# Water Quality Analysis Using Geographic Information System At Moshi, Pune

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***Abstract-*** *Ground water quality in the Moshi ward of Pune have been studied using geographic information system (G.I.S.) and remote sensing (R.S.). Moshi landfill is located in Moshi ward which pollutes the ground water in the nearby areas. Overall 17 samples of ground water were collected from the Moshi ward and were analyzed for the physico-chemical parameters like pH, turbidity, colour, odour, total hardness, alkalinity, total dissolved solids, chlorides, sulphates and MPN. Surface water samples were also collected from a stream near the landfill and were analyzed for the waste water parameters like BOD, COD, oil and grease, heavy metals like lead, etc. Results showed that the values of all these parameters were very high and so the stream water and ground water was highly polluted. Then the Spatial variation of each of the ground water parameter throughout the Moshi ward was plotted using the IDW interpolation technique in the ARC GIS. Overall water quality map was prepared for the whole ward using the Water Quality Index (WQI) to find the residential areas where the ground water is highly polluted.*

***Keywords*** *- GIS, Ground Water Pollution, Landfill, Spatial Maps, WQI*

## I. INTRODUCTION

Ground water is one of the most important natural resources of water known to man since ages. Most of the rural population depend on it for drinking, domestic use and for irrigation. So the ground water quality is a matter of great concern especially in the industrial areas or in the areas where solid waste is disposal areas.

Moshi ward has the 81 acre landfill where all the industrial and domestic waste is dumped from nearby areas by PCMC. They are doing it since more than 25 years and people knew that there is some problem and they wanted some solution. But to find the solution the exact ground water quality with all the important parameters should be known. So the water quality near the Moshi landfill is found out with respect to various parameters like pH, turbidity, colour, odour, total hardness, alkalinity, total dissolved solids, chlorides, sulphates and MPN. 17 locations were selected for the sample collection. Then spatial variation maps were plotted followed by integrated water quality map to find the overall water quality of the area. Surface water quality was also analyzed form the samples collected from the stream passing the

**OBJECTIVES** – Following are the objectives of the study:

1. To take samples from various sampling stations and find their water quality with respect to various water quality parameters.
2. To map the spatial variability of water quality parameters using GIS approach.
3. Find the water quality using integrated water quality map.

## II. STUDY AREA

Moshi ward comes under PCMC (Pimpri Chinchwad Municipal Corporation). It is selected as the study area as it contains Moshi landfill which is the reason for ground water pollution in the nearby area. Moshi ward is the 18 Km2 area and lies between 73049’30”E to 73053’30”E and 18038’30”N to 18041’30”N. Moshi landfill is the 81 acre area in the ward in which 650 metric tonnes of garbage is dumped daily. It contains industrial, medical and domestic wastes.

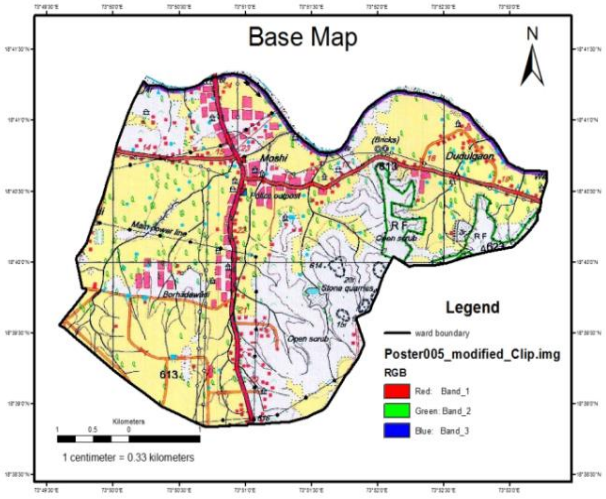


Fig. (1) - Base Map of the Moshi ward

Land Use/Land Cover Map- Prepared by overlapping 5 Google map images on ward map, geo-referencing them and then digitizing all the layers precisely.

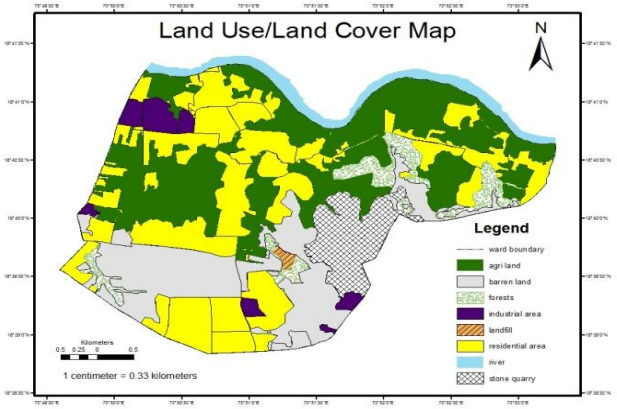


Fig. (2) - Land Use/Land Cover Map

## III. METHODOLOGY

### 1. LOCATIONS FOR SAMPLE COLLECTION

**1.1 SURFACE WATER (STREAM)** – 4 leachate samples were collected from the stream which has passed through the landfill area. Drainage map was prepared by tracing on steams from the toposheet.

Table (1) – Details of Leachate Samples Collected

| Sr. No. | latitude | Longitude | date | Time |
|---|---|---|---|---|
| l1 | 18.65952 | 73.85433 | 03/12/15 | 11:47am |
| l2 | 18.66233 | 73.8513 | 12/02/16 | 12:40pm |
| l3 | 18.66208 | 73.85223 | 12/02/16 | 9:00 am |
| l4 | 18.66273 | 73.85058 | 26/02/16 | 9:15 am |

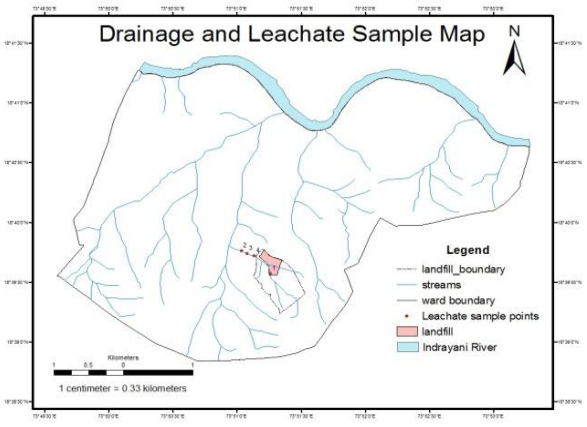


Fig.(3) Drainage and Leachate sample locations

**1.2 GROUND WATER -** 17 samples were collected from the entire Moshi ward as per the availability of the bore wells.

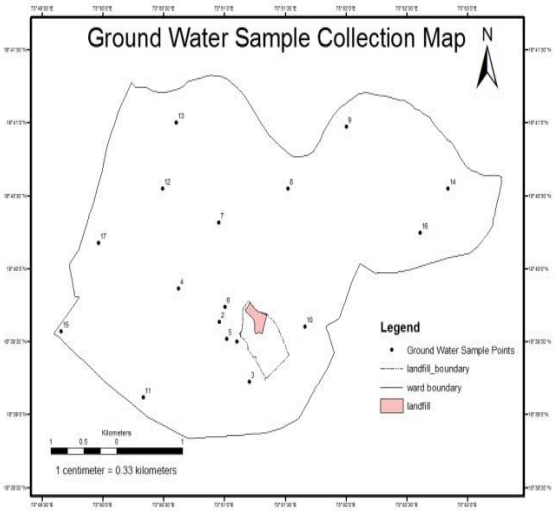


**Fig.(4) Ground Water sample locations**

Table (2) – Details of the Ground water Samples Collected

| Sr. no. | Latitude | Longitude | Date | Time |
|---|---|---|---|---|
| 1 | 18.65835 | 73.8517 | 24/03/16 | 11:15 am |
| 2 | 18.66057 | 73.8493 | 24/03/16 | 11:35 am |
| 3 | 18.65377 | 73.8534 | 24/03/16 | 12:13 pm |
| 4 | 18.66445 | 73.8437 | 24/03/16 | 12:35 pm |
| 5 | 18.65867 | 73.8503 | 24/03/16 | 12:53 pm |
| 6 | 18.6623 | 73.8501 | 24/03/16 | 1:50 pm |
| 7 | 18.67198 | 73.8492 | 24/03/16 | 2:02 pm |
| 8 | 18.67582 | 73.8587 | 24/03/16 | 2:45 pm |
| 9 | 18.6829 | 73.8667 | 25/03/16 | 1:30 pm |
| 10 | 18.66008 | 73.861 | 25/03/16 | 11:40 am |
| 11 | 18.65197 | 73.8389 | 25/03/16 | 12:13 pm |
| 12 | 18.67583 | 73.8415 | 25/03/16 | 12:30 pm |
| 13 | 18.67582 | 73.8806 | 25/03/16 | 12:52 pm |
| 14 | 18.68337 | 73.8433 | 25/03/16 | 1:07 pm |
| 15 | 18.65955 | 73.8275 | 25/03/16 | 1:20 pm |
| 16 | 18.67083 | 73.8768 | 25/03/16 | 1:35 pm |
| 17 | 18.66965 | 73.8327 | 25/03/16 | 1:45 pm |

**2. TESTING OF THE WATER SAMPLES** – Heavy metals and the oil and grease test was done in Microtech lab, Pune while all the water samples were in the COEP Environmental Laboratory. All the standard methods adopted for the testing are given in Appendix 1.

**2.1 LEACHATE SAMPLES –**

Table (3) – Chemical Biological Parameters.

| Sr. No | pH | Cl | TDS | BOD | COD | OIL AND GREASE |
|---|---|---|---|---|---|---|
| | 5.5-9 | mg/l | mg/l | 30 | 250 | max 10 mg/l |
| l1 | 8 | 2299 | 4888 | 290 | 600 | 123 |
| l2 | 7.7 | 5318 | 12708 | 665 | 2000 | 909 |
| l3 | 8.1 | 4039 | 14560 | 1150 | 2700 | 236 |
| l4 | 8.2 | 4219 | 15620 | 900 | 2500 | 448 |

Table (4) – Heavy Metals

| Sr. No | Hg | Pb | As | Cd |
|---|---|---|---|---|
| | max. 0.01 mg/l | max. 0.1 mg/l | max. 0.2 mg/l | max. 2 mg/l |
| l1 | 0 | NT | NT | NT |
| l2 | 0 | 0.7 | 0 | 0 |
| l3 | 0 | 6 | 0 | 0 |
| l4 | 0 | 0.6 | NT | NT |

NT- Not Tested

**2.2 GROUND WATER SAMPLES –**

Table (5) – Physical Water Quality Parameters for Ground water

| Sr. No. | PHYSICAL PARAMETERS | | |
|---|---|---|---|
| | colour | odour | turbidity |
| 1 | Pale yellow | agreeable | 0 |
| 2 | Pale yellow | agreeable | 0 |
| 3 | colourless | agreeable | 0 |
| 4 | colourless | agreeable | 0 |
| 5 | Pale yellow | agreeable | 0 |
| 6 | Pale yellow | agreeable | 0 |
| 7 | colourless | agreeable | 0 |
| 8 | colourless | agreeable | 0 |
| 9 | colourless | agreeable | 0 |
| 10 | colourless | agreeable | 0 |
| 11 | colourless | agreeable | 0 |
| 12 | colourless | agreeable | 0 |
| 13 | colourless | agreeable | 0 |
| 14 | colourless | agreeable | 0 |
| 15 | colourless | agreeable | 0 |
| 16 | colourless | agreeable | 0 |
| 17 | colourless | agreeable | 0 |

Table (6) – Chemical and Biological Water Quality Parameters.

| Sr. No. | Chemical Parameters | | | MPN | | |
|---|---|---|---|---|---|---|
| | Ph | TDS | Cl | TH as CaCO3 | Alkalinity | Sulphate as SO4 |
| | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l |
| | 6.5-8.50 | 500 | Max 250 | Max 300 | Max 200 | Max 400 |
| 1 | 7.22 | 745 | 200 | 539 | 313 | 45 |
| 2 | 6.96 | 639 | 165 | 500 | 284 | 48 |
| 3 | 7.470 | 278 | 38 | 165 | 147 | 30 |
| 4 | 7.160 | 347 | 37 | 283 | 176 | 71 |
| 5 | 6.762 | 885 | 263 | 876 | 512 | 48 |
| 6 | 7.156 | 688 | 184 | 684 | 364 | 41 |
| 7 | 7.370 | 580 | 28 | 349 | 202 | 32 |
| 8 | 6.870 | 590 | 36 | 408 | 332 | 47 |
| 9 | 7.40 | 620 | 44 | 415 | 372 | 64 |
| 10 | 7.330 | 648 | 28 | 511 | 340 | 28 |
| 11 | 7.040 | 360 | 48 | 261 | 160 | 75 |
| 12 | 6.850 | 340 | 43 | 203 | 170 | 45 |
| 13 | 7.280 | 370 | 34 | 230 | 148 | 28 |
| 14 | 6.970 | 440 | 13 | 334 | 222 | 34 |
| 15 | 7.10 | 490 | 18 | 351 | 241 | 43 |
| 16 | 7.430 | 510 | 40 | 321 | 177 | 53 |
| 17 | 6.80 | 390 | 46 | 290 | 232 | 69 |

**GENERATING THEMATIC MAPS–** The variation of all the water quality parameters in the ground water throughout the ward can be easily visualized from the Thematic Maps of all the parameters generated by using the Arc GIS 9.3. Input for generating these maps was the test results of 17 samples for all the parameters. For preparing the Thematic Maps using Spatial Analyst tool in the Arc GIS IDW method for

interpolation was used as it best method suitable for water quality analysis.

Formula for IDW method of interpolation:

$$\lambda_i = \frac{D_i^{-\alpha}}{\sum_{i=1}^{n} D_i^{-\alpha}}$$

$\lambda i$: The weight of point, Di = the distance between point i and the unknown point, $\alpha$ = the power ten of weight.

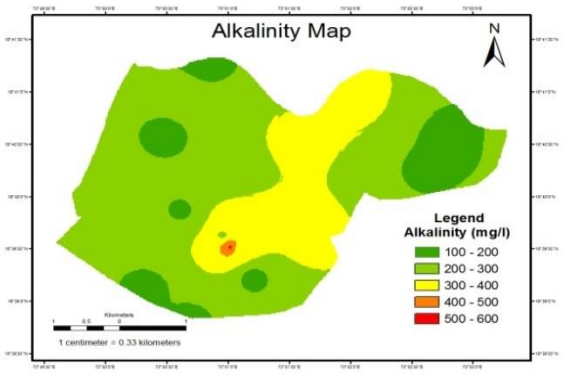


Fig.(5) Alkalinity Variation Map

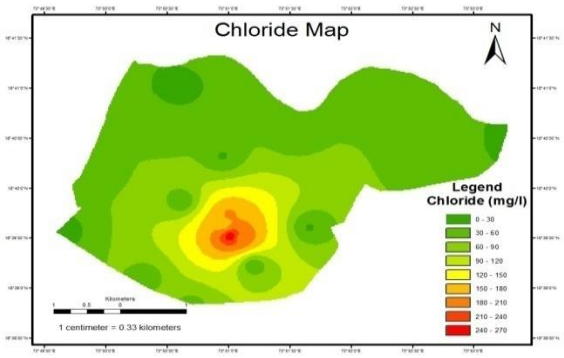


Fig.(6) Chloride Variation Map

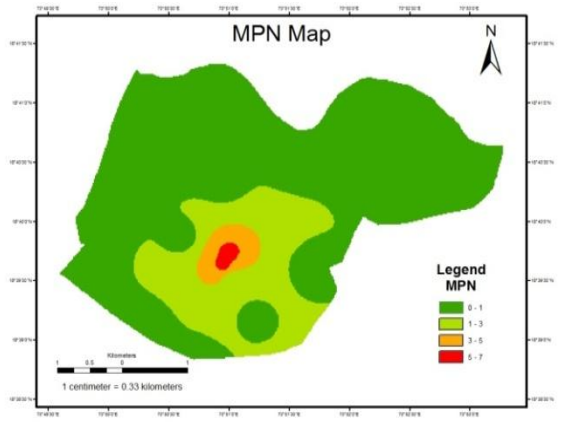


Fig.(7) MPN Variation Map

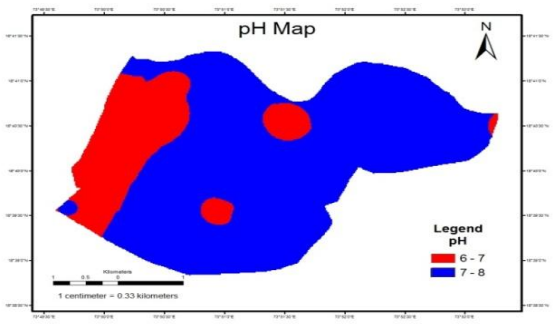


Fig.(8) pH Variation Map

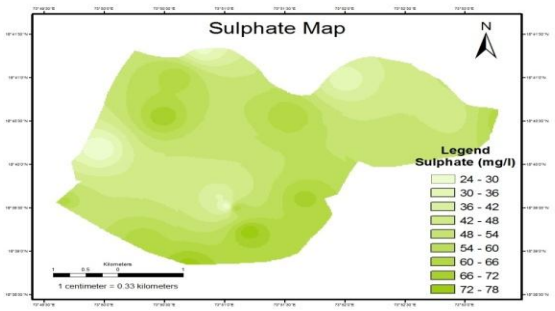


Fig.(9) Sulphate Variation Map

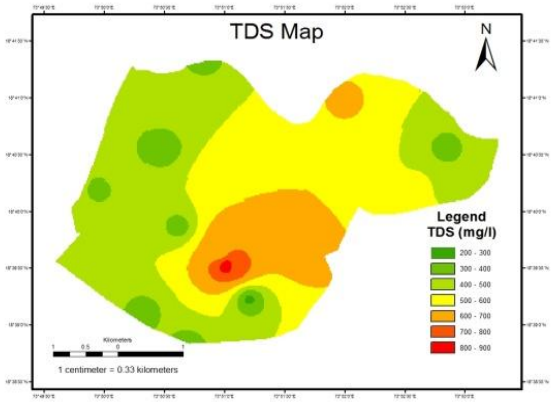


Fig.(10) Total Dissolved Solids Variation Map

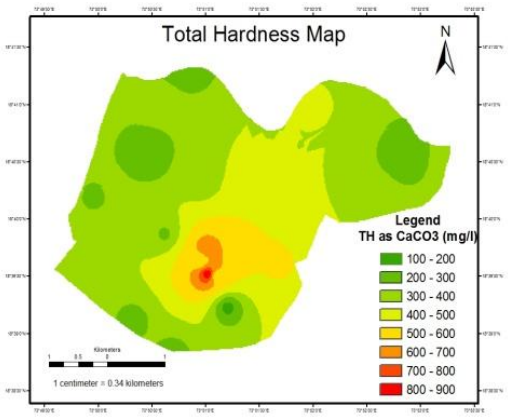


Fig.(11) Total Hardness Variation Map

**4. CALCULATING WATER QUALITY INDEX (WQI)** – A water quality index may be defined as "a rating reflecting the composite influence of number of water quality parameters overall of water".

$$WQI = \sum q_n \, Wn / \sum Wn$$

$$q_n = 100[V_n - V_{io}] / [S_n - V_{io}]$$

qn - Quality rating for nth water quality parameter, Vn –Value of nth parameter in the given sample, W–Unit weight for nth parameter, Sn – Permissible limit for the nth parameter, Vio – Ideal value of the parameter.

**Table (7) – Calculation of WQI for sample 1**

| Sr no. | Parameter | Observed Values | Standard Values (Sn) | | Unit Weight (Wn) | Quality Rating (Qn) | Wn*Qn |
|---|---|---|---|---|---|---|---|
| | | | Desirable | Permissible | | | |
| 1 | pH | **7.2** | **6.5-8.5** | **6.5-8.5** | **20** | **13.3333** | **266.667** |
| 2 | **TDS (mg/l)** | **745** | **500** | **2000** | **6.665** | **37.25** | **248.271** |
| 3 | **Cl (mg/l)** | **200** | **250** | **1000** | **20** | **20** | **400** |
| 4 | **TH (as CaCO3) (mg/l)** | **539** | **300** | **600** | **6.667** | **89.8333** | **598.919** |
| 5 | **Alkalinity (mg/l)** | **313** | **200** | **600** | **6.667** | **52.1667** | **347.795** |
| 6 | **Sulphate (as SO4) (mg/l)** | **45** | **200** | **400** | **13.33** | **11.25** | **150.008** |
| 7 | **E coli (by MPN)** | **2** | **0** | **0** | **26.67** | **200** | **5333.4** |
| | | | | | **100** | | **7345.06** |
| | | | | | | **WQI =** | **73.45** |

Similarly WQI for all the samples was calculated.

Table (8) – WQI for all the Ground Water Samples

| Sr. No. | WQI | Water Quality |
|---|---|---|
| 1 | 73.45 | Poor |
| 2 | 177.07 | Poor |
| 3 | 12.42 | Very Good |
| 4 | 11.49 | Very Good |
| 5 | 81.76 | Poor |
| 6 | 181 | Poor |
| 7 | 14.6 | Very Good |
| 8 | 14.2 | Very Good |
| 9 | 19.15 | Very Good |
| 10 | 17.5 | Very Good |
| 11 | 9.87 | Very Good |
| 12 | 9.63 | Very Good |
| 13 | 10.77 | Very Good |
| 14 | 9.43 | Very Good |
| 15 | 11.33 | Very Good |
| 16 | 15.53 | Very Good |
| 17 | 12.98 | Very Good |

**5. GENERATING THE INTEGRATED WATER QUALITY MAP** – It is the Thematic Map of intergrated water quality genrated from the WQI of all the 17 sample points.

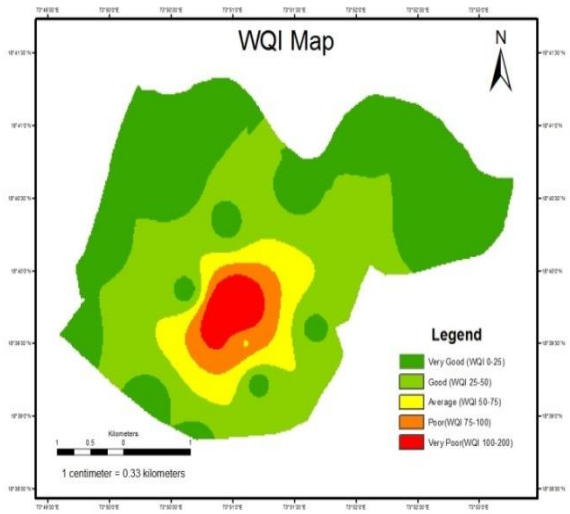


Fig (12) – WQI map for the Moshi ward

## IV.CONCLUSION

1. Ground water of large areas of Khandesh Nagar, Borate Vasti is polluted (high values of MPN and chloride) because of landfill.

2. Ground water of some areas of Borade Vasti and Sector 6 is also polluted because of landfill.

3. Stream water near the landfill is very highly polluted and the presence of very poisonous heavy metal Lead is the matter of concern

4. From the water quality maps of various parameters we can predict water quality at any point in Moshi ward

CONLCUDING MAP – It is prepared by overlaying Residential layer (60% transparent) with the WQI map.

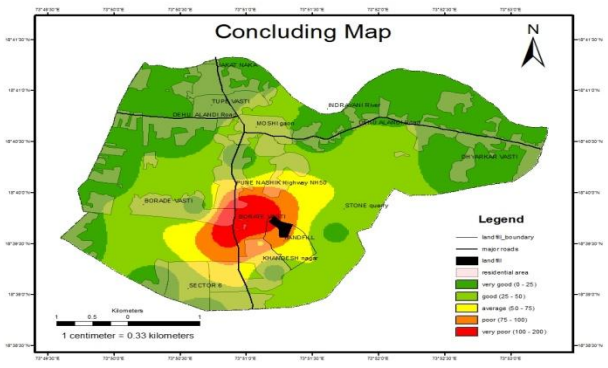


Fig (13) – Water Quality Map Showing the ground water polluted areas in Moshi ward

## APPENDIX

| TESTS | METHOD USED |
|---|---|
| pH | Digital pH Meter |
| Total Dissolved Solids | Gravimetric Method |
| Chloride | Standard Silver Nitrate Method |
| Total Hardness | Complexometric Titration using E.D.T.A |
| Alkalinity | Using Acidimetric Titration |
| Sulphate | Gravimetric Method |
| MPN | Multiple Fermentation Technique |
| BOD | Winkler's Method with Azide Modification |
| COD | Winkler's Method with Azide Modification |
| Oil and Grease | Partition Gravimetric Method |
| Mercury | Atomic Absorption Spectroscopy |
| Lead | Atomic Absorption Spectroscopy |
| Arsenic | Atomic Absorption Spectroscopy |
| Cadmium | Atomic Absorption Spectroscopy |

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