Annexure 9

Methodology for Sample Collection, Preservation and Analysis of Ground and Surface Water Bodies

Introduction: Understanding the water quality is important for assessing the existing water environment and evaluates the expected impact due to the proposed project. In preparation of this report, critical issues are identified to suggest appropriate mitigation measures during operation phase of the quarry. The study of water environment aims at :

- Understand the baseline characteristics,
- Identify water polluting sources;
- Identify critical parameters of water characteristics and their origin;
- Predict impact of the existing and the future relevant activities on water quality

Major Quantity Based Ground Water Problems and Issues

The norms stipulated for evaluation of quantity and Ground Water Development are presented below:

Stage of Ground Water Development	Significant Long Term Decline		Categorization
	Pre-monsoon	Post-monsoon	
<= 70%	No	No	Safe
>70% and <=90%	No	No	Safe
	Yes/No	No/Yes	Semi-critical
>90% and <=100%	Yes/No	No/ Yes	Semi-critical
	Yes	Yes	Critical
>100%	Yes/No	No/Yes	Over-Exploited
	Yes	Yes	Over-Exploited

Ground Water Monitoring: The groundwater contamination occurring due to either natural causes or anthropogenic activities needs regular monitoring of water quality to device ways and means to protect it. Groundwater Survey and Development Agency (GSDA), Central Ground Water Board (CGWB) and MPCB have conducted groundwater quality monitoring programme in the various Districts of Maharashtra state. It involves identification of major pollutants and confirmation of suitability of groundwater for human consumption (drinking purposes, etc).

Sources of Pollution in Ground Water and its Impacts

Parameter	Status	Causative agents	Impacts on Water Quality
pH	Low pH	Acidic rain, water ions such as nitrates and sulfates	Pipe corrosion, causing the release of iron, lead, or copper, discoloration, bitter taste
TDS	High levels of salts	Interaction between ground water and subsurface minerals. Agricultural run-off, urban run-off, industrial wastewater & sewage	Cause corrosion of pipes and plumbing systems, no health threat

Sources of Pollution in Ground Water and its Impacts (Contd..)

Parameter	Status	Causative agents	Impacts on Water Quality
Hardness	Presence of Ca and Mg	Soil type, weathering of limestone, sedimentary rock and calcium bearing minerals, chemical and mining industry effluent, excessive application of lime	Soap consumption, heart related impacts, incrustation of pipes, soap consumption
Sulphate	High levels	Oxidation of sulfite ores, input of industrial wastes, soils rich in minerals containing Sulphate Sodium Sulphate (Glauber's salt), Magnesium Sulphate (Epsom salt), Calcium Sulphate (gypsum)	High sulphate with Magnesium causes laxative effects.
Fluoride	High and low Levels	Geological settings, rocks and to volcanic activity,. Agricultural (use of phosphatic fertilizers)	High fluoride- fluorosis Low fluoride – dental carries
Nitrate	High levels	Over-application of fertilizers, manure and urine, improper operation and maintenance of septic systems	"Blue-baby syndrome" in children less than six months of age, possibility of cancer
Chloride	High levels	High temp and less rainfall. Soil porosity and permeability can build up chloride ions in water	Salty taste
Microorganisms	Presence	Sewage, leaky septic systems	Indicate presence of pathogens, Bacteria can convert nitrate in water to the more dangerous nitrite.

Methodology : In order to generate the data on quality of water bodies, Sampling Procedure for Primary Data Collection have been specified by various authorities. In order to assess the impact of domestic, industrial and other activities on surface and ground water, the identified sources are examined for physico-chemical, nutrient, trace metals and microbiological parameters. Uniform protocol on water quality monitoring as specified by the Ministry of Environment and Forests (2005) was followed for selection of parameters. The samples were collected and analyzed as per the procedures specified in "Standards Methods for the Examination of Water and Waste Water" published by American Public Health Association (APHA) 21st edition (2005).

Samples for chemical analysis are collected in polyethylene carboys. Samples collected for heavy metal analysis were acidified (1ml HNO_3/100 ml). Samples for microbiological analysis were collected in sterilized glass bottles. Parameters analyzed at the site are pH, temperature, odour, turbidity and dissolved oxygen using portable water analysis kits. The methodology for sample collection and preservation techniques was followed as per the Standard Operating Procedures (SOP) mentioned below:

Table 1: Parameter Specific "Standard Operating Procedure" for Water Sample Collection, Size of Sample and Preservation

Parameters	Sample Collection	Sample Size	Storage/Preservation
pH	Grab sampling Plastic/glass container	50 ml	On site analysis
Electrical Conductivity	Grab sampling Plastic/glass container	50 ml	On site analysis
Total Suspended Solids	Grab sampling Plastic/glass container	100 ml	Refrigeration, can be stored for 7 days
Total Dissolved Solids	Grab sampling Plastic/glass container	100 ml	Refrigeration, can be stored for 7 days
BOD	Grab sampling Plastic/glass container	500 ml	Refrigeration, 48 hrs
COD	Grab sampling Plastic/glass container	100 ml	Add H_2SO_4 to pH>2, refrigeration; 7 days
Hardness	Grab sampling Plastic/glass container	100 ml	Add HNO_3 to pH <2, refrigeration; 6 months
Chlorides	Grab sampling Plastic/glass container	50 ml	Not required; 28 days
Sulphates	Grab sampling Plastic/glass container	100 ml	Refrigeration, 28 days
Nitrates	Plastic Containers	100 ml	Refrigeration, 48 hrs
Fluorides	Plastic Containers only	100 ml	Not required; 28 days
Alkalinity	Plastic/glass containers	100 ml	Refrigeration, 14 days
Ammonia	Plastic/glass containers	100 ml	Add H_2SO_4 to pH>2, refrigeration; 28 days
Hexavalent Chromium, Cr^{+6}	Plastic/glass containers rinse with 1+1 HNO_3	100 ml	Grab sample; refrigeration; 24 hrs
Trace Metals (Hg, Cd, Cu, Fe, Zn, Pb)	Plastic/glass containers rinse with 1+1 HNO_3	100 ml	Add HNO_3 to pH >2, Grab sample; 6 months

Source: Standard Methods for the Examination of Water and wastewater, Published by APHA, AWWA, w.e.f. 21th Edition, 2005.

The analytical techniques (Indian Standard Methods / APHA) used for water and wastewater analysis for a few parameters is given in the **Table 2.**

Table 2: Methodology for Analysis of Water

Parameters	Methods (Indian Standard)	Methods (APHA)
pH	IS 3025 (part 11) : 1983	APHA-4500-H^+
Colour	IS 3025 (part 4) : 1983	APHA-2120 C
Odour	IS 3025 (part 5) : 1983	IS:3025, part-4
Temperature	IS 3025 (part 9) : 1984	APHA-2550 B
Dissolved Oxygen	IS 3025 (part 38) : 1989	APHA-2500 O
BOD	IS 3025 (part 44) : 1993	APHA-5210 B
COD	IS 3025 (part 58) : 2006	--
Electrical Conductivity	IS 3025 (part 14) : 1984	APHA-2510 B
Turbidity	IS 3025 (part 10) : 1984	APHA-2130 B
Chlorides	IS 3025 (part 32) : 1988	APHA-4500 Cl^-
Fluorides	--	APHA-4500 F
Total Dissolved Solids	IS 3025 (part 16) : 1984	APHA-2540 C
Total Suspended Solids	IS 3025 (part 17) : 1984	APHA-2540 D
Total Hardness	IS 3025 (part 21) : 1983	APHA-2340 C
Alkalinity	IS 3025 (part 23) : 1986	APHA-2320 B
Sulphates	IS 3025 (part 24) : 1986	APHA-4500 SO_4^{-2}
Arsenic	IS 3025 (part 37) : 1988	APHA-3120 B/ APHA-3114 B/ APHA-3500 As
Calcium	IS 3025 (part 40) : 1991	APHA-3120 B/ APHA-3500 Ca
Magnesium	IS 3025 (part 46) : 1994	APHA-3120 B/ APHA-3500 Mg
Manganese	IS 3025 (part 59) : 2006	APHA-3120 B/ APHA-3500 Mn
Mercury	IS 3025 (part 48) : 1994	APHA-3120 B/ APHA-3500 Hg
Selenium	IS 3025 (part 56) : 2003	APHA-3120 B/ APHA-3114 B/ APHA-3500 Se
Lead	IS 3025 (part 47) : 1994	APHA-3120 B/ APHA-3500 Pb
Copper	IS 3025 (part 42) : 1992	APHA-3120 B/ APHA-3500 Cu
Cadmium	IS 3025 (part 41) : 1992	APHA-3120 B/ APHA-3500 Cd
Iron	IS 3025 (part 53) : 2003	APHA-3120 B/ APHA-3500 Fe
Zinc	IS 3025 (part 49) : 1994	APHA-3120 B/ APHA-3500 Zn
Boron	IS 3025 (part 57) : 2005	APHA-4500 B
Coliforms	IS 5401 (part 1) : 2002	APHA-9215 D

Relevance of Parameters Selected: The water quality and human health are closely related. The drinking water quality causes 75% of diseases to the human beings. The concentrations of the several inorganic and organic substances dissolved in water beyond acceptable range may cause an adverse impact on human health. The harmful effects on human body depending on the quality of water are summarized below in **Table 3.**

Table 3 : Effect of Water Quality on Human Health

Parameters	Probable Effects
Colour, Odour and Taste	Makes water aesthetically Undesirable.
Turbidity	High turbidity increases contamination/pollution
pH	Indicative of acidic or alkaline waters, affects taste and corrode water supply system
Hardness	Affects water supply system (scaling), excessive soap consumption, calcification of arteries, may cause urinary concretions, diseases of kidney or bladder and stomach disorder.
Iron (Fe)	Gives bittersweet astringent taste causes staining of laundry and porcelain. In traces it is essential for nutrition.
Chloride (Cl)	May be injurious to some people suffering from diseases of hearts and kidneys. Taste, indigestion, corrosion and palatability are affected.
Residual free Chlorine,	Excessive free chlorine in drinking water may cause asthma, colitis and eczema. (Only when water is chlorinated)
Total Dissolved Solids (TDS)	Palatability decreases and may cause gastro-intestinal irritation in human, may have laxative effect particularly upon transits.
Calcium (Ca)	Insufficiency causes severe rickets; excess causes concretions in the body such as kidney or bladder stones and irritation in urinary passages.
	Essential for nervous and muscular system, cardiac functions and in coagulation of blood.
Magnesium (Mg)	Its salts are cathartic and diuretic. High concentration may cause laxative effect particularly on new users. Mg deficiency is associated with structural and functional changes. It is essential as an activator of many enzyme systems.
Copper (Cu)	Astringent taste but essential element in human metabolism. Deficiency results in nutritional anemia in infants. Large amount may result in liver damage, cause CNS irritation and depression. In water supply system, it enhances corrosion of aluminum particular.
Sulphate (SO_4)	Causes gastro intestinal irritation with Mg or Na can have a cathartic effect on users. Conc. more than 750 mg/L along with Mg may have laxative effect.
Nitrate (NO_3)	Causes infant methaemoglobinaemia (Blue Babies) at very high conc., causes gastric cancer and adversely affects CNS and cardiovascular system.
Fluride (F)	Reduces dental carries, very high concentration may cause crippling skeletal fluorosis. Less than 1.0 mg/L is essential.
Cadmium (Cd)	Acute toxicity may be associated with renal, arterial hypertension, itai-itai disease. Cd salts cause cramps, nausea, vomiting and diarrhea.
Cadmium (Cd)	Acute toxicity may be associated with renal, arterial hypertension, itai-itai disease. Cd salts cause cramps, nausea, vomiting and diarrhea.
Lead (Pb)	Toxic in acute and chronic exposures, burning in mouth, severe inflammation of gastro-intestinal tract with vomiting and diarrhea, chronic toxicity produces nausea, severe abdominal pain, paralysis, mental confusion, visual disturbances, anemia etc.

Table 3 (Contd..) : Effect of Water Quality on Human Health

Parameters	Probable Effects
Zinc (Zn)	An essential element in human metabolism. Taste threshold for Zn occurs at about 5 mg/L, imparts astringent taste to water.
Chromium (Cr)	Hexavalent state of Cr produces lung tumors, can produce coetaneous and nasal mucous membrane ulcers and dermatitis.
Arsenic (As)	Causes skin damage, circulatory problems and risk of skin cancer.
Antimony (Sb)	Increase in blood cholestorel, decrease in blood sugar.
Aluminum (Al)	Leads to neurological disorders.
Barium (Ba)	Increases blood pressure.
Beryllium (Be)	Is carcinogenic (cancerous).
Cyanide (CN)	Causes nerve damage, thyroid problem.
Mercury (Hg)	Neurological and renal disturbances. Excess causes gonad toxic and mutagenic effects and disturbs the cholesterol metabolism.
Manganese (Mn)	Essential as a cofactor in enzyme systems and metabolism processes. Excess causes change in appetite and reduction in metabolism of iron to form hemoglobin. Imparts undesirable taste and stains plumbing fixtures and laundry.
Selenium (Se)	Leads to hair, finger loss, numbness in fingers or toes, circulatory problems.
Boron (B)	Affects CNS, may cause nausea, cramps, convulsions, coma, etc.
Alkalinity	Imparts unpleasant taste, may be deleterious to humans in presence of high pH, hardness & TDS.
Pesticides	Imparts toxicity when it accumulates in organs of human body affecting immune and nervous systems. May be carcinogenic.
Phosphate (PO_4)	High conc. may cause vomiting and diarrhea, stimulate secondary hyperthyroidism and bone loss.
Sodium (Na)	Harmful to persons suffering from cardiac, renal and circulatory diseases.
Potassium (K)	An essential nutritional element but in excess is laxative.
Nickel (Ni)	Non toxic element but may be carcinogenic (cancerous), can react with DNA resulting in DNA damage.
Pathogenic Micro-Organisms	Causes water born diseases like Jaundice, Typhoid, and Cholera etc. produces infections involving skin, mucous membrane of eyes, ears & throat.
Radioactive Materials	Increases risk of cancer