

*CoMMENT**The View from on High: Satellite Remote Sensing Technology and The Fourth Amendment**LISA J. STEELE* †**Table of Contents**

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You had to live—did live, from habit that became instinct—in the assumption that every sound you made was overheard and, except in darkness, every movement scrutinized.

—George Orwell, 1984

I. INTRODUCTION

In 1984, the United States government placed the sale of images taken by the Landsat satellites in the hands of a commercial company. Two years later, a French company launched its own remote sensing satellite. Then, the Soviet Union joined the market in 1987 offering to sell orbital photographs from its array of satellites. These three vendors constitute a market with far-reaching implications for criminal prosecution and the constitutional right of American citizens to be free from warrantless searches.

The ability of modern satellites to observe subjects has grave implications. The most powerful camera available to civilians, the KFA-1000 aboard the Soviet Resurs F satellite, can resolve details as small as 5 meters across in general and details as small as 1.3 meters

across under limited conditions.¹ Some believe military satellites to have a resolution of between 7.17 centimeters and 23.23 centimeters.² If the courts should find civilian reconnaissance satellites equivalent to aircraft for purposes of "open fields" searches under the Fourth Amendment to the United States Constitution, then citizens may properly anticipate that anything done outdoors may constitutionally be viewed by unseen satellites.

This Comment explains the technical aspects of satellite remote sensing, the constitutional sources of the "open fields" exception to the Constitution's warrant requirement, and the likely application of that exception to space-based searches. It concludes with the warning that while satellite remote sensing is unlikely to pose a threat to the public today, technology will make searches that endanger privacy feasible in the future.

II. THE HARDWARE: THE SCOPE OF COMMERCIAL SATELLITE IMAGERY

Since 1986, the United States Supreme Court has permitted the taking of aerial photographs without a search warrant.³ Certain technical distinctions between satellite imagery and aerial photography, however, may have a crucial effect on both the use of satellite images by law enforcement authorities and the admissibility of evidence obtained in warrantless satellite searches.

The quality of satellite photographs is rapidly approaching that of photographs taken by aerial surveillance cameras. The first high-resolution civilian reconnaissance program, Landsat, was launched in 1972.⁴ Since 1972, several civilian satellite photography companies have developed. Landsat's progeny, Landsats 4 and 5, are managed by a private firm, Eosat, and provide images with 30-meter resolution.⁵ Eosat's primary competitor, the Spot Image Company (Spot), provides images from the French Spot satellites with 10-meter resolution.⁶ The Soviet Union also markets satellite photographs through a government agency, Soyuzkarta, and digital radar images through an American agency. Soyuzkarta's photographs have a resolution of 5 meters. These photographs are taken in orbit and the film is ejected from the satellite to be picked up by an aircraft. The Almaz, another Soviet satellite, uses synthetic aperture radar⁷ and offers a resolution of 10 to 15 meters.⁸

Although these capabilities are impressive, civilian satellites still lag behind military systems. An example of current technology, the Advanced KH-12 espionage satellite, demonstrates the possibility of optical images with 10-centimeter resolution and radar images with 1-meter resolution.⁹ While civilian vendors cannot presently manufacture and launch satellites with these capabilities, these systems provide an illustration of how far the technology has progressed.

One major difference between satellites and aircraft is that satellites are virtually invisible from the ground. A subject may hear or see an observing aircraft, but cannot casually detect a satellite.¹⁰ This poses a significant advantage for those engaged in covert surveillance, and also makes it difficult to detect invasions of privacy which do not lead to arrest.

Satellites also differ from aircraft in that they must remain in fixed orbits. This restricts both the quantity and availability of their images.¹¹ Remote sensing satellites are generally placed in "sun-synchronous" orbits which allow the satellites to pass over the equator at the same solar time each day.¹² For law enforcement purposes, satellites are most useful for investigating ongoing or past criminal activity such as locating narcotics plantations and illegal pollution.

The few satellites available are in high demand. The Landsat 4 and 5 satellites each pass over a given location once every 16 days.¹³ The Spot satellite repeats its orbit once every 26 days; however, its sensors are mounted in a manner which allows it to "revisit" a location 7 days out of 26 days.¹⁴ Unfortunately, the Soviet Union employs a large number of satellites about which information is not readily available. Therefore, satellite availability is difficult to ascertain.¹⁵ Again, this makes it more difficult to observe a spontaneous event than observe an ongoing event.

Even if a satellite is in position to observe a given target, the weather must be sufficiently clear to allow optical observation. Repeated attempts may be required unless the satellite uses other sensors, such as radar, to observe the target. One sensor which may be employed is an infrared camera, which allows the satellite to distinguish different types of plants, or between occupied and unoccupied buildings.¹⁶ Infrared sensors aboard aircraft are used today to locate indoor marijuana plantations by the heat of their 1,000 watt "grow lights."¹⁷ Landsat and Spot's multispectral scanners are also being used to detect drug cultivation in foreign countries by their color "signature,"¹⁸ and there is no technical barrier to using this technology in the United States.

Satellite photography is currently being used in some cases involving violations of environmental laws.¹⁹ To date, satellite imagery is used primarily to provide demonstrative evidence of herbicide use, release of pollution from barges, the existence of land and water boundaries including wetlands, and the presence of specific pollutants.²⁰ Satellites are also used to monitor environmental damage. During the Persian Gulf War, satellite imagery was used to monitor the amount of oil spilled into the Gulf. It can likewise be used to

monitor spills in American waters.²¹ It does not appear that satellite imagery has been extensively used in investigations of domestic narcotics or environmental crimes.

III. THE CONSTITUTIONAL PROTECTION AGAINST WARRENTLESS SEARCH: A HISTORICAL OVERVIEW

Any use of satellites by government agencies to search for evidence of criminal activity must conform to the Fourth Amendment of the United States Constitution which states "The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation" ²² The State may, therefore, seek a warrant from a neutral and detached magistrate in order to lawfully search a person's home and effects. In addition, courts have permitted the State to examine, without a warrant, fields, yards, and other public places.²³

To determine whether a search as defined by the Fourth Amendment has taken place, the courts generally consider the location of the area searched, the reasonableness of the subject's expectation of privacy in the area, and society's willingness to defend that expectation of privacy.²⁴

A. The Reasonable Expectation of Privacy

Early cases regarding warrantless searches focused on property concepts of trespass in determining whether a search fell within the Fourth Amendment. A physical penetration of a dwelling or closure rendered the search unconstitutional. If no such penetration occurred, the search was permissible.²⁵

In 1967, the U.S. Supreme Court changed that rule, setting forth a new standard for review of warrantless searches. In *Katz v. United States*,²⁶ the court considered whether the Constitution permitted the FBI to place a microphone in a public telephone booth. The Court had to abandon its earlier trespass test because the microphone did not require physical penetration of the telephone booth. To invalidate the search, the Court held the search unconstitutional because the government had "violated the privacy upon which [petitioner] justifiably relied while using the telephone booth."²⁷ Justice Harlan, in a concurring opinion, suggested that courts henceforth would ask (1) whether the property owner had demonstrated an actual expectation of privacy and (2) whether society would recognize such an expectation as reasonable.²⁸

The Court has limited this "reasonable expectations" standard in a number of cases involving aerial surveillance. The Court has ruled that since no reasonable expectation of privacy exists in open fields,²⁹ nor for persons in public view,³⁰ no reasonable expectation of privacy exists for subjects in "plain view" of the public airways.³¹

B. Curtilage and the Open Fields Doctrine

An area not closely connected to a residence may be searched without a warrant. In *Hester v. United States*,³² the Court held that "the special protection accorded by the Fourth Amendment to the people in their 'persons, houses, papers, and effects,' is not extended to the open fields." Between 1967 and 1984, some believed that *Katz* had overruled this distinction between searches of the curtilage and of open fields. The Court, however, reaffirmed the *Hester* doctrine in *Oliver v. United States*.³³

In *Oliver*, state narcotics agents investigating a farm entered the lands, passed a locked gate and "No Trespassing" sign, and discovered a marijuana patch. The trial court held that the posted signs and secluded location of the marijuana patch demonstrated a reasonable expectation of privacy and therefore the warrantless search was unconstitutional.³⁴ The Supreme Court reversed, holding that "an individual may not legitimately demand privacy for activities conducted out of doors in fields, except in the area immediately surrounding the home [i.e. the curtilage]."³⁵ Furthermore, the Court reasoned, "open fields do not provide the setting for those intimate activities that the [Fourth] Amendment is intended to shelter from government interference or surveillance. There is no societal interest in protecting the privacy of those activities, such as the cultivation of crops, that occur in open fields. Moreover, as a practical matter, these lands usually are accessible to the public and the police in ways that a home, an office, or commercial structure would not be."³⁶

In three subsequent cases, the Court has expanded the warrantless search doctrine to permit aerial searches of areas within both residential and industrial curtilage. In *California v. Ciraolo*,³⁷ the Court upheld an aerial search of an enclosed yard adjacent to a residence. In *Dow Chem. Co. v. United States ex rel. Administrator, EPA*,³⁸ the Court upheld the use of a highly sophisticated mapping camera to photograph the interior of an industrial facility. Recently, in *Florida v. Riley*,³⁹ the Court upheld a low altitude search by helicopter of the contents of a greenhouse through missing roof panels.

The Court's first consideration of warrantless aerial searches occurred in 1986. In *California v. Ciraolo*,⁴⁰ police officers flew over the defendant's house in a private airplane at an altitude of 1,000 feet-within the public airways. Although a six-foot-high fence protected the defendant's marijuana patch from ground-level scrutiny, aerial observers could see it clearly. The Court determined that, although the patch was within the curtilage of the defendant's home, it was still vulnerable to observation from a public vantage point. Since "[t]he Fourth Amendment protection of the home has never been extended to require law enforcement officers to shield their eyes when passing by a home on public thoroughfares," the Court held the search constitutional.⁴¹

The same day that *Ciraolo* was announced, the Court expanded its holding to permit a warrantless aerial survey with a high-precision mapping camera. In *Dow Chem. Co. v. United States ex rel. Administrator, EPA*, the EPA had been denied permission to examine a 2,000-acre chemical manufacturing facility.⁴² The agency hired a commercial aerial photographer to photograph the facility from various altitudes. The aircraft remained within navigable airspace at all times.⁴³

The Court recognized that Dow had taken every commercially feasible step to secure its property. Elaborate security, including cameras and motion sensors, had been installed. The photographed area was located within internal portions of the facility in order to conceal it from the public. Dow had even demonstrated concern about aerial surveillance by identifying aircraft making multiple passes over the complex and tracking those aircraft to prevent dissemination of photographs revealing trade secrets.⁴⁴ However, the majority held that even these measures did not constitute sufficient protection.

The Court declined to establish a doctrine of "industrial curtilage" and held that the state has a greater latitude to conduct warrantless inspections of commercial subjects than of residential subjects.⁴⁵ Additionally, the aircraft remained within the public airways, thus establishing exposure of the area to the public and making the search constitutional.

In *Ciraolo*, the police had relied upon unaided visual observation. In *Dow Chemical*, however, the EPA utilized a sophisticated mapping camera. The Court held that the *Dow Chemical* search did not become invalid because "the EPA was not employing some unique sensory device that, for example, could penetrate the walls of the building and record conversations . . . but rather [had employed] a conventional, albeit precise, commercial camera commonly used in mapmaking."⁴⁶ The Court did place some limits upon the use of technology, suggesting that the use of equipment "not generally available to the public, such as satellite technology, might be constitutionally proscribed absent a warrant."⁴⁷

In its most recent decision involving aerial surveillance, *Florida v. Riley*, the Court expanded the permissible uses of aerial surveillance in law enforcement. The defendant, Riley, resided in a mobile home within 10 to 15 feet of a greenhouse. The greenhouse was covered by roofing panels which were either translucent or opaque. Acting on a tip, police circled the greenhouse twice in a helicopter at an altitude of 400 feet. Two panels, comprising 10% of the roof, were missing. Looking through these gaps, police identified marijuana plants.⁴⁸ The Court held that because the sides and roof of the greenhouse were left partially open, an aerial observer could have seen the marijuana growing in it. Therefore, Riley could not have reasonably expected that the contents of his greenhouse would remain hidden from police using the same methods employed in *Ciraolo*. The fact that the police used a helicopter did not invalidate the search, since helicopters form a routine part of modern travel and knowledge of them existed in Riley's county. Any member of the public could have legally flown over Riley's greenhouse at the same altitude and noticed the marijuana. The police officers did no more than this.⁴⁹

In *Ciraolo*, the Court had ruled that given the prevalence of air travel, there could exist no reasonable expectation of protection of the curtilage from aerial scrutiny. In a concurring opinion in *Riley*, Justice O'Connor wrote that the plurality's opinion relied too heavily upon the police officer's compliance with FAA altitude regulations for helicopters.⁵⁰ She stated, "Public roads, even those less traveled by, are clearly demarked public thoroughfares. Individuals who seek privacy can take precautions tailored to the location of the road, to avoid disclosing private actions to those who pass by." She reasoned that a person could observe the usual air traffic around their home and tailor precautions to meet that risk.⁵¹ It follows, therefore, that any search should conform to the customary altitude and patterns of flight.

IV. THE NEXT LOGICAL STEP: WARRANTLESS SEARCHES USING SATELLITE IMAGERY

The State Department's Bureau of International Narcotics Matters already uses military and civilian satellites to estimate marijuana production overseas.⁵² These satellites can observe remote locations such as Peru's Upper Huallaga Valley without warning drug smugglers of scrutiny by repeated overflights.⁵³ While there is no technical obstacle to the domestic use of military satellites, the Fourth Amendment may bar such use. The general public obviously does not have access to such technology; however, a search warrant would seem to make such use legal. Neither the Foreign Intelligence Surveillance Act, regulating the electronic surveillance of

wire and radio communications by American intelligence agencies,⁵⁴ nor the Posse Comitatus Act,⁵⁵ regulating the use of the U.S. armed forces to assist local police officers in carrying out their duties, forbid the military from providing information gleaned from military satellite images to law enforcement agencies.⁵⁶

Military satellite information could affect a defendant in two ways. A military officer could provide an anonymous tip to civilian authorities based on satellite data. Civilian authorities could also request a military satellite search with a warrant and later deny that evidence to the defense on national security grounds.⁵⁷

The availability of civilian satellite information to the general public seems questionable, but it exists as a potential means for conducting warrantless searches. Courts will thus need to consider in addition whether space constitutes a public vantage point and whether images obtained by civilian satellites are generally available to the public. The use of infrared sensors or synthetic aperture radar images in warrantless searches will also present problems to the courts.

A. The Question of Space as a Public Vantage Point

The *Riley* decision affirmed the constitutionality of warrantless aerial searches where any member of the general public could have occupied the same location as the police officer and could have likewise seen the contraband. The Outer Space Treaty, an early United Nations effort to govern the use of outer space, states that space "shall be the province of all mankind."⁵⁸ Nonetheless, the public obviously may not access outer space⁵⁹ as readily as a public street or open field. Many Americans can afford to purchase airline tickets or charter an aircraft. Physical access to outer space, however, exists only for a select number of scientists and astronauts. Members of the public can request a license to launch their own spacecraft,⁶⁰ but only large corporations or government-supported ventures can presently afford such an investment.

It seems likely that a court will rule that outer space itself does not constitute a public vantage point. However, the light making up any image taken from orbit must have travelled through the public airways. Thus, a court could rule that a search of a subject visible from a non-public vantage point looking through a public vantage point may proceed without a warrant.

In *United States v. Lacey*,⁶¹ twenty-four to thirty members of the Vermont State Police maintained a twenty-four hour surveillance, for a period of three weeks, on a house, barn, and garage from concealed locations on the opposite side of a public highway. The majority held that because the yard was visible from a public highway, the defendants could have no legitimate expectation of privacy while in that open area, no matter where the police officers kept their vigil. By logical extension, viewing from orbit a subject observable from the air should have no effect on the constitutionality of the search.

Judge Newman, writing in concurrence, pointed out the logical consequence of this position. In those cases which uphold police observations based upon a "public exposure" theory, police saw the subject "from precisely the location from which the defendant knew or should have known that he was observable."⁶² Judge Newman further observed:

A person in a back yard reading Karl Marx or sunbathing in the nude is entitled to rely on his or her own sense of whether anyone is at the one point on an adjacent road from which observation is possible. They take the risk of not hearing a car or not otherwise realizing that someone is there.⁶³

This theory sees satellite photography as constitutionally "unfair" because the subject has no chance to notice the satellite's passage with his or her unaided senses and take appropriate cover from its gaze.

Similarly, in the Oregon case of *State v. Ainsworth*,⁶⁴ Judge Deits stated in her dissenting opinion:

Individuals commonly observe aircraft overhead, they are aware that their property and person can be observed from the sky, and they can easily detect the presence of airplanes or helicopters when they are close by. . . . In other words, an individual's knowledge that he is being observed minimizes the seriousness of the intrusion on his privacy because he can take steps to prevent the observation and because the fear of on-going but undetectable scrutiny is not present.⁶⁵

Undetectability, fear of abusive surveillance, and the fundamental unfairness of being watched without an opportunity to notice the watcher distinguish satellite-based surveillance from aerial surveillance. These considerations may prove critical in a Fourth Amendment challenge to the use of warrantless satellite searches.

B. The Question of Reasonable Anticipation

In *Riley*, Justice O'Connor proposed another test for determining the constitutionality of warrantless satellite observation. Justice O'Connor would have the state demonstrate that the aerial search was conducted from an altitude at which the public sometimes travels. More broadly, the state would have to demonstrate that the public does occasionally travel over the subject premises in order to uphold a warrantless aerial search.⁶⁶

The application of this test to satellite imaging could take one of two forms: the court could inquire into either the frequency of satellite observation of the subject area, or the frequency of conventional overflights at an altitude from which a comparable observation could have been made. Since a satellite in a polar orbit will eventually pass over the entire Earth, however, an inquiry into the frequency of overflight itself would have no value.

Statistical evidence demonstrating that observations from space are so commonplace that potential subjects of satellite surveillance could reasonably anticipate their occurrence may help support the constitutionality of such a search. Additional support may include estimates, such as those by the Commerce Department, that the annual sales of raw satellite data in 1988 totaled \$25 million per year.⁶⁷ Finally, the searching entity could present statistics regarding scientific and commercial surveillance of the specific region, such as images used in the media, academic studies of geologic structures or forestry areas, or commercial studies of those same structures. Such evidence may well persuade courts that a subject in a frequently surveyed area had a diminished expectation of privacy, whereas a subject in an area that rarely gets imaged might receive greater protection.⁶⁸

A comparison between what an air traveler flying over a subject's property can see and what a satellite can photograph may also assist the court in determining whether a subject had a reasonable expectation of privacy which society is prepared to defend. If Justice O'Connor's test is adopted, then the defense of satellite observation will present no more difficulty than that of aerial observation. A court, however, may wish to consider that if location near an airport or flight path strips away Fourth Amendment protection, many population centers, including most large cities, become open to aerial search.

C. The Question of Technology Within Public Use

In *Dow*, the Court accepted the use of a sophisticated mapping camera with the capacity to discern small pipes within an industrial plant.⁶⁹ The courts have also upheld the use of technology which "materially enhances" or "assists" the natural senses, such as telescopes, binoculars, nightscopes, and cameras.⁷⁰

No standard or threshold, however, has been set to interpret such phrases as "widely available commercially,"⁷¹ "not more sophisticated than [technology] generally available to the public,"⁷² or "conventional, albeit precise, commercial camera commonly used."⁷³ To show general availability, the searcher should need to introduce evidence not only of gross sales, but also of the various uses of satellite imagery, such as media, agriculture, forestry, geology, civil engineering, land-use planning, cartography, coastal-zone management, and environmental monitoring.⁷⁴

A focus upon the wide availability of satellite technology to business and academia may, however, miss the point made by the *Riley* and *Dow* courts. In *Dow*, the technology used by the government consisted of a chartered aircraft with a mapping camera. In *Riley*, the technology consisted of a chartered helicopter. Comparing the price of an airline ticket (approximately \$87 for a short flight),⁷⁵ chartering a private plane or helicopter (\$70 per hour),⁷⁶ or purchasing an aerial photograph (\$450),⁷⁷ to the price of purchasing a satellite image (\$700-\$2,500)⁷⁸ shows a wide gap in affordability. Even if the public knows about the availability of satellite imagery, the price alone arguably places such technology well beyond the reach of the general public.

In addition, the requirements for computer processing and interpretation further increase the price of satellite images. Despite recent advances which simplify computer processing,⁷⁹ image interpretation requires experienced personnel and sophisticated software. The general public can hire vendors to process and interpret an image, but this additional cost further decreases the availability of this technology to the general public.

D. Unnatural Senses: Infrared Imaging and Synthetic Aperture Radar

Another difficult question concerns the use of infrared sensors and radar, which have no correspondence to the natural senses. In response to the expanded use of aerial search to detect outdoor narcotics cultivation, many growers have moved their plantations into barns and garages. The Drug Enforcement Agency reported that between 1986 and 1990, the total number of greenhouses seized rose from 1,077 to 1,669.⁸⁰ As a result, the DEA has intensified its research into portable thermal video systems.⁸¹

The courts have examined the use of infrared technology in *United States v. Penny-Feeney*⁸² and in *United States v. Kerr*.⁸³ In *Kerr*, police used an infrared device to examine a shed on the defendant's property. The device revealed that the building was suspiciously well insulated. This and other information suggested to investigators the possible use of the building for indoor marijuana cultivation.⁸⁴ The court held that the warrantless infrared search might have tainted the evidence; however, the search revealed nothing that had not been obtained by independent observation. Therefore, the court declined to express an opinion as to the legality of an infrared inspection.⁸⁵

In *Penny-Feeney*, the police had received several anonymous tips that the defendant sold marijuana. An informant described in detail the defendant's cultivation operation including the physical layout of her garden in the garage. The police corroborated the informant's information by flying over the residence in an aircraft equipped with an infrared device (FLIR). Using this device, an officer detected a disproportionate amount of vented heat from the residence. This evidence supported an application for a search warrant which resulted in the seizure of 247 marijuana plants.⁸⁶

In its review of a motion to suppress the evidence, the court first noted that the infrared device functioned in a passive, non-intrusive manner to detect differences between the subject's surface temperature and the surface temperatures of background objects. The court then recognized that indoor marijuana cultivation produces heat as a by-product and that the defendant had made no attempt to impede the heat's escape or assert dominion over it. Therefore, the court reasoned, the device had detected "heat waste" or "abandoned heat" in which the defendant had no legitimate expectation of privacy.⁸⁷ By analogy to the United States Supreme Court's holding in *California v. Greenwood*⁸⁸ that an expectation of privacy for abandoned garbage is not objectively reasonable, the court held that the search was valid because an expectation of privacy of abandoned heat is not objectively reasonable.⁸⁹

The court also looked to other cases in which the Court upheld the use of extra-sensory technology to investigate or follow a defendant.⁹⁰ The court reasoned that the defendant had no more reasonable expectation of privacy in the heat emanating from her garage which was observed by the FLIR than a subject would have in smells emanating from a trailer⁹¹ or suitcase⁹² which were observed by a trained dog.⁹³

The court's reliance on analogizing "waste heat" to garbage and odors seems misplaced. A person who puts their garbage on a curb expects that passersby or garbage collectors may look through the garbage, discovering its contents. A person does not expect any person will be able to look at their home and see waste heat being given off. In cases where devices which enhance human perception have been held valid, such as dog sniff tests, the level of intrusion has been significantly lower than in the case of FLIR devices. The operator of a FLIR device is not simply given a signal that the heat pattern from the source indicates illegal activity. The operator is given information about all heat emanating from a source, allowing the operator to discover many different types of activity within the walls of that source, not just those which are illegal.

If upheld on appeal, the *Penny-Feeney* decision may permit the warrantless use of satellite technology to sense infrared light emanating from structural walls in the curtilage despite the firm line courts have traditionally drawn at the walls of the home.⁹⁴ An infrared sensor, like a telescope, merely captures light emitted from a structure. Unlike "visible light," however, radiation in the infrared spectrum is detectable through walls. Development in this area of law continues, and this area may be the first to consider the effect of infrared satellite imagery on warrantless searches.

A more difficult question is raised by radar which does not passively interpret information radiated as "waste" from the home, but instead sends a high energy pulse at the subject and examines the reflection. In detecting motor vehicle offenses, for example, the use of radar has long been upheld by the courts. High-resolution radar images, however, have only recently become commercially available. It is unlikely that the public has already ceded its reasonable expectation of privacy in this respect. If infrared detectors become a recognized tool of law enforcement, however, high-resolution radar may follow shortly.

V. CONCLUSION

As society comes to expect ever decreasing privacy in backyards, patios, and decks, it will become impossible for landowners to protect their privacy from satellite surveillance. The courts recognize that one "cannot block off all conceivable aerial views of their outdoor patios and yards without entirely giving up their enjoyment of those areas."⁹⁵ Nor should Americans need to "construct an opaque bubble over [their] land in order to have a reasonable expectation of privacy regarding the activities there in all circumstances."⁹⁶

Budget-conscious law enforcement agencies will note that since satellites have already proved their usefulness in monitoring overseas drug production, training them upon subjects in the United States may result in cost savings by replacing costly aerial sweeps.

Determining how far the courts will permit this effort to expand the role of satellite searches requires a careful examination of the aerial search doctrine with due regard for all its implications. This Comment has provided a framework for that examination and a caution against bringing Orwell's vision closer to reality.

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† J.D. 1991, Western New England College School of Law; B.A. 1986, Mount Holyoke College. This comment received Third Prize in the 1990 High Technology Law Journal Comment Competition. The competition was sponsored by the law firms of Cooley Godward Castro Huddleson & Tatum; Fenwick & West; Ware & Friedenrich; and Wilson, Sonsini, Goodrich & Rosati, all of Palo Alto, California.

1. "Vladimir Pankin, senior engineer at Soyuzkarta, the Soviet remote sensing agency, says the KFA-1000 ' . . . is acknowledged worldwide as the camera with the best resolution available in the world.' He suggests that a 2m resolution may be possible under the best atmospheric and lighting conditions. . . . The camera . . . provides a capability for 5m resolution." T. Furniss, *The DC-3 of Space*, FLIGHT INT'L, June 20, 1990 at 36-37.

2. JEFFREY T. RICHELSON, AMERICA'S SECRET EYES IN SPACE: THE KEYHOLE SPY SATELLITE PROGRAM 186-87 (1990).

3. *Dow Chem. Co. v. United States ex rel. Adm'r, EPA*, 476 U.S. 227 (1986); *California v. Ciraolo*, 476 U.S. 207 (1986).

4. OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, REMOTE SENSING AND THE PRIVATE SECTOR: ISSUES FOR DISCUSSION-A TECHNICAL MEMORANDUM, 4 (1984) [hereinafter REMOTE SENSING]. Although Landsat came after meteorological satellites, it was the first civilian system with sufficient resolution to threaten privacy rights. For a discussion of the history and capacity of meteorological systems see NATIONAL OCEANIC AND ATMOSPHERIC ADMIN., U.S. DEPT OF COMMERCE, TIROS-N SERIES DIRECT READOUT SERVICES USERS GUIDE, 1-2 (1982).

5. David T. Lingren, *Commercial Satellites Open Skies*, BULL. OF THE ATOMIC SCIENTISTS, Apr. 1988, at 35. "Meter" or "spatial resolution" in the context of this note refers to the smallest objects that can be clearly distinguished in the image. This term may also describe the "field view" of a "pixel," the smallest element in an electronic image.

The area represented by a pixel varies depending upon the angle between the object and the satellite sensor. A satellite has its optimum resolution directly beneath the sensor-as the angle increases, the resolution deteriorates.

6. See generally Peter D. Zimmerman, *Remote Sensing Satellites, Superpower Relations, and Public Diplomacy*, in COMMERCIAL OBSERVATION SATELLITES AND INTERNATIONAL SECURITY, 33, 33-36 (Michael Krepon et al. eds., 1990) (discussing the history of these two companies and their respective satellites).

7. Synthetic aperture radar uses a radar beam instead of reflected light to produce an image. It can therefore obtain an image through cloud cover. *Soviet Space Agency to Sell Satellite Radar Images*, MICROWAVE SYS. NEWS & COMM. TECH., Mar. 1990, at 2. France allegedly will develop a similar system for the fourth Spot satellite. *French Develop Satellite to Complement the Spot Series*, AVIATION WK. & SPACE TECH., Oct. 23, 1989 at 48.

8. Craig Covault, *Soviets Launch Earth Resources Satellite on Modern Salyut Platform*, AVIATION WK. & SPACE TECH., Apr. 8, 1991, at 21. (The Almaz satellite was launched on March 31, 1991).

9 SIPRI, YEARBOOK 1989: WORLD ARMAMENT AND DISARMAMENT 75; see generally RICHELSON, *supra* note 2; Daniel Charles, *Spy Satellites: Entering a New Era*, 243 SCIENCE 1541, 1542 (1989); Jeffrey T. Richelson, *The Future of Space Reconnaissance*, SCI. AM., Jan. 1991, at 38.

10. A subject can locate a satellite visually during the early evening or pre-dawn hours and can calculate the satellite's orbit. This effort differs significantly from merely glancing skyward or hearing a distant aircraft.

11. Military satellites have small maneuvering engines which allow them to alter their orbits . Civilian satellites do not have this

capacity. *See, e.g.*, William J. Broad, *Satellites Keep Watch On The Desert*, N. Y. TIMES, Aug. 28, 1990, at C1, C9.

12. OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, COMMERCIAL NEWSGATHERING FROM SPACE-A TECHNICAL MEMORANDUM 13-15 (1987) [hereinafter COMMERCIAL NEWSGATHERING]. In a "sun-synchronous orbit," the satellite passes over the equator in a polar orbit at the same solar time each day. This allows it to obtain imagery with the sun at a constant elevation relative to the point on the ground being imaged.

13. Due to the curvature of the earth, the closer the subject is to the pole, the more often a given satellite passes over it. Thus Landsat takes 16 days to revisit a subject at the equator and only 8 days to revisit a subject near the poles. COMMERCIAL NEWSGATHERING, *supra* note 12, at 13.

14. *Id.*

15. Soyuzkarta's images came from the Resurs F and O1 satellites and the Kate-140 and MKF-6 cameras operated by the cosmonauts on the Mir space station. *Soviet Earth Observation Gets Less Remote*, SPACE MARKETS, Jan. 1990, at 19-20.

16. THE MAP CATALOG 123-26 (Joel Makower ed., 1986). Landsat's multispectral scanner system records information in two visible light wavelengths and two infrared wavelengths. The resulting images may be combined into "false color" portraits showing health of vegetation, building density, or even water depth. *Id.*

Longer wavelengths of infrared light produce less distinct imagery because they "see" heat in air masses above the ground as well as thermal sources on the ground. Because of the longer wavelength of infrared light, infrared images have inherently lower resolution than visible light images for a given field of view. Richelson, *supra* note 9 at 39 (infrared wavelengths cannot penetrate water vapor (clouds)).

17. *See* United States v. Penny-Feeney, 773 F. Supp. 220 (D. Haw. 1991); CANNABIS INVESTIGATION SECTION, U.S. DEPT OF JUSTICE, 1989 DOMESTIC CANNABIS ERADICATION AND SUPPRESSION PROGRAM FINAL REPORT 23 [hereinafter 1989 REPORT]; Jeffrey Miller, *San Diamas Pot Crop Called Part of Growing Trend*, L.A. TIMES, June 22, 1989, § 9, at 1; Jeffrey Miller, *Indoor Pot Plantation Too Hot to Hide*, L.A. TIMES, Apr. 13, 1989, § 9, at 1.

18. William J. Broad, *Charting the Drug Trade from the Skies*, N.Y. TIMES, Oct. 14, 1989, § 1, at 6. An analyst at EOSAT stated that the detection of drugs by color signature might not always prove reliable and that detection of coca plants by this method was easier than detection of marijuana. *Id.*

19. ENVIRONMENTAL MONITORING SYS. LAB., U.S. EPA, REMOTE SENSING IN HAZARDOUS WASTE SITE INVESTIGATIONS AND LITIGATION 337 (rev. 1988) [hereinafter HAZARDOUS WASTE INVESTIGATIONS].

20. A.B.A. & AMERICAN SOC'Y FOR PHOTOGRAMMETRY AND REMOTE SENSING, EARTH OBSERVATION SYSTEMS: LEGAL CONSIDERATIONS FOR THE '90S, 12, 18 (1990) [hereinafter LEGAL CONSIDERATIONS].

21. *Satellite Image Reveals Oil Dumped in Gulf by Iraq*, AVIATION WK. & SPACE TECH., Mar. 4, 1991, at 24; *see also* HAZARDOUS WASTE INVESTIGATIONS, *supra* note 19. Some suggest that civilian satellites have difficulty detecting and distinguishing between various types and sources of spilled oil. Leonard LeBlanc, *Tracking the Culprit*, OFFSHORE, Jan. 1991, at 7. Spaceborn sensors, however, may detect many other types of water pollution. LEGAL CONSIDERATIONS, *supra* note 20, at 18.

22. U.S. CONST. amend. IV.

23. *See, e.g.*, Hester v. United States, 265 U.S. 57 (1924).

24. *See* Katz v. United States, 389 U.S. 347, 351-52 (1967).

25. *See, e.g.*, Silverman v. United States, 365 U.S. 505 (1961) (use of a "spike" microphone contacting the heating duct servicing the house occupied by the petitioners held unconstitutional); Hester v. United States, 265 U.S. 57 (1924) (open fields search held constitutional).

26. 389 U.S. 347 (1967).
27. *Id.* at 353.
28. *Id.* at 361 (Harlan, J., concurring).
29. *Oliver v. United States*, 466 U.S. 170, 181, 184 (1984).
30. *United States v. Santana*, 427 U.S. 38, 42 (1976).
31. *See, e.g., Florida v. Riley*, 488 U.S. 445, 449-50 (1989) (plurality opinion); *Dow Chem. Co. v. United States ex rel. Adm'r, EPA*, 476 U.S. 227, 239 (1986); *California v. Ciraolo*, 476 U.S. 207, 212-14 (1986).
32. 265 U.S. 57, 59 (1924).
33. 466 U.S. 170, 178 (1984).
34. *Oliver v. United States*, 466 U.S. 170, 175 (1984).
35. *Id.* at 178.
36. *Id.* at 179.
37. 476 U.S. 207 (1986).
38. 476 U.S. 227 (1986).
39. 488 U.S. 445 (1989) (plurality opinion).
40. 476 U.S. 207, 209, 215 (1986).
41. *Id.* at 213-14.
42. 476 U.S. 227, 229-30 (1986).
43. *Id.* at 229.
44. *Id.* at 241-42 (Powell, J., dissenting). Had a competitor conducted the same search seeking trade secrets, a court might have found it liable in tort. *See Dow Chem.*, 476 U.S. at 232; "State tort law governing unfair competition does not define the limits of the Fourth Amendment." *Id.*; *E.I. DuPont de Nemours v. Christopher*, 431 F.2d 1012 (5th Cir. 1970), *cert. denied*, 400 U.S. 1024 (1971); RESTATEMENT (FIRST) OF TORTS § 757 cmt. b (1939).
45. *Dow Chem.*, 476 U.S. at 237 (quoting *Donovan v. Dewey*, 452 U.S. 594, 598-99 (1981)).
46. *Id.* at 238.
47. *Id.*
48. *Florida v. Riley*, 488 U.S. 445, 448-49 (1989) (plurality opinion).
49. *Id.* at 451.
50. *Id.* at 454 (O'Connor, J., concurring).

51. *Id.*; see also *Dow Chem.* 476 U.S. at 237 n.4 (noting that the Dow plant was near an airport and within the pattern of planes landing and taking off).
52. Broad, *supra* note 18, § 1, at 6.
53. See *id.*
54. 50 U.S.C. §§ 1801-11 (1991); see also *United States v. Spanjol*, 720 F. Supp. 55 (E.D. Pa. 1989) (suspect not entitled to discovery of materials obtained under § 1801 where those materials did not contain any exculpatory information and discovery would compromise intelligence sources and methods); *United States v. Falvey*, 540 F. Supp. 1306 (E.D.N.Y. 1982) (evidence lawfully obtained by the government under § 1801 was admissible in a criminal trial).
55. 18 U.S.C. § 1385 (1991).
56. See *Bissonette v. Haig*, 776 F.2d 1384 (8th Cir. 1985), *aff'd*, 485 U.S. 264 (1988) (allowing aerial photographs and visual search by military personnel).
57. See *United States v. Spanjol*, 720 F. Supp. 55 (E.D. Pa. 1989). Some have alleged that the Central Intelligence Agency routinely provided satellite images to the EPA for use in assessing damage from oil spills, hurricanes and tornados, conducting forest inventories, forecasting snow runoff, and early detection of crop disease. RICHELSON, *supra* note 2, at 252.
58. Outer Space Treaty, Jan. 27, 1967, art. I, 18 U.S.T. 2410, 610 U.N.T.S. 205.
59. Because no commonly agreed upon definitions of air space and outer space exist, for the sake of this paper, outer space begins at an altitude of 100 kilometers. For a discussion of the problems in defining this boundary, see S. Neil Hosenball & Jefferson Hofgard, *Delimitation of Air Space and Outer Space: Is a Boundary Needed Now?*, 57 U. COLO. L. REV. 885 (1986).
60. Commercial Space Launch Act, 49 U.S.C. §§ 2601-2623 (1990); see also Land Remote Sensing Act of 1984, 15 U.S.C. §§ 4201-4292 (1990).
61. 669 F.2d 46 (2nd Cir.), *cert. denied*, 459 U.S. 854 (1982).
62. *Id.* at 57 (Newman, J., concurring).
63. *Id.*
64. 770 P.2d 58 (Or. Ct. App. 1989), *rev'd*, 801 P.2d 749 (Or. 1990).
65. *Id.* at 65-66 (Deits, J., dissenting).
66. *Florida v. Riley*, 488 U.S. 445, 454-55 (1989) (O'Connor, J., concurring).
67. *Growth, Stability Predicted for Commercial Space Ventures*, AVIATION WK. & SPACE TECH., Mar. 14, 1988, at 108. The Commerce Department further expects that sales of satellite data, interpretation, and enhancement services, could amount to six billion dollars annually by 1998. *Id.*
68. *Cf. United States v. Allen*, 675 F.2d 1373 (9th Cir. 1980) (a person living near military training areas has a lesser expectation of privacy from aerial surveillance), *cert. denied*, 454 U.S. 833 (1981). This, of course, raises the question of whether the subject knew or should have known that he or she lived near a target subjected to frequent academic, administrative, or commercial scrutiny by satellites. In *Allen*, the presence of the military facility was obvious and the defendant certainly had reason to expect the use of sophisticated technology at or near that facility. *Id.*
69. *Dow Chem. Co. v. United States ex rel. Adm'r, EPA*, 476 U.S. at 238. (EPA's photographs contained vivid detail and resolution.

Some of the pictures included equipment, pipes, and power lines as small as 1/2 inch in diameter.)

70. *See, e.g., Allen*, 675 F.2d 1373; *United States v. Moore*, 562 F.2d 106 (1st Cir. 1977), *cert. denied*, 435 U.S. 926 (1978); *United States v. Solis*, 536 F.2d 880 (9th Cir. 1976); *Dean v. Superior Court*, 110 Cal. Rptr. 585 (Ct. App. 1973).

71. *Allen*, 675 F.2d at 1380.

72. *Id.*

73. *Dow Chem.*, 476 U.S. at 238.

74. REMOTE SENSING, *supra* note 3, at 47-52.

75. American Airlines shuttle from Boston to New York City, one way on a weekday (May 29, 1991).

76. Telephone Interview with Charis Air Corporation of Westfield, Massachusetts (May 29, 1991).

77. Telephone Interview with Robert Foss, James W. Sewall, Inc. of Old Town, Maine (May 30, 1991).

78. Telephone Interview with Kevin Corbley, Press Secretary, Eosat (May 29, 1991); Telephone Interview with Clark Nelson, Director of Corporate Communications, Spot Image Corp. (May 29, 1991).

79. *Satellite Data Adapted for Everyday Users*, N.Y. TIMES, Mar. 12, 1991, at C5. A new technique under development at the Los Alamos National Laboratory would allow "[d]rug agents [to] look for fields of poppies and coca without needing expensive computers." *Id.*

80. CANNABIS INVESTIGATION SECTION, U.S. DEP'T OF JUSTICE, 1990 DOMESTIC CANNABIS ERADICATION/SUPPRESSION PROGRAM FINAL REPORT 6 [hereinafter 1990 REPORT]; CANNABIS INVESTIGATION SECTION, U.S. DEP'T OF JUSTICE, 1988 DOMESTIC CANNABIS ERADICATION/SUPPRESSION PROGRAM FINAL REPORT 5.

81. The U.S. Department of Justice has stated:

The value of portable thermal video systems to support indoor cannabis growing investigations was successfully demonstrated in over 15 cases during the year. . . . Indoor growing operations use very powerful (1000 watt) grow lights to simulate the sun. A troublesome by-product of these light sources is large amounts of heat. Consequently, the detection of heat in the public right-of-way by thermally viewing the walls, boarded-up windows, or doors is valuable information which can add to other sources of information to establish probable cause that there is illegal cannabis cultivation at a specific location.

1989 REPORT, *supra* note 17, at 23.

In 1990, the same technology was used in numerous locations nationwide to support the issuance of search warrants. 1990 REPORT, *supra* note 80, at 29.

82. 773 F. Supp. 220 (D. Haw. 1991).

83. 876 F.2d 1440 (9th Cir. 1989).

84. *Id.* at 1442.

85. *Id.* at 1443-44.

86. *Penny-Feeney*, 773 F. Supp. at 222-31.

87. *Id.* at 225-26.

88. 486 U.S. 35 (1987) (warrantless search of garbage bags valid).

89. *Penny-Feeney*, 773 F. Supp. at 237-38.

90. *United States v. Place*, 462 U.S. 696 (1983) (canine sniff test); *United States v. Knotts*, 460 U.S. 276 (1983) (beeper placed in container taken in car); *Smith v. Maryland*, 442 U.S. 735 (1979) (pen register with phone company).

91. *State v. Solis*, 536 F.2d 880 (9th Cir. 1976).

92. *Place*, 462 U.S. 696.

93. *Penny-Feeney*, 773 F. Supp. at 238-39.

94. *United States v. Kim*, 415 F. Supp. 1252 (D. Haw., 1976) (telescopic observation through apartment windows unconstitutional, telescopic observation of open balcony constitutional); *People v. Arno*, 153 Cal. Rptr. 624 (Ct. App. 1979) (binocular observation of office unconstitutional); *see also Justices Hear Arguments in Aerial Surveillance Cases*, 54 U.S.L.W. 1104 (1986) (California Deputy Attorney General questioned on effect of infrared sensing on *Ciraolo* case).

95. *Florida v. Riley*, 488 U.S. 445, 454 (1989) (O'Connor, J., concurring).

96. *United States v. Allen*, 675 F.2d 1373, 1380 (9th Cir. 1980), *cert. denied*, 454 U.S. 833 (1981).