<u>MIA LOSS ASSESSMENT</u>

(Discussion Paper)

Contents

Background

Following discussions on the Sinclair Kight Merz report a number of actions emanated. Three tasks were allocated to me :

1. Channel seepage data : provide results from local studies
2. A total water balance for the MIA, including rainfall runoff etc.
3. Provide loss assessment for Barren Box Swamp

Table 1 below shows a summary water balance for the MIA, prepared from several sources of data. The SMK study document used quite useful concepts and these have been utilised. The last section is a brief discussion is provided on the implications of the water balance and the loss assessment using special constructed diagrams.

Overview of Water Balance

<u>Tabular Presentation</u>

The SKM values are shown in the first column of Table 1. SKM did not consider all relevant items, eg seepage and evaporation from the Wah Wah Channel system were not assessed. The SKM study also tended to concentrate on dry years for the assessment.

The other four columns are water balance estimates based on the diversion and delivery data shown at Table 2 and compiled by Pendlebury over 18 years (78-95), data from my own water balance work using 12 years of data (1979/91) and other information, some of it is approximate only. The columns are meant to represent the average, a 10% dry year, the median and a 10% wet year.

The top section of Table 1 shows meteorological data. The second section shows the inputs to the channel system, and the third section shows the deliveries. The difference between gross diversions and gross deliveries is called the Apparent Loss. The other assessment for total true losses is based on total inputs into the system minus the corrected deliveries. This is shown below the third section of Table 1.

In the fourth section of the table the individual loss iitems are considered. Data were derived from several sources including SKM and Land and Water Management Plan studies. At the bottom of this section these are added up. Below this a comparison is made between the true losses estimated by the gross water balance method (sections 2 and 3) and the individual item assessment total (section 4). The difference between the two assessments is the remaining error in the water balance assessment. Ideally this is zero, but in this case it is shown that a difference in the order of 1% still exists

Graphical Representation

The values of Table 1 have also been put together in a graphical form, resulting in Figures 1, 2, and 3 attached. Figure 1 is for median year values, Figures 2 and 3 are for the 10% dry and wet years.

The right hand side of the diagrams the factors comprising system suppy are shown. The RR+ID component is shown in two parts, that part which ends up being lost (eg Barren Box swamp evaporation), and that part which ends up being re-used. We do not know how much each part is but the 88 Gl/year total value is derived from Table 1.

In wet years there also may be a small contribution from Mirrool Creek upstream, however that is negligible in median years.

The left hand "Uses" side comprises deliveries and various errors/unexplained factors. The latter is about 14% of deliveries. On top of this there are the "true losses", which include evaporation, seepage, flows to the Murrumbidgee and Floodway releases.

The various factors are discussed in a little more detail below.

Rainfall and Evaporation.

The data here are for the 1979-1991, and percentiles applied. A longer term data set may give slightly different results.

MIA System Inputs.

The data prepared by Pendllebury were used. It needs to be noted that there is considerable variation in gross diversions and deliveries. The numbers of Table 1 assume that for the 10% dry years the diversions/deliveries correspond with a 10% dry season and vice versa for the wet years. This is not necessarily 100% correct.

The rainfall runoff (RR) and irrigation drainage (ID) component, which add to inputs into the MIA system were derived from the report "Watertable Control Options of the MIA" by myself (April 1995). This includes surface, rootzone and groundwater balances. The numbers finally adopted in that report were a compromise between NSW Agriculture assessments and other assessments of farm runoff, eg our study a few years ago (Tiwari, 1994). The numbers shown are based on a belief that escapes are about half of total drainage. If it were to be less, as suggested by Hallows in his report on levels of service in the MIA (1995), then the rainfall runoff and irrigation drainage would be more. It may be noted that total drainage volumes in the MIA average about 245 Gl, of which about 220 Gl is generated in the Mirrool Creek catchment.

MIA Deliveries

The MIA deliveries including Wah Wah are based on Paul Pendlebury's assessment 1979/95). However, it is known that the diversions and deliveries when compared to drainage volumes, etc., do not produce a closing water balance for the system (eg van der Lely, 1992). A correction factor of 14% is applied to deliveries to make the water balance close. The 14% correction is based on the water and salt balance of the MIA (1992), and also found to be a good estimate in the SKM report (1995). This assumes that diversions are not over-recording actual volumes and that all the correction should be applied to deliveries. The 14% may be too high for the WWID. The S&D deliveries are estimates only, and includes deliveries to the WWWWU (9U'sA) area. It is estimated that about half the volume of diversions from Barren Box Swamp to the S&D system is lost (see below).

The Wah Wah deliveries values in recent years has been variable and apparently increasing.

An issue may exist in that some deliveries may not be recorded. Murrumbidgee Irrigation appears to record unmetered deliveries, and Stock and Domestic deliveries to many households, but may not record the 22C license volumes from Cudgel Creek, Mirrool Creek and Baren Box Swamp. A total of about 10 Gl/year may be involved, and this would affect the final assessment.

Losses within MIA System

Seepage and evaporation are the main ticket items when it comes to true losses. In addition there are returns to the river, floodway releases and the effect of theft, yabbie and ratholes, overtopping, unrecorded deliveries, etc.

The estimate of channel seepage in the MIA by Tiwari (1995) is for large area farms only, and did not include Wah Wah, the horticultural channels and the Main Canal. An extra 9 Gl/year is being estimated for these additional sources. Horticultural seepage must be significant but since most of it is intercepted by tile drainage systems, its volume is restricted to a likely 20-30% of total tile drainage flows, which is about 10 Gl/year only. The Wah Wah seepage is based on 185 km of channel in the ID and another 365 km of channel in the S&D district, which are used less frequently, but may seep at a higher rate when filled. The 6 Gl/year is probably an overestimate, and includes some allowance for Main Canal seepage in the MIA, not elsewhere listed.

The evaporation from Barren Box Swamp is based on the evaporation and rainfall at the top of the table. I checked with Wayne Meyer of CSIRO who suggests an 0.8 coefficient is appropriate. He stated the evaporation from BBS would be less than Lake Wyangan. SKM used the 0.82 factor based on the Lake Wyangan study during the 1970's. The difference is small. For the area of BBS I used 3300 ha for the 90% year, 3200ha for the median year and 3000 ha for the 10% year. The difference with SKM comes with the rainfall correction, which is significant, even in a dry year.

Leakage and theft, etc, were estimated to be 5Gl/year by SKM. We don't really know, it could be substantially higher. There is also no information as to whether this factors varies between wet and dry years.

The Yanco drainage returns to the river are based on data collected as part of the water quality sampling program. The reported data by SKM in the first column are very consistent with my estimates. The Roaches escape has not been monitored, values for it are based on discussions with MI staff.

The floodway diversion data including the 10% dry and wet years are based on MI data over 18 years. The Wah Wah escapes value is an estimate only.

The SKM study resulted in a 88 GL/year loss assessment for dry years. The assessment of Table 1 adds up to about 122 Gl/year for drier years to 244 Gl/year for wetter years, the increase over the range of years almost fully due to floodway releases. It is concluded that the true losses without floodway releases is in the order of 120-134 Gl/year. If item (3) of Table 1 is also taken into account. A value of about 125 Gl/year is likely.

Water Balance

The losses in Table 1 have been assessed by two methods as described in the overview. The equation for the water balance is as follows :

Inputs - Corrected Deliveries - True Losses = Error in Water Balance

In Table 1 this water balance is represented by lines (1), (3), (4) and (6).

The difference between the two assessments is -5 to 11 Gl/year, which is less than about 1% of of diversions. This is considered to be quite good. If areas of inaccuracies needed to be addressed the main ticket items need to be examined more closely. For instance diversions may be overestimated by up to 4% (SKM report) and that would mean the correction to the deliveries would be less. The Leakage/theft/etc component may be higher than the 5 Gl/year shown. Finally a correction may have to be made for 22C deliveries from Mirrool Creek, Barren Box Swamp and Cudgel Creek, if not already recorded as deliveries, as they should be.

The system generates drainage of which a proportion is channel escape drainage and a proportion rainfall + irrigation runoff (RR+ID). The values in Table 1 assume that RR+ID is about half of total drainage and represent the drainage to Mirrool Creek only. If escape drainage is less than half, as suggested in the MIA Levels of Service report by Hallows (1995) then RR+ID farm drainage would be larger than shown. Item (1) in Table 1 would increase and so would item (3), unless we allow for a larger than 14% error on Dethridge Wheel recording and other unexplained factors. This does not seem realistic. It needs to be noted that the reverse could also apply (escape drainage is greater than half of total drainage).

Conclusion : Whilst one could argue about most of the numbers shown in Table 1, most are now believed to be at fairly close to the actual value. It is felt not much further progress can be made without a lot of additional studies.

Implications

The "apparent loss" traditionally has been calculated as the difference between diversions and deliveries. Figures 1,2, and 3 left hand side show the extent of losses expressed in a different form. It is clear there is not much relationship between "total loss" and "apparent loss". The reason is to do with the drainage re-use factor, which may be highly variable between years.

The Land and Water Management Plan implementation implications are also important. From Hydrology data for the MIA LWMP it is noted for instance that the reduction of drainage losses from all sources in the upstream MIA (some 49 Gl/year proposed) will result in some 20 Gl/year (average) additional diversions to Wah Wah, and the NHPS scheme if viable may require another 10Gl/year, total 30 Gl/year. However, the upstream MIA LWMP also results in reductions in total diversions of some 27 Gl/year (based on Benerembah

EIS tables by Hydrology unit). Overall the situation therefore looks OK as far as the MDBC Cap and the loss allowance is concerned. Unless upstream farmers use all the on-farm savings themselves, there is scope for improving the “apparent loss”.

Several other types of savings would result in less diversions :

- reducing flows returning to the River in the Yanco IA from whatever source. This may have an impact on the S&D salinity credits, dependent on salt loading reductions.
- Savings on-farm in the Wah Wah area may reduce the need for the additional diversions calculated by the BBS model to that area.

Hydrology Unit (E.Lam) has advised that the on-farm drainage reductions in the u/s MIA were assumed to result in a 100% effective equivalent reduction in orders for diversions. Since many farmers installing recycling with storage are likely to use at least part of the savings themselves the reduction in gross diversions predicted is likely to be less than the predicted about 27 Gl/year, but probably still substantial (on average).

It is possible that the end result is that in drier years the diversions are increased compared to the historic average, but in average to wetter years they will be less than the current situation. If farmers demand remains about the same the moving average of the loss should show an improvement.

With respect to savings in “true loss” items, Table 1 shows that the prospect of reducing these by improved management are not very great. The MIA Plan effect of savings in diversions would be mostly due to on-farm savings and reductions in floodway release volumes.

Finally, the matter of off-allocation availability may complicate matters further, especially in respect of Wah Wah. These aspects are not shown in Table 1 and Figures 1-3. Topping up of BBS to satisfy demands for off-allocation downstream affects diversions, hence the “apparent loss”. Being strict with rules on off-allocation appears to be an imperative.

Ary van der Lely
Resource Improvement Services Manager,
Leeton, 28 January 1997

General Data	SKM dry	Average Year	10%dry Year	Median Year	10%wet Year	Source Data
Rainfall (mm)	0	394	287	390	530	1
Evaporation Class A Pan (mm)	1687?	1709	1847	1733	1543	1
MIA Inputs Gl/year)	**SKM dry**	**Average**	**10%dry**	**Median**	**10%wet**	
Gross Diversions	1163	1143	1299	1154	954	9
Mirrool Creek Contribution	0	2	0	1.5	6.4	1
Rainfall Runoff	*0*	*54*	*na*	*na*	*na*	*2*
Irrigation Excess	*0*	*50*	*na*	*na*	*na*	*2*
Rainfall R/O + Irrigation Excess	0	104	55	77	166	2
Tile Drainage	0	10	8	10	12	1
Total Inputs MIA system =(1)	1163	1259	1362	1243	1138	
MIA Deliveries	**SKM dry**	**Average**	**10%dry**	**Median**	**10%wet**	
MIA+ BID + WWID Deliveries	928	934	1068	952	768	9
Wah Wah Deliveries	*0*	*90*	*110*	*85*	*63*	*6*
Correction factor deliveries (14%)	1.14	1.14	1.14	1.14	1.14	1, 5
Stock + Domestic Deliveries	0	*10*	*12*	*10*	*8*	8
Deliveries (Corrected) =(2)	1058	1075	1230	1095	884	
Apparent Loss (Base data)	235	209	231	202	186	
Loss after Correction (1)-(2)=(3)	105	184	132	147	255	
True Losses MIA System (Gl/year)	**SKM dry**	**Average**	**10%dry**	**Median**	**10%wet**	
Seepage MIA Large Area Farms	18	12	12	12	12	3
WWID Channel Seepage Losses	na	6	6	6	6	8
Wah Wah S+D + 9U'sA Losses	na	10	10	10	10	8
Seepage Horticulture	na	3	3	3	3	8
Evaporation Barren Box Swamp	46	31	37	32	23	4
Evaporation Lake Wyangan	na	4	5	4	3	4
Evaporation Channel System	20	18	22	19	14	4
Wah Wah Channel Evaporation	na	3	4	3	2	8
Leakage/Theft	5	5	5	5	5	5
Yanco GMS + YMS Drains to River	0	28	15	24	40	7
Roaches Escape back to River	0	*5*	*2*	*5*	*10*	6
Wah Wah Escapes	na	4	1	3	6	8
Floodway Releases	na	48	0	26	110	6
Losses MIA System = (4)	88	178	122	152	244	
Water Balance						
Corrected - True Losses (5) = (4)-(3)	17	7	11	-5	10	
Water Balance as % Diversions	***1.46***	***0.58***	***0.84***	***-0.41***	***1.10***	

Note : Values of lines in italics are included with other lines.

Sources of Data

1 MIA + BID Water and Salt Balance Data (1979-1991)
2 Evaluation of Watertable Control Options
3 Arun Tiwari, farm drainage investigations report
4 CSIRO for coefficients, and 12 years data 1979-1991
5 Sinclair Knight Merz report
6 Murrumbidgee Irrigation data
7 Water Quality Data
8 Estimated, see text
9 Paul Pendlebury, diversions and deliveries table

Table 1 : Water Balance of Supply System in the MIA

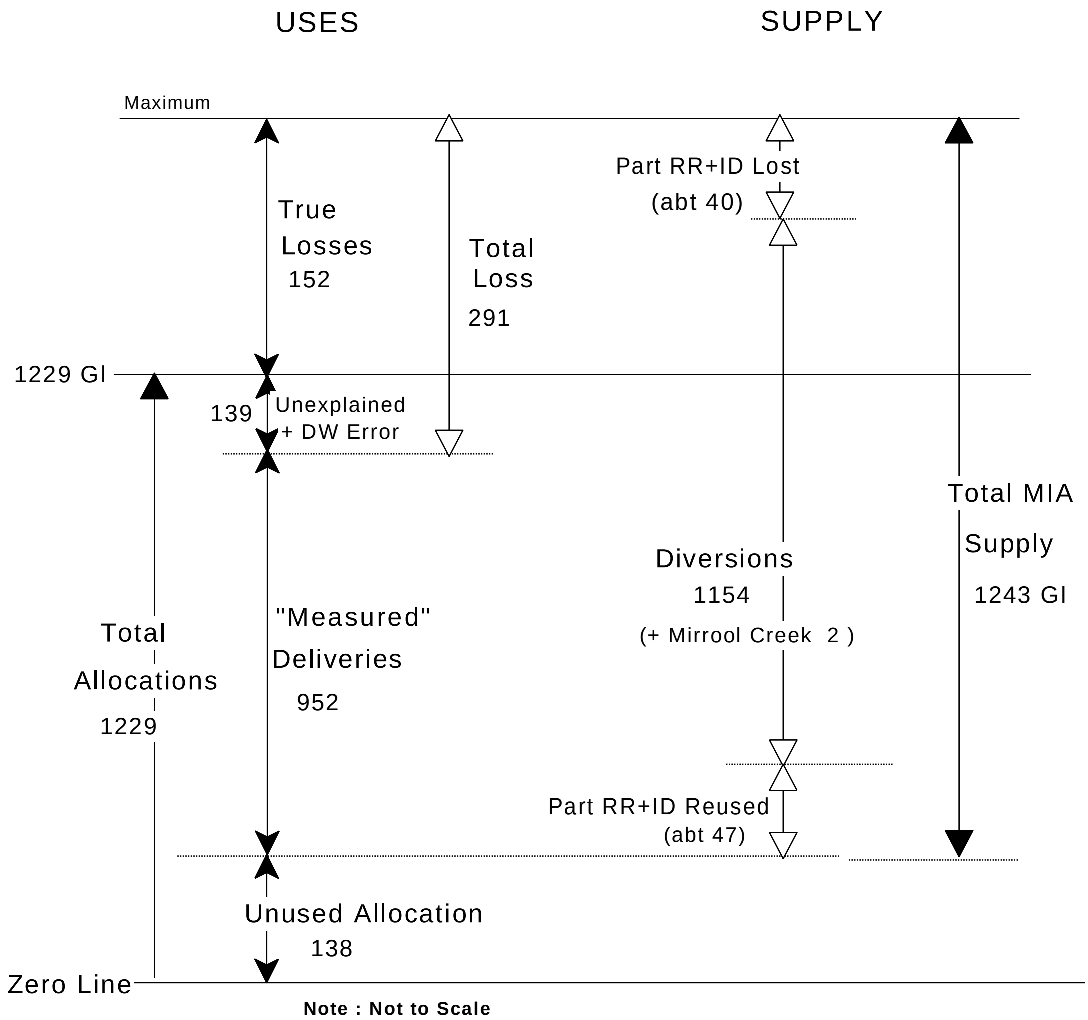
year	diversion GL	delivery GL	loss GL	loss %
1977/78	1282	1134	148	11.5%
78/79	965	832	133	13.8%
79/80	1234	1064	170	13.8%
80/81	1152	974	178	15.5%
81/82	1214	1030	184	15.2%
82/83	1134	961	173	15.3%
83/84	885	739	146	16.5%
84/85	1189	993	196	16.5%
85/86	1156	943	213	18.4%
86/87	1091	923	168	15.4%
87/88	1287	1036	251	19.5%
88/89	1025	781	244	23.8%
89/90	1098	880	218	19.9%
90/91	1194	926	268	22.4%
91/92	1328	1051	277	20.9%
92/93	929	639	290	31.2%
93/94	1046	831	215	20.6%
94/95	1368	1078	290	21.2%
average	1143	934	209	18.3%
median	1154	952	205	
10%	954	768	147	
90%	1299	1068	281	

Note : The first three years data were corrected by Hydrology Unit, P’matta

Table 2 : Annual Diversions and Deliveries and Apparent Loss from system for MIA from 1977 to 1995

MIA LOSS ASSESSMENT

(Median Year Volumes)



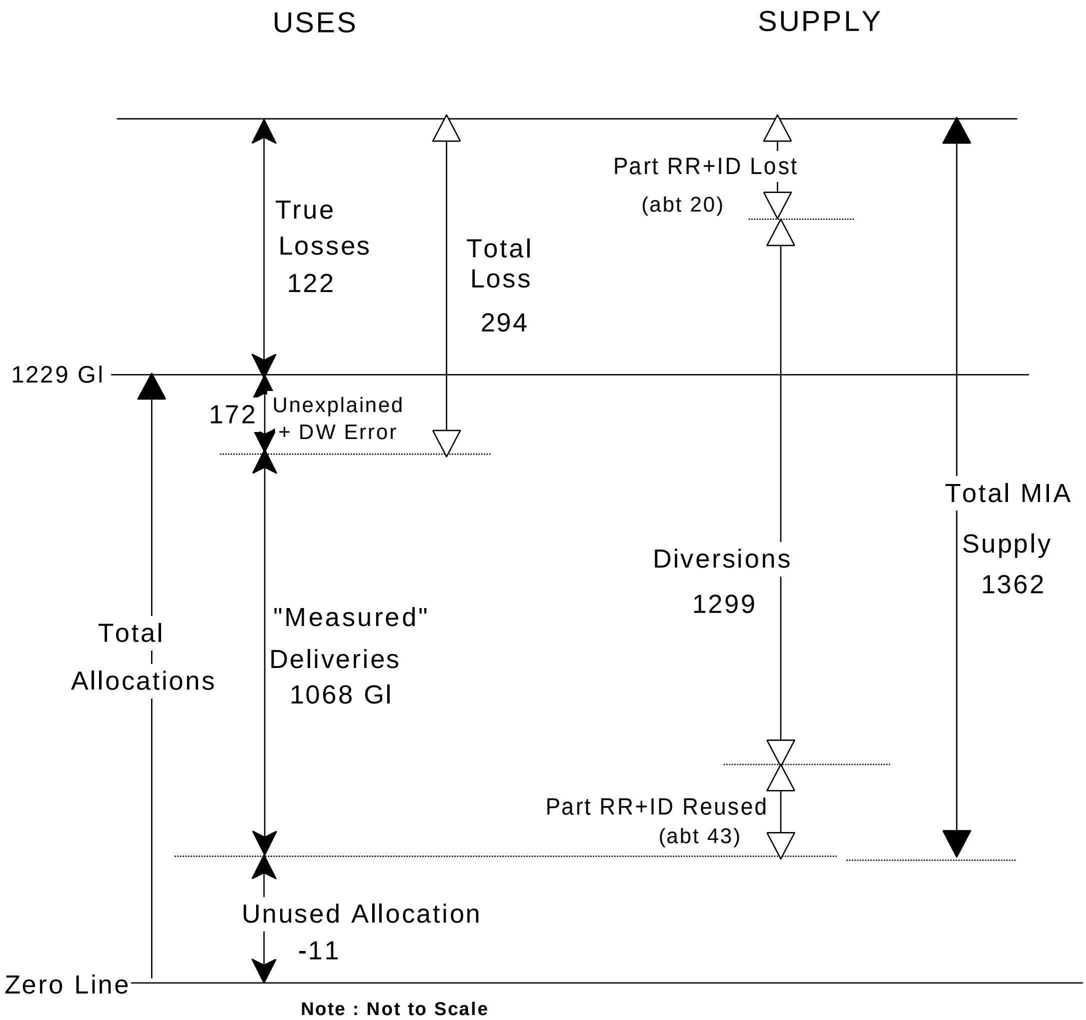
Comment :

1. Total Supply = Diversions + Rainfall Runoff + Irrigation Draiage (used +unused)
2. Uses = Deliveries + Errors/Unexplained + True Losses

Figure 1 : Diagramatic presentation of inputs and outputs to MIA supply system for a Median year

MIA LOSS ASSESSMENT

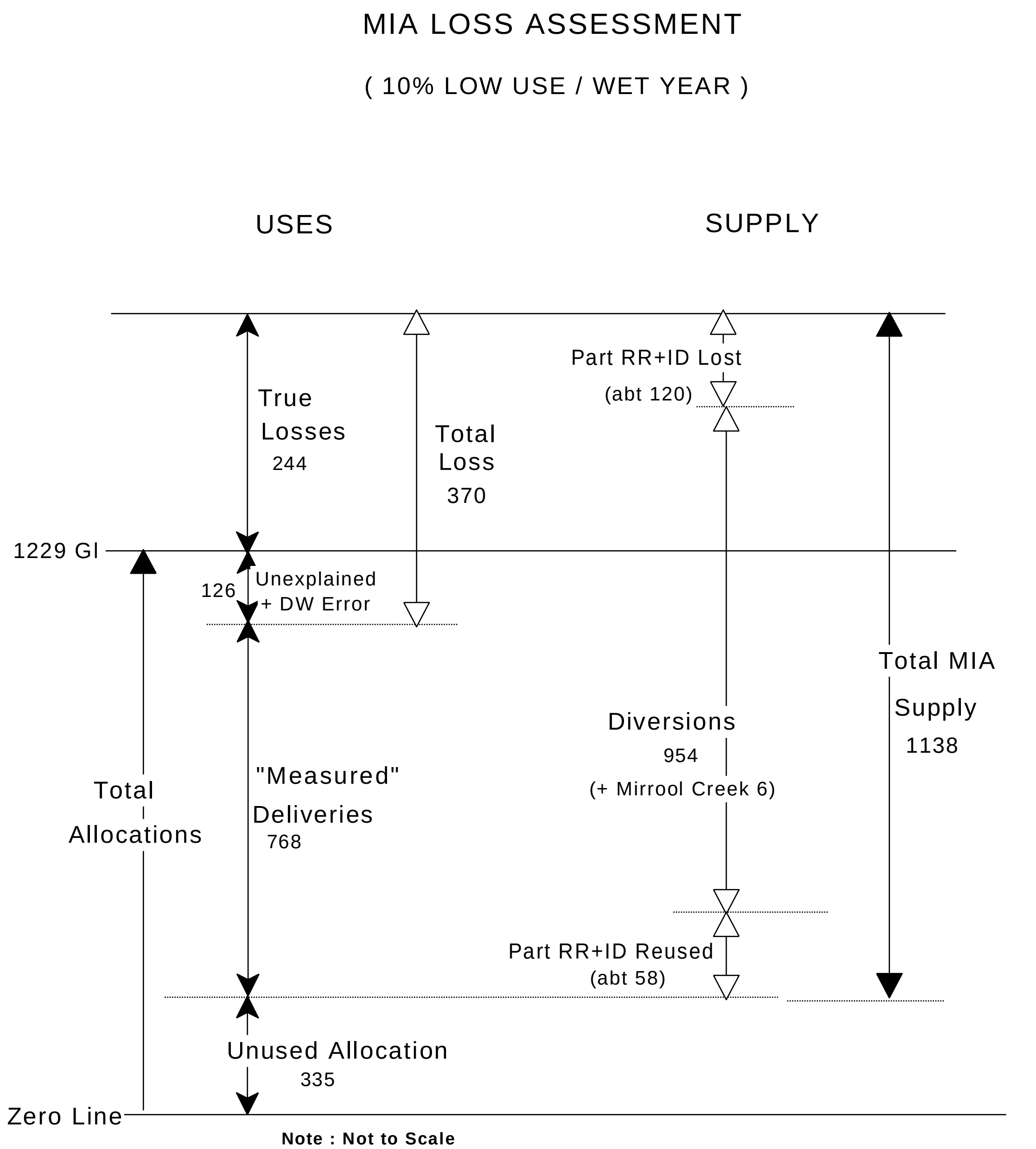
(10% HIGH USE / DRY YEAR VOLUMES)



Comment :

1. Total Supply = Diversions + Rainfall Runoff + Irrigation Draiage (used +unused)
2. Uses = Deliveries + Errors/Unexplained + True Losses

Figure 2 : Diagramatic presentation of inputs and outputs to MIA supply system for a 10% dry year



Comment :

1. Total Supply = Diversions + Rainfall Runoff + Irrigation Draiage (used +unused)
2. Uses = Deliveries + Errors/Unexplained + True Losses

Figure 3 : Diagramatic presentation of inputs and outputs to MIA supply system for a 10% wet year