

For classroom exercise only, not all data is factual

Black Canyon Diversion, Idaho

Problem: Design a sediment management strategy to maximize reservoir life and allow for continued hydropower and irrigation water supply. The plan should include:

1. Method of sediment management
2. Necessary changes to dam
3. Frequency and approximate timing of the activity
4. Estimated impacts to water supply, hydropower, and other reservoir uses
5. Description of other downstream impacts or other ancillary impacts
6. Estimate of costs and benefits of sediment management activities
7. Description of impacts associated with not performing sediment management.

Background: Black Canyon Diversion Dam, on the Payette River near Emmett, Idaho, is a concrete gravity type dam with an ogee overflow spillway. The dam has a structural height of 56 m and serves to divert water to the Payette Division through Black Canyon Canal. The original capacity was 56 million cubic meters but heavy siltation has reduced the capacity to 21 million cubic meters. Water is diverted at Black Canyon Diversion Dam by gravity to serve the Emmett Irrigation District Canal on the north side of the river. The two unit powerplant had an initial total capacity capability of generating about 10,000 kilowatts. Since its closure in 1924, Black Canyon Dam has also been a popular recreation site for fishing and boating. Sand cannot pass through the powerplant.

Purpose: Primarily Irrigation Supply and Hydropower

Watershed: The watershed area is 7,057 sq km, has an annual average precipitation of 102 cm, and an average elevation of 1,700 m. It is approximately 33 % forested and 4% agriculture.

Sedimentation Rate: The average sedimentation rate in Black Canyon was 500,000 m³/yr from 1941 to 1983 and 420,000 m³/yr from 1983 to 2016. Reservoir sediment is approximately 70 % sand and 30 % silt and clay (D₅₀ = 0.3 mm, dry bulk density = 1400 kg/m³, porosity = 0.4). The reservoir was approximately 11 km long as constructed. The width of the reservoir is approximately 350 m and the width of the natural bank full channel is approximately 100 m.

Operations: Diversion of up to 30 m³/s occur during the months of June through September. Flow of up to 45 m³/s can pass through turbines and generate up to 10 MW.

Transport Rates: For the purposes of this class, the rate of sediment transport from the reservoir during a **drawdown** flush will be greatly simplified and can be estimated as suggested by Atkinson (1996):

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$$Q_s = K \frac{Q^{1.6} S^{1.2}}{W^{0.6}}$$

- Q_s = sediment transport capacity (metric tons/s)
- Q = flow (m^3/s)
- S = Slope of reservoir water surface for drawdown condition (-)
- W = erosion width (m)
- K = constant, which is a function of sediment grain size and erodibility; assumed 100 for this study

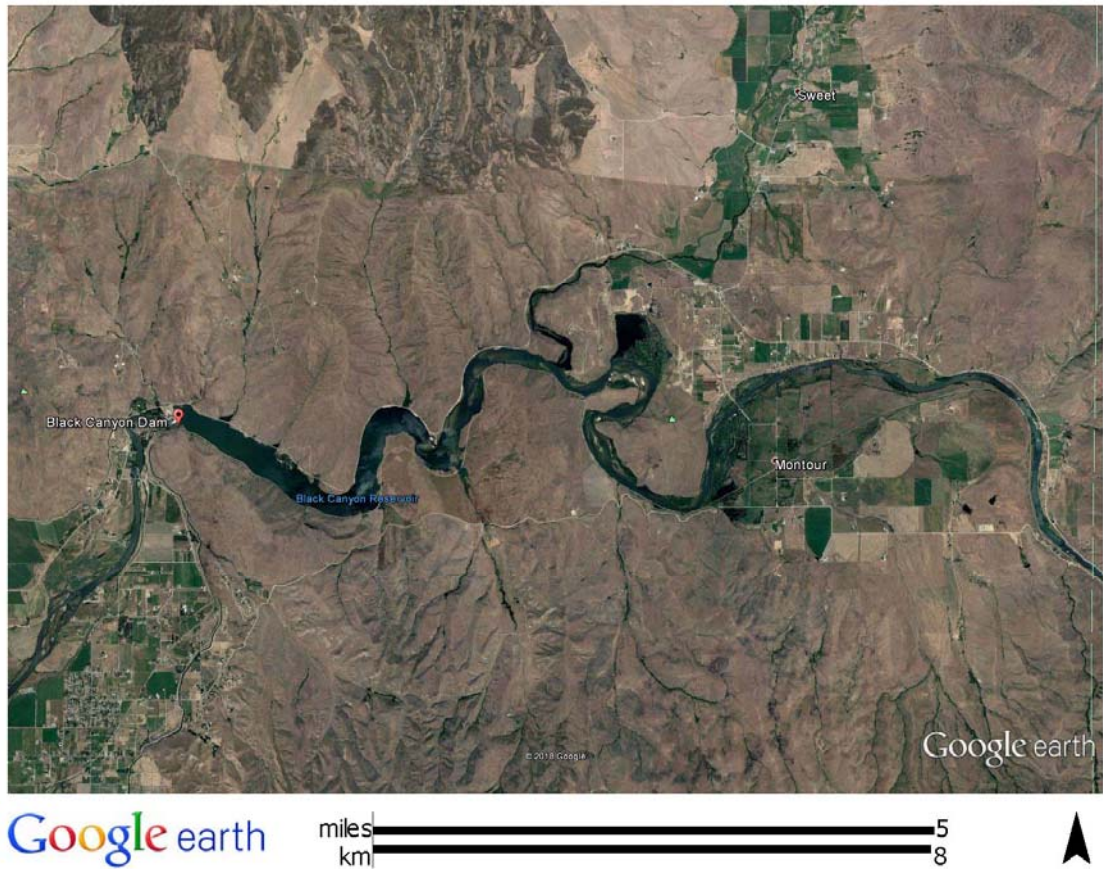


Figure 1. Overview map of Black Canyon Reservoir.

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Table 1. Dam and outlet information.

Parameter	Value
Spillway Elevation	761.4 m
Penstock Centerline Elevation	753.5 m
Low Level Intake Sill Elevation	734.4 m
Original Reservoir bottom elevation	732 m
Current Sediment Elevation at Dam	744 m
Low Level Gate Size	3.3 m x 1.5 m
Low Level Capacity	65 m ³ /s at Elevation 761.4 m
Turbine Capacity	45 m ³ /s at Elevation 761.4 m

Table 2. Storage versus elevation data for Black Canyon Diversion Dam.

Elevation (m)	Active Storage Volume (m ³)		
	1941	1983	2016
734.2	-	-	-
740.7	2,189,000	868,000	-
743.7	4,801,000	2,036,000	76,000
746.8	9,422,000	3,637,000	886,000
749.8	15,445,000	5,964,000	2,476,000
752.8	23,689,000	9,360,000	4,974,000
755.8	33,945,000	13,892,000	8,316,000
757.6	40,398,000	17,875,000	10,806,000
759.0	45,980,000	21,630,000	13,201,000
760.4	51,840,000	27,635,000	16,699,000
761.2	55,189,000	33,433,000	19,695,000
761.4	56,023,000	34,877,000	21,078,000

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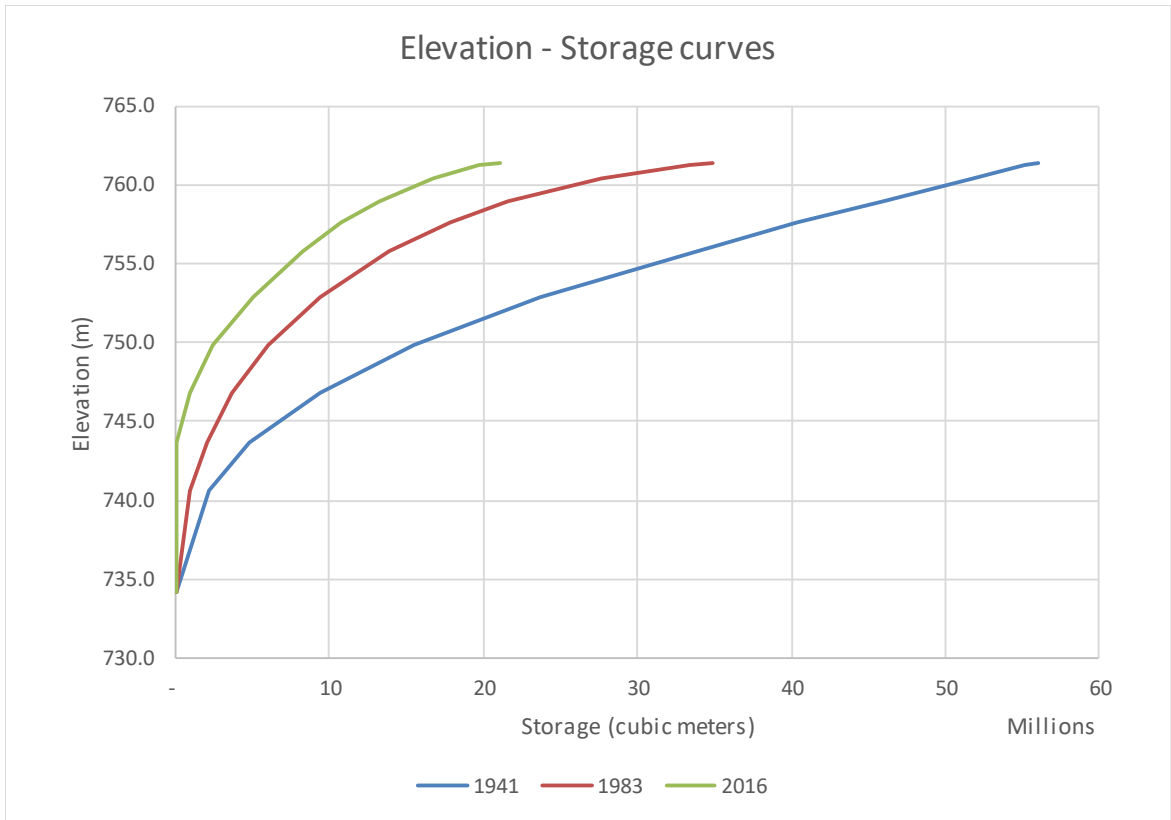


Figure 2. Elevation versus storage curves over time in Black Canyon Reservoir.

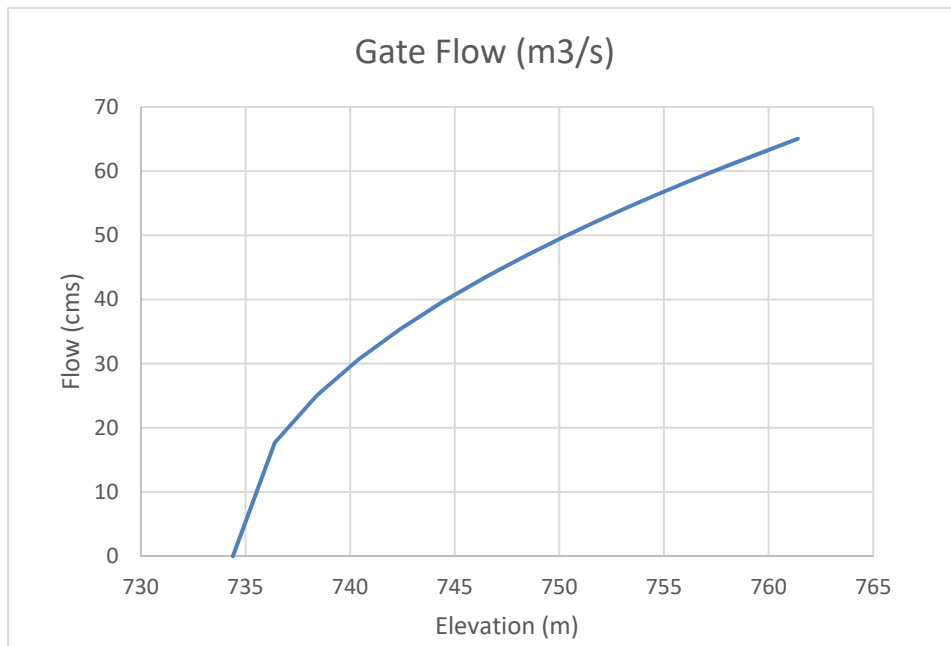


Figure 3. Rating curve at existing low-level outlet.

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Table 3. Monthly Average Inflows into Black Canyon Reservoir.

Month	Average Flow (m ³ /s)	Average Flow Volume (m ³)
Jan	38.9	104,147,000
Feb	44.6	107,831,000
Mar	69.9	187,267,000
Apr	144.3	373,929,000
May	221.5	593,159,000
Jun	219.4	568,657,000
July	104.2	279,143,000
Aug	74.9	200,529,000
Sep	57.5	149,048,000
Oct	36.3	97,175,000
Nov	34.2	88,654,000
Dec	38.2	102,336,000
Yearly	90.3	2,846,460,000

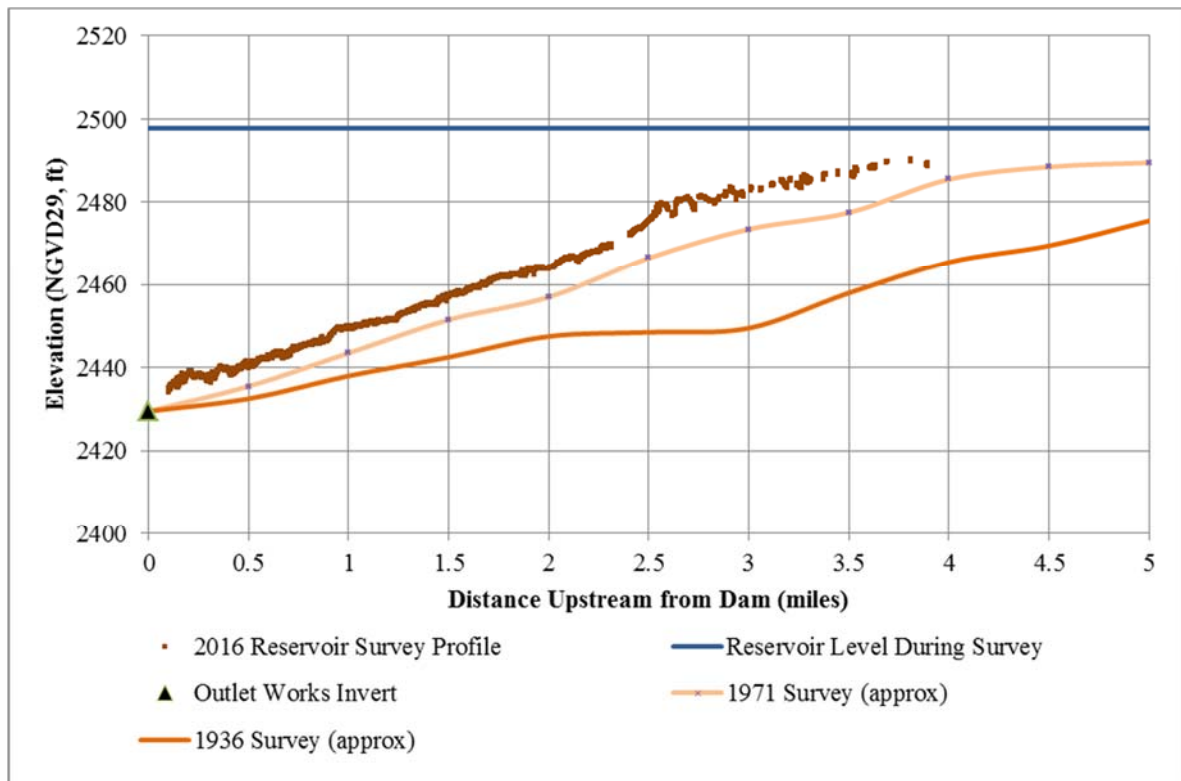
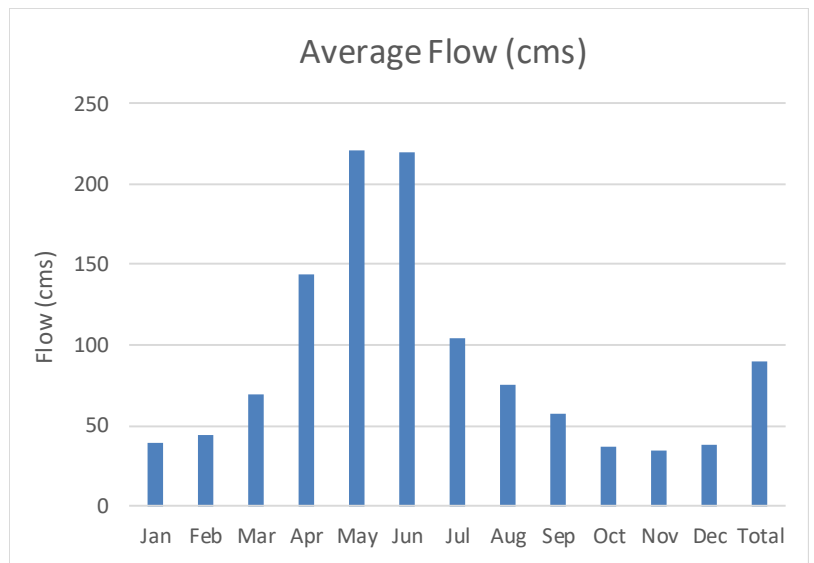


Figure 4. Profile of Black Canyon Reservoir.