6 INTEGRATED ENVIRONMENTAL MANAGEMENT

6.1 Environmental management philosophy

Rand Carbide is committed to implement environmental management programmes, through which it will mitigate or manage and, where possible, eliminate or remove any risks or hazards which may negatively impact the surrounding community and/or environment.

Rand Carbide is also putting in place an Integrated Water and Waste Management Plan (IWWMP) that will be based on the resource protection and waste management hierarchy according to the DWA. This principle can be summarised as follows:

Step 1: Pollution Prevention

↓

Step 2: Minimisation of Impacts
Water reuse & reclamation
Water treatment

↓

Step 3: Discharge or disposal of waste and/or waste water
Site specific risk based approach
Polluter pays principle

Based on this principle, pollution prevention and minimisation have to be addressed first. Pollution could be abated by preventing the contact of water with major pollution sources and by minimising the amount of water used through water conservation awareness. *In this regard, Rand Carbide will strive to minimise the amount of municipal water it brings onto the site (by approximately 25%) by using water already present on the site (storm water and springs), and thereby prevent clean municipal water from being contaminated on the site through its contact with potential pollution sources. Rand Carbide's cooling systems are also closed systems which minimise the evaporative losses and the water quantity required for top-up.*

Where complete pollution prevention is not possible, management measures will be implemented to minimise water quality deterioration and impacts as far as possible. This will be facilitated through minimising contact between water and major pollution sources as well as by preventing contaminated water reaching the environment. *Rand Carbide is currently implementing this in terms of bund walls around potential pollution sources (water is contained and recycled within the circuit from which it originates) and containment of its' contaminated water (process water and storm water to an extent). An improved storm water management system and additional storm water management infrastructure will further assist in meeting Rand Carbide's objective to prevent contaminated water from reaching the environment and clean areas on its site.*

Thereafter, water reuse and reclamation forms an integral part of the larger IWWMP. As part of the water reuse and reclamation strategy, it is important to identify Rand Carbide's water quantity and quality requirements for different uses, in order to establish which water sources can be used for which applications/users. Thus constituents of concern, i.e. constituents that can impact on product quality and yield, or might interfere with processes, need to be identified (salts for example). The water use inventory conducted as part of this project established:

- Water sources: quality and quantity available
  - Municipal water
  - Spring water
  - Captured storm water

- Water uses: quality and quantity requirements
    - Domestic type users
    - Cooling type users
    - Dust suppression etc

Monitoring will indicate where adverse effects due to unacceptable water quality are manifested.

The following were specifically considered:

- Large quantities of water are used for dust suppression due to the quantity of fine particulate matter (of different origin) on the site, as well as Rand Carbide's locality in close proximity to residential areas (human inhalation and health risk concerns).
- Municipal water is used for dust suppression which does not require very high or potable quality water.
- Spring water and/or captured storm water, can be used in order to limit fresh water intake.
- Spring water currently flows into the municipal storm water system.

6.2 Environmental management systems

Rand Carbide holds an ISO 14001:2004 certificate (valid until May 2014) for the manufacturing of ferrosilicon, silicon metal, electrically calcined anthracite, silica fume and Söderberg electrode paste. Please refer to Appendix A.

6.3 WATER USE AND MANAGEMENT

6.3.1 Water supply

Source: Rand Carbide is supplied with water from the eMalahleni Municipality which the municipality obtains from the Witbank Dam. The municipal water can be fed to the Rand Carbide site from one of three (3) different points, namely Christiaan de Wet E, Christiaan de Wet F or Middelburg Road. Each of these has a flow meter. Only one of the three (3) points is used at any one time as the water is in a ring feed supplying the entire site. Currently (2011), Christiaan de Wet E is used as the municipal inlet.

Legal: Permit 282N (29 March 1989; ref B33/2/210/34) from the Department of Water Affairs (DWA) authorises the use of municipal water for industrial purposes at the premises. A quantity of 515 000m^3/annum (1 410m^3/day) is authorised in terms of the repealed Water Act of 1956 (Appendix A). Rand Carbide has used between 79 000m^3/annum and 113 000m^3/annum over the past five (5) years (2007 – 2011) which is well below the 515 000m^3/annum authorised. No water use licence from DWA in terms of the National Water Act (NWA), 1998 (Act 36 of 1998), is required for the use of water supplied by a water services provider such as a municipality. Rand Carbide has no agreement with the eMalahleni Municipality in terms of a guaranteed continued water supply; though it pays the municipality on a monthly basis for the water and has never experienced an interruption in its water supply (Appendix A contains a copy of the monthly municipal account). A large quantity of water was historically required and therefore applied for and authorised as the stokers used large quantities of water (now decommissioned). Therefore, water conservation principles and improved technologies have been implemented since 1989 to reduce the quantity of water required.

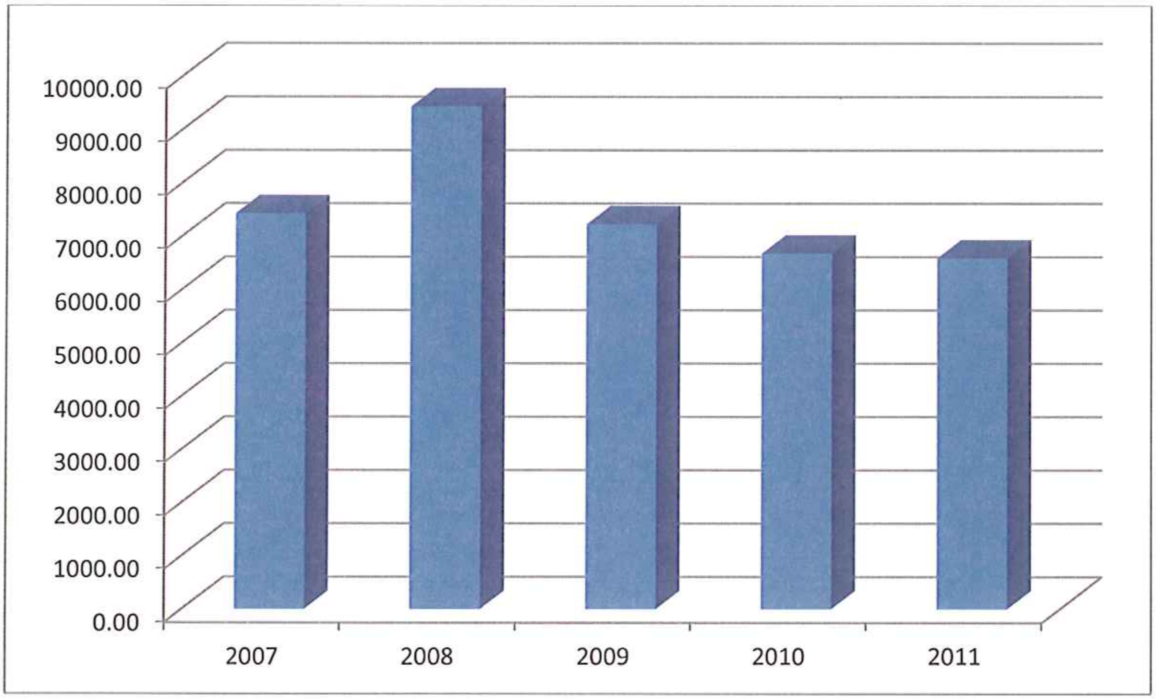


Figure 6.1: Average monthly municipal water supply (2007 – 2011)

Volumes used: There is a decreasing trend in terms of the municipal water used since 2008 (especially between 2008 and 2009) which indicates water conservation principles and cleaner technology implemented by Rand Carbide, as this decrease was in spite of the fact that more water had to be used for dust suppression on the site due to it being mentioned by neighbours as a concern. Other factors which could have contributed to the ***decrease*** in water use are:

- In 2008, the stokers were demolished (cleaner technology is now used).
- In 2009, the combination of closed and evaporative systems used for cooling at the furnaces was converted to closed systems only (water conservation technology).
- In 2011, sweepers were hired to reduce the municipal water consumption for dust suppression; sweepers will possibly be purchased in 2012.

The ***increase*** from 2007 to 2008 probably relates to the recommissioning and start-up of the paste plant towards the end of 2007 after it was not used for approximately 18 months. The EMB plant also started up around 2006/7.

Recommendation: Due to the high cost associated with municipal water (approximately R652 464 per annum which equates to approximately R7.30 per cubic metre of water) and in terms of water conservation principles, Rand Carbide should be considering decreasing the municipal (raw) water intake through reuse and reclamation strategies. Municipal water should only be used for purposes where a potable water quality is required:

- Human consumption/use (offices, change rooms etc.)
- Where water quality can affect product quality (for example paste plant where water is used for cooling of product)
- Where water quality can negatively affect operation (cooling systems where a build-up of salts can interfere with the effectiveness of the operations)

Potential water supply sources: The following potential water supply sources have been identified:

- Municipal water: Supplied through eMalahleni Municipality from the Witbank Dam.

- Captured storm water: Runoff and rain water potentially contaminated by the Rand Carbide facilities, materials or operations, have to be captured and contained on the site to prevent pollution spreading to the surrounding environment. Ideally the water should be reused to minimise raw water intake.
- Springs: Four (4) springs are evident on the site; these are underneath Furnaces E & F, at B conveyor sump and next to EMB.

Table 6.1: Water supply sources and their qualities and quantities

Constituents:	Municipal water[*]	Storm water[$]	Spring water[#]
pH	7.67	7.97	8.01 – 8.35
EC (mS/m)	58	75	67 - 455
TDS (mg/l)	397	544	452 – 3 542
Calcium (mg/l Ca)	50	95	82 - 331
Magnesium (mg/l Mg)	31	22	21 – 138
Sodium (mg/l Na)	32	38	27 - 475
Potassium (mg/l K)	6.1	20	13 - 125
Nitrate & Nitrite (mg/l as N)	0.34	-	2 – 7
Sulphate (mg/l SO_4)	174	180	144 – 1 740
Chloride (mg/l Cl)	25	47	23 – 356
Fluoride (mg/l as F)	0.52	0.59	0.2 – 4.5
Iron (mg/l as Fe)	0.10	-	0.01 – 4.05
Manganese (mg/l as Mn)	0.16	-	0.01 – 0.30
Aluminium (mg/l as Al)	0.04	0.01	0.01 – 0.54
Chromium (mg/l as Cr)	< 0.01	< 0.01	< 0.01
Lead (mg/l as Pb)	0.01	< 0.01	< 0.01
Mercury (mg/l as Hg)	< 0.001	< 0.001	< 0.001
Arsenic (mg/l as As)	< 0.01	< 0.01	< 0.01
Cadmium (mg/l as Cd)	< 0.003	< 0.003	< 0.003
Zinc (mg/l as Cd)	0.055	0.02	< 0.01
Copper (mg/l as Cu)	0.39	0.02	< 0.01
Cobalt (mg/l as Co)	< 0.01	< 0.01	< 0.01
Vanadium (mg/l as V)	< 0.01	< 0.01	< 0.01
Nickel (mg/l as Ni)	0.01	0.01	< 0.01
Silver (mg/l as Ag)	< 0.01	< 0.01	< 0.01
Phenolic compounds	< 0.005	< 0.005	< 0.005
Chemical Oxygen Demand (mg/l COD)	30	34	20 - 112
Quantity available (m^3/month)	42 917	5 763 (wet season) 1 077 (dry season)	365 (wet season) 36.5 (dry season)
Quantity used (m^3/month)	7 500	0	0
Cost (R/m^3)	7.30	0	Nothing currently. Water charges not finalised

Notes:

[*] Municipal water quality is based on 2011 data only.

[&] Storm water quality was taken from one sample taken in April 2011 from Harry's Dam which is currently the only available information as this dam collects runoff from the property. Storm water quantities from E-tek Consulting.

[#] Spring water quality is a range between the three springs' quality, sampled once during July 2011. The wet season water quantity is an estimate based on the dry season quantity which was measured, as no data was available.

The spring water qualities differ significantly and therefore the water qualities are presented separately for parameters where significant differences exist.

Table 6.2: Spring water quality

Constituents:	Springs			
	E furnace	F furnace	B Conveyor sump (embankment)	Mixture$
pH	8.35	8.13	8.01	
EC (mS/m)	108	455	67.4	*139*
TDS (mg/l)	750	3 542	452	*1 018*
Calcium (mg/l Ca)	101	331	82.5	*127.1*
Magnesium (mg/l Mg)	33.6	138	20.6	*42.4*
Sodium (mg/l Na)	83.5	475	27.3	*111.5*
Potassium (mg/l K)	12.8	125	12.7	*31.5*
Nitrate & Nitrite (mg/l NO_3 as N)	3.9	7.2	1.8	*3.1*
Sulphate (mg/l SO_4)	287	1 740	144	*434*
Chloride (mg/l Cl)	56	356	23	*84*
Fluoride (mg/l as F)	0.34	4.5	< 0.2	*0.9*
Iron (mg/l as Fe)	0.01	4.05	0.04	*0.7*
Manganese (mg/l as Mn)	0.27	0.29	< 0.01	*0.1*
Aluminium (mg/l as Al)	< 0.01	0.54	< 0.01	*0.1*
Chemical Oxygen Demand (mg/l COD)	24	112	20	*36*
Water quantity (m^3/month)	3.6	3.6	14.4	*21.6*
Percentage (%)	16.7	16.7	66.6	-

Notes: $ Mixture water quality was based on relative quantities available.

Spring water quality: It can be concluded that the spring underneath Furnace F is contaminated. The source of contamination is unknown but can be from surface (inflow) or from underground (contaminated groundwater). More sampling will be required as results are based on one (1) sample only.

Based on the results presented in Table 6.2 for a mixture of the spring waters, mixing the three (3) sources of spring water is not recommended. The water quality of the spring at the B conveyor sump is good and is of much higher volume than the springs from underneath the furnace buildings. Mixing the water from the other two springs (underneath the furnace buildings) with the water from B conveyor sump will result in a larger volume of more contaminated water.

Storm water quality: The storm water quality presented in Table 6.1 appears to be a good quality of water but represents a once-off sample which was taken from Harry's dam. It is however, possible that contamination (constituents of concern) has precipitated within the dam sediments or along the way. For this reason, the water from the catchment ponds in closer proximity to the plant was also analysed to establish if there exists a higher level of contamination in these.

Table 6.3: Runoff water qualities

Constituents:	Catchment ponds		Main dam
	1	4	Harry's dam
pH	8.0	7.71	7.97
EC (mS/m)	79	78	75
TDS (mg/l)	600	596	544
Calcium (mg/l Ca)	112	108	95
Magnesium (mg/l Mg)	27	27	22

Constituents:	Catchment ponds		Main dam
	1	4	Harry's dam
Sodium (mg/l Na)	37	37	38
Potassium (mg/l K)	12	12	20
Nitrate & Nitrite (mg/l N)	1.3	1.2	-
Sulphate (mg/l SO_4)	193	183	180
Chloride (mg/l Cl)	28	32	47
Fluoride (mg/l as F)	0.40	0.68	0.59
Iron (mg/l as Fe)	0.09	0.07	-
Manganese (mg/l as Mn)	0.32	0.02	-
Aluminium (mg/l as Al)	0.08	0.12	0.01
Zinc (mg/l as Cd)	0.03	0.09	0.02
Copper (mg/l as Cu)	< 0.01	< 0.01	0.02
Chemical Oxygen Demand (mg/l COD)	30	30	34

Water quality between the three (3) different monitoring points for surface water runoff is not very different and it is therefore assumed that the water quality is representative of storm water runoff from the Rand Carbide site. Therefore, the sediments of the dams/ponds were sampled and leached to see if constituents of concern were possibly trapped in the sediments.

Table 6.4: Leachate from sediments

Constituents:	Catchment ponds				Main dam	
	1		4		Harry's dam	
	Demin	ARLT	Demin	ARLT	Demin	ARLT
pH	8.45	6.35	8.32	6.42	7.86	6.26
Calcium (mg/l Ca)	560	4 880	750	5 380	358	3 540
Magnesium (mg/l Mg)	101	298	112	392	42	196
Sodium (mg/l Na)	189	133	170	172	116	89
Potassium (mg/l K)	73	133	77	146	55	112
Sulphate (mg/l SO_4)	466	558	466	550	430	492
Chloride (mg/l Cl)	180	120	120	140	60	80
Fluoride (mg/l as F)	27.2	11.6	21.8	5.6	33.4	6.4
Iron (mg/l as Fe)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Manganese (mg/l as Mn)	16.6	91.2	22.6	80.8	0.6	59.4
Aluminium (mg/l as Al)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Boron (mg/l as B)	4	8	3	5.4	1.8	4.4
Barium (mg/l as Ba)	3.0	3.8	3.8	4.0	1.4	10.4
Zinc (mg/l as Cd)	2.0	2.6	< 0.01	2	0.2	2
Nickel (mg/l as Ni)	0.8	1.0	0.8	1.4	< 0.01	0.6
Copper (mg/l as Cu)	< 0.01	0.2	< 0.01	0.20	< 0.01	< 0.01

Notes: Demin – Demin Water Leach Test
ARLT – Acid Rain Leach Test
Below detection limits: Cd, Cr, Pb, Se, V, Co, Hg
Very low concentrations: Fe, Al, Cu

It can therefore be concluded, that constituents do leach from the sediments. It is however, not certain whether these constituents are associated with contamination or the geology underlying the site as some are present in both. Calcium, Magnesium, Sodium, Potassium and Sulphate are all present in raw materials as are the metals Iron, Aluminium, Manganese and Barium. Iron and Aluminium levels are not elevated but the elevated levels of Barium

(Ba) point towards contamination from the Rand Carbide process and raw materials. Mn is now stored in bags.

Water supply versus water use:

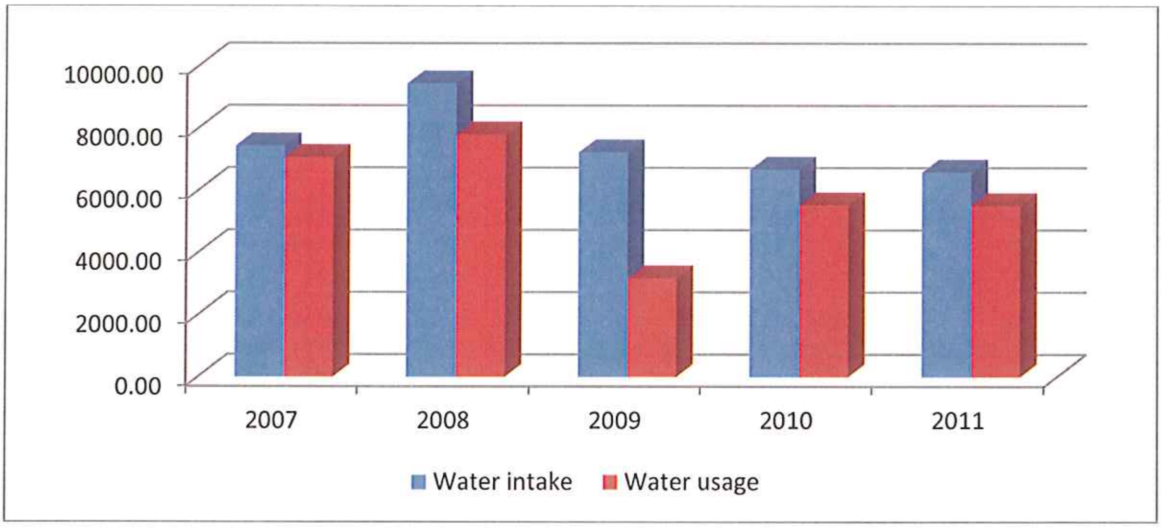


Figure 6.2: Monthly average municipal water intake versus water distribution and use

From Figure 6.2 above, it is evident that the flow measurements taken do not correlate. Not all of the municipal water entering the site can be accounted for and some water users on the site are not accounted for currently. Additional flow meters will be required at certain identified localities (filling point in plant area for water trucks) to reduce the difference. As there are no checks or calibrations done, it is difficult to establish exactly where all the problems lie. Figure 6.2 shows water usage being less than water intake on average over a yearly period. This is however, not always the case. In many instances the water usage exceeds the water intake based on daily measurements.

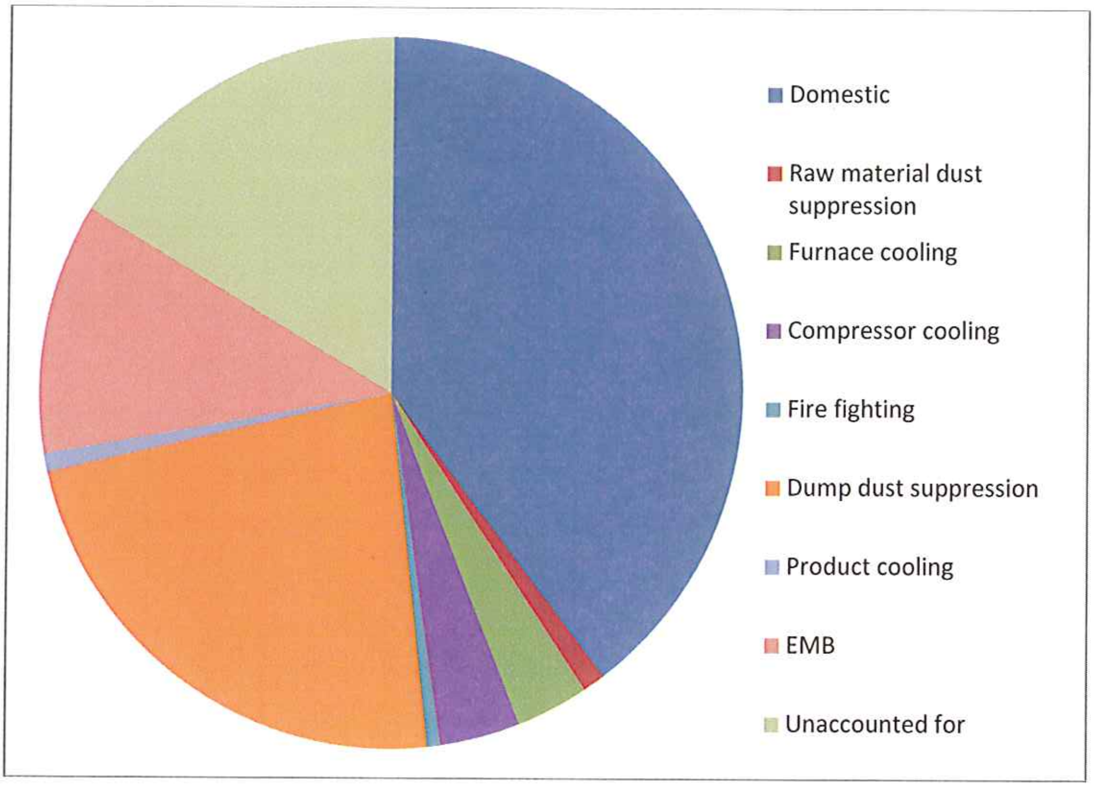


Figure 6.3: Municipal water distribution (2011)

From Figure 6.3, it is evident that the following are the major water users:

- Domestic (human use) – approximately 40%
- Dust suppression (raw materials; plant; dump etc) – varies, but approximately 24% - this is probably much more (up to 40%), as it is suspected that much of the unaccounted-for water is probably used for dust suppression
- EMB – approximately 11%; which will reduce to zero after the XRT sorter has been installed (February 2012)
- Cooling (furnace, compressor and product) – approximately 8%

Unaccounted-for water: On average, 20% of the incoming municipal water in 2011 cannot be accounted for and it is suspected that most of this water is used for dust suppression and not included in a flow meter measurement. This has been confirmed during discussions with on-site personnel (30 August 2011) in terms of the filling of water trucks used for dust suppression at a point without a flow meter. The calculated estimation of this water is 1 500m^3/month (50m^3/day) due to the filling of a 25 000 litre truck once-a-day and the filling of a 5 000 litre truck for the plant area 5 times/day.

Recommendation: Rand Carbide should consider using a different source of water (storm water or spring water), other than municipal water, for dust suppression. Rand Carbide should install additional flow meters to determine where the unaccounted water goes. Flow meters should also be calibrated regularly to ensure accuracy of flow measurements.

6.3.2 Potable water supply

Source: Water for human consumption is supplied by the eMalahleni Municipality from the Witbank Dam.

Table 6.5: Potable water users and quantity requirements (2007 – 2011)

Area / user (flow meter name):	Use:	Quantity (average over 5 years):		
		m^3/day	m^3/month	m^3/annum
Change house	Toilets, showers and floor washing. Used by approximately 189 workers.	56.4	1 714	20 568
Canteen	Preparation of food and cleaning (1 toilet & shower).	6.0	182	2 184
Laundry	Washing of overalls	3.8	115	1 380
Silica Fume Plant	Gardens, ablutions, showers	2.1	65	780
Admin	Offices (lady's shower, toilets, wash basin) and front garden	2.5	76	912
Afrox	Contractor supply (garden, ablution etc)	2.9	88	1 056
Fitting shop	At fitting shop for first aid, workshops, toilets	3.2	97	1 164
Lab	At laboratory: showers, basins, equipment washing. Training Centre, transport, instrumentation, Fe-Si plant etc	13.3	405	4 860
Bakwena Cement Plant	People (offices) and Ready Mix	7.4	225	2 700
TOTAL:		**97.6**	**2 967**	**35 604**

Conclusion: From the above Table 6.5, it is evident that Rand Carbide uses approximately 3 000m^3/month of municipal water for potable use. This water cannot be replaced by water from any other source as the risks to human health are too high.

Notes: It should be noted that the Lab flow meter reading may include water used for dust suppression as the quantity is quite high. The water used in the change house appears to be split between human use (857m^3/month - approximately 150litre per person per day) and floor washing (50:50).

Table 6.6: Potable water quality and acceptability

Constituents (mg/l unless otherwise indicated):	South African Water Quality Guidelines (DWAF, 1996)	SANS 241 (1999) (South African National Standards)	eMalahleni Municipal water supply (from Witbank Dam)
	Domestic use	*Class 0 - ideal*	
pH	6 – 9	6 - 9	7.67
EC (mS/m)	< 70	< 70	58
TDS	< 450	< 450	397
Ca	< 32	< 80	50
Mg	< 30	< 30	31
Na	< 100	< 100	32
K	< 50	< 25	6.1
NO_3 & NO_3 (as N)	< 6	< 6	0.34

Constituents (mg/l unless otherwise indicated):	South African Water Quality Guidelines (DWAF, 1996)	SANS 241 (1999) (South African National Standards)	eMalahleni Municipal water supply (from Witbank Dam)
	Domestic use	*Class 0 - ideal*	
SO_4	< 200	< 200	174
Cl	< 100	< 100	25
F	< 1	< 0.7	0.52
Fe	< 0.1	< 0.01	0.10
Mn	< 0.05	< 0.05	0.16
Al	< 0.15	< 0.15	0.04
Cr	< 0.05	0.05	< 0.01
As	< 0.01	0.01	0.01
Cd (ug/l)	< 5	0.003	< 0.001
Co	NA		< 0.01
Cu	< 1	0.5	< 0.003
Pb	< 0.01	0.01	0.055
Hg (ug/l)	< 0.001		0.39
Ni	NA	0.05	< 0.01
Si	NA		< 0.01
Zn	< 3	3	0.01
V	< 0.1		< 0.01
Coliforms (counts/100 ml)	0 (faecal) < 5 (total)	0	0 0

Potable water quality: The chemical quality of the potable water supply is acceptable for the parameters determined.

6.3.3 Process water supply

Source: Water for industrial purposes (process) is supplied by the eMalahleni Municipality from the Witbank Dam.

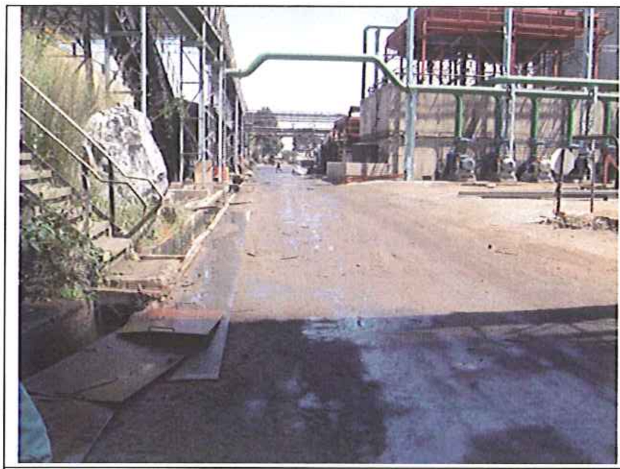
Table 6.7: Process water uses and their requirements (2007 – 2011)

Area / user (flow meter name):	Use:	Quantity (average over 5 years):		
		m^3/day	*m^3/month*	*m^3/annum*
Dust suppression		***84.7***	***2 555***	***30 910***
Stockpile	Dust suppression at raw material stockpiles	2.6	79	948
F Dust Silo	Sprinkler (dust suppression)	4.0	122	1 464
Dumps	Dust suppression	28.1	854	10 248
No flow meter	Filling of dust suppression truck (5 000litre truck filled 5 times per day for dust suppression in plant area; 25 000litre truck filled once a day for dump area)	50	1 500	18 250
Furnace pond (new)	Make-up for furnaces' cooling system. Should be sum of three furnace (D, E, F) make-ups	7.2	219#	2 628
Comp cooling	Compressor cooling system	4.6	139	1 668
Bond / fire hydrant	Fire fighting	1.2	37#	444
Paste Plant Shed	Cooling of product, sprinkler, furnace	1.8	55#	660

Area / user (flow meter name):	Use:	Quantity (average over 5 years):		
		m^3/day	m^3/month	m^3/annum
EMB	Reprocessing of waste material, separation & sorting	24.6	749#	8 988
TOTAL		***124.1***	***3 754***	***45 298***

Note: F furnace is the largest (capacity); E furnace make-up is not representative as some volume may be included in the other two (D & F) furnace volumes; total volume of furnace make-up used (198m^3/month).
Only 2011 data as the monitoring point did not exist prior to 2011.

Water used for dust suppression does not have a specific water quality requirement.




Roads sprayed with water for dust suppression


Sprayers in certain areas and along roads to suppress dust

Watering truck used to spray roads for dust suppression (use approximately 1 600m^3/month)

Plate 6-1: Water used for dust suppression

Recommendation: Rand Carbide should consider using a different source of water (other than municipal water) for dust suppression. Water for dust suppression can be sourced from the springs or captured storm water and result in a reduction in municipal water intake, making that water available to other users and reduce municipal expense (at least 25-40% saving on municipal water consumption and water cost) for Rand Carbide. It is recommended that cooling top-up water (~ 413 m^3/month) be supplied from the municipal source as is currently the case, since the water quality may affect product quality (product cooling at Paste Plant) or affect the operation (scaling or corrosion of equipment, blockages in equipment due to precipitation and build-up of salts etc).

Cooling water is recycled in a closed system, and water indicated above in Table 6.7 and Figure 6.3 only represents top-up water which is lost through evaporation.

Although much of the existing water management (drains, water supply pipes, flow meters etc) and control systems (valves, taps etc) will remain in place, additional systems will also be provided. These systems will include the following:

- Improved housekeeping practices (spillages & cleaning thereof; pollution prevention);
- Maintenance plan to ensure paved and/or concrete areas are in a suitable state of repair;
- Decommissioning and rehabilitation (cleaning and backfill) of Harry's dam, once new storm water management system has been implemented;
- Regular calibration of flow meters;
- Evaluation of process technologies - modifications, improvements or new technologies (cleaner production) to reduce water requirements and prevent losses;
- Bund walls around areas of high contamination potential for containment of spillages/overflows;
- Sumps collecting process water/spillages within bunded areas;
- Pumps within sumps to re-circulate the collected spillages within the area of collection (localised control system for containment & reuse);
- Concrete certain surface areas with high soil & groundwater pollution potential;
- Roof certain areas/buildings to prevent rain infiltration;
- Sloping of areas to prevent ponding and allow runoff to drain freely without causing erosion;
- Drains to intercept and/or capture contaminated storm water from the dirty catchment areas on the site;
- Drains to divert and channel captured storm water to a storm water dam;
- Grit/Silt traps to trap and collect suspended solids from storm water (due to large quantity of fine particles on the site) for removal, thereby preventing drains and dam from silting up (reduce capacity);
- Grit/silt trap will be in duplicate to allow cleaning of one while the other section is used;
- Storm water dam for collection and containment of contaminated storm water from the site (up to 1:50 year storm event, without overflowing more than once in 50 years);
- Pumps to pump collected storm water from the storm water dam (in order to keep dam as empty as possible at all times to allow capacity for major storm events) to the plant for reuse of water;
- Diversion trenches and/or berms to prevent clean storm water from entering dirty areas on Rand Carbide site (prevent contact with potential pollution sources), and to ensure discharge of the clean water into the natural surrounding environment for replenishment of natural resources.

6.3.4 Clean water management facilities

All water in contact with the Rand Carbide plant, infrastructure, facilities and operations on the site can be considered contaminated and therefore not fit for release into the receiving water environment. Therefore, storm water originating from these catchment areas should be captured, contained and reused (see storm water management and dirty water containment systems).

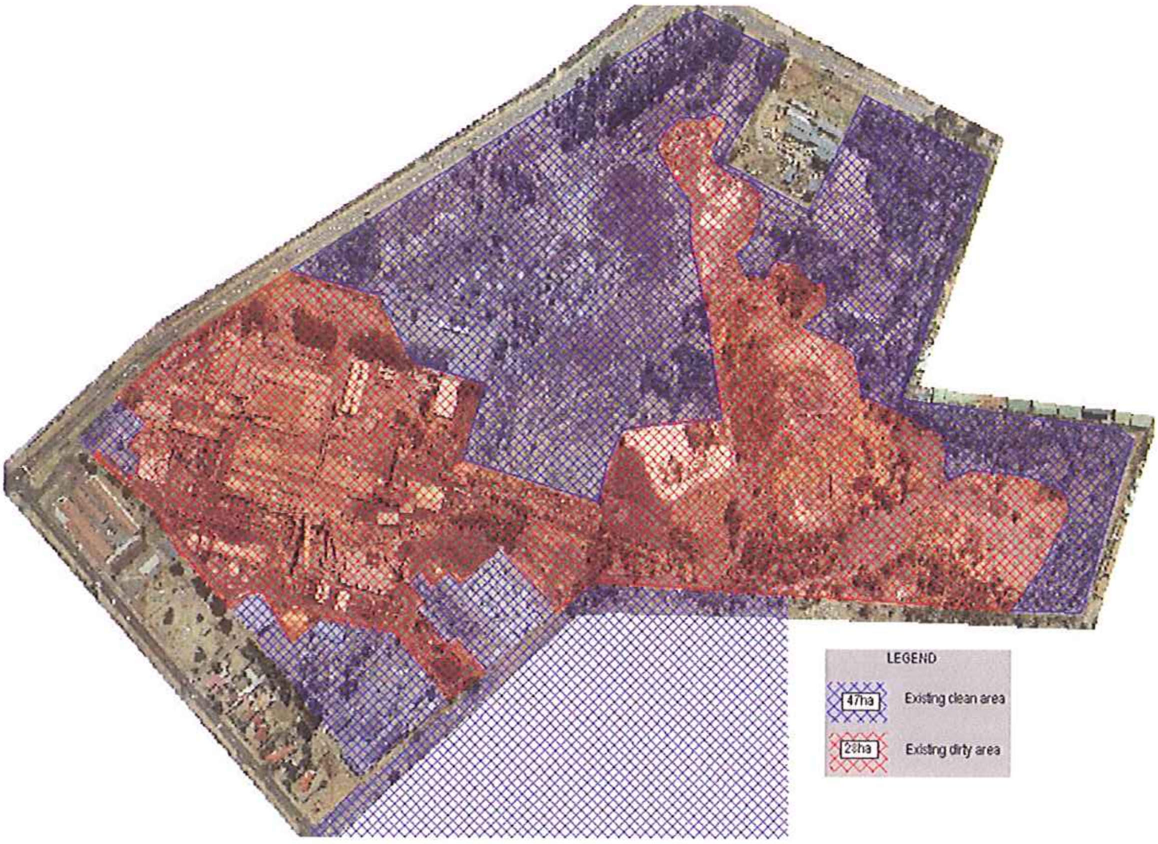


Figure 6.4: Current dirty & clean storm water areas on site (Etek Consulting, 2011)

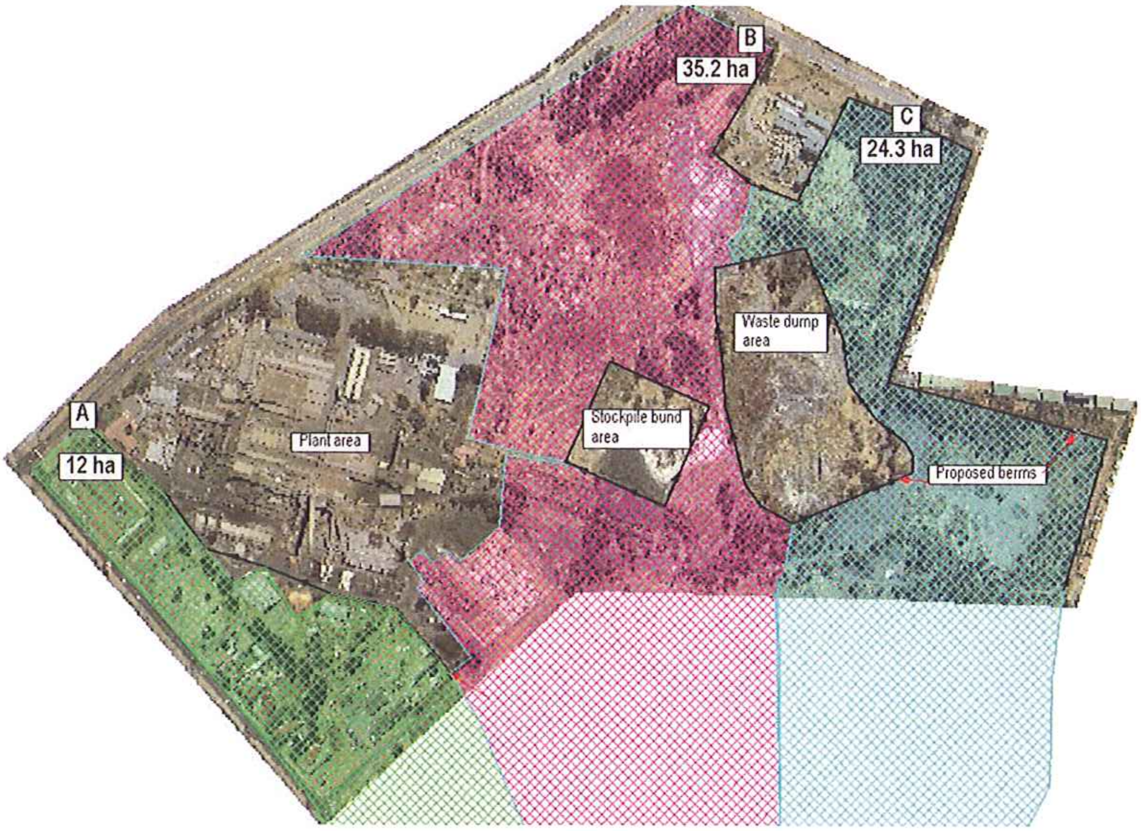


Figure 6.5: Proposed clean storm water areas on site (Etek Consulting, 2011)

Table 6.8: Clean water catchments (Etek Consulting, 2011)

Catchment:	Surface area (ha):	1:50 year storm event	
		Flood (m^3/s)	Volume (m^3)
A	12	1.9	5 344
B	35.2	5.5	17 890
C	24.3	3.6	11 324
TOTAL	**71.5**		**34 558**

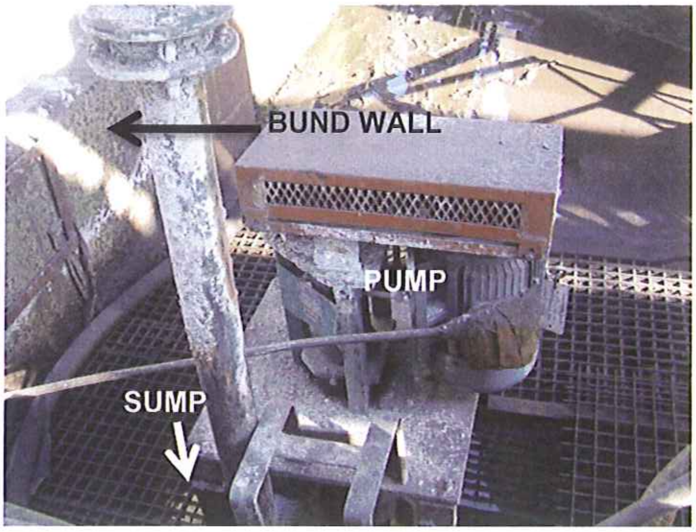
Storm water from areas topographically higher than the Rand Carbide site, should be diverted around the site to prevent contact with Rand Carbide facilities and activities and therefore associated pollution risk. On the north eastern boundary of the Rand Carbide site (in the area of the school), significant quantities of upslope storm water from neighbouring properties finds its way onto the Rand Carbide site. The issue will be discussed with the eMalahleni Local Municipality, and Rand Carbide intends to construct a cut-off trench and/or berm in this area to prevent the storm water from entering its' property and becoming contaminated. Rand Carbide has consent from the eMalahleni Local Municipality on the approval of the concept (site visit, 8 December 2011). This water should discharge to the municipal storm water system in Voortrekker Road.

Clean water areas should be maximised (~26 ha or 46% of the site) to minimise the quantity of water on the site to be managed by Rand Carbide. Storm water from clean catchment areas (non-operational areas) on the Rand Carbide site will also be diverted around potential pollution sources and discharged to the municipal storm water system.

6.3.5 Dirty water containment systems

Impermeable surfaces: Covering of surface areas with concrete, asphalt and sealed paving prevents infiltration/seepage of spillages to the underlying groundwater/aquifer. Areas with poor/damaged existing cover should be repaired as part of the general on-going maintenance programme. The majority of the plant area (approximately 30% of the site) is covered in terms of sealed surface areas.

Bunding: The spillage control measures and dirty water containment further consist of the enclosing of areas, in the plant, with high pollution potential, with bund walls. These bunded areas collect all spillages that could occur within these specified areas during normal operation. (Design should allow for sufficient capacity to contain leaks and spillages even in the event of a storm occurring at the same time as a spillage/overflow). Such spillages are then recycled within the immediate process from which the spillage occurred, through a sump-and-pump system. Spillages thus flow/drain to a sump at a low point within the bunded area and the pump within the sump is then used to recycle the spillage back into the process. In this unlikely event, that the occurrence of a 1:50 year storm event is combined with the maximum spillage from the process (tank rapture for example), some contaminated water from the process water system may enter the storm water system. In this case, due to the dilution, the effect would be minimal.



The first priority is to ensure that all process bunds are designed as per requirements and can hold 110% of the actual capacity of the storage container within it. In the event that a spill occurs, the bunded area must capture and contain the spill, the problem needs to be rectified and the spillage needs to be returned to the source from where it originated.

Pollution control: Three (3) systems operating separately from each other will in future (2013 onwards) function on the site:

1. Clean storm water which will be diverted around Rand Carbide operations/facilities through berms and cut-off trenches and discharged to the surrounding environment (municipal storm water management system);
2. Contaminated storm water which will be captured and conveyed in drains to a storm water containment dam, from where it will be reused in the plant; and
3. Highly contaminated process water.

The pollution & spillage control system implementation has already started and includes:

- roofs over certain areas to prevent rainwater infiltration & contact with possible pollution sources (furnace buildings and paste store for example);
- concrete on surface areas (floors of paste plant and Fe-Si handling, for example) to prevent water infiltration, seepage and groundwater contamination; and
- bunding of high pollution potential areas containing possible pollution sources.

6.3.6 Sewage management facilities

Rand Carbide sewage feeds into the municipal sewage management system. A monthly fee is paid to the municipality for this (see monthly municipal account in Appendix A).

6.3.7 Storm water management

A detailed Storm Water Management Plan (SWMP) was compiled by E-Tek Consulting in September 2011. Selected aspects of this report are discussed in this section, but reference is made to the full report as per Appendix C.

Hydrology: The point of departure of surface water investigations relates to the delineation of the natural watersheds and the natural stream flow. This is derived from the topographical contours which delineates the area into drainage areas. The aim of this delineation is to determine the natural drainage patterns of the water, without intervention. Experience has shown that in major flood situations, the storm water will attempt to follow the natural occurring flow paths. It is therefore a design principle to attempt to adhere to natural flow paths as far as possible when positioning infrastructure. Refer to Figure 3-1 in terms of hydrology, watersheds, drainage flow paths etc.

Methodology: The Rand Carbide site was investigated and the existing storm water infrastructure was holistically assessed and mapped. Critical positions of the infrastructure were then verified in terms of capacity requirements for a 1:50 year flood occurrence (GNR704 requirements).

Conclusions: The Rand Carbide site is in need of a structured storm water management plan to facilitate the effective management of storm water on site. Some major upgrade or additions (to the approximate value of R31 million) to the existing infrastructure was proposed in order to achieve this. These proposals will be implemented over the next eight (8) years and included:

- Diversion of clean storm water runoff from the south, past the site, to the west;
- Reorganisation of the stockpile areas into lined and bunded concrete areas;
- Diversion of dirty storm water from the plant and proposed stockpile areas to a 6 600 m^3 Pollution Control Dam (PCD), with settling ponds;
- Containing and diversion of runoff from the Waste Dump. This contained water should be evaporated from the proposed clay lined evaporation dam. The waste dump storm water is managed separately as the dump is being reprocessed and will "disappear" with time.

6.3.8 Water reuse and reclamation

It is important for Rand Carbide to optimise its water utilisation through water reuse and reclamation for the reasons listed below.

- Water ***conservation*** principles, based on the scarcity of water in South Africa, the demand for human use and to maintain ecosystems. Water use should be effective and this can be achieved through the minimisation of evaporative, seepage and overflow losses, as well as evaluating alternative process technologies which consume less water.
- The ***cost*** associated with the purchasing and intake of municipal water. Rand Carbide currently pays R7.30/m^3 (2011 figure) for water received from the local authority (eMalahleni Municipality). The consumption of fresh/raw water should be limited to processes requiring such good quality water and water requirements that cannot be supplied within the network.
- ***Legislative*** stipulations requiring Rand Carbide to contain water contaminated by its operations. Storage facilities should prevent seepage to soil and groundwater through an impermeable surface, and designed with adequate capacity to contain storm events without overflowing (GNR704).
- Protection of the ***environment***, specifically water resources and public health. Reduction of potential environmental and other liabilities due to impacts on the receiving water resources due to seepage/releases/discharges.
- ***Reclamation*** of water and other valuable products with potential impact on the environment.

The following were particular considerations in the development of the reuse and reclamation strategy:

- Areas where large volumes of water are used. Dust suppression uses at least 2 500m^3/month which is at least 34% of the total consumption.
- Areas where large volumes of water are disposed. Spring water and storm water are currently discharged onto the site or into the municipal storm water management system.
- Areas where good quality water is imported into the water circuits while poorer quality water is lost. Municipal water is used for dust suppression while spring water and storm

water are being discharged into the municipal storm water system rather than being used.

- Areas where good quality water is purchased while water of a poorer quality is acceptable for use without compromising product yield or quality. Municipal water use should be reduced. Dust suppression has no water quality requirements.
- Areas where the implementation of pollution prevention or minimisation strategies do not result in the elimination of all pollution. Storm water from the site is contaminated due to its contact with Rand Carbide operations and facilities.

Pollution prevention

Objective: The prevention or minimization of water quality deterioration where water is used and the prevention of discharges/releases causing pollution of water resources. Thus prevent pollution and where prevention is not possible, prevent or minimise impact.

Specific actions:

Separate clean and dirty water systems.

- Design, construct and implement a new *storm water management system* separate from the dirty/process water system and the clean water system. The storm water management system will include a network of drains, grit traps and a storm water dam which will be operated as empty, as water will be pumped back into the plant and other areas for reuse. Though the storm water is considered cleaner than the process water, the water is by no means clean and containment facilities will be lined accordingly.
- The *process water system* will be for spillage control and to manage process water. The system will comprise a number of bunded areas with sumps and pumps to contain spillages in a specific area and reuse it in this area. The system will be separate from the storm water system to ensure that relatively cleaner storm water is not contaminated by the major pollution sources.

Prevent water contaminated by Rand Carbide from leaving the site.

- Containment of *precipitation (rainfall)* falling onto the Rand Carbide site and possibly being contaminated by Rand Carbide operations and pollution sources. Reuse of this storm water, from the storm water dam in the plant and other areas (for dust suppression).
- Containment of *process water* in bunded areas and recirculation of this water within the process from which it originates (sump-and-pump system).
- Prevent Rand Carbide water from entering the municipal storm water system under normal operating conditions. The storm water dam may spill to this system in a storm event exceeding the 1:50 year event.
- Prevent Rand Carbide dirty storm water from entering clean areas on the Rand Carbide site.

Minimise water contact with major pollution sources.

- *Bund* areas with major pollution sources.
- *Concrete* certain surface areas containing possible pollution sources to prevent these substances from leaching into the soil and groundwater.
- *Roof* certain areas to prevent infiltration of rain and maximise clean runoff.
- *Drain* storm water (rainfall) quickly and effectively through drains and channels from areas where it can be contaminated. Refer to storm water management.
- **Stokers** (not a clean technology) were mothballed in 2008.

Water conservation

Objective: The effective use of water and the minimisation of evaporative, seepage and overflow water losses from the water reticulation system.

Specific actions:

- **Evaporative cooling systems** were replaced with closed systems in 2009. All cooling systems are currently closed systems thereby minimising the evaporative losses.
- **Minimise municipal water intake and consumption.** Rand Carbide currently uses 7 500 m^3/month from eMalahleni Municipality since reuse of water is not optimised (no use of captured storm water). Rand Carbide is also using fresh/raw water in areas not requiring water of such a good quality (dust suppression, for example).
- **Maximise the reuse of water contaminated by Rand Carbide operations.** See above section on pollution prevention - preventing water contaminated by Rand Carbide operations from leaving the site (storm water dam water reuse).
- **Prevent water losses.** Prevent seepage water losses by lining water containment facilities and placing concrete in certain plant areas.
- **Prevent overflow water losses.** Prevent overflow water losses by ensuring adequate capacity for storm water reticulation system and storage infrastructure (storm water dam to contain 1:50 year storm event) to contain storm events. Refer to storm water management plan by E-tek Consulting, 2011.
- **Consider alternative process technologies, which consume less water.**

Cost savings

Objective: The purchase and consumption of fresh/raw water from eMalahleni Municipality will be limited to processes/uses requiring such good quality water and water requirements that cannot be supplied within the network. Thus process water users will be provided with the poorest allowable water quality without compromising product quality/yield or process performance.

Specific actions:

- Municipal water for domestic use due to water quality requirements for domestic use.
- Municipal water for cooling due to potential process interference and product quality compromises if water of a poorer quality is used.
- No fresh/raw water to be purchased and distributed to other processing circuits if sufficient recycled water is available.

Compliance with legislation

Objective: The containment of water contaminated by Rand Carbide operations, which includes prevention of seepage to underlying groundwater aquifers, overflowing of storage facilities and off-site releases, is required by law. This ties in with the water conservation principles (see sections on pollution prevention and water conservation).

Protection of the environment

Objective: The environment, and more specifically, the water resources need to be protected. Prevent or reduce impacts on the receiving water resources (water courses and groundwater aquifer) due to releases/discharges.

Specific actions:

- Minimise seepage in plant area through good housekeeping, spillage control, concrete floor surfaces and bunding (refer to Pollution Prevention: minimises contact with pollution sources).
- Prevent Rand Carbide storm water runoff, or any other water from the plant possibly contaminated by Rand Carbide pollution sources or operations, going off-site (refer to

storm water management and section on Pollution Prevention: containment of storm water and process water).

- Rand Carbide will discharge contaminated storm water from their site to the municipal storm water system no more than once in 50 years.
- Recycle hydrocarbons (oils/greases).
- Dispose of solid general waste onto a licensed regional waste disposal facility (eMalahleni site).
- Dispose of all hazardous waste generated on the site, on an appropriately licensed facility (H:H facility such as Holfontein).
- Segregate waste materials to simplify recycling and reuse, and to prevent cross-contamination.
- Prevent release of dust from furnaces to air (baghouse system).
- Prevent release of dust from operations and site to air (dust suppression).

Reclamation of water and other valuable products

Objective: By reclaiming valuable materials (water or other) from the process, the environmental impact associated with its release is reduced and the material could be reused or sold to recover costs.

Specific actions:

- Reprocessing and reclamation of valuable products from the old dump area through the EMB plant.

Sustainability

General objective: Sustainability of the water reuse and reclamation strategy through the different life-cycles and phases of the process and operation.

Approach / methodology

A step-wise approach was followed in developing the reuse and reclamation strategy. This is an iterative process and the water reuse and reclamation strategy needs to be re-assessed and evaluated at various points within the life-cycle of the operation, to assess whether it is still appropriate, applicable and suitable. Figure 6.6 provides a flow diagram of the steps/procedure to be followed for the compilation/update of a water reuse and reclamation strategy.

Information management: Microsoft Excel was selected as the tool to use for data and information management. All data collected (flow and quality data) will therefore be entered into an Excel spreadsheet database to which a water-and-salt balance is linked.

The data's validity will be confirmed through quality control measures (cation-anion balances etc) before it is entered into the information management system.

Water source allocation: This is done considering the water quantity and quality of the water sources, as well as the water quantity and quality requirements of the users, to ensure that processes receive the worst allowable water quality without compromising process performance and product quality/yield.

Unused water sources: No water sources, too small or isolated, to be incorporated into the water reticulation system, was found. However, storm water and spring water to be intercepted were considered water sources but were not optimally used. Surplus water would arise in the case of an unusual event such as a storm event of an intensity more than the

1:50 year storm event. In this case, the water will have to be discharged into the environment (DWA accepts that all water cannot be contained in the event of a rainfall exceeding the 1:50 year event and a water use licence is not required in this case). The water will be discharged into the municipal storm water system. It would also appear that surplus water will be available during certain months in the wet season.

Acceptable quality: Storm water has an acceptable water quality for plant washing and dust suppression if separated from process water.

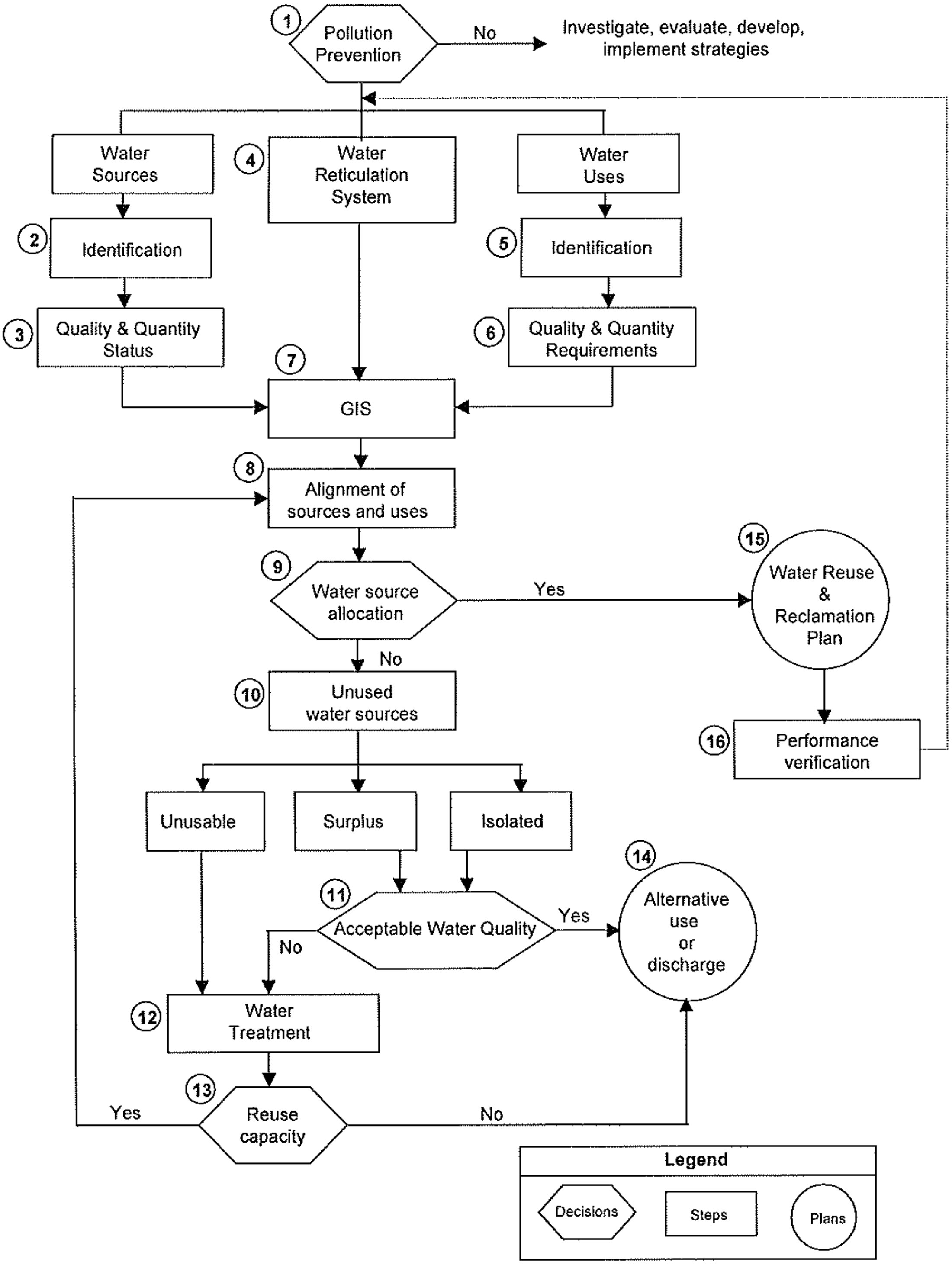


Figure 6.6: Water reuse and reclamation procedure

6.3.9 Operational water balance

Water sources

Water sources are the suppliers of water for possible use on the Rand Carbide site. These are the water sources that are legally available to Rand Carbide for use:

- **Municipal water** - requires an agreement with eMalahleni Municipality and monthly payments to the municipality in terms of the quantities used. The water enters the site through one (1) of three (3) municipal supply lines located along the Middelburg Road and Christiaan de Wet Road boundaries.
- **Captured storm water** – due to rainfall on the site. Storm water, which can potentially be contaminated, due to the operations on the site, needs to be captured and contained according to legislation, duty of care and to prevent environmental impacts. The water can then be reused within the boundaries of the site according to the water management hierarchy and water conservation principles rather than evaporating it.
- **Springs on the site** – water surfacing underneath the E & F furnace buildings as well as in other areas. In order to enable Rand Carbide to continue their operations safely and without risk to infrastructure and people, the water from the springs underneath Rand Carbide infrastructure needs to be pumped away. Though the use of this water requires a water use licence, it is advisable to use it rather than evaporate or discharge it. Discharging the salvaged spring water is not acceptable as the water is in contact with Rand Carbide operations and therefore potentially contaminated.

Water quantity variability: Both the storm water volumes and spring water volumes surfacing will vary seasonally. Figure 6.7 indicates the storm water volume variation.

Water quality variability: Both the storm water and spring water quality will probably vary seasonally due to rainfall, recharge and dilution.

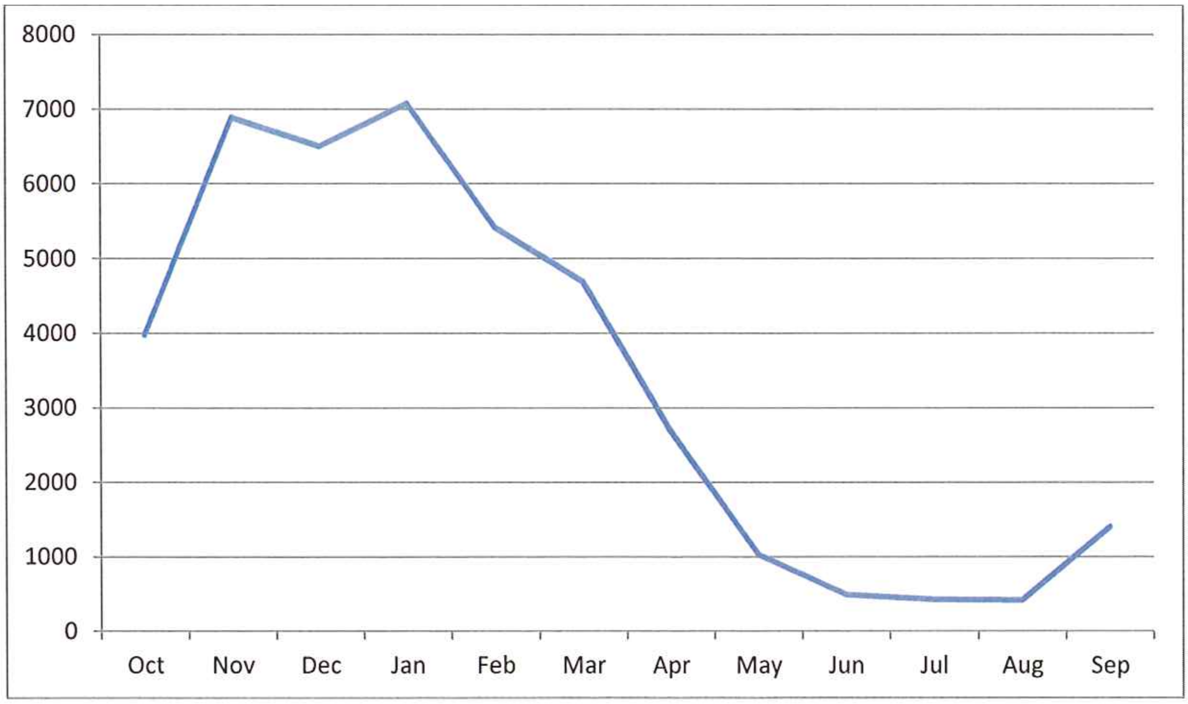


Figure 6.7: Storm water quantity variability

Table 6.9: Advantages and disadvantages of water sources

Type of water	Advantages	Disadvantages
Municipal water	Clean/potable/good water quality.	Costly – R7.30/m^3 Limited availability Required by other users
Storm water dam water	Available for reuse at no cost. Limited level of contamination. No treatment required.	Contaminated by Rand Carbide general surface pollution. Unfit for discharge.
Spring water	Available on site. Require use/discharge.	Contaminated by Rand Carbide activities.
Process water	Reuse in same circuit as origin	Highly contaminated water. Require treatment for certain uses.

Process water sinks

Water sinks constitute water which is taken into the system for operational use but is lost in the system due to the fact that it cannot be captured for either reuse, recycling or reclamation. In other words these water users only consume water and that which leaves the process cannot be used as a water source for other processes as the water cannot be recovered or captured and is consequently lost from the system.

The following are process water sinks:

- Evaporative losses from cooling systems utilised at furnaces, compressors and for paste product. 376 m^3/month is lost to evaporation; the remainder of the water is recycled.
- Evaporative losses from the open water holding facilities such as dams (currently Harry's Dam and storm water control dam in future).
- Evaporative, storage and seepage losses from water used for dust suppression (at least 2 555m^3/month).
- Domestic water used due to sewer discharges from offices, change rooms, laundry etc. (2 967 m^3/month discharged to sewage).

Water users

To summarise, Rand Carbide therefore has the following water users and requirements:

- **Domestic type users** - workers and contractors working on the site require water of a potable quality since water is used in offices, canteen, change houses etc for drinking, food preparation and washing/cleaning purposes as well as water used in the laboratory. These users will use municipal water exclusively.
- **Cooling type users** – furnace cooling, compressor cooling and cooling of product. The cooling type users require water with a low dissolved salt content as water temperature is continuously changed and water is recycled. A build-up of salts will interfere with the process (interruptions due to maintenance and cleaning required) and equipment such as furnaces and compressors (which will need to be cleaned due to scaling) and product (in terms of product quality). Municipal water will therefore be required for these water users.
- **Dust suppression type users** – at the dump (waste), at raw material stockpiles and all across the site especially along internal roads. No specific water quality requirements but secondary impacts on soil and groundwater need to be considered. Dust suppression at the raw material stockpiles should be with clean water to prevent contamination of raw materials and subsequent impacts on the process and product. Dust suppression on the remainder of the site and on the waste disposal area has no water quality requirements but the impact on groundwater if contaminated water is used for this purpose will have to

be investigated. Water from the springs or captured storm water can be considered for dust suppression purposes subject to water quality testing.

- **EMB as water user** – as this is a closed circuit, the losses in the system due to use by EMB is a concern. The quantity of water required represents more than an acceptable loss in terms of evaporation and moisture in product and implies poor housekeeping. A further investigation into this circuit is required. It has subsequently been confirmed (personal communication, 30 August 2011) that EMB will reduce its water usage to zero in the next year (2012/2013) due to different technology (XRT sorter) which will be implemented. Another water source for EMB was therefore not considered as the use will disappear in the near future.
- **Process water users** - needs to be recycled within the process from which it originates. Process water leaving the plant area should be minimal and can be evaporated or treated and reused depending on the financial considerations. The small quantity and cost associated with treatment may render treatment a non-viable option.
- Washing of floors (concrete and bunded areas) in plant and spillages. Any water from the Rand Carbide site can be used (storm water, spring water).

Table 6.10: Water user groups and their requirements

Water user category:	Water source:	Water users:	Water quality concerns:	Water quantity (m^3/month):
Domestic type	Municipal	People & laboratory Change house (workers & contractors) Canteen (food preparation) Laundry (clothes washing) Admin (offices) Afrox (workers) Fitting shop Laboratory Cement plant (workers)	Bacteriological contamination Elevated concentrations of any constituent	3 000
Cooling type	Municipal	Furnaces (D, E, F) Compressor Product (paste plant)	Elevated salts – TDS, sulphate etc Product quality, equipment damage, interruption in process	420
Dust suppression type	Spring Storm water	Dump (waste) Plant (roads etc) Watering trucks	Contamination of soil and underlying groundwater	2 476
		Raw materials stockpiles	Contamination of raw materials	79
EMB	Currently use municipal water Water use will disappear in future			750
Process	Process	Bunded areas	Recycling/reuse is required. Treatment if any other use planned.	0
Cleaning	Spring water Storm water	Cleaning of spillages Floor washing	None. Kept in the system	Unknown

Users/processes not conducive to recycled or reclaimed water

Municipal water group - Certain processes or users require clean/municipal water since water of a lesser quality may impact on human health, interfere with the process performance/optimisation causing maintenance problems etc or may affect the product quality/yield. Domestic users (canteen, offices and administration) require good quality water due to human health risks. Cooling water users also require good quality water with low dissolved solids/salts. Only municipal water should be considered for these uses depending on quality and availability.

Users/processes conducive to recycled or reclaimed water

The recycled/reclaimed water users can be divided into three (3) groups based on water quality requirements:

- **Storm water reuse group** – storm water originates from rainfall on the site and subsequent runoff. The new storm water management system has been designed to minimise pollution of storm water through (i) fast draining and avoidance of ponding by proper sloping of areas, (ii) diversion of storm water around major pollution sources and (iii) isolation of storm water from major pollution sources within bunded areas etc. Storm water quantities available will vary seasonally:
    - 1 077 m^3/month storm water will be available during the dry season; and
    - 5 763 m^3/month storm water will be available during the wet season.
- **Process water reuse group** – process water originates from spillages on the site. The water is highly contaminated and therefore the use of the water is limited without treatment. If no treatment is financially viable, containment and evaporation would be the only alternative. Process water needs to be recycled within the process it originates from. Process water leaving the plant area should be minimal and can be evaporated or treated and reused depending on financial viability. The small quantity and cost associated with treatment may render treatment a non-viable option.
- **Spring water group** – spring water originates from four (4) natural springs on the site. The water quality results of the springs underneath the furnaces show signs of contamination and, rather than discharging this water into the municipal storm water system (as is currently the case), it is recommended that the water be reused for dust suppression on already contaminated areas.

Table 6.11: Water user groups/categories (based on water quality requirements)

Group/category/source	Process/user
Fresh / Raw water intake:	
Municipal water (eMalahleni municipality)	Domestic uses: Offices, canteen, laundry, change houses Cooling: Furnaces Compressor Product
Recycled / reclaimed water:	
Storm water reuse (from captured rainfall – containment and reticulation required)	Floor washing and general spillage clean-up Dust suppression
Process water reuse (from spillages and intercepted seepage)	Evaporation Water treatment to be investigated.
Spring water	Dust suppression, floor washing, spillage clean-up.

Management tool

A water balance is a water management tool that is used to not only indicate areas which require additional monitoring, but also areas that either require management steps to be put in place or more extensive management steps where such steps are already in place. The water balance can also be used to assess compliance with legislation and agreed management objectives. The water balance will therefore assist Rand Carbide to manage their water and waste responsibly and effectively.

The water balance should be used as a water management tool to simulate new inputs and outputs at the Rand Carbide plant.

Calculations

The water balance is based on the following equation:

Total water in (Volume flow rate) = Total Water Out (Volume flow rate)

To address the salt component of the water and salt balance, the following equation should be used:

Salt Load in = Salt Load out

Where salt load (kg/month) = (Flow (m^3/month) x Salt Concentration (kg/m^3))

Raw materials

All the raw materials that are used at Rand Carbide contain Si, Fe and Al, except for the barium sulphate and reductants. One of these can be used for calculating salt balances. Sulphate can be used as a constituent indicating pollution.

Table 6.12: Raw materials

Raw material	*Average Consumption (tons/month)	Purpose	Origin	Constituency:
Quartz	6 163	Source of Si	Earth / mineral	SiO_3, Al_2O_4, Fe_2O_4
Mill scale	1 136	Source of Fe	Steel mills	Fe, SiO_2, Al_2O_3, CaO, TiO_2, P, MgO, MnO, K_2O, Na_2O
Barium sulphate	21	Source of Ba	Earth / mineral	Ba, SO_4
Ferro silicon briquettes	44	Remelts	Recycled Fe-Si dust	Si, Al, P, Ca, Fe, Ti
No 5 seam coal	1 467	Reductant	Earth / mineral	7% moisture#
Low ash coal	776	Reductant	Earth / mineral	11% moisture#
Charcoal	2 010	Reductant	Wood	18 – 21% moisture#
Wood chips	2 516	Reductant	Plantations & Timber Mill	43% moisture

*2010 figures used to calculate
Carbon related

Other possible raw materials (not recently used):

- Aluminium ingots
- Low ash coal briquettes

Current water balance

Municipal intake = domestic use + cooling use + dust suppression + EMB

7 500m^3/month = 2 967m^3/month + 413m^3/month + 2 555m^3/month + 749m^3/month

7 500m^3/month = 6 684m^3/month

This implies that only 89.1% of the intake water is accounted for in the distribution circuit and therefore on average 816m^3/month (27m^3/day or 10.9%) is unaccounted for. This is a large quantity and additional flow meters should be installed to locate the users of this water.

Water balances & circuits

Operational water balances are presented in Figures 6-8 through 6-13.

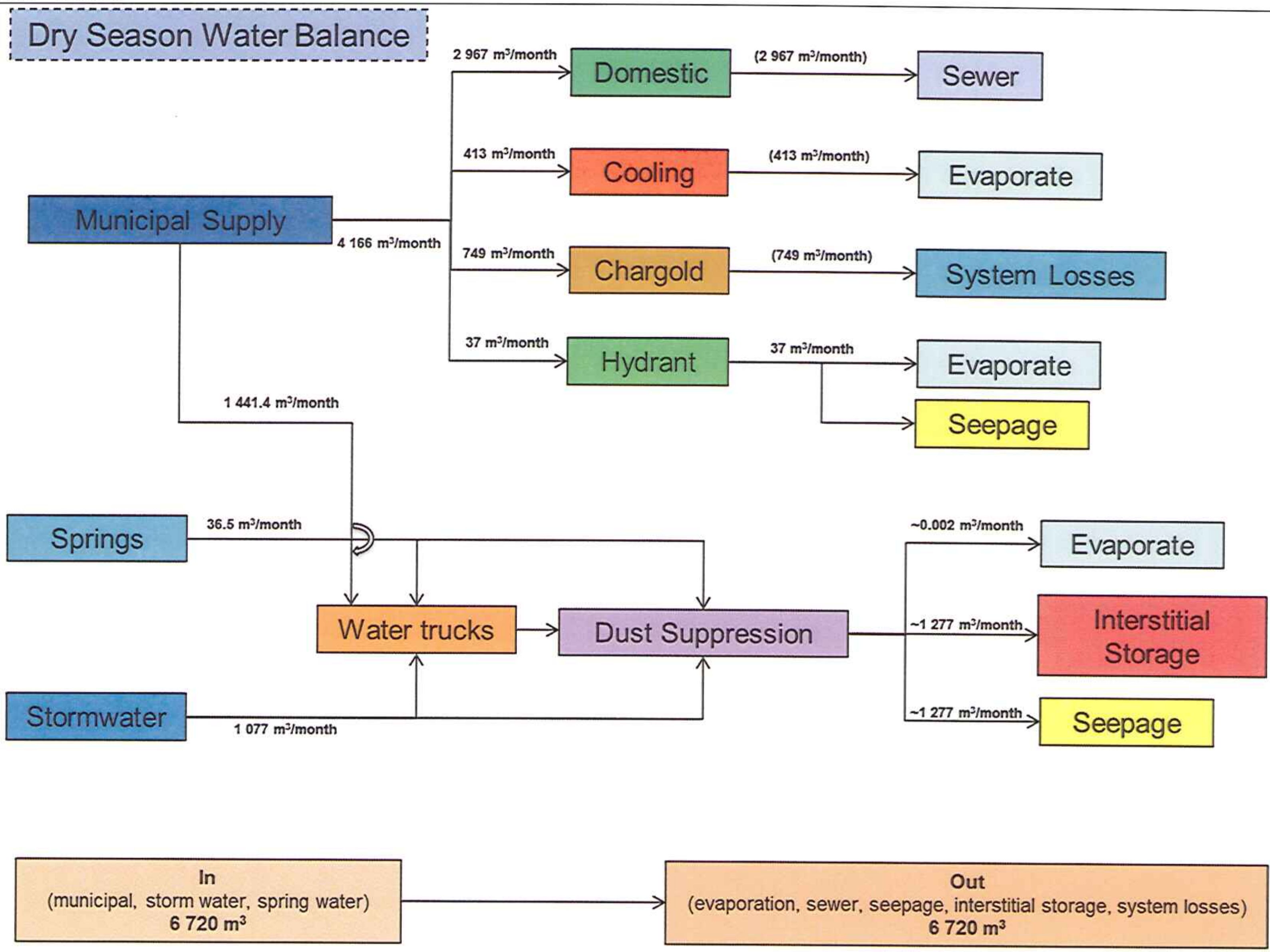


Figure 6-8: Dry season water balance

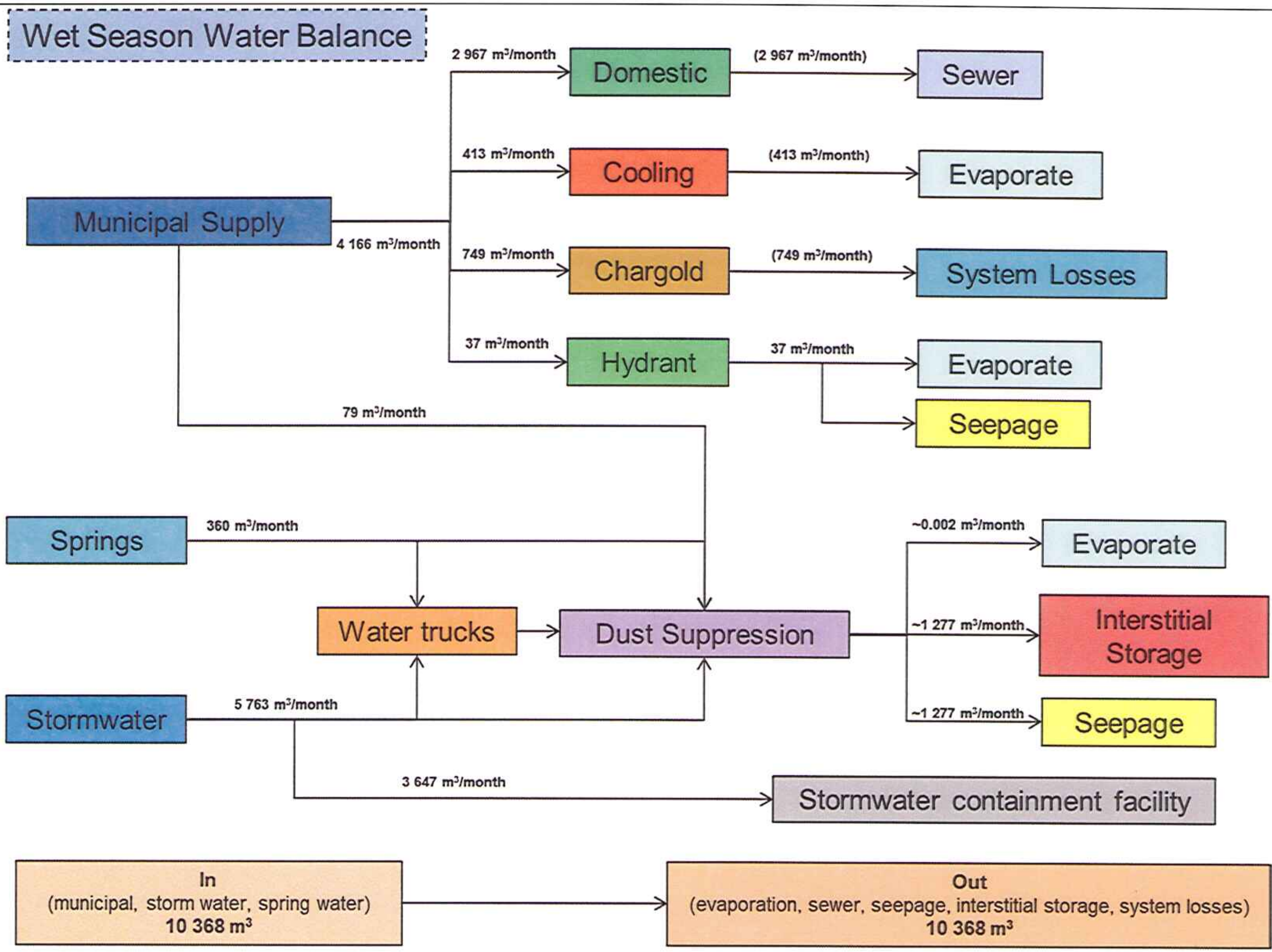


Figure 6-9: Wet season water balance

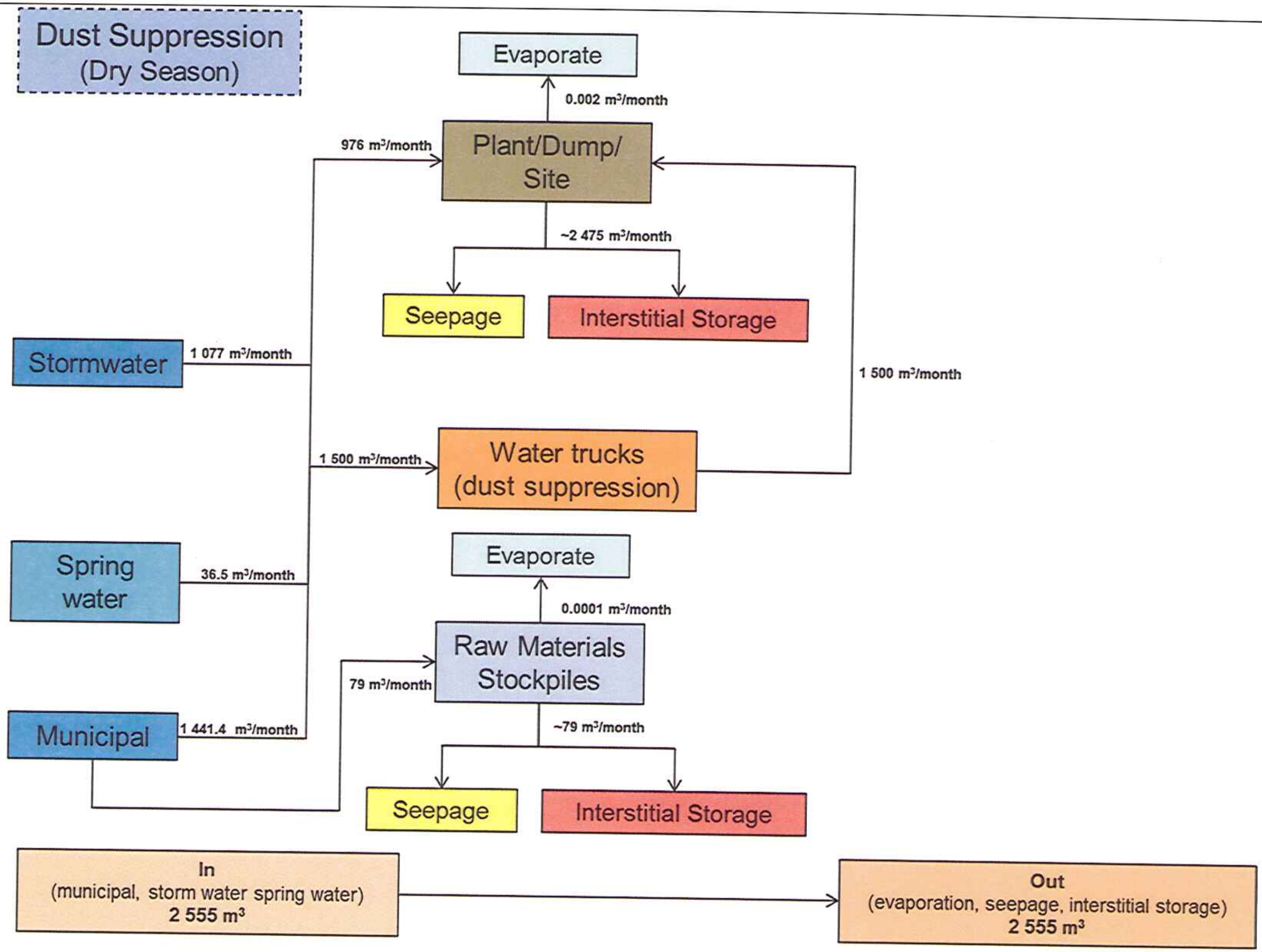


Figure 6-10: Dust suppression water balance (dry season)

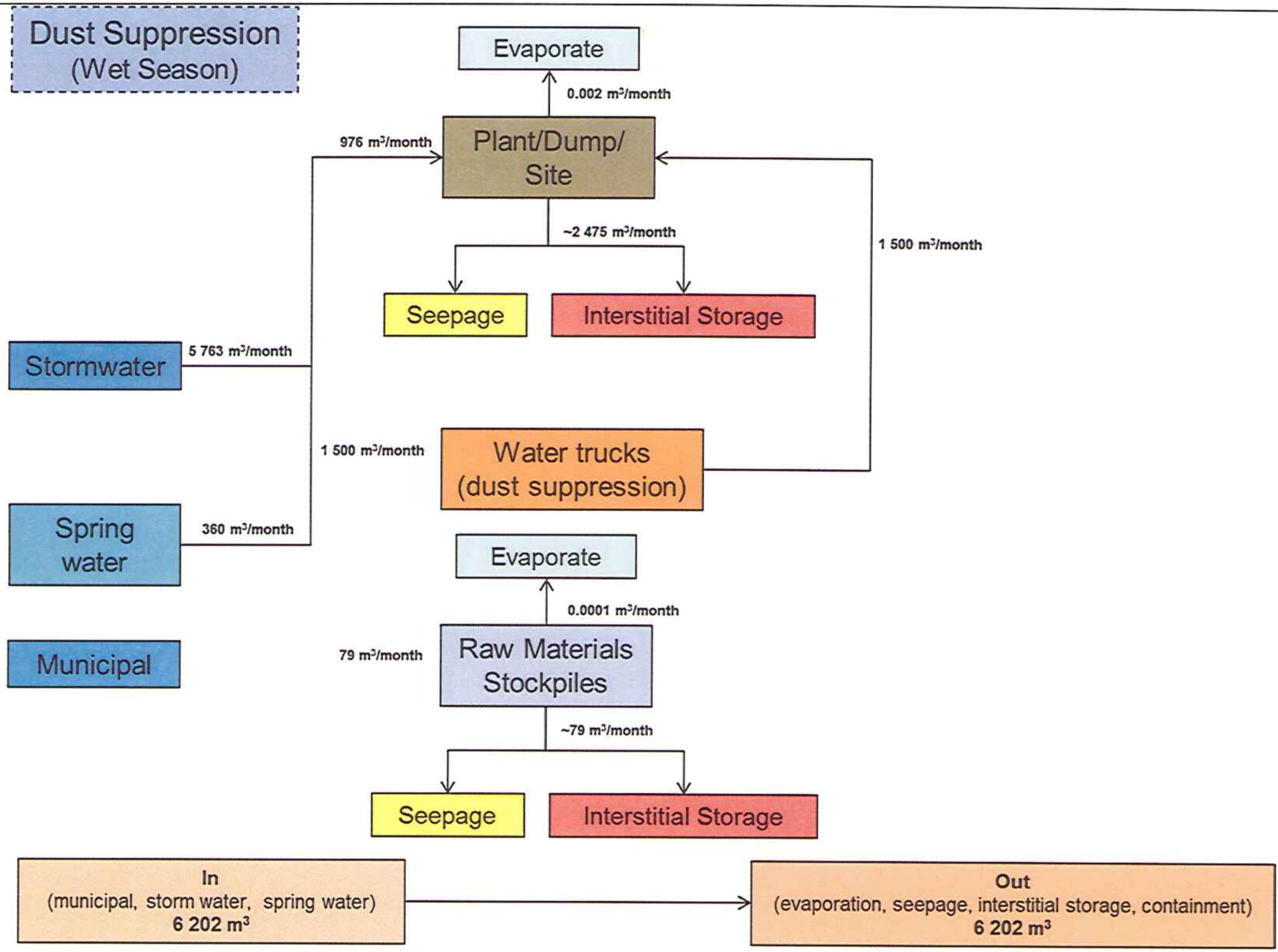


Figure 6-11: Dust suppression water balance (wet season)

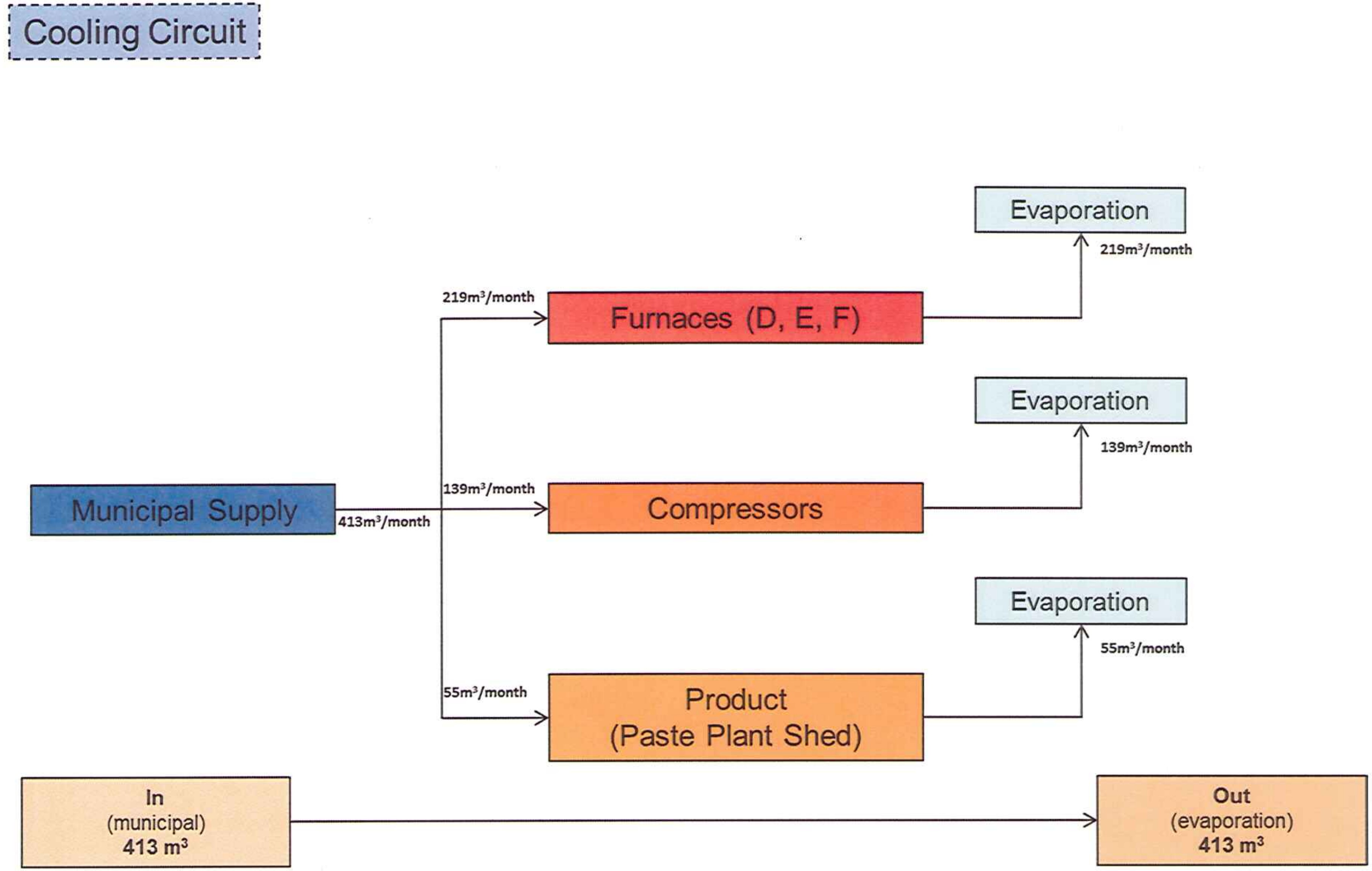


Figure 6-12: Cooling water circuit

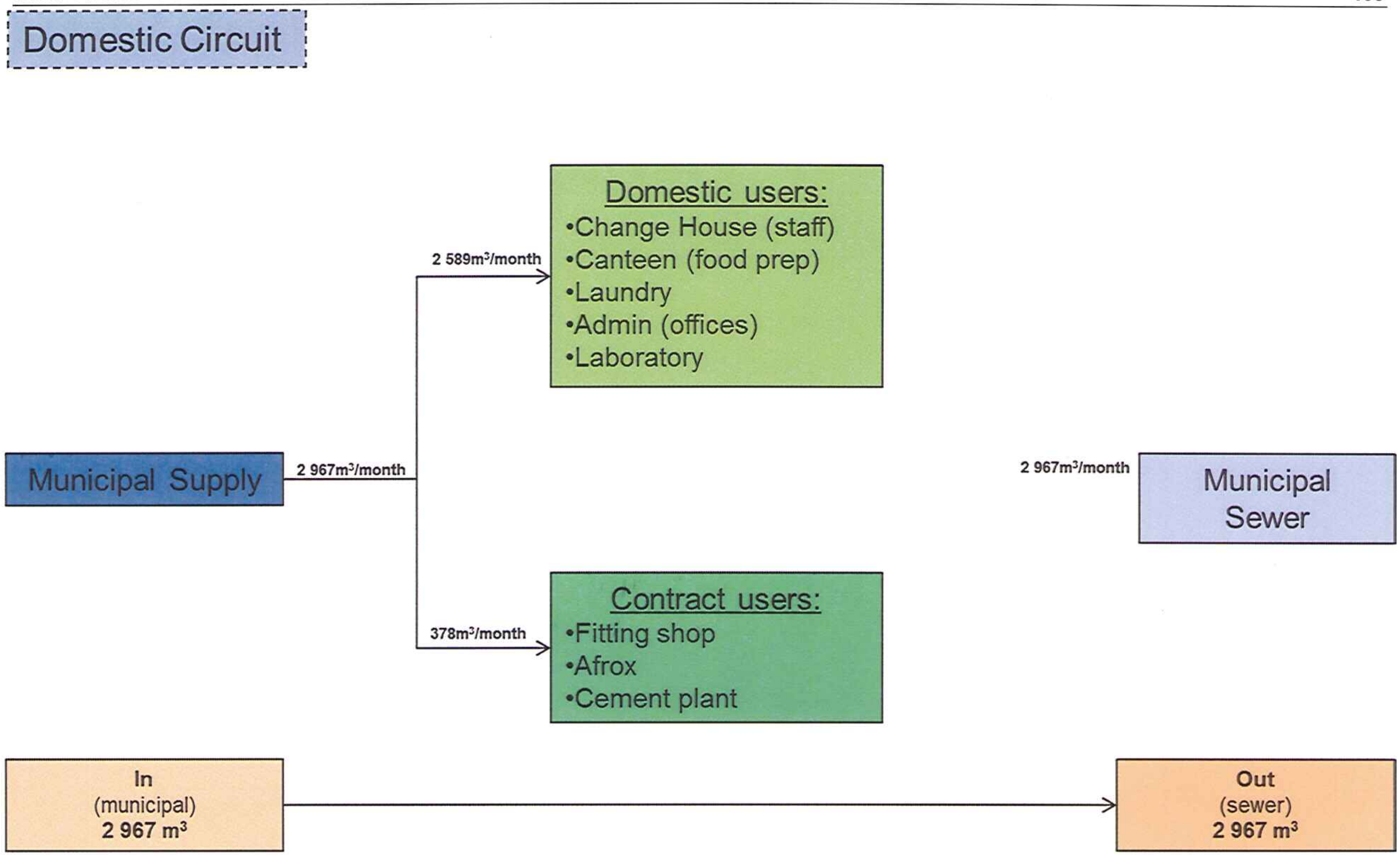


Figure 6-13: Domestic circuit

6.4 Solid waste management

6.4.1 Domestic waste

Annually, a total of 48 tons (1 218 m^3) of general domestic type waste, of which 42 tons (1 176 m^3) is considered compactable, is collected in bins/skips and removed off site by Whale Rock Industries and taken to the municipal landfill site at eMalahleni (Witbank) waste disposal facility for disposal.

6.4.2 Industrial waste on site

History: Rand Carbide has a historic waste disposal dump which was started around 1926 and was actively used until 2006 for the dumping of most unwanted materials on site. Currently, no additional waste is disposed onto the dump.

Size: The waste disposal area extends over 2.25 ha (length of 225 m; width of 100 m and height of 30 m) and contained about 500 000 tonnes of dry waste material.

Waste materials: Material on the historic dump includes the following:
- Contaminated Ferro-silicon (40 tons/annum)
- Amorphous silica fume
- Tarry materials
- Oil soaked calcined anthracite
- Paste
- Char (80 tons/annum)
- Slag (64 tons/annum)
- Coal fines/dust (52 tons/annum)
- Aluminium (18 tons/annum)
- Silica/Quartz fines
- Char/coal fines
- Anthracite fines/dust
- Sweepings (coal dust etc.)
- Stoker refractory (large lumps)
- Stoker ash (fly ash)
- Ladle refractory
- Carbon stoker mix fines
- Refractory bricks
- Paper/wood

Reprocessing: In 2005, Highveld Steel and Vanadium Corporation Limited entered into a memorandum of agreement with Chargold (Pty) Ltd (now EMB) to reduce the volume of the unlicensed waste dump (as described in Section 2.5) as part of clean-up and rehabilitation. In terms of the memorandum of agreement signed in 2007, Rand Carbide (as part of Highveld) appointed Chargold (now EMB) as its agent to not only recover, but also to market and sell the recovered material on behalf of Rand Carbide.

Plant for reprocessing: The plant is a small mobile pre-fabricated 15 ton per hour jigging plant which uses recirculated water to separate the fractions. The process uses the density of the material and gravity to separate the fractions. The plant has a footprint size of approximately 50 m^2 installed on a concrete slab next to the paste plant.

Plate 6-1: EMB Processing plant

Process: Material is loaded into a feed bin, conveyed to a slurry tank, where it is mixed with water and washed over a desliming screen. The slimes (-1mm) is then pumped through a dewatering cyclone onto an existing draining pad, alongside the plant. Water drains off into the sump, from where it is pumped into a recirculation water tank. The residual moisture in the slimes material is expected to be about 10%. Slimes is either sold or taken to a landfill site.

The coarse material (+1 mm) passes from the screen to a jib and is separated into coal, quartz, refractory/slag and ferro-silicon fractions. The coal and quartz was reused as raw material in the Rand Carbide plant process but is not currently taking place. The slag/refractory is sold as aggregate and the ferro-silicon is mixed with current Rand Carbide product.

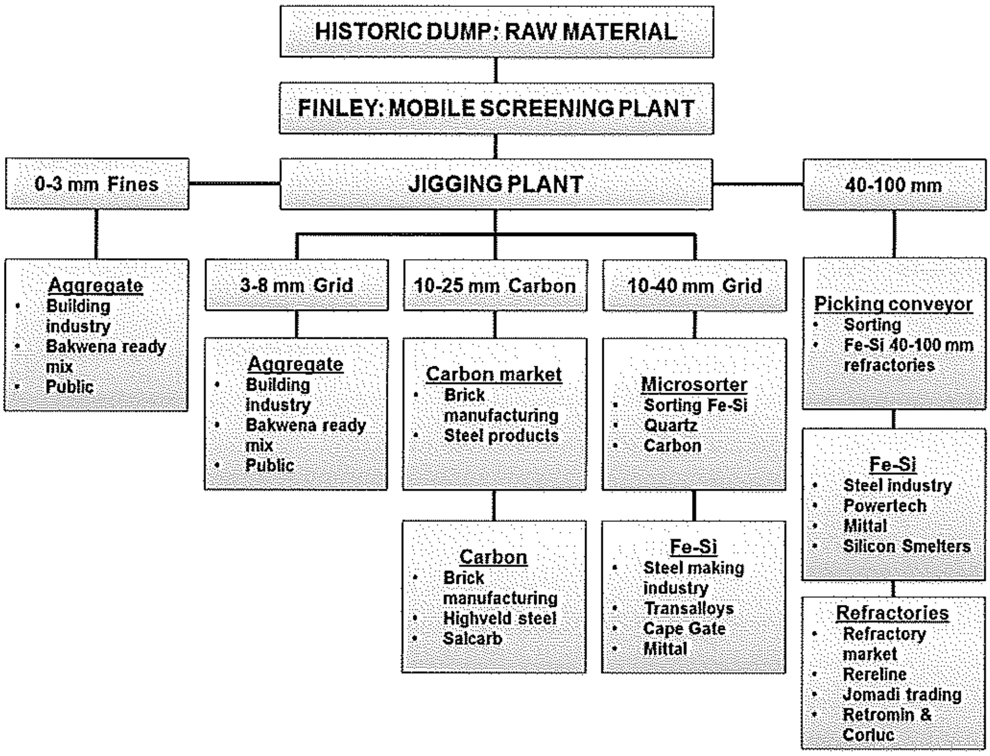


Figure 6-14: Process flow diagram for reprocessing of waste dump

Water use: Apart from residual water remaining in the product, all water is circulated with make-up water approximately 30 – 50 m^3/day.

Recovery: The quantities of material recovered by EMB and sold to various clients are as follows:

Type:	Monthly average (ton):	Annual average (ton):
Sand	241	2 892
Fe-Si	254	3 048
Anthracite	50	600
Dust pellets	1 900 (once in six months)	22 800
Scrap metal	1 633 (once in six months)	19 596

6.4.3 Hazardous industrial waste

Annually, an approximate total of 77 tons (~4 920 m^3) of hazardous waste is handled on site. Compactable wastes and fluorescents (~24 tons) is collected in skips and removed off site by Dark Metals and taken to Rietfontein and Holfontein hazardous landfill sites, respectively for disposal.

Hydrocarbons: Used oil (~5.5 tons) as well as materials contaminated by oil and grease (~47 tons) are collected in 210 litre drums and removed off site by Whale Rock Industries. Used oil is taken to an oil refinery for recycling whilst contaminated materials are disposed of at the Rietfontein waste disposal site.

Waste from reprocessing of waste dump: Approximately 3 700 m^3 (50 tons/hour) of process waste is processed by EMB. 50% of this was re-used by Rand Carbide in its process but currently nothing is re-used by Rand Carbide in its process. Some is recycled and the remaining waste is disposed of at Holfontein.

6.5 Rehabilitation and mitigatory measures

Historic waste dump: In 2005, Highveld Steel and Vanadium Corporation Limited entered into a memorandum of agreement with Chargold (Pty) Ltd (now EMB) to reduce the volume of the unlicenced waste dump in the course of rehabilitation. Please refer to Sections 6.4.2 & 2.5.

Unused areas: On-going rehabilitation of areas no longer used is conducted. The historic waste dump is being reprocessed and the area will be rehabilitated once the entire dump has been completely processed (by 2019). As part of the storm water management plan, an attempt was made to maximise the clean areas on the site in order to reduce the dirty areas with dirty runoff to be managed and the associated cost. Therefore on-site areas not used will be rehabilitated and kept clean to ensure clean runoff from these areas. Clean runoff will be discharged to the municipal storm water management system. This includes the re-organising of some material stockpiles which will cost approximately R14 million.

6.6 Soil and land capability management

6.6.1 Soils

Gijima Ast took soil samples around the EMB plant and had these analysed (NIOSH method 7300, not Minimum Requirements leach tests). The conclusion was made that the risk of soil and groundwater pollution at the EMB plant is low based on the low levels of contaminants detected in the sampled soils. The soils contained no poly aromatic hydrocarbons, volatile organic compounds (VOC), cyanide or hexavalent Chromium (Cr(VI)). The soils contained high concentrations of Aluminium (Al), Calcium (Ca), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na) with the following in lower quantities: Barium (Ba), Chromium (Cr), Sulphur (S), Titanium (Ti) and Zinc (Zn). See laboratory certificates in Appendix E.

6.6.2 Land capability

Land use: Industrial

Storage: Raw materials such as coal, quartz, anthracite and wood chips are stored on concrete slabs to prevent soil and groundwater contamination.

Historic and future land use: The land was zoned for agricultural use but will not be restored to its original land use after closure and rehabilitation due to its location in proximity to residential and other industrial areas.