Eric Beaumont

REVIEW
OF
FRESH WATER SUPPLY
AND MINE WATER CONSUMPTION DEMAND
AT THE CURRAGH RESOURCES INC. MINE
FARO, YUKON

JANUARY 30, 1989

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FRESH WATER SUPPLY AND CONSUMPTION

January 26, 1989
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Conclusions and Recommendations

1. The average winter mine water consumption demand is 0.440 cums (7000 USGM). The average available winter water consumption supply from the pumphouse pond is 0.551 cums (8735 USGM). Therefore, average winter consumption supply exceeds demand. 26. 11,34 m³/min. 33,06 m³/min.

2. The four water wells and North Fork Rose Creek can provide a conservative minimum of 0.189 cums (3000 USGM) of supply, and in January are currently providing 0.227 cums (3600 USGM) of water supply. Freshwater reservoir recharge to the pumphouse pond should be kept at the minimum necessary to maintain the pumphouse pond supply equal to mill demand. This procedure will reduce the rate of reduction in the reservoir storage capacity.

3. At present, 0.126 cums (2000 USGM) is being discharged from the freshwater reservoir, and the mill water requirements are being met. This equates to a weir measurement downstream of the valve house (W1) of 5 centimeters. As winter progresses and the wells and/or North Fork Rose Creek water supply potential decrease, the reservoir discharge will have to be increased. A reservoir maximum discharge of 0.189 (3000 USGM) should be sufficient to meet mill water requirements as supplemental water supply sources diminish. 7,57 m³/min

4. The weir (W1) downstream of the valvehouse should be read at least twice per week during winter months. A depth to flow conversion graph is attached.

5. The water elevation of the freshwater reservoir should be determined every two weeks and the remaining reservoir storage capacity should be calculated and graphed. An elevation to volume conversion graph is attached.

6. In the spring and prior to the shutdown of the water wells, a well reservoir recovery test should be planned. Upon shutdown of the wells, recovery tests should be implemented. Well reservoir recovery tests will provide a foundation upon which the long-term dependability of the wells can be assessed.

7. During the summer of 1989, the bottom elevation of the freshwater reservoir should be mapped. These new contours can then be used to derive an up-to-date freshwater reservoir drawdown curve. The existing drawdown curve is dated, and reservoir basin sedimentation has probably decreased the accuracy of the existing drawdown conversion curve.

1.0 Introduction

In 1987, the average water consumption of the mining and concentrating operation at Faro was 0.393 cums (6233 USGM). However, during specific periods of 1987 water usage approached a consumption rate of 0.442 cums (7000 USGM). Thus, for the purposes of analyzing the availability of water with respect to potential mill consumption, 0.442 cums (7000 USGM) is considered to be the mill water consumption rate.

Curragh Resources Inc. presently has a water license consumption limit of 15.380 million cum/yr (4,063 million USG/yr) and 42,290 cum/dy (11 million USG/dy). With an average water consumption of 0.442 cums (7000 USGM), Curragh's consumption would be 13.938 million cum/yr (3,682 million USG/yr) and 38,189 cum/dy (10 million USG/dy). Thus, a consumption rate of 0.442 cums (7000 USGM) is well within water license limits. However, water availability, especially in a year with low precipitation and with a long, cold winter period, requires special consideration.

2.0 Water Supply System

Curragh's water requirements are pumped from the pumphouse pond located on South Fork Rose Creek immediately upstream of the confluence of North and South Fork Rose Creek. The pumphouse pond water supply is recharged from three sources:

- the freshwater reservoir located upstream of the pumphouse pond. This reservoir is recharged from the South Fork Rose Creek drainage basin.
- four water wells located within the immediate vicinity of the lower reaches of North Fork Rose Creek. (Winter months only: November 1 to April 30).
- a partial diversion of North Fork Rose Creek. (Winter months only: November 1 to April 30).

3.0 The Freshwater Reservoir

3.1 The Freshwater Reservoir Storage Capacity

The freshwater reservoir is the major water recharge source for the pumphouse pond. Table 1 shows reservoir volumes at maximum and minimum reservoir water levels. Assuming that the reservoir is at its maximum level of 1097.3 meters by November of each year, the stored fresh water available for winter use is 3.850 million cum (1017 million USGM).

TABLE 1: MAXIMUM RESERVOIR STORAGE VOLUME

	RESERVOIR WATER ELEVATION (m)	RESERVOIR VOLUME (cum x million)	RESERVOIR VOLUME (USG x million)
MAXIMUM RESERVOIR LEVEL\ VOLUME	1097.3	4.60	1215
MAXIMUM RESERVOIR LEVEL\ VOLUME	1087.0	0.75	198
MAXIMUM RESERVOIR USABLE WATER	10.3	3.85	1017

ABREVIATIONS: (m) = meters
(cum) = cubic meters
(USG) = U.S. gallons

3.2 The Freshwater Reservoir Recharge Capacity

During the year, the freshwater reservoir is recharged with water from the South Fork Rose Creek water shed. Mean monthly inflows as calculated by Acres Consulting Services, March 1985 are shown in Table 2. Winter months are defined as months during which monthly mine water demand (@ 0.442 cums (7000 USGM)) exceeds monthly reservoir recharge. Winter, therefore, extends from the first of November to the first of May of each year.

3.3 The Freshwater Reservoir Water Supply Capacity

The freshwater reservoir has a water supply capacity defined by its maximum storage capacity and by its recharge capacity. As shown in Table 2, during summer months (May through October) recharge on average exceeds water consumption demand. Enough excess water is also normally available to fully recharge the reservoir to its maximum water elevation of 1097.3 meters by November of each year.

During the winter months (November through April), however, recharge is less than water consumption demand, and reservoir storage must be utilized. Therefore, maximum winter reservoir water supply capacity is the combination of the maximum reservoir storage capacity of 3.850 million cum (1017 million USG) and the winter reservoir recharge of 1.51 million cum (399 million USG). The total available reservoir water for winter use is therefore 5.360 million cum (1416 million USG).

For the average winter period of 181 days, this total available reservoir water allows for an average consumption of 0.343 cums (5433 USGM). With a demand of 0.442 cums (7000 USGM), or even 1987's average demand of 0.393 cums (6233 USGM), the freshwater reservoir winter water recharge to the pumphouse pond must be supplemented.

4.0 Water Wells: Winter Water Supplement

There are four water wells located within the immediate vicinity of the lower reaches of North Fork Rose Creek. Table 3 shows volume discharge capacity for these wells. These wells operate only during winter months and together can provide 0.227 cums (3600 USGM) of water to the pumphouse pond.

The four water wells were drilled in June, 1986 and developed by International Water Supply Ltd. International concluded that for 24 out of 25 years, the reservoir water supply augmented by flows from North Fork Rose Creek and the two water wells (PW4 and PW5) will meet mill water demand. The long term reliability of the wells, however, is presently unknown.

In 1986 during well development and in 1987 during the initial months of well operation, International did conduct preliminary well evaluations on PW4 and PW5. (PW3 and PW6 were not evaluated). These evaluations, though, were undertaken in years of high rainfall, high runoff, and high groundwater recharge. International was unable to

TABLE 2: MEAN RESERVOIR RECHARGE VOLUMES (Reconstructed by Acres, 1985)

METRIC MEASURE

MONTH	NO. OF DAYS	MEAN RECHARGE INFLOW TO RESERVOIR		MEAN MINE WATER USAGE	RESERVOIR INFLOW MINUS MINE USAGE	RESERVOIR STORAGE VOLUME	RESERVOIR WATER ELEVATION
		(cums)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum) x (10**6)	(m)
NOV.	30	0.183	0.474	1.146	-0.671	3.179	1095.5
DEC.	31	0.122	0.327	1.184	-0.857	2.322	1092.5
JAN.	31	0.082	0.220	1.184	-0.964	1.357	1091.5
FEB.	28	0.065	0.157	1.069	-0.912	0.445	1088.5
MAR.	31	0.058	0.155	1.184	-1.029	0.000	1087.0
APR.	30	0.068	0.176	1.146	-0.969	0.000	1087.0
MAY.	31	1.373	3.677	1.184	2.494	2.494	1090.0
JUN.	30	2.379	6.166	1.146	5.021	3.850	1097.3
JUL.	31	1.120	3.000	1.184	1.816	3.850	1097.3
AUG.	31	0.752	2.014	1.184	0.830	3.850	1097.3
SEP.	30	0.639	1.656	1.146	0.511	3.850	1097.3
OCT.	31	0.447	1.197	1.184	0.013	3.850	1097.3
	365		19.221 (cum/yr) x (10**6)		5.282 (cum/yr) x (10**6)		

ABBREVIATIONS:

(m)	= meters	(ft)	= feet
(mo)	= month	(yr)	= year
(cum)	= cubic meters	(USG)	= U.S. gallons
(cums)	= cubic meters/ sec.	(USGM)	= U.S. gallons/min.

TABLE 2: MEAN RESERVOIR RECHARGE VOLUMES (Reconstructed by Acres, 1985)

U.S. MEASURE

MONTH	NO. OF DAYS	MEAN RECHARGE INFLOW TO RESERVOIR		MEAN MINE WATER USAGE	RESERVOIR INFLOW MINUS MINE USAGE	RESERVOIR STORAGE VOLUME	RESERVOIR WATER ELEVATION
		(USGM)	(USG/mo) x (10**6)	(USG/mo) x (10**6)	(USG/mo) x (10**6)	(USG) x (10**6)	(feet)
NOV.	30	2901	125	302	-177	840	3594
DEC.	31	1934	86	312	-226	614	3584
JAN.	31	1300	58	312	-254	359	3581
FEB.	28	1030	42	282	-241	119	3571
MAR.	31	919	41	312	-271	0	3566
APR.	30	1078	47	302	-256	0	3566
MAY.	31	21765	972	312	659	659	3576
JUN.	30	37712	1629	302	1327	1017	3600
JUL.	31	17754	793	312	480	1017	3600
AUG.	31	11921	532	312	220	1017	3600
SEP.	30	10129	438	302	135	1017	3600
OCT.	31	7086	316	312	4	1017	3600
	365		5078 (USG/yr) x (10**6)		1399 (USG/yr) x (10**6)		

TABLE 3: WATER WELL CAPACITIES

WELL	PUMP DISCHARGE VOLUME	
	(cums)	(USGM)
PW3	0.044	700
PW4	0.032	500
PW5	0.076	1200
PW6	0.076	1200
TOTAL	0.227	3600

conclude from their tests whether the well water supply would continue to be dependable in a low rainfall year. Even though well performance to date has been satisfactory, well reservoir recovery tests should be conducted in the spring of 1989 to facilitate a more complete evaluation of these wells.

5.0 North Fork Rose Creek Partial Diversion Supplemental

The partial diversion of North Fork Rose Creek, constructed in 1986, can provide a winter average of 0.212 cums (3353 USGM) of water to the pumphouse pond, with wells PW4 and PW5 pumping. (from International Water Supply Limited, 1987). Mean monthly flows for North Fork Rose Creek are provided in Table 4 (from Acres Consulting Services, 1985). It is important to note that total diversion of North Fork during the winter has not been achieved due to difficulties encountered in damming and diverting the main North Fork Rose Creek channel prior to fall freeze. Thus, only one-half to two-thirds of the winter average flow of 0.212 cums (3353 USGM) can be relied upon. North Fork Rose Creek diversion, therefore, provides an average winter water recharge to the pumphouse pond of 0.106 cums (1677 USGM) to 0.141 cums (2235 USGM).

6.0 Water Supply Versus Water Demand (1988/89)

As previously shown, the freshwater reservoir alone cannot supply Curragh's water use demands of 0.440 cums (7000 USGM) during winter months. At this demand loading, the reservoir storage capacity would be exhausted by March, and the mine would not have a water supply until spring freshet in early May.

However, supplemental water from the four water wells provides an additional 0.227 cums (3600 USGM) of consumption capacity and North Fork Rose Creek provides an additional 0.106 cums (1677 USGM) of consumption capacity. In combination with the reservoir capacity of 0.343 cums (5433 USGM), an average total available water supply from the pumphouse pond during the winter months is 0.676 cums (10,716 USGM). This consumption capacity is sufficient to meet Curragh's water consumption requirements during the winter months. Care must be taken, however, to not drawdown the reservoir unnecessarily during early winter months. During the early winter, the well water supply and the North Fork creek supply should be supplemented by the freshwater reservoir supply to meet water demand needs. This procedure will reduce the rate of reduction in reservoir storage water.

In 1988, the freshwater reservoir was at its maximum elevation of 1097.3 meters in early November. The North Fork Rose Creek diversion was operational by late October and the four wells were operational by late December.

As of late January, the reservoir had decreased to an elevation of 1096.0 meters. Thus, the remaining reservoir storage capacity for the rest of the 1989 winter season is 3.250 million cum (859 million USG). With reference to Table 5, this reservoir storage capacity is

TABLE 4: LOW, MEAN AND HIGH MONTHLY FLOWS FOR NORTH FORK ROSE CREEK
(by Acres, 1985)
(reviewed by International Water Services, 1986)

	METRIC MEASURE			U.S. MEASURE		
MONTH	LOW MONTHLY FLOW	MEAN MONTHLY FLOW	HIGH MONTHLY FLOW	LOW MONTHLY FLOW	MEAN MONTHLY FLOW	HIGH MONTHLY FLOW
	(cums)	(cums)	(cums)	(USGM)	(USGM)	(USGM)
NOV.	0.218	0.407	0.659	3456	6459	10448
DEC.	0.147	0.266	0.470	2330	4220	7450
JAN.	0.079	0.179	0.303	1253	2844	4802
FEB.	0.061	0.141	0.238	967	2239	3771
MAR.	0.056	0.127	0.190	887	2007	3012
APR.	0.076	0.148	0.232	1205	2350	3677
WINTER AVG.	0.106	0.212	0.349	1683	3353	5527
MAY.	0.820	3.006	4.485	12999	47656	71094
JUN.	2.854	5.207	9.394	45242	82541	148913
JUL.	1.510	2.451	3.659	23937	38858	58004
AUG.	0.835	1.646	3.227	13236	26087	51159
SEP.	0.689	1.399	2.477	10922	22181	39270
OCT.	0.510	0.979	1.409	8085	15512	22337
YEARLY AVG.	0.655	1.330	2.229	10377	21080	35328

ABBREVIATIONS: (cums) = cubic meters/ sec. (USGM) = U.S. gallons/min.

TABLE 5: MEAN RESERVOIR RECHARGE VOLUMES (Reconstructed by Acres, 1985)

METRIC MEASURE

MONTH	NO. OF DAYS	MEAN MINE WATER USAGE	WATER SUPPLY INPUTS: LOW MONTHLY FLOW NFRC	WATER SUPPLY INPUTS: WELL WATER - INPUT (0.189 cums)	WATER SUPPLY INPUTS: MEAN RECHARGE INFLOW TO FRESHWATER RESERVOIR	TOTAL WATER SUPPLY	SUPPLY MINUS DEMAND	RESERVOIR STORAGE VOLUME	RESERVOIR WATER ELEVATION
		(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum/mo) x (10**6)	(cum) x (10**6)	(m)
NOV.	30	1.146	0.565		0.474	1.039	-0.107	3.743	1097.0
DEC.	31	1.184	0.394		0.327	0.721	-0.463	3.280	1096.0
JAN.	31	1.184	0.212	0.506	0.220	0.938	-0.246	3.034	1095.5
FEB.	28	1.069	0.148	0.457	0.157	0.762	-0.307	2.727	1095.0
MAR.	31	1.184	0.150	0.506	0.155	0.811	-0.373	2.354	1094.0
APR.	30	1.146	0.197	0.490	0.176	0.863	-0.283	2.071	1093.2
WINTER MONTHS' TOTAL	181	6.912 (cum/181 dy) x (10**6)	1.665 (cum/181 dy) x (10**6)	1.960 (cum/181 dy) x (10**6)	1.509 (cum/181 dy) x (10**6)	5.133 (cum/181 dy) x (10**6)	-1.779 (cum/181 dy) x (10**6)	2.071 (cum) x (10**6)	1093.2 (m)
MAY.	31	1.184	2.196		3.677	5.873	4.689	3.850	1097.3
JUN.	30	1.146	7.398		6.166	13.564	12.418	3.850	1097.3
JUL.	31	1.184	4.044		3.000	7.044	5.861	3.850	1097.3
AUG.	31	1.184	2.235		2.014	4.250	3.067	3.850	1097.3
SEP.	30	1.146	1.786		1.656	3.442	2.296	3.850	1097.3
OCT.	31	1.184	1.366		1.197	2.563	1.379	3.850	1097.3
YEARLY TOTALS	365	13.939 (cum/yr) x (10**6)	20.692 (cum/yr) x (10**6)	1.960 (cum/yr) x (10**6)	19.219 (cum/yr) x (10**6)	41.870 (cum/yr) x (10**6)	27.931 (cum/yr) x (10**6)		1096.2 (m)

ABBREVIATIONS: (m) = meters (ft) = feet
(mo) = month (yr) = year
(cum) = cubic meters (USG) = U.S. gallons
(cums) = cubic meters/ sec. (USGM) = U.S. gallons/min.

TABLE 5: MEAN RESERVOIR RECHARGE VOLUMES (Reconstructed by Acres, 1985)

U.S. MEASURE

MONTH	NO. OF DAYS	WATER SUPPLY INPUTS: MEAN MINE WATER USAGE	WATER SUPPLY INPUTS: LOW MONTHLY FLOW NFRC	WATER SUPPLY INPUTS: WELL WATER INPUT (3000 USGM)	WATER SUPPLY INPUTS: MEAN RECHARGE INFLOW TO FRESHWATER RESERVOIR	TOTAL WATER SUPPLY	SUPPLY MINUS DEMAND	RESERVOIR STORAGE VOLUME	RESERVOIR WATER ELEVATION
		(USG/mo) x (10**6)	(USG/mo) x (10**6)	(USG/mo) x (10**6)	(USG/mo) x (10**6)			(USG) x (10**6)	(feet)
NOV.	30	302	149		125	274	-28	1017	3599
DEC.	31	312	104		86	190	-122	1017	3596
JAN.	31	312	56	134	58	248	-65	952	3594
FEB.	28	282	39	121	42	202	-80	872	3593
MAR.	31	312	40	134	41	215	-98	774	3589
APR.	30	302	52	130	47	229	-74	700	3587
WINTER MONTHS' TOTAL	181	1824 (USG/181 dy) x (10**6)	440 (USG/181 dy) x (10**6)	518 (USG/181 dy) x (10**6)	399 (USG/181 dy) x (10**6)	1357 (USG/181 dy) x (10**6)	-467 (USG/181 dy) x (10**6)	-463 (USG) x (10**6)	3587 (m)
MAY.	31	312	580		972	1552	1240	1017	3600
JUN.	30	302	1954		1629	3583	3281	1017	3600
JUL.	31	312	1069		793	1862	1549	1017	3600
AUG.	31	312	591		532	1123	810	1017	3600
SEP.	30	302	472		438	910	607	1017	3600
OCT.	31	312	361		316	677	364	1017	3600
YEARLY TOTALS	365	3679 (USG/yr) x (10**6)	5467 (USG/yr) x (10**6)	518 (USG/yr) x (10**6)	5079 (USG/yr) x (10**6)	11064 (USG/yr) x (10**6)	7385 (USG/yr) x (10**6)		3596 (m)

ABBREVIATIONS:
(m) = meters (ft) = feet
(mo) = month (yr) = year
(cum) = cubic meters (USG) = U.S. gallons
(cums) = cubic meters/ sec. (USGM) = U.S. gallons/min.

equivalent to an end of December drawdown scenario. The well water and North Fork Rose Creek supplements are directly responsible for this reduction in the rate of drawdown of the freshwater reservoir.

With the remaining winter reservoir recharge capacity of 0.488 million cum (130 million USG), the total remaining winter freshwater reservoir supply capacity is 3.738 million cum (988 million USG). Adding a safety factor of 15 days, 135 days of winter potentially remain. Therefore, the maximum average freshwater reservoir consumption rate for the remainder of the winter is 0.320 cums (5080 USGM).

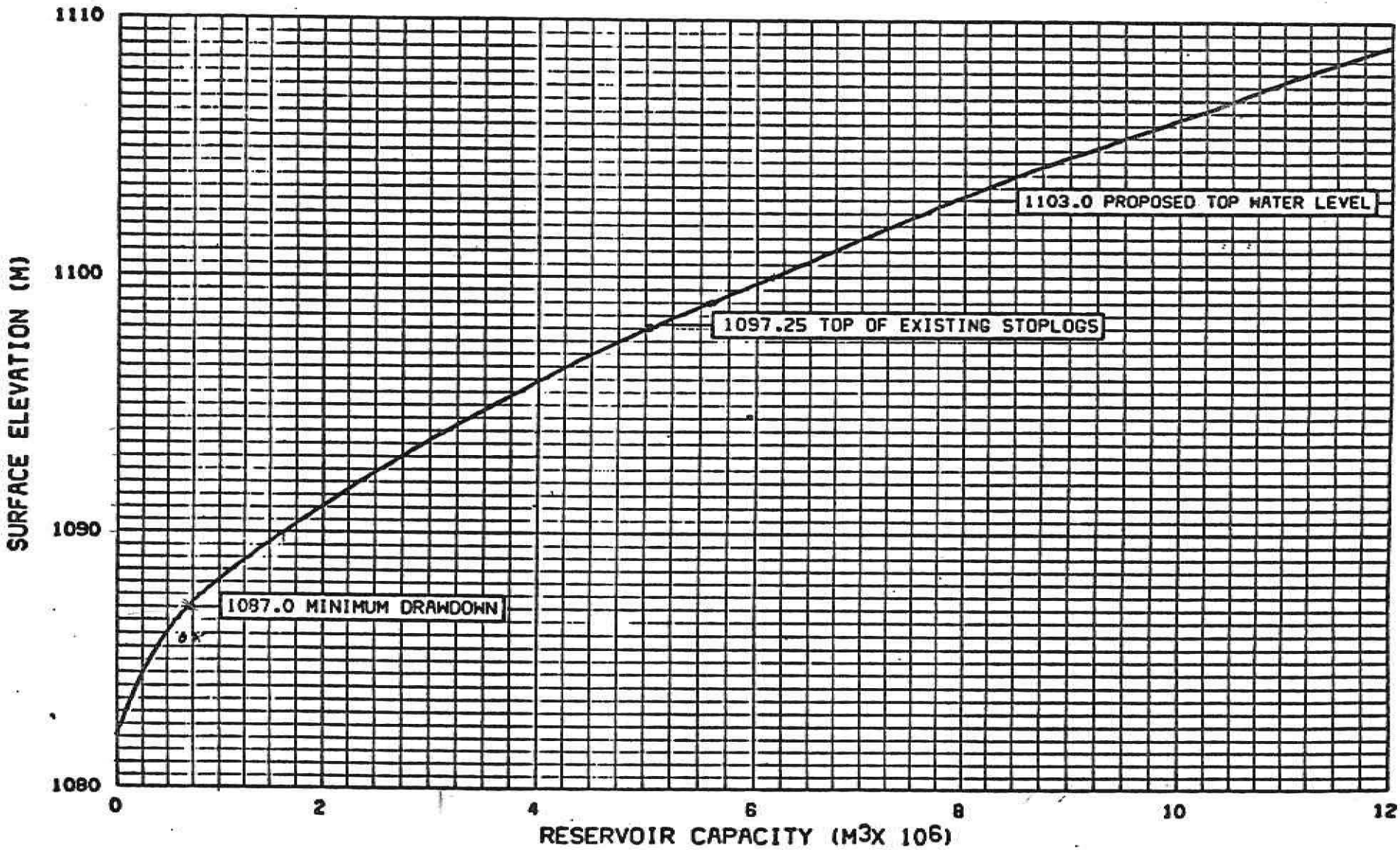
Using conservative water supplements from the wells of 0.189 cums (3000 USGM) and from North Fork diversion of 0.042 cums (673 USGM), a total winter average water consumption rate of 0.551 cums (8735 USGM) is available. Water supply, as calculated, therefore exceeds demand for the remainder of the 1989 winter. Table 5 also provides a monthly water supply versus mill demand scerario based on low North Fork water flows. This more detailed analysis also indicates that water supply will exceed demand for the remainder of the 1989 winter.

FRESHWATER RESERVOIR AND DAM: INFORMATION

1. FRESHWATER DAM: ELEVATION REFERENCES

LOCATION	ELEVATION (m)	ELEVATION (ft.)	ELEVATION (m) (+33.35 m)	ELEVATION (ft.) (+109.4 ft.)	RESERVOIR VOLUME (cum x 10**6)	RESERVOIR VOLUME (USG x 10**6)
DAM CREST	1099.1	3606.0	1132.5	3715.4		
DAM CORE	1097.5	3600.7	1130.9	3710.1		
SPILLWAY: TOP OF CONCRETE WING WALLS	1099.1	3606.0	1132.5	3715.4		
SPILLWAY: TOP OF STOPLOGS	1097.3	3600.1	1130.7	3709.5	4.60 ~~4.500~~	1189
SPILLWAY: CONCRETE FLOOR	1096.0	3595.8	1129.4	3705.2	4.000	1057
MINIMUM DRAWDOWN WITH SAFETY FACTOR	1089.0	3572.8	1122.4	3682.2	1.270	336
MINIMUM DRAWDOWN	1087.0	3566.3	1120.4	3675.7	0.750	198
TOP OF TRASH GRATING ON LOW LEVEL OUTLET	1082.0	3549.9	1115.4	3659.3		

FRESH WATER RESERVOIR

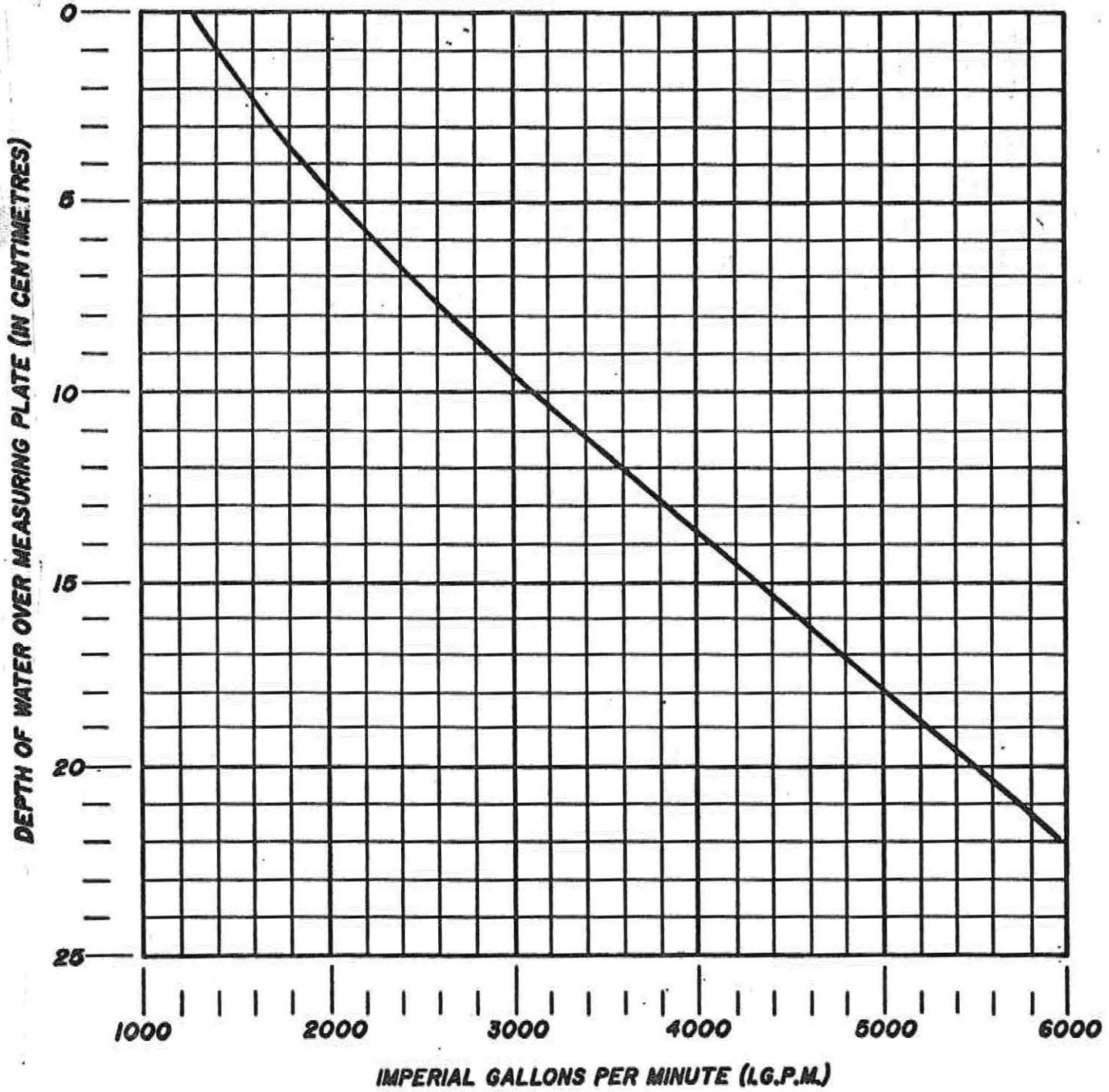


A-FAY-192-01 REV: A 84.08.02 FYDO

SOUTH FORK WATER RESERVOIR WEIR (WI)

FLOW CHART

BASED ON FLOW CHART USED BY
RED EAGLES OF CURRAGH RESOURCES



NO.	WAS	BY	DATE
		A.M.T.	FEB. 3/87

CURRAGH RESOURCES
FARO, YUKON
FLOW CHART

International Water Supply Limited
SASKATOON – BARRIE – MONTREAL

DRN: S.R.K.
CKD: A.M. TOTH P. ENG.

DRAWING NO
S87-751