12.0 GUIDELINES FOR THE DESIGN OF SEDIMENT CONTAINMENT

12.1 General

The function of a sediment containment system is to provide storage capacity to runoff volume and to slow the flow velocity of runoff to allow the sedimentation of suspended soil particles to occur. When designed correctly, most sediment containment systems do one or more of the following:

- Provide containment storage volume for incoming runoff waters;
- Create uniform flow zones, increased flow path length and width and increased sedimentation times to facilitate sedimentation of suspended particles; and
- Discharge water at a controlled rate that permits adequate detention time for sedimentation of suspended particles.

It is important to note that 100% reduction of all incoming suspended particles is not feasible due to practical limits of storage space and available settling time. Therefore, the efficiency of a containment system is based on the efficiency of sedimentation of a target soil grain size.

The sediment containment system should be designed so that the outflow rate during the design rainfall event is equal to or smaller than the inflow rate of sediment-laden runoff. Coarse to medium size silt particles (particle size range 75 μm to 20 μm) can be realistically targeted for sedimentation. Finer size particles (i.e., clay and fine silt) will require a long time to settle and therefore may not be deposited in the sediment containment facility during the time of retention. As such, targeting clay, fine silt particles and organic silts for sedimentation is generally not practical.

The design capacity of a sediment containment system should be sufficient to impound the runoff volume collected from an area of disturbed land (bare soil) for a 1:2 year storm event of 24 hour rainfall intensity or a recommended runoff volume of 250 m^3 per hectare of disturbed land. Under conditions of land constraints, a minimum runoff volume of 150 m^3 per hectare can be considered. The designer of a sediment containment system should consider the flow rate at which sediment laden runoff enters the system and ensure that sufficient geometry exists to permit adequate sedimentation to occur before the flow exits the system.

12.2 Containment Systems (Type I, II and III)

The type of containment system should be selected based on site specific conditions. The selection should generally be based on the following:

- Site erosion potential classification;
- Area of upstream soil exposure;
- Terrain conditions and space constraints; and
- Method of construction.

Construction of the containment system should be completed at high risk areas prior to any land disturbance and construction.

The selection of the location and type of sediment containment system should be based on the experience and judgement of the designer. The criteria for selection of the type of sediment containment systems are presented in Table 12.1.

Table 12.1: Containment System Types

Containment System *	Site Erosion Potential Classification	Design Particle Size *	Affected Land Area *
Type I (Sediment Basin)	High to Very High	Particle size ≤ 0.045 mm (medium silt and finer)	>2.0 ha
Type II (Sediment Trap)	Moderate	0.045 mm < Particle size ≤ 0.014 mm (fine sand, coarse to medium silt)	<2.0 ha
Type III (Sediment Barrier)	Low to Very Low	Particle size >0.14 mm (medium to fine sand, coarse silt)	Grade break and velocity retarder for construction and intermediate areas

*Source: Fifield, 2001

The three types of sediment containment systems are discussed in the following sections.

Type I (Sediment Basin)

Type I sediment containment system requires development of a structure to capture coarse to medium silt and a portion of smaller suspended particles. Since particles of this size have low settling velocities, large storage volumes, long flow-path lengths, and controlled discharges are required. As such, the containment basin will be configured accordingly to provide sufficient retention time and flow velocity reduction to permit sedimentation. Type I systems are designed to have the highest possible net efficiency and are best represented by the traditional sediment basin.

In general, sediment basins should be sized for a minimum recommended storage volume of 250 m^3/ha where possible over the contributing disturbed bare soil area. Length (L) to width (W_e) ratio should be between 4:1 and 8:1. A practical width (W_e) can be 6 to 8 m. Generally, a practical pond depth is 1.2 m. The maximum pond depth should not exceed 1.5 m. An illustration of the Type I structure is presented in Figure 12.1.

Type II (Sediment Trap)

The Type II sediment containment system will capture suspended particles (fine sand to coarse silt) having higher settling velocities than particles requiring Type I structure. Consequently, small storage volumes and shorter flow-path lengths in comparison to widths can be used. As with a Type I structure, these sediment control systems will also have controlled discharges. Whereas their net effectiveness for the inflow and sedimentation of all suspended particles may be low, Type II systems will still have an effective sediment control measure.

In general, sediment traps should be sized for a recommended storage volume of 250 m^3/ha over the contributing area, where possible; or a minimum storage volume of

150 m³/ha under conditions of land constraints. Length (L) to width (W_e) ratio should be between 2:1 to 3:1. A practical pond depth can be 1 m and the maximum pond depth should not exceed 1.5 m. Illustrations of Type II structures are presented in Figure 12.1 and Figure 12.2.

Type III (Sediment Barrier)

The least effective method to control suspended particles in runoff waters is represented by the Type III sediment containment systems. These are not necessarily design structures, as found with Type I and Type II systems, but are often BMPs (such as drainage ditch check structures). Whenever significant runoff occurs, all Type III systems have very low net and apparent effectiveness to control suspended particles. However, when runoff is low, the Type III sediment control systems can be effective in reducing flow velocity and suspended particles (coarse silt to fine sand) along gentle grade areas as long as they are regularly maintained.

12.3 Design Considerations

The design of a sedimentation pond can be a challenge as design parameters are difficult to define (e.g., storm events, runoff, soil erodibility and distribution of erodible soil). Thus, the evaluation of the effectiveness of pond performance is difficult to quantify. Therefore, the design of sediment pond or review of its performance should be undertaken by a qualified engineer with a practical perspective in experience and judgement. A suggested design rationale for the design of sediment containment systems is presented in Appendix G.

The focus of sediment control should be placed on capturing silt and larger sized soil particles. It is not practical to design for clay particles or colloidal organic particles due to the significant amount of time required for them to settle. Therefore, the emphasis for preventing release of water containing clay particles or colloidal organic particles from a construction site should be placed as erosion control.

Methods that estimate the efficiency of a given sediment containment system should be used with caution as there are several variables that affect the effectiveness of these systems. Estimating the efficiency of a sediment containment system should be used as a preliminary means of evaluating various options. However, the final selection should be based on the site conditions and the experience and judgement of the designer.

Care should be taken when designing embankments, since these may have to be designed according to dam design guidelines and regulatory requirements. Regardless of the height of an embankment, the consequences of failure will determine the level of effort during design and construction. A qualified engineer should design the foundation and embankment, and provide inspection during and after construction. Similarly, the optimization of pond areas and depth to obtain maximum efficiency should be undertaken by a qualified engineer.

12.4 Design Examples

A design example for a sediment pond is presented in Appendix H as Example H.16.

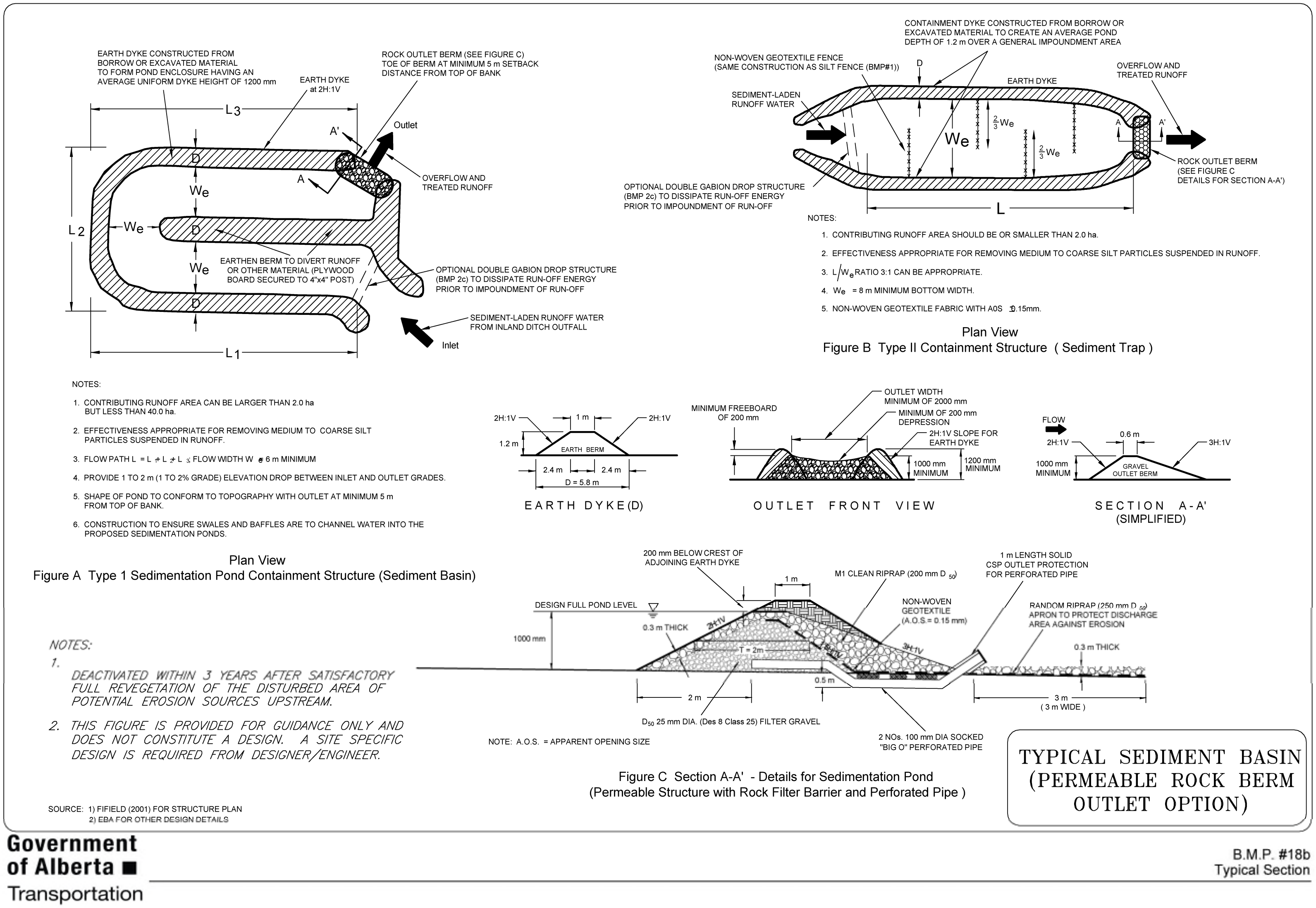

Figure 12.1: Type I and II Typical Sediment Containment Systems

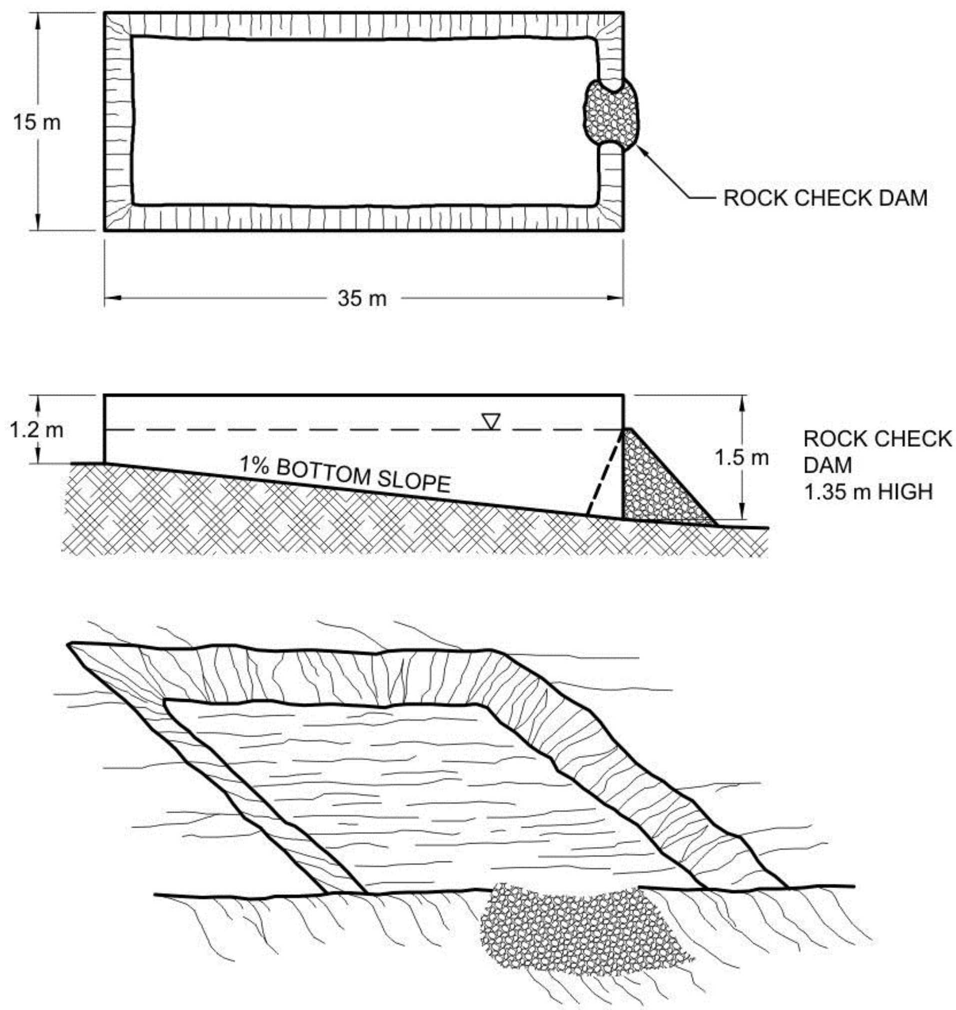

Figure 12.2: Type II Sediment Containment System (Sediment Trap) – Excavation Option

Source: City of Calgary, 2001