

PRODUCTION METHODOLOGY

TS/J2913/PLN/PROD

REVISION HISTORY

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Distribution:

- Employees with a need to know
- Other stakeholders including customers on a need basis

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1. INTRODUCTION

1.1 Purpose & objectives

This document defines the production requirements of Geospatial data capture / update features based on new imagery. The requirements are detailed in subsequent chapters.

1.2 Scope

The scope of the services includes:

Part 3 – Update basemap data based on new satellite imagery / Orthophoto

1.3 Reference Documents

- Bid9671_RFP_V3.0.pdf
- Kickoff Meeting Minutes- 05Jun2018.pdf
- Basemap update.pdf
- Roads data issues.pdf
- Section 1.pdf (MoTC guidelines)
- D1.5 Basemap data capture specification.pdf

2. PRODUCTION REQUIREMENTS

2.1 Task sequence & interaction

1. Input Review
2. Pre-processing
3. Check & Update
4. Process QC
5. Topology
6. Edge match
7. Seamless GDB Creation
8. Product QC

2.2 Input Review

The inputs received from NCSI will be transferred to a server that has access to only those who are involved in the project. Safety and security of the data is ensured with restricted access to client material.

Along with the coverage, the quality of images (such as blur, mismatch of details at edge matching of tiles etc.) is checked so that the features that are required to be captured are not missed, wrongly captured or wrongly interpreted during data capture.

An input review checklist is prepared in which the observations on the input source are noted.

Data Sources for update/capturing all features

Data Reference	Data source usage	Format
New satellite/orthophotos (50 cm) resolution	For update / capturing process	Geotiff
Basemap with “admin boundaries”, “Streets”, “Buildings” and “Planned Plots”	For update / capturing features	FGDB
Project Area and priority list	Project planning	FGDB

2.3 Preprocessing

The two versions of the input imagery (2012 and 2018) is run through a process of change detection where in the changes from the old imagery to the new imagery can be identified, so that the features in the updated areas can be captured. The identified change locations are stored in the server for reference to carry out the update process.

For easy allocation, effective tracking and data management, the entire project area is simplified and divided into discrete modules (named as work packages) and stored in the server as inputs to data capture. As per the priority,

WP1, WP2 and WP3 respectively, each Wilayat in the WP areas are considered as a Lot and again each Lot / Wilayat is divided into discrete parts for easy allocation and internal data management.

2.4 Check & Update

The internally created work package parts are allocated to the selected GIS Engineers for data capture at the identified change locations to start the process. The GIS Engineers attach the input imagery from the server as a reference in the ArcGIS environment and use photo interpretation skills and techniques to capture the following required features:

3. STRUCTURES

3.1 Buildings:

With reference to the existing data, capture of building is done by interpreting their roof outlines and delineating them as closed polygons wherever new or modified buildings are identified. Where applicable, the orthogonal shape (edges with 90° to each other) of buildings is maintained using specific tools and captured accordingly. In case of any voids in the building such as courtyards, the inner edge as well as the outer edge of the buildings is delineated. Each and every building is moved to its base where visible i.e., its footprint, to avoid the height effect. In case the base of the building is not visible in the image, the building polygon is left on top of the building as it is captured.

The buildings are captured in 4 categories namely Main Building, Shaded Area, Ruins & Under Construction Buildings.

Create Building Centroids and remove Building Points from the data set (The current Building points are the Census Building Points)

Add a new entrance feature to all potentially addressable objects, i.e. main entrances of buildings and gates in walls. This may serve to aid how many address units are there on either side of the building and from which street are the buildings accessible and also interpreting of how many address units are there in a building.

Sheds, parking sheds, out houses, caravans etc., are captured in Shaded Area feature class.

Buildings under construction with visible walls and not completed roofs are captured in Under Construction Buildings.

Buildings that are abandoned and unsuitable for use are captured as Ruins.

Demolished buildings are marked for deletion and are attributed with a “Delete” attribute in the table for that particular building.

3.2 Walls/Fences

With reference to the input data, all new or modification identified walls/fences in the ortho photo inside the project area are captured as line features. Where they are surrounding or closing a property, they are captured as closed polylines including the opening left for the gate. In other areas, they are captured as line features where they are not closing a property or an enclosure. Walls sharing the edge with Main Building/shaded areas that are within the property are duplicated at the sharing edge of the buildings. Also, wall/fence surrounding land cover features such as cemetery, plantation, cropland etc. are captured as duplicating the land cover features.

4. LAND COVER FEATURES

With reference to the input data, the new or modifications identified land cover features are captured by delineating their outer edges as polygons in their respective classified layers as listed below:

- Cemetery
- Tanks
- Restricted Areas
- Cropland
- Grassland – Open areas filled with grass that resemble lawns that are found adjacent to highways or main roads, around government buildings, in public places and parks are captured as grasslands. Grasslands inside parks are duplicated or captured as overlapping polygons to park polygons.
- Industrial Area
- Plantation
- Scrub Bush – Dense scrub bushes around the habitation areas and adjacent to other land cover features such as croplands, plantations etc. are captured as polygons.
- Trees – Along with large tree areas that consist of combination of various trees, the row of trees with fully grown up trees alongside highways/main roads are captured as tree polygons.
- Built-up Areas – The outer boundary of the land on which buildings or non-building structures are present to be captured as urban built-up polygon.

Land cover features that are only separated by Walls, Fences and Roads will be captured as separate polygons. The separation is maintained by capturing the land cover features as visible on the imagery. Wherever the land cover features are visible till the edge of the road polygon, they share edges.

Trees and grassland polygons are captured as overlapping polygons in areas where both features are available and visible in the imagery. Grasslands and trees in residential areas are not captured.

Row of trees will be captured only along Express Ways and Major Roads. Rows of trees along secondary and intermediate roads or streets as well as in private properties will not be captured.

5. TRANSPORTATION

5.1 Roads

The new or modified roads (paved/unpaved) are identified and captured. All the new or modified roads are captured by delineating their outer edges and including medians as polygons and classify as per MoTC guidelines (i.e. National Route, Arterial Route, Secondary Route, Distributor Route and Access Route). The road polygons will be captured in continuity with the existing road polygons and merged later.

Capture road-edge details in paved road polygons to include exits, i.e. breaks in the curb line or pavement where there are drive-ways and entrances to individual properties.

The road centerlines for the roads are captured, snapping them to the existing road centerlines provided as input. In areas where there are very narrow streets and difficult to identify the edge of the road for polygon, only road centerlines are captured.

The hanging roads in the source data are connected to the nearest road with a road centerline for network connectivity and continuation. Alleys and unpaved road connections are also represented with a road centerline to maintain connectivity of network.

Roads inside industrial areas, commercial areas, public places and private properties with multiple buildings are captured with road centerlines to show access to the buildings that exist inside these properties.

The newly captured road centerlines are populated with the text "IIC" as an attribute in the "Remarks" field, to identify and distinguish them from the existing input centerlines.

Road polygon is captured only in cases where the paved surface is clearly visible in the imagery. For unpaved roads with clear and uniform width, only road centerlines are captured without any polygon within the dense built-up and residential areas.

5.2 Cart Tracks

With reference to existing cart tracks layer supplied by NCSI, the missing and significant cart tracks that are connected to the paved road and leading to a building or a property such as a farm, cemetery, recreation area, race track etc. are identified and captured. All the missing cart tracks as per requirement are captured by delineating only their centerline. The cart tracks will be snapped to the existing cart tracks and split at

the intersections. Also, the cart tracks connected to the paved roads are snapped to the road centerlines and the road centerlines are split at the intersection.

The newly captured cart tracks are populated with the text “IIC” as an attribute in the “Remarks” field, to identify and distinguish them from the existing input tracks.

The unpaved roads outside dense residential and built-up areas such as rural or land cover filled areas, are also captured as cart tracks.

Tracks connecting any other features such as Pylons or not leading to any property as well as those which are not significant and spread across open areas will not be captured.

5.3 Road Intersection Point

The intersection points of the road centerlines, cart tracks and road centerlines with cart tracks are generated and stored in a separate feature class named ‘Road_Intersection_Point’ in the geodatabase. The type of intersection is assigned to an attribute field ‘Intersection_Type’ that shows as ‘Road Intersection’, ‘Cart Track Intersection’ or ‘Road and Cart Track Intersection’ accordingly.

The newly generated intersection points are populated with the text “New” as an attribute in the “Action” field to identify and distinguish them from the existing input points.

Also add a “type” to road intersection point stating as mentioned below.

- A major street X-intersection
- A major street T-intersection
- A major street roundabout (number of arms)
- A mixed major street/access street X-intersection
- A mixed major street/access street T-intersection
- A mixed major street/access street roundabout (number of arms)
- An access street X-intersection
- An access street T-intersection
- An access street roundabout (number of arms)

6. MISCELLANEOUS FEATURES

With reference to the input data, the new or modifications identified miscellaneous features are captured by delineating their outer edges as polygons in their respective classified layers as listed below:

- Archeological Sites
- Fortification Castle
- Golf Courses
- Parks
- Stadiums and Sports Fields

To differentiate between various sports fields, the type of sport (Football, Basketball etc...) is populated in a "Category" field.

The polygons of the miscellaneous features that are newly captured, those that are modified and those to be deleted are all given an attribute as "Newly Captured" or "Modified" or "To be Deleted" in a "Action" field, so as to differentiate and identify the updated polygons from the source data.

By panning through the work package the correct delineation and topology of features is ensured before closing it. The digitization completed work packages are checked for completeness of feature capture and any missing features, wrong feature interpretation, wrong feature capture etc., before the Process QC is carried out on the work package. After completion of data capture, the work package is copied to the server to the designated location.

The following rules are taken into consideration during the update of base map features.

- Minimum area for capturing the structure polygons is 2 sq. m.
- Minimum length for line segments for Walls, Fences, Road Centerlines and Cart Tracks is 1.5 m.
- All feature classes will be updated with an attribute as "New" or "Existing" or "Modified" or "Deleted" in a separate field and deleted features will be provided as a separate shape file.
- All tracks, which are leading to a house / agricultural property / connected to a main street to be retained or captured and also unwanted hanging tracks, which are not leading to any habitat or street to be deleted.
- All trees along the roads that have been captured as point features in the "Seven towns" project earlier, will now be captured as polygons in those areas to maintain consistency with the remaining project area.
- Street intersections created nearer to each other will be generalized and will be snapped to meet at a single intersection, thereby avoiding unwanted street intersections.

- As per proposed data model provided in “Basemap Update.pdf” by NCSI, the existing data structure will be modified by adding a “Category” field to each feature class in their respective datasets for base map update.
- The previous tool developed by IIC to count the number of features in each feature class will be amended with additional functionality of counting the records having “NULL” values from each field of every feature class.
- IIC will capture all the features and deliver two separate data sets as mentioned in the proposed data models in the “Basemap Update.pdf”.

7. Final Deliverable Data Model for Basemap

Data Capture Project		Proposed Data Model (Same like NGDB)	
Dataset	Feature Class	Dataset	Feature Class
Structures	Building	Buildings	Buildings
	Shaded Areas		
	Ruins		
	Under Constructions		
	Building Points		Building Centroids
	Tanks		No FC
	Wall		Wall and Fences
	Fences		
Landcover	Crop Land	Landcover	Vegetation
	Grass Land		
	Plantation		
	Scrub Bush		
	Trees		
	Oasis		No FC
	Builtup Areas	Landuse	Builtup Areas
	Cemetery		No FC
	Industrial Areas	Industrial Areas	Industrial Zones
Transportation	Road Centre Line	Road Transportation	Road Centre Lines
	Road Polygon		Road Edges
	Road Median		Median Areas
	Road Intersection		Intersections
	Cart Track		Tracks
Miscellaneous	Archeological Sites	Historical Sites	Archeological Sites
	Fortification Castle	Public Venues	Archeological Sites
	Golf Courses		Golf Courses
	Parks		Parks
	Stadium and Sports Fields		Sports Fields
Restricted Area	Restricted Area		No FC
Work Package boundary	Governorate	Work Package boundary	Governorate
	Wilayat		Wilayat
	WP_Boundaries		WP_Boundaries

8. QUALITY CONTROL & SEAMLESS DATA

8.1 Process QC

This QC is performed on the work packages after completion of the Check and Update task. In this process, the files are checked for completeness of data capture as specified for the task. After complete checking, the error marked files along with Process QC log will be copied to the server to the specific location. Verification will be done on the work packages after fixing the marked errors.

All observed errors shall be recorded using the error stamp tool developed internally, which codes errors by type (Critical or Non-Critical). The status of acceptance is calculated automatically and displayed as per the internally formulated Acceptance Criteria. Where there are a high number of errors, or any specific quality problem is detected, the Quality team will raise a Quality Problem Report and sends it to the Production team. For all the errors marked, the production team will check the entire set of files for similar errors.

Initially, QC is performed 100% on each work package, and revised as experience on the requirement and the process is gained by the digitizing team.

For the first few batches almost all the files will be taken for QC as like a production QC process and while moving further the process changes to a sampling method where in only selected files will be taken for QC. The QC is done as per the checklist provided for this purposes. If there are significant positional accuracy issues & any specification related errors exceeding AQL for the scale of mapping then the data will be rejected.

The errors are summarized in the Process QC log, and the status of acceptance is indicated. Where high number of errors is reported or any specific quality problem occurs, the Quality team will raise a Quality Problem Report and send it to the production team. For all the errors marked, the production team has to check the entire block/file for similar kind of errors.

8.2 Topology

The seamless data is checked for topology errors using various combination of rules to ensure data integrity and correctness that is again checked and ensured in the Product QC stage. All the below listed topology validations are done on the data.

Topology Validation:

The Road Centerline data is checked for conformance to standard definitions.

- Line features must contain a minimum of 2 vertices.
- Line features must be contiguous from start to end.

- Line features must not have duplicate sequential vertices.
- Line features must not have kickbacks (collapsed loop).
- Line features that loop or close on themselves must be verified for correctness
- No multipart line feature.

All the polygon features are checked for conformance to standard definitions with following checks.

- Polygon features must contain a minimum of 4 vertices.
- Polygon features must close. First and last vertices must match.
- The exterior boundary of Polygon features must be contiguous.
- The exterior and interior boundaries of Polygon features must not self-intersect. That is, a Polygon feature may not contain loops or any duplicate vertices.
- Holes (interior boundaries) in Polygon features must be totally contained (not touch or intersect) within the exterior boundary of the same Polygon feature.
- Holes (interior boundaries) in Polygon features must not intersect or overlap other holes belonging to the same Polygon feature.
- No multipart polygon feature.

Validate feature connectivity:

Validate the connectivity and geometric spatial relationships between Line and Area features.

Validate for over-shoots.

- Validate for over-shoots between Line features.
- Validate for over-shoots between Line and Area features.

Validate for under-shoots.

- Validate for under-shoots between Line features.
- Validate for under-shoots between Line and Area features.

Validate for slivers and gaps.

- Validate for slivers between Area features.
- Validate for orphan (non-connected) features in linear transportation network

8.3 Edgematch

After the Process QC task is completed and all the data is accepted by the Quality team, the digitization completed work packages are taken for data cleanup and edge matching process during which they are cleaned of topological errors such as undershoots, overshoots, dangles, and closing of polygon areas. After the data cleanup the work packages are stitched together to form a seamless dataset. All the features in each of the layers from adjacent

work packages are merged or connected to features of respective layers. Continuity and completeness of the features at the edges of the work packages is ensured. In this process the existing road layer supplied by NCSI for reference is also merged with the newly captured missing roads. The edge match completed file is copied to server..

8.4 Seamless GDB Creation

Upon cleaning the topology errors in the data updated feature classes, a seamless geo-database with all the feature layers is created for the entire Project Area as per the defined structure and is sent for Product QC before delivery.

A seamless data is created for each Wilayat, Governorate and the entire Project Area, as and when the data update is completed.

8.5 Product QC

Product QC will be performed before shipping the data to customer; this is performed after completion of all post processing tasks, i.e. Edge matching and Topology.

Product QC check will be performed on the parent job prior to shipment. If there are errors exceeding the AQLs for the scale of mapping then the data will be rejected.

The errors are summarized in the Product QC log, and the status of acceptance is indicated. Where a high number of errors are reported or any specific quality problem occurs, the Quality team will raise a Quality Problem Report and send it to the production team. For all the errors marked, the production team has to check the entire block/file for similar kind of errors and validate the entire block/file. QC is performed initially for 100% and revised as experience is gained.

All customer feedback is analyzed and appropriate action be taken (e.g. re-training an operator). All product errors are tracked to closure and monitored for future learning.

General Data Review:

Check Delivery Data Format: Check that the data is in the correct GDB format, specifically that all features are captured in respective feature class.

Check Data Co-ordinate System: Check that the data is defined in the correct projection system “geographic co-ordinate system” (WGS84).

Positional Accuracy Test: Select different features in different sample areas and measure the distance between the feature and its corresponding position on the imagery, ensuring that they fall within acceptable tolerance levels.

Topology Validation:

Verify that all feature data geometries conform to standard definitions.

Validate Line data conforms to standard definitions.

- Line features must contain a minimum of 2 vertices.
- Line features must be contiguous from start to end.
- Line features must not have duplicate sequential vertices.
- Line features must not have kickbacks (collapsed loop).
- Line features that loop or close on themselves must be verified for correctness
- No multipart line feature.

Validate Area data conforms to standard definitions.

- Area features must contain a minimum of 4 vertices.
- Area features must close. First and last vertices must match.
- The exterior boundary of Area features must be contiguous.
- The exterior and interior boundaries of Area features must not self-intersect. That is, an Area feature may not contain loops or any duplicate vertices.
- Holes (interior boundaries) in Area features must be totally contained (not touch or intersect) within the exterior boundary of the same Area feature.
- Holes (interior boundaries) in Area features must not intersect or overlap other holes belonging to the same Area feature.
- No multipart area feature.

Validate feature connectivity: Validate the connectivity and geometric spatial relationships between Point, Line, and Area features.

Validate for over-shoots.

- Validate for over-shoots between Line features.
- Validate for over-shoots between Line and Area features.

Validate for under-shoots.

- Validate for under-shoots between Line features.
- Validate for under-shoots between Line and Area features.

Validate for slivers and gaps.

- Validate for slivers between Area features.
- Validate for slivers between Line features.
- Validate for slivers between Line and Area features.

Validate for orphan (non-connected) features in linear transportation network

Validate feature Edge matching:

- Validate for missing features along extraction area boundaries.
- Validate for mismatched feature classes and types along extraction area boundaries.
- Validate for geometry mismatches along extraction area boundaries.
- Validate for attribute mismatches along extraction area boundaries.

Acceptance Criteria:**AQL Acceptance levels**

No Topology errors should exist in the dataset and

The average critical errors should not exceed 2% of the total number of features.

Acceptable Quality Levels (AQL)

Sl. No.	CRITICAL ERRORS		NON - CRITICAL ERRORS	
	Error Code	Description	Error Code	Description
1	EDGM	EDGEMATCHING	NEDGM	NC EDGEMATCHING
2	INTP	MISINTERPRETATION	NINTP	NC MISINTERPRETATION
3	MSNG	MSNG - MISSING	NMSNG	NC MISSING
4	WCPT	WRONG CAPTURE	NWCPT	NC WRONG CAPTURE
5	WSYM	WRONG SYMBOLOGY	NWSYM	NC WRONG SYMBOLOGY
6	CRO	CROSSING	NCRO	NC CROSSING
7	DEL	DELETE	NDEL	NC DELETE
8	MOD	MODIFY	NMOD	NC MODIFY

9. RELEASE AUTHORIZATION:

After the data has been accepted internally by the authorized persons, the data will be released for shipment by issuing a DQC. Any QC representative who is independent of the project execution, possesses the necessary competence and is authorized by the organization can issue a DQC.

Final data will be uploaded to the clients' contractor FTP site and the client will be informed by the release of an electronic delivery note detailing the delivery files.

9.1 Deliverables

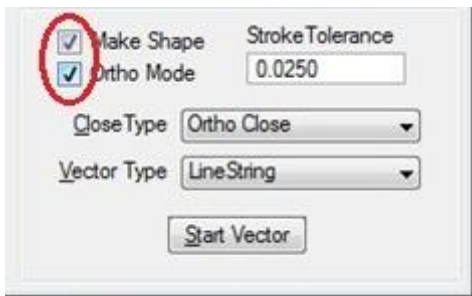
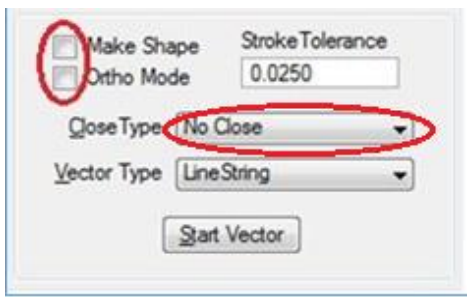
The following GIS Data layers are delivered as output

1. Deliverables for Part 3

No	Layer	Format
1	Updated Building footprint Data Layer - Covering project area	FGDB
2	Updated Walls/Fences Data Layer - Covering project area	FGDB
3	Updated Land cover Data Layer Covering project area	FGDB
4	Updated Road Network data set- Covering project area	FGDB
5	Updated Golf Course	FGDB
6	Updated Parks	FGDB
7	Updated Stadium and sport fields	FGDB
8	Metadata as per ONSDI standards	FGDB

9.2 Tools

Digitization:

1		Used for capturing the building shapes with settings locked for orthogonality and making a closed shape, to maintain the building edges at 90° to each other where applicable.
2		Used to capture the road edges, switching off the orthogonal mode enables free hand digitization of road edges.






IIC's Data Cleanup and Topology Tools:

- Remove duplicate vertices
- Check and clear short length elements as per given tolerance

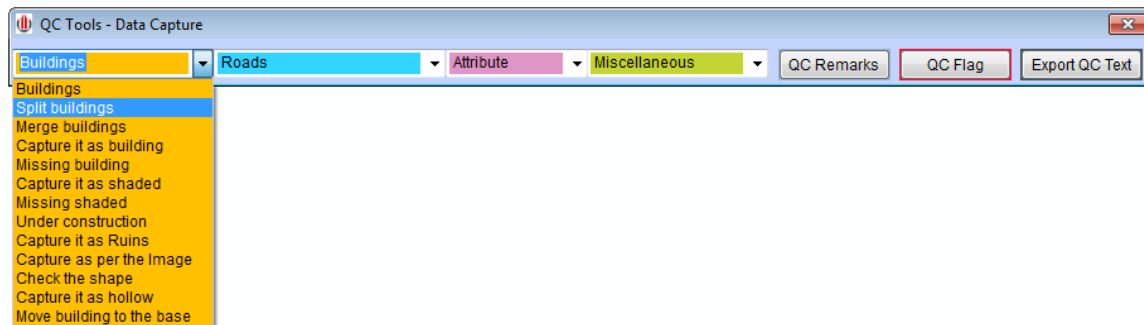
- Check and clear overshoots and undershoots
- Check and clear crossings
- Convert all building features from line strings to shapes
- Creation of centroids to polygon features
- Check and clear crossing “Landcover” features with roads and buildings if any

Topology on Geodatabase:

ArcGIS in-built topology tools will be used for creating and validating the topology between various feature classes to identify overlaps, intersections, short segments, self-intersections, sliver polygons, gaps etc.

	<p>This toolbar is used to move to the next next features in a particular selection set in a fixed zoom scale and can be used to check and validate features for various requirements.</p> <ol style="list-style-type: none"> 1. The first tool  in the toolbar creates a selection set of the selected features. 2. The second tool  brings the next feature in the selection set to the center of the screen. 3. The third tool  brings the previous feature in the selection set to the center of the screen. 4. The last tool  resets the selection set.
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IIC's Process and Product QC Tools:



The above toolbar is used in the QC process during the course of the project to create an error flags file that contains the error code and description. It contains the different categories and error types specific to the project that can be used to mark errors.

10. WORK FLOW

Part3: Work Flow for Base Map Update on New Imagery

