

# **Precious Metal Resources of the Hellyer Mine Tailings Tasmania, Australia**

**for:**

**Wishbone Gold Plc  
Gibraltar**



by

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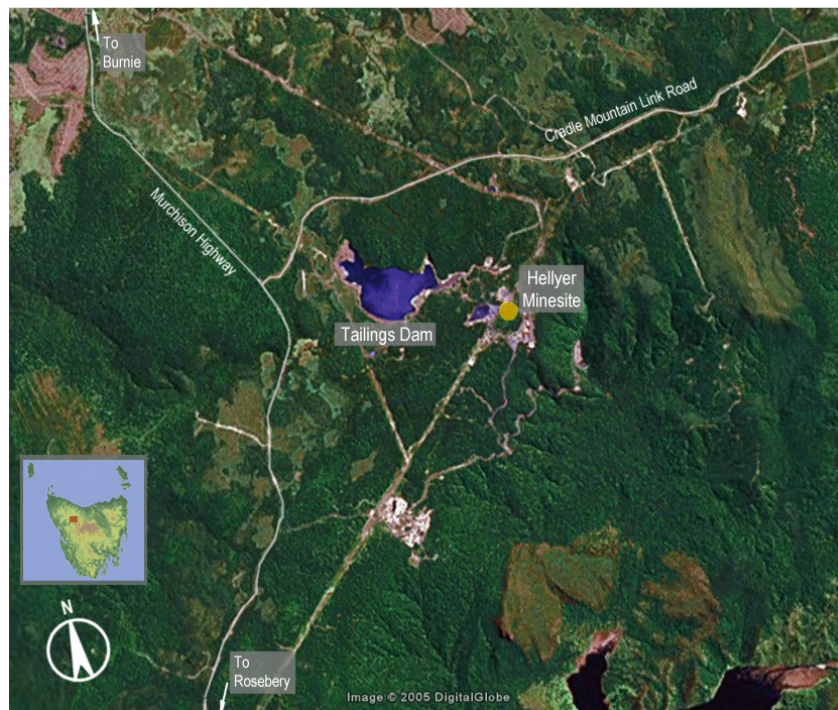
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## I. Scope of Report

On November 6, 2014, Mr. Richard Poulden, CEO of Wishbone Gold plc, requested I2M Associates, LLC (I2M) to prepare a summary report of findings regarding the available tailings at the Hellyer Mine in central Tasmania. This would be based on I2M's previous review of the available historical information and associated reports regarding the precious metal content of the main tailings dam and other disposal sites at the Hellyer Mine, (see Figure 1). I2M was also asked to concurrently provide metallurgical, geological, and engineering support regarding the processing aspects of the recovery of bulk concentrate and precious metals from the tailings during discussions with personnel of Commodity and Mining Insight Ltd. as input to their modeling of the economic framework of dredging and processing the Hellyer Mine tailings.

An understanding of the mineralogy of the tailings is critical to evaluate prior to the study of the various processing options. The mineralogy of the tailings is the key to identifying process options, and to understanding the process performance, particularly with regard to precious metal extraction and reagent and power consumption. We have reviewed the relevant characterizations of the tailings and have incorporated the data in our assessment, when appropriate.



**Figure 1 – Hellyer Mine Area and Layout of the Tailings Dam.**  
(from AMC, 2009) – Click on Figure to Enlarge.

## II. Introduction

Our estimates of the precious metals in the tailings resources are based on a review of the relevant and available documents prepared by a series of consulting and mining companies in Australia, including AMC Consultants Pty Limited (AMC), Western Metals Resources Limited (Western), McArthur Ore Deposit Assessments Pty Ltd (MODA), INTEC Hellyer Metals (Intec), Como Engineers Pty Ltd/Battery Limits JV (Como) and (Battery Limits), PolyMetals, and most recently CSA Global Pty Ltd (CSA), and associated laboratories and other supporting services.

The Hellyer deposit is a volcanic-hosted polymetallic massive sulphide deposit located within the Mount Read Volcanic Arc of Western Tasmania, which also hosts similar deposits such as Hercules, Que River, Rosebery and Mount Lyell. Mineralization is sulphide-hosted and comprised predominantly of pyrite and sphalerite, with lesser galena and arsenopyrite and other minerals. The economic metals mined at the Hellyer underground mine from 1989 to 2000 were lead, zinc, copper, gold and silver. The tailings have been deposited in a depression approximately one kilometer to the west of the Hellyer mine adit and mill. They are now inundated with water and the dam forms a small lake obvious on air photography (Figure 1), just south of the Cradle Mountain link road.



**Figure 2 – Hellyer Mine Property, Tailings Dam and Western Arm, Finger Pond, Eastern Arm, and Shale Pit Disposal Areas.**

(after Ivy Resources, 2013)

(Click on Figure to Enlarge)

### III. Background of Tailing's Content

A November, 2005 resource estimate for Hellyer tailings was prepared by AMC using data available as of July, 2000. AMC received drill-hole files from Hellyer management containing data for the tailings dam from two separate drilling programs, obtained during June; a 1998 program conducted in June obtained 316 samples and a program conducted in July, 2000 that obtained 90 samples. The 1998 and 2000 drilling program was undertaken by Poltock Field Exploration using *Vibracore* drilling.

The analytical results from the two programs indicate that the Hellyer Tailings Dam is a significant resource of gold, silver and base metals in sulphide minerals (Bass Metals, June 2010), which contains about 3% lead, 2% zinc, 0.2% copper, 94 ppm silver, and 2.6 ppm (~2.6 g/t) gold (Como Engineers, May 2010). As indicated in the table below, the sulphide mineralogy consists of sphalerite, galena, chalcopyrite and minor tetrahedrite with the gold contained in pyrite and arsenopyrite and the silver in tetrahedrite and galena. The distribution of minerals and their gold and silver content are shown in Table 1.

**Table 1  
Distribution of Minerals and of Gold and Silver in the Sulphide Minerals**

<u>Minerals Identified</u>	<u>Percentage</u>	<u>Comments on Distribution and Minerals Present</u>		
<b>Sulphide Minerals:</b>	<b>69.7%</b>	<b>Consisting of:</b>		
Pyrite	58.5	44.5 % Crystalline Pyrite 13.9 % Meinikovite (amorphous) Pyrite		
Sphalerite	4.4%	% Range 3 to 5%		
Galena	3.4%	% Range 3 to 5%		
Arsenopyrite	2.7%	% Range 1 to 3%		
Chalcopyrite	0.5%			
Tetrahedrite	0.2%	% 0.1 to 0.3%		
<b>Non-Sulphide Gangue:</b>	<b>30.3%</b>	<b>Consisting of:</b>	<b>%</b>	
		Quartz	11.7%	
		Carbonate	5.5% (Siderite)	
		Sericite	4.4%	
		Chlorite	3.1%	
		Barite	3.6%	
		Other	2.0%	
<b>Precious Metal Distribution:</b>	<b>g/t</b>	<b>Consisting of:</b>	<b>g/t</b>	<b>%</b>
Gold (Au)	2.6 g/t	Arsenopyrite	1.4 g/t	55
		Electrum	0.4 g/t (Au+Ag)	15
		Pyrite	0.4 g/t	15
		Meinikovite	0.4 g/t	15
Silver (Ag)	88 g/t	Pyrite	41 g/t	47
		Galena	29 g/t	33
		Tetrahedrite	16 g/t	18
		Chalcopyrite	1 g/t	1
		Electrum	1 g/t (Au+Ag)	1

From: Como Engineers Pty Ltd/Battery Limits JV, 2010, Bass Metals Ltd Hellyer Tailings Gold Recovery Project, Concept Study



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According to AMC's investigations, the tailings are generally less than 35 µm in size. The physical characteristics of pyrite are mainly presented as free particles with minor inclusions of sphalerite or galena. Sphalerite is present as either free particles (45%) or in binaries with galena (10%) or pyrite (45%).

Galena is dominantly seen as free and very fine, highly surface-oxidized particles. Copper is resident mainly in chalcopyrite, as either free grains or in association with pyrite or traces in sphalerite.

In other mineralogical studies (MODA, 2009), the tailings averaged 2.6 g/t gold and was associated mainly with arsenopyrite (55%), pyrite (30%) and electrum (15%), while silver (88 g/t) was associated mainly with pyrite (~50%), galena (~35%) and tetrahedrite (~15%). Gold was measured in pyrite and arsenopyrite by Laser Ablation ICP-MS at the University of Tasmania (December 2009). Highest gold content measured was 71 g/t in pyrite and 66 g/t in arsenopyrite. The gold content of the melnikovite pyrite is thought to be about 5 times that of the crystalline pyrite. Five samples of arsenopyrite contained an average 26 g/t gold ('Hellyer Tailings Gold, Laser Ablation Microanalysis', McArthur Ore Deposit Assessments Pty Ltd (MODA), December, 2009, Doc. 801).

#### **IV. Tailings Resource Estimates**

AMC was provided with Western Metals Resources Limited's (WML) report on the previous mineral resource estimate for the tailings, completed in June 1998 and the metallurgical balance spreadsheets for the years ending 1989 to 2000 inclusive. A summary of these data is presented in Table 2.

Hellyer Mine management requested AMC to determine whether any layering was evident in the Hellyer tailings. The 1998 drilling data suggested layering in some areas of the tailings dam, but it was not consistent from drill hole to drill hole. AMC expected to see higher grades towards the base of the dam, or base of each deposition layer, but this was not apparent, and probably due to the coarse sampling intervals (averaging 2 meters in 1998 and 6.5 meters in 2000). The dam was treated as a homogenous body in the depth dimension.

The two drill-hole data sets (1998 and 2000) had markedly different average and median core-sample lengths and could not be composited to a common downhole sample length.

Multiple composite lengths were tested, but none gave satisfactory results for both data sets. As a result, drill holes in both sets of samples were composited to one sample downhole, for length weighting during grade estimation.

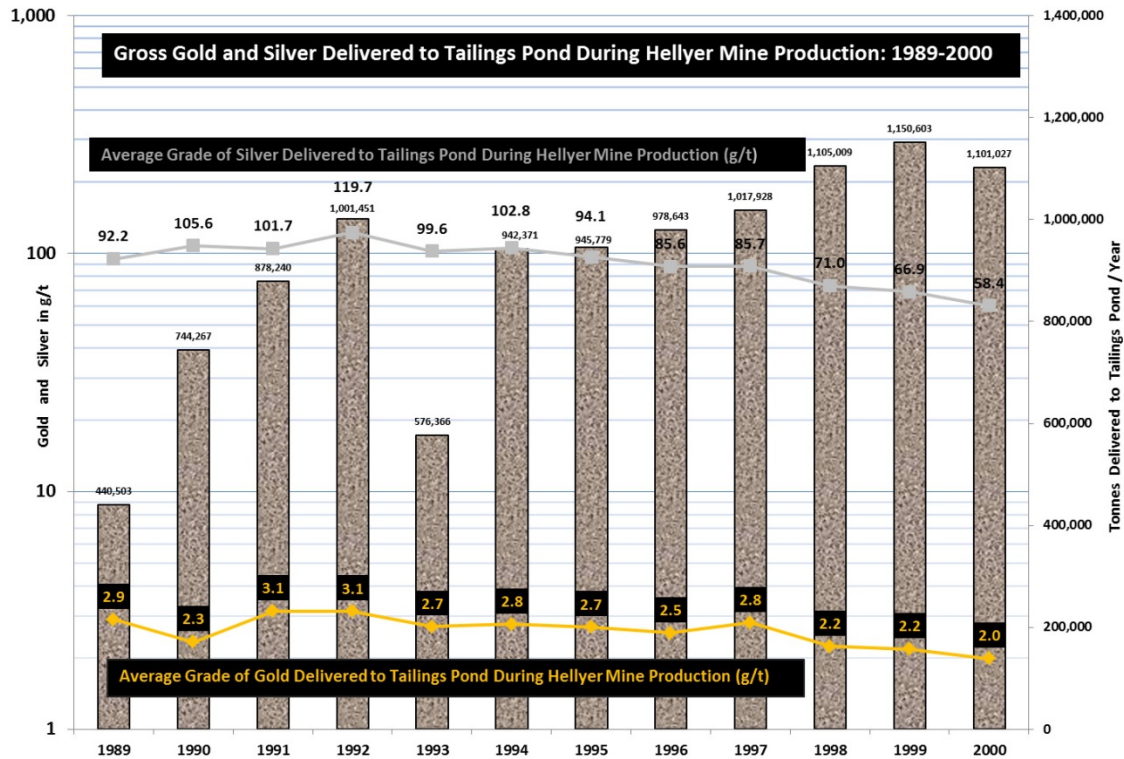


Figure 3 – Gross Gold and Silver Delivered to Tailings Pond During Hellyer Mine Production: 1989-2000  
 (from Aberfoyle\_HELLYER\_CONS\_DATA BASE)  
 (Click on Figure to Enlarge)

As more tailings had been deposited since the 1998 drilling, the 2000 drilling downhole composites had greater lengths in the same areas than the nearest corresponding 1998 drill holes. Thus the 1998 drilling data was essentially an incomplete sample set as it did not sample the overlying tailings and could not be combined with the 2000 drilling data for two-dimensional estimation.

AMC received limited QA/QC data from Hellyer Mine management. The reports consisted of:

- a comparison of NAA and fire assay for 48 gold samples,
- a comparison between x-ray determination (BMD) and NAA for 27 selected silver assays from the 1998 drilling program (10 of which were also compared to a 'wet chemical' analysis method), and



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- a comparison of all 90 silver and zinc assays using NAA and BMD methods from the 2000 drilling program.

The tailings as deposited, lie as a relatively flat, tabular mass and are quite thin relative to their north-south and east-west extents. As a result, the volume model could have relatively large cells in northing and easting dimensions and a much smaller cell size in the depth dimension.

Taking into account the shape and size of the deposited tailings, the drill-hole grid spacings and the statistics and variography of the five main elements, the parent-cell dimensions chosen were 50 meters in easting, 50 meters in northing and one cell high in RL. (X, Y, Z). Sub-cell splitting was allowed down to one quarter the parent-cell size to more accurately define the volume contained between the wireframes without creating excess sub-cells.

The gold and silver values, in addition to zinc, lead, and copper, all have very low coefficients of variance (CV), less than 0.5, and length has a slightly higher CV of 0.4. The metal accumulations for all of the elements have CVs of 0.42 to 0.5 due to being the product of length by grade. These are very low CV values, suggesting very low variability between samples, which might be expected in tailings.

For the year 2000 data, correlation between the elements is generally poor to moderate at best, with copper and zinc having the best correlation with a coefficient of 0.82. Correlation between the elements is weaker in the 1998 data, all of which suggest that the gold and silver at least are distributed within a number of mineral lattices.

AMC's variogram quality was acceptable, considering that there were so few samples, and was probably the result of the low coefficients of variance and the narrow grade ranges. The nugget effects for the accumulations were low, generally lower than 5%, with gold being 13% and zinc unusually high at 22%. All of the variograms had very long major axis ranges, over 400 meters suggesting good uniformity of tailing sediments.

As the deposited tailings were spread relatively thinly over a large area (about 760m by 740m by 20m) and the drill-hole samples had to be composited as one sample per drill hole, AMC used a two-dimensional grade estimation approach. Grade was allowed to vary by parent-cell block in the easting and northing directions (X and Y) and grade was constant in the depth direction (Z) for each parent-cell.





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Density values are important factors used in estimating in-place resources. They were initially provided in various spreadsheets by Hellyer Mine management, relating to the 1998 drilling and the 2000 drilling. These values varied considerably and appeared to be related to mineral specific gravity (SG) values, or a mixture of SG values and in-situ bulk densities, with the units of  $\text{tm}^{-3}$  or cubic meter of tailings material.

In 1998, the tailings were sampled (as a cubic meter of tailings material) and SG (~ density) reportedly ranged in value from 0.43 to 5.97, and averaged 1.93. According to Table 2 in WML's report on the previous estimates, the SG of the tailings samples varied from 1.03 to 3.24, and averaged 1.84. AMC indicated that these values seem low and Hellyer Mine management agreed, stating that they used a value of 2.11 in its estimate. This was derived from a sampling of part of the tailings in the storage facility dam and an estimate of the deposited tonnage for the same area (shown in Figure 3).

The 2000 drilling database contains 288 records for pulp density (SG), which ranged from 1.11 to 2.11 and averaged 1.62. These values are almost certainly low on the basis that AMC was informed that water was added to the samples while drilling as an aid to improve sample recovery. No moisture contents were recorded for this data to eliminate this addition.

Several versions of density determination datasets were provided, but there were inconsistencies between them and several values seemed either extremely low or high. Buckets containing the individual samples from the 2000 drilling campaign were retained at the BRL laboratory and AMC requested that new density determinations be undertaken using these samples. BRL performed 39 determinations on these samples, equivalent to in-situ bulk density (SG). The results ranged from 1.30 to 2.63 and averaged 1.93. AMC used these results for the in-situ density of the tailings by using the average of the determinations in the November, 2005 resource model.

AMC was requested by IHM to classify the resource model according to the JORC2 Code. A numeric code, RESCODE, was set in the model, with values of one, two or three, corresponding to Measured Resource, Indicated Resource and Inferred Resource respectively.



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AMC indicated that the model has been classified in a global sense and the classification was only intended to be valid if the tailings were mined in their entirety, which is clearly not likely for a number of reasons including dam integrity, dredge efficiency, and associated processing issues.

The AMC model was classified as Measured Resource in all areas where the drilling density was sufficient to allow an estimate of grade in the first pass. This equates to most of the tailings dam that was drilled in 2000. Kriging efficiency testing helped to confirm the classification in this area.

The model was classified as Indicated Resource at the peripheries of the drilling, as there was greater uncertainty in the continuity of grade. Two areas of the model have been classified as Inferred Resource, as there was uncertainty in grade continuity as well as uncertainty in the volume represented by the wireframes in these areas. The areas in question are the western edge of the model in the areas marked as 'shale borrow pits' and the north eastern corner of the model where the tailings have inundated a shallow creek (See Figure 2). AMC had to modify the original topography wireframe in these areas to allow it to lie below the 2005 tailings surface survey and thus the volumes were in question at that time.

## **V. AMC Tailings Resource Estimate**

The Hellyer Tailings Mineral Resource is summarized in Table 2, and indicated to be in accordance with the prevailing JORC Code. Mineral resource estimates were previously completed by AMC Consultants (2006, 2009) and PolyMetals Group (2006, 2007), which confirmed earlier estimates. AMC did not model vertical zonation of grade and completed a 2-D model only. PolyMetals, however, did recognize vertical zonation and constructed a 3-D block model, but they only estimated zinc grades in their model.



**Table 2**  
**AMC / PolyMetals Hellyer Tailings Resource Estimates**  
 (from AMC, Confirmed: Tyrrell, 2006 and 2009)

Classification (JORC)	Tonnes (M)	Gold g/t	Silver g/t
Measured	4.9	2.7	105
Indicated	2.5	2.6	104
Inferred	2.1	2.4	103
<b>Total</b>	<b>9.5</b>	<b>2.6</b>	<b>104</b>
Total Resources (In Place)		Gold Ounces	Silver Ounces
Measured		400,000	17,000,000
Indicated		200,000	8,000,000
Inferred		200,000	7,000,000
<b>Total</b>		<b>800,000</b>	<b>32,000,000</b>
<b>* In-Place Value: @ \$1,200/Gold oz</b>		US\$ 960 M	
<b>* In-Place Value: @ \$12/Silver oz</b>			US\$ 384 M

\* Note: In-place Gold and Silver values have no economic basis and should be treated only as an initial value from which costs must be subtracted to dredge, process, and recover, and to sell the metals, in addition to paying land costs, environmental fees, royalty payments, reclamation and other fees and costs.

## VI. CSA Tailings Estimate

Later, CSA Global Pty Ltd (CSA) was asked to review previous estimates and concurred with the approach taken by PolyMetals when generating their resource estimate. However, CSA identified a vertical variation in metal grades down the drill holes and like PolyMetals, considered that the approach taken by AMC in earlier estimates could be improved. CSA presented their findings to Como and Bass Metals, and proposed generating a new resource model along the lines of the PolyMetals approach, but included the additional grade data for metals other than zinc. The CSA estimated resource for the Hellyer tailings storage facility is presented in Table 3. Wireframe surfaces and solids and drill-hole data were provided by Como and Bass, which included the 1998 and 2000 drill-hole data using *Vibracoring*. QAQC analyses were reported by AMC (Tyrrell, 2006 and confirmed 2009).

**Table 3**  
**CSA Hellyer Tailings Resource Estimate**  
 (CSA, 2010)

Classification	Tonnes (M)	Gold g/t	Silver g/t
Measured	3.5	2.6	93.7
Indicated	0.7	2.7	96.1
<b>Total</b>	<b>4.2</b>	<b>2.6</b>	<b>94.1</b>
Total Resources (In Place)		Gold Ounces	Silver Ounces
<b>Measured + Indicated</b>		354,000	12.7 M
<b>* In Place Value: \$1,200/oz Au &amp; \$12/oz Ag</b>		US\$424.8 M	\$152.4 M

\* Note: In-place Gold and Silver values have no economic basis and should be treated only as an initial value from which costs must be subtracted to dredge, process, and recover, and to sell the metals, in addition to paying land costs, environmental fees, royalty payments, reclamation and other fees and costs.



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It should be noted that depleted and non-recoverable resources have been excluded from the CSA estimate, none of which were classified as Inferred Resources in Table 3. The CSA estimate deducted tailings material within 200 meter of the main dam wall and within 1 meter of the base of the tailings. Further deductions from these resource volumes have been made to account for possible losses due to slumping of material along the base of the reclaimed area during dredging and to the impracticality of reclaiming all this material. The low clay content of the tailings material resulted in the tendency for the tailings to slump and will have to be accounted for should further dredging operations be undertaken in the future.

In addition, approximately 1.9 Mt of tailings are present in the Black Shale Pit and the Western and Eastern arms of the tailings dam (see Figure 2). This material consists of tailings that remain from the previous retreatment operations and is of lower grades and would be more difficult to dredge. Recovery of this material has not been included in the CSA estimate, although these tailings should be re-examined in any future operations.

## **VII. Conclusions and Recommendations**

Based on our review of the numerous reports that focus on Hellyer tailings resource estimates, we have concluded that the Hellyer Tailings Pond(s) clearly contain substantial gold and silver in place that are of substantial value at the current market prices. However, the gold and silver occur for the most part within the crystal lattices of a number of sulphide minerals and hence require multi-stage processing.

The cost to liberate the precious metals from the refractory materials will be relatively high. However, preliminary economic modeling being conducted by Commodity and Mining Insight Ltd., with input from I2M personnel, suggests that dredging and processing of the tailings appear to be of economic significance, assuming the conceptual processing designs, related assumptions, and associated costs can be confirmed, and assuming the price of the precious metals remain at their currently high levels.

For the purposes of the preliminary economic modeling, three cases should be considered based on: 1) minimum available tailings resources (4.2 million tonnes containing 354,000 ounces of gold and 12.7 million ounces of silver), 2) likely available resources (6.5 million tonnes containing 550,000 ounces of gold and 20 million ounces of silver), and 3) maximum available resources (9.5 million tonnes containing 800,000 ounces of gold and 32



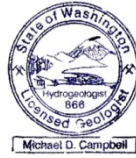
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million ounces of silver) at the Hellyer Tailings Storage Facility. The median resource base (item 2) was selected on the basis that the estimate allowing a resource of 4.2 million tonnes may be unnecessarily conservative, while the estimate projecting a resource of 9.5 million tonnes (and higher) may be too liberal in establishing the areas to be dredged. We, therefore, recommend that the economic modeling evaluate all three resource estimates to bracket the likely tailings resource base present at the Hellyer Mine and to represent the likely economic framework anticipated for the project.

Please note that we reserve the right to make revisions to this report if and when new information becomes available that would change our views on any material aspect covered in this report.

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## IX. References

This list of references contains the primary references cited herein and the background references, most of which were located in the large database provided by personnel of Bass Metals Ltd. and reviewed by I2M personnel where available. To illustrate project evolution, the references and other reports of interest are presented in chronological order, from the most recent to the older documents.

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