

**RAY**

**GIS, MIS & GIS - MIS Integration  
2013 - 2022**



**Government of India  
Ministry of Housing & Urban Poverty Alleviation**

# Rajiv Awas Yojana (RAY)

Guidelines for  
GIS, MIS & GIS - MIS Integration  
2013 - 2022



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## Preface

Rajiv Awas Yojana (RAY) envisages a “Slum Free India” with inclusive and equitable cities in which every citizen has access to basic civic and social services and decent shelter.

In pursuance of this vision of “Slum free India”, Rajiv Awas Yojana (RAY) was launched in June 2011 in two phases; the preparatory phase for a period of two years which ended in June 2013 and implementation phase. Central Government has approved the implementation phase for the period of 2013-2022.

RAY envisages a two-step implementation strategy i.e. preparation of Slum Free City Plan of Action (SFCPoA) and preparation of projects for selected slums.

RAY Scheme Guidelines issued by the Ministry broadly describe the Scope, Coverage, Reforms, Implementation Approach, Central Assistance, Administrative and Implementation structure and Monitoring mechanisms under RAY.

However, to assist States/ULBs to implement RAY, the following operational guidelines have been prepared by the Ministry:

1. Guidelines for Reforms
2. Guidelines for GIS, MIS and GIS-MIS Integration
3. Guidelines for preparation of Slum-free City Plan of Action
4. Guidelines for Community Participation
5. Guidelines for preparation of Detailed Project Reports
6. Guidelines for Project Management
7. Guidelines for Social Audit
8. Guidelines for Capacity Building
9. Quality Assurance Manual

The above mentioned guidelines are uploaded on the Ministry’s website at [www.mhupa.gov.in](http://www.mhupa.gov.in).

Operational guidelines provide a general reference framework for implementation under RAY. Feedback and suggestions are welcome and may be posted at Ministry through RAY Vaarta ([www.mhupa-ray.gov.in](http://www.mhupa-ray.gov.in)), an interactive website which serves as a common platform for discussions and dissemination of information.





## Abbreviations

BT	Bituminous
CAD	Computer Aided Design
CC	Cement Concrete
CGG	Centre for Good Governance
DEM	Digital Elevation Model
DPR	Detailed Project Report
GIS	Geographical Information System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GTS	Great Trigonometrical Survey
IFB	Invitation for Bid
MIS	Management Information System
MoHUPA	Ministry of Housing & Urban Poverty Alleviation
NBO	National Buildings Organisation
NRSC	National Remote Sensing Centre
NSDI	National Spatial Data Infrastructure
PHC/HC	Public Health Clinic
PSP	Public Stand Post
RAY	Rajiv Awas Yojana
RFP	Request for Proposal
SRSAC	State Remote Sensing Application Centre
TBM	Temporary Bench Marks
TC	Technical Consultant
TSS	Total Station Survey
ULB	Urban Local Body
UTM	Universal Transverse Mercator
WBM	Water Bound Macadam
WGS	World Geodetic System
YASHADA	Yashwantrao Chavan Academy of Development Administration





## 1. Introduction

Under the scheme, two step implementation strategy has been adopted i.e. preparation of Slum-free City Plans of Action (SFCPoAs) on ‘whole city’ basis and Detailed Project Reports (DPRs) on ‘whole slum’ basis for selected slums. The preparation of SFCPoA and DPR will involve Socio-economic survey, mapping of slums using geospatial technology, integration of geospatial and socio-economic data, identification of development model and implementation of the same for each selected slum. Preparation of these guidelines is mainly to assist the ULBs/States on the process to be followed for GIS mapping at City and Slum level, data entry of slum survey and household survey data into MIS and integration of this MIS with GIS at slum level and household level for preparation of SFCPoA & DPR. The key stakeholders are Slum Dwellers, ULBs, States and the Ministry of Housing and Urban Poverty Alleviation.

GIS mapping & GIS MIS integration under RAY will need to be conducted only for cities with population more than 3 lakh (as per 2011 census). However, all cities which were included during preparatory phase of RAY will need to conduct GIS mapping & GIS MIS integration irrespective of city population.

ULBs will conduct the slum survey and input the data into Slum MIS. Concerned authorities at State and at the Ministry can review all reports for periodic monitoring of progress. All cities covered in preparatory phase and to be included during implementation phase (irrespective of city population), will be required to undertake data entry into Online Monitoring System for Slum, Household & Livelihood Survey.

### 1.1 Geographical Information System (GIS) & Remote Sensing

Remote Sensing which includes both aerial as well as satellite based systems, allow collection of physical data rather easily, with speed and on repetitive basis, and together with GIS will help to analyze the data spatially, offering possibilities of generating various options for slum re-development (modelling), thereby optimizing the whole planning process. These information systems also offer interpretation of physical data with other socio-economic data, and thereby providing an important linkage in the planning process and making it more effective and meaningful. With the help of satellite based maps and digital information all the required information is integrated in GIS based urban management system. This not only helps to unify information on common platform but also enables updating information as and when required with ease and precision. This has specific importance in the context of slums and



informal settlements where accurate representation of the ground scenario with that of the socio-economic conditions of the people is a necessity for inclusive planning.

## 1.2 Management Information System (MIS)

### 1.2.1 Online Monitoring System for Slum, Household & Livelihood Survey

Online Monitoring System for Slum, Household & Livelihood Survey (Slum MIS) is a web based online tool developed by Ministry to build a robust information system about facilities available in Slums and also about the socio-economic profile of the households and their livelihoods. User Manual has been prepared and made available as an online help through a 'Help' option<sup>1</sup>. Socioeconomic survey for RAY is to be conducted in the formats prescribed by M/o HUPA<sup>2</sup>. The details should be entered into Slum MIS. Reports can be generated by using e-tools provided in the system.

This Slum MIS will serve as a useful databank for various reports to be used for monitoring and implementation of all programmes of the ULB. Some of benefits could be as under:

- Baseline Information for Planning & Policy making.
- Identification of current levels of civic & social infrastructure, gaps therein so as to take appropriate steps to overcome shortcomings.
- Identification of livelihood needs such as training, employment etc. in each Slum area and decision-making on the same.

### 1.2.2 Offline Monitoring System for Slum, Household & Livelihood Survey

Though it is preferred and expected that data in MIS will be entered using online system but if for some reason it is not possible to use online system then to facilitate data entry an offline data entry module has also been developed within the existing online system. The desired ULB may use the "Offline Services" menu (<http://surveys.cgg.gov.in>) and register itself for offline data entry. The Survey Agency can further download the offline module, configure it on a single computer (or multiple computers over the LAN) and enter the data and upload the data file to the Online System. The ULB will have the access to see the details of upload

<sup>1</sup> Online MIS Users Manual ([http://surveys.cgg.gov.in/helpDesk/ULB\\_UM.pdf](http://surveys.cgg.gov.in/helpDesk/ULB_UM.pdf)), Offline MIS Users Manual ([http://surveys.cgg.gov.in/helpDesk/ULB\\_UM\\_OFFLINE.pdf](http://surveys.cgg.gov.in/helpDesk/ULB_UM_OFFLINE.pdf))

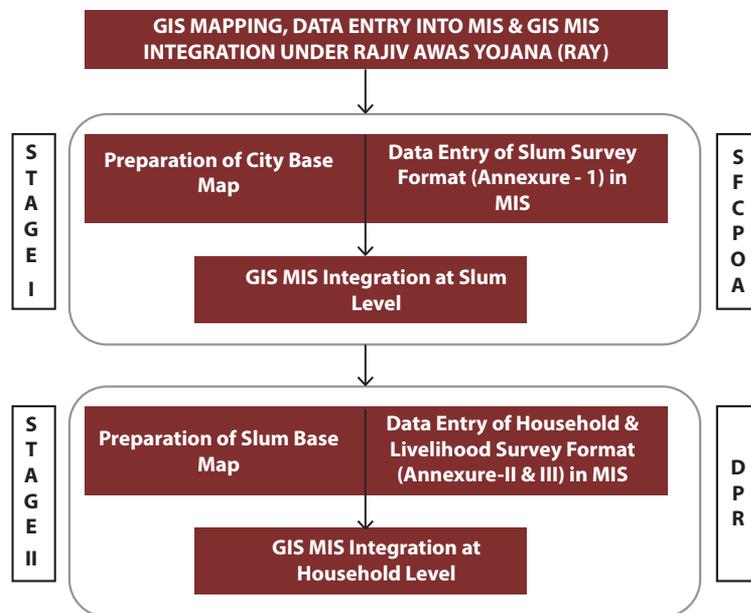
<sup>2</sup> Refer D.O No. N-11011/43/2013-RAY-II dated 13<sup>th</sup> May'2013, Guidance Note & Revised format can be downloaded from <http://mhupa.gov.in/ray/>



and reports through online system. The user guide is available at “Offline Services” menu at the in the online system. The user guide is also available at “Admin Services / Help” in the offline module.

### 1.3 GIS-MIS Integration

GIS MIS integration activities under RAY have been divided into two stages, i.e. during the stage of preparation of Slum Free City Plan of Action (SFCPoA) and preparation of Detailed Project Report (DPR). During Slum Free City Plan of Action preparation stage, GIS MIS Integration at Slum Level (with City Base Map) and during the stage of preparation of DPR, GIS MIS integration at Household level (with Slum Base Map) have been envisaged. The GIS enabled MIS data at Slum level will be used for tenability analysis and prioritisation of Slums at the stage of Slum Free City Planning. Further, the GIS enabled MIS data at household level will be used for preparation of DPR and implementation plan and monitoring of progress of implementation.



**Flow Chart - 1**



## 2. GIS Mapping & GIS MIS Integration for Preparation of Slum Free City Plan of Action (SFCPoA):

The SFCPoA will be an overall action plan of the ULB with investment requirements projected and prioritized for improving/developing the existing slums and providing houses including basic civic infrastructure and social amenities for the urban poor for the next 10-15 years. To achieve these things, a systematic approach is essential for better designing & planning. An updated city base map prepared using high resolution satellite image and GIS integrated MIS data at slum level will help to find appropriate and accurate solution in a shorter time.

**2.1 Preparation of City Base Map for the “planning area”<sup>3</sup>:** The basic requirement for starting the Slum socio-economic survey is to have an updated City Base Map for the “planning area”. The steps required to undertake for preparation of City Base Map will be as follows:

- a. *Step – I: Data Inventory of existing City Base Map:* A city base map between 1:2000 – 1:10,000 scale may be available with the ULB or any other department of State Govt. In such cases, the first step will be collection of those base maps for the “planning area” including boundaries of municipal area, zones, wards & Slums. These maps may be in two forms i.e paper maps (hard copy or soft copy) or GIS layers. These maps/layers can be used /modified for preparation of updated city base map for RAY. In case of existing GIS data, only the required layers needs to be extracted, updated and converted to prescribed output data format and projection system<sup>4</sup>(if the data format and projection system are different). In case of paper maps, the data for preparation of city base map will be captured in three steps, i.e scanning, georeferencing and digitisation. Georeferencing of scanned paper maps (scanned paper map usually called raster map/image-after scanning paper maps will be converted to raster image) involves various steps which are illustrated in Annexure I as an example using one of the software tools. These steps may change depending on the software selected for georeferencing of raster image. The potential source of existing GIS data and Paper Maps has been provided in Annexure II.
- b. *Step – II: Inventory of Existing High Resolution Satellite Image:* In some cases, high resolution satellite image (Cartosat – I, II, Quickbird, World View or IKONOS etc)

<sup>3</sup> “Planning Area” means any area declared to be a regional planning area, local planning area or a site for a new town under the relevant Act

<sup>4</sup> Refer para 1.2.3(b) of Annexure4.



may also be available in ULB or any other department of State Govt. If these images have been procured recently, it can also be used for city base map preparation under RAY.

- c. *Step – III: Procurement of Cartosat I/II Satellite Image:* If base map/GIS layers/high resolution satellite image are not readily available with the cities/States, then CartosatI/II image needs to be procured from National Remote Sensing Centre (NRSC) for the entire “Planning Area” of the RAY City. For cities/towns where Cartosat I/II<sup>5</sup> images are not available, concerned States/ULBs would need to take approval of CSMC with demand and justification for an alternative satellite product as it will have cost implication.

Availability of Cartosat I & II data may be checked in NRSC by using following steps:

- Go to NRSC website: <http://www.nrsc.gov.in/>
  - Click to Option User Services
  - Click to New User Option to complete Registration formalities
  - After completing registration formalities, put user id and password to enter into browsing site.
  - Click to Demos option to learn the step by step process of searching satellite image and placing order for satellite images.
- d. *Step – IV: Collection of GCPs for Georeferencing of Satellite Image:* After procurement of satellite images, GCPs (Ground Control Points) should be collected from field using DGPS<sup>6</sup> for georeferencing of Satellite Image. Minimum 10 GCPs should be collected. These points should ideally be spread over the entire planning area.
- e. *Step – V: Georeferencing of Satellite Image:* The process of defining the position of geographical objects relative to a standard reference grid is known as georeferencing. It is a system that links information to a position on earth’s surface. The GCPs collected during DGPS survey can directly be downloaded in the GIS platform and will be used as tie point for georeferencing of Satellite image. The detailed step by step process of georeferencing has been explained in Annexure I.

<sup>5</sup>Refer to 2nd CSMC Minutes of Meeting Dated 19th January, 2012.

<sup>6</sup>Differential Global Positioning System is an enhancement to Global Positioning System that provides improved location accuracy, from the 15-meter nominal GPS accuracy to about 10 cm in case of the best implementations.



f. *Step – VI: Feature Extraction from Satellite Image for preparation of City Base Map:*  
Following thematic layers needs to be extracted/digitised:

1. Administrative boundaries (planning area, municipal, zones & wards). Each boundary needs to be marked on the satellite image using GPS survey points.
2. Key physical features such as roads, rivers, railways, water bodies, important land marks etc.
3. Land use & Land cover

*Delineation of Slum Boundary and Identification of Vacant land on the GIS Base Map:* After finalisation of the updated Slum list, each Slum will be marked on the city base map using GPS survey points and satellite image. This information will be saved in a separate thematic layer (Slum Boundary), over the City Base Map. The Slum boundary layer should indicate the Slum code numbers of all the Slums. After demarcation of all the Slum boundaries in GIS interface, a unique Slum code needs to be entered in the attribute field of Slum Boundary layer. This unique Slum code should be the same as the Slum codes to be given or already given in the NBO format (Slum Profile, Revised Annexure I Part C) for socio-economic surveys, which will be used as common reference point for integration of socio-economic data and GIS data at Slum level. This will become the Slum code for all future references to that Slum. Before initiating the process of delineation of Slum boundary and Slum survey, ULBs need to finalise the unique slum code (as specified in revised Annexure I of NBO format) of each Slum. In the same way, vacant lands should be identified and marked in a separate thematic layer on the city base map of planning area with the help of satellite image and field verification.<sup>7</sup>

During the preparatory phase, 20 cities (Ajmer, Bhopal, Jabalpur, Indore, Gwalior, Hyderabad, Vijaywada, Belgaum, Bellary, Shimoga, Tumkur, Davangere, Gulbarga, Hubli Dharwad, Mangalore, Kathua, Annathnag, Udampur, Agartala, Madurai) have completed preparation of City base map and SFCpoA. The city like Ajmer (population – 5.42 lakh as per census 2011) with planning area of 375.36 Sq. Km took approximately 1 month for preparation of city base map and approximately 6 months for completing entire process of preparation of SFCPoA.

<sup>7</sup>Note: Data for administrative boundaries including Slum boundaries may be available in two forms, technical description/coordinates and paper maps. Annexure – I may be referred for detailed step by step process of delineation of boundaries from technical description/coordinates and paper maps.



## 2.2 Data entry into Online Monitoring System for Slum, Household & Livelihood

**Survey:** The Slum Survey data collected through Socio Economic Survey should be entered in Online/Offline Monitoring System for Slum, Household & Livelihood Survey (<http://surveys.cgg.gov.in/>). The Slum Survey Format (Annexure I of NBO format) has been revised<sup>8</sup> by highlighting essential /mandatory parameters and adding some additional fields for the purpose of preparation of SFCPoA. Data entry into online/offline Monitoring system needs to be done as per the revised format. Cities/towns that have completed their slum survey under USHA Scheme should validate/ratify the data and incorporate changes in the slum survey data into MIS, if required. The analysis reports which can be generated in MIS have been detailed out at Annexure III.

**Note:** As the complete process of GIS & MIS integration at Slum level is dependent on the Unique Slum Code, ULB should take necessary steps to ensure that same unique code (example of unique slum code: 0001 - 9999) has been entered in MIS & GIS data of each slum.

Preparation of city base map and data entry into MIS can be done simultaneously as shown in Flow chart - 1

**2.3 GIS & MIS Integration at Slum Level:** Integration of GIS with MIS means matching the common parameters (fields) from the attribute of the spatial data (Map) with MIS based common fields. This would enable the viewing of the integrated data and the preparation of the reports. Under RAY, Unique Slum code will be the common reference point for GIS MIS integration at slum level. Based on this unique slum code, the attribute tables associated with the GIS layers of geo-referenced base map will then be integrated with MIS at Slum, zone and city level base maps on GIS platform. The data integration procedure from MIS to GIS has been illustrated in Annexure IV. After integration, the socio-economic and other databases on tenability, land tenure, land ownership, land value of Slums in MIS could be viewed spatially on the GIS map. Further, the entire process of tenability analysis and prioritisation of slums can also done in GIS and the process of tenability analysis and prioritisation of slums under GIS have explained in Annexure V.

<sup>8</sup> Refer D.O No. N-11011/43/2013-RAY-II dated 13<sup>th</sup> May'2013, Guidance Note & Revised format may be downloaded from [http://mhupa.gov.in/ray/Annexure\\_I\\_Slum\\_Survey\\_Format\\_Revised\\_for\\_RAY.pdf](http://mhupa.gov.in/ray/Annexure_I_Slum_Survey_Format_Revised_for_RAY.pdf)



The list of standardised thematic layers needs to be generated at this stage have indicated in Annexure VI

Note: MIS linked GIS databases of City base map will be fundamental datasets for ULBs; therefore it must be prepared correctly. In case ULBs do not have the capability to create such data, it is recommended to outsource the work to any Agency with expertise in image processing and GIS. Detailed Guidelines for engagement of Technical Consultants and Model Bid document for GIS Mapping under Rajiv Awas Yojana (RAY), have been provided at Annexure VII & VIII.



### 3. GIS Mapping & GIS MIS Integration for Preparation of Detailed Project Report (DPR):

On the basis of prioritization of slums in SFCPoAs, cities would be required to prepare Detailed Project Reports (DPRs) following a 'whole slum' approach. In each selected slum, an integrated approach would be adopted with the provision of housing, basic civic infrastructure and social amenities. The detailed Slum Base Map prepared using Total Station Survey (TSS) data and GIS enabled MIS data at household level will help to establish the locations and spatial dimension of property and also to improve the coverage and provision of municipal services.

#### 3.1 Preparation of Geo Referenced Slum Base Map of Prioritised Slums using TSS:

In case of Slums which are prioritised and are to be developed in situ, it is required to carry out detailed physical survey using Total Station<sup>9</sup> for preparation of DPR. During preparation of DPR, for detailed infrastructure planning and designing of a slum, it is necessary to map the existing infrastructure, the actual ground coverage of each house/building and also the topography. For this purpose it is required to create spatial information at 1:500/1:200 scale. This large scale map cannot be derived only using high resolution satellite data. Thus, it is required to create detailed plan by carrying out Total Station Survey for the slum selected for intervention and preparation of DPR.

With the use of total station topographical survey will be faster, accurate and can be performed at multiple sites simultaneously. It is capable of creating many more data sets. TSS data can be quickly and directly transferred to computer which in turn will reduce the scope of manual error to bare minimum. Further, computers can be employed for map making and plotting contour and cross-sections. Contour intervals and scales can be changed in no time. Therefore, it is recommended to use Total Station for surveying instead of any traditional method of surveying for preparation of DPR.

Further, it is also required to carry out TSS and Slum mapping exercise in the 100 -200 meter peripheral belt of the slum. This will help to establish linkages with cities existing trunk infrastructure and total fund requirement for establishing the said linkages.

For the preparation of digitized base map (Annexure VI) of the Slum, the following information needs to be collected from the field survey/total station survey:

<sup>9</sup>A total station is an electronic/optical instrument used in modern surveying. It consists of an EDM (Electronic Distance Meter), Theodolite, Microprocessor combined into one. It also has a memory card to store the data.



- Slum boundary with schedule of boundaries of related Slum / Slum pockets.
- Width and length of plots of all occupants, building foot prints.
- Approach road, streets, lanes, by-lanes in the Slum.
- Existing land use such as residential, commercial including petty shops or others.
- Type and length of existing roads (CC, BT, WBM and earthen)
- Existing water supply lines and details of Public Stand Posts (PSPs), bore wells, hand pumps and individual connections.
- Details of sewerage system and Sanitation services – individual, community and public toilets.
- Details of storm water drains and the pucca / kutcha drains leading to final disposal points.
- Solid waste management system with details of dustbins and collecting points.
- Street lighting with pole number, location and type of fixture and distance to transformer and its capacity.
- Community hall, anganwadi centre, PHC/HC, primary school and other educational institutions.
- Contours at 0.5 m and 1.0 m intervals shall be incorporated through total station or similar spatial survey techniques.

**Note:** Before initiating TSS, Municipal Officials should conduct data inventory of the existing data sets within its own department or any other department of State Govt. The data may be available in the form of GIS layers or paper maps. The same needs to be modified/updated during the time of physical survey, if required.

Whenever total station surveys are carried out, care should be taken to establish control points and temporary bench marks (TBM) at suitable locations during survey for use at a later stage or during implementation of works. The list of such control points and TBM



shall be recorded both in drawing as well as in MS excel format. During the survey, all levels should refer to mean sea level (MSL). For this purpose, GTS benchmark<sup>10</sup> should be used. If a GTS benchmark it is not available within the town or city, the nearest GTS benchmark should be used to establish one or more control points using a closed traverse. It is required to capture at least levels at road intersections/junctions covering the entire Slum up to points of connectivity to town wide infrastructure with respect to water supply, sewerage and storm water drainage systems like ELSRs/GLSRs/Sumps/pumping stations etc. While the Total Station Survey generally captures all surface features, underground utilities like water supply, pipeline, sewer line, electric cables etc will have to be superimposed on drawings generated out of Total Station Survey. In general, Total Station Survey drawings are plotted on CAD platform. These drawings need to be converted into the GIS platform and superimposed over City Base Map.

### 3.2 Data entry into Online Monitoring System for Slum, Household & Livelihood Survey:

The Household and Livelihood Survey data collected through Socio Economic Survey needs to be entered in Online/Offline Monitoring System for Slum, Household & Livelihood Survey (<http://surveys.cgg.gov.in/>). The Household and Livelihood Survey Format (Annexure II & III of NBO format) has been revised<sup>11</sup> by highlighting essential /mandatory parameters and adding some additional fields for the purpose of preparation of DPR. Data entry into online/offline Monitoring system needs to be done as per the revised format. Cities/towns that have completed their Household & Livelihood survey under USHA Scheme should validate/ratify the data from community and incorporate changes in the Household & Livelihood survey data into MIS, if required. The analysis reports which can be generated in MIS have been detailed out in Annexure III.

**Note:** Preparation of slum base map and data entry into MIS can be done simultaneously as shown in Flow chart - 1.

### 3.3 GIS & MIS Integration at Household Level:

During Household survey, each house and household in the Slum should be assigned

<sup>10</sup>A G.T.S. (Great Trigonometrical Survey) benchmark is a permanently fixed reference survey station (or point), having known elevation with respect to a standard datum (mean sea level).

<sup>11</sup>Refer D.O No. N-11011/43/2013-RAY-II dated 13<sup>th</sup> May'2013, Guidance Note & Revised format may be downloaded from [http://mhupa.gov.in/ray/Annexure\\_II & III\\_Survey\\_Format\\_Revised\\_for\\_RAY.pdf](http://mhupa.gov.in/ray/Annexure_II_III_Survey_Format_Revised_for_RAY.pdf)



unique number<sup>12</sup> by Municipal authority. In case, houses and household do not have house and household number, ULB should issue unique numbers for each house and household. The same unique numbers must be given to the TSS team, by the ULB authorities, so that they can assign the same number in the GIS (TSS) database (attribute field) against each building foot print of the priority Slums. The unique house number will be used as a common reference point for GIS (TSS)-MIS integration at household level. GIS MIS integration at Household level is to be done for the purposes of preparing DPR.

**Note:** ULB should take necessary steps to ensure that same House Number & Household Number has been entered in MIS & GIS data of each house & household. The unique House Number is important for GIS MIS integration for Household level. Further it is also noted that Unique Household Number will also be used for linkages with UIDAI for Biometric information.

The GIS enabled MIS data at household level will then be used for the preparation of following thematic layers during DPR stage:

- Existing Infrastructure Base Map of Slum
- Digital Elevation Model (DEM)<sup>13</sup>, Relief<sup>14</sup> & Slope Map of Slum.
- Socio economic condition of Slum Households
- Location & size of each dwelling Units

The GIS enabled MIS data at household level will be used for preparation of entire implementation plan and to track progress of construction of dwelling units.

**Note:** MIS linked GIS databases of slum base map and CAD data will be fundamental datasets for ULBs; therefore it must be prepared correctly. In case ULBs do not have the capability to create such data, it is recommended to outsource the work to any Agency with expertise in image processing, Total Station Survey and GIS. Detailed Guidelines for engagement of Technical Consultants and Model Bid document for GIS Mapping under Rajiv Awas Yojana (RAY), have been provided in Annexure VII & VIII.

<sup>12</sup>Example: House No – 1, Household No – 1/A, 1/B, 1/C etc. This will also determine how many Household is residing in one house.

<sup>13</sup>DEM will help to analyse ground condition of slum, topography, ground slope and direction of drainage. Further, this will also help to identify the vulnerable areas like prone to flooding/water logging and landslides (in case of hilly areas).

<sup>14</sup>Relief map will be used to generate 3D view of the Slum Base Map (existing housing and infrastructure condition) and the proposed development models (layout plans) during the preparation of DPR.



#### **4. Funding Pattern:**

The above mentioned activities will be funded by Central Government in the ratio 50:50 for cities with population more than 5 lakhs, 75:25 for cities with population less than 5 lakhs and 80:20 for NE and special category States. Financial norms in term of per unit cost for different activities for GIS mapping, data entry into MIS and GIS MIS integration are applicable as decided in 2<sup>nd</sup> & 3<sup>rd</sup> CSMC meeting held on 19.01.2012 & 11.09.12.

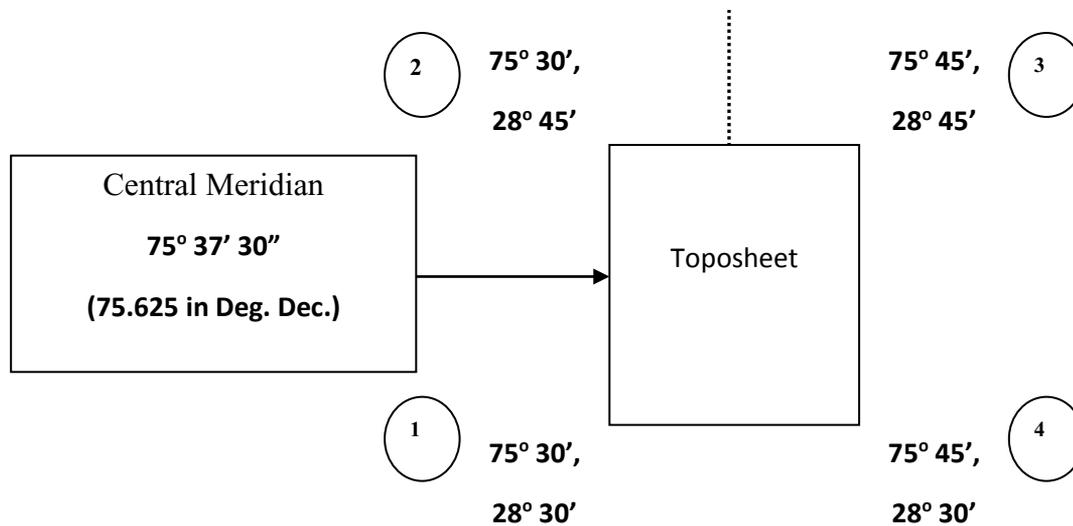


**Illustrative examples of Georeferencing of paper maps & DGPS survey points**

**a. Illustrative example: process of Georeferencing**

*Identification of Ground Control Points (GCPs) on existing maps:*

A set of GCPs could be identified on maps such as four corners of a toposheet (not limiting only to 4 corner points), which provides information of latitudes and longitudes at the four corners. For better results, additional known control points could be identified and mapped. These points should ideally be spread over the entire map. In the following example, the longitudes and latitudes of four corners are as indicated (For the sake of understanding, geo-referencing procedure is illustrated for only four corners points of a toposheets).



Values in Degree Minutes Seconds need to be converted into Degree Decimals. The four points would have following values respectively for points marked (1) to (4) –

Longitude	Latitude
75.5	28.5
75.5	28.75
75.75	28.75
75.75	28.5



Prepare a table as shown above for the GCPs in **.dbf** format. (Such a table could be prepared in MS Excel and saved as a Dbase table). This table could be named as GCP.dbf, which would be used for registration of the scanned toposheet. The step-by-step guide is given below of using ArcGIS georeferencing tool as an example.

*Creating a Master GCP layer:*

1. Open ArcMap. From the “View” menu chose “Data Frame Properties”. The Data Frame Properties window opens. It shows the Co-ordinate System Tab indicating “No projection” in “Current Co-ordinate System”. Co-ordinate system for the map needs to be specified.
2. Click on “New” button to choose “Projected Co-ordinate System”. A window for “New Projected Co-ordinate System” opens. Specify a name for the new co-ordinate system such as “My Projection”. In the projection frame – chose “UTM” from the drop-down list.
3. The remaining parameters of False Easting, False Northing, Central Meridian and Latitude of origin need to be specified, based on the extent of map. For this, we would take reference of Lat-Long values that we have used.
4. For example, following values will be considered as parameters
  - False Easting – 0.0
  - False Northing - 0.0
  - Central Meridian - 75.625 (Central meridian of the Toposheet)
  - Latitude of origin - 0.0
5. In the Geographic Projection System area, Click “Select” button. This opens the “Browse for Co-ordinate System” dialog. Double-click on “Spheroid Based” folder. From the available list, chose “WGS84.prj”. Click “Ok” on all the co-ordinate system windows. This would apply the specified projection and geographic co-ordinate system parameters to the “Data Frame”. Also, from the “General” tab, change the display units from “meters” to “Degree; Minutes; Seconds”. Click “Apply” and then “Ok” on the “Data Frame Properties” window.
6. Go to the main menu bar in ArcMap. Select “Tools” and then chose “Add X- Y Data”. A window for “Add X-Y Data” opens. From this “Chose a table from the map or browse for another table”



option, click on the button having an icon resembling “open folder” icon. Chose the appropriate location where your **GCP.dbf** table (created in step 2) is stored. Once the table name is selected, the fields of Longitude and Latitude are automatically picked up for X-Field and Y-Field. Do not select any spatial reference at this stage. Click “Ok” on the “Add X-Y Data” window. The system processes and adds a layer in Table of Contents and shows the four points on the display area. Thus, control points are established with the specified co-ordinate system.

7. Right click on the layer name in the Table of Contents, chose “Data” from the context menu and chose “Export Data”. (This would help to export this layer as a new shape file). You are asked by the software to opt between two options, which are –
  - Use the same co-ordinate system as this layer’s source data and
  - Use the same co-ordinate system as the Data Frame.
8. Select the second option and specify an output shape file name such as “Projected\_GCP.shp”.
9. In case of data available in DGPS, you can directly download GCPs from DGPS and convert into GIS format/shp file. Further, it is also necessary to define/project the projection system (as mentioned above).
10. You can use this projected shape file for assigning spatial reference information properties to other image file or vector files (Do not close ArcMap at this stage).
11. Go to ArcMap and add this image file. At first, the image file will not be seen in the display area. Now, go to the “View” Menu and select Toolbars > Georeferencing.
12. From the Georeferencing toolbar, make sure that “Auto Adjust” is un-selected.
13. From the same toolbar, click on “Fit to Display”. This would show the image file on the display area. Now, the image as well as control points will be visible. Using “add control points button” on “georeferencing” toolbar, links between points on the toposheet image and the control points can be added. When all the links have been established, select “Update Display” from the “georeferencing” toolbar.
14. This would register the image with GCPs. Now, select the “View Link Table” button from the “georeferencing” toolbar, RMS error in the form of “Residual” will appear. If the RMS error is



within acceptable limits select “Auto Adjust”.

- Following images present an illustration of how a map is scanned and geo-referenced. Figure I.1 below shows a scanned map. After the image is set to match the projection of the base map, the scanned image would be appropriately positioned aligning with the base map with appropriate x, y coordinates as shown in Figure I.2.

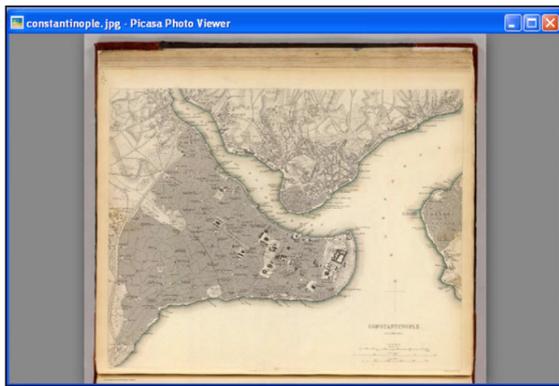


Figure I.1: Scanned Map

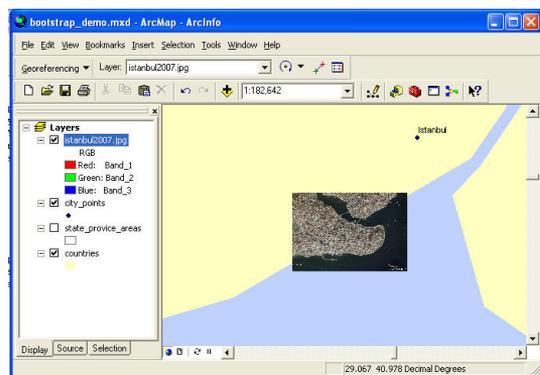


Figure I.2: Projected Scanned Image

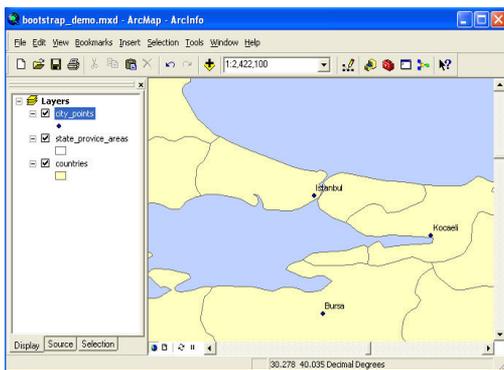


Figure I.3: Identifying and fixing control points

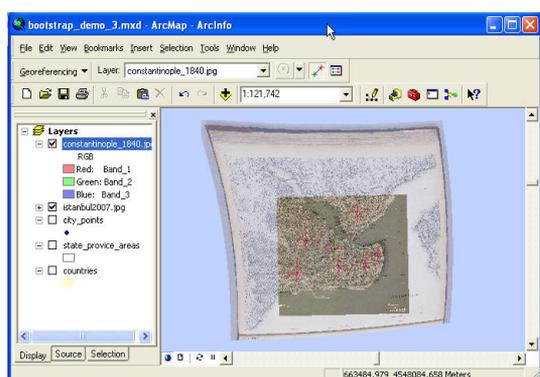


Figure I.4: Creating polygons using Control points

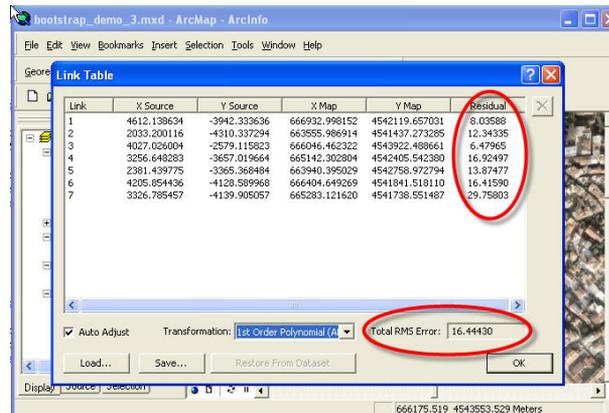


Figure I.5: Populating fields

Based on the feature of interest, multiple coordinates could be digitized and hence, polygons can be drawn (Figure I.5). The attribute table of the polygon will have to be then populated with information pertaining to the polygon. For instance, if a slum is digitized from the map, information on land ownership, dimensions of the structure and any relevant information need to be populated under individual fields. An example of populating fields is shown in Figure I.2 above. Each polygon would also have a unique identification number.

### b. Illustrative procedure of digitizing CAD based paper maps or toposheets

If there are CAD based paper maps available, those maps can also be digitized using the procedure explained above. ULB will be able to convert a CAD file with necessary geo-coordinates to a GIS vector file format (shape file). Following figures (Figure I.6 to Figure I.10) are an illustration of how CAD based maps could be digitized.

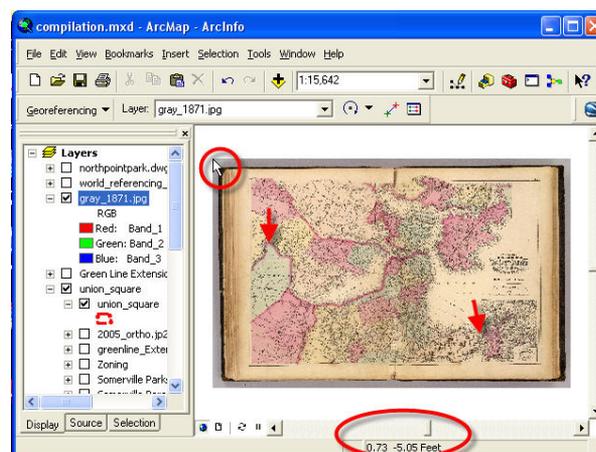


Figure I.6: Scanned Image

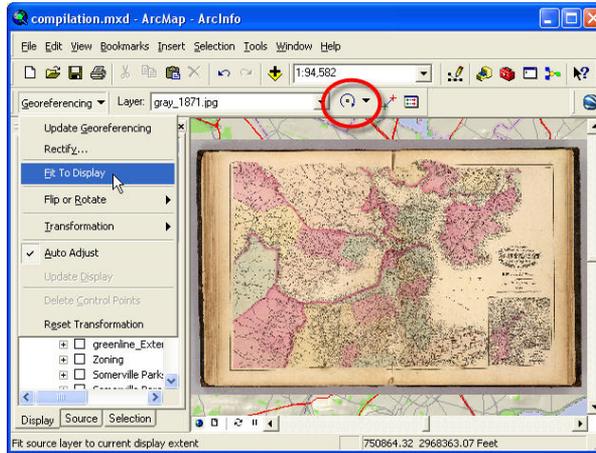


Figure I.7: Activate geo-reference tool (red circle)

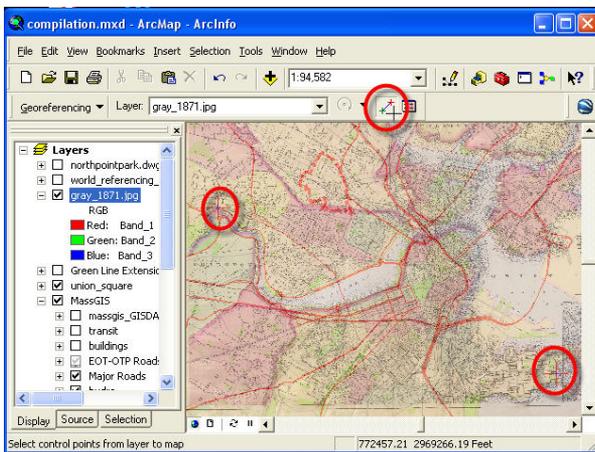


Figure I.8: Set Control points as shown

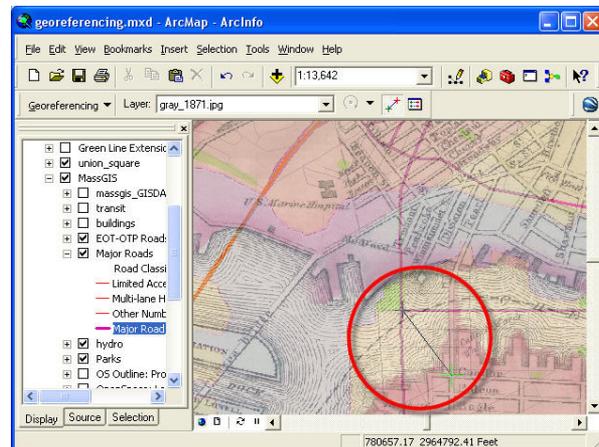


Figure I.9: Setting up additional control points

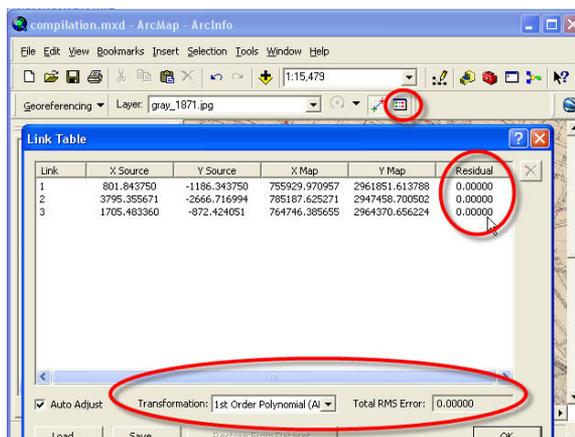


Figure I.10: Populating the attribute table of line shape file



After digitizing the scanned map and vectorisation with associated attributes, a separate layer will be created with appropriate title as shape file. Along with the city base map and other infrastructure layers such as roads, sewer and other permanent feature shape files, the newly created layer would also be brought into the user interface on the screen as required. This layer, as with other layers could be activated and de-activated depending on the need.



### Potential Sources of Base Map Features

Base map features	Potential source of data
<b>Administrative boundary</b>	
State Administrative boundary	Survey of India (SOI), Open Series of maps
Municipal and ward boundary	ULBs
Slum/Habitations boundary	ULBs/Municipalities, generate using satellite data, GPS based field data
<b>Natural features</b>	
Natural landmarks	SRSAC, ULBs, SOI, generate using satellite data ,GPS based field data
Stream, creek	SRSAC; ULBs, SOI, generate using satellite data ,GPS based field data
<b>Man-made features</b>	
Roads: National; City/Municipal/Slum (line segment)	SRSAC, ULBs, SOI, generate using satellite data satellite data
Railway (line features)	SRSAC, ULBs, SOI, generate using satellite data
Airport (line features)	SRSAC, ULBs or Directorate of Economics & Statistics, SOI, generate using satellite data , GPS based field data
Built-up area of slums in a generalized manner	Satellite imagery, aerial photograph, GPS based field data
Other landmarks such as temples, mosques, church etc. (points or polygon)	SRSAC; ULBs, SOI, GPS based field data
Contour lines	SOI, Ground Survey
Cadastral maps	ULBs, land records and survey (LRS)

#### Note

For detailed contact addresses of State Remote Sensing Centres and for other information like list of standard GIS packages, list of empanelled agencies for quality assurance of base maps/GIS maps and specifications for procurement of hardware & software, previous guidelines on GIS Mapping, MIS development and Integration of GIS with MIS issued by MoHUPA during preparatory phase may be referred.



### List of Standardized Reports

#### Slum Reports

- Number of Notified/Non-Notified slums in State/UT's
- Distribution of slums according to area in State/UT's
- Distribution of slums according to their age in years in State/UT's
- Distribution of slums by location in each state/UT's
- Distribution of slums by type of area surrounding slums
- Distribution of slums by physical location of slum where the slum is located
- Distribution of slums by type of ownership of the land where the slum is located
- Distribution of Slum Population by Caste
- Distribution of Slum BPL Population by Caste
- Distribution of Households by Caste
- Distribution of No of slums by type of structure of the dwelling units
- Distribution of No of slums households by different income group
- Distribution of No of slums by land tenure status of the dwelling units
- Distribution of No of slums households source of drinking water
- Distribution of No of slums households existing source of drinking water
- Distribution of No connectivity of the slum to city-wide water supply system
- Distribution of No of slum households having access to drainage & sewerage facility
- Distribution of No of slums households by different occupation
- Distribution of slum having connectivity to city-wide storm-water drainage
- Distribution of No of slums connectivity to city-wide trunk sewerage
- Distribution of slums being prone to flooding due to rains
- Distribution of No of slum households according to use of different type of latrine
- Distribution of slums according to frequency of garbage disposal
- Distribution of slums according to arrangement for garbage disposal
- Distribution of slums according to frequency of clearance of open drains
- Distribution of slums by type of approach road/lane constructed path to the slum
- Distribution of no of slums according to distance in from the nearest motor able road
- Distribution of no of slums by type of internal road in the slum
- Distribution of no of slums having street light facility in the slum
- No of slums by distance from nearest anganwadis primary schools



- No of slums by distance from nearest Municipal pre-school
- No of slums by distance from nearest Private pre-school
- No of slums by distance from nearest Municipal Primary School
- No of slums by distance from nearest State Government Primary School
- No of slums by distance from nearest Private Primary School
- No of slums by distance from nearest Municipal High School
- No of slums by distance from nearest State Government High School
- No of slums by distance from nearest Private High School
- No of slums by distance from nearest Adult education centre
- No of slums by distance from nearest Non-formal education centre
- No of slums by distance from nearest Urban Health post
- No of slums by distance from nearest Primary Health Centre
- No of slums by distance from nearest Government hospital
- No of slums by distance from nearest Maternity Centre
- No of slums by distance from nearest Private Clinic
- No of slums by distance from nearest Registered Medical Practitioner
- No of slums by distance from nearest Ayurvedic doctor/vaidya
- No of slums by availability of no of community hall within slum
- No of slums by availability of no of Livelihood centre within slum
- No of slums by availability of no of Vocational training/Training-cum-production centre within slum
- No of slums by availability of Street children rehabilitation centre within slum
- No of slums by availability of no of Night shelter within slum
- No of slums by availability of no of Old Age Home within slum
- No of slums dwellers holding/covered under social development/welfare schemes
- No of Self Help Groups/DWUCA Groups functioning within slum
- No of Thrift and Credit societies functioning within slum
- No of slums having slum-dwellers association in the slum
- No of Youth associations functioning within the slum
- No of Women associations/Mahila samithis functioning within the slum

### Household Reports

- Distribution of slum population by sex
- Distribution of slum households by caste



- Distribution of slum households by religion
- Status of slum as per minority status
- Distribution of female headed household in slum according to the marital status
- Distribution of illiterate adult members in the slum household according to the gender
- No of children in slum household in the age group 6-14 not attending school
- No of handicapped person per family in slums
- Status of female major earning member in the slum household
- Distribution of families below poverty line in slums
- Distribution of slum household by land tenure status
- Distribution of slum household by house type/structure
- Distribution of slum household by type of roof
- Distribution of slum household by type of flooring
- Distribution of slum household by type of lighting
- Distribution of slum household by type of fuel for cooking
- Distribution of slum household by source of drinking water
- Distribution of slum household by duration of piped water supply
- Distribution of slum households according to the distance from the source of water supply, if it is outside premises of the household
- Distribution of slum household according to the existence of toilet facilities
- Distribution of slum household according to bath room facilities
- No of slum households by type of road in front of houses
- No of slum households by type of pre-school available
- No of slum households by type of high-school available
- No of slum households by type of health facility access
- Access to welfare benefits to family members in the slum household
- Possession of consumer durables among slum households
- Possession of livestock by slum households
- Migration details of household of slum according to no. of years of stay in this town/city
- Migration stream of household of slum
- No of slum households by type of migration
- Reason for migration of household of slum
- Income-expenditure details of households of slum
- Average monthly income of households of slum



- Average monthly expenditure of households of slum
- Debt outstanding as on date of survey of household of slum

### **Livelihood Reports**

- No of earning members of slum households
- Distribution of earning members of slum households according to age groups
- Distribution of earning members of slum households according to religion
- Distribution of earning members of slum households according to caste
- Distribution of earning members of slum households according to educational qualification
- Distribution of earning members of slum households according to skill training acquired
- Distribution of earning members of slum households according to type of institution from which skill training received
- Distribution of earning members of slum households according to employment status
- Distribution of earning members of slum households according to distance to place of work
- Distribution of earning members of slum households according to time of work
- Distribution of earning members of slum households according to monthly earning
- Distribution of earning male & female members of slum households according to primary and secondary occupation
- Distribution of unemployed members of slum households according to reason for unemployment
- Distribution of male members of slum households preferred area for training for primary occupation
- Distribution of male members of slum households preferred area for training for secondary occupation
- Distribution of female members of slum households preferred area for training for primary occupation
- Distribution of male members of slum households preferred area for training for secondary occupation

### **Analysis Reports**

- Slum Profile
- Distribution of slums with reference to population and location
- Distribution of slums with reference to age and location



- Slum Profile - Distribution of population and households
- Average Monthly Income of Household
- BPL data and Economic profile of slum
- Average Monthly Expenditure of Household
- Relationship between age and Density in Notified slums
- Relationship between age and Density in Non-Notified slums
- Distribution of slums with reference to area and physical location
- Slums Prone to floods
- Distribution of Slums with reference to Land Use of Surrounding Area
- Distribution of Slums based on land ownership, age and legal status
- Distribution of Household living on rent, land and ownership
- Distribution of Slums based on land ownership, population and area
- Distribution of Slums based on legal status, population and area of slums
- Distribution based on availability of facilities within slums
- Distribution of slums based on availability of Social Groups/Associations within slums
- Distribution of number of beneficiaries (holders) under social Development/Welfare Schemes
- Slum Population/ Slum Growth at glance
- Overall Slum Area, Population and Households in the city (City Profile)
- Health Facilities located within the slums or at some distance from the slum
- Education Facilities located within the slums or at some distance from the slum

### Exception Reports

- Status of slums Whether Notified or Non-Notified has not been Captured
- Number of Slums for which population and households ratio  $\leq 3$  (including 0) or  $\geq 7$  (including infinity)
- Number of Slums for which Area=0sqm
- Number of Slums for whose age  $\leq 3$  (including 0) or  $\geq 50$  (including infinity)
- Number of Slums for which basic information indicators have not been entered
- Number of Slums for which water, sanitation and road infrastructure has not been captured
- Number of Slums for which education facilities have not been captured
- Number of Slums for which health facilities have not been captured
- Number of Slums for which social development facilities have not been captured



- Number of Slums for which pension holders information has not been captured
- Number of Slums for which no. of SHG's and other societies information has not been captured



### Illustration of data integration from MIS to GIS

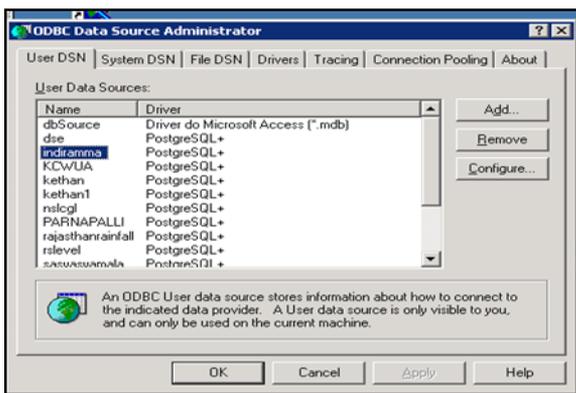
The illustration given hereunder is the procedure adopted using the ArcGIS software as an example. Data from a tabular relational database can be brought into ArcGIS (and most other GIS software programs) in at least two ways:

- Databases in .dbf format can be imported into ArcGIS from any source that supports the .dbf format
- Databases can be queried “live” using SQL and ODBC capabilities - this method may be preferable in situations where data is continually being updated by MIS System (Surveys).

Using the Open Database Connectivity (ODBC) Manager to Configure a Connection:

The ODBC Manager in Windows XP/NT manages how different databases including Excel, Access, Arcview, etc., can link to one another. Before any link is made a connection must be established by using the ODBC Manager. Following steps illustrates the procedure.

1. Click on the Windows START button, then go to SETTINGS - CONTROL PANEL
2. In the CONTROL PANEL window, double click on the ODBC icon.
3. Following interface form will be visible.



FigureII.1: ODBC data source admin

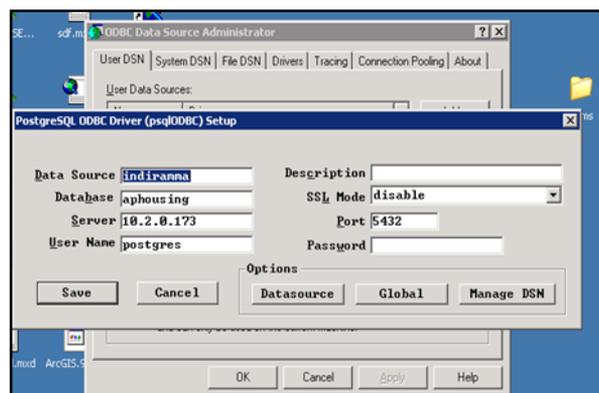


Figure II.2: ODBC data source set up

4. Under the User DSN tab, click Add.
5. Select the Microsoft Access Driver and click Finish.
6. For Data Source Name, type ms-access
7. Choose OK. The “ms-access” driver should now appear under User Data Sources
8. Click OK to exit
9. Close the CONTROL PANEL
10. The Basic SQL Connect Process
11. Assuming there is access to PostGres database (including tables or queries), follow these steps to connect to it from ArcGIS. By right clicking the appropriate layer, system will display the popup menu.

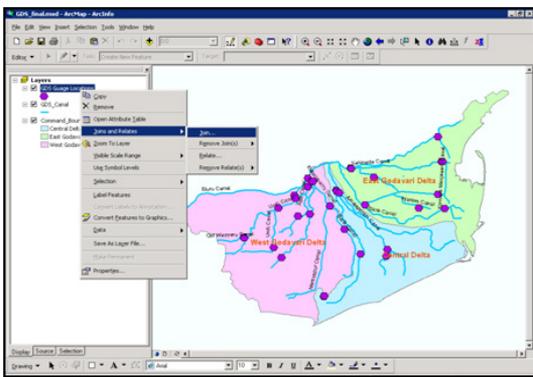


Figure II.3: Linking data source to base map

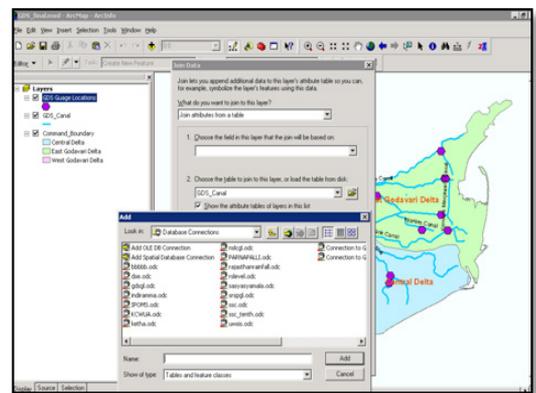


Figure II.4: Linking MIS table to ArcGIS ArcGIS basemap

12. As shown in figure above, go to 'Join and Relates' and then click on 'join'. The system will display the below screen.
13. Referencing figure above, browse the relevant data source and select the app table and chose the common field in the ArcMap attribute data and the data source table. With this process the system will link the data to ArcMap.

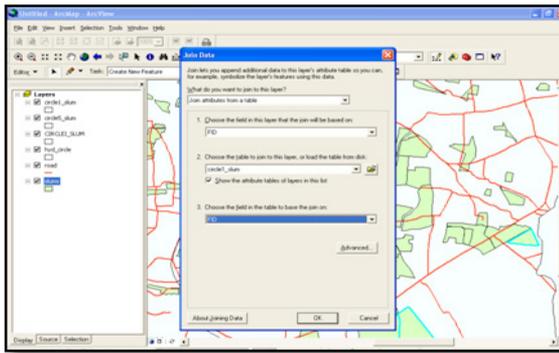


Figure II.5: Linking the MIS fields to ArcIMS basemap

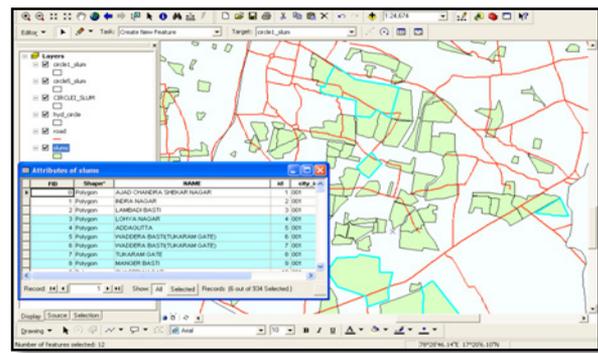


Figure II.6: ArcIMS, MIS data mapped

After joining the data source to ArcIMS, MIS data mapped will be displayed as shown in figure above.



### Tenability Analysis & Prioritisation of Tenable Slums using GIS

- 1 *Tenability Analysis*: Creation of 3 thematic layers in GIS - Tenable, Semi tenable (will be determined by overlaying Slum Boundary layer over Master Plan Map) and Untenable.<sup>15</sup>
- 2 *Prioritisation of Tenable Slums*: Prioritisation of Tenable Slums will be done based on the infrastructure, housing condition, tenure status and BPL, SC / ST population. Separate sets of thematic layers will be used to analyse the status of infrastructure, tenure and vulnerability of Slums.<sup>16</sup> The steps to be followed for prioritisation of tenable Slums using GIS are as follows:
  - Creation of Infrastructure deficiency layer by sorting following parameters from the main Slum Boundary layer of GIS Base Map
    - o Percentage of households not covered with piped water supply
    - o Percentage of households not covered with individual toilets
    - o Percentage of length not covered with pucca drains
    - o Percentage deficiency of pucca road, narrow access (<3m)
    - o Percentage of road length without street lights
    - o Percentage of households without access to facilities of disposal of solid waste
  - Creation of vulnerability condition layer by sorting housing condition, BPL and SC/ST parameter from the main Slum Boundary layer of GIS Base Map
  - Assigning scores to each parameter of Infrastructure and vulnerability layers.
  - Add a table/field to calculate average score/ weightage in both the layers.
  - Use Weightage Sum technique to calculate final score and preparation of final thematic layer of prioritised Slum.

<sup>15</sup>Refer Step2, 2.2 of Guidelines for Preparation of Slum Free City Plan of Action.

<sup>16</sup>Refer Step2, 2.3 of Guidelines for Preparation of Slum Free City Plan of Action.



### Standardised list of Thematic Layers/Maps

#### Stage - I

1. Location map of the city showing regional setting (India-State-District-City)
2. Geo-referenced city base map
3. Slum pockets marked on the GIS base map with municipal boundary and ward boundaries.
4. Slum pockets marked on the satellite image of the Planning Area
5. Existing land use land cover of Planning Area
6. Tenable, Semi-tenable and Untenable slums
7. Tenure status of slums
8. Land ownership of slums
9. Slum Density
10. Land value ranges of areas under slums
11. Vacant land pockets marked on the satellite image of planning area
12. Vacant land with trunk infrastructure marked on satellite image of planning area
13. Vacant land with residential zoning marked on satellite image of planning area
14. Vacant land with non-residential zoning marked on satellite image of planning area
15. Land pockets reserved for EWS/LIG housing including in industrial estates.(if any)
16. Spatial distribution of affordable housing zones developed in the last 5 years

#### Stage – II

- Georeferenced Slum Base Map
- Land use Land cover Map
- Existing infrastructure layout
- Location & Size (Building foot prints) of existing Dwelling Units & all other plots (including vacant plots)



## **Guidelines for Technical Support Institutions/ Agencies/ Consultants and the norms of engagement of Technical Consultants to be engaged by the States/Cities under Rajiv Awas Yojana (RAY), MoHUPA.**

### **1.1 Introduction**

This section is intended to provide guidance to the ULBs regarding the work to be carried out for mapping by external agencies such as Technical Consultant and / or institution to be engaged by the ULBs in the event that the ULBs themselves are unable or not in a position to carry out the work themselves. The quality checking of the deliverables may be carried out by the ULB through a Third Party Inspection Monitoring (TPIM) process.

### **1.2 Scope of Work**

#### **1.2.1 Brief Description of work**

The work may comprise either or both (i) city level mapping and (ii) mapping of slums in a particular ULB. In case of City level mapping, the work will comprise preparation of Base Maps of the geographical area generally within the ULB area and around, depending on specific requirement of a ULB. The Base Map will depict all physical features like roads, highways, railway lines, parks, open areas, water bodies (e.g., rivers, canals, nalas etc.), administrative boundaries like municipal boundaries, ward boundaries etc. in separate layers., In case of Slum Mapping, the work will comprise of preparation of maps of slums showing each property or structure, lanes, open areas, landmarks, surrounding roads/lanes/ access etc.

Ground truthing has to be carried out along with the collection of attribute data for spatial features. The bidders will have to deliver the final outputs in CD-ROM media (should be readable under standard windows NT/2000 platform) and hard copy. Each of the activity will be followed by quality assurance checks by the RAY Technical Cell experts (city team) and the Municipal Corporation officials or the empanelled agency/State level Space Application Centre (SRSACs).



### 1.2.2 Objectives

The objectives of Mapping are:

- Develop a common digital geo-referenced base map that will be used by all participating sections/departments within ULB for detailed mapping. This map is to be updated regularly to maintain an accurate and reliable information data base on properties and all components of infrastructure on a common, scalable and physically verifiable municipal GIS platform.
- Establish the locations of property (building or plot) in slums onto the GIS base map and its corresponding data which would provide a spatial dimension of Properties.
- Improve the coverage and provision of municipal services (e.g. water and sewerage connections) through mapping of all existing infrastructure facilities onto the map.
- Allow spatial analysis of service provision levels, revenue generation and social composition, particularly identifying the location of poor and socially excluded communities.

### 1.2.3 Description of Tasks

#### (a) Preparation of Geo-referenced City Base Map and Slum Mapping

This task is focused on the preparation of digital geo-referenced GIS base map for the town/city/agglomeration limits of the ULB. It is likely that the ULB may or may not have GIS base maps obtained from satellite imageries. ULB should share existing GIS database /paper maps/satellite image with TC. The Technical Consultant (TC) shall review all available maps (either print on paper or available soft copies), quality of available data and date(s) of acquisition as well as their scales. In the absence of GIS maps, the TC shall procure such satellite images or maps from official sources (e.g., NRSC, State RSACs etc.) or other reliable sources. In case the ULBs have paper maps on a suitable scale, the TC may geo-reference it using GPS, as outlined in **Annexure I**.

Total Station survey will be used for slum mapping. The base map shall contain all key physical features, the boundaries of each plot or building (structure) and a plot or building identification number (Unique House no & Household no as specified in Section 3.3). The map shall be multipurpose and could be used by various sections of the ULB such as engineering, revenue (taxation) and town planning.



### (b) Data Contents and Specifications

The preparation of geo-referenced city base map shall be based on high-resolution latest satellite imageries and DGPS. Slum mapping shall be done using Total Station Survey. To facilitate sharing of information between various municipal sections, it is critical that GIS base mapping be compatible with standard data base formats as specified below.

- Vector data format: Shape file format (.shp)/ Geodatabase
- Raster data format (including Satellite image): Geo tiff
- Projection: UTM
- Datum: WGS 84

The base map shall be prepared using various layers for ease of operation in GIS. Each layer shall include, but not be limited to, the following:

**Table: Data contents and specifications**

Sl. No	Layers	Data contents and specifications	Availability of existing GIS layers
1	City /Town Base Map	<ul style="list-style-type: none"> <li>- Refer to Section 2.1 detailed guidelines in the preparation of Base maps.</li> <li>- Major physical features, such as highways, roads, railways, important land marks (temples, mosques etc.), water bodies, canals, rivers etc; depicting right-of-way.</li> <li>- Municipal/agglomeration boundary, ward and zone boundary and slum boundary</li> <li>- Land use &amp; Land cover including location of Vacant land</li> <li>- The Technical Consultant will also mark the approximate boundaries of each slum in clear outlined location onto the municipal base map.</li> </ul>	



Sl. No	Layers	Data contents and specifications	Availability of existing GIS layers
2	<b>Slum Base Map</b>	<ul style="list-style-type: none"><li>- Refer to Section 3.1 detailed guidelines in the preparation of Base maps.</li><li>- Foot prints of each building (structure) and its use (residential, commercial etc.), number of levels (storeys), community centres, anganwadis, balwadi centres, community toilets, schools, health clinics/post offices and religious structures.</li><li>- Structures related to garbage collection, boundary walls and fencing and other utilities, plinth level of each building structure.</li><li>- Open (vacant) plots, play grounds, parks and gardens</li><li>- Commercial and non-household based activity areas such as small factories and manufacturing units if any</li></ul> <p>Integration of GIS data with MIS data at slum level</p> <p>Existing Infrastructure at Slum Level</p> <ul style="list-style-type: none"><li>- Roads &amp; footpaths (both pucca and kutcha), Parks, Playgrounds and Open spaces, all drains with direction of flow (in the case of larger drains, sections and levels), landmarks e.g., Places of Worship, Police Stations, Bus Stations etc;</li><li>- Water supply pipelines, source works e.g., bore wells/hand pumps etc. or municipal supply), public water stand-posts</li><li>- Sewers, location of manholes (gutters)</li><li>- Street lights, electric poles</li><li>- Power and telecommunication lines / poles</li><li>- Natural and man-made drainage channels</li><li>- Elevations at all road junctions and turnings</li></ul>	



Sl. No	Layers	Data contents and specifications	Availability of existing GIS layers
		<p><i>Existing Offsite infrastructure (adjacent linked infrastructure)</i></p> <ul style="list-style-type: none"> <li>- Urban Infrastructure e.g., Roads/lanes/access, drainage, sewerage, water and power (access roads, location of secondary water mains and information on any main drains running through the slum or to which the slum is connected.</li> <li>- Distances of slum to city wide services like access road, outfall drain, section of offsite drains and major culverts, disposal points and HFLs, diameters of pipes, ELSR/GLSR capacities and levels.</li> <li>- Diameters of trunk sewer, MH top and invert levels at junction with main sewer distance from the slum settlement and capacity of treatment facilities. Transformer (location and capacity) connection for street lighting.</li> <li>- Municipal Corporation boundary, ward and zone boundaries and slum boundary</li> </ul> <p>Contours</p> <ul style="list-style-type: none"> <li>- Contours at 0.5 meter interval. Spot levels at all junctions, changes in slope and at 30 meter intervals along all roads and lanes.</li> <li>- GTS Bench mark – Exact location, Reduced Level and notation</li> <li>- TBM – Exact location, Reduced Level and notation.</li> <li>- DEM &amp; slope map</li> </ul> <p>Integration of GIS data with MIS data at household level</p>	



ULB should issue unique numbers for each house and household. The same unique numbers will be assigned to all buildings or structures in each slum. This is critical for proper representation of geographical data and location of each structure, which shall form part of GIS for the spatial analysis and will link property referencing for Unique Identification Authority of India. In the case of digitization, the data needs to be checked for accuracy, completeness, displacement, edge matching, symbology etc. All accuracy specifications as described by the implementing agency will have to be strictly adhered to. Adequate number of benchmarks shall be put and catalogued.

#### **1.2.4 Quality assurance**

In order to maintain the desired quality of mapping, it is required to assure the quality of work. In the case of preparation of city-level Base Maps using high resolution latest satellite imageries such as, Cartosat or Quickbird images, spatial accuracy needs to be maintained. In case of digitization and geo-referencing of paper maps of various components of infrastructure, the method to be adopted for digitization shall conform to the standards prescribed by the Survey of India. In the case of digitization, the data needs to be checked for accuracy, completeness, displacement, edge matching, symbology etc. The Base Maps should clearly show location of each slum – notified or otherwise. While superimposing infrastructure and utilities, care should be taken to achieve high accuracies on ground in conformity with the scale of mapping. For example, If 1 m spatial resolution satellite images are used, the scale of thematic map should be 1:4,000 and RMS (Root Mean Square) error should be less than a pixel. However, the positional accuracies would be 2.0 m with respect to 0.5 mm mapping/ plotting accuracy of such maps. In special cases, an accuracy interval may be specified to prepare required maps in the first stage, which could further be improved on quality evaluation and recommendations. These may be updated at a later stage by systematically carrying out checks covering each ward / zone with respect to each component – water supply, sewerage, storm water drainage, power transmission / distribution, telephone and similar utilities. Since each of them will be in separate layers, updating and verification by each department / agency should be practicable. The updated, corrected and verified layers can then be superimposed by the ULB or their TCs. This way, the ULBs will have a reliable and accurate data base, which can be updated at regular intervals and used by concerned departments / agencies, without any conflict, whether spatial or administrative.

During delineation of Slum Boundary, it is required to assign unique Slum Code ( as specified in para 2.2 of the Guideline) in the attribute field of slum boundary layer – whether



notified or not. Unique House No (as specified in para 3.3 of the Guideline) for all buildings or structures in each slum shall be done in close consultation with the ULB Technical Cell. This is critical for inter-linking of (a) geographical data and location for each structure (which shall form part of GIS for the spatial analysis) and (b) Slum socio-economic data in a seamless manner. At a future date, these IDs may be utilized to be converted / linked with the IDs generated by the Unique Identification Authority of India.

In case of maps being produced by Total Station Survey, the map scale is 1:500, and a plotting accuracy of 0.5 mm will be required, representing 0.25 m on the ground.

All accuracy specifications as stipulated by the implementing agency should be strictly adhered to. Adequate number of benchmarks (minimum 2 in each slum or 3 in a slum cluster) shall be established and catalogued.

The ULBs through its RAY Technical Cell experts (city team) and / or its designated officials or Empanelled Agency or SRSACs: should carry out checks to ensure availability of the following:

- o Index grid and inventory of the city cadastral sheets, as much as available.
- o Inventory of the other maps like development plan, infrastructure/ facility/amenity maps with date(s) of production
- o Clarity and readability of the scanned files.
- o Correct mosaic
- o Digitization accuracy
- o Layers name in digitization and colour codes
- o Topological accuracy
- o Metadata for scanned files
- o Correctness, mapping accuracy and consistency of the output produced with respect to the input maps



In addition, the designated cell / officials should co-ordinate between GIS Mapping team(s) and MIS and Socio-economic survey team(s) to ensure that proper integration of GIS and MIS interfaces are maintained.

### **1.2.5 Outputs and Deliverables**

#### **a. For City-level Base Maps:**

- Detailed Geo-referenced maps as described in the scope of work shall be produced both in digital form and hard copy(ies).
- City maps with various layers as per scope of work.

#### **a. For Slum Mapping:**

- Detailed Geo-referenced maps as described in the scope of work for the selected slums – separate maps for each unit of the slum or cluster of slums shall be produced both in digital form and hard copy(ies).
- Slum maps with different layers (including cadastral information)

Hard copies shall be produced (preferably in A2 size sheets) at a scale of 1:500. The digital copy should have facility such that the printout of combination of layers may be taken as required.

The printed copies shall include standardised cartographic legends, bar scale, north sign, control points, sheet reference, date of survey, title and project logo. The standard map layout should be finalised in close consultation with the city level Technical Cell.

### **1.3 Working Arrangement**

The assignment will be contracted by the ULB(s) to Technical Consultants / Survey firms or other para-statal organisations. Management of the assignment and all logistical, financial and methodological arrangements will be ensured by the ULB. The ULBs will ensure the support of municipal officials and other concerned agencies, where necessary through monitoring and output review committee or such other suitable arrangements.

**a. Items to be provided by the ULBs**

The ULBs will:

- Provide a Senior officer in the rank of deputy commissioner or equivalent to liaise with the TC
- Brief the Consultant on the objectives, design, methodology and programme for the GIS mapping and survey
- Nominate officers to participate in a) survey work, b) database development and (c) GIS mapping; (d) making them available in the field to observe and oversee survey work and data verification.
- Provide timely advice to the Consultant concerning the work under the programme and slums for survey.
- Provide the TC with maps of survey areas, if available
- Provide the Consultant with necessary authorisation to procure the satellite data or maps of existing town area and the future expansion area (periphery or urban agglomeration area).
- Provide the TC with all necessary authorisation to undertake the surveys and field verification.
- Provide access to office space, if available.

**b. Items to be provided by the Technical Consultant**

In addition to the results and deliverables listed above, the TC will provide:

- All materials (including satellite data) and equipment necessary for DGPS surveys, digitised base mapping
- All survey equipment and data entry staff
- All satellite data processing, field survey and data entry staff
- Organisation and orientation training to enable municipal staff to participate in the GIS base mapping preparation, survey and data entry, and to manipulate and produce



reports from the databases.

- Arrange office equipments – Computers, software including software for satellite data processing.
- Arrange for all transportation and travelling required for their (TC's) own staff

#### 1.4 Requirement of manpower for the Technical Consultants/Agency / Institute

The technical consultants/ Agency/Institute should have following competencies with adequate manpower.

- Team Leader
- GIS/Remote Sensing Specialist
- Town/Urban Planner
- Municipal Engineer
- Surveyor
- Draughtsman (Civil)

#### 1.5 Reporting and Timing – To be specified by ULBs while work allotment

Report for each slum or slum group	Suggested time period from starting date
Inception Report highlighting review of collected available maps and related data, identification of existing data gaps and proposal how to bridge data gaps, detailed work programme	__weeks
Draft City base map	__weeks
Slum Map(s), including infrastructure provision / availability of off-site services as applicable	__weeks
Final City base map Including Final Slum Map(s) and Report based on the TOR including Analysis & GIS-MIS integration.	__weeks

Please refer to Annexure VIII for Illustrative Bid Document.

**Annexure 'VIII'****Bid and Contract Specifications**

Where states/cities find it difficult to engage consultants with technical abilities to handle both engineering and GIS areas, separate agencies might be contracted through transparent tendering processes to include tenders for engineering and GIS consultants separately.

**Illustrative Bid Document<sup>17</sup>**

To streamline the process of engaging vendors, consultants and other professional services for the Government of India projects, the Ministry of Finance, GoI, have issued a “Manual of Policies and Procedure of Employment of Consultants”. The purpose of these Guidelines is to define the Government of India’s broad policies and procedures for selection, contracting and monitoring of consultants and other professional services providers financed from Govt. of India’s resources. It is therefore, advised the ULBs, implementing RAY programme adhere to the guidelines listed in the manual.

To help ULBs in selecting a Vendor for creation of a model bidding document is prepared and appended in this section. A few changes are generally necessary to meet local ULBs requirements in the Instructions to Bidders and the Conditions of Contract.

The model Bidding Documents is intended as model Contract. Care should be taken to check the relevance of the provisions of the standard documents against the requirements of the specific Services to be procured. The following directions should be observed when using the documents:

1. All the documents listed in the Table of Contents are normally required for the procurement of Services; however, they should be adapted as necessary to the circumstances of the particular Project.
2. Details to be provided by the ULBs prior to release of the bidding documents are limited to the Invitation for Bids (Section I), Instructions to Bidders and Bidding Data (Section II), and Special Conditions of Contract (Section V), in addition Specifications (and/or Terms of Reference),

<sup>17</sup>(YASHADA 2008)



Drawings, symbology and Activity Schedule, respectively can be included as separate Sections. Specific details should be furnished in the spaces indicated by italicized notes inside brackets. Those details not filled in by the Corporation are the responsibility of the Bidder.

3. Modifications to address specific Project or Contract needs should be provided as amendments to the Conditions of Contract. If modifications are made to the bidding procedures, they can be presented in the Bidding Data.
4. The cover should be modified as required to identify the bidding documents as to the names of the Project, Contract and Corporation, in addition to the date of issue. In the following paragraphs a model bid document following two bid system for procuring GIS services is described. This document can be appropriately modified and used for procuring GIS services for urban areas.

### **Illustrative Bid Document**

#### **Invitation for Bids**

Notes on the Invitation for Bids

The Invitation for Bids is normally issued as

1. An advertisement in at least one newspaper of national circulation in the country and in two news papers of state and local circulation and in the official gazette, if any; and
2. A letter addressed to a Service Providers who had expressed interest in bidding for the Services required.

Its purpose is to supply information to enable potential bidders to decide on their participation. Apart from the essential items listed in these Sample Bidding Documents, the Invitation for Bids should also indicate any important bid evaluation criteria.

The Invitation for Bids may be incorporated in the bidding documents merely for the record, or it may be omitted. In either event, the information contained in the Invitation for Bids should conform to the bidding document, and in particular, to the relevant information in the Bidding Data and the Special Conditions of Contract.

**Invitation for Bids (IFB)**

The Municipal Corporation of ....., invites sealed bids in prescribed form in two envelopes system, one for technical and the other for commercial proposal , from eligible Bidders for carrying out the Creation of large scale database in GIS environment using high resolution satellite images , large scale maps and field Survey data , wherein the work involves scanning, digitization, geo-referencing, edge matching, mosaicing and information extraction pertaining to the infrastructure, utilities / facility /amenity, urban land use, surveying and conversion of vector data format etc.

Bidding documents (and additional copies) may be purchased at [*name and address of Municipal Corporation office*] for a non-refundable fee of [*amount in Rupees*], for each set. Interested bidders may obtain further information at the same address.

Bids shall be valid for a period of [*days*] after Bid opening and must be accompanied by bid security of [*amount in Rupees*] or its equivalent in a convertible currency, and shall be delivered to [*name and full address of receiving office*] on or before [*time and date of Bid closing*], at which time they will be opened in the presence of the bidders who wish to attend. Late bids will be rejected.

Bids of those qualifying in the Technical Qualification described in Section – I will be considered for evaluation, while that of disqualified bidders will be returned unopened.

The attention of prospective Bidders is drawn to the fact that they will be required to certify in their bids that all software used is either covered by a valid license or was produced by The Bidder.

Place:

*Commissioner/ Admin Officer*

Date:

*Municipal Corporation of ....*



## Illustrative Technical Qualification Proposal

### Instructions to Bidders on Technical Qualification Proposal

The proposal would be evaluated by the evaluation Committee constituted by the Municipal Corporation on the basis of criteria set out in the technical qualification document to identify the successful bidders for execution of the work.

### Scope of Work

The scope of services include provision of GIS support services to create geo-referenced city base map showing slums using high resolution satellite images, to overlay all infrastructure data like road, property, drain, sewer, water supply, utility points erected on road/footpaths, culverts, street lights, bus shelters, hoardings, traffic points data etc. over the base maps, in various layers. These maps are to be created using the physical surveying (Total Survey Station or GPS technology), ancillary data, departmental input and collection of data for attributes of various layers. The maps thus created should be geo-referenced and Geographic Information Systems compatible. The field data collection, validation with municipal and other records and integrating with the base maps are also to be provided by the Bidders.

The scope of works shall include the following major components. (The corporations can add more work here and or delete a few if not required by them)

- a. Preparing the City Base Map in GIS environment using high resolution satellite images (refer para 2.1 of the guidelines) and GIS & MIS integration at Slum level (refer para 2.3 of the guidelines)
- b. Field verification for creation of city base maps and slum base maps.
- c. Mapping of slums and collection of data regarding slums (refer para 3.1 of guidelines) and GIS & MIS integration at Household level (refer para 3.3 of the guidelines)
- d. Mapping of various Utilities like water, electric, sewage, street lighting etc, using spatial survey (like Total Station Survey), GPS and Ground penetrating Radar (GPR) where ever necessary.



- e. Conducting field surveying for slum areas to generate contours of 0.5 meter interval for creation of Digital Terrain maps for drainage planning / disaster management etc.

### **Type of Illustrative contract**

The entire work may be distributed to multiple consultants in order to meet the project schedule as and when required. The job contract would be awarded to the empanelled consultants in lots/ sections. The job contract of one section at a time would be awarded. Next section would be awarded after successful completion of the previous awarded work.

All activities will have to be executed at Corporation office premises. If required, Consultants will have to carry out physical site verification as well as collect the additional data for spatial features. The proposal shall remain valid for a period of two years from the date of issue of notification of award unless extended by mutual consent subject to satisfactory performance of the work by consultants. Corporation reserves the right to accept or reject any or all the proposals /bids which does not meet the requirement without assigning any reason thereof. The consultant should clarify that their firm is not black listed or debarred for participating in any bid/ tender by the State /any Govt. agency.

### **Content of Qualification and Bidding Documents**

The contents of the Technical Qualification and Bid Documents are listed below and should be read in conjunction with any addenda issued:

- Section I Technical Qualification Proposal
- Section II Sample forms for Technical Qualification
- Section III Bidding Document
- Section IV Sample Forms for Commercial Bidding

Bidders are expected to examine all instructions, forms, terms, specifications, and other information in the Qualification and Bid Document. Failure to furnish all information required by the Document or to submit a bid not substantially responsive to the Qualification and Bid Document in every respect will be at the Bidder's risk and may result in its rejection.



## Bid Opening

The following is the schedule of bid opening:

The date of opening of technical qualification proposal is (*insert Date*) at (*insert time*) Hrs.

The expected date of opening of commercial bid will be indicated to the technically qualified bidders by the telephone/ fax/ mail.

## Technical Qualification Criteria

### Experience

- a. Qualification will be based on Bidders meeting all the following minimum criteria regarding their general and particular experience, financial position, personnel and equipment capabilities, other relevant information as demonstrated by The Bidder's responses in the Information Forms attached to the Letter of Application and evaluation of the sample work.
- b. The Bidder shall provide evidence that it has been engaged in Remote Sensing / GIS activities/ Total Station Survey/mapping utilities/large scale database creation, in the role of prime Consultant, partner in a joint venture, or sub consultant.
- c. The Bidder should also give evidence that it has successfully completed or substantially completed work of a nature, complexity, and requiring technology similar to the proposed contract. The works may have been executed by The Bidder as a prime Consultant, or proportionately as member of a joint venture, or sub Consultant, with references being submitted to confirm satisfactory performance.
- d. The Bidder have to compulsorily produce the documentary evidence for completion of the work of similar nature valued with turnover of not less than Rs. Lakhs ( in words) for each of the last three financial years



### Financial Capabilities

- a. The Bidder shall demonstrate that it has access to, or has available, liquid assets, unencumbered real assets, lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the activity cash flow requirements for the subject contract(s) in the event of stoppage, start-up, or other delays in payment, of the
- b. The minimum estimated amount of Rs (specify amount in Rs) or in multiples thereof depending on the number of lots taken up simultaneously.
- c. In the relevant Information Form, The Bidder shall also demonstrate, to the satisfaction of Corporation, that it has adequate sources of finance to meet the cash flow requirements on activities currently in progress and for future contract commitments.
- d. The audited balance sheets or, other financial statements acceptable to Corporation, shall be submitted and must demonstrate the soundness of The Bidder's financial position. If deemed necessary, Corporation shall have the authority to make inquiries with The Bidder's bankers.

### Personnel Capabilities

The Bidder shall provide general information on the management structure of the firm, and shall identify the suitably qualified personnel of the proposed project team<sup>18</sup> including Project Manager, GIS Specialist and Image processing /CAD specialist, Urban/town Planner, Municipal Engineer, Surveyor and Draughtsman (Civil) required during contract implementation. The Bidder shall provide further details of the proposed personnel and their experience records in the relevant information forms.

### System Capabilities

The Bidder shall own, or have assured access (through hire, lease, purchase agreement, or other commercial means, or approved subcontracting) to systems including licensed software, in full working condition, as listed below, and must demonstrate that, based on known commitments, they will be available for timely use in the proposed contract.

<sup>18</sup>No of specialist in each position will depend on the size of city and slum



## System Types

1. GIS Systems
2. CAD Systems and
3. Image Processing Systems etc.
4. GPS systems and post processing software
5. Total station survey equipment and data conversion capabilities

## Methodology & Project Plan

The Bidder must attach with their application, a detail note giving a general description on the approach to the methods, specifications, data formats, technologies, quality assurance schemes proposed, deployment schedule, capacity, number of systems proposed to be used, number of lots that it can undertake simultaneously, etc., for ensuring completion of the work as per specifications within the desired time-frame.

## Submission of Sample work

- o The Bidder should submit the completed sample work in digital format on CD-ROM along with the Qualification Document. The deliverables of the sample work will be as per the specifications provided in the Section 1.2.3 (b) & Table of Data content and specification. The vector layers should have proper annotation, symbology and unique ID to facilitate attribute attachment. Metadata file should be submitted in excel format and ULBs may also refer to the NSDI format<sup>19</sup> for the same. Surveying of utilities like water pipelines, sewage lines, electric lines etc using ground penetrating Radar (GPR) where ever applicable and associated attribute data collection. A write up on the methodology followed, accuracy parameters including error limitations and systems used.

## Litigation History

The Bidder shall provide accurate information on the related Application Form about any litigation or arbitration resulting from contracts completed or ongoing under its execution over the last two

<sup>19</sup><http://nsdiindia.gov.in/nsdi/nsdiportal/images/NSDIMetadataDocument.pdf>.



years. A consistent history of awards against The Bidder or any partner of a joint venture may result in failure of the application.

### **Right to Waive**

Corporation reserves the right to waive minor deviations in the qualification criteria if they do not materially affect the capability of the Bidder to perform the contract.

### **Disqualification**

Even though The Bidder meets the qualification criteria, they are subject to be disqualified if they have:

- made misleading or false representation in the form, statements and attachments submitted; and/or
- Record of poor performance such as abandoning the work, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures, etc.



Illustrative form for Technical Qualification

Technical Qualification Proposal

[letterhead paper of The Bidder or partner responsible for a joint venture, including full postal address, and telephone, facsimile and telex numbers, and cable address]

Date:

To:

Project Name: Creation of large scale slum survey and creating Geodatabase of the slums.

1. Being duly authorized to represent and act on behalf of \_\_\_\_\_ (hereinafter referred to as "The Bidder "), and having reviewed and fully understood all of the Qualification requirements and information provided, the undersigned hereby applies for Qualification to bid on the contract or contracts indicated below:

Contract No: Corporation /....., Dated .

2. Attached to this letter are copies of original documents defining1:

- (a) The Bidder 's legal status;
- (b) the principal place of business; and
- (c) the place of incorporation (for Bidders that are Corporations), or the place of registration. (for Bidders that are partnerships or individually owned firms).

3. Corporation and its authorized representatives are hereby authorized to conduct any inquiries or investigations to verify the statements, documents, and information submitted in connection with this application, and to seek clarification from our bankers and clients regarding any financial and technical aspects. This Letter of Application will also serve as authorization to any individual or authorized representative of any institution referred to in the supporting information to provide such information deemed necessary and as requested by yourselves to verify statements and information provided in this application, such as the resources, experience, and competence of The Bidder.

4. Corporation may contact the following persons for further information:

General and managerial inquiries	
Contact 1	Address and communication facilities
Personnel inquiries	Address and communication facilities
Contact 1	
Technical inquiries	
Contact 1	Address and communication facilities
Financial inquiries	
Contact 1	Address and communication facilities
Contact 2	Address and communication facilities



5. This application is made with the full understanding that:
- (a) bids by qualified Bidders will be subject to verification of all information submitted for Qualification and bidding;
  - (b) Corporation reserves the right to:
    - amend the scope and value of any contracts to be bid under this project; in which event, bids will be invited only from those Bidders who meet the resulting amended Qualification requirements; and
    - reject or accept any application, cancel the Qualification process, and reject all applications.
  - (c) Corporation shall not be liable for any such actions under 5(b) above.
6. Appended to this application, we give details of the participation of each party, including capital contribution and profit/loss agreements, in the joint venture or association. We also specify the financial commitment in terms of the percentage of the value of the contract, and the responsibilities for execution of the contract.
7. We confirm that any resulting contract, will be:
- (a) signed so as to legally bind all partners, jointly and severally; and
  - (b) submitted with a joint venture agreement providing the joint and several liability of all partners in the event the contract is awarded to us.
8. The undersigned declare that the statements made and the information provided in the duly completed application are complete, true, and correct in every detail.

Signed	Signed
Name	Name
For and on behalf of (name of Bidder / Consultants or partner in charge of a joint venture)	For and on behalf of (name of Bidder / Consultants or partner in charge of a joint venture)

(Sections 2.5 through 2.7 are borrowed from manual on Geographic Information Systems for Urban Areas, YASHADA, Pune)



### **Expertise and Inputs**

The staff proposed should have experience in the design of services; experience in managing and developing client relationship; in product development, project management; and also experience in technologies like Windows operating systems; client/server hardware and software; input/output technology, digitizing equipment, internet services and related technologies.





## CONTACTS:

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Joint Secretary & Mission Director (JNNURM & RAY)  
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