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Full Length Research Article

GEOSPATIAL MAPPING FOR OPTIMIZING RIGHT-OF-WAY (ROW) ACQUISITION IN GAS PIPELINE CONSTRUCTION

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ABSTRACT
This study aims at mapping of the Right-of-Way (ROW) acquired from KP292 Escravous at Mojoda, Epe, Epe Local Government Area (LGA) to Lekki Free Trade Zone Area, Ibeju-Lekki LGA, both in Lagos State, Nigeria, for the construction of gas pipeline networks. The total distance covered is 52.6 km of which 5.6 km is presented for this study. The methodological tools used are Remote Sensing, Geographical Information System (GIS) and spatial analysis techniques for the assessment of the terrain, land use, and environmental constraints along a pipeline corridor, identifying suitable routes and Multi-Criteria Decision Analysis (MCDA) and Least-Cost Path Analysis (LCPA) to determine the most efficient pipeline alignment. This study provides geospatial data (coordinates and elevations i.e. X, Y, Z) of locations and features (artificial and natural) within the ROW; the planimetry and longitudinal profile of the route for the purpose of designing and planning for the construction of the proposed gas pipeline route. The height of the centre line at the starting point 0+000 of the project at Mojoda is 48.120 m. The highest point on the centre line ground level for the entire route is 49.100 m at 0+100 chainage; and the lowest height of 2.400 m is recorded at 5+600 chainage. The accuracy of the traverse and levelling is 1/36,000 and + 0.011 respectively. The results obtained show the amount of cut and fill that is required by the Engineer in the process of construction and laying of the gas pipelines; and the cost implications for the construction of the project including compensation. Therefore, it can be concluded that geospatial data is the bedrock for the acquisition of ROW for the construction of gas pipeline.

Keywords: Right-of-Way (ROW), Gas Pipeline Network, Geospatial Data, Planimetry and Profiling, Construction, Planning

INTRODUCTION

Right-of-way (ROW) is the right to make a way over a piece of land, usually to and from another piece of land (Lebeza, 2021). From the definition of the Transportation Association of Canada (TAC), a right of way is a type of easement granted or reserved over the land for transportation purposes (Lebeza, 2021). This can be for a highway (road), oil and gas pipelines, railway and canal, electrical transmission lines, oil and gas pipelines, and public footpath (Lebeza, 2021). ROW is also defined as a legal right of passage over another person's ground (Merriam-Webster, 2025). ROW acquisition is the process by which the client successfully acquires land for construction and other purposes without hindrances imposed by applicable laws and procedures in the country (Kidane, 2021). Land acquisitions are divided into five phases as planning, appraisal (evaluation), negotiation, asset management, and relocation (FHWA, 2009).

The essence of Right-of-Way (ROW) acquisition is to achieve sustainable public infrastructure provision (Otaru, 2016). Right of way acquisition is the power of government to acquire private rights in land without the willing consent of the owner or occupant in order to benefit the society (Odinakachi & Akujuru, 2020). A fundamental prerequisite to the ROW acquisition is the availability and provision of land (Odinakachi & Akujuru, 2020). Compulsory land acquisition as a process is attended by the payment of compensation to cover losses incurred by land owners who surrender their lands in favour of a public project (Odinakachi & Akujuru, 2020). Furthermore, the power for ROW acquisition as exercised by the government is backed by legislations (Odinakachi & Akujuru, 2020).

ROW acquisition continues to grow more expensive, complicated, and time-consuming for project execution (Ahmed et al., 2023). The costs involved in ROW acquisition are rapidly increasing, making it more difficult for agencies to complete projects on time and budget; and ROW purchases are selected based on expert judgment; and on individual analyses (Carlos et al., 2014).

ROW acquisition is one of the key parts in the preconstruction activities of transportation projects because the construction schedule highly depends on it (Chung et al., 2022); and the failure to make its timely acquisitions causes significant delays and conflicts (Sohn et al., 2014). However, the complex nature of the acquisition processes makes it difficult to acquire the require parcels of land in a timely manner; and the ROW acquisition duration often depends on the number of parcels to acquire; and the need for relocation assistance is considered to be the most significant factors impacting the acquisition timeline(Chung et al., 2022). The prompt ROW acquisition processes are not only an economic issue that needs to be executed in a timely manner, but it is also a socially sensitive and personal issue in most cases that deals with public and private property ownership (Aleithawe, 2010). Acquiring ROW can be costly and time consuming (Kidane, 2021).

Property owners must be compensated when the government acquires their land (Odinakachi & Akujuru, 2020). An "approved appraisal" based on the fair market value of the property needs to be used for estimating an amount to be paid (Haque et al., 2023). The acquisition of private or commercial land by ROW projects causes economic changes to the remainder property (Haque et al., 2023).

The acquisition of rights to construct, operate, and maintain a linear facility such as an underground gas or petroleum pipeline or overhead electric transmission line involves many players(Hart, 2012). The initial contact with landowners (the grantor and those unaffected by the corridor) is most often made by the ROW acquisition specialist or negotiator to acquire right of entry (ROE) to perform surveys for engineering design, geotechnical analysis, and environmental studies; and field surveys for engineering design are often conducted in conjunction with the land ties for the preparation of legal descriptions and for the acquisition of rights necessary to the project (Hart, 2012).

Any delays in the ROW acquisition processes can lead to major delays in the construction phase; and factors that have contributed to delays in the ROW acquisition processes are lack of transparency, lack of price disclosure to the public (Aleithawe, 2013); the property owners intended to be protected under the eminent domain legislation against the government seizing their property for an unfair price (Ahmed, 2020; Tesfaye, 2019); condemnation ratio, number of revisions (design changes); and number of parcels per project were identified as significant factors that contributed to acquisition delay (Aleithawe et al., 2012); compensations (Husein, 2021; Taye, 2019) for owners of buildings sited within the ROW (SCIR-BRRI, 2022; Tesfaye, 2019), operators of commercial businesses along the ROW (Shambel & Patel, 2018).

Several factors are holding up the Right of Way acquisition (ROW). These include delays in compensation (Husein, 2021; Muriisa, 2019; Taye, 2019; Shambel & Patel, 2018), budget constraints, inflated land valuation rates, and discrepancies in property valuations (Kidane, 2021). On top of that, there are other hurdles like a lack of awareness from local governments, illegal construction activities, the premature demolition of land that has already been compensated, and the removal of utilities that were compensated for (Kidane, 2021; Muriisa, 2019; Taye, 2019; Tesfaye, 2019).

In addition, it is important to identify and focus on all parcels within the ROW, but especially those that might cause delay, such as those that may require eminent domain acquisition or have other inherent problems; utilities with a history of slow response when adjusting should be aggressively managed; and should be noted that ROW and utility adjustment issues may be of concern even in cases where the parcel or utility is owned by a separate public entity (Kidane, 2021). A strategy must be developed to address all problematic parcels and/or utility adjustments (Bingham, 2010). Furthermore, the acquisition costs for ROW may include the market value of the parcel of land, damage done to the remainder of the land, condemnation or litigation costs, and delay costs associated with the acquisition of the parcel (Ahmed, 2020). Professionals involve in the acquisition of ROW include Land Surveyor, Lawyer, Estate Valuers (Le et al., 2010).

Geospatial data gives the exact location of a feature and its area (Morakinyo, 2025a, b, c, d; Morakinyo, 2024b, c; Morakinyo et al., 2020a,b). Technological advances have revolutionized the acquisition of geospatial data, reduced the production cost, and made it easier to extract valuable insights from geospatial datasets (Morakinyo, 2025b; Scott & Rajabifard, 2017). Geospatial technology applied to the ROW related projects include Global Positioning System (GPS) for accurate positioning (Morakinyo, 2025c; Li et al., 2016); Geographic Information System (GIS) for pre-negotiation planning, active negotiation, and quick visual inspection of the site (Jones, 2022; Neteler & Mitasova, 2008; Hancock, 2006); drones for the evaluation of the existing ROW conditions, and post-project management of the ROW (Foster, 2022); and Remote Sensing for spatial analysis and assessment of the terrain, land use, and environmental constraints along a pipeline corridor (Morakinyo, 2024; Morakinyo, 2023a, b; Umbugala & Morakinyo, 2023; Morakinyo et al., 2023, Morakinyo et al., 2022a, b; Morakinyo et al., 2021; Morakinyo et al., 2019; Stock & Guesgen, 2016).

This study highlights the importance of geospatial data to the physical demarcation of Right-of-Way (ROW) on ground, its acquisition and possession; and that without geospatial data ROW acquisition will not be possible. The research is guided by three (3) key questions: (1) What is the Right-of-Way (ROW)? (2) What are the geospatial data required for the acquisition of ROW for the gas pipeline construction? (3) How is geospatial information essential for the acquisition of ROW for the gas pipeline construction? The primary aim of this study is to assess how geospatial data serve as the basis for the demarcation and acquisition of ROW for the gas pipeline construction. This study provides geospatial data, the planimetry and longitudinal profile maps of the route used for designing and planning of the construction of gas pipeline network to enable proper distribution of gas to the Lekki Free Trade Zone (LFTZ) area and its axis. The specific objectives of the study are (1) Identification of geospatial data require for the acquisition of ROW; (2) Establishment of ROW Controls; (3) Provision of coordinate and height of point at every 20 m along the centre line of the proposed route; (4) Determination of the size of the ROW boundary; (5) Mapping of the ROW route i.e. planimetry and longitudinal profile of the route; (6) Production of plan and profile of the route.

MATERIALS AND METHODS

Study site

During the planning stage of building refinery by Dangote Plc., Dangote Fertilizer Industries in conjunction with the Nigerian Gas Processing and Transportation Company (NGPTC) agreed to lay the gas route that will be useful for the building of Dangote Fertilizer industry in that axis, and for other industries that will spring up; and require the usage of gas for their various businesses in the area. The site is located between Latitude 06° 38' 55.32" to 06° 40' 51.69" N and Longitude 03° 54' 46.31" to 03° 59' 10.21" E. The proposed corridor for the gas route is 25 m and the ROW beacons to demarcate the route at not more than 300 m interval. The entire route covers a total distance of 52.6 km of which 5.6 km (portion of) is being presented. The route has its chainage 0+000 at KP292 Escravous, Mojoda area and 5+600 chainage at Igbodu area all in Epe Local Government Area (LGA), Lagos State, Nigeria. The route passed through some thick, light and farm settlement. Figure 1 show the location of the site from Mojoda to Igbodu.

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Figure 1: 1) Map of Nigeria (ESRI, 2025); 2) Map of Lagos State, Nigeria; 3) Study site from Majoda to Igbodu, Epe LGA (Google Earth, 2025)

Methods

Reconnaissance (Recce)

From the first visit to the site, the comprehensive plans for the best approach to the project were drawn adequately(Morakinyo, 2025a, b, c, d; Morakinyo, 2024a, b, c; Morakinyo, et al., 2021, Morakinyo et al., 2020a, b). The proposed route has been pre-planned in conjunction with the Lagos State Government to know the best route that can be adopted without hampering or affecting their already acquired acquisition for other developmental projects. Also, the assessment of the potential environmental impacts of the pipeline route was carried out in order to address land acquisition concerns.

The coordinates of the route were generated and uploaded into the Total Station (LEICA, 307) for guidance toward the direction of the proposed route.

The available existing controls along the project route are XTT175, XTT176 and XTT177 from which controls were extended along the route in order to control the alignment of the route. Table 1 show the list of coordinates of available existing controls within the project site.

Table 1: List of Existing Controls Within the Project Site

Points	Northings (m)	Eastings (m)	Heights (m)
XTT 175	735871.595	609438.268	40.673
XTT 176	736409.535	609267.175	42.323
XTT 177	737314.695	609291.661	45.442

Equipment used

The following equipment were employed in the execution of this project: Total Station (LEICA, 307) and its accessories; four (4) sets of prisms with targets; four (4) Tribrach with 2 spindles; four (4) Tracking rods; four (4) small tape; four (4) pair Motorola Walkie Talkie; tribrach with spindle; 100m steel tape (4); ranging poles (8); Leica Automatic level with full accessories (2); Levelling staff (8); cutlass (4) and hammer (5).

Control Check

The authenticity of controls XTT175, XTT176 and XTT177 were checked both angularly and linearly before they were used for the control transfer in order to check if they are in order or good survey condition. Table 2 show the results obtained for both angular and linear check of these controls.

Table 2: Angular and Linear Check for the Controls

From station	To station	Face	Horizontal angle	Mean angle	Distance (m)
	XTT175	L	000º 00’ 00”		905.490
XTT176	XTT177	L	160º 48’ 24”	160º 48’ 24”	564.490
	XTT177	R	340º 48’ 22”	160º 48’ 20”	564.488
	XTT175	R	180º 00’ 02”	160º 48’ 22”	905.489

Establishment of Global Positioning System (GPS) Control Stations along the Route

Having identified the controls to be used, the GPS control stations were established along the entire route in order to adequately control the mapping of the pipeline route. The parameters used for the establishment of these controls are the following:
Origin: Universal Transverse Mercator (UTM) Zone 31
North: UTM North
Datum: Minna Datum
These controls are prefixed “DF” and “GP” with their references (Table 3).

Control Transfer

Hi-Target Static GPS was used for the transfer of controls established along the route to assist in traversing, detailing of features and heighting; and to assist during the construction proper. The master GPS was mounted on XTT 177 while the rovers were moved from DF3, DF4 to GP1-GP5 (Table 3).

Table 3: Results of Controls Established

Station Name	Northing (m)	Easting (m)	Height (m)
DF3	738816.099	607948.362	47.214
DF4	738807.901	607908.778	46.521
GP1	737682.145	607201.260	35.211
GP2	737655.177	607165.263	36.243
GP3	736555.888	605974.868	45.214
GP4	736510.161	605927.133	45.304
GP5	735127.557	604110.785	14.713
GP6	735089.193	604057.213	10.821
XTT177	737314.695	609291.662	45.442

Acquisition of Geospatial Data for Right-of-Way (ROW)

Geospatial data required for the acquisition of the Right-of-Way are location data i.e. coordinates of all locations within the ROW; and their elevations above the Earth surface. The coordinates which are in the form of Nothings (N) and Eastings (E) can be established by Traversing method. The height or elevation of feature above the

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ground which is referred to as h or Z could be established using levelling or tacheometric methods.

Traversing: Determination of Horizontal Coordinates
Selection of the traverse points was done simultaneously during the traversing. The traverse points were mostly marked with iron rod that was painted with red colour paint. The LEICA 307 used was check prior to the traverse observation; and it was found to be in good adjustment. The traverse section was divided into three loops because of the long distance involved. The established GPS controls along the route assisted in the control of the survey.

Horizontal angular observations and distances were measured in two faces (face left and face right). True Horizontal distances were measured directly with the Total Station from the field. The first traverse loop was taken from the established GPS control points DF3 and DF4 and closed back on another established GPS control points GP1 and GP2. It covers a total distance of 1472.056 m with 12 traverse stations. The second traverse loop started from GP1 and GP2 and closed back on GP3 and GP4 covering a total length of 1672.503 m with 13 traverse stations. The third traverse loop commenced from GP3 and GP4 and closed back on GP5 and GP6 which also covered a total length of 2297.128 m with 12 traverse stations. Tables 4 and 5 show the coordinates of ROW beacons along the left and right-hand sides of the route. Table 6 show the coordinates of traverse points along the route of the ROW.

Establishment of Controls for Detailing/ Right-of-Way (ROW)
The details (natural and artificial features) were picked using radial offset; and the X, Y, Z data were determined simultaneously during traversing. The details along the route were picked by Tacheometry method. Tacheometry is a system of rapid surveying by which the horizontal and vertical positions of points on the surface of the Earth are determined relative to one another. The ROW beacons were cast in-situ with ratio 1:2:3 that is one bag of cement, two bags of gravel and three bags of sand respectively and equally coordinated at same time.

Heighting: Determination of Vertical Coordinates
The determination of height along the route was achieved simultaneously during traversing by using Tacheometry method. The centre line of the route was tracked and heighted at every 20 m interval. Also, the ROW was heighted through the same Tacheometry method during traversing.

Data Processing using Traverse Programme.
Traverse Computation
The horizontal angles were obtained; and the mean were computed. The true horizontal distance was measured directly from the field. Hence, the problem of slope correction is eliminated. Computations and necessary adjustment were carried out in order to derive the corrected horizontal coordinates for all the selected traverse points along the route. The bearings were reduced and corrected. The latitude and departure were also reduced and linear misclosure obtained. This was achieved using the traverse program for the computation. The detail and centreline (X,Y,Z) data were obtained through the in-built data processing in the Total Station, as data were obtained directly from it.

The same traverse program was used for the backward computation of the bearings and distances between the ROW beacons which also provided the included area within the (portion) of the proposed corridor for the ROW.

Table 4: Coordinates of Right-of-Way Beacons Along the Route (Left Hand Side)

Points	Northing (m)	Easting (m)	Height (m)
DLG1AL	738845.937	607997.524	48.321
DLG1L	738799.148	607970.687	46.421
DLG2L	738627.863	607872.396	40.613
DLG3L	738453.468	607774.452	22.588
DLG4L	738278.894	607676.760	16.382
DLG5L	738104.444	607578.533	40.843
DLG6L	737930.527	607480.630	31.315
DLG7L	737754.231	607381.108	30.456
DLG8L	737618.596	607230.424	34.211
DLG9L	737504.119	607065.451	39.591
DLG10L	737351.894	606933.810	36.814
DLG11L	737260.581	606832.407	46.428
DLG12L	737084.312	606636.506	27.673
DLG13L	736950.509	606487.856	23.741
DLG14L	736816.956	606338.672	40.547
DLG15L	736683.096	606190.044	38.192
DLG16L	736549.191	606041.810	44.141
DLG17L	736415.422	605893.160	38.413
DLG18L	736253.770	605715.750	19.929
A2L	736108.870	605509.986	12.908
A3L	735964.079	605306.189	16.385
A4L	735819.490	605102.859	22.227
A5L	735674.336	604898.768	07.704
A6L	735529.382	604695.016	15.631
A7L	735384.415	604491.250	15.650
A8L	735239.645	604287.519	20.549
A9L	735094.762	604083.794	11.629

Table 5: Coordinates of Right-of-Way Beacons Along the Route (Right Hand Side)

Points	Northing (m)	Easting (m)	Height (m)
DLG1AR	738845.718	607969.010	48.411
DLG1R	738815.694	607951.952	46.891
DLG2R	738640.109	607850.699	43.212
DLG3R	738465.635	607752.733	23.084
DLG4R	738291.333	607654.585	12.594
DLG5R	738117.033	607557.177	40.237
DLG6R	737942.769	607458.865	30.401
DLG7R	737770.109	607361.432	28.491

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DLG8R	737637.779	607214.236	31.972
DLG9R	737485.713	607081.903	42.869
DLG10R	737370.562	606916.431	34.527
DLG11R	737273.592	606809.509	46.841
DLG12R	737102.848	606619.806	29.633
DLG13R	736969.003	606471.166	24.540
DLG14R	736835.531	606321.856	41.602
DLG15R	736701.78	606173.223	39.598
DLG16R	736567.757	606024.781	44.952
DLG17R	736433.974	605876.388	37.667
DLG18R	736272.375	605697.076	19.617
A2R	736129.358	605495.455	12.024
A3R	735984.484	605291.752	15.442
A4R	735839.606	605087.957	21.664
A5R	735694.689	604884.259	05.961
A6R	735549.815	604680.506	13.087
A7R	735404.849	604476.854	14.639
A8R	735260.005	604273.074	18.663
A9R	735115.129	604069.380	12.511

Table 6: Coordinates of Traverse Points Along the Route

Points	Northing (m)	Easting (m)	Height (m)
D1	738826.180	607971.681	48.121
D2	738764.372	607936.567	49.091
D3	738658.993	607877.228	44.471
D4	738484.781	607778.957	23.530
D5	738326.013	607688.733	08.774
D6	738198.176	607618.199	24.023
D7	738019.409	607516.454	34.782
D8	737842.734	607416.594	26.652
D9	737761.650	607368.837	28.762
D10	737648.229	607244.564	31.231
D11	737565.881	607151.132	44.733
D12	737501.581	607079.424	40.312
D13	737392.001	606954.576	34.201
D14	737283.896	606842.954	45.061
D15	737195.377	606742.280	35.512
D16	737092.442	606625.181	28.011
D17	736972.560	606499.499	24.540
D18	736875.455	606387.099	37.271
D19	736748.193	606238.689	40.011
D20	736635.004	606114.955	39.342
D21	736532.049	606002.648	45.855
D22	736444.723	605906.670	40.411
D23	736262.952	605703.773	18.433
D24	736164.345	605565.125	08.972
D25	736043.32	605396.375	12.321
D26	735902.339	605194.652	25.181
D27	735771.908	605011.789	13.311
D28	735639.614	604831.109	10.451
D29	735494.460	604628.961	12.351
D30	735390.898	604479.286	15.812
D31	735249.629	604281.979	19.361

Figure 2 show the methods adopted for the acquisition of geospatial data, processing and analysis for the ROW for the gas pipeline construction.

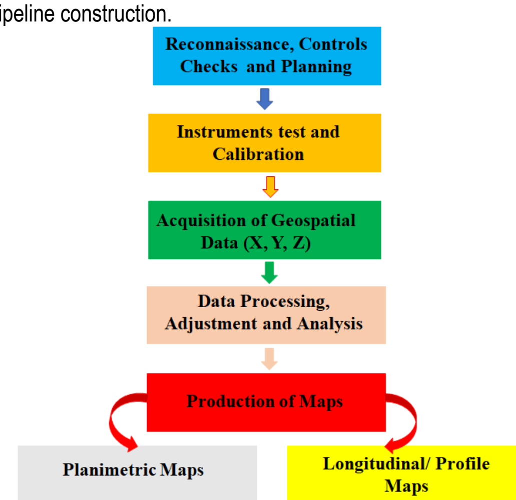

Figure 2: Methodology for acquisition of geospatial data and processing for Right-of-Way for the Gas Pipeline Construction

The methodology adopted for this study centres ground survey and field data (in-situ) collection method. However, remote sensing and photogrammetry methods are other ways of acquiring spatial data for administrative and cadastral purposes i.e. parcel ownership records for legal and compensation considerations; existing infrastructure data regarding roads, railways, water bodies; and other utility networks for integration and impact analysis. Also, Multi-Criteria Decision Analysis (MCDA); Least-Cost Path Analysis (LCPA) for optimal route selection; and Buffer Analysis for ROW delineation were carried out for Geographical Information System (GIS) based spatial analysis for route selection.

RESULTS AND DISCUSSION

The results obtained are presented in this section. Table 7 presented the final coordinates of the established GPS control points. Tables 8 and show the final coordinates for traverse points and some heights along the centre line of the route.

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Table 7: Final Coordinates for the Established GPS Controls

Station	Northings (m)	Eastings (m)	Height (m)
DF4	738807.900	607908.778	46.5211
DF3	738816.099	607948.361	47.2143
GP1	737682.144	607201.260	35.2112
GP2	737655.176	607165.263	36.2431
GP3	736555.888	605974.867	45.2136
GP4	736510.161	605927.133	45.3041
GP5	735126.897	604111.843	14.7126
GP6	735094.762	604083.794	10.8213

Table 8: Final Coordinates for Traverse Points

Station	Northings (m)	Eastings (m)	Height (m)
D1	738826.18	607971.681	48.121
D2	738764.372	607936.567	49.091
D3	738658.993	607877.228	44.471
D4	738484.781	607778.957	23.530
D5	738326.013	607688.733	8.774
D6	738198.176	607618.199	24.023
D7	738019.409	607516.454	34.782
D8	737842.734	607416.594	26.652
D9	737761.65	607368.837	28.762
D10	737648.229	607244.564	31.231
D11	737565.881	607151.132	44.733
D12	737501.581	607079.424	40.312
D13	737392.001	606954.576	34.201
D14	737283.896	606842.954	45.061
D15	737195.377	606742.28	35.512
D16	737092.442	606625.181	28.011
D17	736972.56	606499.499	24.540
D18	736875.455	606387.099	37.271
D19	736748.193	606238.689	40.011
D20	736635.004	606114.955	39.342
D21	736532.049	606002.648	45.855
D22	736444.723	605906.67	40.411
D23	736262.952	605703.773	18.433
D24	736164.345	605565.125	8.972
D25	736043.32	605396.375	12.321
D26	735902.339	605194.652	25.181
D27	735771.908	605011.789	13.311
D28	735639.614	604831.109	10.451
D29	735494.46	604628.961	12.351
D30	735390.898	604479.286	15.812
D31	735249.629	604281.979	19.361

Table 9: Height Along the Centre Line of the Route

Chainage	Northing	Easting	Height
0+000	738833.203	607975.501	48.123
0+200	738658.991	607877.230	44.471
0+400	738484.779	607778.959	23.528
0+600	738310.568	607680.687	12.157
0+800	738136.356	607582.417	34.411
1+000	737962.144	607484.145	31.648

1+200	737787.932	607385.874	28.02
1+400	737648.230	607244.562	31.228
1+600	737514.438	607095.879	44.735
1+800	737380.645	606947.196	35.222
2+000	737246.933	606798.441	45.191
2+200	737113.070	606649.822	28.945
2+400	736979.268	606501.148	23.268
2+600	736845.475	606352.465	39.457
2+800	736711.683	606203.782	37.9
3+000	736577.890	606055.100	42.785
3+200	736444.098	605906.417	40.413
3+400	736310.305	605757.734	23.771
3+600	736188.258	605599.629	10.408
3+800	736072.209	605436.719	11.763
4+000	735956.283	605273.721	17.681
4+200	735840.358	605110.723	23.189
4+400	735724.433	604947.725	9.64
4+600	735608.508	604784.727	13.549
4+800	735492.583	604621.729	12.347
5+000	735376.657	604458.731	17.042
5+200	735260.732	604295.733	19.674
5+400	735144.807	604132.735	14.503
5+600	735028.881	603969.737	2.395

Traverse loops

The traversing for the ROW was divided into three (3) loops. Tables 10-12 show the results obtained for loops 1-3, i.e. the bearing and distance from one point to another; and the coordinates of points. The total distance and the linear misclosure for the 3 loops are 1,472.056 and 36535; 1,672.503 and 20294; and 2,297.128 and 23047.

Table 10: Traverse Loop 1 Results

From station	Bearing (° ′ ″)	Distance (m)	Northing (m)	Easting (m)	To station
DF3	066 37 24	025.407	738826.180	607971.681	D1
D1	209 36 02	071.086	738764.372	607936.567	D2
D2	209 22 55	120.938	738658.993	607877.228	D3
D3	209 25 32	200.018	738484.781	607778.957	D4
D4	209 36 26	182.613	738326.013	607688.733	D5
D5	208 53 09	146.005	738198.176	607618.199	D6
D6	209 38 42	205.693	738019.409	607516.454	D7
D7	209 28 28	202.944	737842.734	607416.594	D8
D8	210 29 42	094.103	737761.650	607368.837	D9
D9	227 36 46	168.247	737648.229	607244.564	D10
D10	308 04 05	055.002	737682.144	607201.260	GP1
GP1	233 09 38	000.000			

Table 11: Traverse Loop 2 Results

From station	Bearing (° ′ ″)	Distance (m)	Northing (m)	Easting (m)	To station
GP2	18859 34	090.400	737565.881	607151.132	D11
D11	22807 06	096.310	737501.581	607079.424	D12
D12	22843 37	166.110	737392.001	606954.576	D13
D13	22555 06	155.383	737283.896	606842.954	D14
D14	22840 37	134.049	737195.377	606742.280	D15
D15	22841 02	155.903	737092.442	606625.181	D16
D16	22621 14	173.680	736972.560	606499.499	D17
D17	22910 36	148.530	736875.455	606387.099	D18
D18	22923 15	195.493	736748.193	606238.689	D19
D19	22732 58	167.688	736635.004	606114.955	D20
D20	22729 20	152.350	736532.049	606002.648	D21
D21	31038 09	036.607	736555.888	605974.867	GP3
GP3	22613 49	000.000			

Table 12: Traverse Loop 3 Results

From station	Bearing (° ′ ″)	Distance (m)	Northing (m)	Easting (m)	To station
GP4	197 21 53	068.560	736444.723	605906.670	D22
D22	228 08 35	272.400	736262.952	605703.773	D23
D23	234 34 45	170.130	736164.345	605565.125	D24
D24	234 21 08	207.653	736043.320	605396.375	D25
D25	235 03 02	246.094	735902.339	605194.652	D26
D26	234 30 02	224.604	735771.908	605011.789	D27
D27	233 47 17	223.926	735639.614	604831.109	D28
D28	234 19 09	248.853	735494.460	604628.961	D29
D29	235 19 12	182.002	735390.898	604479.286	D30
D30	234 23 51	242.656	735249.629	604281.979	D31
D31	234	210.25	735127.5	604110.7	GP5

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	30 30	0	57	85	
GP5	234 23 34	000.00 0			

Analysis of Results

Table 13 shows the analysis of results obtained for traverse loops 1-3 as compared with the allowable limits while Table 14 is for the levelling results. The result show that the attained accuracy compared with the allowable misclosure indicated that the job was properly executed.

Table 13: Analysis of Results for Traversing

Traverse 1			
Observation type	Allowable	Obtainable	Remark
Angular	00°01' 26.6"	00°00' 39"	Satisfactory
Linear	1: 3,000	1:36,535	Satisfactory
Traverse 2			
Observation type	Allowable	Obtainable	Remark
Angular	00°01' 30.14"	00°00' 28"	Satisfactory
Linear	1: 3,000	1:20,294	Satisfactory
Traverse 3			
Observation type	Allowable	Obtainable	Remark
Angular	00°01' 40"	00°00' 43"	Satisfactory
Linear	1: 3,000	1:23,047	Satisfactory

Table 14: Analysis of Results for Levelling

Observation Type	Distance (m)	Allowable (mm)	Obtainable (mm)	Remark
Loop 1	1472	0.030	+ 0.010	Satisfactory
Loop 2	1672	0.032	– 0.008	Satisfactory
Loop 3	2297	0.038	+ 0.011	Satisfactory

Maps

Two types of maps produced from the mapping of this oil and gas pipeline ROW are planimetric and longitudinal profile maps. Both plan and profile were digitally plotted together with the aid of AutoCAD 2007 and Microsoft Excel, plotted on scale 1:5,000 and 1:500 for both the horizontal and the vertical scales respectively. The vertical scale was exaggerated with respect to horizontal scale in order to make the difference in elevation more pronounced.

Planimetry Maps

The entire 5.6 km route presented in this study is shown in Figure 3-6. Figures 3-6 show the map of the route from0+000 chainage at Mojoda to 1+200 chainage; from 1+200 chainage to 3+200 chainage; from 3+200 chainage to 4+800 chainage; and from 4+800 chainage to 5+600 chainage at Igbodu respectively.

Figure 3: Map of the route A) from 0+000 chainage at Mojoda to 0+600 chainage; B)from 0+600 chainage to 1+200 chainage

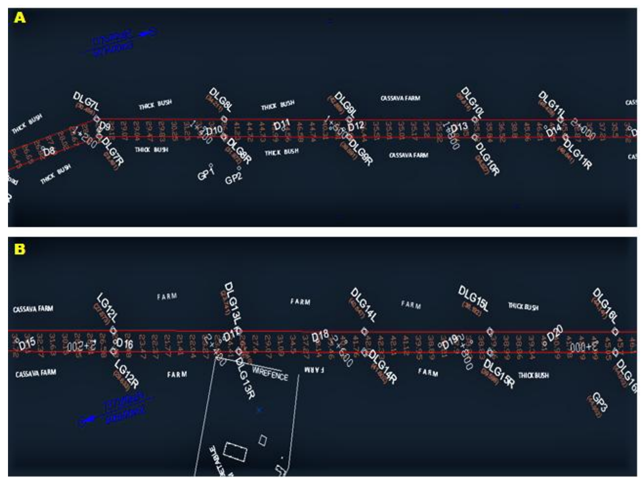

Figure 4: Map of the route A) from 1+200 chainage to 2+200 chainage; B) from 2+200 chainage to 3+200 chainage

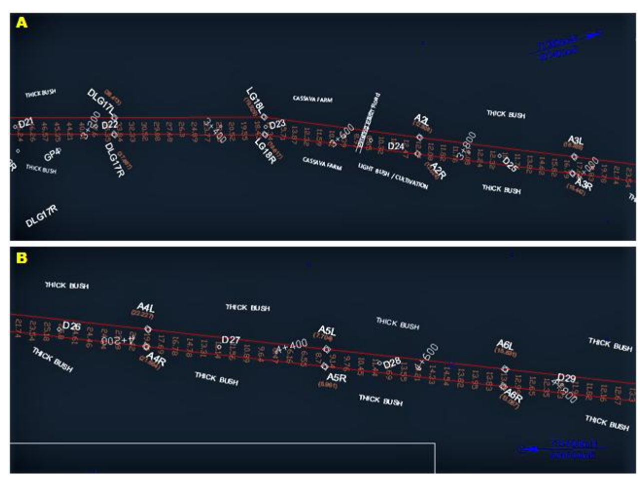

Figure 5: Map of the route A) from 3+200 chainage to 4+200 chainage; B) from 4+200 chainage to 4+800 chainage

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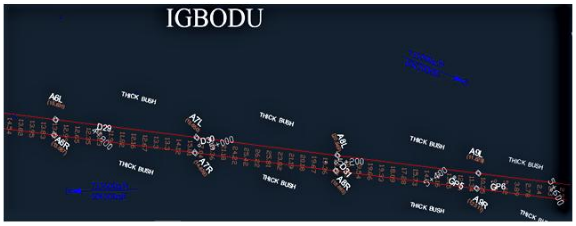

Figure 6: Map of the route from 4+800 chainage to 5+600 chainage at Igbodu

Longitudinal Section (Profile)

Figures 7-10 show the longitudinal profile of the route from 0+000 chainage at Mojoda to 1+040 chainage; from 1+040 chainage to 2+780 chainage; from 2+780 chainage to 3+760 chainage; and from 3+760 chainage to 5+600 chainage respectively. In Figure 7, number 1 is the beginning of the project at KP292 Escravous at Mojoda area; number 3 shows the location of a flowing stream; and numbers 2, 4 and 5 show Earth-filled roads. Also, in Figure 9, another Earth-filled road is presented at number 6. The proposed route covers various land cover and land use types such as thick bush (Figures 7, 8, 9 and 10), farming activities e.g. Cassava farms (Figures 7, 8 and 9). Furthermore, the height of the centre line at the starting point 0+000 of the project at Mojoda is 48.120 m. The highest point on the centre line ground level for the entire route is 49.100 m at 0+100 chainage; and the lowest height of 2.400 m is recorded at 5+600 chainage.

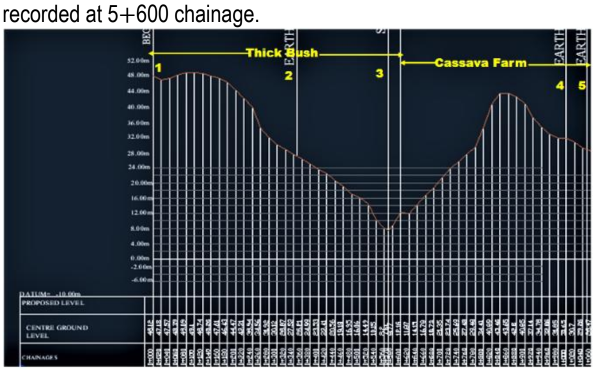

Figure 7: Longitudinal profile of the route from 0+000 chainage at Mojoda to 1+040 chainage

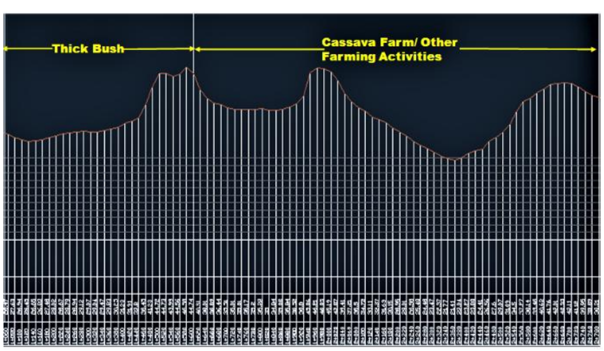

Figure 8: Longitudinal profile of the route from 1+040 chainage to 2+780 chainage

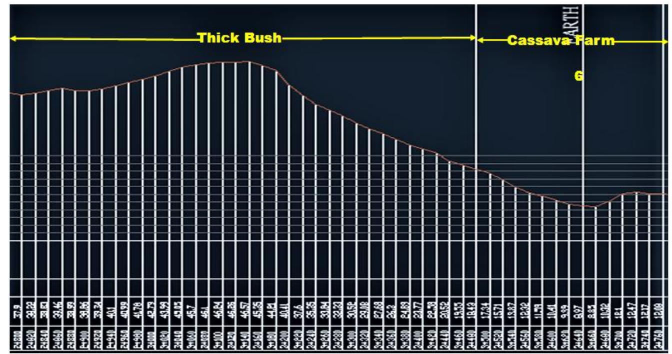

Figure 9: Longitudinal profile of the route from 2+780 chainage to 3+760 chainage

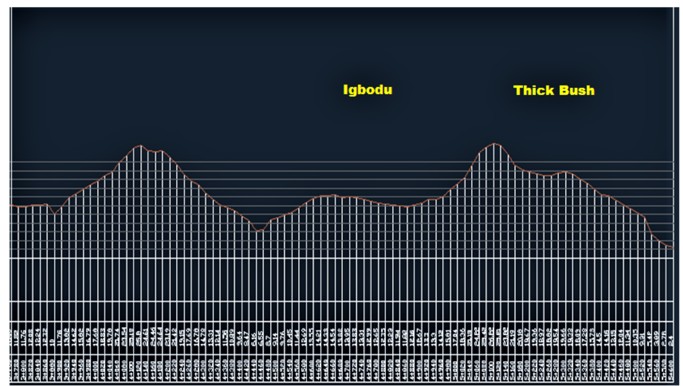

Figure 10: Longitudinal profile of the route from 3+760 chainage to 5+600 chainage

Description of Right-of-Way for the study

For this study, the title of the Right-of-Way description is "Right-of-Way description for the proposed 36" Natural Gas Pipeline from KP292 at ELPS (Mojoda Area) to Dangote Fertilizer Site at Lekki, Lagos State (Portion of). Then, starting from a point DLG1AL very close to KP292, Mojoda Area, Epe, Lagos State, marked with galvanized pipe embedded in concrete with DLG1AL(CH.0+000) coordinate of which are738845.937 mN, 607997.524 mE of UTM(Zone 31) origin, Minna Datum; run through the route down to Igbodu Area, Lagos State, Nigeria, A9L(CH.5+600) coordinateof which are 735094.762mN, 604083.794mEof UTM (Zone 31) origin, Minna Datum and back to KP292, Mojoda Area, Epe, Lagos State, Nigeria. The bearing and distance from one control to another are presented in Table 15.

Table 15: Bearings and Distances from One Control to Another (Mojoda to Igbodu)

From	Bearing	Distance (m)	To
DLG1AL	209 50 15	53.939	DLG1L
DLG1L	209 50 57	197.483	DLG2L
DLG2L	209 19 10	200.017	DLG3L
DLG3L	209 13 53	200.05	DLG4L
DLG4L	209 22 57	200.203	DLG5L
DLG5L	209 22 35	199.58	DLG6L

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DLG6L	209 26 44	202.447	DLG7L
DLG7L	228 00 31	202.738	DLG8L
DLG8L	235 14 34	200.801	DLG9L
DLG9L	220 51 09	201.251	DLG10L
DLG10L	227 59 50	136.457	DLG11L
DLG11L	228 01 10	263.53	DLG12L
DLG12L	228 00 32	200	DLG13L
DLG13L	228 09 52	200.231	DLG14L
DLG14L	227 59 33	200.022	DLG15L
DLG15L	227 54 27	199.76	DLG16L
DLG16L	228 00 58	199.977	DLG17L
DLG17L	227 39 39	240.012	DLG18L
DLG18L	234 50 48	251.664	A2L
A2L	234 36 27	249.995	A3L
A3L	234 34 59	249.498	A4L
A4L	234 34 43	250.445	A5L
A5L	234 34 16	250.053	A6L
A6L	234 32 14	250.072	A7L
A7L	234 36 09	249.929	A8L
A8L	234 34 51	249.99	A9L
A9L	324 42 45	24.952	A9R
A9R	54 34 40	249.961	A8R
A8R	54 35 43	250.012	A7R
A7R	54 33 20	249.979	A6R
A6R	54 35 10	250.008	A5R
A5R	54 34 15	249.988	A4R
A4R	54 35 27	250.044	A3R
A3R	54 34 46	249.967	A2R
A2R	54 39 02	247.194	DLG18R
DLG18R	47 58 27	241.386	DLG17R
DLG17R	47 57 50	199.796	DLG16R
DLG16R	47 55 20	199.993	DLG15R
DLG15R	48 01 00	199.953	DLG14R
DLG14R	48 12 20	200.27	DLG13R
DLG13R	47 59 53	200.021	DLG12R
DLG12R	48 00 39	255.227	DLG11R
DLG11R	47 47 40	144.345	DLG10R
DLG10R	55 09 58	201.595	DLG9R
DLG9R	41 01 51	201.584	DLG8R
DLG8R	48 02 39	197.934	DLG7R
DLG7R	29 26 11	198.254	DLG6R
DLG6R	29 25 47	200.083	DLG5R
DLG5R	29 11 56	199.672	DLG4R
DLG4R	29 23 01	200.036	DLG3R
DLG3R	29 18 50	200.096	DLG2R
DLG2R	29 58 13	202.688	DLG1R
DLG1R	29 36 10	34.531	DLG1AR

Conclusions

Mapping of the ROW was carried out for the construction of gas pipeline from KP292 Escravous at Mojoda and terminates along Dangote Fertilizer Company boundary covering approximately a total distance of 52.6 km, but 5.6 km is presented for this study. This study provides geospatial data (coordinates and elevations) of locations, and features (artificial and natural) within the ROW; the planimetry and longitudinal profile of the route for the construction of gas pipeline network in Lekki Free Trade Zone (LFTZ) area. The results show the general terrain and characteristics of the route providing essential information for the Engineer regarding the amount of cut and fill required in the process of laying the gas pipelines; also, the cost implications of the project, including compensation can be determined. Therefore, it can be concluded that geospatial data is the basis for the acquisition of the Right of Way for the construction of gas pipeline network.

Some problems encountered during the execution of this project includes the host communities who claims government has come to take over their landed property; farming along the route; the choice of the alignment with the appropriate government agencies; and compensation issue to be settled. Hence, the following recommendations are made: Nigerian Government should review and strengthen its policies on Right-of-Way (ROW) acquisition to ensure an efficient and equitable process, enabling the achievement of sustainable public infrastructure provision. Government should review and strengthen its policies on Right-of-Way acquisition for the efficient and equitable processes to enable the achievement of sustainable public infrastructure provision. Nigerian Government should enforce the immediate publication of the acquisition of the Right-of-Way and its alignment in the daily new papers through the office of State Surveyor General. This will inform the public of such acquisition. Relevant international bodies (World Bank, African Development Bank, and Food and Agriculture of the United Nations etc.) guidelines and policies on Right-of-Way acquisition and its compensation should be adhered to. Finally, the keeping of accurate database on the positions of buried utility services using GIS applications could significantly reduce the costs of acquisition of ROW.

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