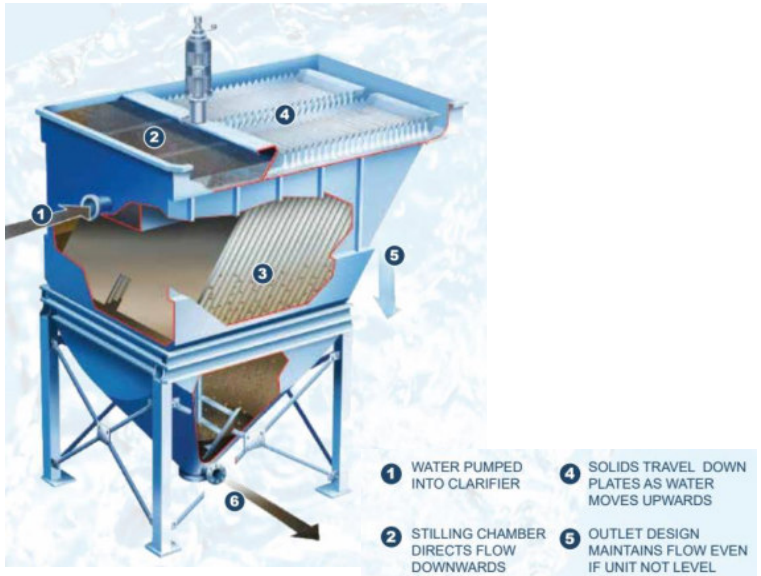
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/ibc-storage-tank-pallet-spill-containment-bund-stand/?sku=IBCSP&gclid=Cj0KCQiA8aOeBhCWARIsANRFrQFTsDlSEUrk4rdov4TcTBQOwNZguishep9-yj6_qx9NexUXnAv6ONkaAq8ZEALw_wcB>

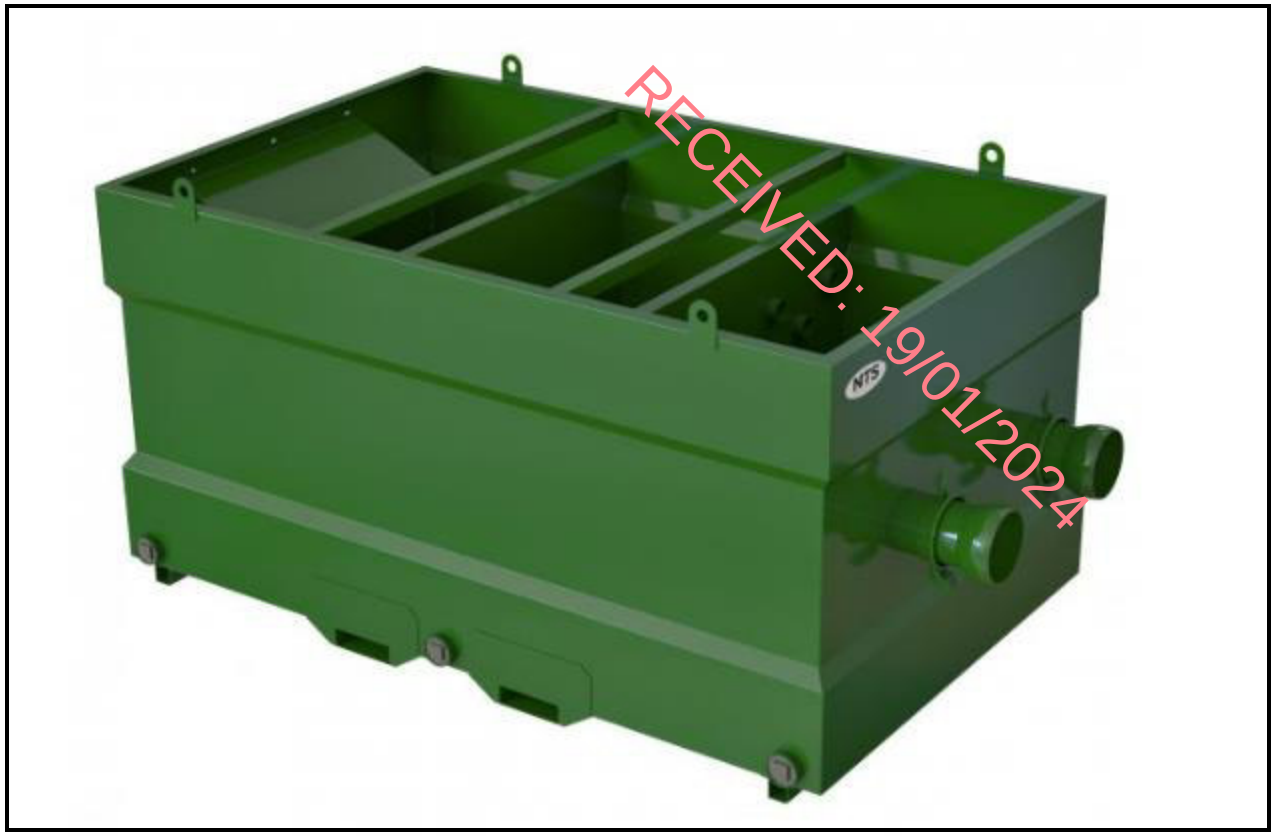
Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/bp4c-covered-4-drum-spill-pallet-bund-sump/?gclid=Cj0KCQiA8aOeBhCWARIsANRFrQFNE1gbC8i9OUP2HLpHeKcFDNjrurp_ui5Nz6rmRa1WblNXRH17di8aAn-kEALw_wcB>

Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/gsp2ibc-galvanised-steel-double-ibc-spill-pallet-bund/?gclid=Cj0KCQiA8aOeBhCWARIsANRFrQGfh5e3lUi9TcfRiXMAcEnilLo5gFmKlb0_dHBi7MRkIwiM0cU7F2oaAkDSEALw_wcB>

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile no. 10** **Examples of Mitigation Measures During Construction Phase- Environmental 'Good Practice' of Bunded Materials**	**Date:**	19/04/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			



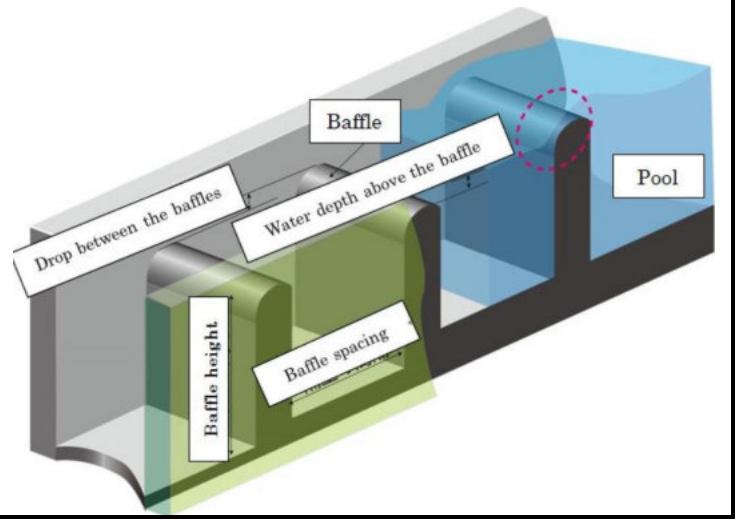
Siltbuster ® (2017) "Solutions for Suspended Solids Removal: Hire, Sales & Technical Support" Siltbuster Ltd. Available at: https://www.siltbuster.co.uk/wp-content/uploads/2020/10/Solutions-for-Suspended-Solids-Removal.pdf.



Example of a Water Settlement Tank used during the construction phase of Developments. Northern Tank Store, 2023) Available at: <https://www.northerntankstore.co.uk/4500-litre-water-settlement-tank?source=googlebase&gclid=Cj0KCQiA8aOeBhCWARIsANRFrQEE5dO0G9tiEpP2Uh2LkIwGP8QCNjG1qTeoypePyxNCHtzEls-wljYaAk2QEALw_wcB>

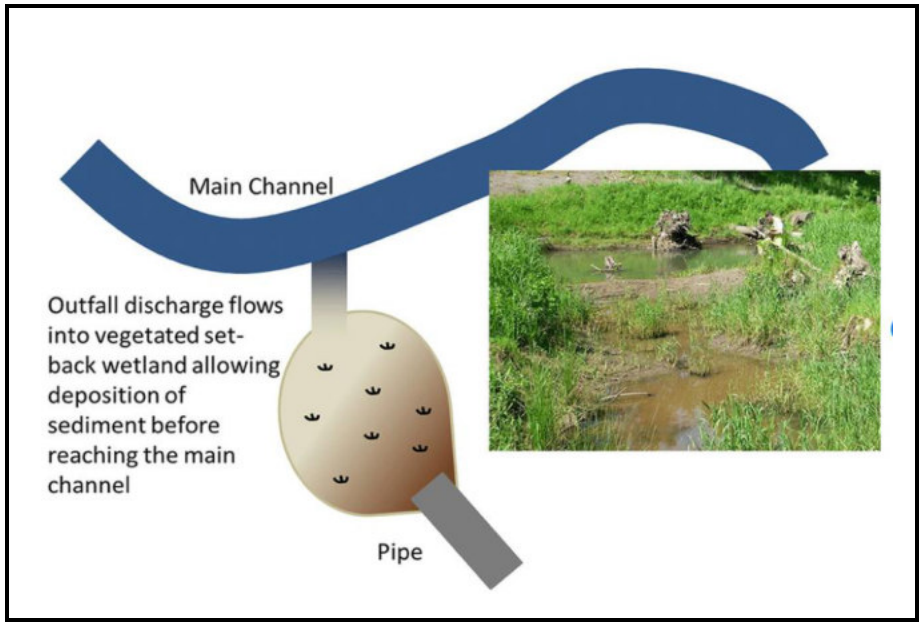
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientists	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile no. 11 Examples of Mitigation Measures to Reduce Sediment Transport; Settlement Tank**	**Date:**	19/04/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Conceptual graphic of weir pool and the use of baffles
(Public Works Research Institute, 2015)

Example of an underflow baffle in a weir pool, in practice
(Open Channel Flow Manufacturers, 2022)



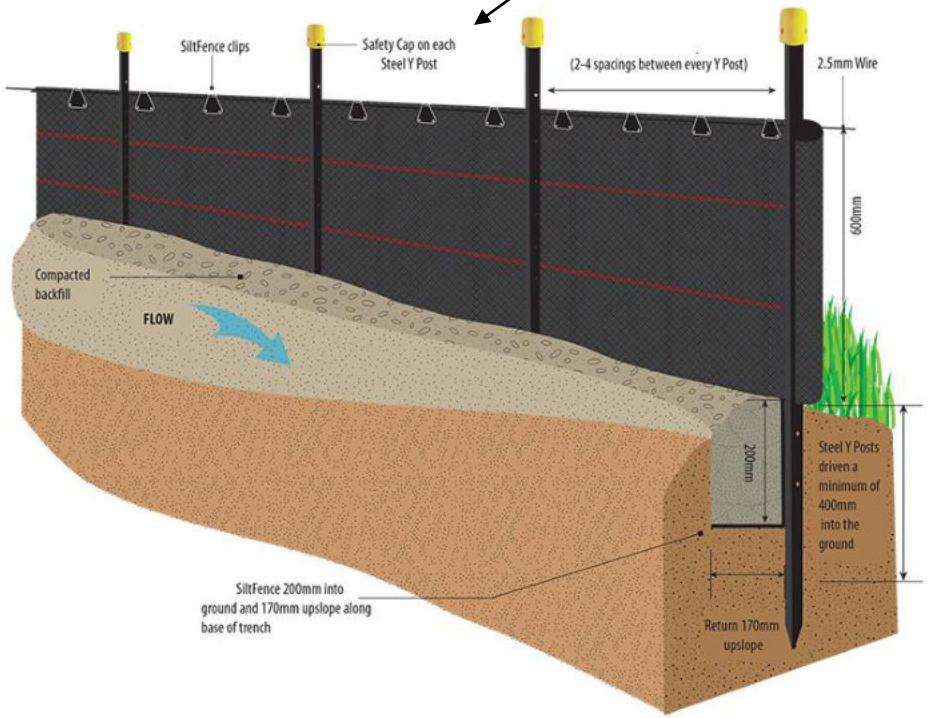
Conceptual graphic of a discharge to vegetated outfall
(Janes-Bassett *et al.*, 2016)

Example of a silt bag
(Cascade Geotechnical Inc., 2022)

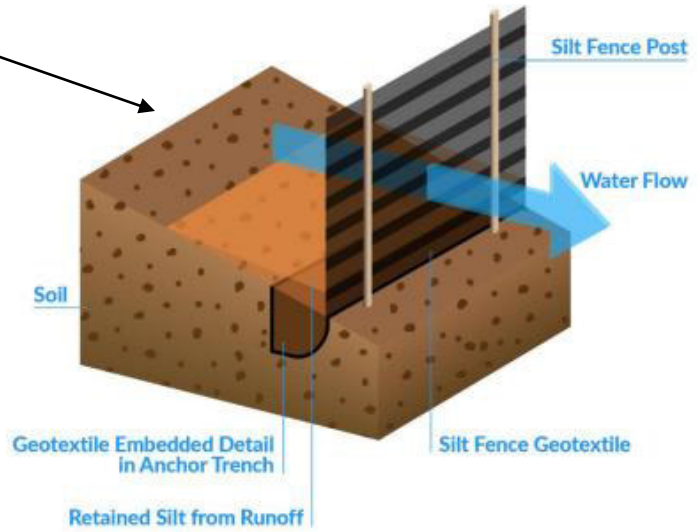
Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 12** **Examples of Mitigation Measures to Reduce Sediment Transport**	**Date:**	19/04/2023	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Temporary barrier fabric used to retain erosion of sand, silt, and clay. Geotextile silt fencing acts as a vertical, permeable, interceptor to sediment-laden waters from construction.



Conceptual graphic of a silt fence
Tech Weave (2020) Available at:<https://techweave.com/silt-fences/>



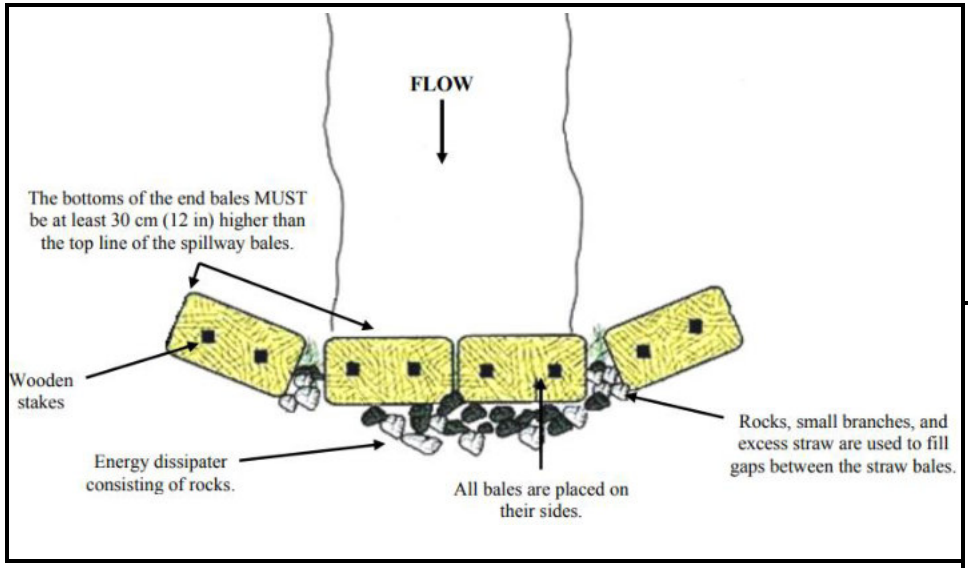
Conceptual graphic of a silt fence
Available at: https://www.pub.gov.sg/Documents/SiltFences.pdf

Example of Silt fencing in use
(EnviroPro, 2022) Available at:
<https://www.enviropro.co.uk/entry/153977/Siltbuster/Terrastop-silt-fences-for-erosion-and-runoff-control/>

Example of Silt fencing in use
Bowman Construction Supply (2023) Available at:<https://www.bowmanconstructionsupply.com/products/silt-fence/>

Silt fences control runoff by allowing water to pass through the fabric while collecting leftover sediment.

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile no. 13 Silt Fencing**	**Date:**	19/04/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			



Conceptual graphic of a straw bale checked dam
(Storrar, 2013)

Example of an underflow baffle in a weir pool, in practice
(Kawartha Conservation, 2020)

Example of buffered outfall with coarse aggregate
(Catchments and Creeks Pty Ltd., 2020)

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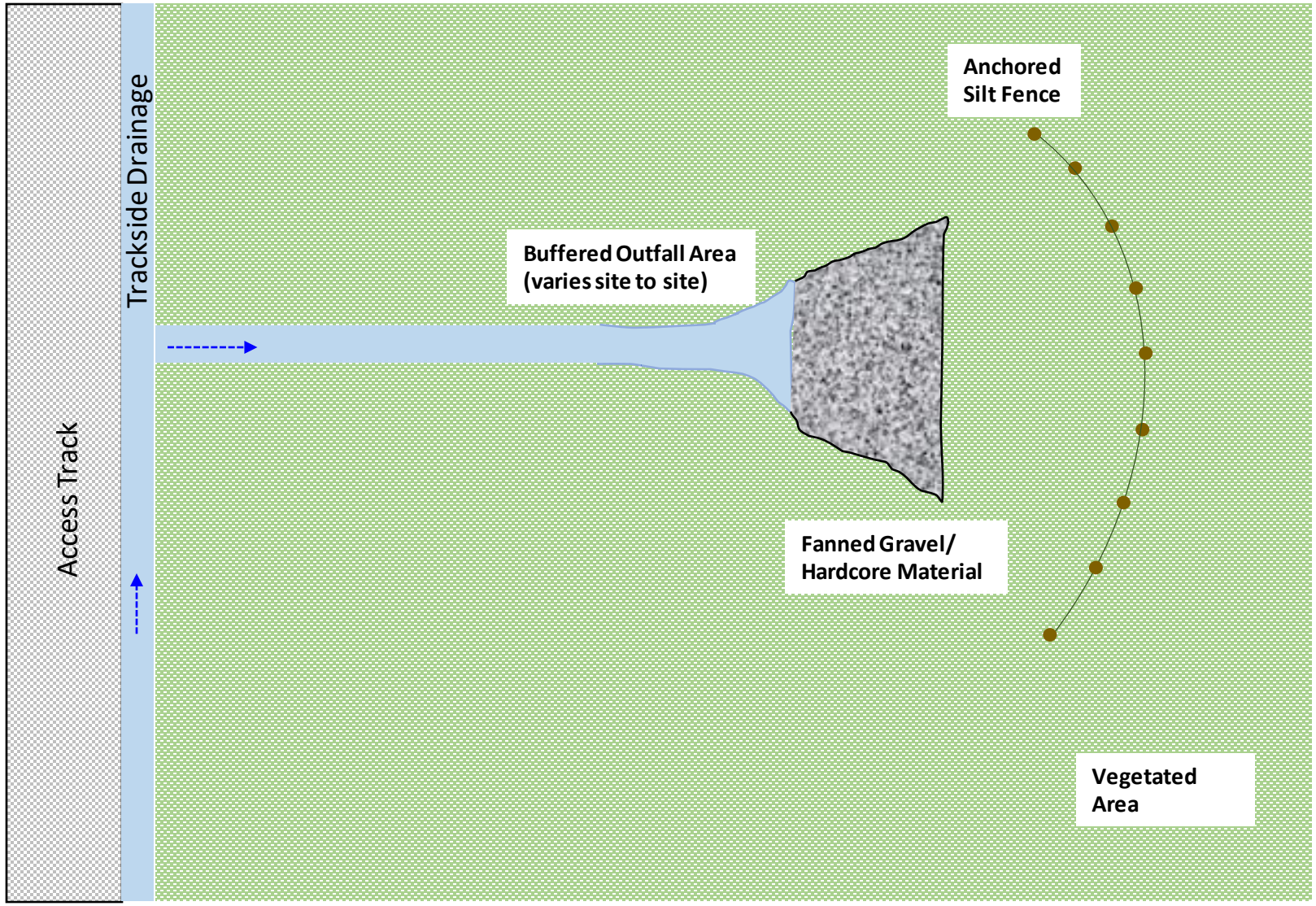
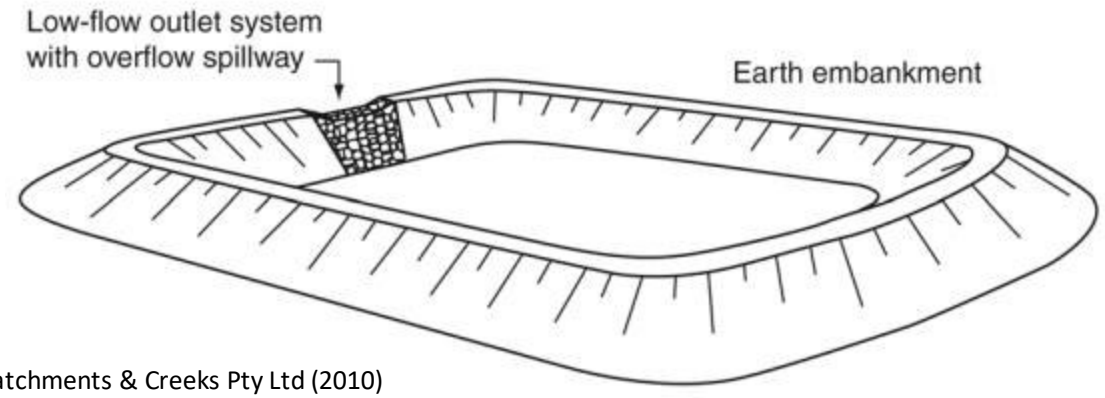
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 14** **Examples of Mitigation Measures to Reduce Sediment Transport**	**Date:**	19/04/2022	**Reviewed By:**	SK	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

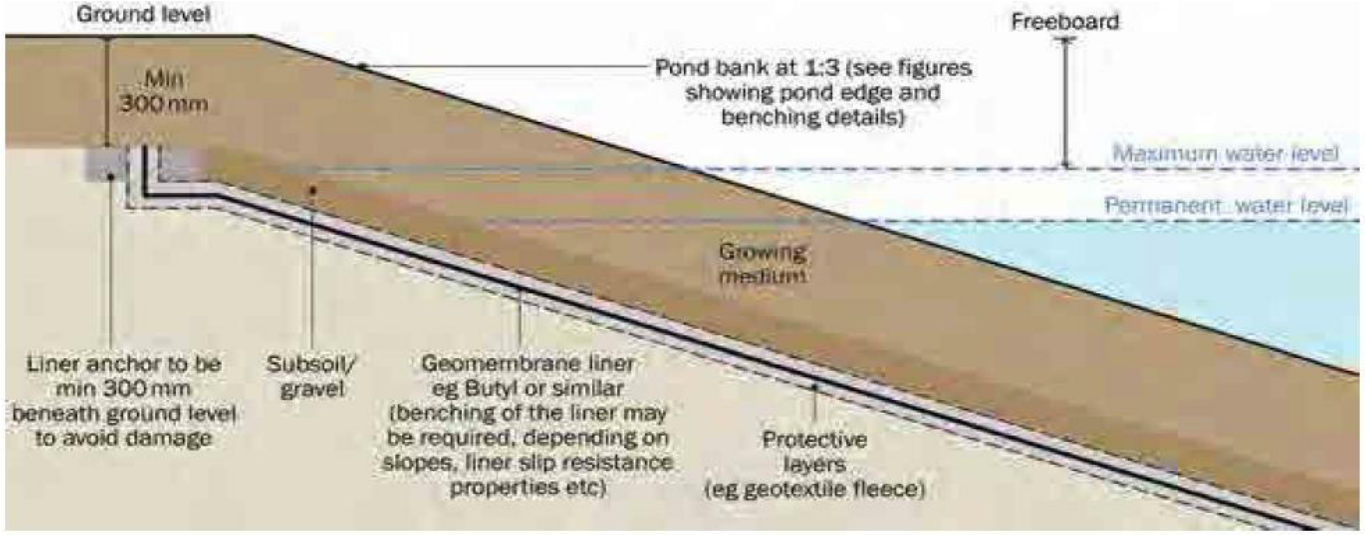


Site Name: Letter Wind Farm, Co.Leitrim	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	JOD		
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 15 Collector Drains and Buffered Outfalls**	**Date:**	05/07/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

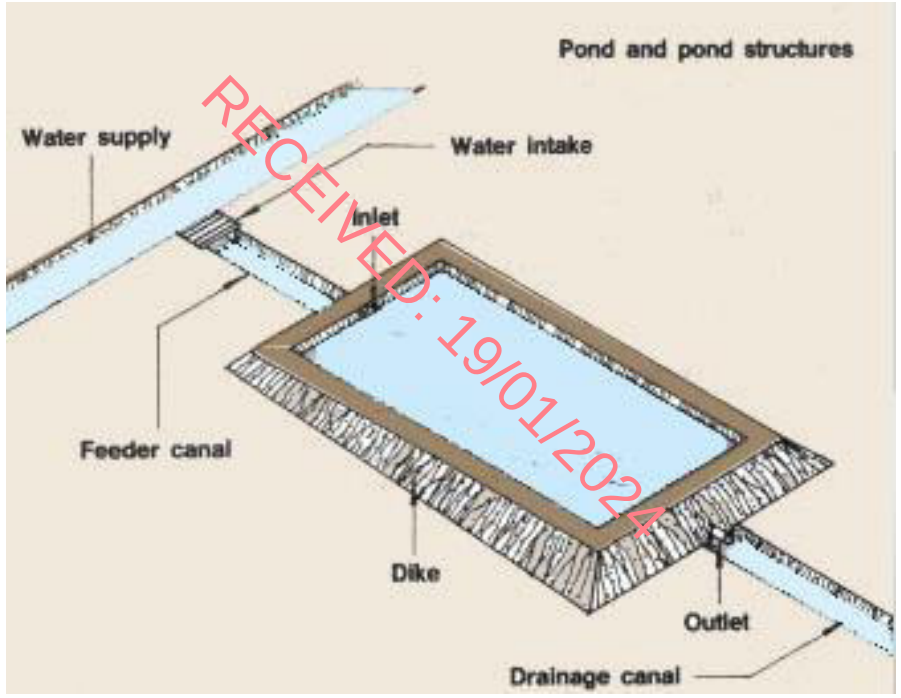
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Catchments & Creeks Pty Ltd (2010)
<https://www.catchmentsandcreeks.com.au/docs/SEP-1.pdf>



CIRIA SuDS Manual (2015)



United Nations Food and Agriculture Organization
<https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e01.htm>

Ponds should be designed to mimic natural forms and have varying depths which can provide a range of different habitats.

Site Name: **Letter Wind Farm, Co. Leitrim**	**Project No.**	603680	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	JOD			
Figure Name: **Appendix 9.5 – Conceptual & Information Graphics – Tile 16 Settlement Ponds**	**Date:**	19/04/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.