



Arts & Humanities  
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## Satellite Monitoring as a Legal Compliance Tool in the Environment Sector

### **Case Study Four: The Global Positioning System and Waste Tracking**

(Ref: AHRC Report 22).

#### **1. Introduction**

GPS (the Global Positioning System) is a satellite-based radio navigation system which, through the interaction of a network of 24 satellites, ground control stations and receivers which measure and decode satellite transmissions, can provide information on positioning, velocity and precise timing in real-time. GPS can be used to track the movements of vehicles, and has the potential to be used in the monitoring and enforcement of environmental legislation which regulates the movement of materials and substances such as waste or hazardous waste. The first part of this note looks at international and European law concerning the transboundary movement of waste and also the treatment of waste generated by the member states of the European Union. It sets out the requirements of the Basel Convention and the European legislation regulating the movement of wastes. The second part looks at how GPS technology might be used to facilitate implementation of these legal requirements.

#### **2. The Transboundary Movement of Waste**

##### **2.1 International Law**

The Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal 1989 aims to control the transboundary movement of categories and specific types of hazardous and other wastes (as specified in Annexes I

and II to the Convention). It does this in part by requiring its parties to prohibit the movement of waste where:

- The proposed importing state has prohibited importation of the waste type concerned;
- The exporting state has the technical capacity and necessary facilities to dispose of the waste in an environmentally sound and efficient manner;
- The proposed export is to a state which is not a party to the Convention;
- An import is proposed from an exporting state which is not a party to the Convention;
- It is proposed that exported waste be disposed of within an area south of 60 degrees south latitude.

Where the export or import of waste is not prohibited, the parties are required to control its transboundary movement as follows:

- A state from which the export of waste is proposed must give notice containing prescribed information to the proposed importing state and to all states (whether or not parties to the Convention) through which the waste is to be transported. The information to be provided includes (a) the intended carrier (b) the projected dates of shipment, the period of time over which the waste is to be exported and the proposed itinerary (including points of entry and exit) (c) the means of transport envisaged (d) the designation and physical description of the waste;
- The export may not proceed until the state of import has consented (with or without conditions) and has confirmed that a contract exists between the exporter and the disposer for the environmentally sound management of the waste. Transit states may deny permission for the movement within 60 days

of acknowledging receipt of the notice or give written consent to it with or without conditions. The export state may not allow the transboundary movement to commence until it has received this written consent (or unless the transit state allows it to proceed by a general waiver of its right to object);

- Where the necessary consents have been received, an export may proceed. The transportation or disposal of waste may only be performed by persons appropriately authorised by a party. Parties must ensure that each person who takes charge of the waste movement signs a movement document on delivery or receipt of the waste. The movement document should contain the information prescribed in Annex V B including (a) the date the transboundary movement started and dates and signatures on receipt by each person who takes charge of the waste (b) means of transport to be used, the countries of export, transit and import and points of entry and exit where these have been designated;
- Confirmation that the waste has reached its destination and ultimately of its disposal should be provided by the disposer to the exporter and state of export. The state of export is required to notify the state of import if this information is not received.

Waste movements which are prohibited by the Convention, for which the notification and consent procedure has not been followed, which do not conform in a material way with the notification or movement documents or which result in the disposal of waste in contravention of the Convention, are regarded as illegal. Parties to the Convention must treat any such movement as criminal and introduce legislation to prevent and punish such traffic. States of export are also responsible for ensuring that wastes illegally transported from their territory be taken back or otherwise disposed of in accordance with the Convention's provisions. Where the illegality is due to the conduct of the importing state or disposer, the importing state has ultimate responsibility for disposal of the waste in accordance with the Convention's requirements. These requirements provide an incentive to states for ensuring that the

Convention's requirements are adhered to and that transported wastes reach their intended destination and are properly disposed of once there.

## **2.2. European Law**

The transboundary movement of waste both within the European Community and outside of its borders is regulated by Regulation 1013/2006 on shipments of waste from 12 July 2007. The regulation repealed Council Regulation No.259/93 on the supervision and control of shipments of waste within, into and out of the European Community which had been amended on several occasions, to bring it in line both with the Basel Convention when the European Community became a party in 1994 and with OECD Decisions including the decision to prohibit the export of hazardous waste to non-OECD members.

This Regulation establishes an updated system for managing the transboundary movement of waste by EC Member States both within the Community and through its export and import. Under this system, the movement of wastes within the Community is subject to a procedure of prior written notification and consent from the destination state and transit states for all waste destined for disposal, and for specified waste types destined for recovery. This procedure is also used to monitor shipments of waste into and out of the Community with appropriate modifications). The notification and movement documents used in this process must give prescribed information concerning the countries of dispatch, destination and transit and the means of transport envisaged (the notification document) and the proposed route including the point of exit from and entry into each country concerned, possible alternatives to the route, and customs offices of entry into and exit from the Community where an export or import is intended (the movement document).

Once the necessary consents have been obtained, the movement of waste is monitored by:

- Insertion into the movement document of the date of shipment (the movement document is sent to the competent authorities for the states concerned at least 5 working days before the shipment);
- Signature of the movement document by each person who takes responsibility for carriage of the waste;
- Written confirmation of receipt of the waste by the facility responsible for its recovery or disposal within 3 days of receipt to the notifier and the competent authorities;
- Certification of recovery or disposal by the facility within 30 days of completion of relevant operations.

As with the Basel Convention, there are certain circumstances in which the transboundary movement of waste is prohibited. These include:

- The export of waste from the European Community for disposal save to an EFTA country which is also party to the Basel Convention;
- The export of specified waste types from the European Community for recovery in countries not bound by OECD Decision C(2001) 107/final on the control of transboundary movements of wastes destined for recovery operations;
- The import of waste for disposal except from a country party to the Basel Convention or to a bilateral agreement which covers the import or from areas during situations of crises and war;
- The import of waste for recovery except from states which are subject to the OECD decision, parties to the Basel Convention or to a bilateral agreement which covers the import or from areas during situations of crises and war.

Member states are required to take appropriate measures to implement and enforce the Regulation. Article 50 requires that such measures should provide for the conduct of checks on shipments including at the point of origin, at their destination, and at frontiers and for spot checks at any point during the shipment. These checks should include inspection of documents, confirmation of identity and, where appropriate, the physical checking of waste.

Under Article 24, where an illegal shipment is discovered and is the responsibility of the ‘notifier’,<sup>1</sup> the competent authority of the state from which it was exported has ultimate responsibility for arranging for it to be taken back and/or for its recovery or disposal. Where the illegal shipment is “the responsibility of the consignee”, the competent authority of the state of destination bears this burden. These requirements provide an incentive to states for ensuring that the Regulation’s requirements are adhered to and that transported wastes reach their intended destination and are properly disposed of once there

### **3. GPS Background**

The NAVSTAR (Navigation Signal Timing And Ranging) GPS constellation has 30 satellites distributed equally among six orbital planes above the earth’s surface. The orbital planes are centered on the Earth and do not rotate. The GPS satellites orbit at an altitude of approximately 20,200 km. The orbits are arranged so that at least six satellites are always within line of sight from almost everywhere on Earth's surface.

A GPS receiver on the earth’s surface uses at least three GPS satellites to calculate the coordinate of the GPS receiver according to the World Geodetic System WGS84 coordinate system. A GPS receiver needs to know the precise time to calculate its position. The satellites are equipped with extremely accurate atomic clocks. The GPS receiver identifies an individual satellite's signal by its distinct transmitting code. Then the receiver measures how long it took to transmit the signal from the satellite to the GPS receiver. The orbital position data, obtained from the transmitting code, is then used to calculate the satellite's precise position in space. The GPS receiver

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<sup>1</sup> Article 2 (15)

calculates the coordinate on the earth's surface by using the position of the satellite in space and the distance between the satellite in space and the GPS receiver on the earth's surface.

Since 2000, GPS receivers have an accuracy of approximately 10 meters. The accuracy of the coordinates can be improved to within several meters using a technique called differential correction. Differential correction of GPS coordinates can be completed in real-time two GPS receivers are used or at the computer after the coordinate was obtained by comparing the coordinate from a GPS receiver to that of a precisely known location This can be done more precisely in urban areas where there are more fixed locations monitored than in the countryside. GPS receivers would need to be fitted to vehicles carrying waste in order to track their movements.

GPS receivers can ascertain a vehicle's latitude, longitude and elevation. From this information, location, velocity and time can be monitored. The GPS system cannot obtain any information regarding the contents of the waste transport vehicle, but if the contents of the vehicle are known prior to movement, this information combined with the data received from the GPS can create a clearer picture of the activities of the vehicle.

#### **4. Use of GPS Technology to Monitor Waste Carrying Vehicles**

Although both the international and European regimes for controlling transboundary movements of waste have been in place for nearly 15 years, there remains a high incidence of illegal waste movements. Inspection and enforcement projects coordinated by the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) have shown that approximately 48% of waste shipments leaving the European Union are illegal and reveal a particularly high incidence of illegal shipments from Europe's ports<sup>2</sup>.

The United Kingdom also reports problems with the vehicle registration system introduced in part to implement Article 12 of Directive 2006/12/EC, with registrations

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<sup>2</sup> See [http://ec.europa.eu/environment/impel/pdf/tfs-multiannual\\_work\\_prog.pdf](http://ec.europa.eu/environment/impel/pdf/tfs-multiannual_work_prog.pdf)

at a low level and many examples of fly-tippers registering as waste carriers and using their certificates to deceive waste producers as to the lawfulness of their operations.<sup>3</sup> IMPEL are engaged in a work programme running between 2006 and 2010 to review the enforcement of Regulation 1013/2006.<sup>4</sup> In the United Kingdom, the Department for Environment Food and Rural Affairs (DEFRA) is also engaged in a consultation on how its approach to the registration of waste carriers might be improved.<sup>5</sup> These reviews do not appear to be examining the potential use of GPS technology in enforcing the relevant legislation. Nor is there a reference Directive 2006/12/EC or Regulation 1013/2006 to the possibility of using GPS as a monitoring tool, despite their recent introduction and their aim, to tighten up the monitoring of waste traffic. Nor does it appear to be significant uptake of the technology by states in implementing their waste obligations, although the use of GPS by companies in the waste management sector to track the whereabouts of their vehicles is now common, in the UK at least.

The GPS receiver can be used to monitor and track waste movement. The GPS can be used to determine if there were any irregularities in the intended waste movement from the waste generating facility to its intended storage facility. The GPS can be used with signatures to fully monitor waste tracking and who was specifically responsible at each point along the journey.

The use of GPS to monitor the movement of waste by transmitting the coordinates of their movements by radio waves to a monitoring station, in a similar way as flight coordinates of airplanes are transmitted to airport towers. GPS can be used to monitor movement by any person who has access to the GPS receiver and/or the signal transmitted by the GPS receiver.

The infrastructure necessary to establish a GPS monitoring system is not complicated. GPS devices are already being used by the private sector such as a security device in cars and to recover stolen vehicles.<sup>6</sup> It is feasible for a state to do

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<sup>3</sup> See <http://www.defra.gov.uk/corporate/consult/waste-controls/waste-carriers.pdf>

<sup>4</sup> See [http://ec.europa.eu/environment/impel/impel\\_tfs.htm](http://ec.europa.eu/environment/impel/impel_tfs.htm)

<sup>5</sup> see <http://www.defra.gov.uk/corporate/consult/waste-controls/waste-carriers.pdf>

<sup>6</sup> see LoJack at <http://www.lojack.com/> in the US and Tracker at <http://www.tracker.co.uk> in the UK.

the monitoring. Third party providers, such as private firms that provide vehicle security and recovery from theft, can provide monitoring services. Thus a third party could be designated to monitor waste movement and serve as a 'warning service' to state authorities to trigger inspections of irregularities in waste movement.

The only problems with GPS are mainly associated with electronic errors that reduce the precision of coordinates. The electronic problems can be corrected by differential correction, which uses known coordinates to correct errors in the GPS receiver. After differential correction, the GPS coordinate can get positions accurate to within 5 meters or less of the true position. In built up areas, differential correction would be necessary to identify the exact location of the GPS transmitter.

The costs involved in setting up a GPS monitoring system are the costs of fitting a GPS receiver to the vehicle(s), the cost of computing equipment needed for monitoring and the ongoing costs of monitoring, either by the relevant or by a private sector company. GPS receivers can vary in cost from \$100 US to \$3,000.

It would be feasible also for states to collaborate in a monitoring process because a GPS receiver can transmit coordinates electronically and these coordinates generated by the GPS receiver do not change between states. On the contrary, where a state does not desire to collaborate with another data encryption may be used to protect the information.

The same GPS receiver technology may be used for any vehicle types - motor vehicle, rail, air, sea-going vessel, or via inland waterways. The precision of the GPS coordinate, and the ability to perform correction only varies according to the distance of the GPS receiver from a known ground reference location.

Data obtained from GPS may be used to evidence a vehicle's route by identifying its location at precise times and dates. The vehicle's route can be presented numerically in terms of date, time and location of each movement or visually in terms of a map of the vehicle's route with the GPS coordinates overlaid on the map.

While the information will need to be processed by someone experienced in the use of GPS monitoring systems, there is little scope for varying interpretations of the data, once the accuracy of the coordinates has been ascertained.

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The technology may not be capable of detecting persons operating entirely outside of national authorisation and registration systems for waste movement; nor can the technology replace spot checks for determining whether waste other than that notified is being carried. However, if coupled with a requirement for licensed persons to fit GPS receivers in their vehicles, an appropriate inspection regime for licensed vehicles, and a more rigorous approach to enforcing licensing requirements, the technology may be used to identify licensed vehicles making unauthorised journeys, e.g. where vehicles depart from agreed routes or terminate at unregistered sites for waste disposal.

The potential use of GPS as a deterrent was examined in a study by Parker et al. of liquid waste management in Western Australia.<sup>7</sup> This study found that in the early 1990s compliance with regulations for the disposal of liquid wastes in the Perth Metropolitan area was low, even amongst authorised liquid carriers. However, the introduction of measures including the mandatory GPS tracking of licensed tankers practically eliminated illegal activities, with the use of GPS making it difficult for tanker drivers to dump waste illegally or falsify records without detection.

Satellite-based systems for tracking the whereabouts of ships (vessel monitoring systems) are now widely used in connection with fisheries management. Molenaar

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<sup>7</sup> 'Liquid Waste Management in Western Australia: A Case Study in Enforcement and Compliance' by A.J.Parker et al at <http://www.inece.org/5thvol1/parker.pdf>

and Tsamenyi<sup>8</sup> describe the practice amongst states and by Regional Fisheries Management Mechanisms of requiring the installation of ‘automatic location communicators’ in vessels engaged in fishing. It is also a requirement of the 1995 Fish Stocks Agreement<sup>9</sup> that flag states shall monitor and control fishing operations by “the development and implementation of vessel monitoring systems, including, as appropriate, satellite transmitter systems”. Molenaar and Tsamenyi report that information transmitted by automatic location communicators aboard fishing vessels to a satellite, and ultimately to a fishery monitoring centre, can be used to check the identity of a vessel, its whereabouts, what activities it is engaged in, and how long it stays in a location. This information can be used to monitor whether a ship is in an area where it is permitted to fish and may reveal a vessel’s ‘fishing signature’. The technology may also allow a vessel to voluntarily transmit other information such as details of its fish catches.

A recent prosecution by the Environment Agency in the United Kingdom shows the potential value of evidence derived from GPS technology in the enforcement of environmental legislation. JK Environmental & Sons were fined £2,500 in May 2007 for the discharge of contaminated waste liquid by one of their tankers into an inland waterway.<sup>10</sup> As part of the evidence of the case a specialist on GPS tracking systems extracted data from a computer showing the route taken by the tanker and the stops it had made at a number of mobile homes with septic tanks before discharging its contents.

## **5. Hypothetical monitoring design**

Figure 1 is a conceptual design of different ways waste can be shipped. I assume waste leaves from a facility in the UK and has only one potential change in transport. I assume that the waste generating facility only has transport by road and that there is no rail, air or boat transport directly to the waste generating facility. The same is

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<sup>8</sup> Satellite-Based Vessel Monitoring Systems; International Legal Aspects and Developments in State Practice at [www.fao.org/legal/prs-01/lpo0.pdf](http://www.fao.org/legal/prs-01/lpo0.pdf)

<sup>9</sup> Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

<sup>10</sup> see [http://environment-agency.wales.gov.uk/news/1763088?region=Anglian+Region&\).](http://environment-agency.wales.gov.uk/news/1763088?region=Anglian+Region&)

assumed for the waste holding facility. If transport is by land and road only, there may be no change in transport carrier and transparency tracking would only be needed for road transport from the initial departure at the waste generating facility to the waste storage facility. If waste goes by rail, tracking would need to be transparent from the initial departure at the waste generating facility, to the train, and back off the train by road to the waste holding facility. The same is true for air and water. If there are multiple changes, such as by road from the generating facility, to sea, off the boat to road, to rail, off the train to road and on to the storage facility, the amount of transparency required increases with increasing changes in transport. A GPS receiver would have to be carried for the entire journey and signatures obtained at each change in transport. So at the minimum, between one and three signatures would be required by land, and three signatures by air and water.

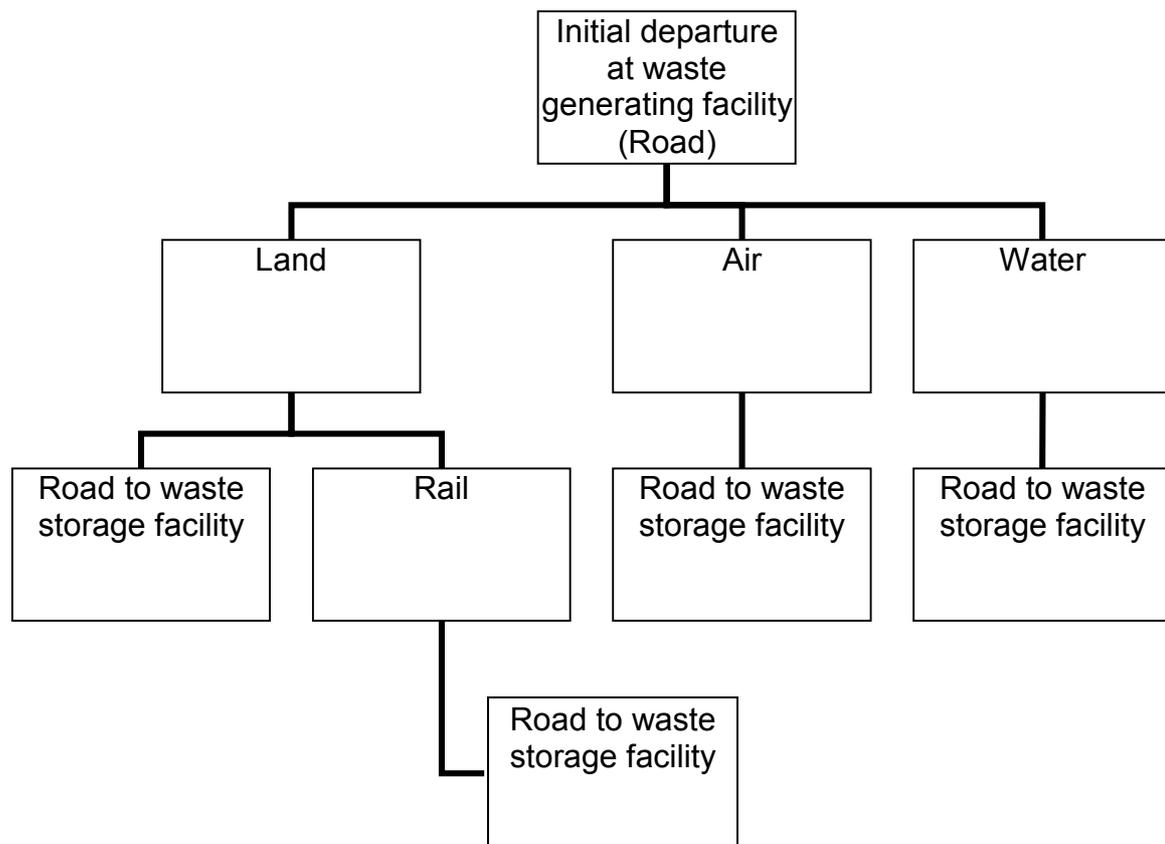


Figure 1 Hypothetical GPS waste monitoring programme for transport between the waste generating facility and the waste monitoring facility.