@ROAD
MOBILE RESOURCE MANAGEMENT

White Paper

White Paper

Increasing Residential Waste Services Productivity

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@Road, Inc.
World Headquarters
47071 Bayside Parkway
Fremont, CA 94538
Tel: 1-877-7AtRoad
www.road.com

@Road (India)
AtRoad Software India Private, Ltd.
901 (A1) & 902 (A2), Tidel Park
No. 4 Canal Bank Road
Taramani, Chennai 600 113
Tel: 91 (44) 2254-1941

@Road, Ltd. (EMEA)
North Felaw Maltings
48 Felaw Street
Ipswich IP2 8HE, UK
Tel: 44 (0) 1473-696-300
www.road.com

@Road (APAC)
Level 8, 15 Talavera Road
North Ryde NSW 2113
Australia
Tel: (61) 2 8875-0588
www.road.com

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www.road.com

Introduction

Until recently, measuring productivity on residential waste collection routes was an imprecise exercise relying on human route audits and driver input. Now, with GPS tracking, wireless text messaging, lift sensors and wireless vehicle diagnostics, in-vehicle technology is capable of precisely measuring productivity and driving efficiency. Deployment of these technologies helps operators of residential waste collection services:

- Establish performance metrics for drivers
- Maximize the number of pickups per driver
- Minimize missed pickups
- Minimize deadhead time
- Provide accurate proof of service
- Offer real-time dispatch of closest drivers for extra pick-ups and missed pick-ups
- Maintain a higher level of safety
- Reduce accidents
- Lower gas emissions
- Reduce fuel costs
- Maintain the public's confidence by providing responsible and reliable service

GPS and wireless technology was first deployed in the waste management industry in 2000, but until recently, it has been installed primarily in commercial and roll-off fleets. Over the last three years, innovative waste management operators and municipal environmental departments have deployed GPS in residential fleets, with the result of lower operating costs and improved driver performance. This document describes how to implement GPS, messaging, and diagnostic technologies in a residential waste collection service. It also demonstrates how to obtain a positive return on investment (ROI) by implementing these technologies.

Residential Waste Collections Productivity

Improving productivity for a residential waste collection service means maximizing the number of pick-ups a driver makes during a shift while minimizing or eliminating overtime. For residential service, route optimization is the first step to realizing increased efficiency. With off-the-shelf mapping and routing software, a route manager can concentrate inefficient and scattered routes into compact geographic areas.

As an example, a large city in California is using GPS, messaging and diagnostic technologies to improve productivity and reduce costs. This city has re-routed more than 180 trucks to optimize efficiency. Workloads, which varied widely in the past, were redistributed to curb overtime costs and reduce employee rivalries for coveted routes — ones with more overtime. Route optimization also eliminated favoritism for some drivers by supervisors.

After optimizing routes, route managers then evaluated and created baselines for driver efficiency. In this case, driver routes have a house count of about 1,000 houses per route. Arm lift sensors record pick-ups, and GPS – through the establishment of boundaries or landmarks around route areas, landfills, and yards – are used to monitor and record time on route and deadhead time (time traveling to and from the route area to the landfill or yard). The GPS and lift sensor data enables route managers to fine tune the number of pick-ups expected for a route area within an eight hour shift.

The goal of an efficient residential service is to identify underperformers and improve their performance, or eliminate them. In the California city, drivers are evaluated and compensated based on their ability to complete their routes within their eight hour shifts. At different intervals, drivers were assigned to different routes and eventually data was gathered on drivers' performances on every route.

With performance data on all drivers on all routes, the city could establish performance metrics. For example, consider a route with 1,000 houses where driver A picks up 1,000 times in an eight hour shift, driver B picks up 975 times, driver C picks-up 950 times and driver D picks-up 875 times. The average for all four drivers is 950, indicating that at least 950 pick-ups can be achieved within an eight hour shift on this route. A driver on this route should be able to pick-up a minimum of 950 times. If a driver is not performing to the mean (950) or higher, corrective action can be taken to improve performance.

@Road applies the functionality of the @Road GeoManager solution, a web-based mobile software application that integrates GPS, wireless communications, satellite and Internet technologies to deliver on-demand visibility into a waste services firm's mobile workforce and vehicles. GeoManager helps waste companies instantly map the locations of vehicles, find vehicles close to a customer, log work hours, exchange text messages and forms with mobile workers, track and improve vehicle maintenance management or view and print detailed activity reports.

@Road GPS System Description

@Road GPS transceivers installed in residential haulers provide the position, speed and direction of each vehicle. This information is transmitted and recorded on secure @Road central servers for viewing and storage. The @Road system allows 24/7 access to GPS information by multiple users — dispatchers, route managers, district managers, etc. — from different locations. All that is required is a PC with an Internet connection.

With @Road deployment, each vehicle in a residential fleet contains a GPS transceiver, called an iLM® (Internet Location Manager™), an antenna and an iDT (Internet Data Terminal™) with keypad. The iLM provides GPS location information, while the iDT allows messages to be sent to and

from the vehicle. A GeoManager™ user account, which a route manager logs into over the Internet, allows him or her to view data about the vehicles, send messages and administer the GeoManager data. The reports and data about the fleet provided by GeoManager enable residential waste services to lower operating costs by optimizing routes, increasing lifts, eliminating speeding and excessive idling, documenting service and increasing fuel efficiency.

A lift sensor ties into a vehicle's electrical system and records each arm lift. Each lift receives a time, date and location stamp, and is recorded in GeoManager.

Real-time Dispatch

GPS data enables real-time dispatch of vehicles for missed pick-ups (MPUs), extra pick ups (XPUs) or any other activity or service. With the @Road MapView feature, a dispatcher can see real-time vehicle location information, shown in Figure 1, and is able to identify the nearest vehicle available for dispatch for a MPU, XPU or other activity, shown in Figure 2 and Figure 3. The dispatcher can then send a text message to the driver with instructions, addresses and driving directions. Dispatching the nearest vehicle saves time, reduces fuel costs and lowers the cumulative total of vehicle emissions.

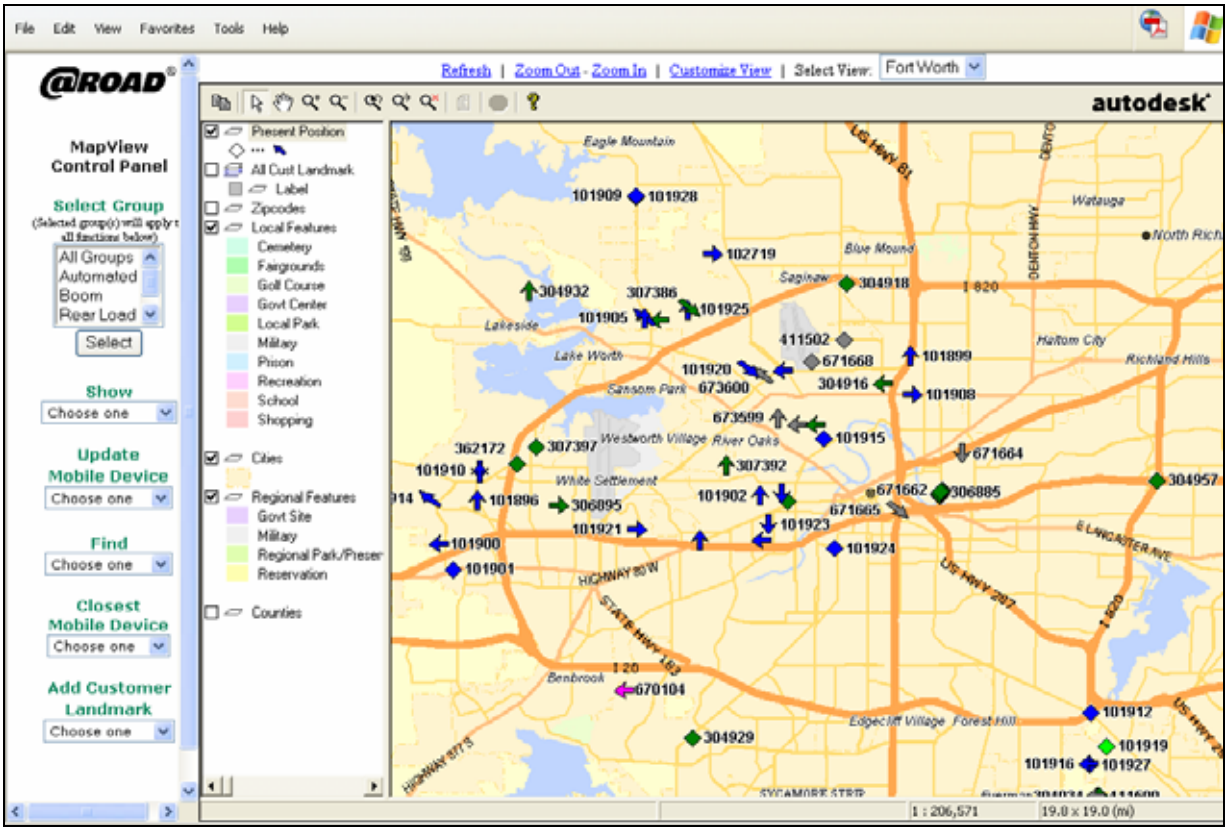


Figure 1: @Road MapView with Real-Time Locations of Vehicles

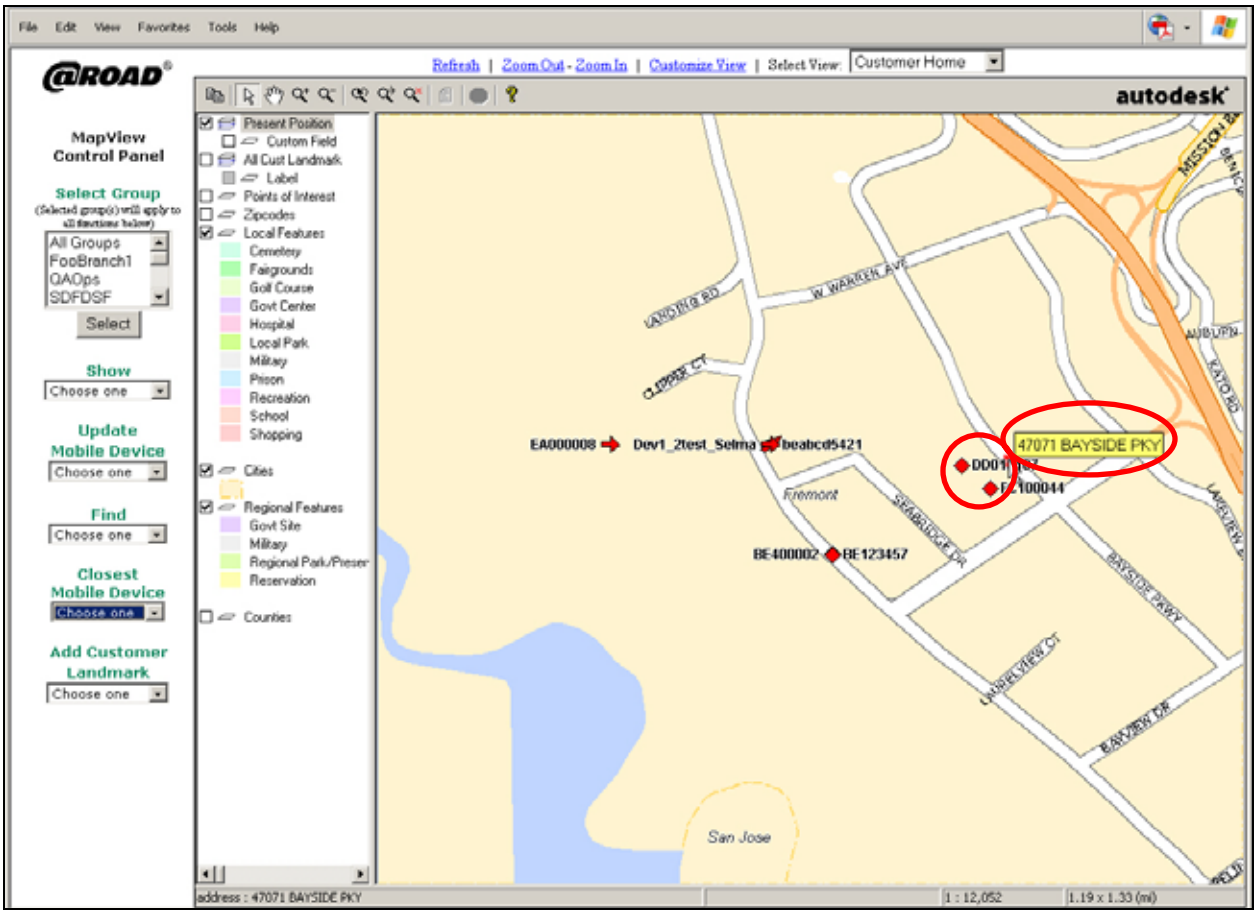


Figure 2: @Road MapView with Locations of Vehicles Closest to a Particular Address

Closest Mobile Device(s) to :

Route 402 CarryOut Garbage (3005 ASTER AVE, FORT WORTH, 76111, TX, USA)

Mobile Device	Distance(miles)	Direction
306911	2	W
411502	2	W
671662	2	W
101905	2	W
670104	2	W
304938	2	W
671664	2	W
101904	2	W
DA001527	2	W
304947	2	W
306906	2	W

Return Done

Figure 3: @Road GeoManager Window Showing Closest Vehicles to a Particular Address

Proof of Service

Accurate proof of service is obtained through text messaging and arm lift sensors. For example, if a garbage can is not out, the driver sends a “not-out” message to the dispatcher. This message also contains a time, date and location stamp showing where the truck was (the customer’s house) at the time the message was sent.

Using the iDT, which is installed in each hauler equipped with the @Road system, dispatchers and drivers are able to send messages to and from a vehicle. The route manager determines the form and substance of the messages communicated to and from the drivers on a daily basis. GeoManager allows route managers to create form messages that can be sent to one or all drivers by simply hitting the send button. Managers can create form messages for MPUs, ETAs and XPUs or send and receive text messages just as one would with a mobile phone or an email program.

Managers can also create form messages for the iDTs in the vehicles. For example, they can create a form that allows drivers to key extra yardage for billing or residential "not-outs" as they occur.

Messaging provides several important benefits. It is a cheaper and more cost-effective way to communicate with drivers than mobile phones. The @Road messaging service costs a flat $6 per month, compared to a cell phone at $60 or higher. It also provides a written record, with a time and date stamp, of what was communicated by a driver and dispatcher.

Examples of driver messages and forms for residential service are shown in Figure 4, Figure 5 and Figure 6. On the iDT, the driver simply selects the appropriate message and hits send.

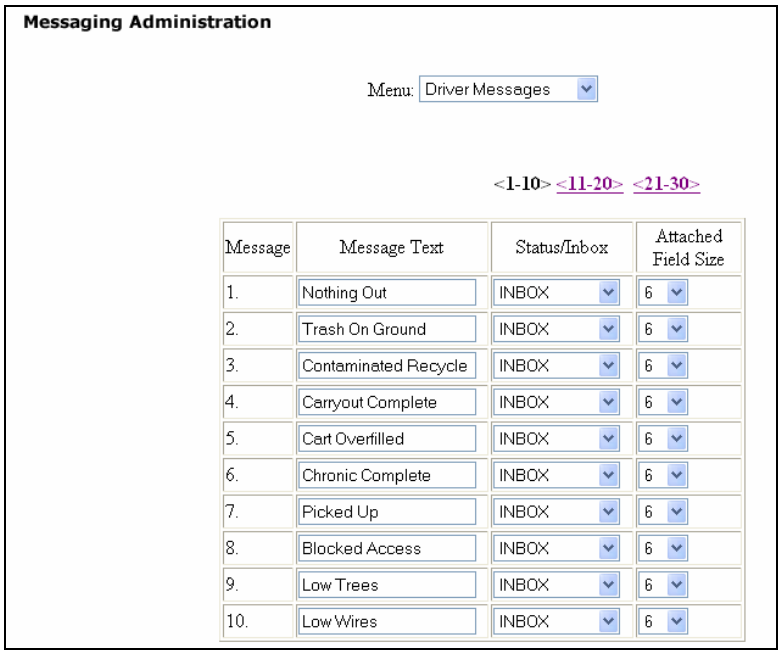


Figure 4: Pre-Programmed Driver Messages for Residential Service

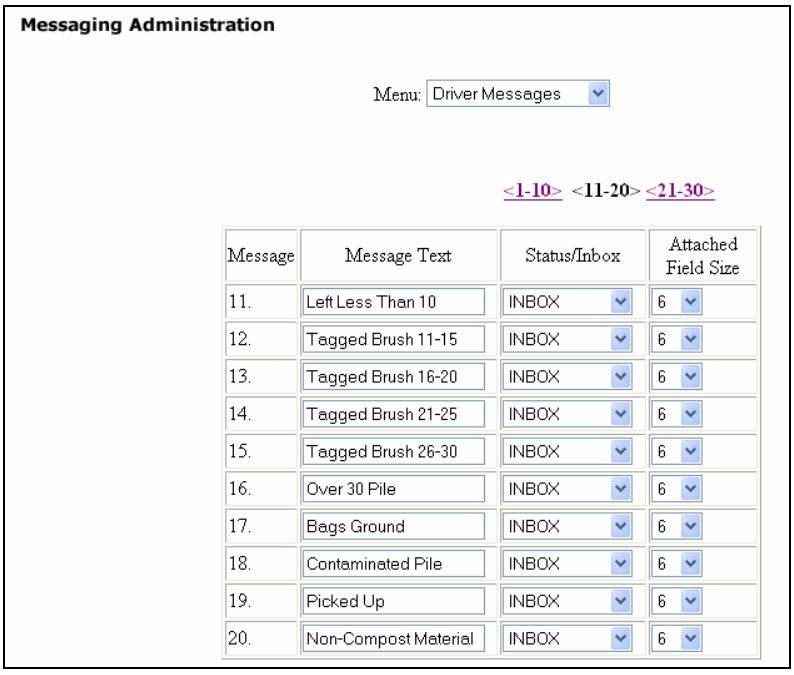


Figure 5: Pre-Programmed Driver Messages for Residential Service

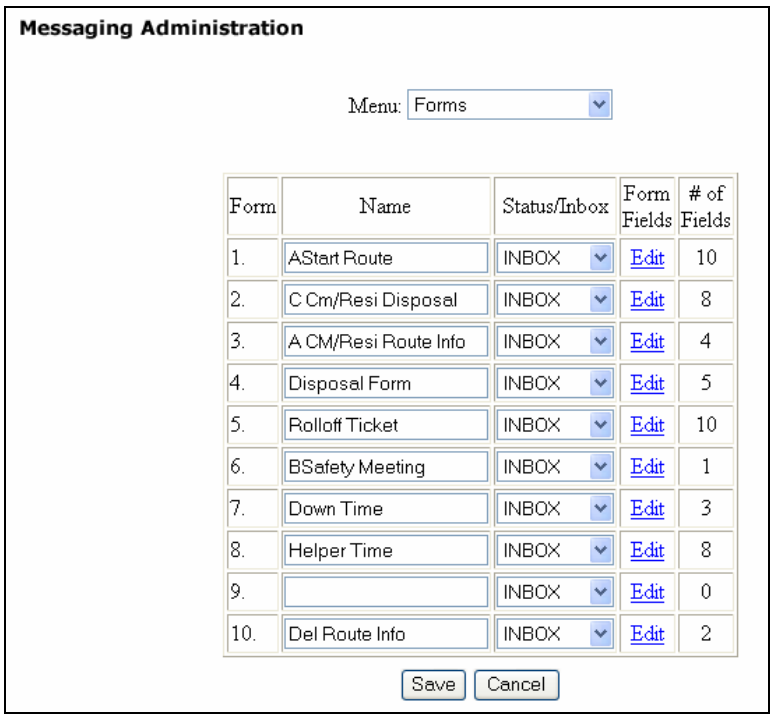


Figure 6: Pre-Programmed Form Messages in GeoManager

When drivers key activities like extra yardage and residential "not-outs" in real-time, an instant billing record is created with a date, location and time stamp. No paper record keeping is required

from the dispatcher or driver. The elimination of paper record keeping typically saves drivers and dispatchers 10 to 30 minutes per day, resulting in lower operating costs.

Since drivers are able to key residential "not-outs" at the time they occur, and a record is created with a location, time and date stamp, disputes with customers over missed pick-ups are reduced. Further savings are achieved by not erroneously dispatching a truck for a missed pick-up. Because of this money-saving feature, the @Road system is required in a number of municipal collection contracts. It can be used to differentiate your service offering from competitors' when competing for these contracts.

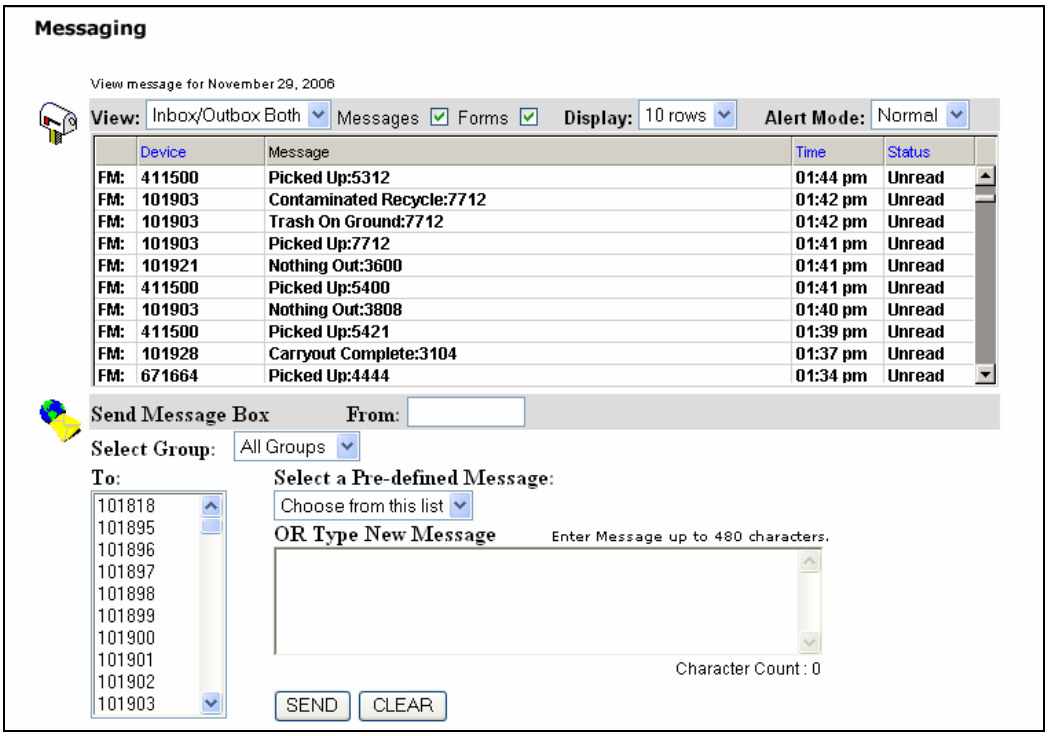


Figure 7: Mailbox in GeoManager Containing Residential Collection Messages

Proof of Service with Lift Sensors

Lift sensors are used to record every lift a truck makes. As with a text message, a date, time and location stamp is attached to each lift message to provide proof of service down to the address level.

Note: Since GPS accuracy is to within 100 feet, routes with a high density of homes may not have complete accuracy down to the address level; this may be the case when two containers are within ten feet of each other. In this case, proof of service is proved by comparing the number of arm lifts on a street to the number of containers assigned to that street.

Speeding and Idling Exceptions

Controlling excessive speed and reducing idling time lowers fuel costs, decreases emissions and improves safety. According to the U.S. Environmental Protection Agency (EPA), idling trucks consume from .82 to 2 gallons of fuel per hour and increase the frequency that preventative maintenance is required. Reduction of idling lowers costs by reducing fuel consumption and the frequency of scheduled preventative maintenance.

Speeding by drivers of residential trucks plays a very significant role in the frequency of accidents. Drivers know it is safer to obey the posted speed limit, but unfortunately may choose to speed in order to get to a landfill or other destination more quickly. In GeoManager, route managers can implement speeding exceptions, shown in Figure 8, and receive real-time notification when a driver is exceeding a designated speed. Alerts appear in the GeoManager Exception Console, shown in Figure 8, and can also be sent to email or a cell phone or palm device.

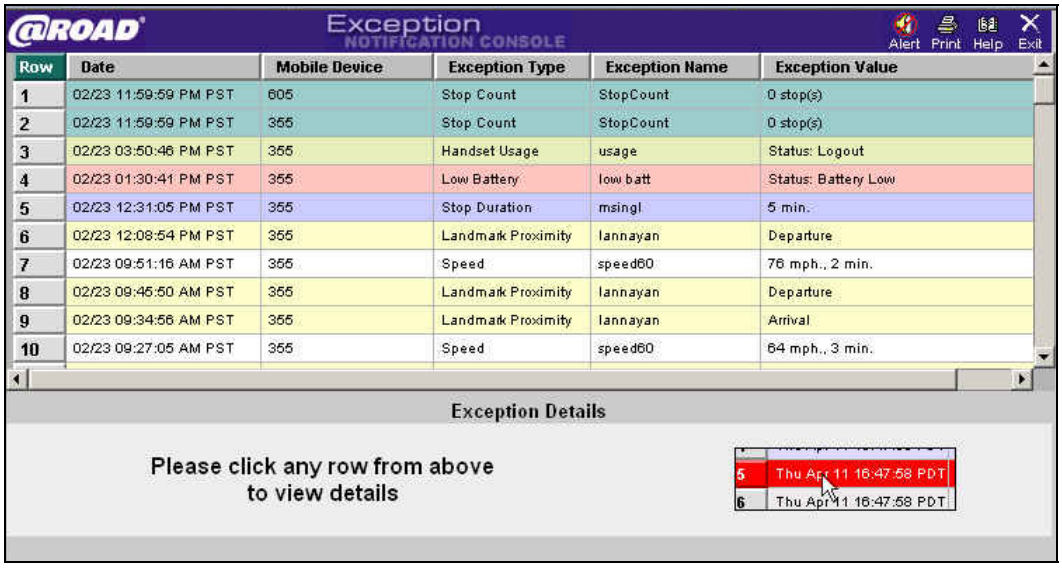


Figure 8: Exception Console in GeoManager

Landmarks

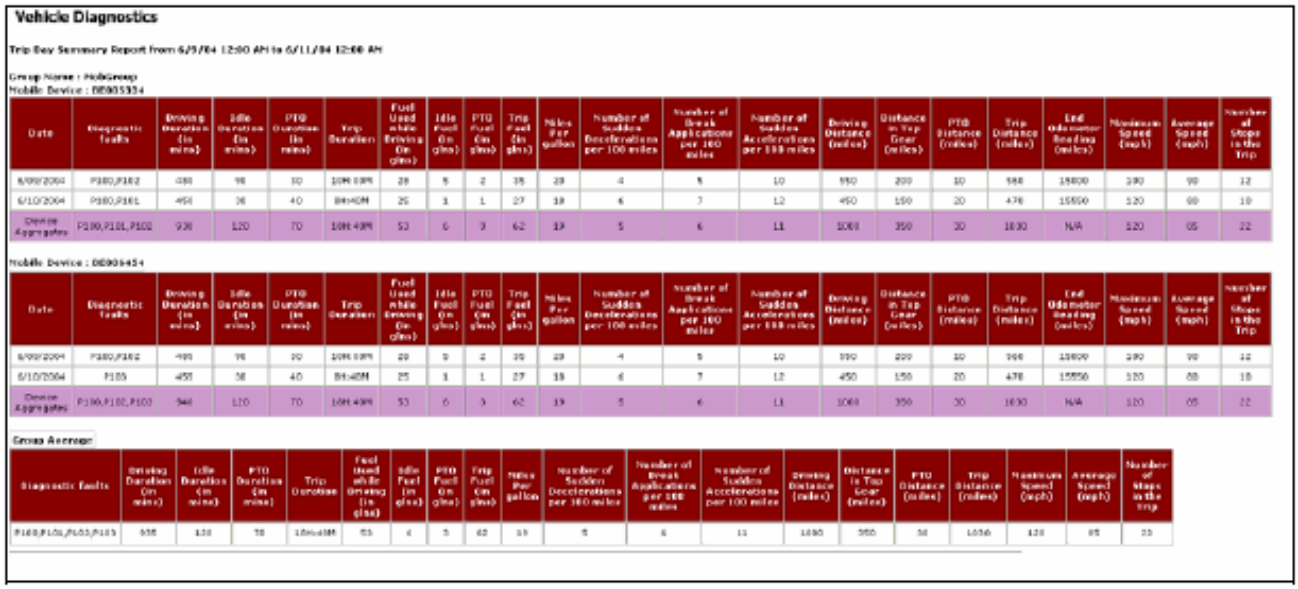
Landmarks, which can be pick-up locations, service areas, break locations, landfills or any other stops, are designated within GeoManager to give route managers the ability to measure driver and fleet performance. Using the GeoManager Landmarks feature, shown in Figure 9, managers can verify whether drivers are following their assigned routes, servicing customers on time, taking excessive breaks or making unnecessary or personal detours. Landmarks are also used to determine a driver's time on route and deadhead time, such as time spent going to and from a landfill or elsewhere outside the route area.

Figure 9: Landmarks Shown in GeoManager MapView

Vehicle Diagnostics

J1708 Vehicle Diagnostics is a protocol that enables a vehicle's Electronic Control Module (ECM) to transmit data. This standard is set by SAE (Society of Automotive Engineers) for medium to heavy duty vehicles (Class 5 or above). J1708, along with the @Road GeoManager service, can be used to remotely monitor vehicle malfunctions, engine performance and driver behavior. This visibility allows fleet managers to reduce operational costs and improve safety.

The @Road J1708 adapter retrieves critical engine information from the vehicle's ECM and transmits this data through the @Road iLM. Managers can use this information to remotely monitor important engine parameters for proactive intervention and prevention of downtime. Critical data on engine faults such as low oil pressure, very high coolant temperature and sustained excessive engine speed can be derived from Trip Detail Reports or Trip Summary Reports, shown in Figure 10, which are provided either in a daily summary or in real time.



Vehicle Diagnostics

Trip Day Summary Report from 6/9/04 12:00 AM to 6/11/04 12:00 AM

Group Name : HobGroup
Mobile Device : 08005334

Date	Diagnostic Faults	Driving Duration (in mins)	Idle Duration (in mins)	PTO Duration (in mins)	Trip Duration	Fuel Used while Driving (in gals)	Idle Fuel (in gals)	PTO Fuel (in gals)	Trip Fuel (in gals)	Miles Per gallon	Number of Sudden Decelerations per 100 miles	Number of Break Applications per 100 miles	Number of Sudden Accelerations per 100 miles	Driving Distance (miles)	Distance in Top Gear (miles)	PTO Distance (miles)	Trip Distance (miles)	End Odometer Reading (miles)	Maximum Speed (mph)	Average Speed (mph)	Number of Stops in the Trip
6/09/2004	P180,P182	480	90	30	10H 00M	28	5	2	35	28	4	5	10	550	200	10	568	15800	190	90	12
6/10/2004	P180,P181	450	30	40	8H 40M	25	1	1	27	18	6	7	12	450	150	20	478	15850	120	60	10
Device Aggregates	P180,P181,P182	930	120	70	18H 40M	53	6	3	62	19	5	6	11	1000	350	30	1030	N/A	120	65	22

Mobile Device : 08005454

Date	Diagnostic Faults	Driving Duration (in mins)	Idle Duration (in mins)	PTO Duration (in mins)	Trip Duration	Fuel Used while Driving (in gals)	Idle Fuel (in gals)	PTO Fuel (in gals)	Trip Fuel (in gals)	Miles Per gallon	Number of Sudden Decelerations per 100 miles	Number of Break Applications per 100 miles	Number of Sudden Accelerations per 100 miles	Driving Distance (miles)	Distance in Top Gear (miles)	PTO Distance (miles)	Trip Distance (miles)	End Odometer Reading (miles)	Maximum Speed (mph)	Average Speed (mph)	Number of Stops in the Trip
6/09/2004	P180,P182	480	90	30	10H 00M	28	5	2	35	28	4	5	10	550	200	10	568	15800	190	90	12
6/10/2004	P180	450	30	40	8H 40M	25	1	1	27	18	6	7	12	450	150	20	478	15850	120	60	10
Device Aggregates	P180,P181,P182	930	120	70	18H 40M	53	6	3	62	19	5	6	11	1000	350	30	1030	N/A	120	65	22

Group Average

Diagnostic Faults	Driving Duration (in mins)	Idle Duration (in mins)	PTO Duration (in mins)	Trip Duration	Fuel Used while Driving (in gals)	Idle Fuel (in gals)	PTO Fuel (in gals)	Trip Fuel (in gals)	Miles Per gallon	Number of Sudden Decelerations per 100 miles	Number of Break Applications per 100 miles	Number of Sudden Accelerations per 100 miles	Driving Distance (miles)	Distance in Top Gear (miles)	PTO Distance (miles)	Trip Distance (miles)	Maximum Speed (mph)	Average Speed (mph)	Number of Stops in the Trip
P180,P181,P182,P183	930	120	70	18H 40M	53	6	3	62	19	5	6	11	1000	350	30	1030	120	65	22

Figure 10: Trip Summary Report (Resized to fit page)

Vehicle Maintenance

With @Road Vehicle Maintenance, fleet managers may designate which maintenance items to track, access valuable reports showing maintenance status and set up automatic reminder notifications for maintenance that is due. Using these features, managers can see a clear picture of the maintenance history for each vehicle, plus they benefit from automated system assistance in tracking required maintenance actions and keeping each asset up-to-date. Such maintenance tracking and follow-through can improve overall vehicle performance and safety, which lowers the risk of costly breakdowns and resulting service interruptions. As an added benefit, using the module to track ongoing maintenance helps retain the resale value and extend the life of your vehicles, reducing capital costs.

A specific color code shown under each component states whether a vehicle requires no service, is due for service or is overdue for service, shown in Figure 11. When moving a mouse over any color-coded dots, a message appears, shown in Figure 12, showing the status details for each maintenance item.

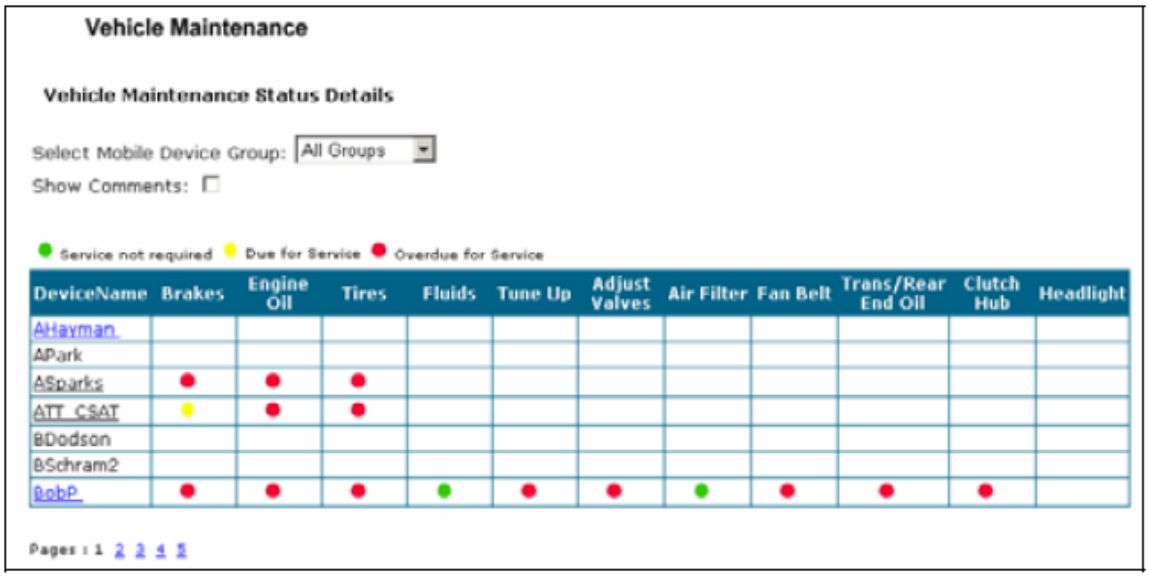


Figure 11: Vehicle Maintenance Status Details Screen

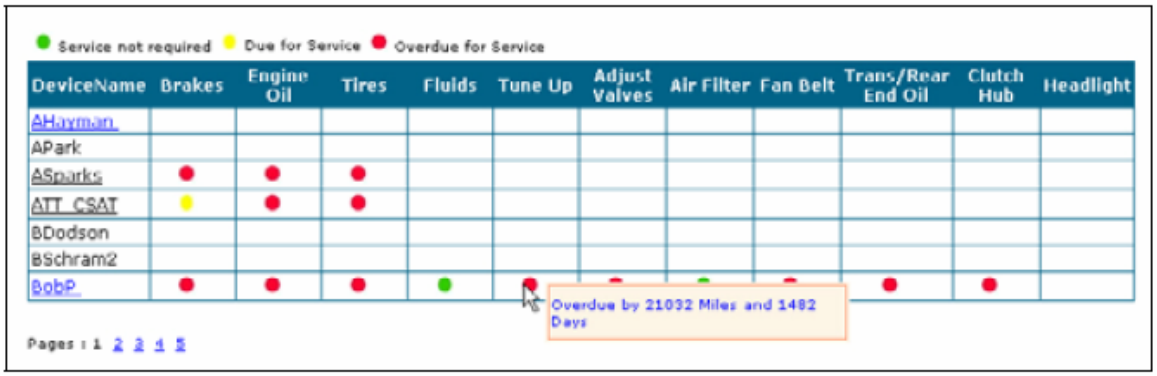


Figure 12: Vehicle Maintenance Status Details Mouse-Over

Conclusion

The combination of in-vehicle technologies — GPS tracking, wireless text messaging, lift sensors and wireless vehicle diagnostics — with the GeoManager feature set enables residential waste collection services to improve vehicle and driver efficiency and lower operating expenses. For the first time, managers can remotely track, monitor and improve driver performance. Real-time dispatch of the nearest hauler improves customer service and reduces costs, while the elimination of speeding and idling increases safety, reduces emissions and lowers fuel expenses. All these benefits can be realized within one month of installing an @Road system.

Contact the @Road waste industry support team to get started with a 12-step residential waste service implementation plan. This six-person team providing sales, technical and account maintenance support can be reached by calling 1-877-4ATROAD.