



**2021 DAM MONITORING  
GUIDE FOR OPERATORS**



**NORTHWEST TERRITORIES  
POWER CORPORATION**

## **INTRODUCTION:**

This Document provides information to assist the Operators in the Inspection of the Dams in The Northwest Territories Power Corporation's Hydro System

The Operators are required to be thoroughly familiar with the Dams to the extent that any change in condition can be recognized and reported to the Dam Safety Engineer.

## **Overview:**

Dams are located throughout Canada and vary in size. They are constructed as single or multi-purpose structures for the following:

- fishing and recreation
- flood control
- hydropower development
- industry
- irrigation and agriculture, including livestock watering
- municipal/household water supply
- tailings containment
- wastewater containment, including sewage lagoons

Dams can be located either on-stream or off-stream. On-stream dams have been constructed on most major rivers and tributaries to store spring runoff. The storage reservoirs created by these dams provide water year-round for the various uses mentioned above. Most have become multi-use facilities and serve as the cornerstone in the development and management of water resources in river basins.

River flows are generally variable year-round as they are primarily fed by glacial and/or snowmelt in the spring and precipitation during the remainder of the year. Highest flows typically arrive in the spring, allowing reservoirs to be filled before the dry summer months when water demands reach their peak.

Off-stream dams are typically used to collect storm water, hold mining tailings, or as sewage lagoons or industrial water supply and storage.

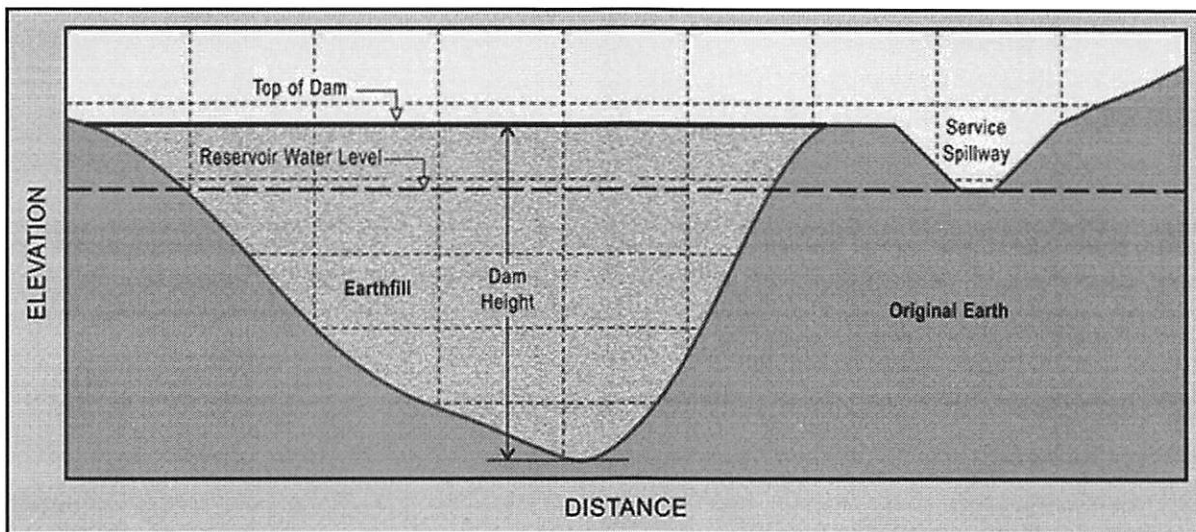
**Dams pose risks and consequences, especially in the case of a breach or failure; therefore, it is important to understand what a dam is, where they are located and who is responsible for their safety.**

## What is a dam?

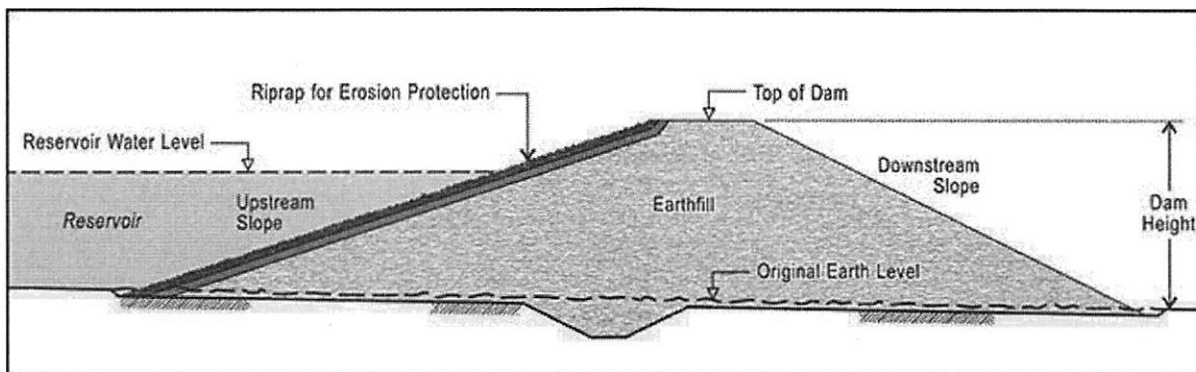
A dam is a barrier constructed for the purpose of storing water, including water containing any other substance such as the tailings from mining projects. Dams can be constructed from a variety of materials including earth, concrete, timber and metal.

## Earthfill dams

While each dam is unique in how it is designed and constructed, most are earthfill dams. These dams are constructed using one or more types of suitable soils to accommodate a variety of factors including the local geology and geography, and the purpose, size and risk associated with the dam. The following diagrams show a cross section and profile of a simple earthfill dam.



Profile diagram of a simple earthfill dam



Cross-section diagram of a simple homogenous earthfill dam. "Top of Dam" also termed "Crest".

Dams have 3 visible faces:

- upstream slope (the face of the dam facing the reservoir/pond)
- downstream slope (the face of the dam facing away from the reservoir/pond)
- crest (the top of the dam, which is often used as the foundation for a road)

To protect the dam from erosion these surfaces can be covered with a variety of materials such as rock, vegetation, concrete and asphalt. A typical dam will have rock armour (known as rip-rap) on the upstream slope, grassy vegetation on the downstream slope, and asphalt or gravel on the crest.

Basic Terms of Dam Characteristics.

The following is a list of terms and their definitions that are frequently used when discussing the physical characteristics of dams.

- ❖ **ABUTMENT:** The part of the valley side against which the dam is constructed. Right and left abutments are those on respective sides as an observer when viewed looking downstream or away from the reservoir.
- ❖ **BASE WIDTH:** The width of the dam measured along the dam/foundation interface.
- ❖ **BREACH:** An opening or a breakthrough of a dam sometimes caused by settlement followed by overtopping, rapid erosion of a section of earth embankment by water.
- ❖ **CONDUIT:** A closed channel to convey the discharge through or under a dam. Usually pipes, penstocks constructed of concrete or steel.
- ❖ **CORE IMPERVIOUS.** A zone of material of low permeability in an embankment dam, hence the terms *central core, inclined core, --- etc*
- ❖ **CREST LENGTH:** The developed length of the top of the dam along the crest from one abutment to the other.
- ❖ **CREST OF DAM:** The term *crest of dam* is also termed the *top of dam and most often is provided with gravel topping to serve as an access road.*
- ❖ **CUTOFF:** An impervious construction, such as curtain grouting by means of which seepage is reduced or prevented from passing through foundation material.
- ❖ **CUTOFF WALL:** A wall of impervious material, for example, concrete, wood pilings, steel sheet piling, built through the dam to the foundation to reduce seepage.
- ❖ **DRAINAGE LAYER OR BLANKET:** A layer of pervious material placed directly over the foundation material, toe area or downstream slope to facilitate seepage drainage and to enhance the stability of the embankment.
- ❖ **DRAWDOWN:** The resultant lowering of water surface level due to release of water from the reservoir.
- ❖ **EMBANKMENT:** Fill material used in the construction of a dam, usually earth or rock, placed with sloping sides and compacted

- ❖ **EMERGENCY ACTION PLAN:** A predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in an area affected by a dam break.
- ❖ **FULL SUPPLY LEVEL (FSL).** The normal high operating level of the reservoir.
- ❖ **LOW SUPPLY LEVE (LSL).** The lowest allowable operating level of the reservoir.
- ❖ **IDF.** The Inflow design flood. “IDF” means the reservoir flood inflow magnitude selected on the basis of size and hazard potential classification for emergency spillway design requirements of a dam.
- ❖ **FLASHBOARDS:** Lengths of timber, concrete, or steel placed on the crest of a spillway to raise the operating water level, but that may be quickly removed in the event of a flood either by tripping a supporting device or by designing the flashboard supports to fail under specified conditions.
- ❖ **FOUNDATION OF DAM:** The natural insitu material on which the dam structure is placed.
- ❖ **FREEBOARD:** The vertical distance from the water surface to the lowest elevation at which water would flow over the dam at a section not designed to be overflowed.
- ❖ **GATE:** A gate controlling the outflow of water from a reservoir.
- ❖ **HEEL OF DAM:** The junction of the upstream face of a gravity or arch dam with the foundation surface. In the case of an embankment dam the junction is referred to as the upstream toe of the dam.
- ❖ **INTAKE:** Any structure in a reservoir, dam, or river through which water can be drawn into an outlet pipe, penstock, flume, etc.
- ❖ **LOW LEVEL OUTLET (BOTTOM OUTLET):** An opening at a low level from the reservoir generally used for providing compensation water bypass flow or for emptying the impoundment.
- ❖ **PERVIOUS ZONE:** A part of the cross section of an embankment dam comprising material of high permeability such as clean sand & gravel serving as a filter zone.
- ❖ **RIPRAP:** A layer of large stones, broken rock, or precast blocks placed in a fashion to minimize voids on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action.
- ❖ **SPILLWAY:** A structure over or through which flood flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway; if the elevation of the spillway crest is the only control, it is considered an uncontrolled spillway.

- ❖ **OGEE SPILLWAY (OGEE SECTION):** An overflow spillway, which in cross section the crest, downstream slope, and bucket have an 'S' or ogee form of curve. The shape is intended to match the underside of the nappe at its upper extremities.
- ❖ **AUXILIARY SPILLWAY (EMERGENCY SPILLWAY):** A secondary spillway designed to operate only during exceptionally large floods.
- ❖ **SPILLWAY CHANNEL (SPILLWAY TUNNEL):** A channel or tunnel conveying water from the spillway to the river downstream.
- ❖ **STOPLOGS:** Large logs, timbers or steel beams placed on top of each other with their ends held in guides on each side of a channel or conduit so as to provide a cheaper or more easily handled means of temporary closure than a bulkhead gate
- ❖ **TOE OF DAM:** The junction of the downstream face of a dam with the natural ground surface. This is also referred to as the downstream toe. For an embankment dam the junction of the upstream face with ground surface is called the upstream toe.
- ❖ **DAM WIDTH:** The thickness or width of a dam at the top of the dam, measured in the upstream – downstream direction.
- ❖ **TRAINING WALL:** A wall built to confine or guide the flow of water.
- ❖ **TRASH RACK:** A steel grating located in the waterway at an intake to prevent the ingress of floating or submerged debris

## **POTENTIAL DAM SAFETY PROBLEMS.**

See Pages 3 to 5. Sketches 1 to 15.

These are rather simple sketches however they do illustrate most problems to look for when inspecting dams.

### 1. FLOATING DEBRIS

Logs, brush, trees and floating Islands (as at Rapids Dam and Dam 4). Possibly will obstruct intakes and spillways.

### 2. LAND SLIDES.

Land slides into reservoir, generates waves which could impact the Dam. Threat mostly in mountainous areas. Ref: Vaiont Dam in Italy. Mountain slid into the reservoir, overtopped the concrete arch dam. Wiped out a town near the dam - 2600 lives were lost.

### 3. BEAVER/ANIMAL ACTIVITY.

Known to borrow into dams below waterline causing cave-ins. Also will obstruct drainage at toe and borrow into downstream slope. TransAlta's has had these problems. Hired trappers to rid the beavers.

### 4. CREST RUTS

Creates soft conditions. Can result in instability of the slope. i. e. sloughing. Crests should have a firm layer of gravel when used for access.

### 5. LONGITUDINAL CRACKS.

Can be caused by frost heave & ice lensing. Also aggravated by poor compaction and saturation . If extensive and not maintained to drain could cause slope instability. Rapids Dam.

### 6. TRANSVERSE CRACKS.

Can be caused by settlement, frost action. If deep, could lead to washout.

### 7. LOW AREA ON CREST.

Could result from poor compaction and settlement. If at leakage location piping could be occurring.

### 8. SINKHOLES.

Often associated with culverts through the foundations. Wash-out at leaky joints. Can also occur where leakage is concentrated through the dam.

### 9. DISPLACED RIPRAP.

(Or poorly placed) Fine material will wash-out under wave action causing beaching and slope instability.

10. SLUMP / SLIDE.

Soft, wet poorly compacted material. Can be activated following periods of heavy rain or related to seepage through the dam.

11. WET AREAS.

If persistent through dry weather – most likely related to seepage through the dam where the phreatic surface can be seen on the downstream slope. Could lead to slope instability and failure.

12. CAVE IN / COLLAPSE.

Can result from beaver activity, piping.--- etc

13. EROSION.

Animal trails or non planar features results in concentrated run-off and erosion.

14. BOILS.

Washout of fine sand from the foundations which forms a ring at the point of exit. Generally requires a reverse filter to arrest the migration of fines.

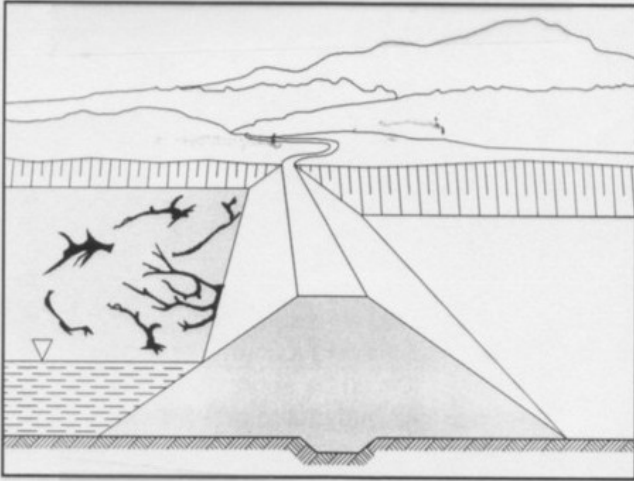
15. STANDING WATER AT TOE.

Can cause soft conditions and slope instability if Dam is built from fine grained homogenous materials. Drainage should be provided. Rock – fill dams and rock toe sections have suitable design and can accept water ponded at the toe.

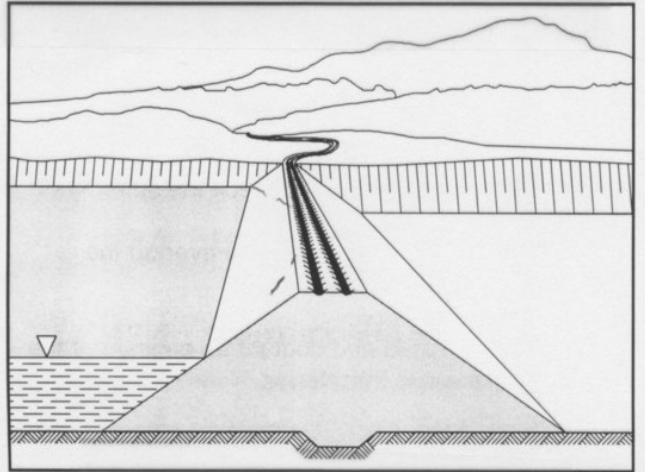
NOTE:

There may-be other factors causing the problems other than those given as examples.

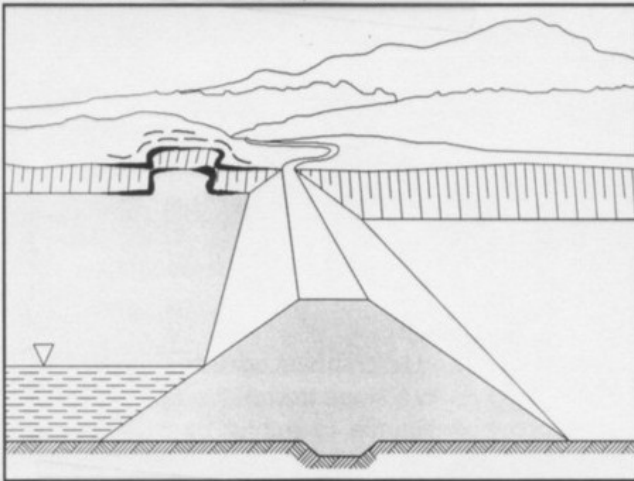
**FLOATING DEBRIS 1**



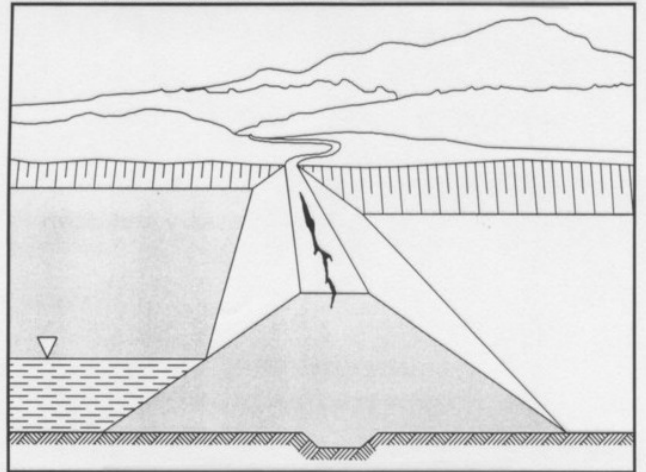
**RUTS ALONG CREST 4**



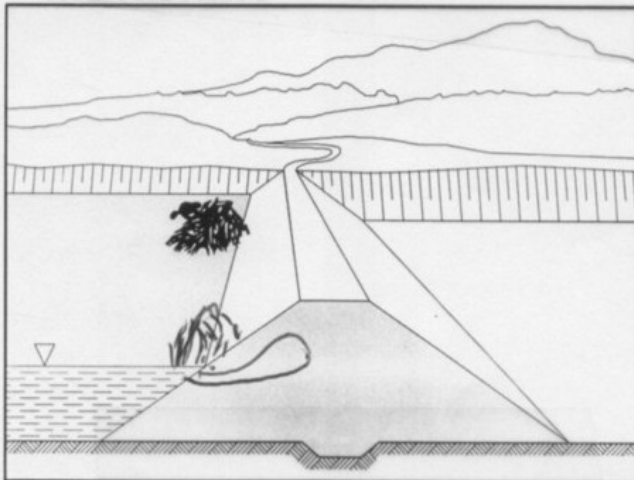
**SLIDES AND SLOUGHS 2**



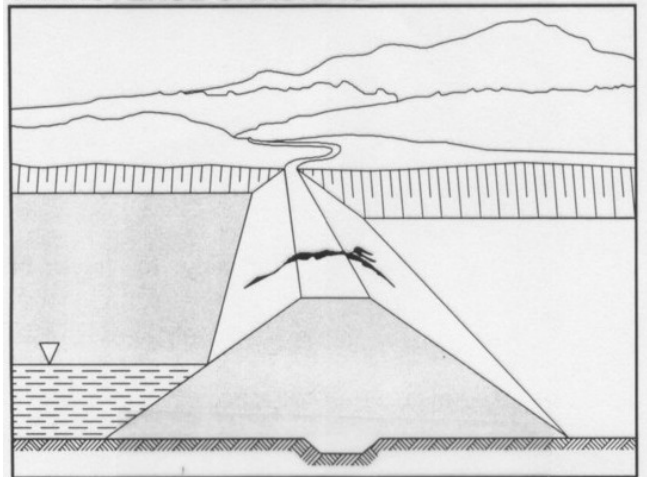
**LONGITUDINAL CRACKS 5**



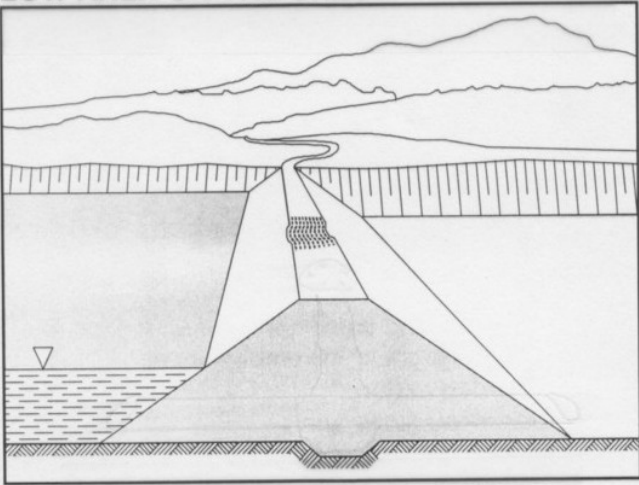
**BEAVER ACTIVITY 3**



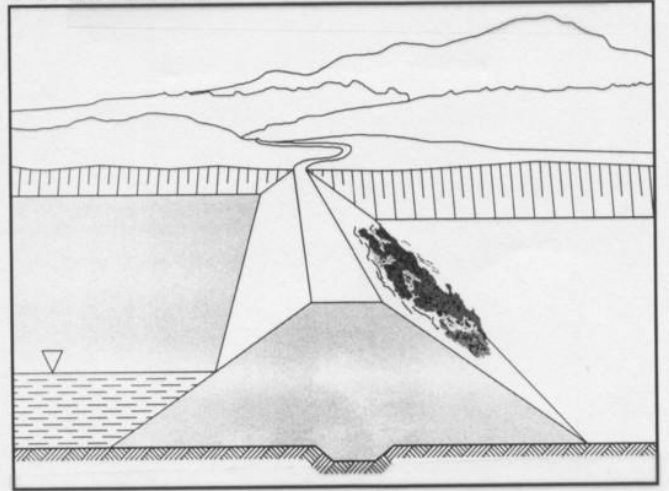
**TRANSVERSE CRACKING 6**



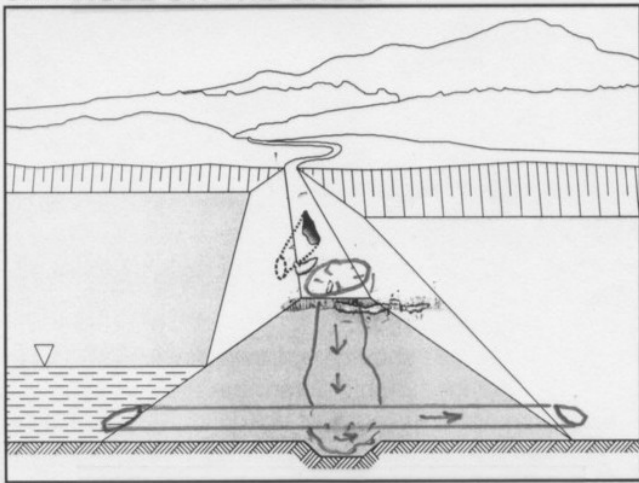
**LOW AREA ON THE CREST 7**



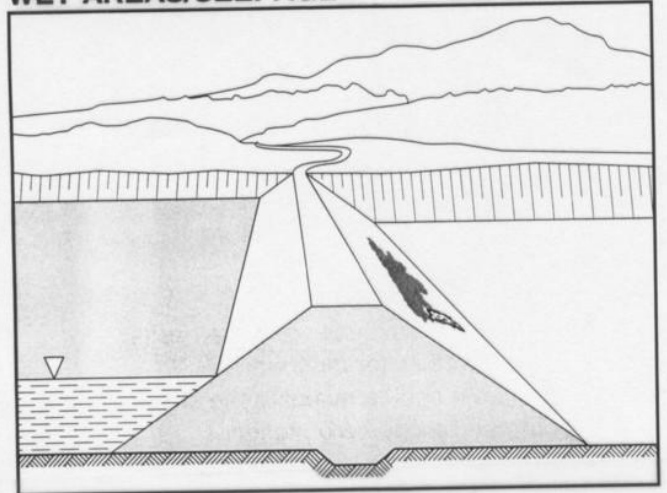
**SLUMP/SLIDE 10**



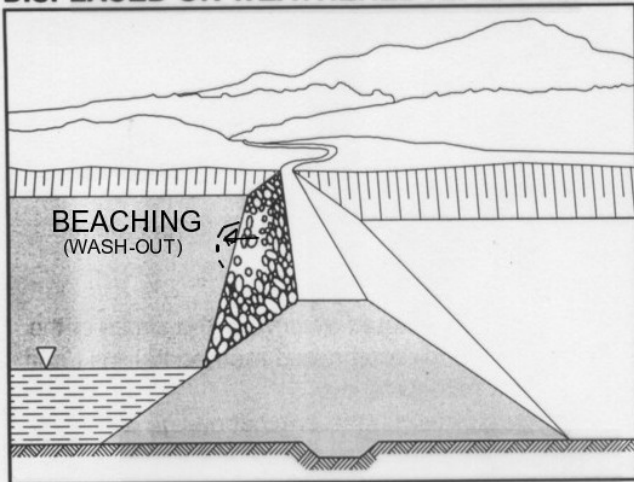
**SINKHOLE ON THE CREST 8**



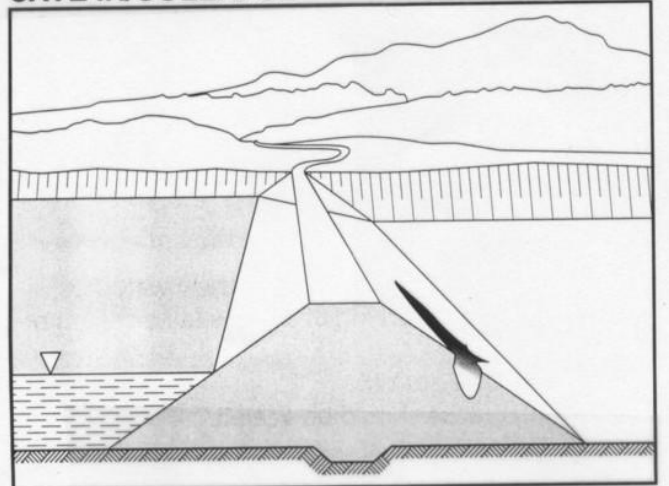
**WET AREAS/SEEPAGE 11**



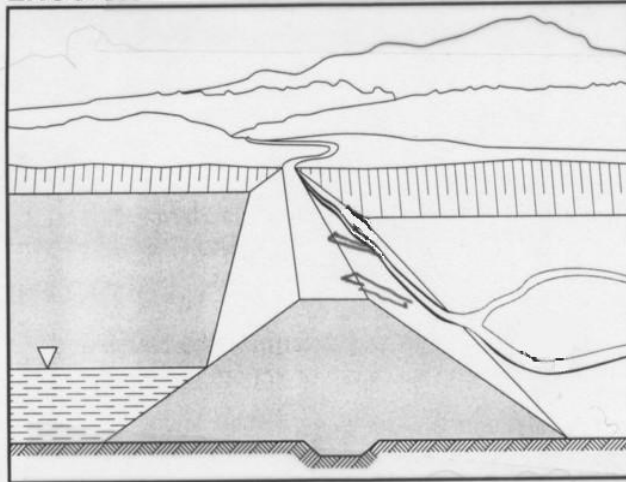
**DISPLACED OR WEATHERED RIPRAP 9**



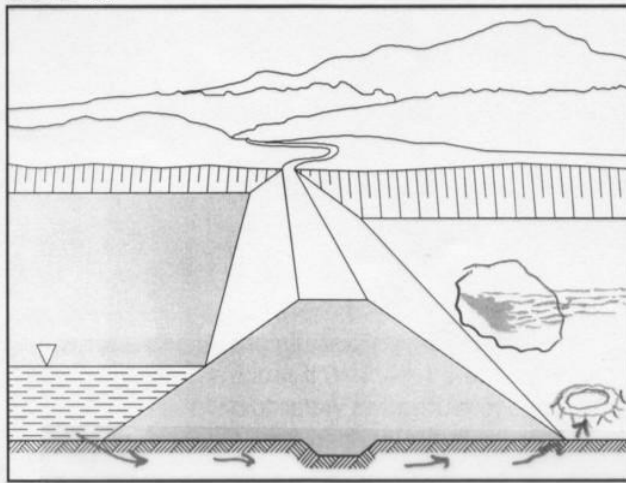
**CAVE IN/COLLAPSE 12**



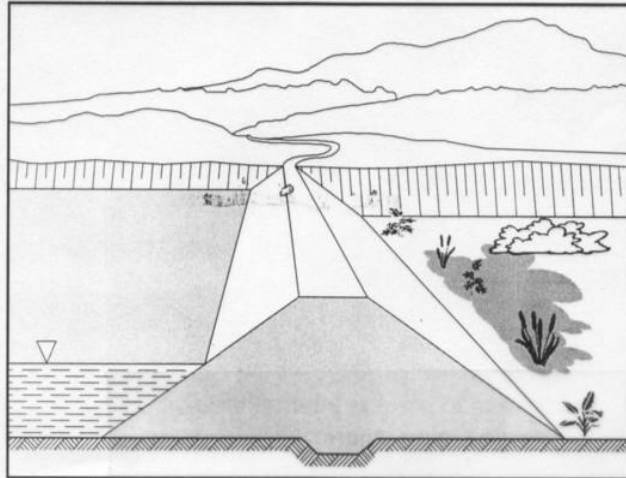
**EROSION 13**



**SEEPAGE WATER EXITING FROM A WATER BOIL 14**



**STANDING/PONDED WATER AT THE DOWNSTREAM TOE 15**



**INSPECTION CHECKLIST  
SNARE RAPIDS – RAPIDS MAIN DAM**

Inspector:						Date Inspected:					
Weather:						Forebay Elevation:					
Temperature:						Estimated Precipitation last 24hrs:					
<b>Thermistor reading:</b>											
1	2	3	4	5	6	7	8	9	10	11	12

**Directions: Mark “X” in Yes or No Column.**

**If “Yes” describe in the Comments Column: State size (depth, width, length).**

<b>1.0 Dam Crest</b>	<b>Yes</b>	<b>No</b>	<b>Comments/Observations:</b>
1.1 Depression or Settlement?			
1.2 Ruts / Potholes?			
1.3 Sinkholes?			
1.4 Longitudinal Cracks?			
1.5 Crack Perpendicular to Dam Axis?			
1.6 Excessive Vegetation?			
<b>2.0 Upstream Slope</b>	<b>Yes</b>	<b>No</b>	<b>Comments/Observations:</b>
2.1 Riprap Depression or Slough?			
2.2 Beaching or Erosion?			
2.3 Sinkholes?			
2.4 Longitudinal Cracks?			
2.5 Cracks Perpendicular to Dam Axis?			
2.6 Excessive Vegetation?			

<b>3.0 Downstream Slope</b>	<b>Yes</b>	<b>No</b>	<b>Comments/Observations:</b>
3.1 Depression or Slough?			
3.2 Longitudinal Cracks?			
3.3 Cracks Perpendicular to Dam Axis?			
3.4 Animal Burrows?			
3.5 Bulging?			
3.6 Seepage or Wet Areas?			
3.7 Slope Erosion?			
3.8 Sinkholes?			
3.9 Excessive Vegetation?			

<b>4.0 Downstream Toe</b>	<b>Yes</b>	<b>No</b>	<b>Comments/Observations:</b>
4.1 Soft / Wet Areas?			
4.2 Any Visible Seepage?			
If Yes; estimated flow (L/min)? _____			
Water quality (clear / cloudy)? _____			
Any Visible Boils?			
4.3 Excessive Vegetation?			

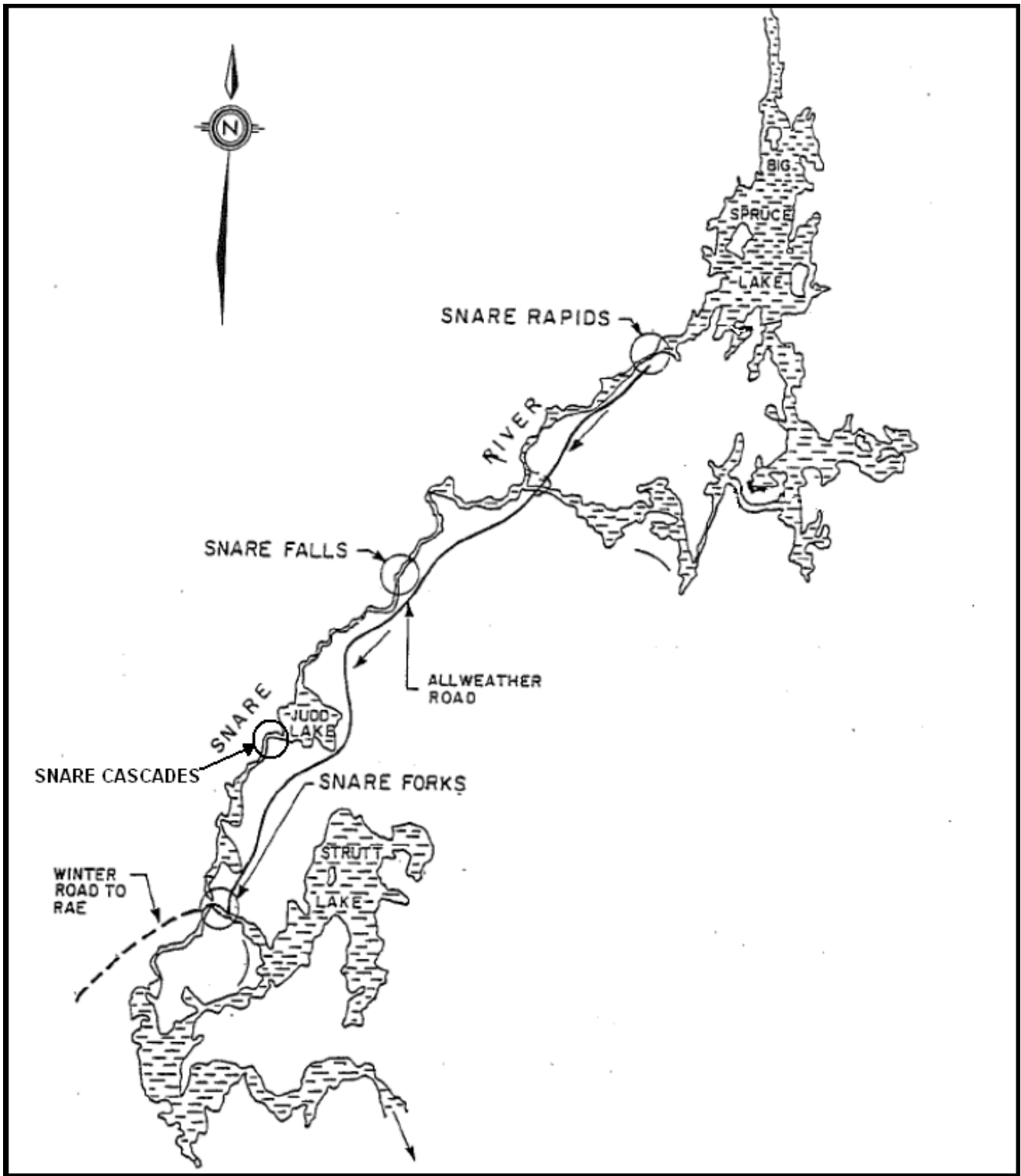
<b>5.0 Right Abutment Contact</b>	<b>Yes</b>	<b>No</b>	<b>Comments/Observations:</b>
5.1 Any Run-off Erosion?			
5.2 Visual Differential Movement?			
5.3 Any Cracks?			
5.4 Any Seepage?			
5.5 Excessive Vegetation?			

6.0 Left Abutment Contact	Yes	No	Comments/Observations:
6.1 Any Run-off Erosion?			
6.2 Visual Differential Movement?			
6.3 Any Cracks?			
6.4 Any Seepage?			
6.5 Excessive Vegetation?			
7.0 Leakage Specific			
7.1 Digital Weir Reading (inside the plant)	Digital Gage Reading: _____ Estimated Flow (L/min): _____		
7.2 Turbidity of Water.	Clear or Cloudy? _____		
7.3. Seepage flow rate (at riverbank D/S of the plant; use measuring cup/stopwatch).	Reading (L/min): _____ Clear or Cloudy? _____		
7.4 “Toe Well” at Left Abutment.	Clear or Cloudy? _____		

**Other Comments & Observations:** Right – Left when looking Downstream.

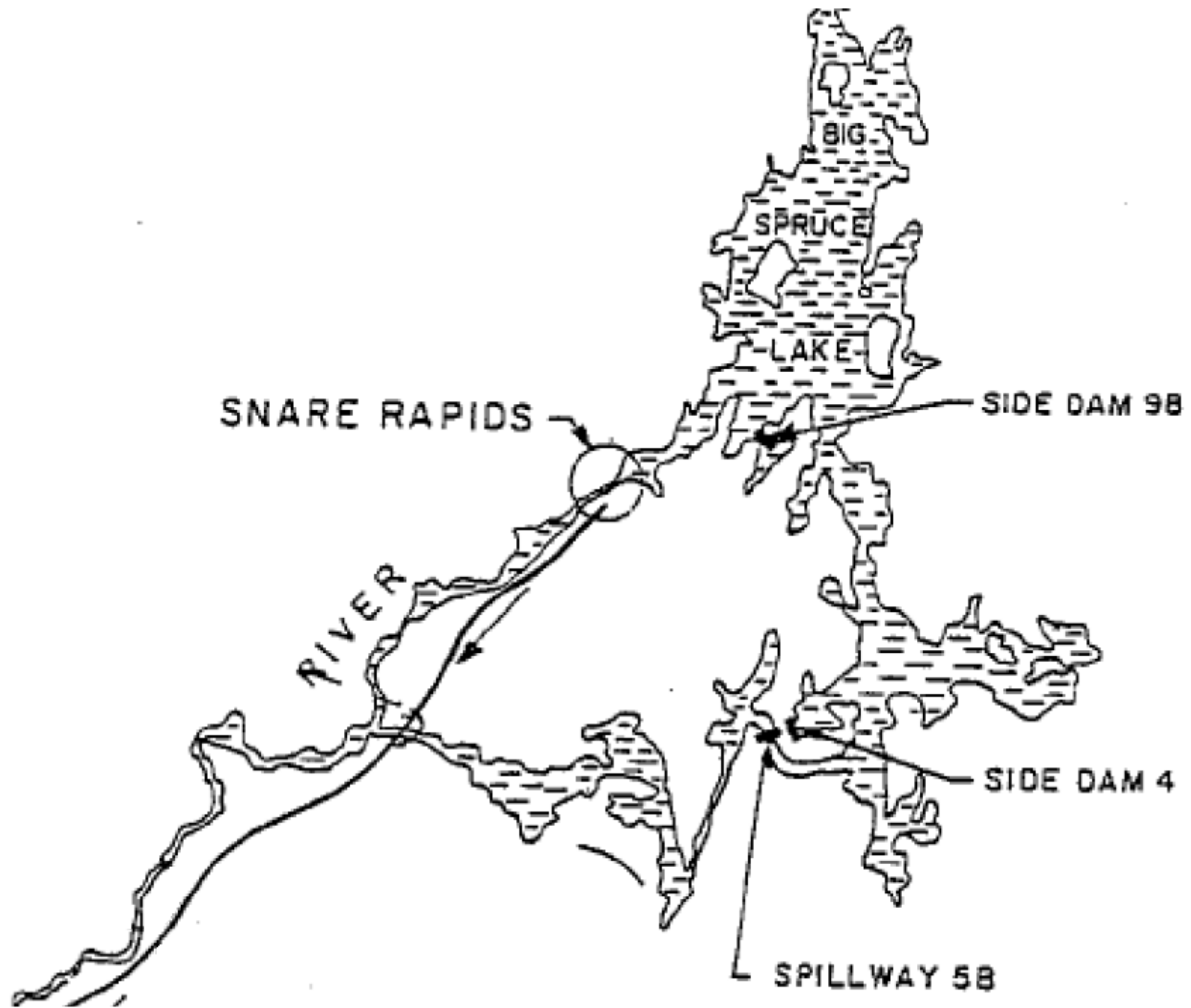
Signature of Inspector: \_\_\_\_\_

# **SNARE HYDRO**



Snare Hydro – Site Plan

# **SNARE RAPIDS**



Snare Rapids – Site Plan

**Structure:** Snare Rapids Dam  
**Location:** Uppermost site on the Snare system, located approximately 145 km northwest of Yellowknife on the Snare River.

**Constructed:** 1948

**Type:** Zoned Earth Fill Embankment

**Core:** Uniformly Graded Fine Silt

**Length:** 220 m (722 ft)

**Height:** 21 m (69 ft)

**Foundation:** Granite Bedrock

### **CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Core: 223.00 m (731.7 ft)

Crest: 224.02 m (734.9 ft)

Spillway: Variable (See 5B Spillway)

**Allowable Res. Levels<sup>2</sup>:** Minimum: 217.90 m (714.9 ft)

Normal Max: 222.30 m (729.3 ft)

High Flow Max: 222.50 m (730.0 ft)

### **Characteristics**

- Potential for piping is low considering the small amount of leakage, wide core and bedrock contact, and adjacent filters.
- Less vulnerable to overtopping because of adequate spillway capacity as well as low "saddles" around the reservoir.
- Not likely to fail due to foundation movement or settlement.

### **Seepage Monitoring Points**

#### **1. Rapids Powerhouse North**

- Monitored by a V-notch wooden weir in a manhole on the north corner of the rapids powerhouse.

#### **2. Rapids Powerhouse East**

- Monitored by a manhole on the east corner of the rapids powerhouse
- Typically very small amount of flow, if any.

#### **3. South Abutment**

- Collected in a manhole between the south abutment and the staff house.
- Discharge line runs from manhole to the river.
- Discharge line monitored by a manhole part way between the collection manhole and the river.

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<sup>1</sup> Core and Crest elevations taken from the Snare Hydro OM&S Manual

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

### **Dam Monitoring Instrumentation**

- Thermistor in the top 6 m of the dam records temperature fluctuations at 0.5 m intervals in the core and top of the dam. Located approximately 60 m from the south abutment.

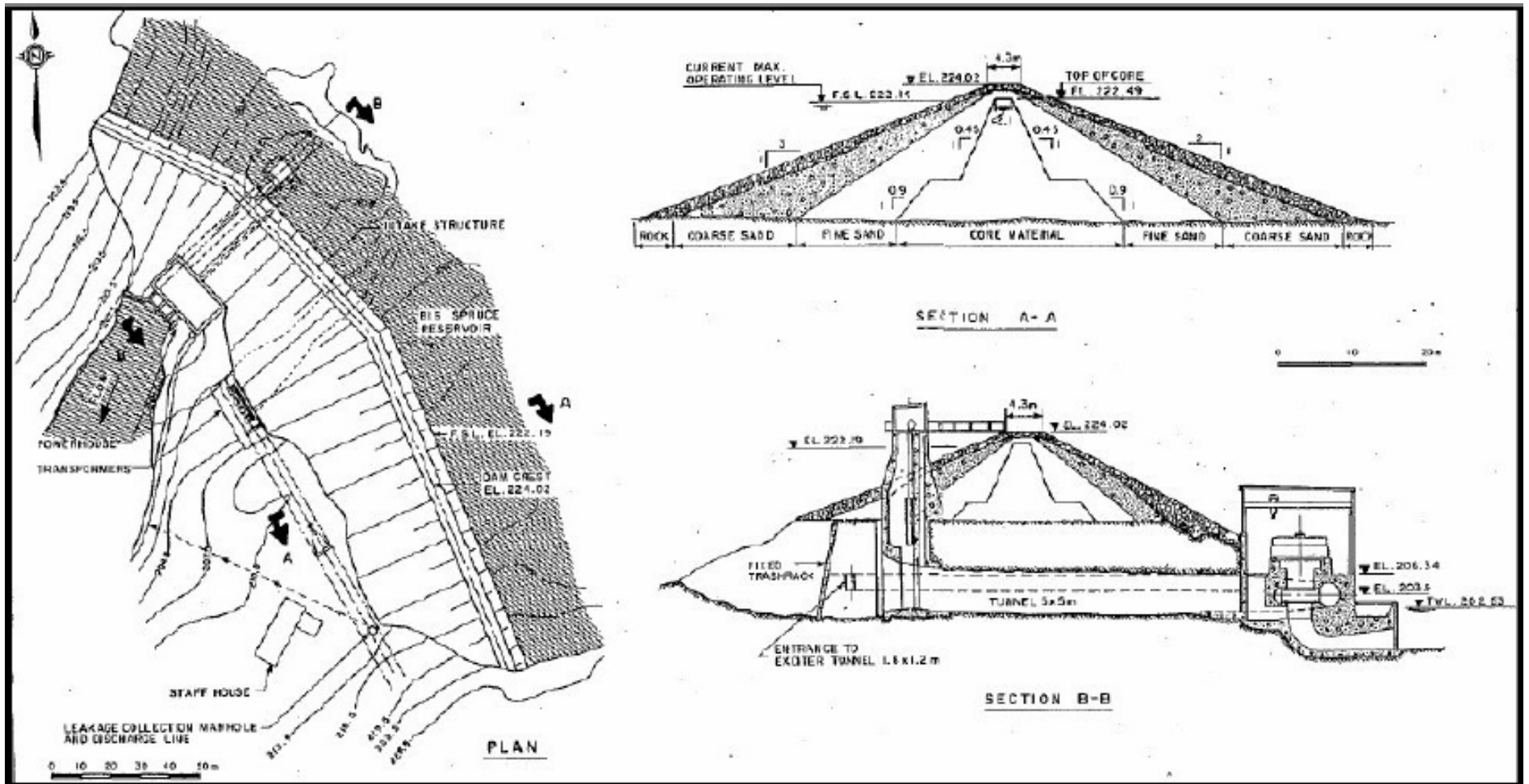


Seepages at Powerhouse

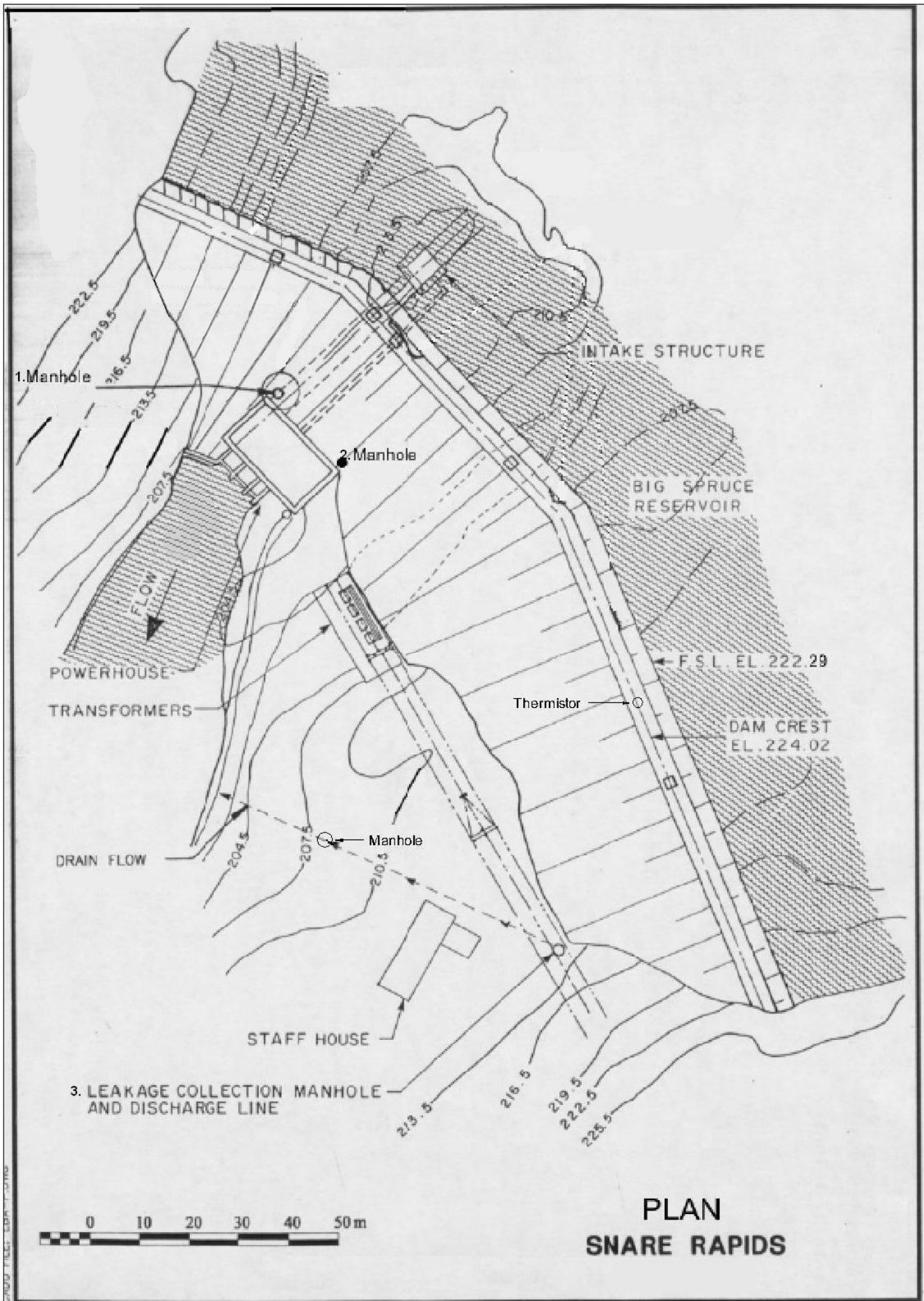
South Abutment manhole

Seepage Outlet

Snare Rapids Site



Snare Rapids Plan & Sections



Snare Rapids Seepage & Seepage Monitoring Locations

## SNARE RAPIDS WEIR FLOW RATE TABLE

Head		Flow		Head (inches)		Flow	
Inches	Millimeters	cfs	L/min	Inches	Millimeters	cfs	L/min
1/8	3	2.7E-05	0.047	3 1/8	79	0.086	145
1/4	6	1.5E-04	0.26	3 1/4	83	0.094	160
3/8	10	4.3E-04	0.73	3 3/8	86	0.104	176
1/2	13	8.8E-04	1.5	3 1/2	89	0.114	193
5/8	16	0.0015	2.6	3 5/8	92	0.124	211
3/4	19	0.0024	4.1	3 3/4	95	0.135	229
7/8	22	0.0036	6.0	3 7/8	98	0.147	249
1	25	0.0050	8.4	4	102	0.159	270
1 1/8	29	0.0067	11	4 1/8	105	0.171	291
1 1/4	32	0.0087	15	4 1/4	108	0.185	314
1 3/8	35	0.011	19	4 3/8	111	0.199	337
1 1/2	38	0.014	23	4 1/2	114	0.213	362
1 5/8	41	0.017	28	4 5/8	117	0.228	388
1 3/4	44	0.020	34	4 3/4	121	0.244	414
1 7/8	48	0.024	41	4 7/8	124	0.260	442
2	51	0.028	48	5	127	0.277	471
2 1/8	54	0.033	55	5 1/8	130	0.295	501
2 1/4	57	0.038	64	5 1/4	133	0.313	532
2 3/8	60	0.043	73	5 3/8	137	0.332	564
2 1/2	64	0.049	83	5 1/2	140	0.352	598
2 5/8	67	0.055	94	5 5/8	143	0.372	632
2 3/4	70	0.062	106	5 3/4	146	0.393	668
2 7/8	73	0.070	118	5 7/8	149	0.415	705
3	76	0.077	131	6	152	0.437	743

**Structure:** 5B Spillway/Side Dam  
**Location:** Located approximately 6 km southeast of the Snare Rapids main dam on Big Spruce Lake.  
**Constructed:** 1962

### Spillway

**Type:** Stoplog Controlled Reinforced Concrete Structure  
**Bays:** 8 Bays: 6 - 6 m (wide) x 2.5 m (deep)/ 2 - 6 m x 5.8 m (19.69 ft x 8.20 ft/ 19.69 ft x 19.03 ft)  
**Length:** 60 m (197 ft)  
**Height:** 5.8 m (19 ft)  
**Elevations<sup>1</sup>:** Top of Stoplogs: 223.00m (731.7 ft)  
Sill: 217.20/220.50 m (712.63/723.5 ft)  
Crest: 224.02 m (735.0 ft)

### Side Dam

**Type:** Earth/Rock Fill Embankment  
**Core:** Central Till Core  
**Length:** 110 m (361 ft)  
**Height:** 4 m (13 ft)  
**Elevations<sup>1</sup>:** Core: 224.03 m (735.0 ft)  
Crest: 224.84 m (737.7 ft)

**Foundation:** Bedrock

### **CDA Consequence**

**Classification:** High, due to economics  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 217.90 m (714.9 ft)  
Normal Max: 222.30 m (729.3 ft)  
High Flow Max: 222.50 m (730.0 ft)

### Characteristics

#### Spillway

- Good rock/concrete contacts, some minor erosion at contacts.
- Low potential for overtopping.
- Not likely to fail due to foundation movement or settlement.
- Repairs to stoplog guides in 2015, repair to Pier 5 foundation in 2017.

#### Side Dam

- High leakage, possibly through bedrock.
- Very low potential for overtopping.
- Not likely to fail due to foundation movement
- Not likely to fail due to foundation settlement

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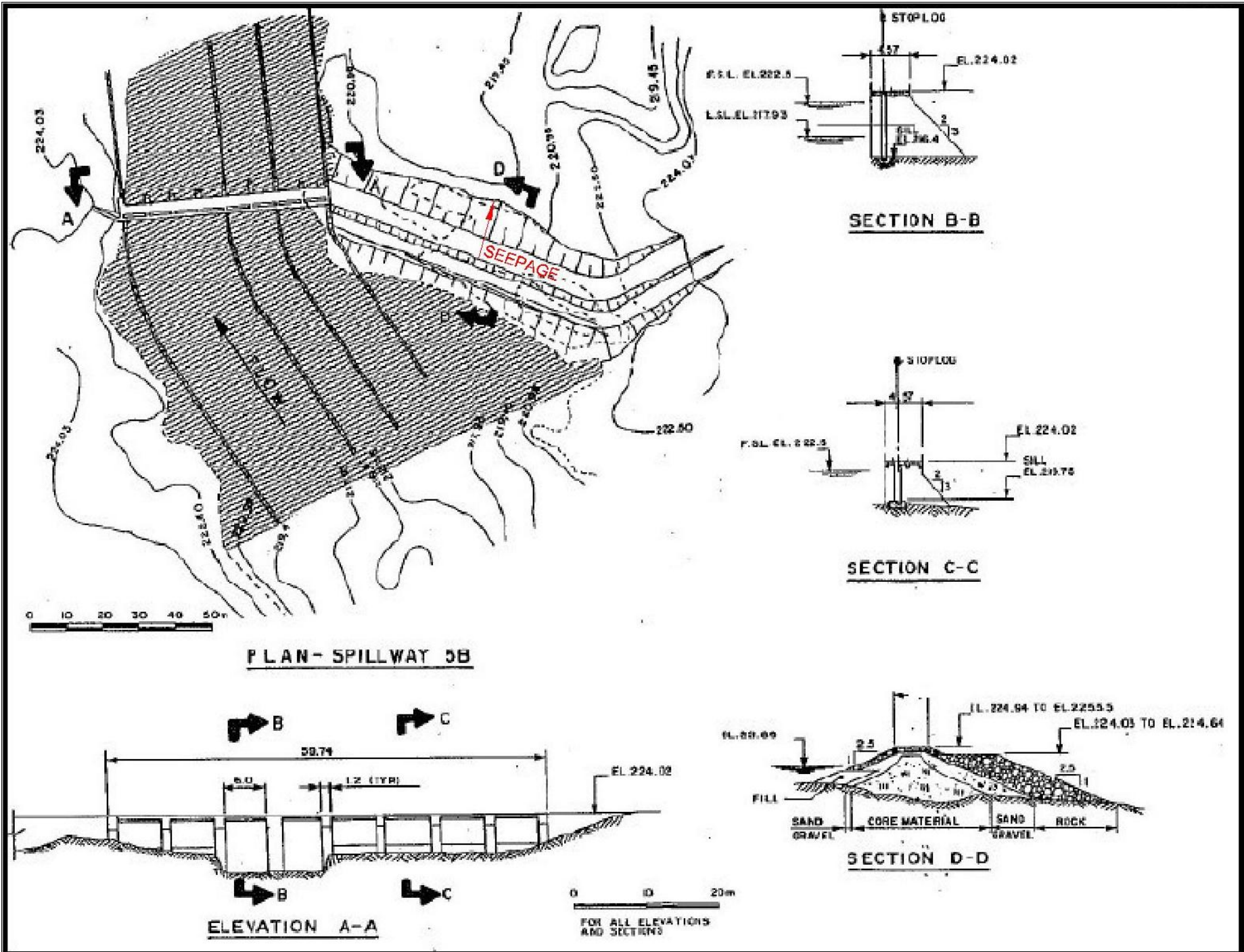
<sup>1</sup> Elevations taken and derived from attached drawing

<sup>2</sup> Allowable Reservoir Levels taken from Snare Hydro OM&S Manual

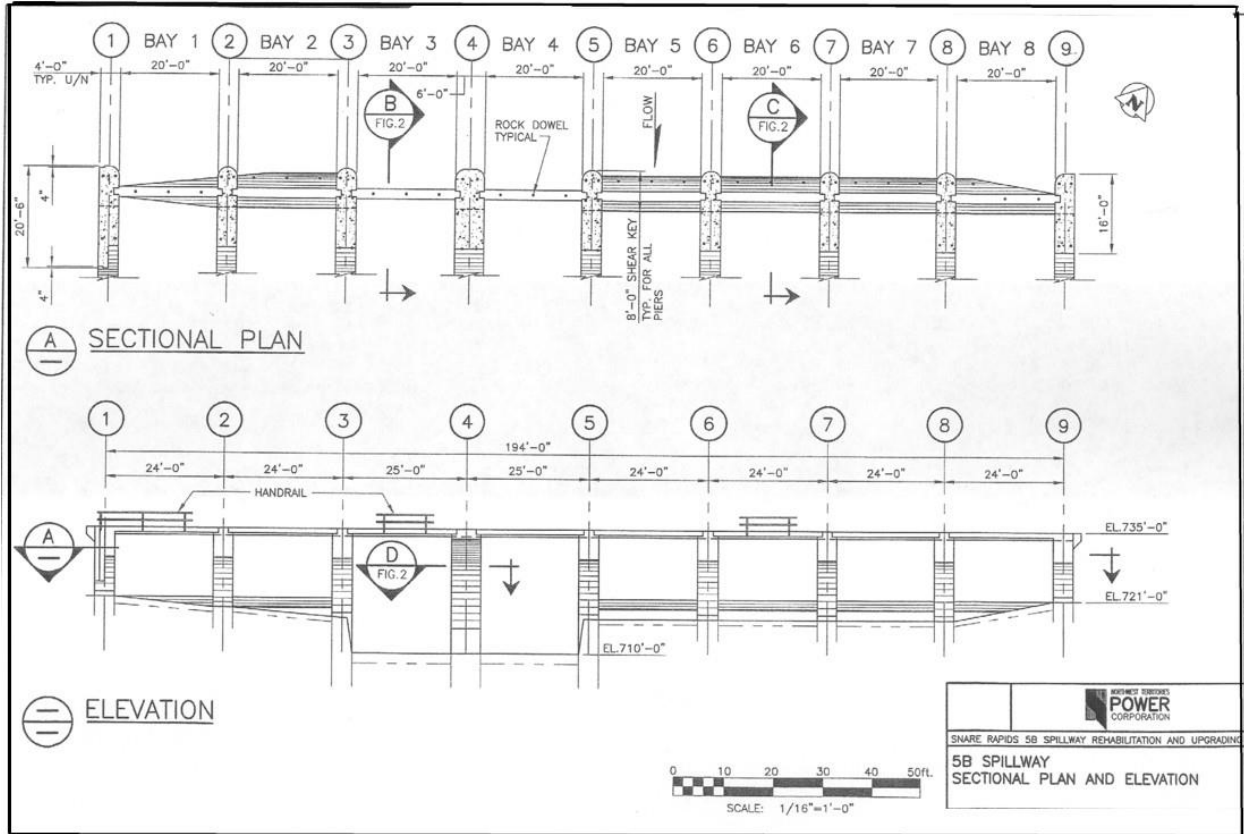
## **Seepage Points**

### **Side Dam**

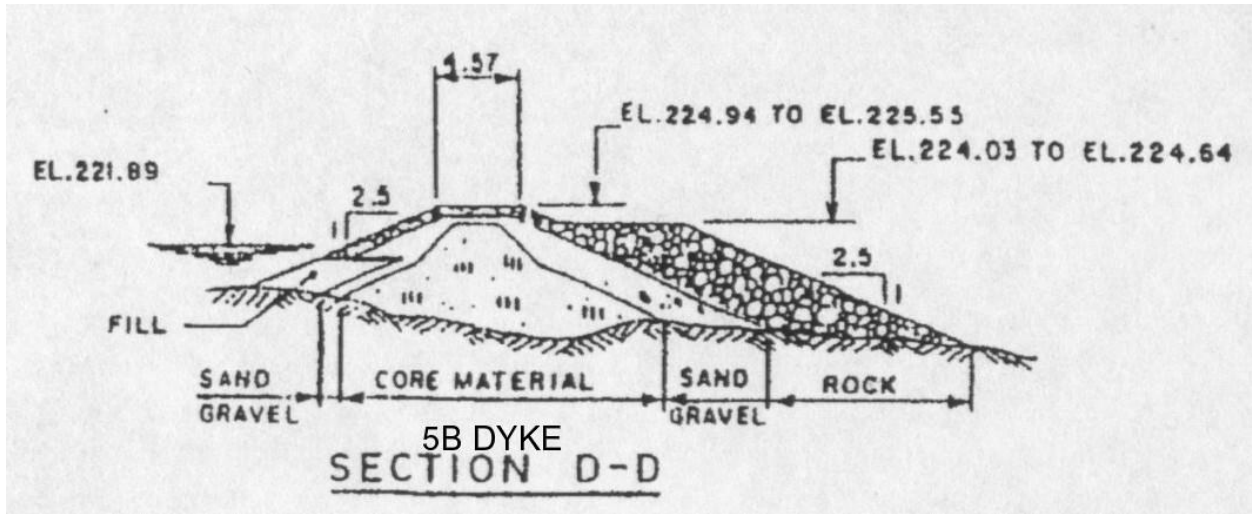
- Approximately 50 m from the spillway.
- Clear leakage.
- Concrete rectangle slot weir shows flow of approximately 160 L/min, on average.
- Some leakage flowing beneath the weir in 2020, repairs are planned.
- Weir readings should be recorded on occasions when NTPC Staff visit the site for stoplog operations.



5B Spillway – Plan, Sections & Seepage Location



5B Stoplog Spillway; Plan & Profile



5B X-Section Zoned Earthfill Dyke



5B Spillway Seepage and Weir Location

# **5B SIDE DAM WEIR FLOW RATES**

Weir Width (w) = 1.33ft

Flow (q) = 3.33 x w x d<sup>1.5</sup>

Depth		Flow		Depth		Flow	
in	ft	cfs	L/min	in	ft	cfs	L/min
1/8	0.01	0.005	8	6 1/8	0.51	1.62	2744
1/4	0.02	0.01	23	6 1/4	0.52	1.66	2828
3/8	0.03	0.02	42	6 3/8	0.53	1.71	2914
1/2	0.04	0.04	64	6 1/2	0.54	1.77	3000
5/8	0.05	0.05	89	6 5/8	0.55	1.82	3087
3/4	0.06	0.07	118	6 3/4	0.56	1.87	3174
7/8	0.07	0.09	148	6 7/8	0.57	1.92	3263
1	0.08	0.11	181	7	0.58	1.97	3352
1 1/8	0.09	0.13	216	7 1/8	0.59	2.03	3443
1 1/4	0.10	0.15	253	7 1/4	0.60	2.08	3534
1 3/8	0.11	0.17	292	7 3/8	0.61	2.13	3625
1 1/2	0.13	0.20	333	7 1/2	0.63	2.19	3718
1 5/8	0.14	0.22	375	7 5/8	0.64	2.24	3811
1 3/4	0.15	0.25	419	7 3/4	0.65	2.30	3905
1 7/8	0.16	0.27	465	7 7/8	0.66	2.35	4000
2	0.17	0.30	512	8	0.67	2.41	4096
2 1/8	0.18	0.33	561	8 1/8	0.68	2.47	4192
2 1/4	0.19	0.36	611	8 1/4	0.69	2.52	4289
2 3/8	0.20	0.39	663	8 3/8	0.70	2.58	4387
2 1/2	0.21	0.42	716	8 1/2	0.71	2.64	4486
2 5/8	0.22	0.45	770	8 5/8	0.72	2.70	4585
2 3/4	0.23	0.49	825	8 3/4	0.73	2.76	4685
2 7/8	0.24	0.52	882	8 7/8	0.74	2.82	4786
3	0.25	0.55	941	9	0.75	2.88	4887
3 1/8	0.26	0.59	1000	9 1/8	0.76	2.94	4990
3 1/4	0.27	0.62	1061	9 1/4	0.77	3.00	5092
3 3/8	0.28	0.66	1122	9 3/8	0.78	3.06	5196
3 1/2	0.29	0.70	1185	9 1/2	0.79	3.12	5300
3 5/8	0.30	0.74	1249	9 5/8	0.80	3.18	5405
3 3/4	0.31	0.77	1315	9 3/4	0.81	3.24	5511
3 7/8	0.32	0.81	1381	9 7/8	0.82	3.31	5617
4	0.33	0.85	1448	10	0.83	3.37	5724
4 1/8	0.34	0.89	1517	10 1/8	0.84	3.43	5832
4 1/4	0.35	0.93	1586	10 1/4	0.85	3.50	5940
4 3/8	0.36	0.97	1656	10 3/8	0.86	3.56	6049
4 1/2	0.38	1.02	1728	10 1/2	0.88	3.62	6159
4 5/8	0.39	1.06	1800	10 5/8	0.89	3.69	6269
4 3/4	0.40	1.10	1874	10 3/4	0.90	3.76	6380
4 7/8	0.41	1.15	1948	10 7/8	0.91	3.82	6492
5	0.42	1.19	2024	11	0.92	3.89	6604
5 1/8	0.43	1.24	2100	11 1/8	0.93	3.953	6717
5 1/4	0.44	1.28	2177	11 1/4	0.94	4.020	6830
5 3/8	0.45	1.33	2256	11 3/8	0.95	4.087	6945
5 1/2	0.46	1.37	2335	11 1/2	0.96	4.155	7059
5 5/8	0.47	1.42	2415	11 5/8	0.97	4.223	7175
5 3/4	0.48	1.47	2496	11 3/4	0.98	4.291	7291
5 7/8	0.49	1.52	2578	11 7/8	0.99	4.3599	7407
6	0.50	1.57	2660	12	1.00	4.4289	7525

**Structure:** Side Dam 4  
**Location:** Located approximately 6 km southeast of the Snare Rapids main dam, impounding Big Spruce Lake.  
**Constructed:** 1960  
**Type:** Zoned Earth Fill Embankment  
**Core:** Compacted Silt  
**Length:** 130 m (427 ft)  
**Height:** 8 m (26 ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Core: 224.40 m (736.0ft)  
Crest: 225.25m (739.0 ft)  
Spillway: Variable (See 5B Spillway)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 217.90 m (714.9 ft)  
Normal Max: 222.30 m (729.3 ft)  
High Flow Max: 222.50 m (730.0 ft)

**Characteristics**

- Most vulnerable to piping.
- Very low potential for overtopping.
- Solid foundation with no movement or settlement.

**Seepage Points**

None observed

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<sup>1</sup> Core and Crest elevations taken from the 2006 Snare Hydro DSR

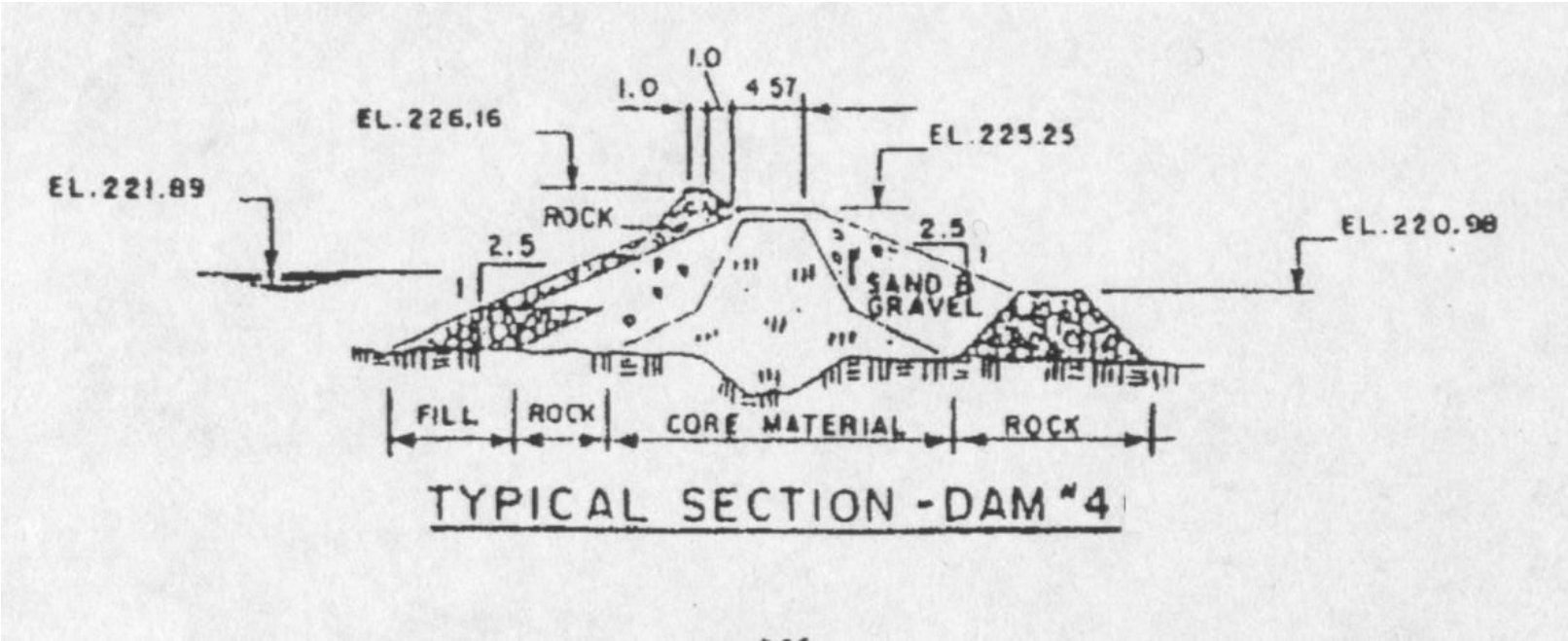
<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Side Dam 4 – Aerial Photo

Snare 4B Dam Section

Figure X-Section of Dam 4



**Structure:** Side Dam 9B  
**Location:** Located approximately 3 km east northeast of the Snare Rapids main dam on Big Spruce Lake.  
**Constructed:** 1960  
**Type:** Sand Fill Embankment with Upstream Clay Blanket  
**Core:** None  
**Length:** 50 m (164 ft)  
**Height:** 3 m (10 ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Core: 224.40 m (736.0ft)  
Crest: 225.25m (739.0 ft)  
Spillway: Variable (See 5B Spillway)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 217.90 m (714.9 ft)  
Normal Max: 222.30 m (729.3 ft)  
High Flow Max: 222.50 m (730.0 ft)

### **Characteristics**

- Vulnerable to rock fill settlement due to flow through during high reservoir conditions.
- Upgraded in 2009 with an upstream impervious bentomat liner.
- Serves as a retaining structure in the event of a flood.
- Originally constructed on a layer of surface ice on foundation of peat/till 10ft thickness over bedrock. Ice melt and settlement of softer foundation materials required the dam to be raised several times though settlement appears to have ceased since 2009.

### **Seepage Points**

None observed

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<sup>1</sup> Core and Crest elevations taken from the 2006 Snare Hydro DSR

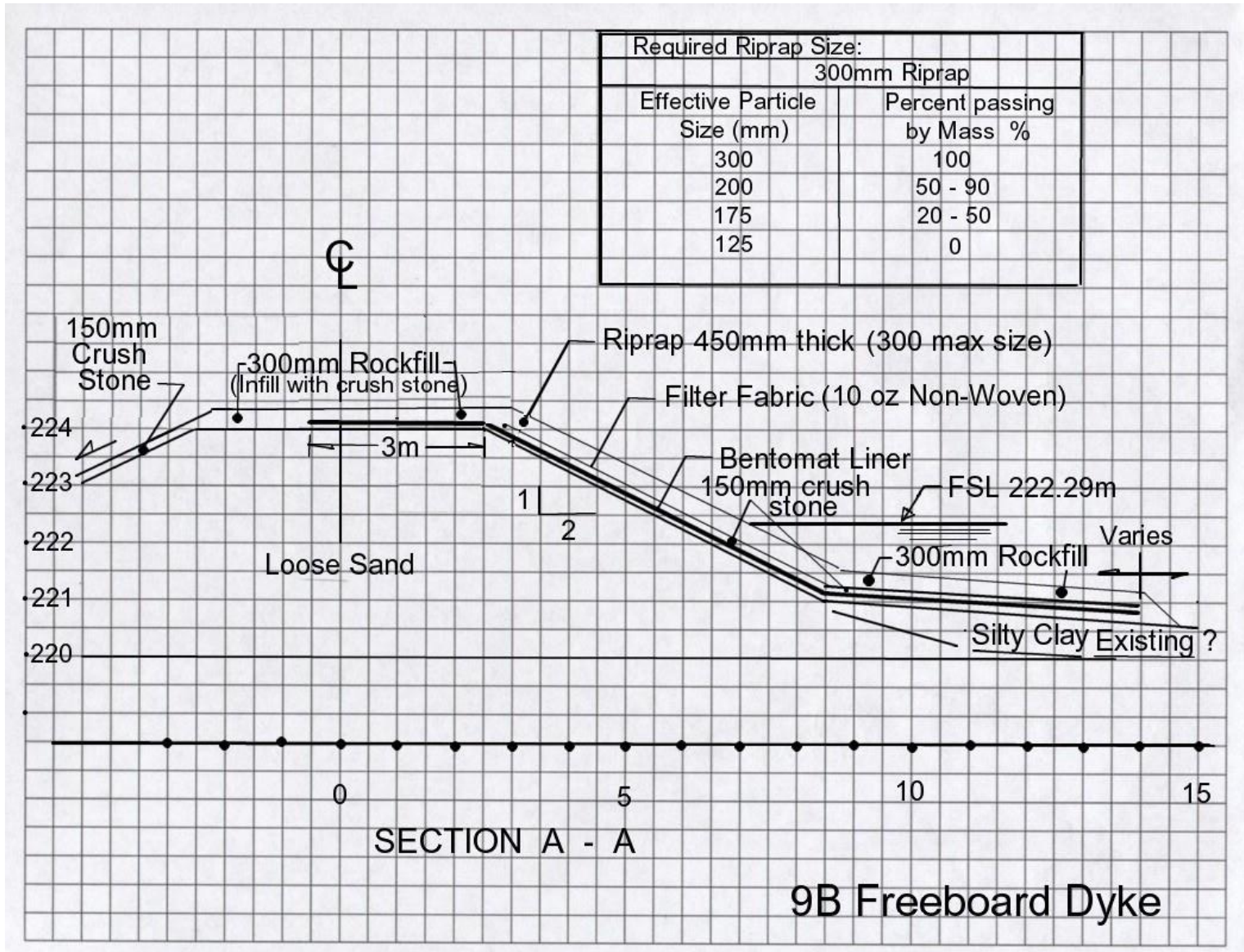
<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



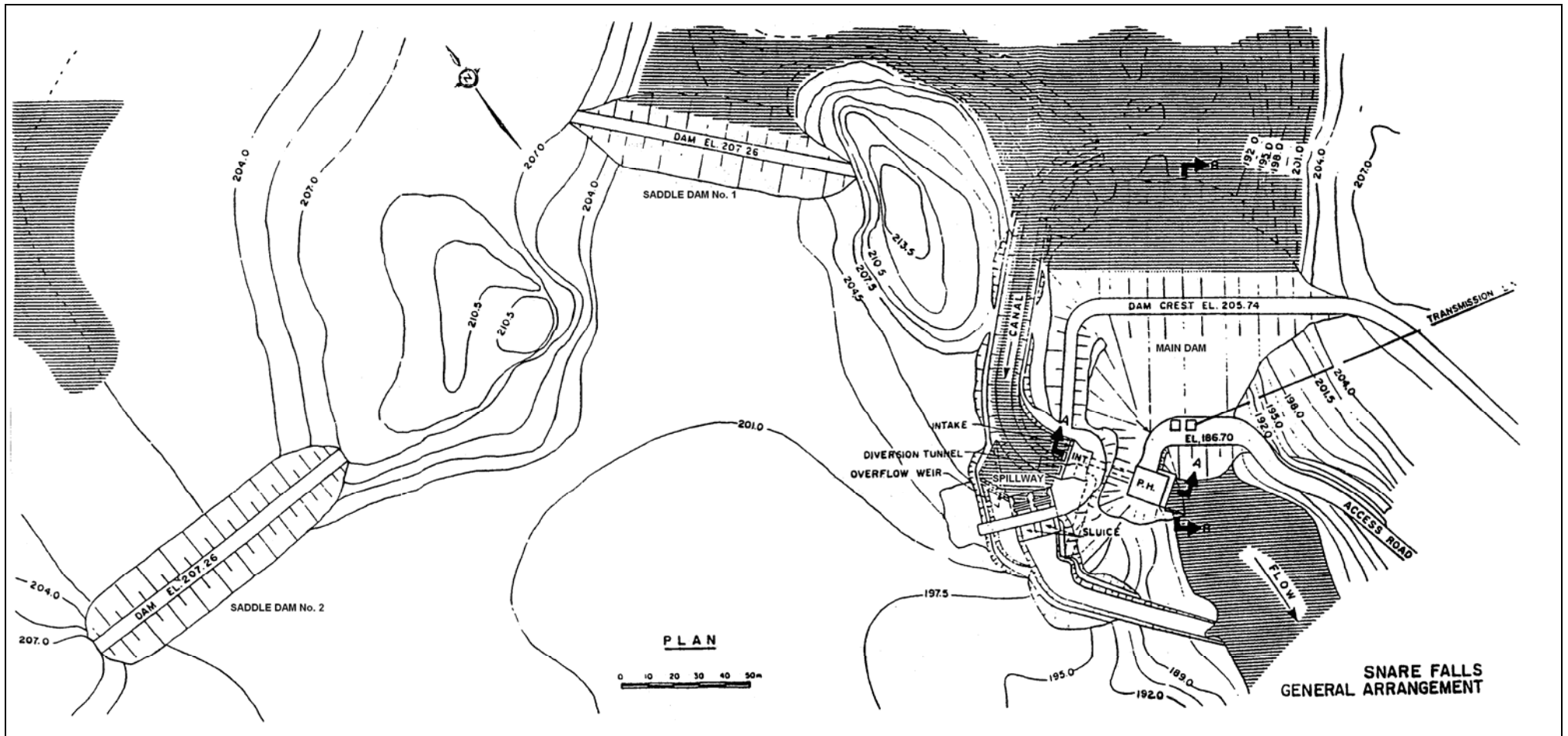
Side Dam 9B – Aerial Photo (Upstream Face Shown)

# 9B Dam Section

FIGURE X-SECTION 9B FREEBOARD DYKE

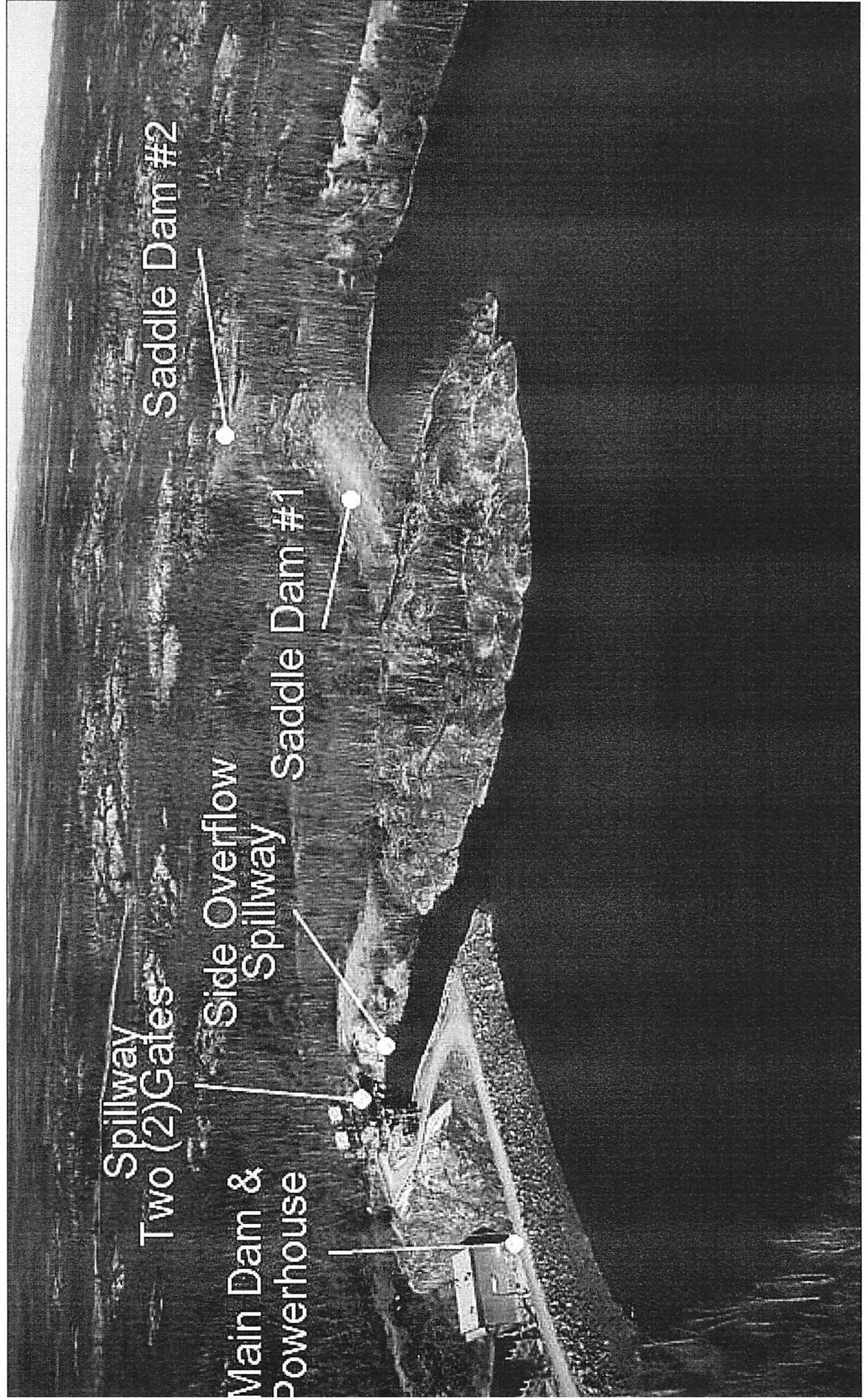


# **SNARE FALLS**



Snare Falls – Plan

## Falls Overview



**Structure:** Snare Falls Main Dam  
**Location:** Second uppermost site on the Snare system. Located 15.5 km downstream of Snare Rapids.  
**Constructed:** 1960

**Type:** Earth/Rock Fill Embankment  
**Core:** Rolled Silt  
**Length:** 152 m (500 ft)  
**Height:** 23 m (75 ft)  
**Foundation:** Granite Bedrock

**CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Core: 204.82 m (672.0 ft)  
Crest: 205.74 m (675.0 ft)  
Berm: 206.96 m (679.0 ft)  
Spillway: Gate Controlled (See Falls Spillway)

**Allowable Res. Levels<sup>2</sup>:** Minimum: 201.80 m (662.1 ft)  
Normal Max: 202.40 m (664.0 ft)  
High Flow Max: 203.60 m (668.0 ft)

**Characteristics**

- Firm crest with no prior evidence of cracks or settlement.
- Sound foundation with no movement or settlement.
- A 1.3m high riprap groin is provided along U/S shoulder for future riprap maintenance if required.

**Seepage Points:**

- Some seepage noted in the wintertime as ice accumulating at the toe. A sand filter has been placed at the seepage location.

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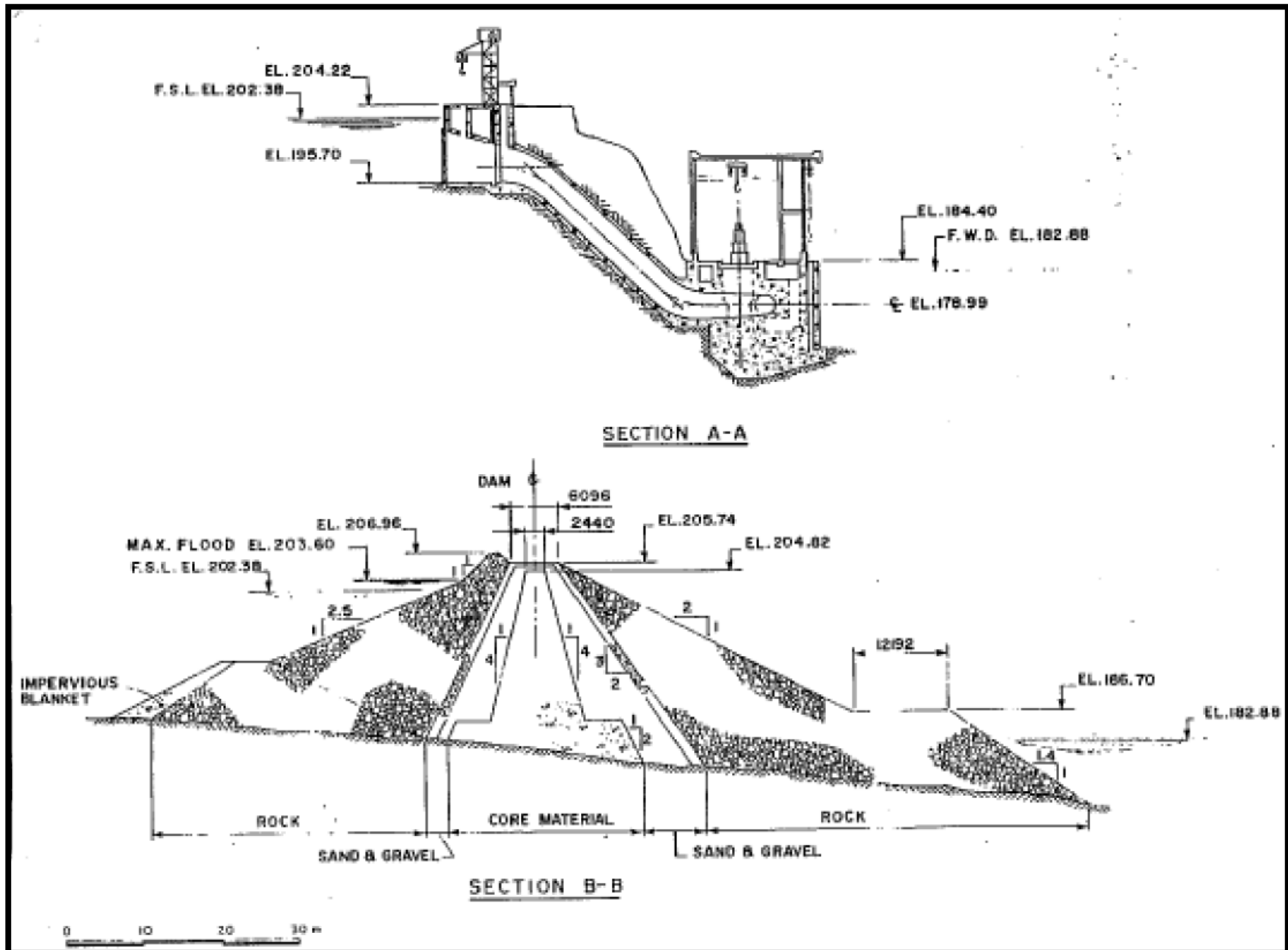
<sup>1</sup> Core, Crest and Berm elevations taken from attached drawing

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Location of Minor Seepage

Snare Falls Site



Snare Falls Dam – Typical Sections

**Structure:** Snare Falls Spillway  
**Location:** Adjacent to Snare Falls Main Dam  
**Constructed:** 1960  
**Type:** Gated Concrete Structure  
**Foundation:** Granite Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Sill: 195.38 m (641.0 ft)  
Auxiliary Overflow  
Weir: 202.39 m (664.0 ft)  
**Gate Sizes<sup>2</sup>:** 2 – 5.8 m (wide) x 7.0 m (high) (19.0 ft x 23.0 ft)  
**Allowable Res. Levels<sup>3</sup>:** Minimum: 201.80 m (662.1 ft)  
Normal Max: 202.40 m (664.0 ft)  
High Flow Max: 203.60 m (668.0 ft)

### **Characteristics**

- Most vulnerable to piping
- Vulnerable to overtopping
- Not likely to fail due to foundation movement or settlement

### **Seepage Points**

None Observed

### **Other**

- There are diagonal cracks on the downstream ends of the piers which require monitoring.
- There are also vertical cracks adjacent to all of the gate guides.

---

<sup>1</sup> Spillway elevations taken from design drawings in feet and converted to meters

<sup>2</sup> Gate sizes taken from the Snare Hydro OM&S Manual

<sup>3</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Snare Falls Spillway – Diagonal Cracks on Downstream Pier



Snare Falls Spillway – Vertical Cracks Adjacent to Gate Guides

**Structure:** Snare Falls Saddle Dam No. 1  
**Location:** Located approximately 100 m North of Snare Falls main dam  
**Constructed:** 1960  
**Type:** Zoned Earth Fill Embankment  
**Core:** None  
**Foundation:** Granite Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Length:** 100 m (328 ft)  
**Height:** 2.6 m (8.5 ft)  
**Crest Elevation<sup>1</sup>:** 204.5 m (670.9 ft)  
**Allowable Res. Levels<sup>2</sup>:**     Minimum:                 201.80 m (662.1 ft)  
  Normal Max:                 202.40 m (664.0 ft)  
  High Flow Max:             203.60 m (668.0 ft)  
**Other:** Modified in 2003 to act as a “fuse plug” spillway to provide emergency flood handling. Crest was lowered approximately 2.7 m.

### Characteristics

- Strong Foundation.
- Provided with riprap erosion protection to act as an emergency spillway.
- Heating of the second spillway gate will enhance the Falls spillway reliability such that operation of the emergency spillway won't be needed.

### Seepage Points

None Observed

---

<sup>1</sup> Crest elevation taken from the Snare Hydro 2006 DSR conducted by Klohn Crippen Berger

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Snare Falls Saddle Dam No. 1

# Snare Falls Side Dam #1 Section

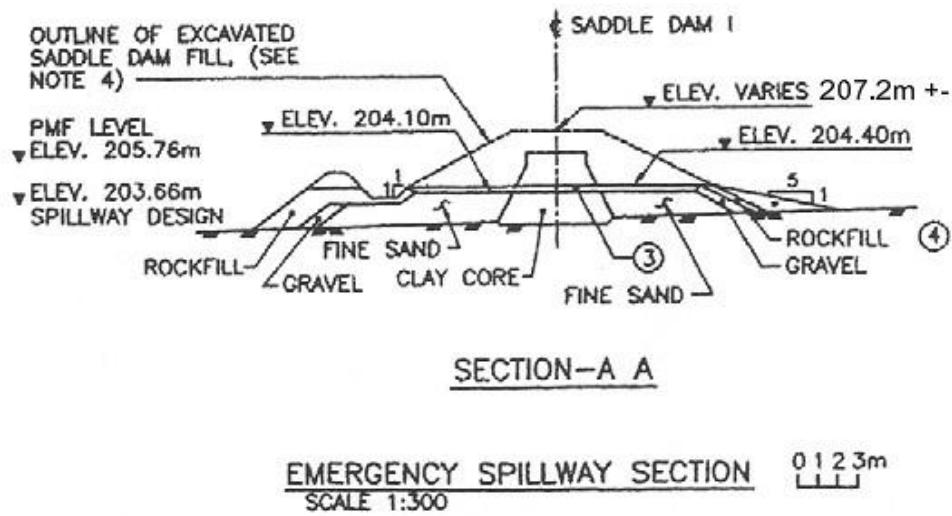
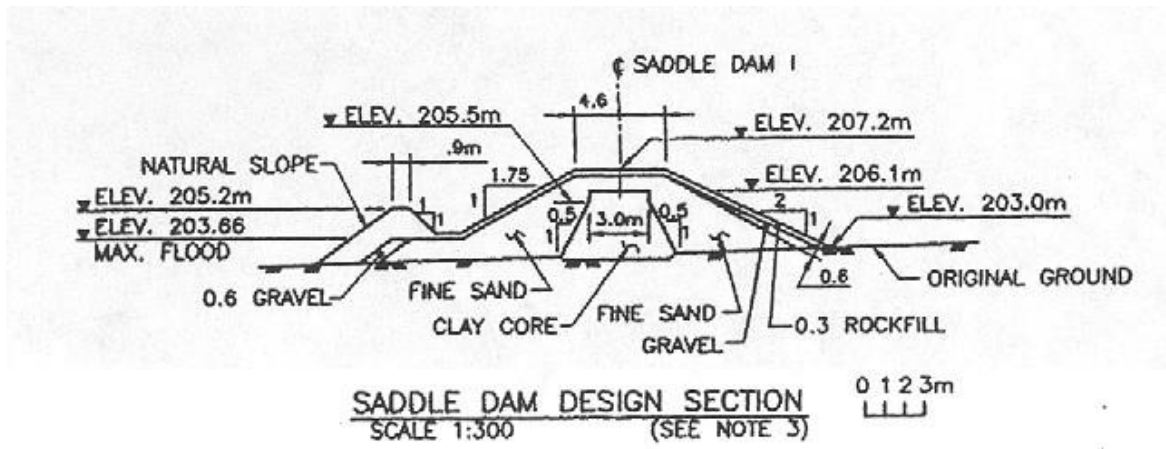


FIGURE  
2003 Modifications to Falls Side Dam #1  
Emergency overflow Spillway

**Structure:** Snare Falls Saddle Dam No. 2  
**Location:** Located approximately 250 m west of Snare Falls main dam  
**Constructed:** 1960  
**Type:** Zoned Earth Fill Embankment  
**Core:** None  
**Foundation:** Soil  
**CDA Consequence**  
**Classification:** High, due to economics  
**Length:** 90 m (328 ft)  
**Height:** 8 m (26 ft)  
**Crest Elevation<sup>1</sup>:** 207.26 m (675.0 ft)  
**Allowable Res. Levels<sup>2</sup>:**     Minimum:             201.80 m (662.1 ft)  
  Normal Max:           202.40 m (664.0 ft)  
  High Flow Max:       203.60 m (668.0 ft)

**Characteristics**

- More vulnerable to foundation settlement than other dams because of soil foundation.
- Very low head on this structure.

**Seepage Points**

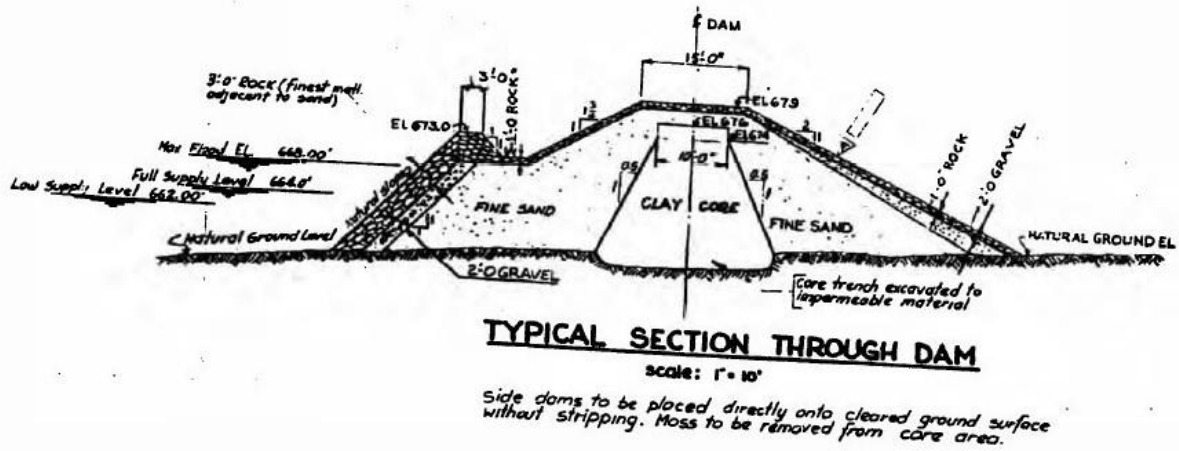
None Observed

---

<sup>1</sup> Crest elevation taken from the Snare Hydro 2006 DSR conducted by Klohn Crippen Berger

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

# Snare Falls Side Dam # 2 Section



Ref Dwg: Montreal Engineering  
NCP - 13899 Rev A  
Side Dams 1 & 2, Plan & Section  
Dated Aug 18 1959

SNARE FALLS

Figure: Snare Falls Side Dams "As Built"

# **SNARE CASCADES**

**Structure:** Snare Cascades Channel Dyke  
**Location:** Second lowermost site on the Snare system. Located 3 km downstream of Snare Falls.

**Constructed:** 1996

**Type:** Rock Fill Dyke  
**Core:** Concrete Cutoff Wall  
**Length:** 162 m (531 ft)  
**Height:** 7 m (23 ft)  
**Foundation:** Bedrock

#### **CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Core: 185.00 m (607.0 ft)  
Crest: 185.30 m (602.0 ft)  
Spillway: 182.88 m (600.0 ft)

**Allowable Res. Levels<sup>2</sup>:** Minimum: 181.88 m (596.7 ft)  
Normal Max: 182.94 m (600.2 ft)  
High Flow Max: 185.00 m (607.0 ft)

#### **Characteristics**

- Good concrete/rock contacts with low potential for erosion.
- Vulnerable to rock fill settlement on the crest (it has been an issue in the past)
- Not likely to fail due to overtopping, piping, foundation movement or foundation settlement

#### **Seepage Points**

The four identified leaks are all observed within a 10 m radius at approximately the midpoint of the dyke. The pool that the seepages flow into has previously been observed to be cloudy. This most likely from rain and melt water washing out the finer particles from the rock fill and is not a concern since the core is concrete. As these leaks are too low to be observed when water is flowing over the spillway, regular inspections may not be possible and operations personnel will have to inspect them whenever the water is low enough.

##### **1. Seepage Point #1**

- Through the bedrock at the toe of the dam
- Approximately 3 L/min

##### **2. Seepage Point #2**

- Approximately 0.75 L/min

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<sup>1</sup> Elevations taken from attached drawings

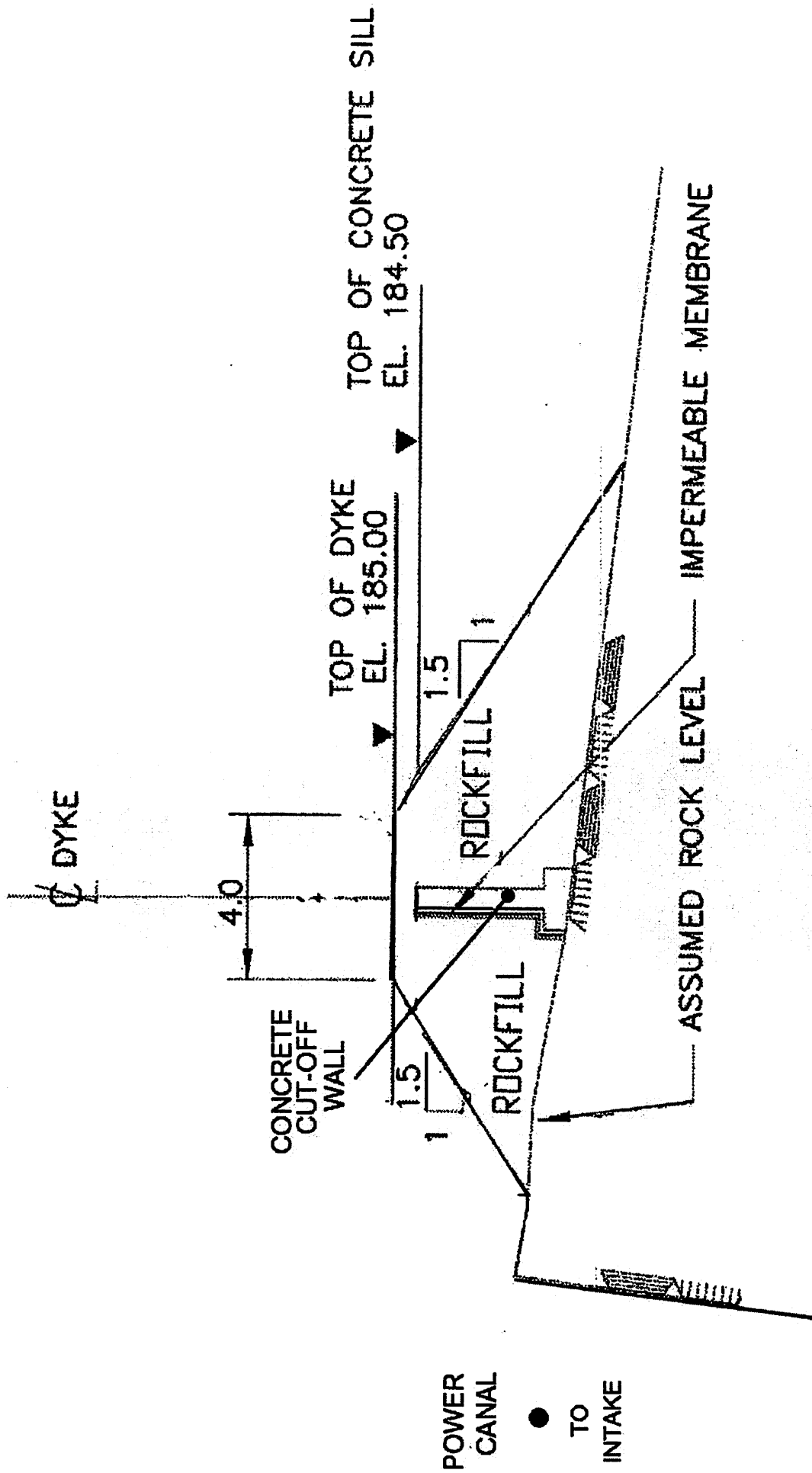
<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

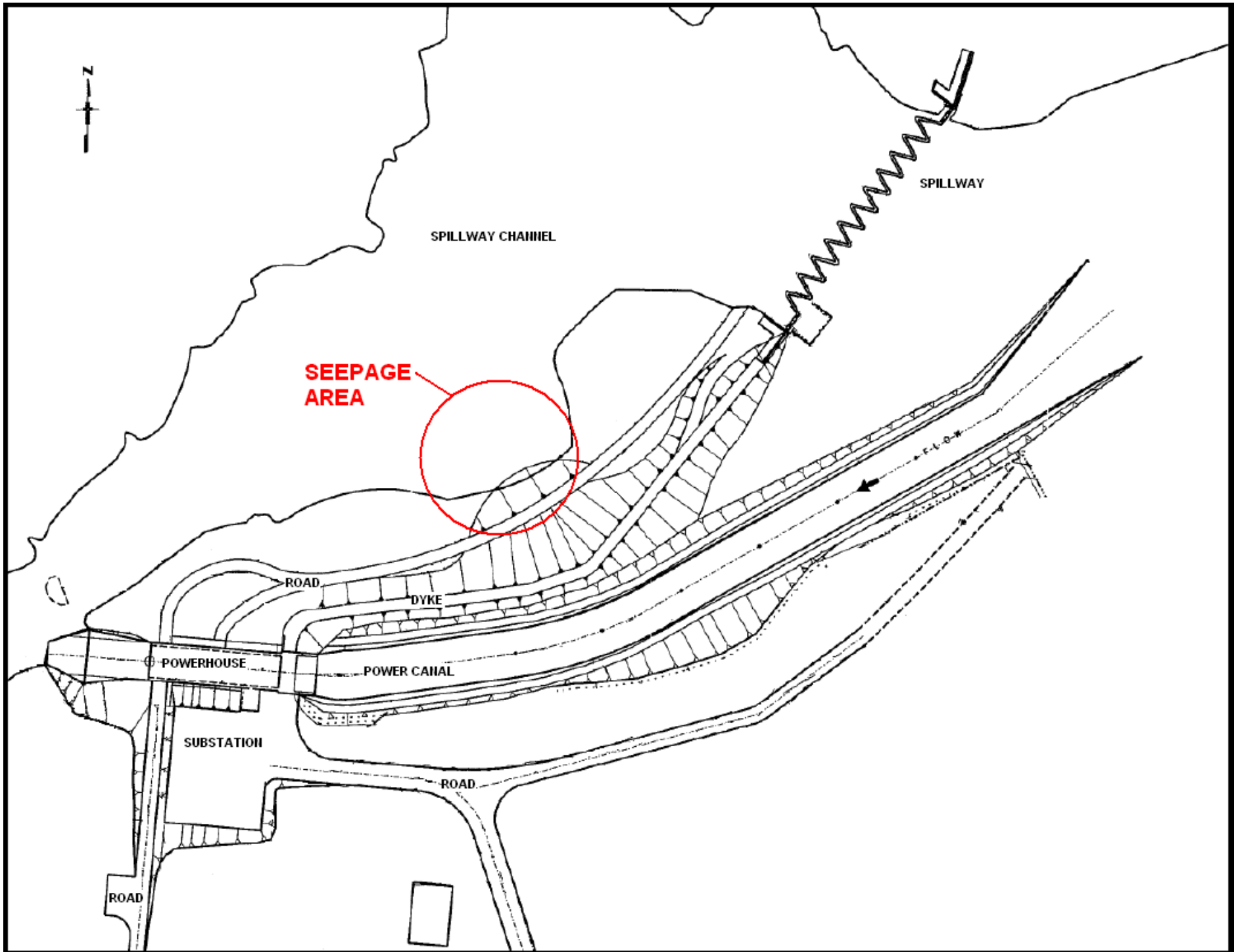
**3. Seepage Point #3**

- Approximately 0.1 L/min

**4. Seepage Point #4**

- Approximately 0.5 L/min





Snare Cascades – Simplified Plan with Seepage Locations



Snare Cascades – Seepage Locations

**Structure:** Snare Cascades Spillway  
**Location:** Extends from the north end of the Cascades dyke to the opposite bank  
**Constructed:** 1996  
**Type:** Free-Flow Labyrinth Concrete Spillway  
**Length:** 70 m (230 ft)  
**Height:** 5 m (16 ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Crest Elevation<sup>1</sup>:** 182.88 m (600.0 ft)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 181.88 m (596.7 ft)  
Normal Max: 182.94 m (600.2 ft)  
High Flow Max: 185.00 m (607.0 ft)

### Characteristics

- Reinforced concrete structure on granite bedrock.
- Competent foundation, no erosion or undermining.

### **Cracks and Erosion**

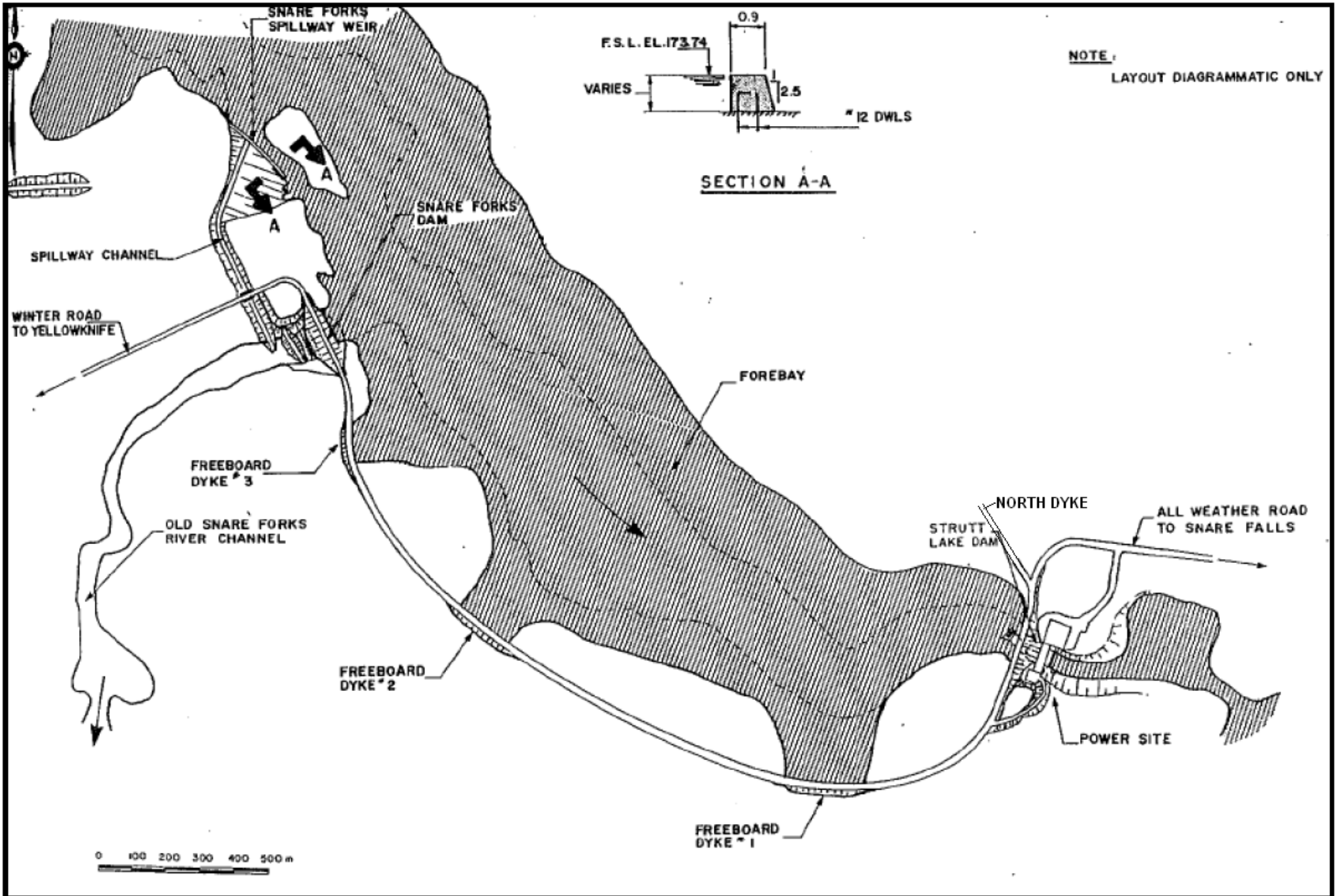
- Areas on the slab with cracks, erosion, and exposed reinforcing steel were repaired in 2015.
- Surface erosion was repaired by application of 50mm coating of Sikacrete-08 self compacting concrete.
- A reinforced concrete wall, 300mm thick, was also poured against the downstream face of the slab.
- Frost action can lead to crack propagation and erosion, these types of issues should be looked for during inspections.

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<sup>1</sup> Crest elevation taken from attached drawing

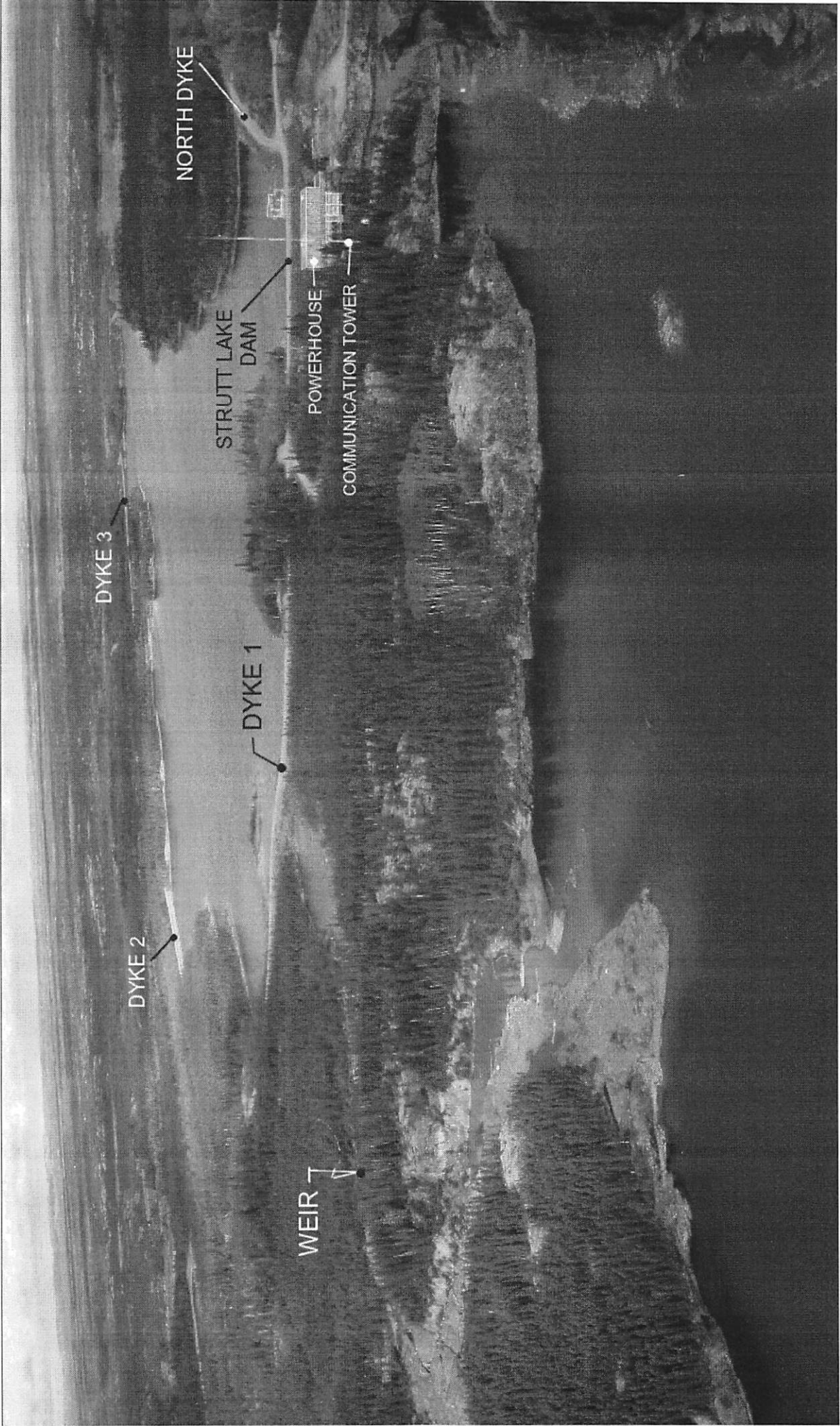
<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

# **SNARE FORKS**



Snare Forks General Layout & Spillway Section

Forks Overview



**Structure:** Strutt Lake Dam  
**Location:** Furthest downstream site on the Snare system. Located 10 km downstream of Snare Cascades. Impounds the South channel of Snare River.

**Constructed:** 1976

**Type:** Zoned Earth Fill Embankment

**Core:** Sloping Till Core

**Length:** 160 m (525 ft)

**Height:** 18 m (59 ft)

**Foundation:** Bedrock

### **CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Core: 175.58 m (576.1 ft)

Crest: 176.78 m (580.0 ft)

Spillway: 173.74 m (570.0 ft)

**Allowable Res. Levels<sup>2</sup>:** Minimum: 173.13 m (568.0 ft)

Normal Max: 173.73 m (570.0 ft)

High Flow Max: 175.26 m (575.0 ft)

### **Characteristics**

- Seepage is small with little change since 1976.
- Not vulnerable to overtopping due to the low dykes.
- Solid foundation with no settlement or movement.

### **Seepage Points**

- Seepage flow exists at the toe of Strutt Dam near the entrance to the Plant walkway. In 2019 a boil was observed at this location which was attributed to pent-up water within the overburden along the toe which was released during spring thaw.
- As an enhancement to stability, a 1m cover of clean crush gravel filter material was placed over this area in 2020.
- Seepage has rarely occurred at the right abutment, the flow appears as a wet area and is not measurable but should be visually inspected.

---

<sup>1</sup> Elevations taken from attached drawings

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Seepage Area / Stability Enhancement

Minor Seepage Area

Strutt Lake Dam – Aerial Photo



**Structure:** Snare Forks Dam  
**Location:** North of Dyke #3. Impounds the north channel of Snare River.  
**Constructed:** 1976  
**Type:** Zoned Earth Fill Embankment  
**Core:** Sloping Till Core  
**Length:** 105 m (345 ft)  
**Height:** 10 m (33 ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Core: 175.58 m (576.1 ft)  
Crest<sup>2</sup>: 176.79 m (580.0 ft)  
Spillway: 173.74 m (570.0 ft)  
**Allowable Res. Levels<sup>3</sup>:** Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

### Characteristics

- Good foundation, no movement or settlement.
- Not vulnerable to overtopping as the dykes are 1m lower.

### Seepage Points

- Small amount of seepage through a culvert in the downstream. Only visible when spillway channel is dry.
- It is recommended that monthly seepage readings are taken at the berm culvert when the spillway is not overflowing.

---

<sup>1</sup> Core and Spillway elevations taken from attached drawings

<sup>2</sup> Crest elevation from 2010 Snare Forks Dykes Survey

<sup>3</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

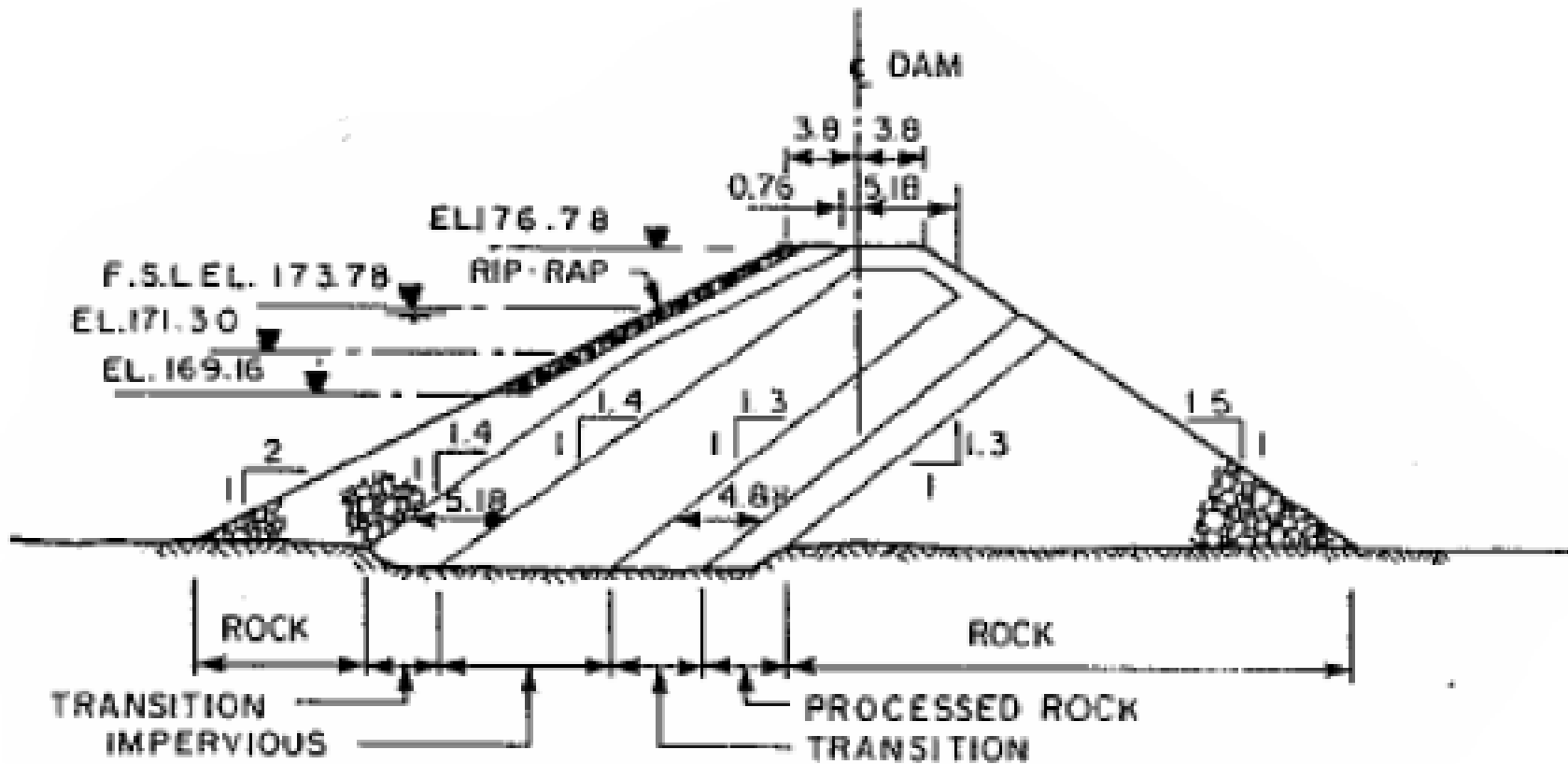


SPILLWAY

Seepage  
Culvert

FORKS  
MAIN DAM

DYKE 3



Snare Forks Dam – Typical Section

**Structure:** Snare Forks Spillway  
**Location:** Approximately 300 m north of Snare Forks Dam  
**Constructed:** 1976  
**Type:** Free-Flow Concrete Weir  
**Length:** 100 m (328 ft)  
**Height:** 2.25 m  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Crest Elevation<sup>1</sup>:** 173.74 m (570.0 ft)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

### Characteristics

- Most vulnerable to frost action causing concrete erosion and crack propagation.
- Rock erosion protection was placed along the downstream face, enhancing the stability of the Weir.

### Seepage Points

- Small seepage point was identified during the 2011 DSR inspection near the middle of the spillway.

---

<sup>1</sup> Crest elevation taken from attached drawing

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Snare Forks Spillway – Aerial Photo

**Structure:** Snare Forks North Dyke  
**Location:** Extends to the northwest from the north abutment of Strutt Lake Dam  
**Constructed:** 1976  
**Type:** Zoned Earth Fill  
**Core:** Rolled Silt  
**Length:** 380 m (1247 ft)  
**Height:** 2.5m (6.56ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Core:  
Crest: 176.78 m (580.0 ft)  
Spillway: 173.74 m (570.0 ft)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

### **Characteristics**

- Good foundation, no movement or settlement.
- Not vulnerable to overtopping as the dykes are 1m lower.

### **Seepage Points**

None observed.

---

<sup>1</sup> Elevations taken from attached drawings

<sup>2</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Snare Forks North Dyke – Aerial Photo

**Structure:** Snare Forks Dyke #1  
**Location:** Approximately 500 m southwest of Strutt Lake Dam  
**Constructed:** 1976 Reconstructed 2006  
**Type:** Sand Fill Embankment  
**Core:**  
**Length:** 300 m (984 ft)  
**Height:** 3 m (10 ft)  
**Foundation:** Permafrost Lacustrine Soils  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations:** Core:  
Crest<sup>1</sup>: 175.69 m (576.4 ft)  
Spillway<sup>2</sup>: 173.74 m (570.0 ft)  
**Allowable Res. Levels**<sup>3</sup>: Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

### Characteristics

- Some potential for piping to occur.
- It is thought that the permafrost under the dyke no longer exists after 35 years, however, if permafrost remains occasional settlement will continue.
- Not likely to fail due to foundation movement.

### Seepage

- Breached on June 15, 2006.
- Seepage is present at the breach section (approximately midpoint).
- Filter blanket constructed over leakage area to mitigate potential piping.
- Elevation is slightly below design elevation around the location of seepage.
- Seepage water is clear.
- Monitored by a concrete V-notch weir approximately 500 m downstream.
- Weir is accessed by a foot path from the radio tower by the Forks plant.
- Flow through the weir is normally around 2.1 ft<sup>3</sup>/s.

---

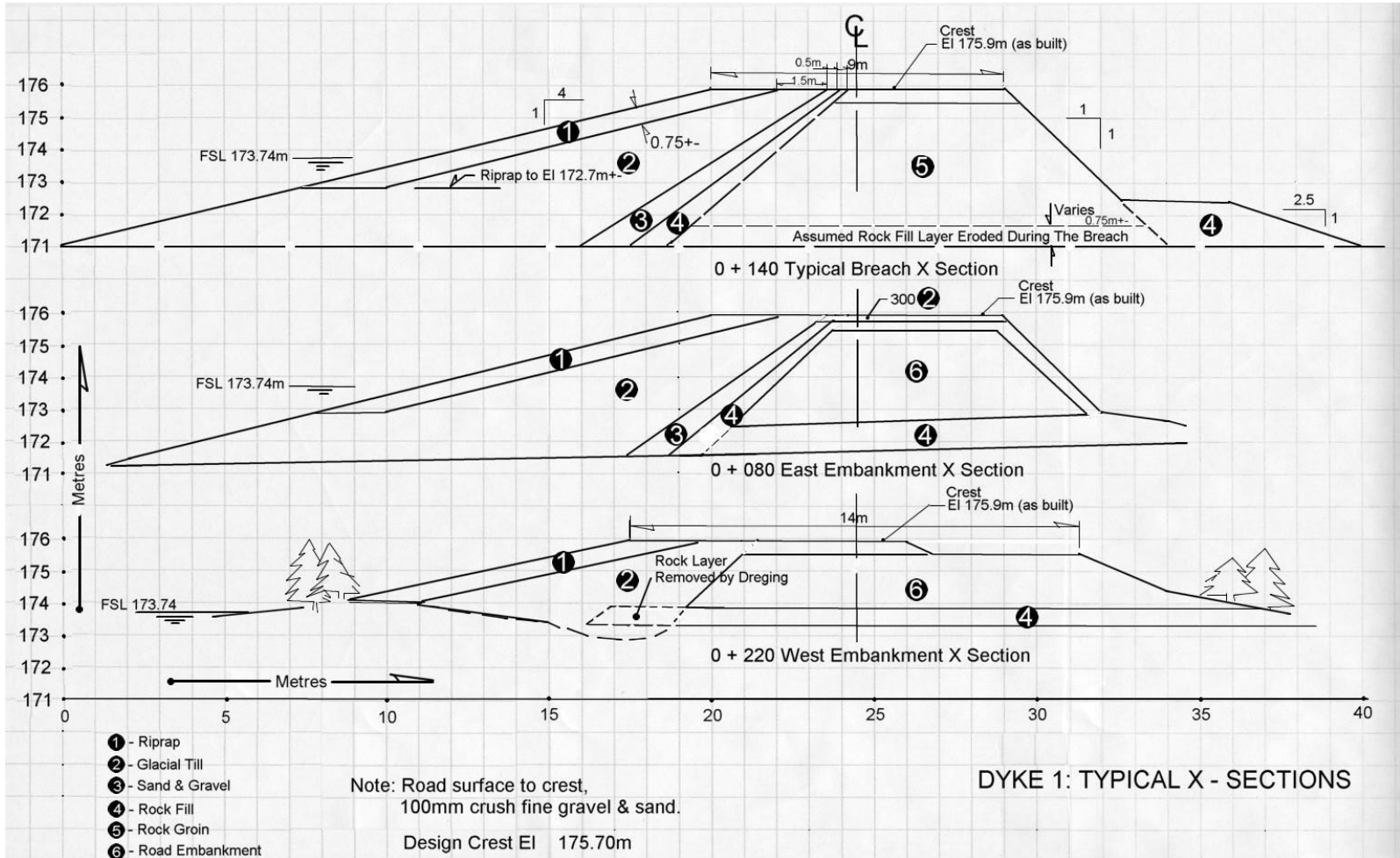
<sup>1</sup> Crest elevation from 2010 Snare Forks Dykes Survey

<sup>2</sup> Spillway elevation taken from attached drawing

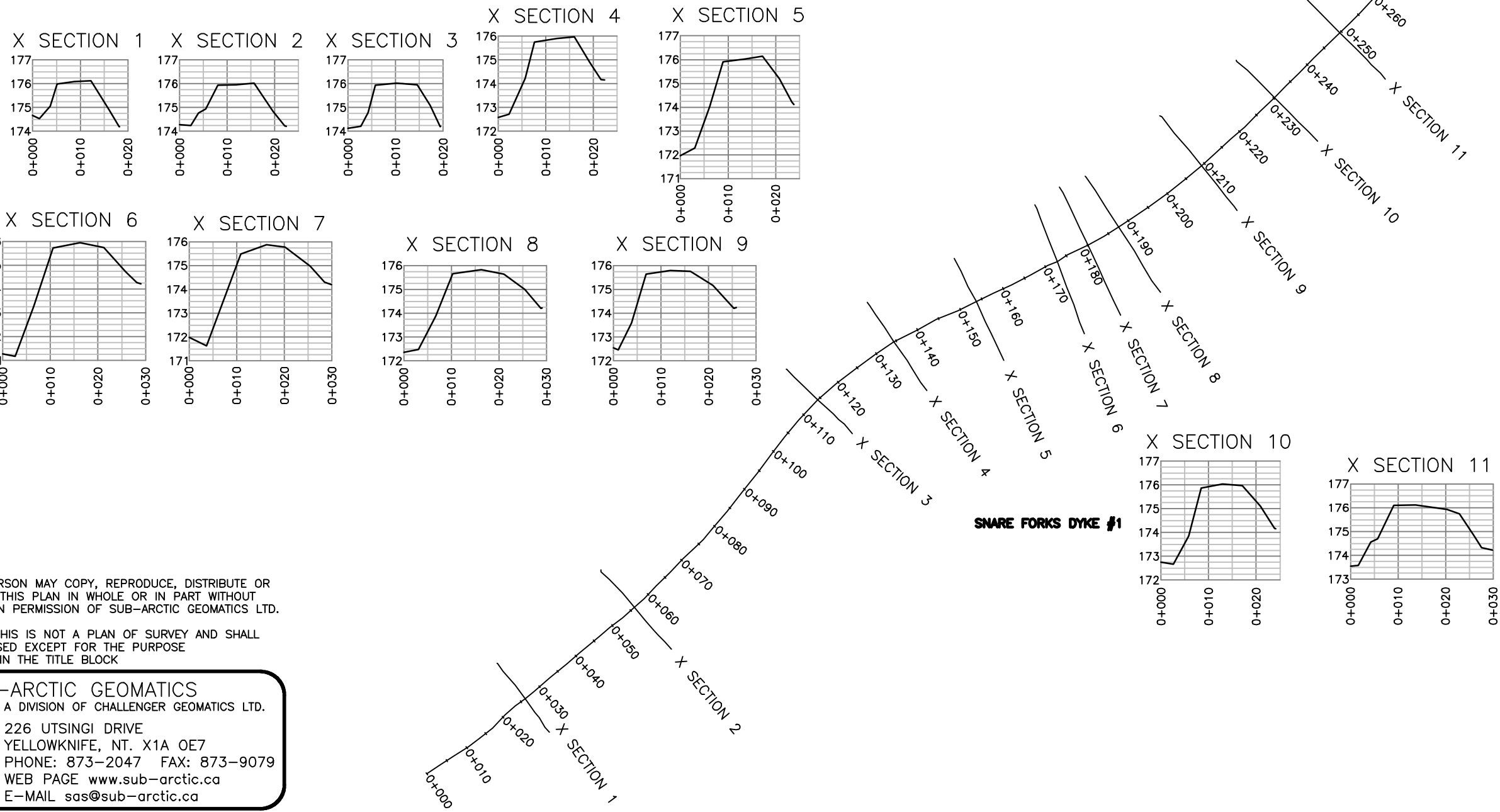
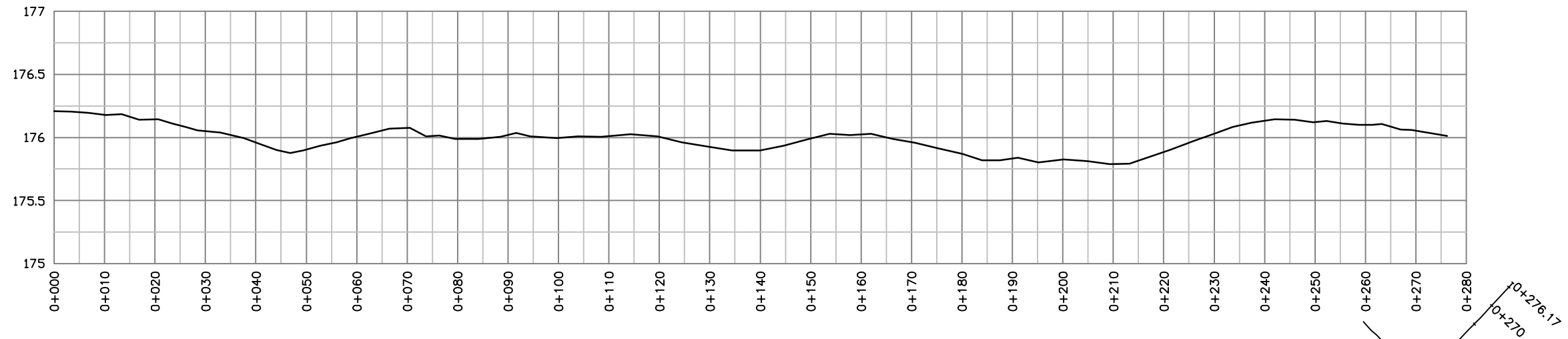
<sup>3</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual

# Forks Dyke 1 Sections

FIGURE 16.11 Dyke 1 X-Sections



# SNARE FORKS DYKE #1 PROFILE



NOTES:  
 DATE OF SURVEY: OCTOBER 27 TO 29, 2020  
 ALL ELEVATIONS ARE EXPRESSED IN METRES OR DECIMALS THEREOF.  
 SURVEY REFERENCE POINT:  
 BASE 1  
 NORTHING: 7022516.52  
 EASTING: 533965.94  
 ELEVATION: 176.6

NO.	REVISION\ISSUE	DATE:

DRAWN BY: M.D./J.N.  
 CHECKED BY: M.D.

**NORTHWEST TERRITORIES  
 POWER CORPORATION**

**PROFILE AND  
 CROSS SECTIONS  
 OF  
 FORKS DYKE #1  
 SNARE LAKE HYDRO - NT**

PROJECT NO.: 80610  
 FILE NO.:  
 80610-FORKS DYKE&STRUTT LAKE-N009  
 DATE: NOVEMBER 10, 2020  
 SCALE: 1:1000

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CAUTION: THIS IS NOT A PLAN OF SURVEY AND SHALL NOT BE USED EXCEPT FOR THE PURPOSE INDICATED IN THE TITLE BLOCK

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 E-MAIL sas@sub-arctic.ca



Snare Forks Dyke #1 – Seepage & Filter Blanket Location



Dyke #1 Weir

# SNARE FORKS DYKE 1 WEIR FLOW RATE TABLE

Discharge Constant ( $c_d$ ) = 0.578) Gravitational Constant ( $g$ ) = 32.2 ft/s<sup>2</sup>

Flow ( $q$ ) =  $0.533c_d(2g)^{0.5}h^{2.5}$

Depth		Flow		Depth		Flow		Depth		Flow	
in	ft	cfs	L/min	in	ft	cfs	L/min	in	ft	cfs	L/min
1/8	0.010	2.7E-05	0.05	6 1/8	0.510	0.460	782	12 1/8	1.010	2.539	4313
1/4	0.021	1.5E-04	0.26	6 1/4	0.521	0.484	823	12 1/4	1.021	2.605	4425
3/8	0.031	4.3E-04	0.73	6 3/8	0.531	0.509	865	12 3/8	1.031	2.672	4539
1/2	0.042	8.8E-04	1.5	6 1/2	0.542	0.534	908	12 1/2	1.042	2.740	4655
5/8	0.052	0.0015	2.6	6 5/8	0.552	0.560	952	12 5/8	1.052	2.809	4772
3/4	0.063	0.0024	4.1	6 3/4	0.563	0.587	997	12 3/4	1.063	2.879	4891
7/8	0.073	0.0036	6.0	6 7/8	0.573	0.615	1044	12 7/8	1.073	2.950	5012
1	0.083	0.0050	8.4	7	0.583	0.643	1092	13	1.083	3.022	5134
1 1/8	0.094	0.0067	11	7 1/8	0.594	0.672	1142	13 1/8	1.094	3.095	5258
1 1/4	0.104	0.0087	15	7 1/4	0.604	0.702	1192	13 1/4	1.104	3.169	5385
1 3/8	0.115	0.011	19	7 3/8	0.615	0.733	1245	13 3/8	1.115	3.245	5512
1 1/2	0.125	0.014	23	7 1/2	0.625	0.764	1298	13 1/2	1.125	3.321	5642
1 5/8	0.135	0.017	28	7 5/8	0.635	0.796	1353	13 5/8	1.135	3.398	5774
1 3/4	0.146	0.020	34	7 3/4	0.646	0.829	1409	13 3/4	1.146	3.477	5907
1 7/8	0.156	0.024	41	7 7/8	0.656	0.863	1466	13 7/8	1.156	3.556	6042
2	0.167	0.028	48	8	0.667	0.898	1525	14	1.167	3.637	6179
2 1/8	0.177	0.033	55	8 1/8	0.677	0.933	1586	14 1/8	1.177	3.719	6318
2 1/4	0.188	0.038	64	8 1/4	0.688	0.970	1647	14 1/4	1.188	3.801	6459
2 3/8	0.198	0.043	73	8 3/8	0.698	1.007	1710	14 3/8	1.198	3.885	6601
2 1/2	0.208	0.049	83	8 1/2	0.708	1.045	1775	14 1/2	1.208	3.970	6746
2 5/8	0.219	0.055	94	8 5/8	0.719	1.083	1841	14 5/8	1.219	4.057	6892
2 3/4	0.229	0.062	106	8 3/4	0.729	1.123	1908	14 3/4	1.229	4.144	7040
2 7/8	0.240	0.070	118	8 7/8	0.740	1.164	1977	14 7/8	1.240	4.232	7190
3	0.250	0.077	131	9	0.750	1.205	2047	15	1.250	4.322	7342
3 1/8	0.260	0.086	145	9 1/8	0.760	1.247	2119	15 1/8	1.260	4.412	7496
3 1/4	0.271	0.094	160	9 1/4	0.771	1.291	2193	15 1/4	1.271	4.504	7652
3 3/8	0.281	0.104	176	9 3/8	0.781	1.335	2267	15 3/8	1.281	4.597	7810
3 1/2	0.292	0.114	193	9 1/2	0.792	1.380	2344	15 1/2	1.292	4.691	7970
3 5/8	0.302	0.124	211	9 5/8	0.802	1.425	2422	15 5/8	1.302	4.786	8131
3 3/4	0.313	0.135	229	9 3/4	0.813	1.472	2501	15 3/4	1.313	4.882	8295
3 7/8	0.323	0.147	249	9 7/8	0.823	1.520	2582	15 7/8	1.323	4.980	8460
4	0.333	0.159	270	10	0.833	1.568	2664	16	1.333	5.078	8628
4 1/8	0.344	0.171	291	10 1/8	0.844	1.618	2749	16 1/8	1.344	5.178	8797
4 1/4	0.354	0.185	314	10 1/4	0.854	1.668	2834	16 1/4	1.354	5.279	8969
4 3/8	0.365	0.199	337	10 3/8	0.865	1.719	2921	16 3/8	1.365	5.381	9142
4 1/2	0.375	0.213	362	10 1/2	0.875	1.772	3010	16 1/2	1.375	5.484	9318
4 5/8	0.385	0.228	388	10 5/8	0.885	1.825	3101	16 5/8	1.385	5.589	9495
4 3/4	0.396	0.244	414	10 3/4	0.896	1.879	3193	16 3/4	1.396	5.694	9675
4 7/8	0.406	0.260	442	10 7/8	0.906	1.934	3286	16 7/8	1.406	5.801	9856
5	0.417	0.277	471	11	0.917	1.990	3381	17	1.417	5.909	10040
5 1/8	0.427	0.295	501	11 1/8	0.927	2.047	3478	17 1/8	1.427	6.019	10226
5 1/4	0.438	0.313	532	11 1/4	0.938	2.105	3577	17 1/4	1.438	6.129	10413
5 3/8	0.448	0.332	564	11 3/8	0.948	2.164	3677	17 3/8	1.448	6.241	10603
5 1/2	0.458	0.352	598	11 1/2	0.958	2.224	3779	17 1/2	1.458	6.353	10795
5 5/8	0.469	0.372	632	11 5/8	0.969	2.285	3882	17 5/8	1.469	6.468	10988
5 3/4	0.479	0.393	668	11 3/4	0.979	2.347	3988	17 3/4	1.479	6.583	11184
5 7/8	0.490	0.415	705	11 7/8	0.990	2.410	4094	17 7/8	1.490	6.699	11382
6	0.500	0.437	743	12	1.000	2.474	4203	18	1.500	6.817	11582

**Structure:** Snare Forks Dyke #2  
**Location:** Approximately 1 km west of Strutt Lake Dam  
**Constructed:** 1976  
**Type:** Sand Fill Embankment  
**Core:**  
**Length:** 200 m (656 ft)  
**Height:** 2 m (7 ft)  
**Foundation:** Permafrost Lacustrine Soils

#### **CDA Consequence**

**Classification:** High, due to economics

**Elevations:** Core:  
Crest<sup>1</sup>: 175.97 m (577.3 ft)  
Spillway<sup>2</sup>: 173.74 m (570.0 ft)  
**Allowable Res. Levels**<sup>3</sup>: Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

#### **Characteristics**

- A reverse filter was placed on the downstream of the dyke in 2009 to help eliminate the presence of boils found during the 2006 DSR.
- Less vulnerable to foundation settlement (will probably settle if permafrost is lost)
- Not likely to fail due to foundation movement.

#### **Seepage Points**

None observed.

---

<sup>1</sup> Crest elevation from 2010 Snare Forks Dykes Survey

<sup>2</sup> Spillway elevation taken from attached drawing

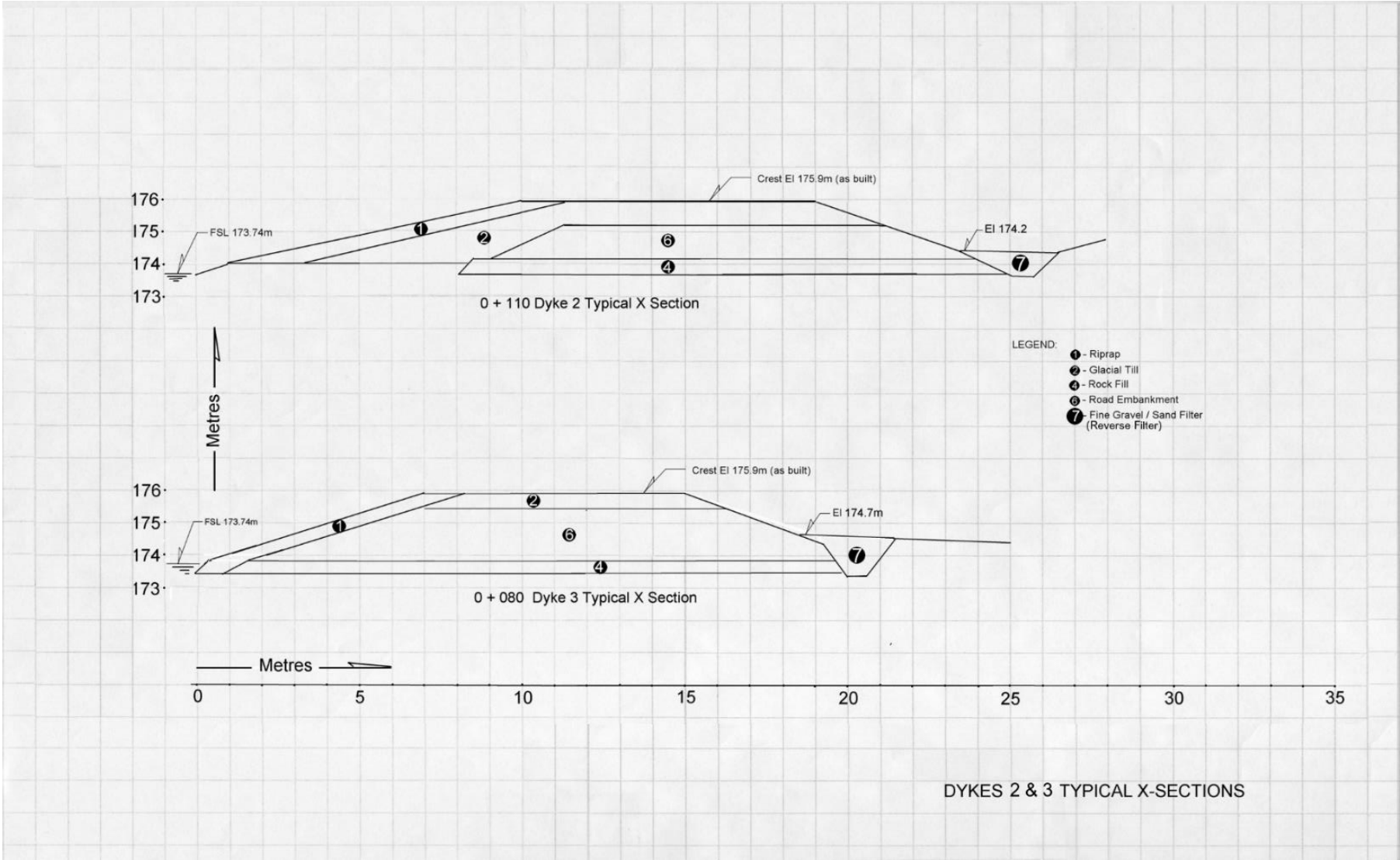
<sup>3</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Forks Dyke #2 – Aerial Photo

# Forks Dyke 2 & 3 Sections

Figure: Dykes 2 & 3 X-Sections.



**Structure:** Snare Forks Dyke #3  
**Location:** Approximately 1 km west of Strutt Lake Dam  
**Constructed:** 1976  
**Type:** Sand Fill Embankment  
**Core:**  
**Length:** 260 m (656 ft)  
**Height:** 2 m (7 ft)  
**Foundation:** Permafrost Lacustrine Soils

**CDA Consequence**

**Classification:** High, due to economics

**Elevations:** Core:  
Crest<sup>16</sup>: 175.92 m (577.2 ft)  
Spillway<sup>17</sup>: 173.74 m (570.0 ft)  
**Allowable Res. Levels**<sup>18</sup>: Minimum: 173.13 m (568.0 ft)  
Normal Max: 173.73 m (570.0 ft)  
High Flow Max: 175.26 m (575.0 ft)

**Characteristics**

- Settlement of the dykes may continue due to permafrost melt.
- Crests of all three Forks dykes are surveyed yearly and raised as required to maintain the design elevation.

**Seepage Points**

None observed.

---

<sup>16</sup> Crest elevation from 2010 Snare Forks Dykes Survey

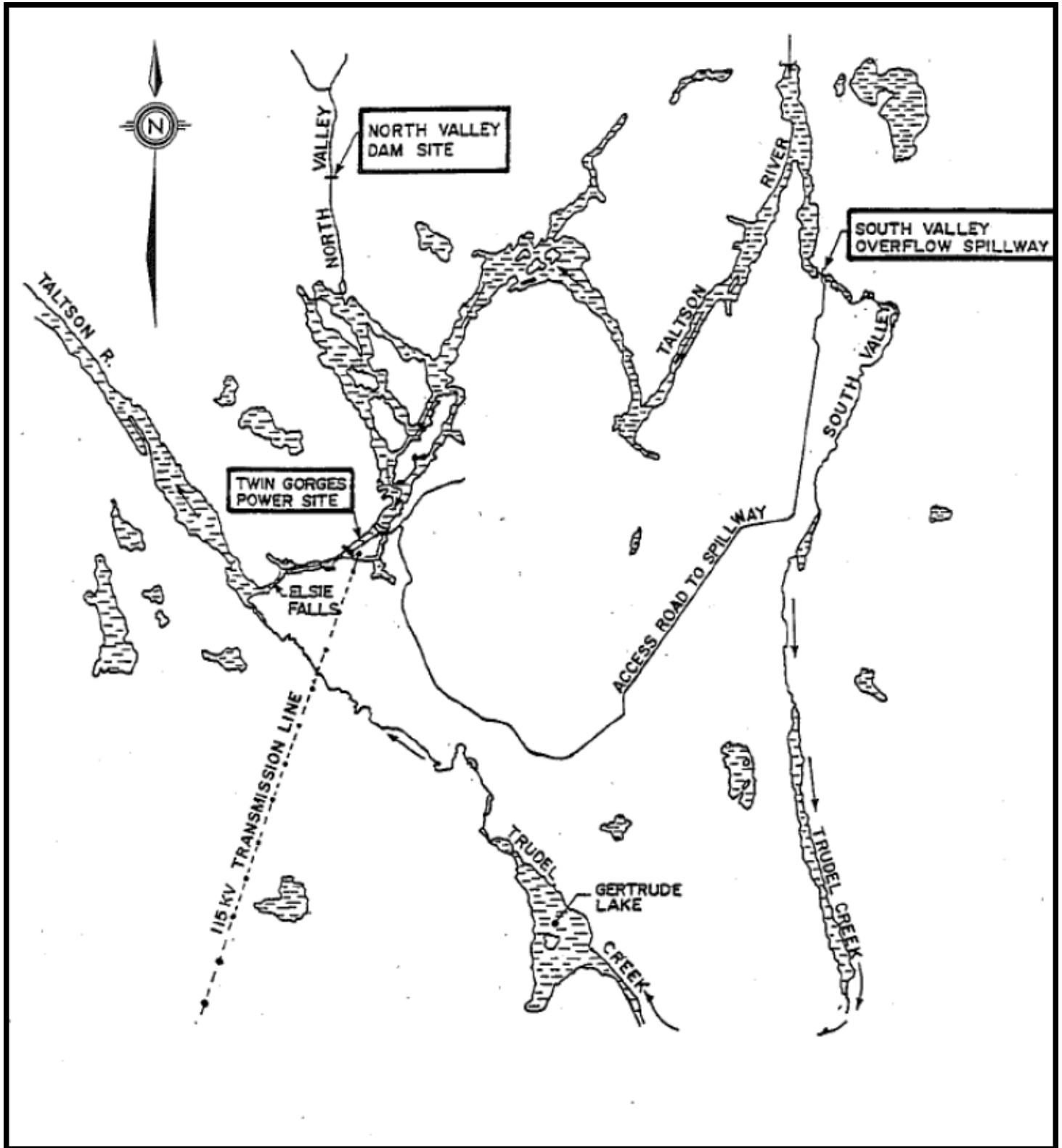
<sup>17</sup> Spillway elevation taken from attached drawing

<sup>18</sup> Allowable Reservoir Levels taken from the Snare Hydro OM&S Manual



Forks Dyke #3 – Aerial Photo

# **TALTON HYDRO**



Taltson Hydro – Site Plan

**Structure:** Taltson Twin Gorges  
**Location:** Approximately 56 km northeast of Fort Smith, just upstream of Elsie Falls on the Taltson River.

**Constructed:** 1966  
**Type:** Zoned Earth and Rock Fill Embankment  
**Core:** Central Till Core  
**Length:** 285 m (935 ft)  
**Height:** 25 m (82 ft)  
**Foundation:** Bedrock

#### **CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Bund/Berm: 244.14 m (801.0 ft)  
Crest: 243.29 m (798.0 ft)  
Core: 241.71 m (793.0 ft)  
Spillway<sup>2</sup>: 239.27 m (785.0 ft)

**Allowable Res. Levels<sup>3</sup>:** Minimum: 238.90 m (783.8 ft)  
Normal Max: 239.27 m (785.0 ft)  
High Flow Max: 240.90 m (790.4 ft)

#### **Characteristics**

- Small amount of seepage makes the potential for piping and internal erosion low.
- The dam incorporates a substantial cofferdam beneath the reservoir surface.

#### **Seepage Points**

##### **1. Toe of the dam in the east gorge**

- Occurs between the dam and the large pond at the toe of the dam
- Approximately 2 m from the edge of the large pond.
- Water may be turbid
- May be due to:
  - Inadequate core filtering
  - Piping of infilling in bedrock features not sealed by grouting
  - Piping of native soil beneath the downstream shell of the dam
- Several other small, non-turbid seepages located on various bedrock outcrops

##### **2. Toe of the dam, adjacent to penstock access road**

- Located at a bedrock outcrop to the east of the penstock
- Non-turbid
- Only visible at the source
- Seepage rate varies throughout the year
- Causes ice build-up on the access road

##### **3. Between the penstock and west gorge**

---

<sup>1</sup> Bund/Berm, Crest and Core elevations taken from design drawings in feet and converted to meters

<sup>2</sup> Spillway elevation taken from the Taltson Hydro OM&S Manual

<sup>3</sup> Allowable Reservoir Levels taken from the Taltson Hydro OM&S Manual

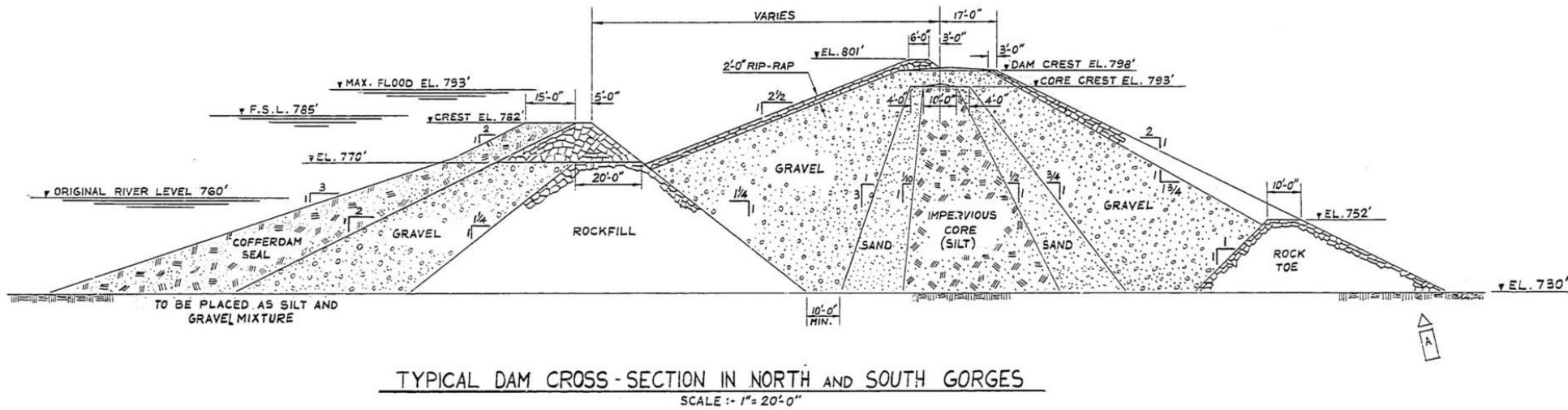
- Located to the west of the penstock, adjacent to the west gorge at the toe of the dam
- About a 5 m wide pond
- Speculated that seepage from underlying soil/bedrock collects in the depression and similarly, drains away through the soil/bedrock
- Seems to be in-line with a depression on the crest of the dam

#### **4. West gorge**

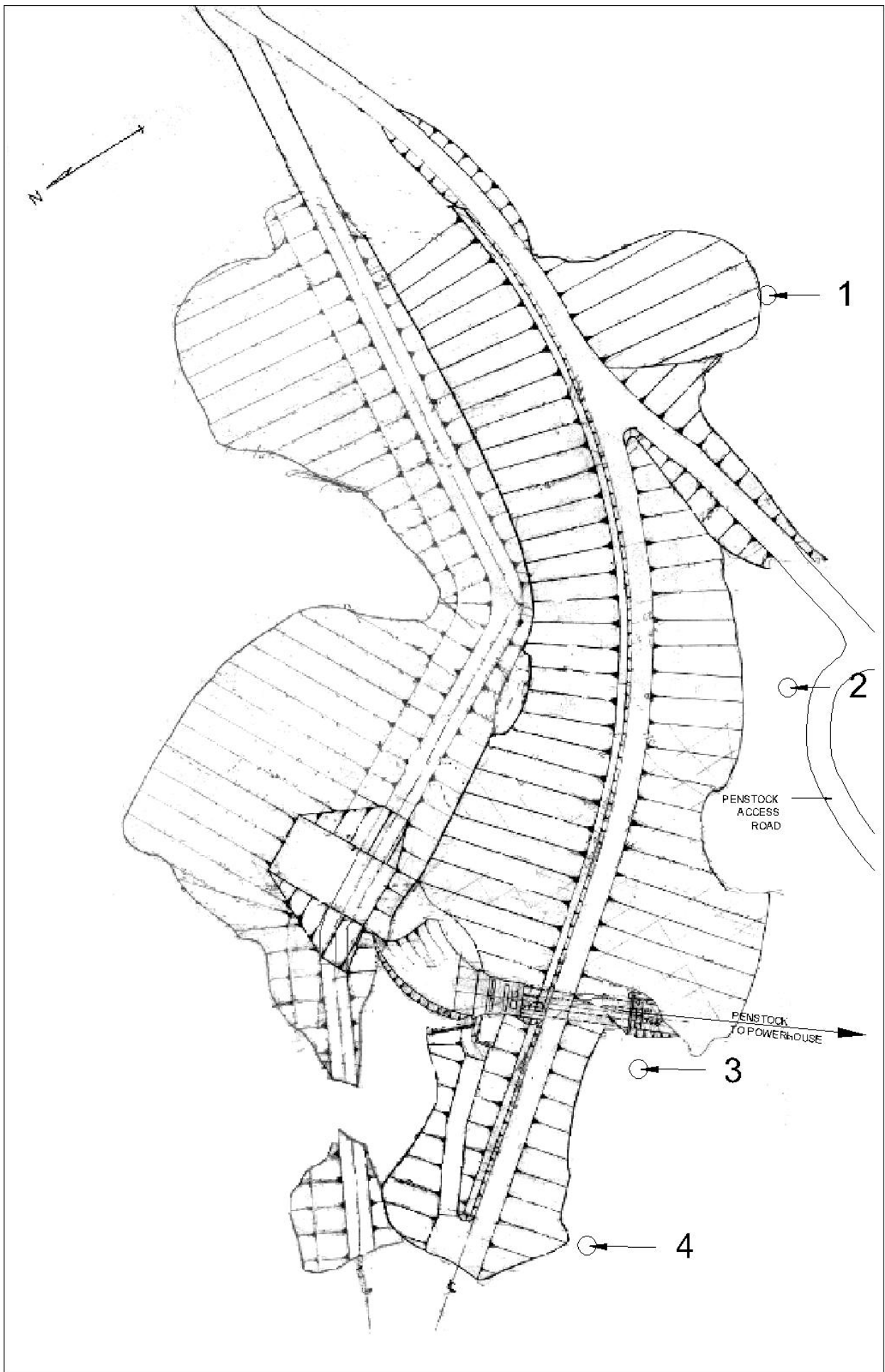
- Seepage located in gorge on the east side of the powerhouse
- Likely due to regional groundwater discharge
- Has caused severe ice build-up in the past and continues to cause ice build-up
- Seepage collection and discharge measures include:
  - Covered and heated concrete catch basins and
  - Heat traced discharge pipes

# Taltson Twin Gorges Sections

FIGURE Twin Gorges Dam  
X - Section



TALTSON DAM  
NORTH & SOUTH GORGES  
X - SECTION



Taltson Dam – Key Plan Showing Seepage Locations



Taltson Dam – Aerial Photo Showing Seepage Locations

**Structure:** South Valley Spillway  
**Location:** Approximately 6 km northeast of the Twin Gorges.  
**Constructed:** 1966  
**Type:** Two reinforced concrete ogee-type weirs separated by a rock outcrop, and a third small natural channel  
**Length:** 200 m  
**Height:** 6 m  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Crest Elevation<sup>1</sup>:** 239.27 m (785.0 ft)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 238.90 m (783.8 ft)  
Normal Max: 239.27 m (785.0 ft)  
High Flow Max: 240.90 m (790.4 ft)

### Characteristics

- Most vulnerable to deformation from ice loading. However, ice loading does not currently occur since water is constantly spilling.
- The spillway has been in overflow mode for the past 33 years since the Pine Point Mine closed in 1988.
- Potential for erosion at concrete/bedrock contacts and at the crest.
- Not likely to fail due to foundation movement or settlement.

### Seepage Points

None observed

---

<sup>1</sup> Crest elevation taken from the Taltson Hydro OM&S Manual

<sup>2</sup> Allowable Reservoir Levels taken from the Taltson Hydro OM&S Manual

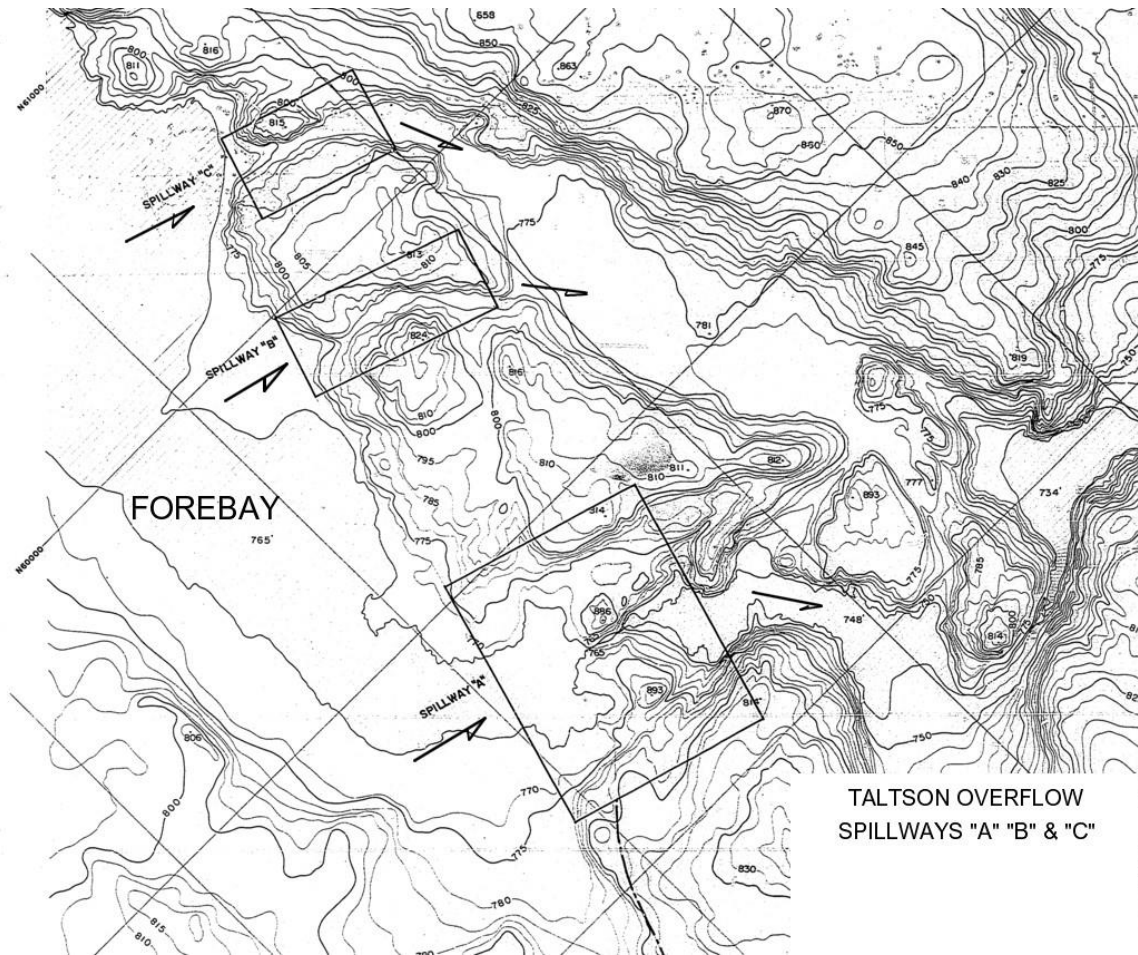


Figure 11. TALTSON SOUTH VALLEY SPILLWAYS.

Shows the topography at the Taltson Overflow Spillways at Sections A, B & C. The channels A & C are provided with a concrete sill overflow. The flow through Section B is contained in a rock cut without a concrete sill.

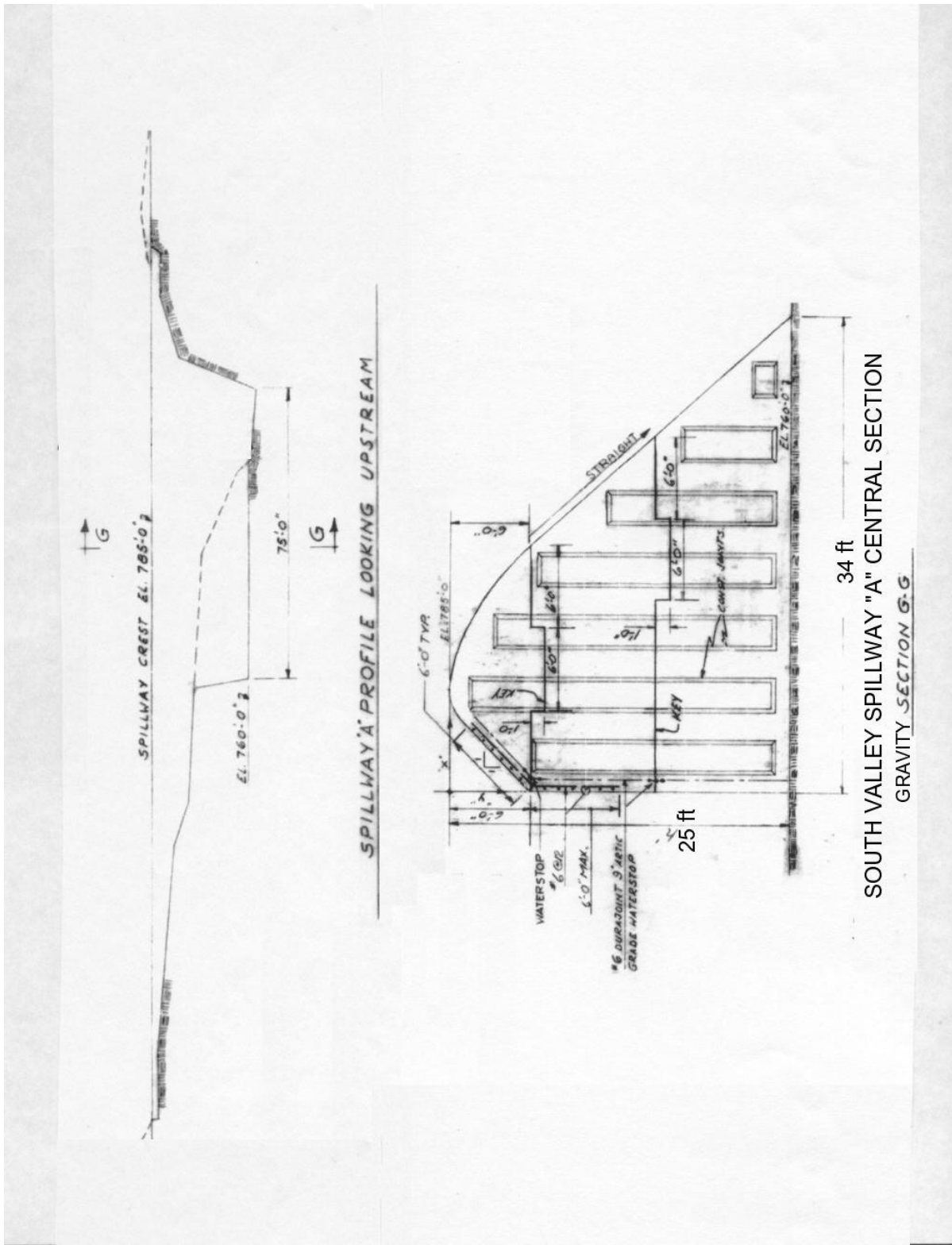


FIGURE 12  
SECTION - TALTSOON SOUTH VALLEY SPILLWAY



South Valley Spillway – Aerial Photo

**Structure:** North Valley Freeboard Dam  
**Location:** Approximately 4 km north of the Twin Gorges.  
**Constructed:** 1966  
**Type:** Rock Fill Embankment  
**Core:** None  
**Length:** 95m (312ft)  
**Height:** 2.44 m (8.0 ft)  
**Foundation:** Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations:** Crest: 243.39m  
Spillway<sup>1</sup>: 239.27 m (785.0 ft)  
**Allowable Res. Levels**<sup>2</sup>: Minimum: 238.90 m (783.8 ft)  
Normal Max: 239.27 m (785.0 ft)  
High Flow Max: 240.90 m (790.4 ft)

### **Characteristics**

- Potential for rock fill settlement in the event of significant flow-through that could wash out finer material from within the dam, leading to overtopping in a flood situation.
- Dam is built at a favorable topographic containment area with rising land downstream, height of the land downstream may be investigated in the future.

### **Seepage Points**

None observed.

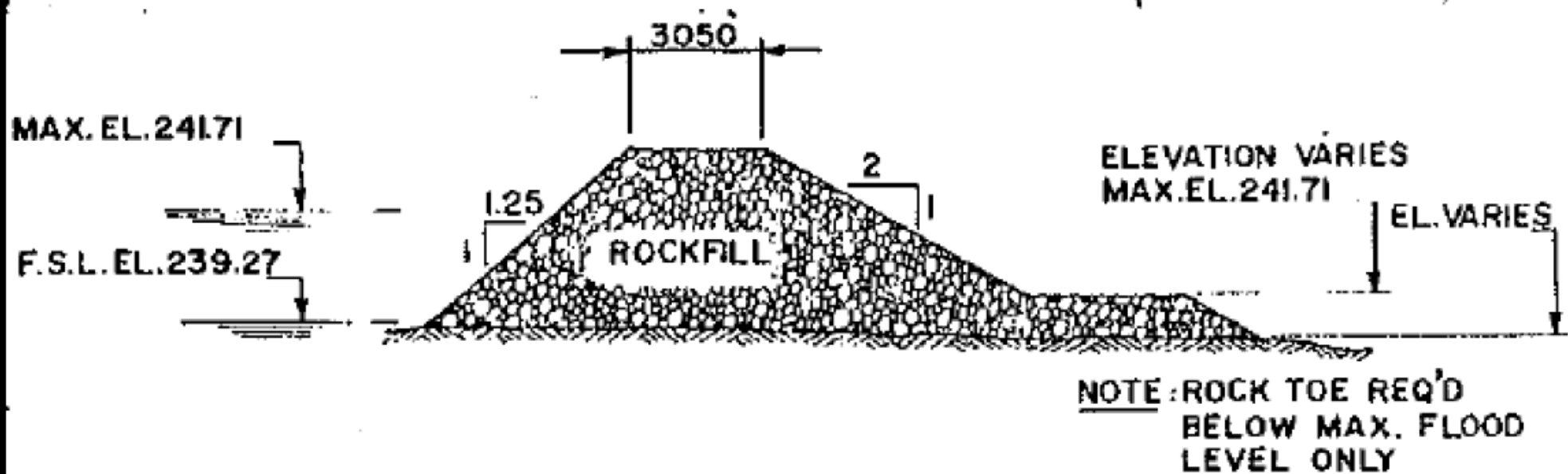
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<sup>1</sup> Spillway elevation taken from the Taltson Hydro OM&S Manual

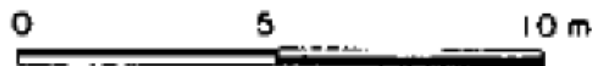
<sup>2</sup> Allowable Reservoir Levels taken from the Taltson Hydro OM&S Manual



North Valley Dam – Aerial Photo



SECTION THROUGH NORTH VALLEY DAM



**Structure:** Nonacho Lake Control Structure  
**Location:** Approximately 150 km northeast of Taltson Hydro at the outlet of Nonacho Lake on the Taltson River.

**Constructed:** 1968

**Type:** Rock Fill Embankment

**Core:** None

**Length:** 160 m (525 ft)

**Height:** 9 m (30 ft)

**Foundation:** Bedrock

### **CDA Consequence**

**Classification:** High, due to economics

**Elevations:** Crest<sup>1</sup>: 324.00 m (1063.0 ft)

Spillway<sup>2</sup>: 321.10 m (1053.5 ft)

**Allowable Res. Levels**<sup>3</sup>: Minimum: 319.30 m (1047.6 ft)

Normal Max: 320.00 m (1049.9 ft)

High Flow Max: 322.50 m (1058.1 ft)

### **Characteristics**

- Made up of a dam, control structure, and natural overflow spillway.
- Potential for rock fill settlement because of significant flow-through that could wash out finer material from within the dam.
- Area of minor settlement on the dam which occurred shortly after construction and has been stable ever since.

### **Seepage Points**

There is substantial flow throughout the dam, particularly near the right abutment and around the sluices. This is because the structure was built as a flow through rock fill dam with no impervious core. There is minor settlement around the areas of higher seepage.

### **Sluice Gates**

- 3 - 2 m x 2 m (6.56 ft x 6.56 ft) wooden box culvert sluices.
- Flow is controlled by wooden gates equipped with manual Armco CPE-12 screw hoists.
- Operating problems have occurred in the past due to debris jammed in the wood crib structure.

---

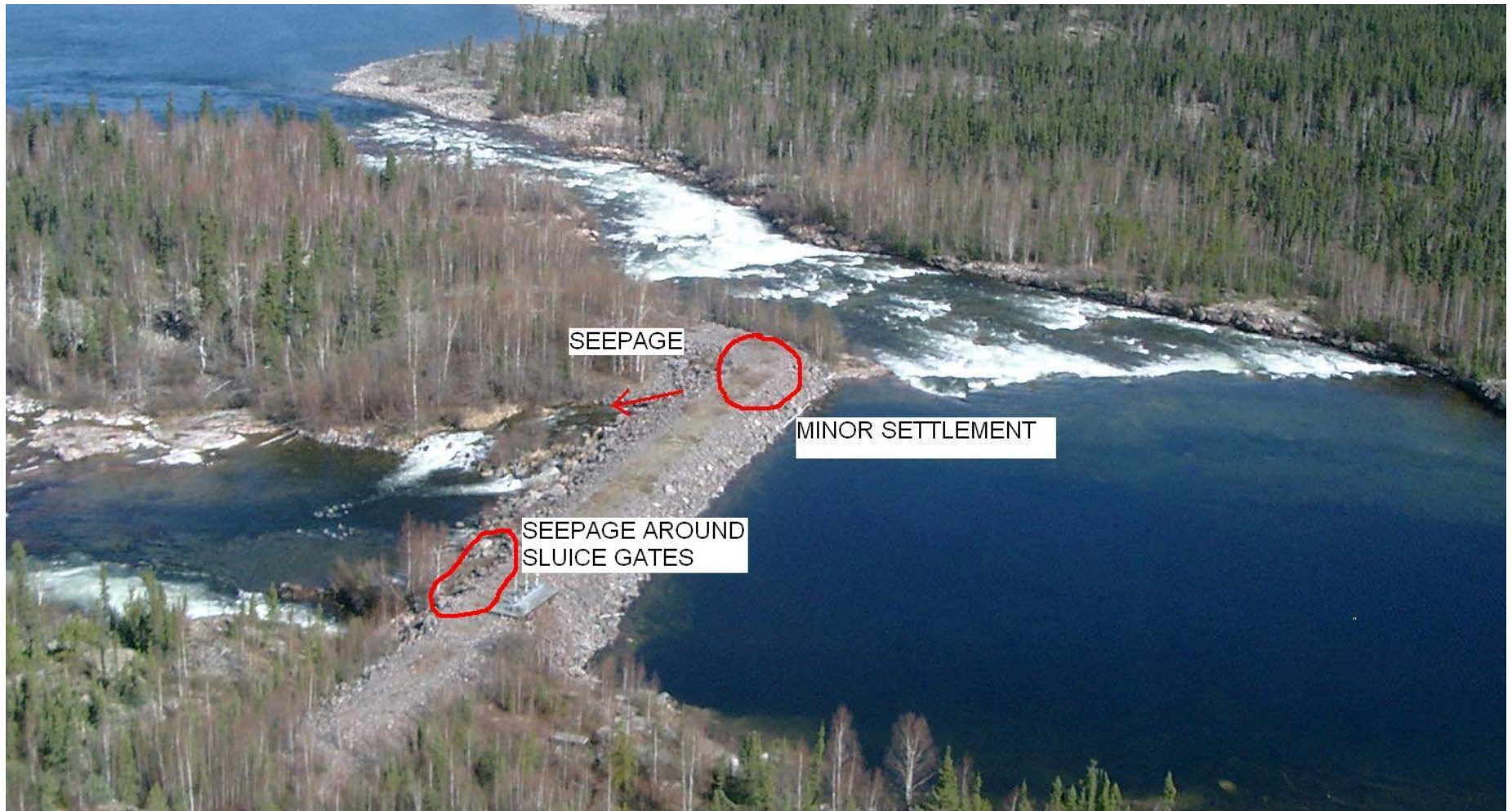
<sup>1</sup> Crest elevation taken from attached drawing in feet and converted to meters

<sup>2</sup> Spillway elevation taken from the Taltson Hydro OM&S Manual

<sup>3</sup> Allowable Reservoir Levels taken from the Taltson Hydro OM&S Manual



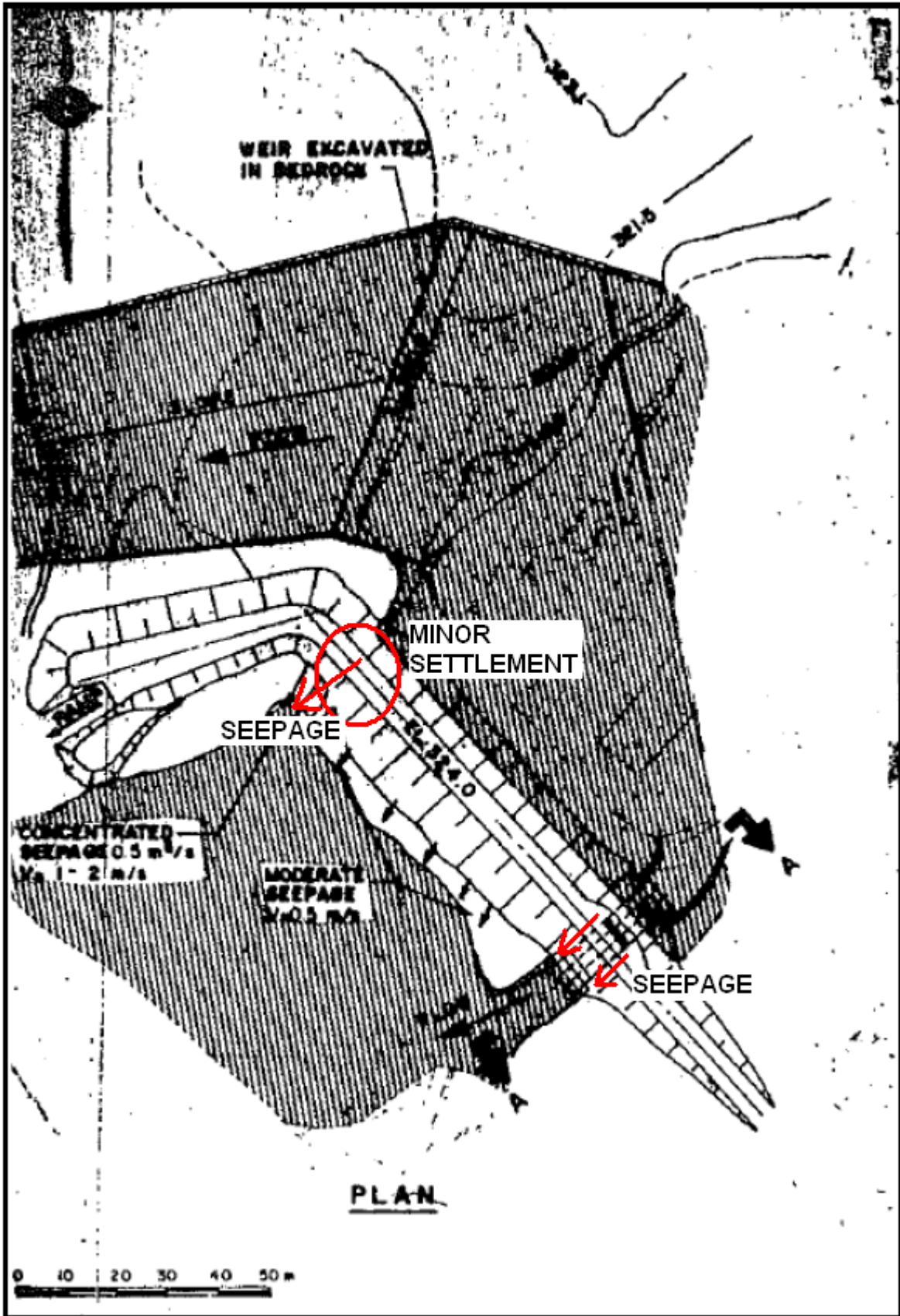
Nonacho Lake Control Structure



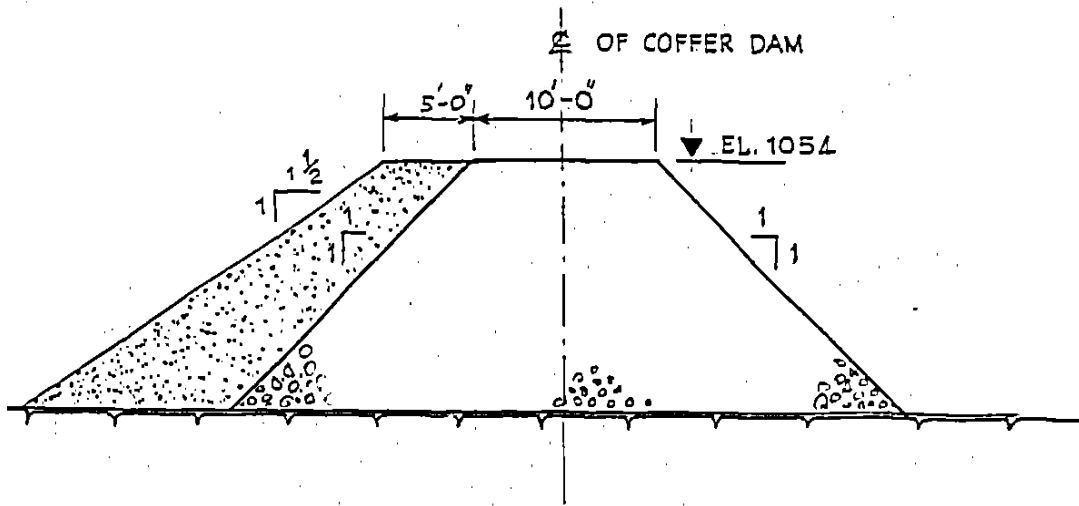
Nonacho Lake Control Structure – Seepage and Settlement Locations



Settlement on the right near the right abutment

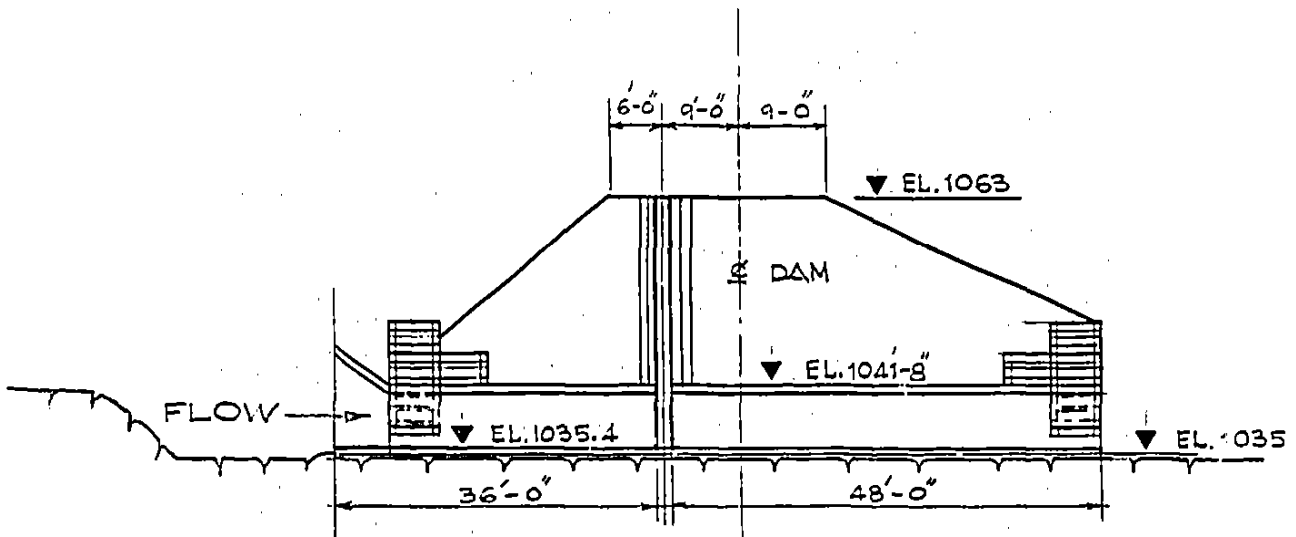


Nonacho Lake Control Structure – Seepage and Settlement Locations



Typical Cross Section

SCALE 1" = 10'-0"

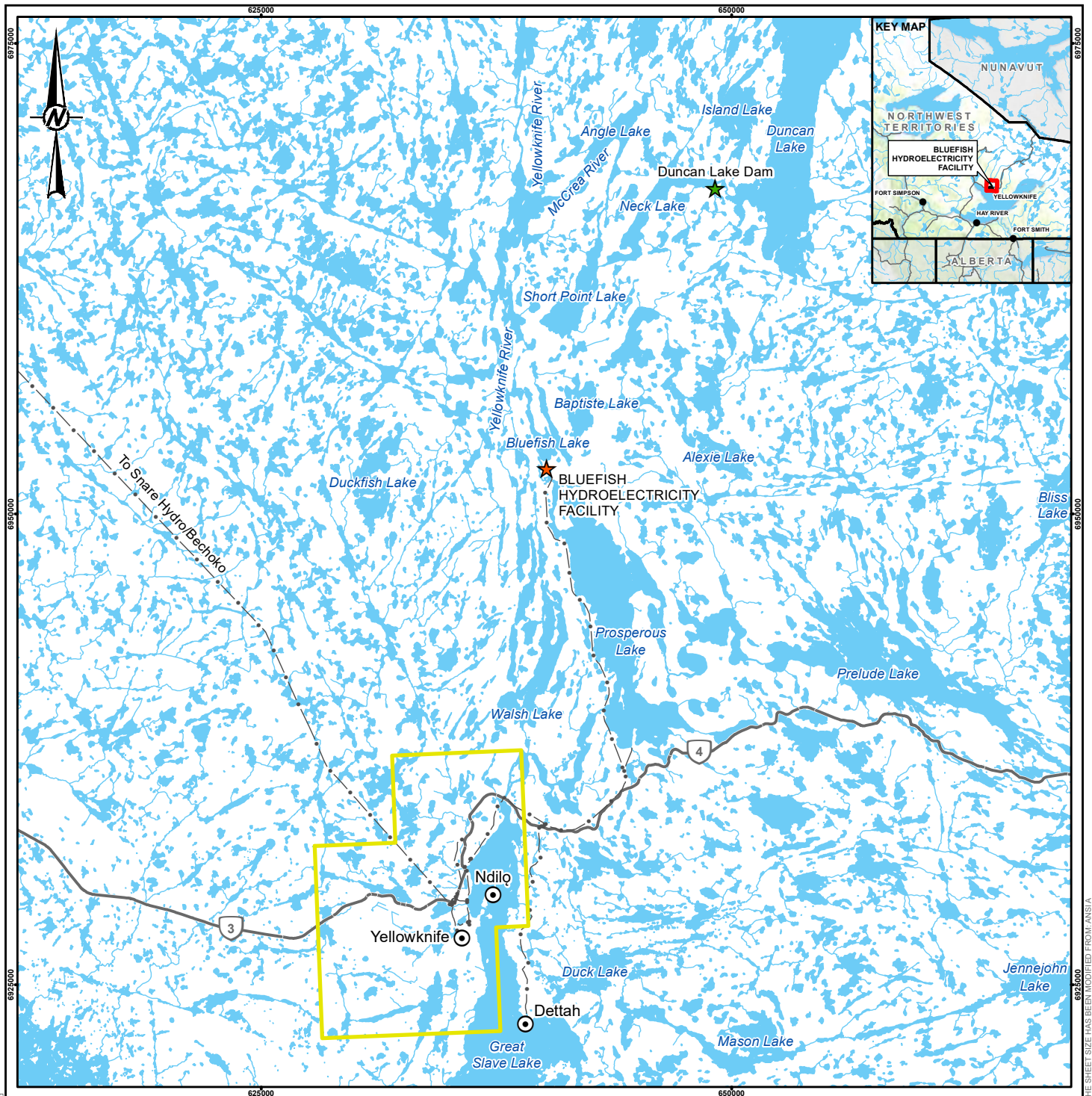


SECTION A-A

SCALE 1" = 20'-0"

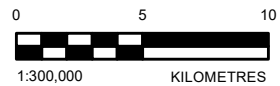
Nonacho Lake Control Structure – Cross Sections

# **BLUEFISH HYDRO**



**LEGEND**

- BLUEFISH HYDRO
- YELLOWKNIFE MUNICIPAL BOUNDARY
- COMMUNITY
- DUNCAN DAM
- ACTIVE TRANSMISSION LINE
- HIGHWAY
- WATERCOURSE
- WATERBODY



**REFERENCES**

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 DATUM: NAD 83 PROJECTION: UTM ZONE 11

**CLIENT**



**CONSULTANT**



YYYY-MM-DD	2020-06-30
DESIGNED	LB
PREPARED	AB
REVIEWED	KR
APPROVED	DP

**PROJECT**

BLUEFISH HYDROELECTRIC FACILITY PROJECT

**TITLE**

**BLUEFISH HYDROELECTRIC FACILITY – GENERAL SITE LOCATION**

PROJECT NO.  
20142314

REV.  
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FIGURE  
**1**

**Structure:** Bluefish Dam  
**Location:** North end of Prosperous Lake, approximately 39km north of Yellowknife.  
**Constructed:** 2012  
**Type:** Zoned Rock Fill Dam.  
**Core:** Stainless Steel Membrane.  
**Length:** 164 m (538 ft)  
**Height:** 11.20 m (38 ft)  
**Foundation:** Granite Bedrock  
**CDA Consequence**  
**Classification:** High, due to economics  
**Elevations<sup>1</sup>:** Core: 170.92m (560.8ft)  
Crest: 171.22m (561.8ft)  
Spillway: 168.78m (553.7ft)  
**Allowable Res. Levels<sup>2</sup>:** Minimum: 165.73m (543.7ft)  
Normal Max: 168.78m (553.7ft)  
High Flow Max: 170.22m (558.5ft)

### Characteristics

- Stainless steel membrane in the core mitigates against any potential piping.
- Newest and most instrumented dam with thermistors, piezometers, corrosion monitoring tabs, and settlement monitoring.
- Concrete key trench on a solid bedrock foundation.

### Seepage Monitoring Points

1. **Old River Channel** – There is a small amount of seepage in the original riverbed along the toe which cannot be seen but flows beneath the downstream shell where a trickling sound can be heard. Pond level is high at the toe location in the riverbed such that this leakage cannot be measured, consideration is being given on how to lower the pond level and enable monitoring.

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<sup>1</sup> Core and Crest elevations taken from the Bluefish Hydro OM&S Manual

<sup>2</sup> Allowable Reservoir Levels taken from the Bluefish Hydro OM&S Manual, Operations staff levels use Miranmar Con Mine Datum which is equivalent to these levels + 17.15m.



Bluefish Dam Aerial View



**Structure:** Duncan Dam  
**Location:** Cove at the outlet of Duncan Lake, located north of Yellowknife.  
**Constructed:** 1974  
**Type:** Reinforced Concrete Gravity Dam.  
**Core:** Concrete.  
**Length:** 29.4 m (96.5 ft)  
**Height:** 7.3 m (24 ft)  
**Foundation:** Granite Bedrock

#### **CDA Consequence**

**Classification:** High, due to economics

**Elevations<sup>1</sup>:** Crest: 213.41 m (700.2 ft)

Spillway: 212.49 m (697.1 ft)

**Allowable Res. Levels<sup>2</sup>:** Minimum: 212.04 m (695.7 ft)

Normal Max: 212.49 m (697.1 ft)

High Flow Max: 213.35 m (700 ft)

#### **Characteristics**

- Watch for concrete weathering and erosion.
- Concrete rehabilitation was completed on the dam in 2017.
- The right abutment is founded on bedrock and the remaining two-thirds of the dam on a boulder field infilled with gravel. Wash out of this gravel in 1994 led to eventual upgrades in 2007 including an upstream bentomat blanket, foundation grouting, and filling of voids between boulders with concrete.
- Since 2007 dam performance is good with no significant leakages, sinkhole activity, signs of settlement or movement.

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<sup>1</sup> Core and Crest elevations, Allowable reservoir levels taken from Bluefish OMS Manual and Bluefish DSR 2016.



Duncan Dam Upstream



Duncan Dam Downstream

# Duncan U/S Blanket As-Built

FIGURE DUNCAN DAM UPSTREAM BLANKET. X-SECTION

