Report No - OM/ATPS/2023/01

# Report on Underground Utility Survey Using

# GROUND PENETRATING RADAR

## NAME OF WORK

Ground Penetration Radar (GPR) Survey for Detection of Underground Utilities for 1x660 MW Super-Critical Unit at ATPS , Chachai, MPPGCL , Madhya Pradesh.

| | |
|---|---|
| Date of Survey | July 2023 |
| Location of Survey | ATPS , Chachai , MPPGCL |
| Report Submission Date | August 2023 |
| Revision | 00 |

**REPORT SUBMITTED TO**

**Superintending Engineer, Civil**
**ATPS , Chachai, MPPGCL ,**
**Madhya Pradesh , India.**

**REPORT PREPARED FOR**

**Superintending Engineer, Civil**
**ATPS , Chachai, MPPGCL ,**
**Madhya Pradesh , India.**


**OM SURVEY WORKS PRIVATE LIMITED**

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# Executive Summary

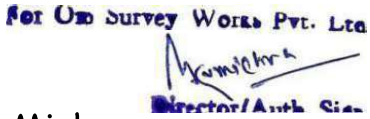
The present work consists of **Ground Penetration Radar (GPR) Survey** for detection of buried utilities such as water, sewer, gas, fire pipelines, electric cables, telecom/Optical fibre cable (OFC) cables etc. up to 6m depth in ATPS , Chachai premises (Area = 2,40,469 m2 ~ 59.421 acres) using the following survey technologies/methods:

(a) Ground Penetrating Radar (GPR)
(b) Electric Pipe Locator (EPL)
(c) Total Station (TS) Survey
(d) Differential Global Positioning System (DGPS)

The work was sub-contracted to M/S Om Survey Works Pvt. Ltd. by Superintending Engineer(Civil), ATPS, MPPGCL, Madhya Pradesh. The work was carried out as per specifications and requirements of Superintending Engineer(Civil), ATPS, MPPGCL, Madhya Pradesh. The total quantity of 2,40,469 m2 ~ 59.421 acres GPR Survey was successfully executed in months from July 2023. Detection of underground utilities was performed using Ground Penetrating Radar Survey technique popularly known as GPR Survey. Analysis and interpretation of raw GPR data has delineated a number of utilities buried under the survey area. Location of these utilities has been marked in the form of AutoCAD drawings and presented in this report.

This detailed report on the field work performed as per work order and the inferences derived from the data are submitted for further acceptance and reference.

Thanks & Regard




Anuj Mishra
For Om Survey Works Pvt. Ltd.

CONTENTS

# REPORT ON

# DETAILED TOPOGRAPHICAL SURVEY & UNDERGROUND UTILITY SURVEY BY USING GROUND PENETRATING RADAR, EPL , DGPS & TOTAL STATION INSTRUMENTS AT ATPS , CHACHAI , MPPGCL , MP.

## 1.0 INTRODUCTION

Ground Penetrating Radar (GPR) is a non-destructive and environment friendly technique to produce a continuous cross-sectional profile - a two-dimensional image of the soil and subsurface features. Three-dimensional image scan also be produced using raw field data and appropriate post-processing software. These profiles are used to decipher buried utilities, such as, pipes, cables, etc. The electro-magnetic waves emitted by GPR can reach depths up to 30 meters in low conductivity materials, such as, dry sand or granite. However, moist clays, shale, and other high conductivity materials may drastically attenuate or absorb GPR signals, decreasing thereby the depth of penetration to even one meter or less. Present report is intended to delineate underground utilities at ATPS premises, Chachai , MPPGCL , MP.

## 2.0 PRINCIPLE

The Ground Penetrating Survey works by detecting subsurface changes in EM properties (dielectric permittivity, conductivity, and magnetic permeability) which in a geological setting are functions of soil and rock material, water content, and bulk density. GPR data is acquired by transmitting high frequency electromagnetic (EM) signals into the ground and receiving back the signals reflected from various boundaries manifesting contrasts in their EM properties. The equipment receives the reflected waves over a selectable time range and

displays them in real time on screen. The reflected wave data is also saved in appropriate memory for subsequent processing and interpretation. GPR measurements are used in geologic, engineering, hydrologic, and environmental applications.

## 3.0 OBJECTIVE

The objective of the present survey to locate underground utilities at ATPS , Chachai ,based on findings of GPR Survey. The total survey route consists an area of 2,40,469 m2 ~ 59.421 acres.

## 4.0 SURVEY LOCATION

The survey comprises area at ATPS premises,Chachai. The survey was conducted during the day hours in month of July 2023. The tentative location of the survey area is displayed in the following Google Earth image.


**Tentative Location of GPR Survey @ ATPS Premises , Chachai , MP.**

## 5.0 EQUIPMENT DEPLOYED

**(1) GPR Machine -** The instrument deployed for the work was Zond 12e Ground Penetrating Radar. This equipment is portable digital subsurface sounding radar carried by a single operator. The unit is designed for solving a broad range of geotechnical, geological, environmental and engineering and other tasks where non-destructive operational environmental monitoring is needed. Data are recorded on a hard disc for further processing, interpretation, printout, etc.


**GPR Antennae**


**GPR Unit**

**EPL Unit**

## 5.1 ANTENNA (GPR)

The transmitting part of the antenna is meant to generate Electromagnetic (EM) signals that penetrate into the sub-surface where secondary EM signals are build up and received at ground by receiving part of antenna. The selection of transmitting frequency is dependent on the zone of interest. The present survey was conducted using 300 and 500 MHz antennas.

## 5.2 EQUIPMENT FEATURES (GPR)

| | |
|---|---|
| Performance | Single channel or double channel |
| Time Range | User selected from 1 to 2000 ns with 1 ns step |
| Transmit Rate | 115 kHz |
| Scan Rate | 80 scans per second (using double channel) |
| Samples / Scan | 512 |
| Resolution | 16 bit |
| Filters | High pass filter from set: 0.00; 400; 800 Hz |
| Data Transfer | through Ethernet to PC |
| Input Power | 10.5-13 V DC 0.4 A (rechargeable battery) |
| Dimensions | 35 x 50 x 5.5 cm |

## (2) EPL Machine -

The vLoc3-Pro utility locator introduces new innovative tools for locating buried utilities assuring damage prevention while gathering information for analysis. With two sets of screened 3D antennas signal distortion is easily detected and displayed on the bright full color display. Along with classic locate screens the vLoc3 series locators offer new locate perspective screens of Vector Locate for fully automatic non-walk over locating, Transverse Graph showing both peak and null simultaneously providing immediate measurement of signal distortion, Plan View showing the relative orientation of the cable at any angle, and a new graphical Sonde screen with guidance arrows leading to the sonde location even when it is vertical.

The highly user configurable vLoc3 series contains eight passive locate modes, fault-find mode, SD (showing direction of outgoing current), and a range of configurable frequencies from 16Hz to 200 kHz. Audio and mechanical vibration alerts can also be configured by the user providing warnings for shallow depth, overload, overhead cables, and excessive swinging. Plug-in-play options for the receiver include optional Bluetooth module useable with external GPS devices and EMS foot to locate buried markers.

## EPL Features :-

Weight & Dimensions - 4.6lbs (2.1kg) / (321mm x 124mm x 676mm)
Display - Transmissive 480 x 272 Pixel, 16-bit Color, High Visibility LCD, 4.3''
Battery options - Rechargeable custom Lithium-ion batteries with 100-240V AC mains.
Battery life - Lithium-ion – typically 27-hours.
Operating frequencies- Configurable frequencies from 16Hz to 200 kHz Power - 50Hz and 60Hz.
Operating modes - Classic Locate (Bar graph), Transverse Graph Mode.
Data logging and transfer - 50 Million records - Records include depth, current & frequency.

**(3) DGPS Machine -** This report provides a description of the differential global positioning system (DGPS) operation, setup procedure, and post processing procedure to obtain milimeter accuracy of GPS data for the synchronous impulse reconstruction radar. This highly accurate position information will allow proper focusing of the radar image and will maintain image quality on a moving platform.
The system has three major components: space, earth control, and end user. The space component consists of a constellation of 24 satellites arranged in such a way that they circumnavigate the earth in six orbital planes, each with four satellites at any given time. Therefore, on average, a typical receiver on earth can track 7 to 12 satellites at any given time of the day. Each satellite continuously transmits encrypted information via carrier signal over L1 and L2 bands at 1,575.42 and 1,227.6 MHz, respectively, to GPS receivers so users can precisely identify their location on earth by the triangulation principle.

Accuracy of position data were obtained through the proper use of a differential GPS solution. A GPS receiver (rover) was installed on a platform and a stationary (base station) GPS receiver was set up in the project area to collect data simultaneously. After completion of the data collection, the two GPS sources are imported into the software, a high precision post-processing engine, to generate a differential GPS output. Finally, the results are exported to a file for cross-referencing with time tags embedded into the radar data. The differential GPS provides the essential positioning information needed to allow the radar data to be focused in a known coordinate system.

DGPS Unit

Total Station Unit

**(4) Total Station Machine** - Total station is used for computing slant distances, horizontal and vertical angles, elevations in topographic and geodetic works, tacheometric surveys, etc. The total station is a pre-eminent contribution to modern surveying and hence the equipment is designed for speed, range, and accuracy. They are a combination of Theodolite and Electronic Distance measurement (EDM). This enables computing the vertical, horizontal as well as slope measurements.

They acts as a substitute for theodolite, EDM, Data collector, and a Microprocessor. Moreover, they are lightweight and compact machines and perform like transit stadia and plane table alidades.

The integration of microprocessors helps in the data collection and measurement computation process. Further to that, the inbuilt software helps to generate the maps instantly.

Apart from taking the measurements, the total station helps in computing, interpreting, and documenting the data. Here is a list of activities that are computed, interpreted, and analyzed.

Horizontal angle , Vertical angle , Slope distance , Coordinate of point,

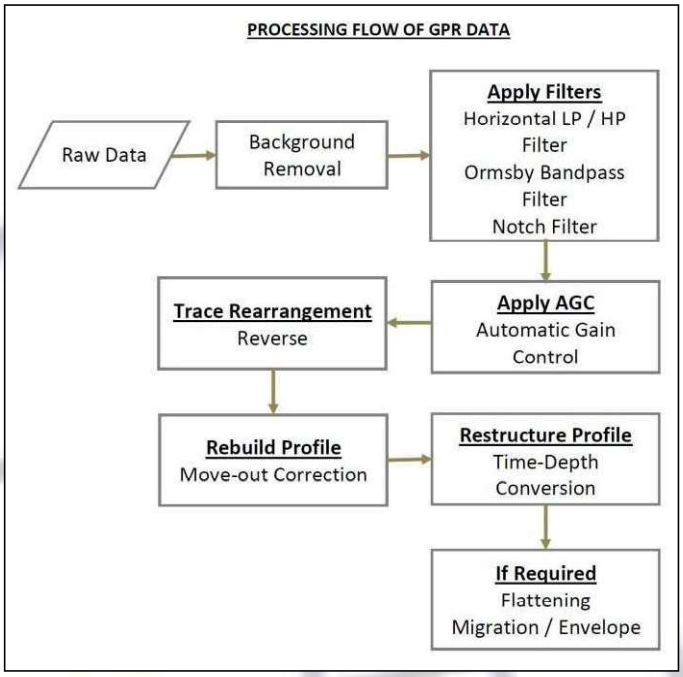
Missing line measurement , Area calculation & Contour level.

## 6.0 DATA ACQUISITION

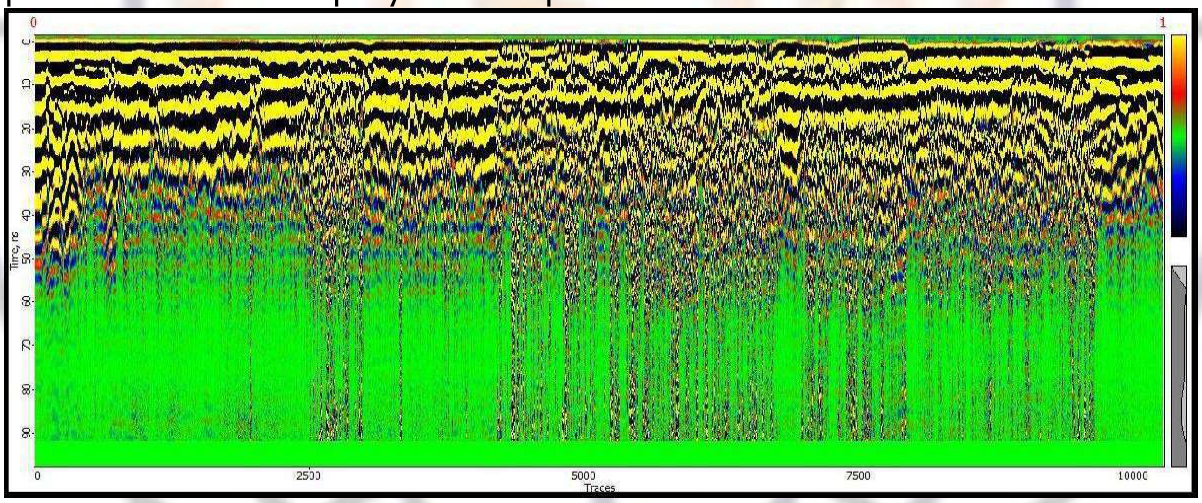
The survey was conducted during the day hours in month of July 2023 by M/S Om Survey Works Pvt. Ltd, New Delhi (refer profile at Appendix-1) on behalf of Superintending Engineer(Civil),ATPS,MPPGCL,Madhya Pradesh. The total survey area assigned was approximately 2,40,469 m2 ~ 59.421 acres. A total 05 No's of crew members executed the survey. For GPR Survey, it is essential that the area to be scanned should be even and clutter-free to provide good coupling of the GPR with the ground. Efforts were made to scan the given area in the best possible way to avoid any technical pitfalls in the data, and to achieve the desired objectives.

# 7.0 PROCESSING AND INTERPRETATION

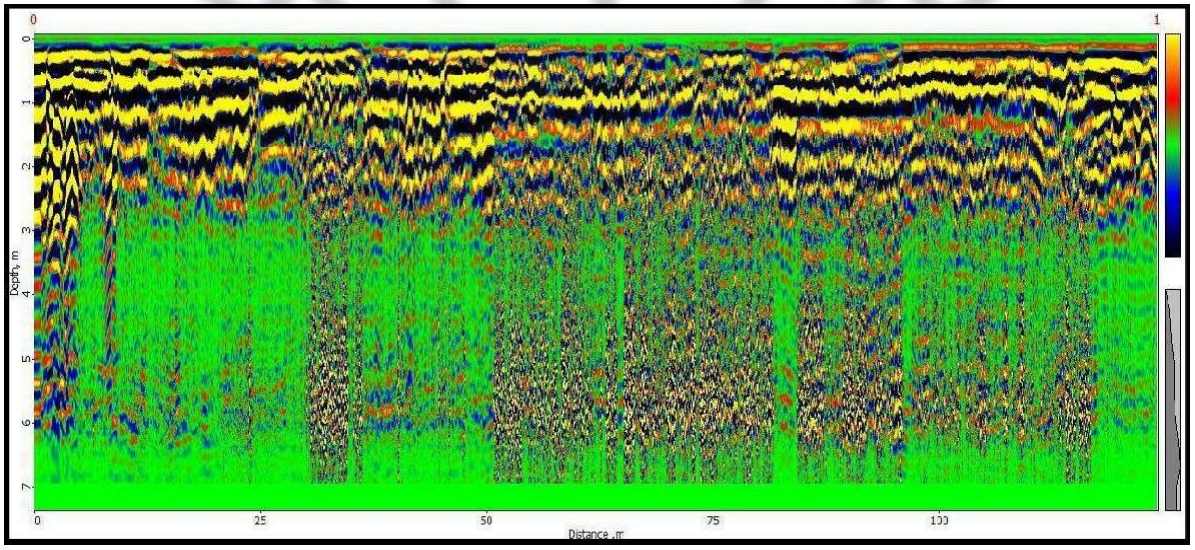
Raw data was processed as per the standard industry practices for background removal, high-pass and low-pass filters, different band pass filters and AGC (refer adjacent diagram). After processing of the raw data, interpretation was carried out using prescribed

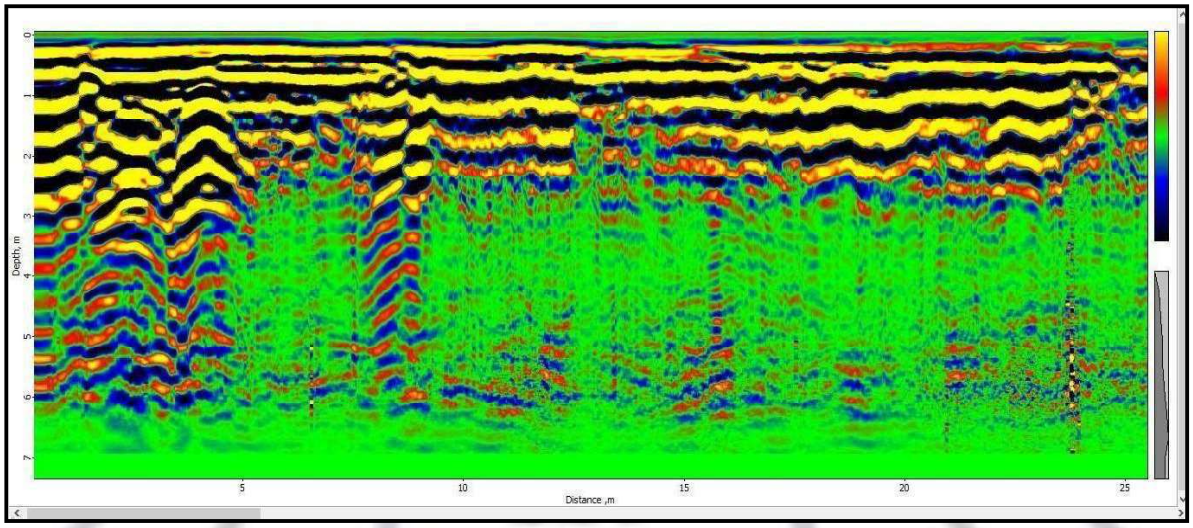



software for the purpose. Despite the technical limitations of the site, e.g., uneven surface, katcha roads, the recorded data quality is found to be satisfactory. Presented below are the samples of raw and processed data display for the present site.




**Unprocessed GPR data display**






## 8.0 QA and QC

QA (Quality Assurance) is undertaken through the provision of, and enforced compliance with, appropriate engineering and operational standards, specifications, and procedures, during the whole process from start to finish. QC (Quality Control) is monitored by an in-house expert on all of the processes involved to ensure compliance with standards and specifications as mentioned in Om Survey Works SOP document. Data QC has been given special attention during acquisition and also at processing and interpretation phases. It has been checked thoroughly and found within satisfactory limits. Special care has been taken during data acquisition for antenna and target effects such as target resonance which can introduce periodic events into GPR data that may be misinterpreted as multiple reflections, stratigraphy, or multiple buried objects.

## 9.0 FINDINGS OF THE SURVEY

Based on the findings of GPR survey conducted at the proposed site, several utilities have been detected at different depths and positions. Position and depth of the interpreted utilities are plotted in the attached drawing using AutoCAD software. Further, depth of utilities as shown in the drawings is the depth to the top of a utility.

### 9.1 MAP / DRAWING

Drawings of the surveyed area is attached as separate sections in Annexure-1. These drawings are self- explanatory.

## 10.0 QHSE

Adequate safety measures were taken during surveys. The operators were provided with proper PPEs. First Aid Box was available with the crew for any medical emergency. As a concern to the environment, the crew refrained from any littering in the surroundings.

## 11.0 APPLICABLE STANDARD

Om Survey follows ASTM standard in equipment, field procedures, and interpretation methods for the assessment of underground utilities using Ground Penetrating Radar.

## OUR SURVEY PROCEDURE

Our survey procedure for underground utility detection categorized in four (4) quality levels. Which are as followings…

1. Quality Level D (QL-D)
2. Quality Level C (QL-C)
3. Quality Level B (QL-B)
4. Quality Level A (QL-A)

**1. Quality Level D (QL-D)**

We source, review, compile and merge all existing utility maps, records and information for the survey area. Survey type D is a prerequisite for survey types C, B and A. This existing utility information is assigned quality level QL-D.

**2. Quality Level C (QL-C)**

We inspect and survey all visible utility-related surface features on- site like electric transformer, electric pole, telephone pole, telephone junction box, telephone chamber, electric chamber, sewer manhole,water valve etc. When compared and merged with utility information from the existing records search (survey type D) this step conforms to a survey type C.

**3. Quality Level B (QL-B)**

We carry out detailed GPR reflection profiling, using site-specific frequencies and acquisition settings, on a suitable grid basis over the survey area. The survey grid/ search resolutions are chosen to conform to PAS 128 detection methods (M1-M4).We are chartered geophysicists and acquire our GPR surveys in accordance with the standards set out in ASTM D6432-11. We own and operate a wide range of GPR antenna configurations to guarantee optimum data acquisition over different site conditions. The GPR experience of the GPR operator is crucial to ensure high quality data is acquired.

**4. Quality Level A (QL-A)**

MANHOLE SURVEY/ GROUND TRUTHING

For each access point (manhole or inspection chamber) relevant to the survey area exposed utilities are visually inspected, photographed and surveyed. We record location and attribute information for each utility.The exposed utility is assigned quality level QL-A at the point of direct measurement.

## 12.0 LIMITATIONS

The most significant performance limitation of GP is observed in high-conductivity materials such as clay and shale that are salt contaminated. If the soil conductivity is high, attenuation of the radar signal in the soil can severely restrict the maximum

penetration depth of the radar signal. Scattering of signal in rocky soils and in similar heterogeneous conditions is another important limitation of GPR technology.

- To acquire the highest quality data, proper coupling between the antenna and the ground surface is necessary. Poor data may be obtained at sites covered with debris, an uneven surface, tall grass and bush. Objects located at curbs are difficult to see.
- Reflections from objects situated along side of the antenna may also be seen in the record, but the actual location of the object relative to the antenna is not obvious.
- Penetration of the GPR signal is "site specific" and its depth of penetration at a particular site cannot be predicted ahead of survey. Near surface conductive material, such as salty or contaminated ground water and wet, clay-rich soil, may attenuate the radar signal. This might drastically diminish the effective depth of penetration. Reinforced concrete also attenuates the signals. Radars may produce reflections that look like pipes.
- The reflection visible in a GPR record is very complex and the complexity increases with variations in electrical properties of the soil. Thus, an anticipated target in mind may not even produce the reflection. Due to "noise" in the data, a particular target may be missed. Utilities may be misse if they are under debris and/or below other pipes.
- Adequate contrast between the ground and the target is required to obtain reflections. Utilities may be missed if they are badly corroded. Utilities made of "earth" materials like clay and

concrete may not be detected since their electrical properties are similar to the surrounding soil.

- For determination of the depth to an object, "ground- truthing" is sometimes helpful. But even with the ground-truth at several locations of the same site, changes in soil properties across the site may bring about errors in depth determination.

APPENDIX-1

# PROFILE OF
# OM SURVEY WORKS PRIVATE LIMITED

Organized and managed by team of experienced professionals, offers services for subsurface investigations and Consultancy Services in various geophysical exploration activities.

**GPR Surveys** has wide applications in

Civil Engineering

- locating pipes (metallic and non-metallic), electric cables (Induction Locator is further used to identify live cables) drums, tanks, sewers, and boulders
- such as, roads and railroad track-bed studies, and highway bridge scour studies
- Inspection of brick, masonry, and concrete structures

Archaeological studies
Mapping Geological conditions

**Seismic Refraction Surveys**

Mapping bedrock profile and thickness of overburden
Identification of fractures, weak zone
Topography of Ground water and Geological Units
Estimation of Soil Elasticity Modulii
Rippability assessment in mines

**Electrical Resistivity Tomography**

Imaging subsurface structure
Monitoring of Ground water flow
Archaeological Application

**Cross-hole Tests**

Profiling of in-situ Seismic wave (P and S) velocities
Evaluation of Lateral and Vertical material continuity
Liquefaction Analysis, Deformation Studies
Study of Amplification and attenuation of Ground Motion

**Cross-hole Tomography**

- Identification of features like Fault zones and voids
- Mapping of Loose Zones, Sinkholes
- Anomalous zones in Dams
- Study of old Foundations

**Geotechnical field investigation**

- Soil boring diameter ranges from 65 mm to 600 mm
- Rock core drilling diameter ranges from 65 mm to 450 mm

- Tube wells
- DCTP, SCPT, SPT
- Plate load test
- Pressure meter test
- Permeability test

**Geotechnical lab testing**

- Sieve analysis
- Determination of Density, Specific gravity, Natural Moisture Content
- Unconfined compressive strength (UCS)

Direct shear test
Triaxial test
Consolidation test

**Slope Stabilization**

Soil / Rock Nailing
Grouting
Pilling
Shotcreting

**Geodetic Services**

Topographic Surveys
Contour Surveys
Route and Boundary Surveys
Construction and Design Surveys

**Consultancy Services**

Solar Energy Applications
Wind Energy Applications
Geothermal Energy
Petroleum Exploration

- Block Evaluation
- 2D/3D Seismic Survey Design, Resource Planning
- 2D/3D Seismic Data Processing
- Bore Log and Seismic Data Interpretation
- GGR Analysis

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**Contact Address**

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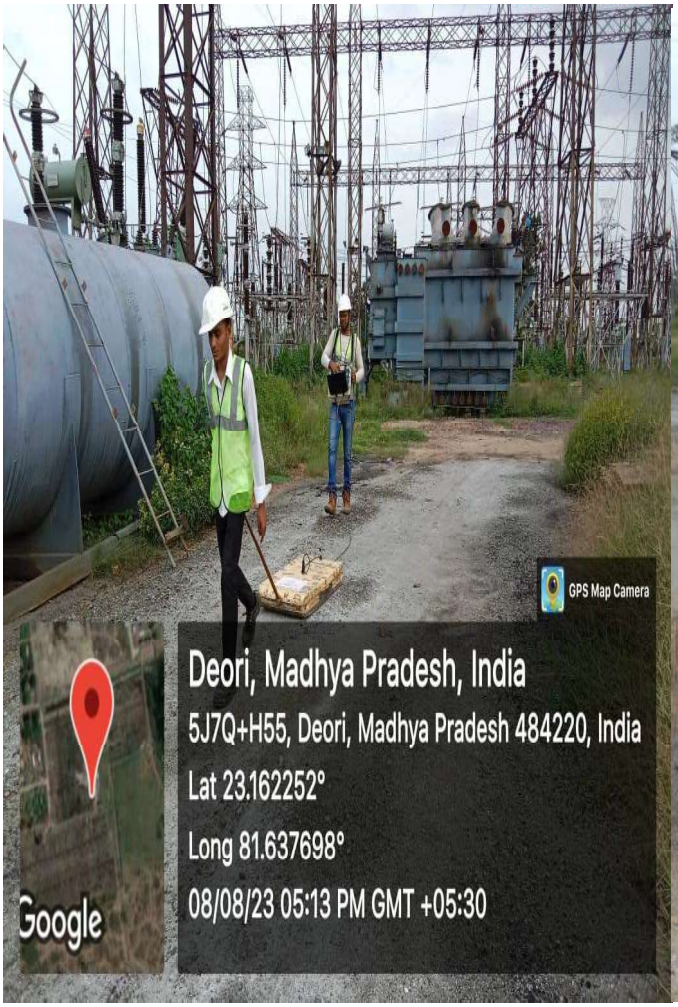
# MAIN PLAN


N 50
NS 0.0
S 100
S 200
S 300
S 400
S 500
S 600
S 650
850 W
800 W
700 W
600 W
500 W
400 W
300 W
200 W
100 W
00 W
00 E
SUTHNA RESERVOIR
LEGEND AND SYMBOLS :-
W Utilities Water
M Utilities Metalic
C Utilities Cable
PIPE Utilities Pipe
Tin Barricade
Grill
Drain
Compound Wall
Road
Hut
Tap
High Mask
Track
Electric Pole
Bushing
Plinth
Piller
PT
CT
TT
Gate
Tree
Trench
CH Chamber
HT Tower
Cable Trey
TANK Tank
Water Valve
Pipe Trey
Light Pole
Culvert
Conveyor
EB Electric Box
Sign Board
Building
Control Point/TBM
Check Post
Transformer
TITLE: GROUND PENETRATION RADAR SURVEY FOR DETECTION OF UNDERGROUND UTILITIES.
PROJECT: GROUND PENETRATION RADAR (G.P.R.) FOR 1X660 MW SUPER CRITICAL UNIT AT ATPS; CHACHAI, DISTT.-ANUPPUR (M.P.) - 484220
CLIENT :
MADHYA PARDESH POWER GENERATION CO. LTD.
OFFICE OF THE SUPERINTENDING ENGINEER
(CIVIL) ATPS; CHACHAI,
DISTT.-ANUPPUR (M.P.) - 484220
DRAWN BY : PK
CHK BY : AM
SHEET SIZE:A0
SURVEY CONSULTANT :
OM SURVEY WORKS PVT. LTD.
264 , E-BLOCK , AYANAGAR ,
NEW DELHI - 110047
CONTEC" -9871462!33,8368993965
E-MAIL :- contactomsurvey@gmail.com
Notes :-
(1) All dimensions are in meter.
(2) Bench Mark :-
CP16 - S=326.902, W=130.444
CP17 - S=290.432, W=53.384
CP12 - S=-87.966, W=806.616
CP13 - S=-2.162, W=813.327
(3) Area :- Total Surveyed Area=2,40,469 Sqm.


GPS Map Camera
Deori, Madhya Pradesh, India
5J7Q+H55, Deori, Madhya Pradesh 484220, India
Lat 23.162252°
Long 81.637698°
08/08/23 05:13 PM GMT +05:30
Google


GPS Map Camera
सकोला, मध्य प्रदेश, भारत
नाम-रहित सड़क, सकोला, मध्य प्रदेश 484220, भारत
Lat 23.161888°
Long 81.636587°
08/08/23 05:10 PM GMT +05:30
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