Assessing the implementation of Rawalpindi's Guided Development Plan through GIS and Remote Sensing

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1 ABSTRACT

Rawalpindi is the fourth largest city of Pakistan inhibiting 2 million people. Growth of Traffic in Rawalpindi city has acquired an alarming situation and put tremendous pressure on infrastructure of the city. Rawalpindi Development Authority conducted the series of traffic surveys in 1995, 1998 and a Guided Development Plan was formulated to develop proper road infrastructure, a series of main & sub-main traffic corridors. The plan is supposed to be implemented soon. But with the passage of time, road alignment plans are required to be updated with respect to the ongoing development activity in the area. Traffic and ground surveys were conducted in year 2007. But it 2009, the plan needs to be rechecked. Required cost, time and manpower for this purpose make this task virtually impossible, thus hindering the implementation of the project.

In this paper, we have proposed a system of regularly monitoring on ground situation, using high resolution "Quickbird" satellite images of and Geographical Information Systems, at a relatively lower cost. Satellite images have been used to identify the exact on ground alignment of the proposed roads through spatial overlays of georeferenced data. The process will support authority to know whether the proposed development falls under the right of way of a proposed network. The system will thus help regularizing the development activity and help identify the unauthorized construction activity taking place in the area. The approach also helps identifying alternative route alignment more efficiently.

2 INTRODUCTION

2.1 The study area

Rawalpindi is the fourth largest city of Pakistan hosing approximately 2.2 million persons. Rawalpindi lies between 33° - 28' and 33° - 48' north latitudes and 72° - 48' and 73° - 22' east longitudes. The city is bounded by Islamabad area on north and east and with motorway and Taxila cities on west. The Rawalpindi area spreads to 250 square kilometers on the south-western side to the national capital of Islamabad. Rawalpindi area falls under the jurisdictional responsibility of Rawal Town (RT), Rawalpindi Cantonment Board (RCB) and the Rawalpindi Development Authority (RDA). Rawalpindi is a historic city in the Potohar Pleatu. The city was declared as interim capital which witnessed serious housing shortage in the city with the increased business opportunities. Till then, the city grew tremendously but the infrastructure and services could not keep pace with the population growth.

It is estimated that the population of city will reach 3.2 Million persons by the end of 2020 (Population Census Organization, 1998). Population expansion in Rawalpindi region since 1972 has given in Table 1.

Year	Rawalpindi Municipal Corporation Area	Rawalpindi Cantonment Area	Rawalpindi Development Authority Area	Total
1,972	373	242	245	859
1,981	457	338	322	1110
1,998	782	628	486	1890
2,010	1030	864	629	2520
2,020	1280	1100	762	3150

Table 1: Population growth in Rawalpindi (Thousand persons). Source: Population Census Organization, 1998

The table shows that population of the study area increased continuously with time. Each part of the study area witnessed a steady rise in its population. Rawalpindi city housed 373, 000 persons in 1972 and, by year 2010, the figure is estimated to reach 1, 000, 000 persons. Rawalpindi Cantonment housed 245, 000 persons in 1972, which is now estimated to reach 629, 000 persons by year 2010. Population in Rawalpindi

Development Authority area also increased from 245, 000 to 629, 000 persons since 1972 to 2010. Similarly the total population of the study area was around 859, 000 persons; which is estimated around 2.5 millions presently. The growth of the City is restricted on the north side by Islamabad city. Similarly on the north-eastern side, Islamabad Highway and National park are the physical barriers (CDA, 1960). As such, the existing trend of the city is towards south and south - western directions. Adiala road, Dhamial road, Chakri road and Girja road are the main corridors for the growth, where development has already started in the form of private housing schemes and road side linear pattern of housing. In addition, nearness of Lahore - Islamabad Section of the Motorway with interchanges at Chakri and Kashmir road, has further opened up this area for development. These are major radial traffic arteries serving the city population and lead to outside city. They play an important role to open southern part of the city for development activities. The future growth of the City has therefore, been planned in these directions. (CDA, 1973)

2.2 History of Traffic Planning In Rawalpindi

In 1960, Doxiadis prepared first plan of the metropolitan area covering Islamabad to Rawalpindi cities. It proposed a grid iron pattern of wide roads for Rawalpindi area as well (Fig. 1, Rawalpindi Master Plan 1960). This master plan followed grid iron pattern of major roads with a right of way of 600 feet and 1200 feet. (Doxiadis, C.A 1960) The plan in Rawalpindi never came into implementation due to absence of necessary institutional arrangement to incorporate Rawalpindi. It was not mandatory for RT, RCB and RDA to follow the guidelines and design.

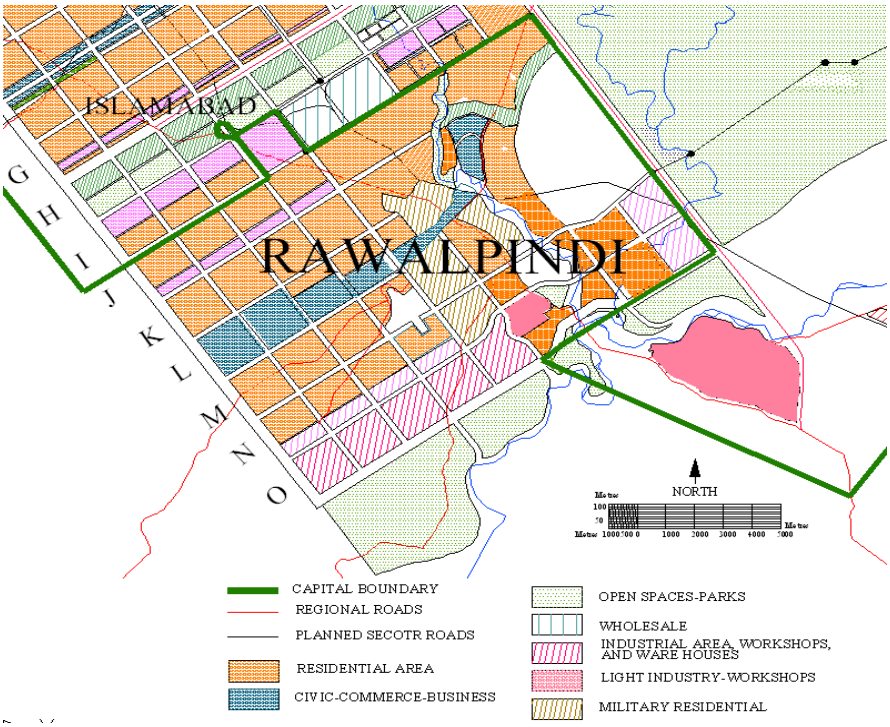

Figure 1. Master Plan of Rawalpindi (1960-2000)

Secondly, a new master plan was prepared for the period 1996-2016. This is a legal document to guide and control physical development of the city. It provides arrangement of land uses and connection links between three parts of Rawal Town, Rawalpindi Cantonment and RDA area. Master plan proposed a road network comprises of arterial roads, major roads and secondary roads. The categorization is based on nature and volume of traffic (National Highway Authority, 2001). Whereas, the planning of minor roads have been left to the three local authorities (Government of Punjab, 1996).

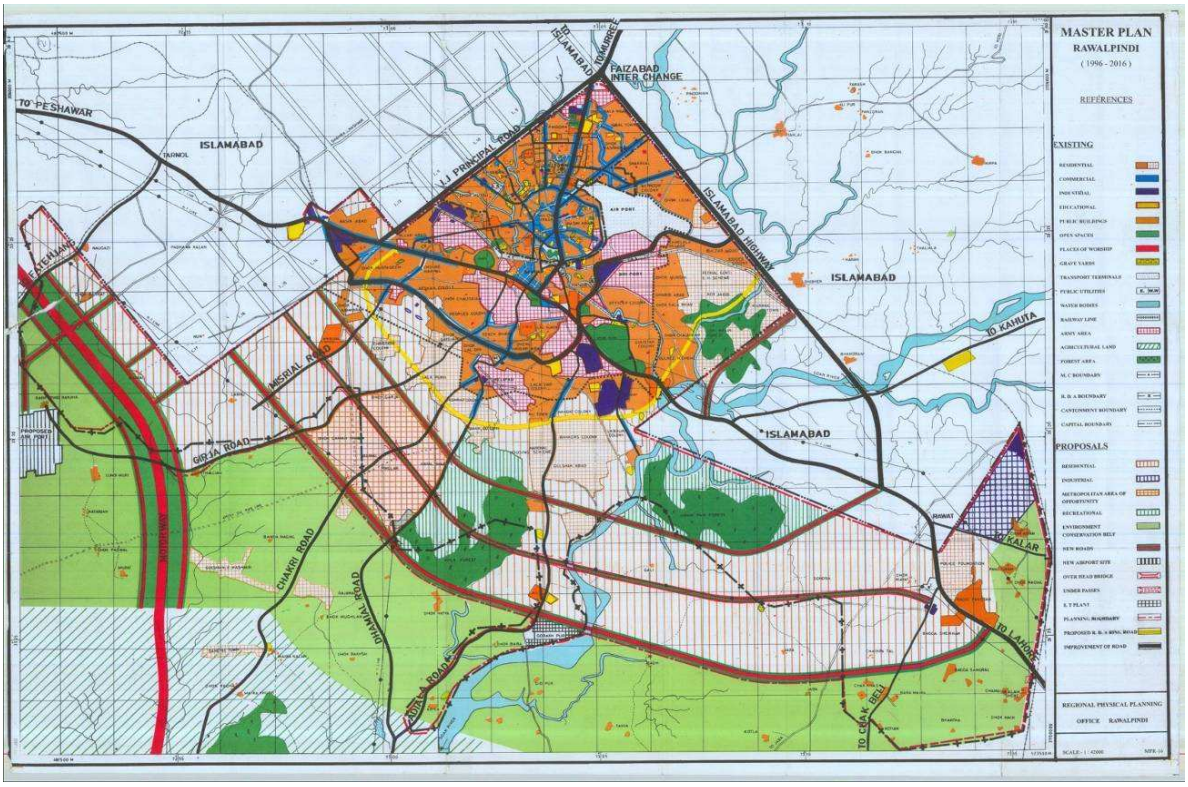

Figure 2 Master Plan of Rawalpindi (1996-2016)

RDA has prepared Guided Development Plan providing a network of Ring Roads and Arterial roads connecting city's urban and peripheral areas up to Motor Way. Six numbers of Ring Roads and seven numbers of Arterial Roads make complete network of the proposed future 'Guided Development'. RDA has proposed 400' ROW width for Arterial Roads and 800' ROW width for Ring Roads. The reserved 'right of way' area of these thirteen proposed roads is under development. (Fig. 3, Guided Development Plan of Rawalpindi, 1996-2016)

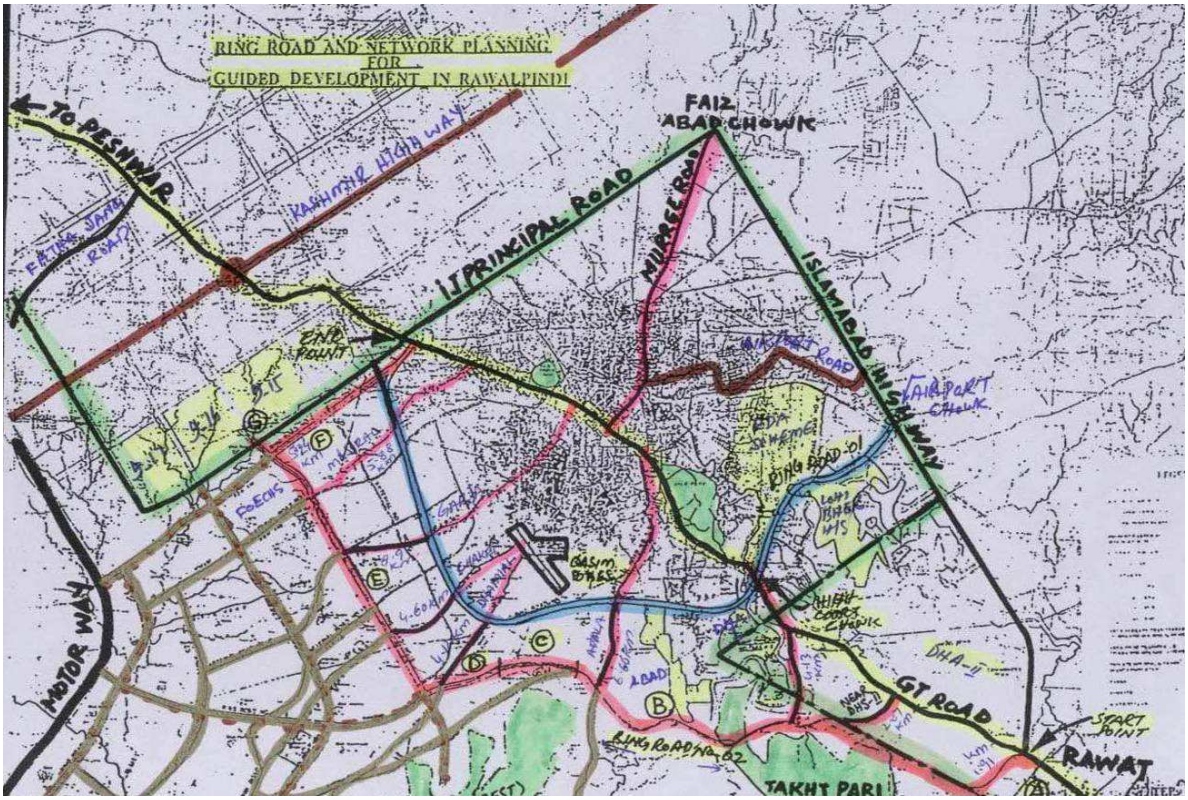

Figure 3 Guided Development Plan of Rawalpindi (1996 to present)

3 PROBLEMS AND ISSUES

For the development of transportation corridors, development plans are superimposed on topographic survey maps which are mostly outdated and do not represent the actual on ground position. In some cases, the survey plan to be used for this purpose has been prepared more than two years earlier.

As shown in Figure 4, the proposed road developments plan is superimposed on the paper based survey map of the study area. As a result of mismatching the temporal characteristics of datasets, the actual on ground situation is not realized properly. Revision of topographic survey also takes considerable time and effort. It is observed that a fresh survey in the study area can cost approximately Rs. 400 per 1000 Sq. meter land.

Figure 4 Right of Way of proposed Ring Road II overlaid on Survey Plan

Considering the other factors like environmental constraints, availability of manpower and the prevailing law and order situation of the area, the process of planning and development is seriously affected by this traditional method. Secondly, for land acquisition, the plans are superimposed on cadastral maps which are mostly paper form. Printing the development plans on them usually distorts scale of drawing and it does not give a holistic view of the area covering other details like location of infrastructure services through the area etc.

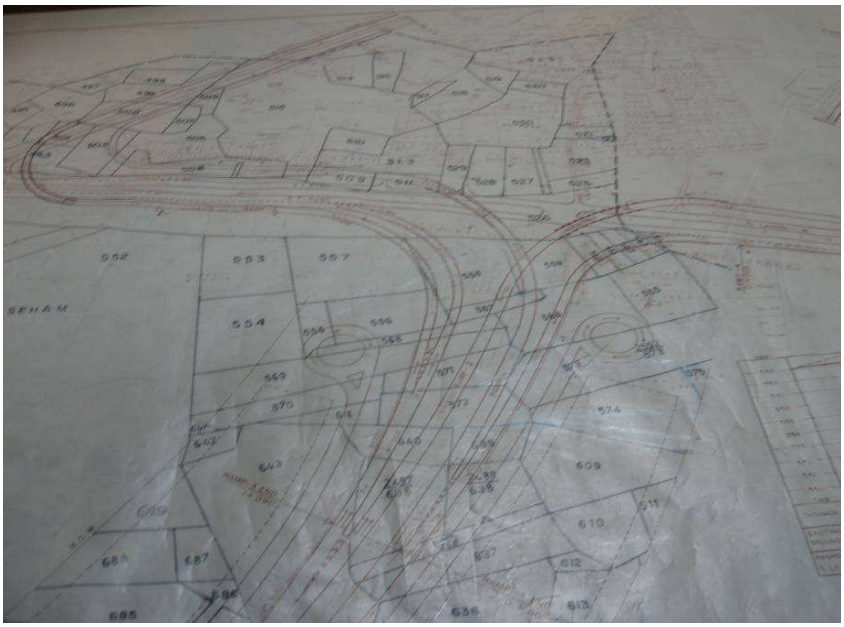

Figure 5. Proposed Ring Road II Plan overlaid on cadastral map for land acquisition planning

Figure 5 is showing such an example where the proposed ring road plan is superimposed on land ownership map of the study area.

4 DATASETS USED

The datasets used in study include map data, satellite images and the text data of the study area. The details have been shown in figure below:

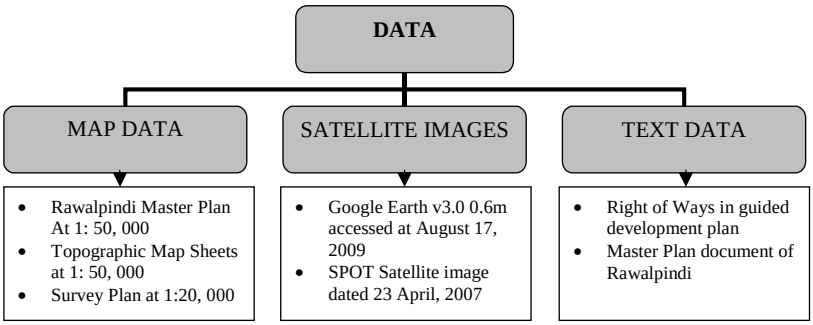

Figure 6: Data used in the research

5 METHODOLOGY

The study proposes a GIS based coordinated approach to prepare and finalize the road development plan. It suggests that the satellite imagery be used as a base map and the other map data be overlaid on this base map for planning and development of the area. The study used the following methodology to identify the existing development within the proposed road right of ways of guided development plans

- Digitization, Georeferencing through GPS coordinates and Mosaicking of the Guided Development Plan
- Generating road right of ways through buffer operations
- Georeferencing and Mosaicking and Image Enhancement of satellite images
- Stacking satellite imageries over Guided Development Plan and Digital Survey Maps
- Georeferencing Digital Survey Plans and updating survey map through visual image interpretation
- Performing vector overlay analysis (Clip function etc.) to map the construction within the right of way of the propose roads

6 DATA ANALYSIS

When the guided development plan is overlaid on the satellite image of the area, on ground situation becomes much clear than the digital survey sheets. Visual recognition of locations and objects become more simple and efficient. By performing overlay analysis and "Clip" operation in ArcGIS, structures falling within the right of ways were separated from the other structures that do not fall in the road right of way. In this way, the procedure of identifying unauthorized buildings became efficient and more accurate.

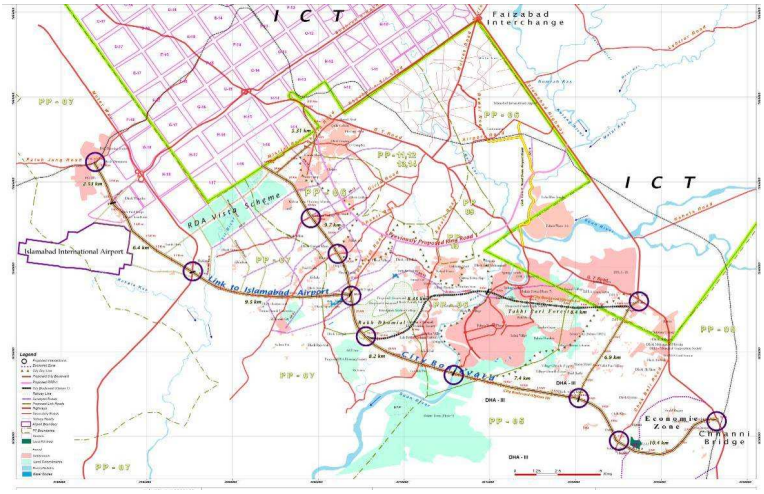

Figure 7. Guided Development Plan of Rawalpindi

Figure 7 shows the transportation maps of the study area.

The guided development plan was superimposed on the satellite image of the area as a first step to identify unauthorized structure falling within the road right of ways in the study area. (Figure 8)

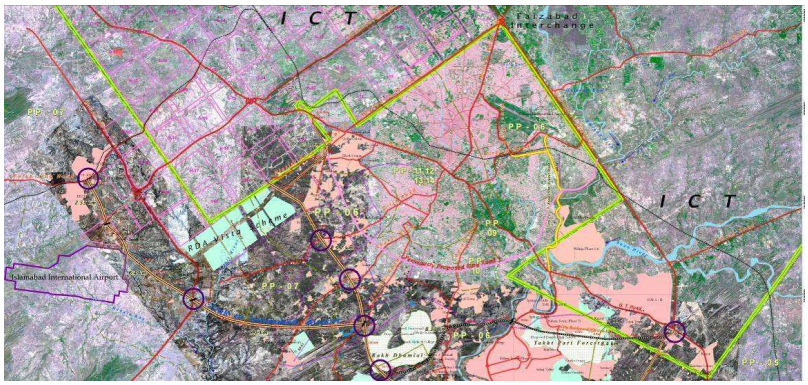

Figure 8. Rawalpindi Guided Development Plan superimposed on satellite imagery

Road right of ways were created through "Buffer" command in ArcGIS. The identified the location of road right of way lines in on the satellite image. (Figure 9)

Figure 9. Proposed roads with Right of way boundaries superimposed on satellite imagery

When the built up area layer was stacked on the road right of way lines, the buildings falling within road areas were identified and the "clip" operation was used to separate these unauthorized construction. (Figure 10)

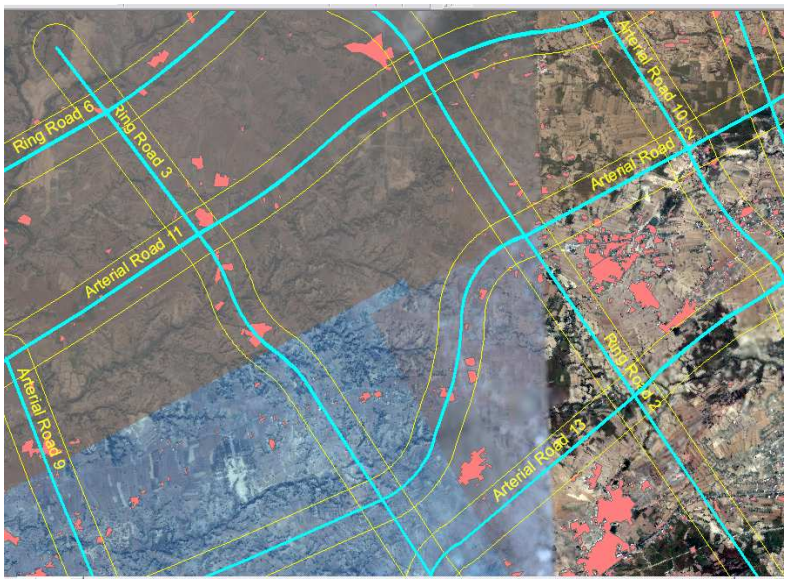

Figure 10. Extraction of built up areas along the proposed roads with Right of way, superimposed on satellite imagery

Below is a rough comparison of the estimated cost and time required to obtain data regarding development in the study area. Which shows that the plan updating and construction activity monitoring through satellite imagery is less expansive (almost four times) and time saving as compared to that using traditional method of topographic surveying. The ability to easily preview the temporal changes over a given area is also a plus point of using satellite imageries.

Mode of Data acquisition	Estimated price for 25 km^2 area (Rupees)	Estimate time of acquisition
Topographic surveying	800, 000	At least one month
Satellite image mapping*	200, 000	3-4 days for ordering and receiving imagery

Table 2: comparison of estimateed cost of data collection through topograpihc surveying and satellite imagery

* Data is taken from SUPARCO Pakistan and processed, digitized at office

7 RESULTS & DISCUSSION

The research shows that Geographic Information Systems and Satellite imageries can be efficiently used in monitoring the areas reserved for planning of traffic corridors. It is suggested that the authorities should identify geographic location of the proposed building on satellite imageries prior to the grant of plan approval. The process will ensure that the road right of way remains preserved and the buildings do not encroach these reserve areas. A quarterly updating of satellite imagery is also desirable to keep a track of current construction activities in the area.

The process of GIS overlays does not only give an overall picture of the development activity in the area but it can easily identify the unauthorized development activities that fall within the road right of ways. Secondly, it can result in preparation and updating of land use map of the area. Once location coordinates of a proposed development are entered in the GIS data, the location can be identified on the map. The method can be beneficial to identify whether the proposed development activity falls within the declared right of way or not. This process will ensure the preservation of road right of ways. Regularly updating the satellite imagery will result in a quick aerial view of the area to identify ongoing unauthorized development.

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