KENYA ROADS BOARD

APRIL 2009

ROAD and BRIDGE INVENTORY AND CONDITION SURVEY

PROCEDURE MANUAL

KENYA ROAD INVENTORY AND CONDITION SURVEY OF UNCLASSIFIED ROADS

PREFACE

This manual was developed as part of the Reclassification of the Road Network and Undertaking of a Road Inventory and Condition Survey of the Unclassified Roads, a project funded by the Nordic Development Fund as part of the Northern Corridor Improvement Programme. It was prepared to assist field crews from the Kenya Roads Board, Ministry of Roads, Roads Department as well as any consultant personnel in the collection of data needed for managing the rehabilitation and maintenance needs of the unclassified road network in Kenya. The data will be used by the MRPW and the KRB for studying road needs and for developing maintenance and capital improvement programs.

The manual should be used both as a training aid and as a field guide. A copy should be placed in each survey vehicle. Each member of each survey team should be intimately familiar with its contents. From time to time, as new situations or needs arise, the manual may need additional revisions.

The manual fulfills the contract requirement for a Road Inventory and Condition survey Manual.

This procedure manual was prepared by the following organizations and individuals:

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	ABBREVIATIONS AND ACRONYMS	
	4WD	Four wheel drive vehicle
	AARB	Australian Road Research Board
	ATV	All Terrain Vehicle
	DRE	District Roads Engineer
2	ESRI	Environmental Systems Research Institute
	GIS	Geographic Information System
	GPS	Global Positioning System
	GPRS	General Packet Radio Service
	IRI	International Roughness Index
	KRB	Kenya Roads Board
	KWS	Kenya Wildlife Services
	MC	Motorcycle
	MoR	Ministry of Roads
	RD	Roads Department of MoR
6	RICS	Road Inventory and Condition (RIC) Survey
	URICS	Unclassified Road Inventory and Condition (RIC) Survey
	VHF	Very High Frequency

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Equipment / Technique	Complexity
Rod and level survey	most simple
Dipstick profiler	
Profilographs	simple
Response type road roughness meters (RTRRMs)	complex
Profiling devices	more complex

Zones									
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Trans Nzoia	3,000 Km
Nandi North	1,500 Km
Koibatek	800 Km

DISTRIC	

Section 1

EQUIPMENT

This section discusses the equipment used during the URICS project, including various types of vehicles, GPS receivers together with their advantages/disadvantages. It also looks at other equipment that could be used for future surveys.

Vehicles
The RICS of the unclassified roads was carried out using a combination of 4WD vehicles, All Terrain Vehicles (ATVs) and motorcycles.

Each type of vehicle has its advantages in certain circumstances. For example, 4WD vehicles can be used in all weather conditions and can work more hours, since they could go back to base even after nightfall.

They were however more expensive to use than the Motorcycles and ATVs. They also required a crew of minimum two persons, a driver and the GPS operator, where the motor cycles and ATVs needed a crew of just one GPS operator/Rider.

All Terrain Vehicle Used in URICS

Other advantages of the ATVs and motorcycles include:

- Cheaper to purchase, run and maintain compared to motor vehicles
- Easier to maneuver over narrow roads and rough or rocky terrain
- Highly productive in urban or other densely populated areas

They however have several disadvantages including:

- They cannot operate in rainy weather
- They cannot operate after dark, in sparsely populated areas, in forested areas or in wildlife parks due to security concerns.
- Cannot operate in open country where they would have needed to travel long distances before refueling(e.g. North Eastern Province), due to the limited fuel tank capacity
- They do not have facilities for charging equipment batteries.
- Motorcycles are very prone to accidents, and especially on poorly maintained roads

Off Road Motor Cycle used in URICS

Equipment carried on vehicles

Comment [yar1]: This was moved from below

Each 4WD vehicle should be equipped with: 1) Backup battery or car charger for the GPS Unit. 2) Long range HF radio for communication with the Nairobi head office and other vehicles 3) Short range VHF radio for communication with surveyor carrying the portable VHF sets. 4) Mobile phone 5) Safety gear including warning triangles, flashing lights, reflective jackets etc. 6) Shovels, spades, pangas etc. 7) At least 2 spare tyres 8) High lift jack 9) Spare diesel containers 10) 30m Tape 11) Letter of introduction, stating the purpose of the survey and identifying the occupants as part of the contractor's team working for the Government of Kenya, signed by an official of the KRB.

Each vehicle should be manned by a surveyor/data collector a district / local authority road officer and a driver.

Survey Vehicle

Comment [yar1]: This was moved from below

Each ATVs or Motorcycles should be equipped with:

1) Portable VHF radio set
2) 30m Tape
3) Reflective jacket
4) Letter of introduction, stating the purpose of the survey and identifying the occupants as part of the contractor’s team working for the Government of Kenya, signed by an official of the KRB

GPS Equipment

The reference system for the visual surveys is established with GPS equipment. Different makes of hand held GPS equipment are available in the market and the user may decide which make is more convenient for the purpose as long as the basic requirements to accuracy, reliability and data capture capabilities are fulfilled. The Trimble make of GPS receivers are described below.

Trimble Recon XB Handheld GPS

This model consists of a data logger and a GPS receiver that are connected using wireless Bluetooth technology. The receiver is placed anywhere within 10 meters of the logger, and it transmits GPS information to the logger that is operated by the surveyor using ‘touch screen’ method.

This model is very rugged and is both waterproof and shock resistant. It is very reliable, but having to charge and carry two separate gadgets is sometimes an inconvenience to the surveyors.

Trimble Recon XC Handheld GPS

This model is similar to the XB but has an in-built data logger. However the model proved to be very un-reliable possibly due to some inherent design problems. The consultant stopped the use of this model due to persistent problems with its operation.

Trimble Juno ST Handheld GPS

This model was launched during the course of the project. It is a highly productive yet affordable, non-rugged GPS receiver for field data collection. It incorporates a high-sensitivity GPS receiver, and has been specifically designed to maximize yield of positions in hostile environments, such as under forest canopy and up against buildings.

This model is the most popular amongst the survey teams as it is light, small in size and easy to operate. The main setback is that its battery life short and requires to be recharged after 5-6 hours of continuous use. It therefore cannot be effectively used by motorcycle of ATV crews who do not have a way of recharging the equipment in the field. It is also not as rugged as the others described above, and needs to be handled with care. It also cannot be used in rainy weather as it is not water proof.

Digital Cameras

Each team should also be equipped with a digital camera that is used to take photographs of points of interest including:

- Bridges, Culverts, drifts and other road structures
- Institutions and Facilities
- Locations with road maintenance problems
- Other areas of interest

During the survey, the operator needs to record the GPS location of where each photograph is taken, and thus needs to note also the photo number and the date/time.

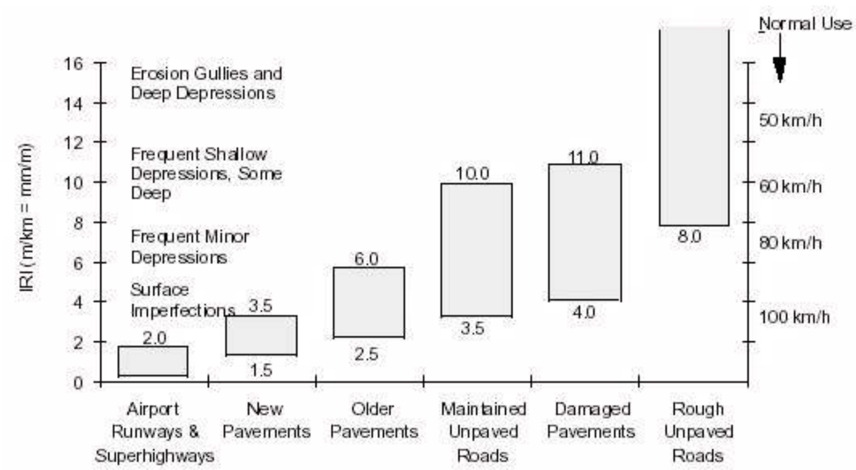
Several makes of GPS units that have an inbuilt digital camera such as the Magellan Mobile Mapper 6, and the Trimble Juno SB or SC were recently released into the market. With the inbuilt camera, the equipment automatically records the coordinates of any photographs taken and stores these in the GIS system, and thus the operator does not need to record these manually.

International Roughness Index (IRI) Measurement Equipment

Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle delay costs, fuel consumption and maintenance costs. Roughness is also referred to as "smoothness" although both terms refer to the same pavement qualities.

The international roughness index (IRI) was developed by the World Bank in the 1980s (UMTRI, 1998). IRI is used to define a characteristic of the longitudinal profile of a traveled wheel track and constitutes a standardized roughness measurement. The commonly recommended units are meters per kilometer (m/km) or millimeters per meter (mm/m). The IRI is based on the average rectified slope (ARS), which is a filtered ratio of a standard vehicle's accumulated suspension motion (in mm, inches, etc.) divided by the distance traveled by the vehicle during the measurement (km, mi, etc.).

IRI Roughness Scale Measurement Techniques The equipment for roughness survey data collection can be categorized into the four broad categories as follows:



Roughness Measuring Equipment

a) Rod and Level SurveyDipstick Profiler

The dipstick profiler can be used to collect a relatively small quantity of pavement profile measurements. The Dipstick Profiler consists of an inclinometer enclosed in a case supported by two legs separated by 305 mm (12 in.). Two digital displays are provided, one at each end of the instrument. Each display reads the elevation of the leg at its end relative to the elevation of the other leg. The operator then "walks" the dipstick down a premarked pavement section by alternately pivoting the instrument about each leg. Readings are recorded sequentially as the operator traverses the section. The device records 10 to 15 readings per minute. Software analysis provides a profile accurate to ± 0.127 mm (± 0.005 in.). The dipstick is commonly used to measure a profile for calibration of more complex instruments.

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b) Profilographs

Profilographs have been available for many years and exist in a variety of different forms, configurations, and brands. Due to their design they are not practical for network condition surveys. Their most common use today is for rigid pavement acceptance construction inspection, quality control, and acceptance. The major differences among the various profilographs involve the configuration of the wheels and the operation and measurement procedures of the various devices.

Profilographs have a sensing wheel, mounted to provide for free vertical movement at the center of the frame (see Figure below). The deviation against a reference plane, established from the profilograph frame, is recorded (automatically on some models) on graph paper from the motion of the sensing wheel. Profilographs can detect very slight surface deviations or undulations up to about 6 m (20 ft) in length.

c) Response Type Road Roughness Meters (RTRRMs)

The third category of roughness data collection equipment is the response type road roughness meters (RTRRMs), often called "road meters". The Roughometer II used in the URICS project belongs to this group of equipment. RTRRM systems are adequate for routine monitoring of a pavement network and providing an overall picture of the condition of the network. The output can provide managers with a general indication of the overall network condition and maintenance needs

RTRRMs measure the vertical movements of the rear axle of an automobile or the axle of a trailer relative to the vehicle frame. The meters are installed in vehicles with a displacement transducer on the body located between the middle of the axle and the body of a passenger car or trailer. The transducer detects small increments of axle movement relative to the vehicle body. The output data consists of a strip chart plot of the actual axle body movement versus the time of travel.

The disadvantage of a RTRRM is that its measured axle body movement vs. time depends on the dynamics of the particular measurement vehicle, which results in two unwanted effects (UMTRI, 1998):

- Roughness measuring methods have not been stable with time. Measures made today with road meters cannot be compared with confidence to those made several years ago.

- Roughness measurements have not been transportable. Road meter measures made by one system are seldom reproducible by another.

Because of these two effects, profiling devices are becoming more popular.

d) Profiling Devices

Profiling devices are used to provide accurate, scaled, and complete reproductions of the pavement profile within a certain range. They are available in several forms, and can be used for calibration of RTRRMs. The equipment can become fairly expensive and complex. Three generic types of profiling systems are in use today:

- Straight edge. The simplest profiling system is a straight edge. Modifications to the straight edge, such as mounting it on a wheel, result in a profilograph.

- Low speed systems. Low speed systems are moving reference planes. They can be a long trailer that is towed at low speeds of 3 to 8 kph (2 to 5 mph). The slow speed is necessary to prevent any dynamic response measurement during the readings.

- Inertial reference systems. Most sophisticated road profiling equipment uses the inertial reference system. The profiling device measures and computes longitudinal profile through the creation of an inertial reference by using accelerometers placed on the body of the measuring vehicle to measure the vehicle body motion. The relative displacement between the accelerometer and the pavement profile is measured with either a "contact" or a "noncontact" sensor system.

The earliest profiling devices used a measurement system in direct contact with the pavement to measure profile. Several contact systems have been used, and are still in use today.

Systems used today in the United States are frequently installed in vans which contain microcomputers and other data handling and processing instrumentation. Older profiling devices are usually contact systems, while the more recently manufactured devices use noncontact sensors. The noncontact systems use probes, either acoustic or light (Laser), to measure differences in the pavement surface. For instance, one type of road profiler simultaneously collects three ultrasonic profiles, one for each wheel path and one for the lane center. These profiles are used to calculate (by computer) a mathematical measure of roughness and an estimate of rutting at specified intervals along the roadway.

Integrated Road Data Collection Van

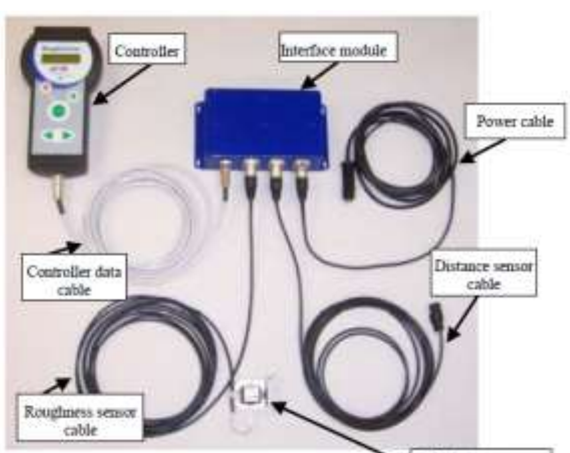
IRI Survey in URICS Project

In the URICS project, the consultant chose to use the ARRB Roughometer II to measure the IRI of paved roads. This is a very simple equipment to use and can be easily and quickly fitted to most vehicles. All operations are controlled by five buttons and a two line LCD display. The roughomenter is an RTRRM equipment.

Vehicle hardware

The standard equipment that comes with the Roughometer includes the following:

- Hand held data collection unit, the 'Roughometer Controller'
- Interface module
- Cable set
- Roughness sensor and mounting brackets
- User Manual.



Vehicle hardware

Office Components
To download and process the IRI data collected in the field, the following are also provided:

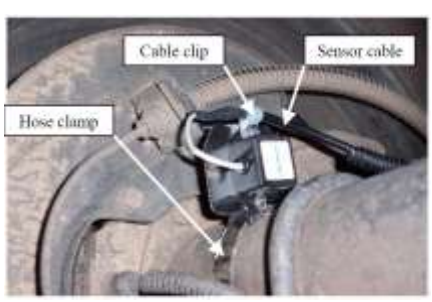
- Roughometer Controller
- Download (communications) cable
- Plugpack Power Supply
- Roughometer Processing Software CD

Roughomenter Controller
The Controller is used by the surveyor to perform all the set up and survey functions. It provides operator feedback during the survey accepts Control Point and Event inputs from the operator and acquires Distance, Time and Roughness data. All data are stored in non-volatile internal memory. The Controller is operated by using five keys

Roughness Sensor

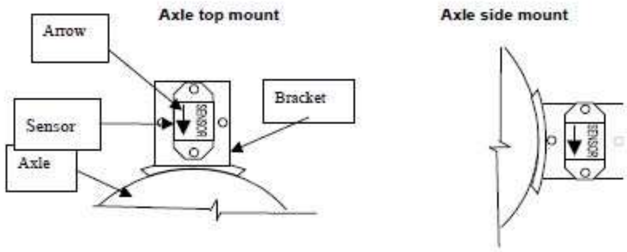
Before installing the sensor, it should be calibrated as explained later in this document. The sensor bracket is installed onto the vehicle's rear axle, as close as possible to the driver's side wheel, and positioned so that it is oriented as near to vertical as possible.

Sensor Fitted to the Vehicle Axle



The bracket is secured to the vehicle axle using the hose clamp supplied. A small spirit level can be used to correctly orient the sensor. For more details on the installation procedure, refer to the Roughmeter II user manual in the appendix.

Distance Measurement



Accurate distance measurement is critical when doing an IRI survey. Distances can be measured using the following methods. a) Connecting the Roughmeter II to the vehicle's odometer. This only applies to vehicle with digital odometers. For details on how to connect, refer to the attached user manual.

b) Using an externally fitted sensor such as the ARRB Rotopulser. (See figure below). The calibration procedure for this equipment is covered later in this document.

c) Using GPS positioning. The Roughmeter II has a GPS interface, and thus one can be used to measure distances and collect location data.

Section 2

FIELD OPERATING PROCEDURES

Comment [yar2]: Detailed description should be added. Other types of roughness meters and Odometers should be mentioned. The distance/coordinates may also be obtained from connected GPS.

In this section, the field procedures that were used in the URICS and those recommended for any future surveys are discussed including

cted GPS.

- Planning
- Liaison with various stakeholders
- Team organisation
- Safety consideration
- Reporting

Planning

Comment [yar3]: Additional headings suggest by KRB in letter of 11 November 2008

The Data • Monitoring collection was carried out district by district as this was the most logical survey unit. A number of criteria were used for planning and programming, including the following;

- Rainfall patterns in the country
- Estimated number of kilometers to be surveyed within each district
- The size of the district
- Adjacency of the districts
- General layout of terrain in the district and the infrastructural development
- Estimated survey output in km for each vehicle type
- Number of each type of vehicles
- Ability of various vehicle types to carry out survey in different parts of the country.

Rainfall patterns in the country

The Meteorological Department has long term rainfall averages for the main weather stations around the country (see figure below). Using these, the country was divided into 10 survey zones as listed below. For each zone, districts that have similar rainfall patterns are adjacent to each other or have similar network characteristics were grouped together, with a view to carrying out the survey group by group. For each group the surveys were planned to be carried out during the time with lowest rainfall.

It should however be noted that during the actual RICS, it was not possible to follow the planned survey sequence due to the erratic rainfall pattern that was experienced during the period and other factors such as security.

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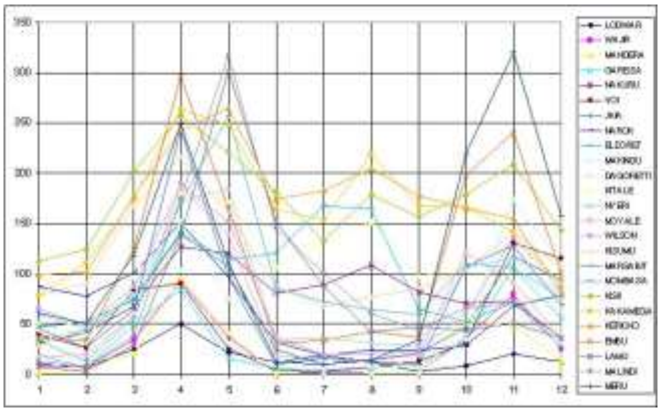
Long Term Rainfall Averages

Survey Zones



Number of kilometers to be surveyed in each district
The original estimate of about 115,000km of unclassified roads to be surveyed included 14,530 of urban roads, 90,000km unclassified rural roads, 2,736 KWS roads and 6,800 county council roads.

The distribution of this network within the 71 original districts was estimated based on the assumption that the length of the road network in a district is proportional to the population density, and hence densely populated district also have a high density of road network. The results of this distribution are shown in the table below.

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Road Length in Districts

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As explained later in this section, the estimated length of road network in each district was used to determine the number of survey teams allocated to each district.

Adjacency of the districts

In order to reduce the relocation time after completing the survey for a district, the teams were expected to move to adjacent districts whenever possible, or to the closest district in the zone. This was not always practical due to other factors such as rainfall.

Estimated survey output

In forming the teams, the average kilometers of unclassified road that each vehicle type (4WD, ATV or Motor Cycle) would be able to survey

- 4WD Vehicles 40km/day
- ATV and Motor Cycles 20km/.day

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Ability of ATVs and motor cycles to carry out survey

The ab... mainly due to their limited fuel tank capacities.

ATVs and motorcycles were not used in the following districts: Wajir, Mandera, Samburu, Baringo, Marakwet, West Pokot, Turkana, Marsabit, Moyale, Isiolo, Teso, Mt. Elgon

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Liaison with Various Stakeholders

The data collection teams must coordinate their work with the designated Project Engineers at KRB and MoR. This will include discussing the planned sequence of surveys in the districts, and any changes in survey procedures that may become necessary based on field conditions or equipment availability.

Before starting out on the surveys, the Team Leaders of the various survey teams should conduct a desk study to collect whatever maps and data are available at KRB, MoR Head Office, Provincial and District Offices. For example, the Survey Team should have the most recent maps available for the districts as well as any information on security, weather, road conditions, road closures, or other hazards.

Also, before starting a survey in a district, the Team Leader of the Survey Team should prepare a routing plan to improve the efficiency of the survey by avoiding any unnecessary “backtracking”. Preferably, the survey should be planned so that the team will end up at the end of each day near their intended destination. For example, if the team is planning to return to the office or a hotel at night, then to the extent possible, the routing should be laid out so that the team ends up near their desired destination.

The Team Leader must also visit the District Roads Office before starting the survey and discuss the routing plan with the District Roads Engineer (DRE). If the DRE can provide information on road conditions, such as classified roads that are not on the map or roads that are on the map, but no longer exist in the field, these situations should be marked on the map and the routing plan updated to reflect these situations. A District representative, who knows the road network, should accompany the team during the field surveys.

Team Organisation

During the URICS project, the survey teams were composed of six 4WD vehicles, four ATVs, and four motorcycles. Each vehicle was manned by a driver a surveyor and whenever possible, a Ministry of Roads or Local Authority officer to assist in identifying the unclassified roads. The ATVs and motorcycles were manned by a surveyor/rider.

Initially some teams were carrying out the survey of rural roads while others carried out that of urban areas including the IRI survey of paved roads. However this was found to be impractical and each team was asked to carry out the survey of both rural and urban roads in their assigned areas. The IRI survey was assigned to a special team, and was carried out after the inventory and condition survey had been completed and maps showing the location of urban roads prepared.

The survey teams were distributed around the country in a way that ensured that:

- No district would take unduly long and a maximum of 3 weeks was set as the upper limit
- There would not be too many teams within a small area which would create a potential for duplication of survey work
- Teams in each district should be within a reasonable distance to each other in order to offer assistance in-case of a breakdown or an emergency.

Safety Considerations

The primary concern of the field teams must be safety, both for the team and for other road users. The following guidelines will help provide a safer operating environment for the field teams:

1) Situation Awareness -The best assurance for safety is known as “situation awareness”. Be aware of what is going on around you. If you are the driver, be aware of other vehicles and pedestrians in your vicinity and what they are doing. If you are a data collector and are outside the vehicle, be aware of the traffic around you. Position yourself where you can see on-coming traffic and never turn your back to approaching traffic.

2) Use Warning Lights -Whenever the survey vehicle is operating at a speed lower than the general traffic flow, or stopped along the highway, the 4-Way Emergency Flashers and the Amber Flashing Light on top of the vehicle must be on. Whenever the survey vehicle is parked along the road, for data collection or other reasons (e.g., flat tire), the 4-Way Emergency Flashers and Amber Flashing Light should be on.

3) Use Caution Signs – Use a Caution sign on the back of the survey vehicles to alert other drivers to the fact that the vehicle may be slow-moving.

4) Stay Visible -Whenever the survey team members leave the vehicle to collect data, they must wear a florescent orange or green safety vest.

5) Left Lane Operation – In general, and on 4-lane roads in particular, Survey Teams should drive in the left lane as much as possible since it offers the opportunity to pull over to the shoulder without having to weave through traffic to get there.

6) Safe Parking -For the survey teams that have to stop their vehicles to collect data, the vehicle should be parked in a safe place, beyond the shoulder if possible, or at a wide spot in the road such as a driveway entrance (leave part of the driveway open). Do not park on sharp curves or just below the crest of a hill where sight distance is limited.

7) Use Traffic Cones -If the stop will require leaving the vehicle to collect data, traffic control cones must be placed in front and back of the vehicle, about 10m from the vehicle and at the same distance from the edge of pavement as the edge of the vehicle is from the edge of pavement. For example, if the edge of the parked vehicle encroaches onto the travel lane by 1m, then the traffic cones should also be placed 1m from the edge of the travel lane.

8) <u>Use Red Flags</u> -Whenever the survey teams are collecting data on the ground, the driver should use the red flag to direct traffic around the vehicle and the work area. In urban areas or other high-traffic areas, one of the aides in the crew should also act as a flagman so that traffic control is provided at both ends of the work area. If two flagmen are used, they must coordinate their signals with each other to avoid causing traffic conflicts and confusion to motorists.

Progress Monitoring

The team leader should regularly monitor the progress of the field teams and compare it with the planned output. During the URICS project, each team gave a daily report via radio, telephone or email on the following key issues.

- Location of survey
- Mileage travelled the previous day
- Estimated Km of Road surveyed
- Vehicle and equipment condition
- Expenses
- Weather
- Other factors affecting the progress of the survey
- Work plan for the day

In order to monitor progress even more closely, the vehicles were fitted with a GPS/GPRS vehicle tracking system that allowed the operator in the head office to monitor the movement of vehicles in real-time.

GPS/GPRS Vehicle Tracking Module

<u>Reporting</u>

The progress of the field work may be summarized in weekly reports which are given to the client. These would include:

-Kilometers surveyed per team / surveyor -Total Kilometers surveyed by all teams for the week -Cumulated Kilometers surveyed -Programmed Kilometers -Number of Districts completed -Number of ongoing districts -Weather and other factors affecting the survey work

Sample progress reports are annexed in the appendices.

Section 3

EQUIPMENT CALIBRATION

This section covers the procedures used in calibrating any equipment that is used in the field and in particular the Roughness measuring equipment

The GPS equipment used in collecting the inventory and condition data does not require any calibration; however it is necessary to calibrate the devices that are used to carry out the roughness survey before commencing the field work.

Generally the roughness survey is carried out with a suitable roughness sensor and a distance meter. This equipment requires calibration at the start of the survey and regular checking of the calibration

Calibration is carried out in the vehicle that will be used for the survey. The quality of the survey data will depend on these calibrations, therefore the procedures should be followed carefully.

survey

Comment [yar4]: Should the equipment manuals be provided as annexes??

Cor

[yar4]: Should the equipment manuals be provided as annexes??

Calibrating the Roughness Sensor

The roughness sensor or roughness meter shall be calibrated as described in the equipment manual for the selected equipment. The roughness sensor is sensitive to vertical motion. When correctly installed, it will accurately measure the vertical motion induced by the road surface profile as the vehicle is driven along the road.

The roughness sensor used for the RICS was the ARRB Roughometer II and the calibration of this equipment is described below.

To calibrate the roughness sensor

Press Scroll to display

Press Yes to select the sensor calibration mode.

The display asks you to place the roughness sensor in the 0 degrees position. Holding the sensor against a vertical surface with the sensor arrow facing downward (see Figure below), press Yes.

Calibrate Sensor
Yes To Select

Sensor at 0 degs
Esc or Yes

The output from the sensor is continuously measured and displayed. Adjust the sensor's vertical position (small movements) to achieve the maximum output voltage reading, and then press Yes.

Rotate the sensor 180 degrees (arrow up). Then press Yes.


Sensor at 0 deg.


Sensor at 180 deg.

Esc or Yes The display will change to show the sensor output voltage. The displayed voltage in this position will be less than the voltage displayed for the 0 degrees position. Adjust the sensor's vertical position to achieve the minimum output voltage reading, then press Yes.

The calibration value will vary from unit to unit but should be around 2.6. If the 'new' value differs greatly from the 'old' value or is greater than 3.5 or less than 2.0, press Esc and repeat the procedure.

If the calibration value remains outside the recommended values or is not repeatable, there may be a fault. If the 'new' value is acceptable, press Yes and the Controller will be updated with the new calibration

The Controller will update the calibration value. This will take several seconds to complete and then

the calibration procedure may be annexed to this

Sensor = 2.52V
Esc or Yes

Sensor = 1.68V
Esc or Yes

Old 3.11 New 2.44
Esc or Yes

Updating
Please wait ...

mode manual

Comment [yar5]: The equipment manual with the calibration procedure may be annexed to this manual

Con

[yar5]: The equipment manual with

Distance Calibration

Accurate distance measurement is dependent upon the distance calibration. The Distance Calibration will vary considerably depending on the distance sensor, the vehicle type, wheel diameter, tyre pressure, etc. A Distance Calibration must be performed whenever the system is installed on a vehicle, or the tyres are changed.

The calibration factor is stored in the Roughometer II Controller. If a new or different controller is used, a calibration must be performed..

The distance meter used for the RICS was the wheel mounted rotary encoder (Rotopulser) and the calibration of this equipment involves driving the survey vehicle along a marked and measured track. The track can be from 100 metres to 2000 metres in length. A greater length of track will produce a more accurate calibration

To perform a distance calibration

1) Accurately measure out a distance of between 100m and 2000m on a straight stretch of road.

2) Position the vehicle at the start marker of the calibration track and select the distance calibration mode using the Scroll buttons.

Press Yes to select the Distance calibration mode. Press Scroll to select the required calibration distance and press Yes.

Press Start to start the calibration.

3) Drive the vehicle along the measured calibration track at a steady speed and ensure that the vehicle wheels track as straight as is practical. The displayed distance will increment to show the distance measurement produced by the distance calibration settings.

4) Slow the vehicle as it approaches the end of the track and stop the vehicle precisely at the end marker, press Stop.

The selected Calibration Distance was 2000m. The Old value shown is the distance as measured using the current calibration parameters. The New value shown is the distance measured using the newly calculated calibration parameters.

Press Yes to save the new calibration or press ESC if the New value indicated is not to be saved, for

Distance Cal.
Yes to select.

Cal. Distance
2000m Scroll/yes

At Start Point
Press Start

Old 2002 New 2000
Yes Save or ESC

example because of inaccurate start or end positioning, or if for some reason the vehicle deviated from the true track. The updating process will take several seconds to complete and the keypad is locked during this process. The distance calibration procedure is now concluded.

On completion of the distance and roughness sensor calibrations, the Roughometer is ready to be

survey

Comment [yar6]: The manuals with the calibration procedures for the equipment may be annexed to this Manual

Cor
[yar6]: The manuals with the calibration procedures for the equipme
annexed to this Manual

Section 4

DATA COLLECTION

This section covers the procedures used in the actual data collection. It includes a detailed description of the data dictionaries used to collect attribute information during the URICS project as well as any future surveys. It also describes the procedures to be followed in the field to record changes in road condition or other attributes along the road, or when a surveyor finds an additional inventory item.

The survey teams carried out detailed Road Inventory and Visual Condition Survey of road links, structures and drainage elements using GPS data loggers running Trimble Terransync Professional® software, with the data dictionary described below. The procedure for using the GPS equipment is described in detail in the GPS Field and Office Manual.

4.1 Road Condition Survey

The table below shows the data dictionary used to collect attribute data for the Road inventory and condition survey. The remark column in the table gives more information on each attribute

The attributes in the data dictionary are arranged to facilitate quick data entry in the field, i.e., the features that may change and require segmentation of the road section are near the top of the list, while those that remain constant throughout the road section are at the bottom of the list. The attributes are described below, with their Data Dictionary abbreviation in parenthesis, if different from the attribute name.

<u>Surface Type (SurfType)</u> – The road surface type will be described as one of the following types:

> <u>Premix</u> – A bituminous surface of premixed asphalt, placed by paving machine or grader, followed by a roller, typically placed as hot material (may also be placed cold) in layers of 25 to 75mm thickness.
>
> <u>Surface Dressing</u> – A bituminous surface consisting of a spray of liquid asphalt covered by crushed stone chippings. One or more layers may be placed.
>
> <u>Gravel</u> – May consist of crushed stone, naturally occurring screened gravel, or naturally occurring unscreened gravel, which may have been graded to provide a smooth riding surface.
>
> <u>Earth</u> – Earth roads are unpaved roads with a natural surface of fine-grained material, which may have been graded to provide a smooth riding surface.
>
> <u>Sand</u> – An unpaved road consisting of natural or placed granular material, which may have been graded to provide a smooth riding surface.

Roads

Concrete Portland individual bars, but

Concrete of Portland

or load

Concrete individually Portland

Brick – placed baked clay.

26

ABBREVIATIONS AND ACRONYMS	
4WD	Four wheel drive vehicle
AARB	Australian Road Research Board
ATV	All Terrain Vehicle
DRE	District Roads Engineer
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
GPRS	General Packet Radio Service
IRI	International Roughness Index
KRB	Kenya Roads Board
KWS	Kenya Wildlife Services
MC	Motorcycle
MoR	Ministry of Roads
RD	Roads Department of MoR
RICS	Road Inventory and Condition (RIC) Survey
URICS	Unclassified Road Inventory and Condition (RIC) Survey
VHF	Very High Frequency

Equipment / Technique	Complexity
Rod and level survey	most simple
Dipstick profiler	
Profilographs	simple
Response type road roughness meters (RTRRMs)	complex
Profiling devices	more complex

Zones									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Kiambu	Transzoia	Mbeere	Kericho	Kwale	Ijara	Samburu	Turkana	Bondo	Nairobi
Machakos	Uasin Gishu	Embu	Bomet	Mombasa	Garissa	Baringo	Marsabit	Siaya	Large Urban
Makueni	Keiyo	Meru South	Buret	Kilifi	Wajir	Marakwet	Moyale	Teso	
Narok	Nandi North	Tharaka	Nyamira	Lamu	Mandera	West Pokot	Isiolo	Busia	
Kajiado	Nandi South	Meru Central	Kisii	Malindi				Mt. Elgon	
Thika	Koibatek	Meru North	Gucha	Tana River				Vihiga	
	Laikipia		Rachuonyo	Taita Taveta				Bungoma	
	Nakuru		Homabay	Kitui				Lugari	
	Nyandarua		Suba	Mwingi				Butere	
	Nyeri		Migori					Kakamega	
	Kirinyaga		Kuria					Kisumu	
	Muranga		Transmara					Nyando	
	Maragua								

DISTRICT	Estimated Km
Nakuru	4,086 Km
Kiambu	2,593 Km
Machakos	3,600 Km
Kajiado	2,000 Km
Thika	2,900 Km
Uasin Gishu	2,500 Km
Keiyo	700 Km
Nandi South	1,300 Km
Laikipia	1,400 Km
Nyeri	2,300 Km
Muranga	1,800 Km
Mbeere	1,000 Km
Embu	1,200 Km
Meru Central	2,400 Km
Kericho	2,100 Km
Buret	1,900 Km
Nyamira	2,400 Km
Rachuonyo	1,400 Km
Suba	700 Km
Makueni	4,000 Km
Narok	2,000 Km
Trans Nzoia	3,000 Km
Nandi North	1,500 Km

Jointed – Road surface of Cement Concrete, poured as slabs, without reinforcing with expansion joints.

Reinforced – Road surface Cement Concrete poured continuously with reinforcing transfer bars.

Block – Road surface of placed blocks made of Cement Concrete.

Road surface of individually bricks, typically made of

Set Stone – Road surface of individually placed natural or broken stones, typically placed in rows, with or without concrete.

Natural – Road that has never been graded or improve in anyway. Usually this type of road will have no visible tyre tracks and will have grass growing on most of the surface.

Track -Road that has not been improved but has clearly visible vehicle tire tracks, due to regular usage .

A change in the surface type that persists for more than about 0.2km is considered significant and will require the road section to be segmented.

Surface Condition (SurfCond) – A five-point scale is used for visual condition ratings on roads, bridges and appurtenances, plus an “Under construction” code (0), as shown below:

Name Numeric Value

Excellent 1 Good 2 Fair 3 Poor 4 Very Poor 5 Under construction 0

The following definitions provide a general description of the rating system:

Excellent (1) – To receive an Excellent rating, the feature must be new or in like-new, well-maintained condition, and fully functional in all respects.

Good (2) – A Good rating indicates that the feature is in nearly new condition, and only needs some minor additional maintenance work. There should be no more than a 10 percent reduction in serviceability, functionality, or capacity of the feature.

Fair (3) – A Fair rating indicates that the feature is exhibiting occasional signs of distress or damage that are causing a noticeable reduction in serviceability, functionality, or capacity, in the order of 10 to 25 percent. Substantial additional maintenance or repair effort is required.

Poor (4) – A Poor rating indicates that the feature is exhibiting frequent signs of distress or damage that is causing a significant reduction in serviceability, functionality, or capacity, in the order of 25 to 50 percent. Major maintenance or reconstruction effort is required to restore the feature.

Very Poor (5) – A Very Poor rating indicates that more than 50 percent of the feature is beyond the point of restoration by routine maintenance and reconstruction or replacement is required. Under construction (0) – This rating is used for roads that are under construction and the new section is not yet available for road users.

Note – For general guidance, “Excellent” refers to a road or road feature that is in “like new” condition and “Very Poor” indicates a road or road feature that is just barely serving, or not serving, its intended purpose. Most roads are likely to fall within the “Good”, “Fair” and “Poor” categories. Very few are expected to be in the “Excellent” category, unless recently built, and hopefully not many will be in the “Very Poor” category.

The rating should reflect the predominant condition over the section. A change in the surface condition that persists for more than about 0.2km will require the road section to be segmented.

Usage – This attribute reflects the observed traffic on the road. The value maybe ‘Busy’, ‘Used’ and ‘Rare,. Where ‘Used’ refers to a road who’s observed traffic volume is low say 1 to 20 vehicles per day. ‘Rare’ is for roads which are rarely used with only a few vehicles per week or month passing over the road section.

Number of Lanes (NumLanes) – This is the total number of through-traffic lanes. It must be a number between 1 and 10. Turning lanes, acceleration and deceleration lanes, and frontage roads (treated as a separate road) are not counted. Climbing lanes are counted since they may continue for significant distances. A typical road with one travel lane in each direction would be counted as “2” lanes. Multilane roads, with or without a median, are reported as the total number of travel lanes, e.g., if the road is a divided highway with two lanes in each direction, the number of lanes would be reported as “4”. The section of a two-lane road with a hill-climbing lane would be reported as “3” lanes. Some unpaved roads may consist of a single lane. A change in the number of lanes will require the road section to be segmented.

Shoulder-This refers to whether a shoulder exists or not.

Shoulder Material(ShouldMat) – If a shoulder exists, is it paved or not?

Direction – Is the traffic flow on the road section in one or two directions?

Speed Limit(SpeedLT) – Speed limit on road section if existing.

Drainage: -Is there a formed drain on the road? If so is it ‘Lined’, ‘Unlined’, or ‘Covered’

Location of Drain (Loc Drain) – If a drain exists, where is it located? ‘One Side’ or ‘Both Sides’

Drainage Condition (DrainageCond) – What is the flow condition of the drain? ‘Good’, ‘Fair’or ‘Poor’

Street Lighting – Are there street light on the road section?

Road Reserve (R_Reserve) – Where there is a clear boundary to the road such as a fence or a bulding line, the road reserve should be measured using a measuring tape. If there is obvious encroachment on to the reserve, the surveyor should make the best estimate of the width of the road reserve based on observations of the surroundings.

If there is no boundary (such as in an open field) the road reserve should be taken as 9m which is the minimum acceptable for a road.

<u>Road Width</u> – The width of the carriageway/graveled surface, but in any case, not including the area beyond the break in the front slope, i.e., the point where the surface begins to slope downward into the ditch area. Measure the width to the nearest tenth meter using the 30m measuring tape.

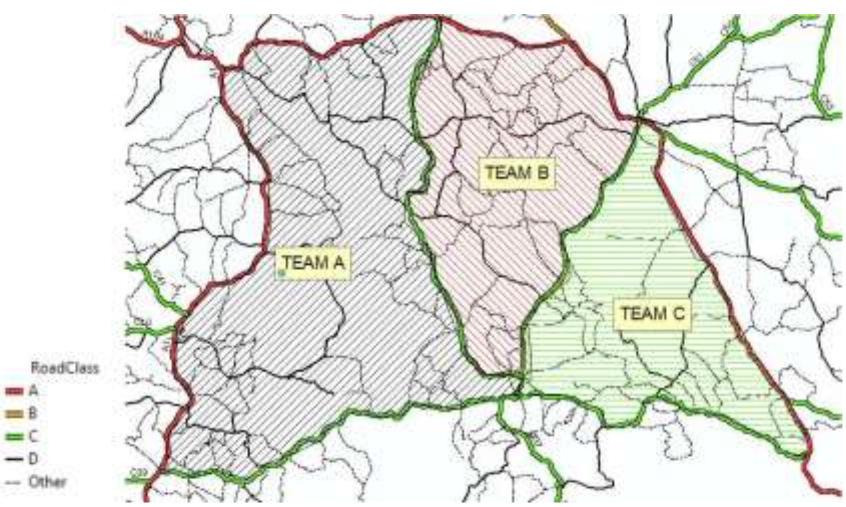
Survey Procedure

A geo referenced image (jpeg) showing the classified road network, towns, facilities and other features that were collected during earlier surveys is loaded in the GPS unit as a background to assist the surveyors to know their location as the survey proceeds. The map is regularly updated with the new data collected by the survey teams to ensure that no roads are left out or repeated .

When working with many survey teams in one area, each team should be assigned a survey unit bounded by major classified roads or physical features such as rivers, valleys or ridges to ensure that they do not overlap. Whenever possible the team would make use of local road officers, provincial administration and area residents to help identify the roads.

Assignment of survey areas

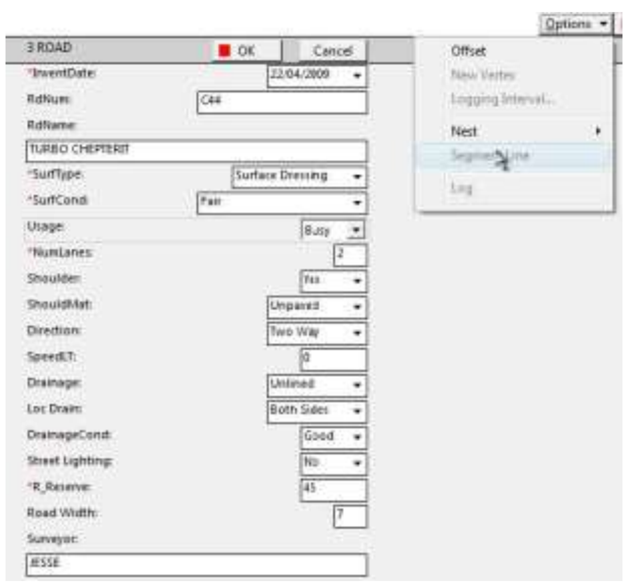
To ensure that no roads were missed out, the teams should use a consistent procedure of surveying one side of the direction of travel before embarking on the other. For example, if they start with the first left branch from the road, they should take the first left off that road, and any left from that one, and once they reach the end they turn back and now survey on the left hand of their new direction of travel until they get back to the starting point. From this point they can then proceed until they get to the next left junction and repeat the procedure outlined above. Following this simple procedure ensures that no road is missed out.



Following is a description of the typical daily routine of the survey team:

1. <u>Enroute to the Starting Point</u> – As the team sets out for the first road to be surveyed, all equipment should be turned on and checked to ensure that it is working properly. If the GPS Equipment is not working, the Team should return to base for repairs or substitute equipment, since a primary purpose of this survey is to collect the GPS data. Each day, a new GPS file should be created and given a unique name. For convenience, the default file name assigned by the GPS unit should be set to start with the letter of the team e.g. “A” for Team A, and should contain the date and time of creation.

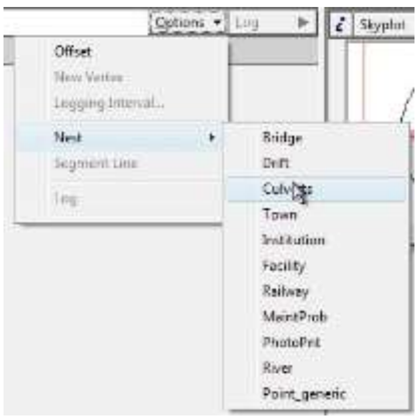
2. <u>Starting the survey</u> – The starting point of a road section will normally be a road junction or a district boundary. The vehicle should stop, to allow the GPS Operator to create a Road Line feature and enter the required data for the road section as described in the GPS Field and Office Manual. As the vehicle starts to move, the surveyor should begin logging the GPS track for the road.
3. <u>Change of Road Attribute Values</u> – If any of the attributes of the road changes significantly eg. surface condition, surface type or road reserve, the surveyor should select ‘Segment Line’ from the ‘Options’ menu and enter the attribute value for the new road segment. It is usually not necessary to stop the vehicle when a single attribute changes, though it is important to ensure that the vehicle is not moving too fast otherwise the surveyor may miss some changes. .



4. Culverts, Drifts,Bridges etc. If the surveyor comes across another feature such as a culvert or a bridge while still logging the road, the driver will turn on all flashing lights and pull over to the shoulder to allow the GPS Operator time to enter the required data for the road. The operator should then select ‘Nest’ from ‘Options’ menu and then the type of feature that is encountered. This opens the data dictionary, associated with the feature and also temporarily stops the logging of the road.

When inspecting culverts, it may be necessary to use the panga to clear a path so that the opening and the condition of the culvert may be observed. Caution should be taken to avoid snakes and other hazards.

If the culvert is inaccessible, e.g., due to flooding or a very deep ravine, the District representative may be able to provide information about the type of culvert and its condition. In such cases, it is permissible to include such data without verification.



Once all the fields have been filled in the relevant data dictionary, the operator should
select ‘Resume’ in order to continue logging in the road.

Note: Detailed data dictionaries used to collect attribute information for above features are presented in the Appendices.

5. Ending the Road Section – The end point of a road section will normally be a road junction The end point could also be a point at which the road is closed or impassable. As the vehicle crosses the end of the road section, the GPS Operator will close the Road Line feature on the GPS unit.

If any problems were encountered on the survey, the Team Leader should make a note in his Daily Diary so that any errors can later be corrected in the database.

Have the driver position the vehicle at the start of the next road and then repeat the process starting at Step 2, above. If this is the end of the last survey for the day, go to Step 6.

6. End of the Day – At the end of the last survey for the day, the GPS Operator will close the file on the GPS unit and shut down the GPS equipment. When the team returns to base, the day's files should be uploaded to a laptop or desktop computer that has Pathfinder Office installed, and emailed to the office.

Bridge Condition Survey

The URICS project did not require a detailed bridge inventory and condition survey. Therefore, a special bridge survey team was not used , but the work was carried out together with the road condition survey. The data dictionary used while collecting the bridge data is as shown below:

Bridges

Bridges are identified and described by the following attributes and values:

Bridge Number (BridgeNo) – The Bridge Number is the sequential number of the structure along the road. For example, if this is the third structure from the beginning of the road in a district, then the Structure Number is “3”. For the purposes of the field survey, it does not matter which end of the road is the starting point. The Structure Number increments automatically each time a Structure point feature is created. Therefore, it is important to remember to re-set the number to “1” at the start of each road.

Road Number (RoadNum) – Enter Road Number if available.

ABBREVIATIONS AND ACRONYMS	
4WD	Four wheel drive vehicle
AARB	Australian Road Research Board
ATV	All Terrain Vehicle
DRE	District Roads Engineer
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
GPRS	General Packet Radio Service
IRI	International Roughness Index
KRB	Kenya Roads Board
KWS	Kenya Wildlife Services
MC	Motorcycle
MoR	Ministry of Roads
RD	Roads Department of MoR
RICS	Road Inventory and Condition (RIC) Survey
URICS	Unclassified Road Inventory and Condition (RIC) Survey
VHF	Very High Frequency

Equipment / Technique	Complexity
Rod and level survey	most simple
Dipstick profiler	
Profilographs	simple
Response type road roughness meters (RTRRMs)	complex
Profiling devices	more complex

Zones									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Kiambu	Transzoia	Mbeere	Kericho	Kwale	Ijara	Samburu	Turkana	Bondo	Nairobi
Machakos	Uasin Gishu	Embu	Bomet	Mombasa	Garissa	Baringo	Marsabit	Siaya	Large Urban
Makueni	Keiyo	Meru South	Buret	Kilifi	Wajir	Marakwet	Moyale	Teso	
Narok	Nandi North	Tharaka	Nyamira	Lamu	Mandera	West Pokot	Isiolo	Busia	
Kajiado	Nandi South	Meru Central	Kisii	Malindi				Mt. Elgon	
Thika	Koibatek	Meru North	Gucha	Tana River				Vihiga	
	Laikipia		Rachuonyo	Taita Taveta				Bungoma	
	Nakuru		Homabay	Kitui				Lugari	
	Nyandarua		Suba	Mwingi				Butere	
	Nyeri		Migori					Kakamega	
	Kirinyaga		Kuria					Kisumu	
	Muranga		Transmara					Nyando	
	Maragua								

DISTRICT	Estimated Km
Nakuru	4,086 Km
Kiambu	2,593 Km
Machakos	3,600 Km
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Thika	2,900 Km
Uasin Gishu	2,500 Km
Keiyo	700 Km
Nandi South	1,300 Km
Laikipia	1,400 Km
Nyeri	2,300 Km
Muranga	1,800 Km
Mbeere	1,000 Km
Embu	1,200 Km
Meru Central	2,400 Km
Kericho	2,100 Km

Structure Type (StrucType) – Structure Type is used to identify whether the surveyed road passes

over or under the structure. The codes are listed below: Road On Structure– The surveyed road passes over the structure. Road Under Structure – The surveyed road passes under the structure.

Structure Material (StructMat) – The Structure Material is the predominant material of the main structural element, i.e., the superstructure, of the structure. For example, if a bridge has steel girders or trusses, with a concrete deck and concrete supports, it is classified as “Steel”. If a pedestrian overpass has a steel structural section across the road, with concrete steps on either side, it is classified as “Steel”. The material types are listed below:

Concrete – Portland Cement concrete, usually poured in place. Steel – Use this category if main structural elements in

superstructure are steel. Timber – Use this category for all structures with wooden decks and wooden

supporting elements, or wooden decks and steel or concrete supporting elements.

Masonry – This category is used for all structures made of masonry, i.e., bricks, blocks, or stone, with cement as the binding material. Bailey – This is a temporary bridge made of steel components, bolted together. This

category is used for both Bailey and Eiffel bridges. Composite – This category is used to indicate that different materials were used for some of the major components of the structure. Examples of composite structures include: 1) steel truss with concrete deck and concrete piers, 2) concrete deck on steel girders with concrete piers. Crossing Type (CrossType) – Crossing Type describes the feature being crossed by the surveyed

road. The choices are: Road – The surveyed road passes over or under another road. Pedestrian – The surveyed road passes over or

under a pedestrian crossing. Railway -The surveyed road passes over or under a railway. Waterway – The surveyed road

passes over a waterway, natural or otherwise. Other -The surveyed road passes over or under a feature not listed above.

Structure Length (StructLen) – The overall length of the structure, from end of span to end of span, including any approach spans, is expressed in meters to the nearest tenth. If a range finder is used, have one person stand at one end of the structure, while the rangefinder operator aims the device and takes a reading. If the measuring tape is used, two people will extend the tape to its full length and to take as many measurements as necessary to obtain the total length of the structure. Typically, bridge structures are equal to or greater than 6m. However, the minimum allowable length was set at 4m to allow for small bridges that cannot be categorized as pipes or boxes.

Structure Width (StructWid) – This is the overall width of the structure, from railing to railing, or edge of deck to edge of deck, expressed in meters to the nearest tenth

Number of Spans (NoSpans) – This is the total number of spans, or sections, of the structure. Typically, the Number of Spans is equal to the number of piers plus one. The default value is “1”. Be sure to change this value to the correct number.

Horizontal Clearance (HorClear) – This is the minimum horizontal clearance width of the structure for the survey road. It indicates the widest load on the survey road that could be transported across the structure, in meters to the nearest hundredth. For example, if the survey road passes over an open bridge structure with railings, the Horizontal Clearance would be measured from inside edge of railing to inside edge of railing, at the narrowest point. If the survey road passes under an overhead structure, it is the width of the widest rectangular object that can move across the structure.

Vertical Clearance (VerClear) – This is the minimum vertical clearance from the surface of the survey road to the lowest point on the bottom side of the overhead structure, measured in meters to the nearest hundredth. It is measured within the edgelines of the carriageway. It indicates the height of the tallest rectangular object, that can move across the structure.

Structural Condition (StrucCond) – This feature is used to record the condition of the superstructure, i.e., the main structural elements of the structure, excluding the deck and supporting elements such as piers, piles, footings and abutments. The surveyor will inspect the top and undersides of the superstructure and assign a rating based on a visual inspection. For some structures, binoculars may be necessary to see the condition of the structural elements.

Use Condition Ratings presented earlier.

Deck Condition (DeckCond) – This feature is used to record the condition of the deck of the structure. The surveyor will inspect the deck and assign a rating based on a visual inspection.

Use Condition Ratings presented earlier.

Support Condition (SuportCond) – This feature is used to record the condition of the supporting elements structure, i.e., the piers, piles, footings and abutments. The Bridge Engineer will inspect the undersides of the structure and assign a rating based on a visual inspection. For some structures, binoculars may be necessary to see the condition of the structural elements.

Use Condition Ratings presented earlier in Table 4-1.

Number of lanes (BNolanes)-This refers to the number of lanes on the bridge deck.

. Photo Number (PhotoNum) -Photographs should be taken of each structure inspected. Enter the photo number from the digital camera here. If Multiple photos are taken, enter the range of numbers eg. 5-8. It is important to ensure that the date and time in the digital camera and that in the GPS are synchronized as this will be used to determine when the photos were taken.

Survey Procedure.

As stated earlier, there was no special bridge survey team, and the data was collected as the road condition survey proceeded. As a structure is approached, the driver will turn on all flashing lights, slow down, and pull over to the shoulder or other safe parking area and stop. Traffic cones will be placed to warn approaching traffic of the work zone. The driver will use a red flag to direct traffic through the work area is necessary. The driver will also guard the vehicle, since the Team members may be out of sight of the vehicle for some period of time.

The GPS operator should select 'Nest' from 'Options' menu and then the 'Bridge' as the type of feature that is encountered. This opens the 'Bridge' data dictionary, and also temporarily stops the logging of the road.

The bridge structure may be a bridge, road or railroad overpass, pedestrian crossing structure (over or under the road), or overhead sign structure, with an overall length of 4m or more (anything smaller is considered a culvert). In the case of a bridge deck, the Point feature should be created at the approximate center of the bridge. In the case of an overpass or underpass, the Point feature should be at the center of the crossed feature. For example, as the survey road passes under a pedestrian overpass, the Point feature should be created when the structure is directly overhead.

Once all the fields in the data dictionary have been filled, the operator should select 'Resume' in order to continue logging in the road.

Survey of other Features

The following section covers the other features that were surveyed during the exercise.

Culvert – Culverts are identified by the following attributes and values

Culvert Type (CulvertType) – Consists of the following types:

Pipe – A pipe culvert has a round or oval cross-section. Box – A box culvert has a square or rectangular cross-section. Arch – An arch culvert has a semi-circular or half-oval cross-section. Other – This is assigned if the culvert type does not fit any of the options above

Number of Lines (NumOfLines) – The number of pipe or box lines, or conduits, that

represent one culvert installation. Default is “1”. Culvert Size (CulvSizeMM) – The diameter of the pipe, or width of the box, in millimeters. Options are 300, 450, 600, 900, 1200 and over 1200. In case of multiple lines, only one diameter or width measurement is needed. Default is “600”.

Culvert Material (CulvertMat) – Consists of the following material types: Concrete – Culvert made of Portland Cement Concrete material. Armco – Culvert made of metal, such as Armco corrugated steel pipe. Other – Culvert material made of material other than concrete or Armco. Unknown – Unknown is assigned as a default value, if uncertain of correct value. Culvert Structural Condition (CulvCondn) – This attribute is used to describe the structural integrity of the culvert, not its capability to permit water to flow. Available options are Excellent, Good, Fair, Poor and Very Poor. Culvert Flow Condition (CulvFlow) – This attribute is used to describe the water flow capacity of the culvert, not its structural integrity.

Available options are Excellent, Good, Fair, Poor and Very Poor. Drifts – The following attributes are collected for drifts Drift Number Auto (DriftNum) – This is a number that is generated automatically Drift Name (DriftName) – This is the local name of the drift if existing. Drift Length (DriftLen) – Length of drift Drift Width (DriftWid) – Width of drift Drift Condition (DriftCond) -This attribute is used to describe the structural integrity of the culvert.

Available options are Excellent, Good, Fair, Poor and Very Poor. DNumLanes (Number of Lanes) – This refers to the number of lanes on the drift DScour (Scouring) – Is there any scouring visible on the drift? Town – If the survey road passes through a town, create a Point feature where the road passes

through the approximate center of the town.

Town Name (Name) – This is a 20-character field, with the default being “Unknown”. The District Representative may be able to provide the name of the town, or it may be necessary to ask a local resident.

Other attributes collected include:

Administrative Status (AdmStatus)

- ProvHQ – Provincial Headquarters
- DISTRICT HQ – District Headquarters
- DIVISIONAL HQ-Divisional Headquarters
- LOCATION HQ – Locational Headquarters

- Other Type (Type of Town)
  - City
  - Municipality
  - Town Council
  - Urban Council
  - Major Market
  - Local Market
- Shopping Centre Major Maintenance Problem (Major Maint Problem) – If an extreme road condition is encountered, such as a washout, bridge out, landslide blocking the road, etc., a Point feature will be created to call attention to that fact. The attributes and values are:

Type of Problem (TypeProb) – This describes the type of problem, not the cause, as follows:

Road Blockage – An object, such as a tree or landslide is preventing the free flow of traffic through the area, but traffic can pass with difficulty.

Road Closed – The road is closed due to flooding, bridge out, or any other reason.

Surface Failure – The road surface is missing, but traffic can pass with difficulty, although 4-wheel drive may be needed.

Other Closure – Any other major impediment to the free flow of traffic, not included above.

Unknown – Unknown is assigned as a default value, if uncertain of correct value.

Cause of Problem (CauseProb) – This describes cause of problem, not type, as follows:

Debris in Road – An object in the carriageway, other than a landslide (e.g., tree, trucker’s lost load, dead animal) is causing traffic to stop and maneuver around the object. A temporary or minor situation, such as an accident scene or police checkpoint, should not be recorded.

Landslide – A rock or earth slide that is blocking one or more lanes of traffic.

Pavement Failure – A section of the paved surface has deteriorated to the point

where most of the paving material is missing. Road Washout – A section of the carriageway has washed away, making passage in a vehicle difficult or impossible.

Other Road Problem – Any condition on the road surface that is impeding or preventing the flow of traffic, not listed above. Unknown – Unknown is assigned as a default value, if uncertain of correct value. Bridge Blocked-Bridge exists but is blocked by objects such as trees, rocks or landslide Bridge Collapsed – Bridge is missing or is in sufficiently poor condition to prevent usage. Other Bridge Problem-any other condition not covered above Encroachments – the road has been closed due to encroachments Overgrown Bush-the road is not accessible due to overgrown bush Institution – This includes all educational institutions

Descriptive name of Institution (InstName) – Enter the full name of the institution Photograph Number (PhotoNum) – Photographic record for each institution should be Kept and the photograph number read off the digital camera and recorded here. If a series of photos are taken enter the number range eg. 23-26

Facility -This includes hospitals, tea buying centers, factories, water tanks etc. Name (Descriptive Name of Facility) -Enter the full name of the facility PhotoNum (Photograph Number) – as described

above

Railway Lines

Number of Lines – Enter number of tracks

Point Feature (Generic) – The Trimble Data Dictionary includes a default point feature that may be used to identify and locate new point features that are not pre-defined. This option should not be used unless the team leader believes that an unusual point feature should be identified and recorded.

<u>Line Feature (Generic)</u> – The Trimble Data Dictionary includes a default line feature that may be used to identify and locate new line features that are not pre-defined. This option should not be used unless the team leader believes that an unusual line feature should be identified and recorded.

<u>Area Feature (Generic)</u> – The Trimble Data Dictionary includes a default area feature that may be used to identify and locate new area features that are not pre-defined. This feature should not be used unless the team leader believes that an unusual area feature should be identified and recorded.

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The following section briefly outlines the procedure used in carrying out IRI survey. For more details refer to the ARRB Roughometer II user manual attached.

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II

Roughometer

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Comment [yar8]: I find the description too detailed and have tried to delete some text. Reference may be made to the operating manual for the equipment

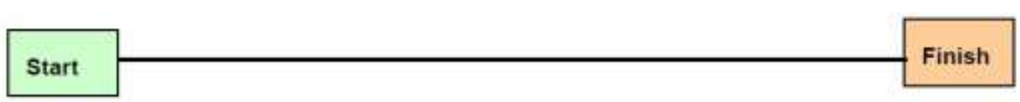
date and time of the computer that will be used to download the data.

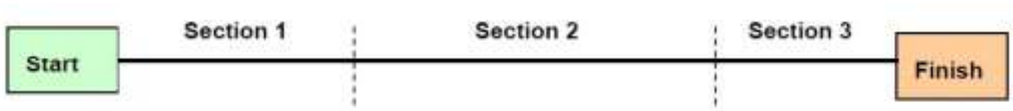
It is important to synchronise the time as when the data is subsequently downloaded, it is stored in folders which are named according to the survey date and time.

The simplest survey is one section from point to point with no events noted during the survey.

A more complex survey is one where the survey is divided into a number of sections.

During the survey, it may be desirable to note the location of events of interest. For example, if the vehicle needs to cross a railway line or if there are some road works. These events will influence the roughness of that particular section and it is useful to have the events recorded along with the data to help explain any unusually high results.

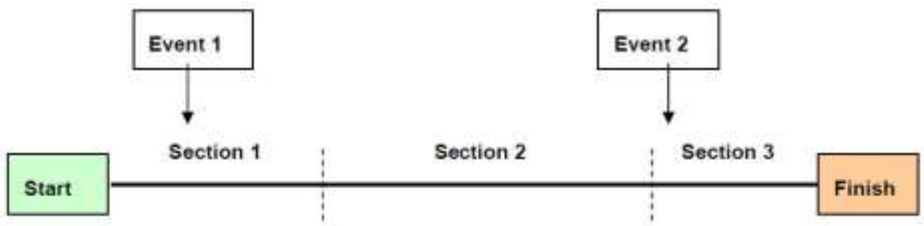




For example:

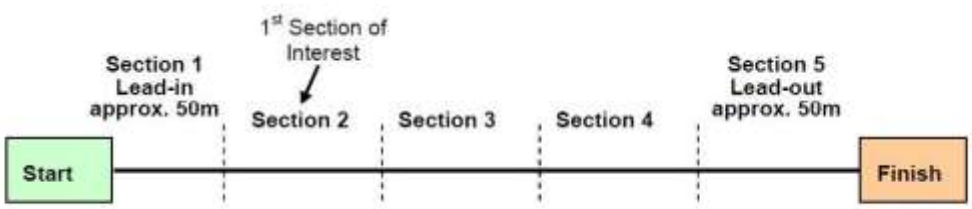
During the Data Processing, Events 1 and 2 can be renamed as ‘Rail Xing’ and ‘Road works’ (for instance).

To optimise the processing of data, it is recommended that the survey include a ‘Lead-in’ and ‘Lead-out’ section. The Lead-in is effectively data acquired before the first section which allows the processing algorithm to prime the numerical filtering with some historical data before the first section of interest. The Lead-out improves data processing at the end of the survey. E.g.:



To improve accuracy and to ensure repeatability, it is important that wherever possible, a constant survey speed is maintained. Actual survey speed will depend on the road, but generally, a speed of 40 – 60 km/h has been shown to provide good results. The speed should be above 25 km/h. The driver should reach the survey speed before pressing Start. A survey speed below 25 km/h can result in significantly higher Roughness results. For sealed roads, a survey speed of up to 70 km/h is generally acceptable.

There are inevitably situations where the driver will need to slow down to negotiate a turn or to allow for traffic conditions. The processing software can detect these occurrences and compensate to ensure the low speed results do not influence the surrounding valid results.



Press Start approximately 50 metres (yards) or more before the start (if possible) of the section to be Surveyed. This ensures that the data processing software has enough information to perform the roughness calculations and is referred to as the ‘Lead In’. The display will change to indicate the distance travelled.

During the survey it is possible to enter control points and event markers into the data. Control points are typically used to mark the start point of the survey (after the Lead In) and to separate sections within the survey. Event Markers are used to show the location of points of interest along the survey route.

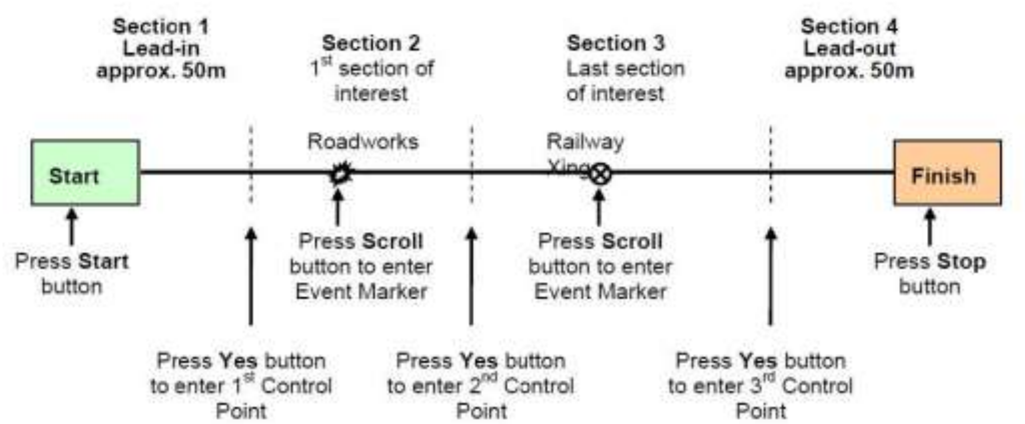
If conditions allow, accuracy at the end of the survey can be improved by inserting a Control Point at the end of the survey section. Press Yes then continue for approximately 100 metres (or as far as is practical) past the end point before pressing Stop.

This additional information is required by the data processing software and is referred to as the 'Lead Out'. At the end of the Lead Out, press Stop. The Controller will automatically complete the data saving process and ready itself for the next survey.

The Roughometer has storage capacity for up to 275 kilometres (171 miles) of survey. This can consist of up to 100 individual surveys. Once this limit is reached, the data needs to be downloaded and the memory cleared in order to continue the survey.

The survey operations are shown diagrammatically below.

Survey Progress Beep
To provide an audible confirmation of the progress of the survey, the Controller emits a 'beep' every 100m during the survey. The 'beep' is purely for operator feedback and is not related to the roughness processing interval. The beep can be disabled or enabled by pressing both Scroll buttons simultaneously.



Data Processing

On completion of a survey, the data needs to be downloaded into the office computer for processing. To do this, connect the Controller to the serial communications connector of the computer and start the processing software.

The Roughometer Desktop contains a series of Tabs that access the various data processing functions

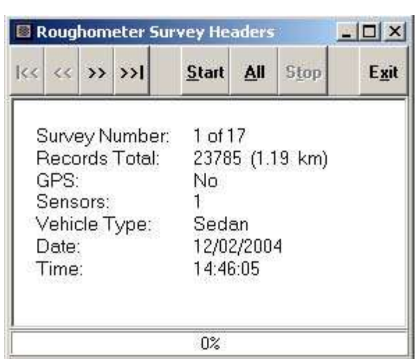
The desktop tabs are: a) Download is used to download survey data from the Controller. b) Process is used to start processing downloaded survey data. c) Open is used to open reports which have been previously generated. d) Edit is used to edit the Header and Event information for a report. e) Right is used to display the next graph if the graph report is divided into several sheets f) Left is used to display the previous graph. g) Down is used if the graph has been divided vertically h) Up is used if the graph has been divided vertically i) Print is used to print out the Graph or Report currently being displayed. j) Exit to close the application.

Download survey data
Click Download Data to access the surveys currently stored in the Controller Unit, Use the ‘First, Prior, Next and Last’ (|<<, <<, >>, >>|)buttons to select the survey(s) of interest. The information window for that survey is then displayed.

The selected survey data may be downloaded by clicking the Start button. To download all the surveys stored in the Controller, click All. The download process can be halted by clicking Stop.

When the Downloading is completed, press OK and Exit.

Downloaded survey data are stored in the folder “C:\SurveyData”. This is a default folder and can be changed by selecting Tools then Application Options. Click on the Download tab and ‘Browse’ to the desired folder.



Within that folder a new subfolder is created with the name “YYYYMMDD” where YYYY, MM, DD are values for the year, month and day when survey data is collected. For example: the new subfolder “20040925” will be created, (or used if it already exists) to store the survey data. The file name is “svHHMMSS_NN.cpt” where HH, MM, SS are survey hours, minutes, seconds and NN is the survey number as allocated by the Controller.

Two files are downloaded from the Controller: 1) svHHMMSS_NN.cpt This file contains the raw roughness sensor data.

2) svHHMMSS_NN.ipt This file contains the Header information such as total number of records, sensor calibration factors and time and date of the survey.

Processing the Survey Data Click Process from the Toolbar. Navigate to the desired folder then select the survey to be processed. Double click on the selected file or click Open to start processing.

When the data processing is complete, a number of reports are generated. They can be viewed and printed directly from the Roughometer program or they can be accessed using programs such as Microsoft Word and Excel.

The reports are stored automatically in the folder “C:\SurveyResult”. This is the default folder which can be changed by selecting Tools then Application Options. Click on the Process tab and ‘Browse’ to the desired folder.

Within the C:\SurveyResult folder, a new subfolder (Date Folder) is created with the name “YYYYMMDD” (year, month, day) corresponding to the date when the survey data was collected. This method of file storage simplifies the location of survey data.

Roughness reports can be produced in either IRI (metric or imperial) or NAASRA (metric only) format .

The files produced are:

svHHMMSS_NN.csv IRI roughness data in a ‘Comma Separated Variable’ file suitable for importing into Excel. Does not contain any Header Information.

svHHMMSS_NN.rst Complete IRI results file including Header information and File Folder information. Note: this file is not formatted for readability

SvHHMMSS_NNa.rtf Assessment file containing IRI results sorted into ‘Assessment Bins’. The file is in Rich Text Format (RTF) suitable for Text editing programs such as Microsoft Word.

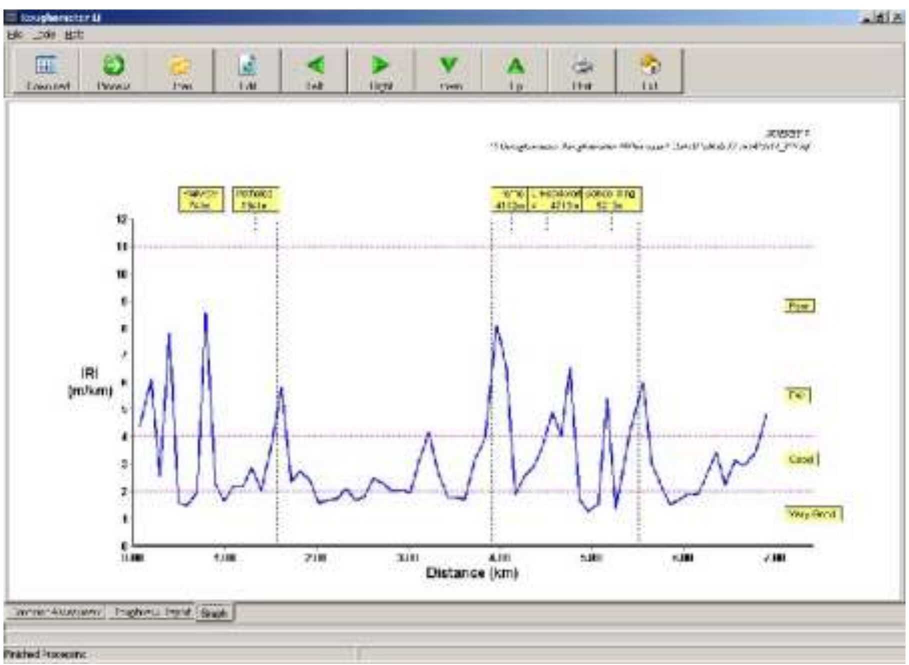
svHHMMSS_NNi.rtf Formatted IRI results file. Includes all Header, Section and Events Information. The file is in Rich Text Format (RTF) suitable for Text editing programs such as Microsoft Word.

svHHMMSS_NNn.rtf Formatted NAASRA roughness counts (NRC). Includes all Header, Section and Events Information. The file is in Rich Text Format (RTF) suitable for Text editing programs such as Microsoft Word.

The Roughness Report, Condition Assessment Report and a graph of Roughness vs Distance can be viewed directly from the Roughometer program. To change the view, click on the appropriate tab at the bottom left of the screen.

Processing options

Roughness and Distance units Roughness data can be processed to produce results and graphs in metric or imperial units. If Metric units are selected, then roughness is expressed in units of metres/kilometre correlating to the International Roughness Index (IRI) or in Roughness Counts/kilometre from a vehicle based Response Type Road Roughness Measuring System (RTRRMS). In Australia, these RTRRMS counts are known as NAASRA counts. For both units, the rougher the road, the higher the roughness result. The Roughometer processing software can produce result tables and graphs in either IRI or NAASRA counts.



Distance is displayed in metres or kilometres depending on the length of the survey. If Imperial units are selected, then roughness is expressed in units of inches/mile correlating to the International Roughness Index (IRI). NAASRA counts are not available in imperial units. Distance is displayed in miles.

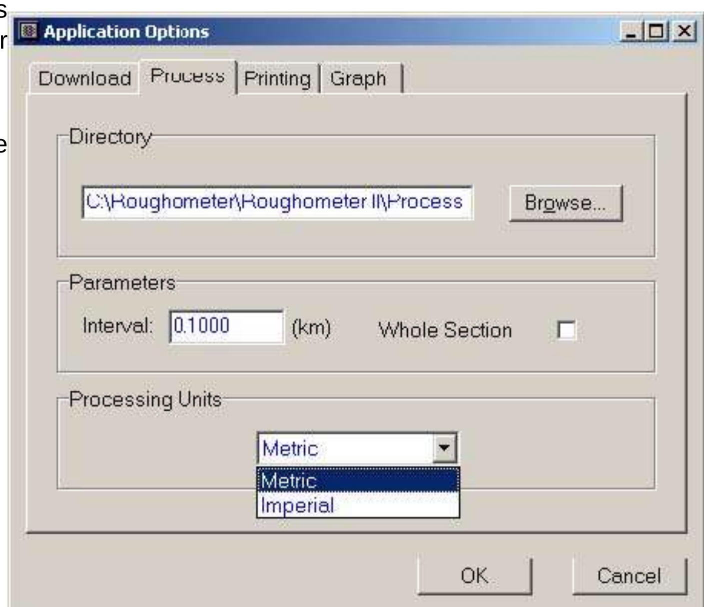
To select the desired Roughness Units, click Application Options from the Tools menu. Select the Process tab and click either metric or imperial in the 'Processing Units' window.

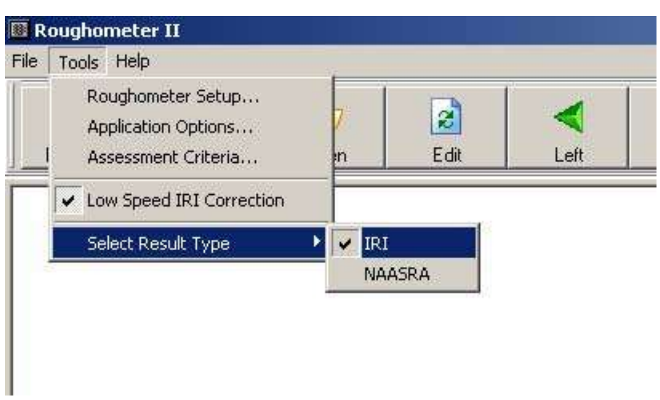
Click OK to save this option. The selected units will be the default next time the program is launched If metric units were selected, the user can then select between NAASRA or IRI roughness units.

From the Tools menu click Select Result Type, then click on either IRI or NAASRA (NAASRA Roughness Counts).

Selecting the reporting interval

Typically Roughness of a road section is reported in 100 metre intervals. It may be desirable to vary this





reporting interval, for instance to report a more localised feature (shorter reporting interval) or to get an overall roughness number for a whole road section.

To change the Reporting Interval, select Application Options from the Tools menu then click on the Process tab. A new reporting interval can be entered in the Interval box. If a single Roughness result is required for each section, then click on the Whole Section box. Click OK when complete. Survey data can then be reprocessed using this new Reporting Interval.

The assessment criteria To assist in the quick assessment of a road survey, a report is available which sorts the Roughness results into a number of categories or 'bins'. For clarity, the assessment Criteria are only specified in IRI. The bins and their default IRI roughness criteria are:

	Metric	Imperial
Very Good	0 – 2	0 - 157
Good	3 – 4	158 - 284
Fair	5 – 6	285 - 411
Poor	7 – 10	412 - 664
Bad	11 +	665 +

The criteria will vary from user to user. A logging track carrying low speed trucks through a forest would be assessed as fair with a roughness of, say 6, but an unsealed road in a rural area carrying relatively high volumes of traffic at speeds of around 80 km/h would regard the same road as poor or bad. The criteria can be varied to suit the location and road type. Note: the actual IRI values calculated will not vary, only the assessment 'bins' into which they are sorted.

Low speed IRI correction
While it is desirable to maintain a constant survey speed above 25 km/h, it is inevitable that the driver will occasionally need to slow down to negotiate a corner or allow for traffic conditions. This low speed data can produce unrealistically high IRI results and influence surrounding valid data. By default, the processing program detects the low speed data and compensates to ensure it does not produce peaks in the IRI results which may also influence surrounding data.

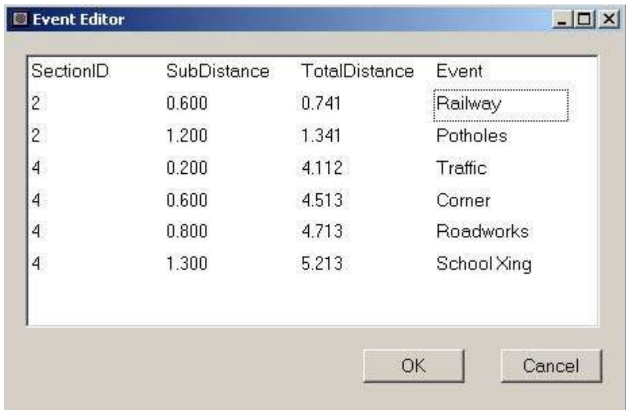
During the survey, the operator should enter an Event to signify where the slow-down occurred. In examining the report, IRI results around the event of low speed should be treated with caution and most likely disregarded. To examine the results without the automatic Low Speed IRI Correction, it can be disabled before processing.

Editing event information
The Events displayed in an open report file can be edited to provide more information about the event. For example, an Event may be a Rail Crossing, Cattle Grid, and Slow down for traffic, etc. This information cannot be entered into the Logger during the survey, but must be noted and edited into the report at Processing Time. The Report may be opened immediately after processing or it may have been opened from a previously processed Result Folder.

To edit the Events, Click on Edit in the main Roughometer Toolbar. Select Events, then click OK The first event will be highlighted. Type a new description of the event (e.g. Bridge), Tab to the next Event. Type a new description (e.g. Road Work). Tab to the next event if applicable. Press Enter or click on OK to complete the editing. The event description will be updated in the reports.

Editing header information

Header Information such as Road Name, Travel Direction, Operator, etc. is typically entered before processing. It can also be edited after processing. The Report may be opened immediately after processing or it may have been opened from a previously processed Result Folder.



SectionID	SubDistance	TotalDistance	Event
2	0.600	0.741	Railway
2	1.200	1.341	Potholes
4	0.200	4.112	Traffic
4	0.600	4.513	Corner
4	0.800	4.713	Roadworks
4	1.300	5.213	School Xing

To edit the Header Information: Click on Edit in the main Roughometer Toolbar. Select Header, then click OK. Tab to the fields to be edited and enter the new description. Press Enter or click on OK to complete the editing. The Header Information will be updated in the reports.

Section 5 QUALITY

CONTROL

This section describes the various steps taken to ensure that the data collected in the field is of high quality/integrity. It also outlines the procedure to be used to correct any information that needs updating or is found to be erroneous.

In order to ensure that the field work is of high quality, the consultant employed several methods

control

Training of field staff All GPS operators/Surveyors and the drivers were thoroughly trained on all aspects of data collection prior to commencing the project. The training covered such topics as

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control methods

- Objectives of the project
- Planning the field work
- Safety Considerations
- Using the GPS equipment
- Visual road condition survey
- Collecting data on road inventory

This training ensured that all staff were well versed with what was required of them, and also that there was consistency in the attribute values determined for each road or inventory feature by different surveyors.

At the start of the project, the teams were accompanied to the field by experienced inventory and condition surveyors who ensured that each team was following the laid out procedures and that the data collected was of acceptable quality.

Random Field Checks

During the entire field exercise the survey team leader carried out random field visits to verify the quality of data collected by teams. He also joined them to verify that they were following the expected procedures.

Identification of missing or incorrectly captured road links.

By overlaying the road condition and inventory data on Maps, Satellite Images and aerial photographs, it was possible to identify any roads that had been missed out during the survey or were incorrectly captured. Most urban areas were well covered by high resolution satellite images or aerial photographs, and these provided an accurate basis for checking the accuracy of the survey work.

After the survey teams completed a district, maps showing the location of unclassified roads were printed and sent to the respective district engineers to confirm the inventory. The engineers would then mark any corrections on the prints.

Once all missing links were identified, a team was dispatched back to the district, to survey the missing or incorrect links.

Updating Condition and Inventory Data

The road inventory and condition data will need to be updated regularly to ensure that the database is up-to date as possible. If for example a section of a road has either improved or deteriorated since the last time a survey was done, the GPS operator will go to the beginning of the road section and follow the procedure outlined earlier in this manual to collect the updated information data.

The new GPS log will then be sent to the GIS operator at KRB who will then update the database.

Section 6 DOWNLOADING AND TRANSFER OF FIELD DATA

This section outlines the procedure to be used in downloading, transmitting and storing the field data.

The most convenient way of sending data from the field to the office is to use email. The field teams are either equipped with a laptop which has a GPRS modem, or required to use the services of internet cyber cafes to email the data regularly.

The procedure of downloading and transferring from the GPS unit is as follows:

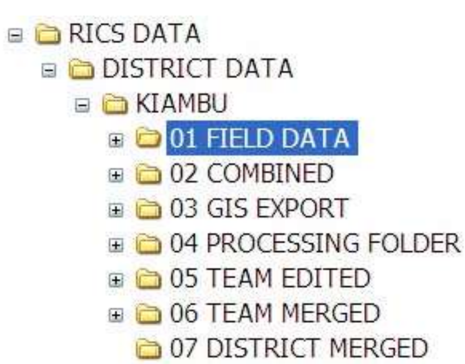
1) Connect the GPS unit to the laptop/PC, using a USB cable. Once a connection has been established, browse to the \documents\Terrasync folder where the data file are stored

2) Select the files to be sent, ensuring that for each data file, all the associated files are also selected. These will have the following extensions: .dd .obs .obx .gis .gix .gic .giw .gip

3) Copy these files to a folder on the laptop/PC and attach them to the email message.

4) Send the email to GIS operator and confirm that the data is received uncorrupted.

Once the data is received in the office, it is saved in the server under file/folder structure that makes it easy to find it. The figure below shows how the Field Data folder is organised for each district.



For more information on the file storage structure, please refer to Section 5 of the GPS Field and Office Manual prepared under this project.