Cecil

Cecil Spaceport

At Cecil Airport
Jacksonville Aviation Authority

Cecil Spaceport Master Plan

Jacksonville Aviation Authority

JAA
Jacksonville Aviation Authority

March 2012

Prepared by

RS&H
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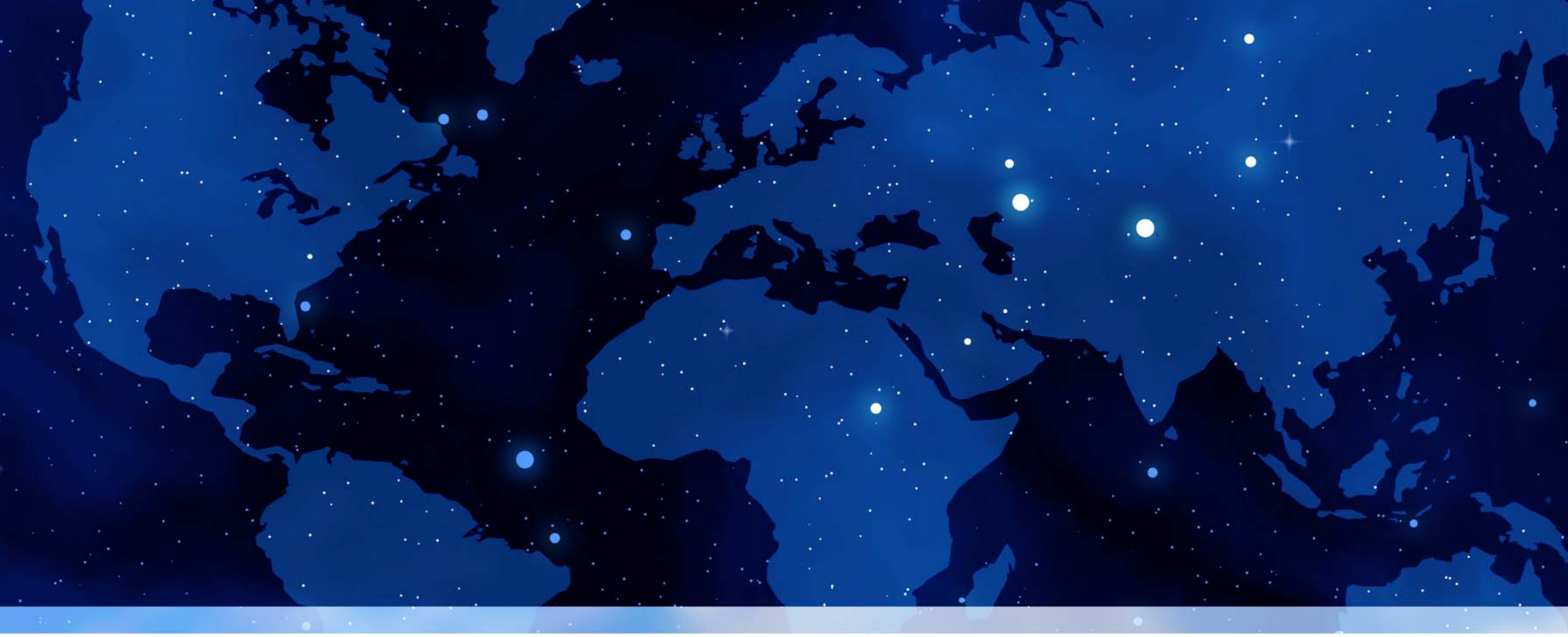

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EXECUTIVE SUMMARY

1.1 PROJECT BACKGROUND

The Cecil Spaceport Master Plan describes the strategic vision, market forces, competitors, operating/development plan and implementation plan required for Cecil Spaceport to meet the anticipated demands of operators of horizontal reusable launch vehicles (RLV) capable of delivering people, goods, and/or small satellites into a suborbital or orbital trajectory.

The Cecil Spaceport, co-located with Cecil Airport in Jacksonville, Florida, will utilize its existing 12,500-foot-long Runway 18L-36R to launch and recover space vehicles that take off and land horizontally. Initially, Cecil Spaceport intends to conduct horizontal space launch operations using existing facilities to the extent possible, with long-term plans to develop dedicated facilities as warranted by the number of space flight operations conducted at Cecil Spaceport.

The Cecil Spaceport was granted a Commercial Launch Site Operator License by the Federal Aviation Administration/Office of Commercial Space Transportation (FAA/AST) in January 2010. Federal law also requires commercial launch operators to hold licenses, either as permission for a single launch of a specific vehicle or a broader license to allow a certain type of vehicle to be launched by that operator from a specific facility.

Access to space historically has been supplied by government-owned and operated facilities, launching government-owned rockets. However, interest in “space tourism” is high, and many companies have been investigating ways to tap into the commercial launch market. Only one company has so far succeeded in launching humans into space on a privately developed, privately operated spacecraft, but several others are making progress toward that goal.

“Space flight” actually involves several kinds of flight profiles: suborbital, orbital (and beyond), and point-to-point. Each requires a different kind of vehicle. Speed, safety systems, life support systems and technological challenges vary greatly, depending on the specific mission at hand. Suborbital is the least complex, with routine commercial operations likely to begin within the next few years. Point-to-point operation presents the most significant technological challenges, due to vehicle requirements and the need to resolve international air traffic control procedures.

Suborbital flights are “ballistic” flights in which the vehicle climbs to its maximum altitude, spends a short period of time coasting to its apogee (which provides the “weightless” experience), and then returns to Earth. To be considered “space flight,” the vehicle needs to climb higher than an altitude of 328,000 feet above mean sea level (MSL), which is 62 miles/100 km. Suborbital launches will typically involve flights at approximately Mach 3, which is about 2,000 miles per hour.

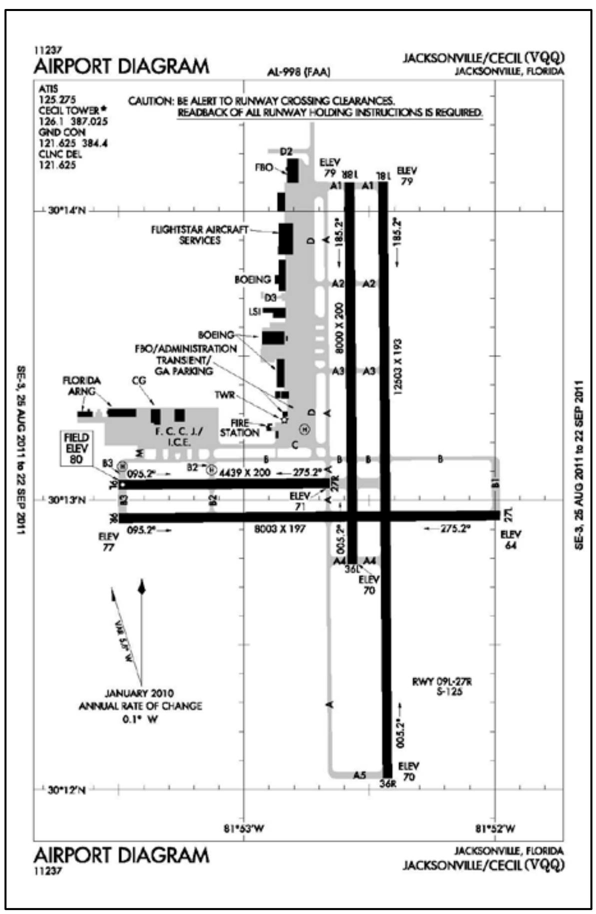
Orbital flights involve much higher speeds, requiring substantially more thrust and increasing the challenges involved with atmospheric re-entry. Orbital velocity needs to exceed about 17,000 miles per hour, and represents a more significant technical challenge. Orbital flights (and beyond) would provide longer-duration weightlessness and require more life-support systems, tracking, and other logistical support. The higher re-entry speeds also require thermal shielding that historically has been problematic to develop and maintain.

Point-to-point space transportation will involve climbing to an altitude outside of most of the atmosphere, maintaining a speed of Mach 5 to Mach 10 for a period of an hour or more, and then landing at a destination different from the launch point. This form of transportation envisions long-distance flights such as New York to Tokyo in less than two hours. The technical challenges associated with developing engines that can maintain such a high rate of speed and deploying a vehicle that would have the dispatch reliability required to make these flights commercially viable mean this type of vehicle is many years away.

The prospect of horizontal takeoff and landing of space vehicles has been under development for decades and now appears to be on the verge of becoming a viable industry. Medium and heavy lift launches will continue to be made by conventional rockets for the foreseeable future.

The parallel is often drawn between the state of commercial space travel now and the aviation industry shortly after the Wright brothers inaugurated powered flight. Just as they could not have foreseen the pace and direction of aviation development, so is it difficult now to see the path of space development. What is clear, however, is that commercial space vehicles are coming, and they will need facilities from which they can operate. Cecil Spaceport (See Figure 1-1) is one of the first facilities worldwide to embark on development plans to accommodate this nascent industry.

Figure 1-1 VQQ Airport Diagram



Source: FAA Terminal Procedure Publication, retrieved September 2011

1.2 HISTORY OF SPACEPORT ACTIVITIES

In 2006 the Jacksonville Aviation Authority (JAA) determined to examine the feasibility of developing a commercial spaceport at Cecil Airport. An environmental assessment, defined by FAA order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures,* was conducted to study the existing natural and manmade environment in the vicinity of Cecil Airport. That order outlined a number of categories of interest, including air and water quality, wildlife impacts, noise, and risks to population. The environmental assessment was completed in July 2009 and resulted in the FAA issuing a Finding of No Significant Impact (FONSI) for the project.

In 2007 JAA began work on an application for a Launch Site Operator License. The license study investigated the potential flight paths, flight trajectories, impact dispersion areas and casualty expectancy for the various types of vehicles. It also examined the potential impacts of explosive materials, including liquid oxygen, nitrous oxide, ethanol, RP-1 and solid propellants.

During the course of the two studies, operations by two different concepts of vehicles were considered. Concept X vehicles take off under jet power like a conventional jet and climb to altitude. Once there, rockets ignite and propel the vehicle out of the atmosphere. On descent, the vehicle glides to the origin spaceport or, in some concepts, returns under conventional jet engine power. Concept Z vehicles involve a carrier vehicle that carries a separately piloted captive vehicle. The carrier aircraft takes off like a conventional jet and climbs to altitude. Once there, the captive vehicle is released. The carrier aircraft returns to the spaceport and lands like a conventional jet. The captive aircraft fires its rockets and climbs into space, and then upon return, glides to the origin spaceport.

Operations by vertical launch rockets were not included in the studies, nor were Concept Y vehicles. Concept Y vehicles are those that take off horizontally like an aircraft, but are rocket-powered. They climb quickly out of the atmosphere, and then return to the origin spaceport like a glider. These operations would need to undergo environmental assessment and Cecil Spaceport's license would need to be amended before operations could be approved.

JAA was granted a Launch Site Operator License in January 2010. Space Florida passed a resolution encouraging legislation to amend the Florida Statutes to designate Cecil a "Space Territory." The legislation passed, making Cecil eligible for Florida Department of Transportation (FDOT) funding for space transportation-related infrastructure. In conjunction with the Space Territory designation, Cecil Spaceport was also approved by the state of Florida as a planned Strategic Intermodal System (SIS) facility. SIS facilities are used to link multiple modes of transportation throughout the state, and the approval opens additional doors for infrastructure funding for spaceport facilities.

1.3 PURPOSE OF THE MASTER PLAN

The Cecil Spaceport Master Plan documents the basic elements of the facility, business and operational needs of the Spaceport over the long term, and prepares the basic elements of a traditional master plan for identifying the future infrastructure development requirements of the Cecil Spaceport. The master plan also outlines and describes the strategic/business plan elements that will be necessary for the long-term success of the Cecil Spaceport.

The master plan is intended to help guide the process of bringing the space industry to Northeast Florida, where it can provide economic growth for the Spaceport, JAA and the community as a whole. Through this process, JAA hopes to lay the groundwork that will allow it to attract enough commercial space operators to enable the development of a thriving economic base of space-related industries. For the time being, JAA's existing business plan for the Cecil Commerce Center and Airport Master Plan for Cecil Airport will remain as they are, with only a limited focus on space activities. However, that plan will be revised as necessary as Cecil Spaceport's business matures.

The Cecil Spaceport Master Plan is the first step in creating a viable commercial spaceport that will meet the evolving needs of commercial space launch industry. It will define and plan the facilities likely to be needed by horizontal-launch spacecraft, and outline how those needs can be met over the next several years. Because of the developing nature of the commercial space launch business, particularly when it comes to horizontal-launch vehicles, infrastructure improvements at Cecil Spaceport must be carefully planned and justified to ensure they are both necessary and affordable. To that end, infrastructure improvements will need to meet the criteria of being suitable for aviation use should commercial space operations prove not viable, and they will need to demonstrate a suitable return on investment that renders them cost-effective.

1.4 STRATEGIC VISION

Defining the proper strategic vision for Cecil Spaceport is a crucial task, because the commercial space industry is in its infancy. The decisions made regarding how to develop and operate the Spaceport will set the stage, not only for future Cecil operations, but possibly the operations and methods of doing business at other spaceports around the world.

Commercial spaceports are an emerging business, much like airports were a century ago during the barnstorming years. Developing the space business will require JAA and Cecil Spaceport to educate many different stakeholder groups about what a spaceport is and isn't, and what it will and will not do. Forecasting market demand requires a number of assumptions regarding pricing, timetable, safety and payload capability. In addition, the emergence of competing launch technologies creates extreme uncertainty as to what the ultimate capabilities and requirements of the launch platforms may be.

Through the work and vision of numerous leaders at JAA, the community, and the commercial space industry, a vision for the development of Cecil Spaceport has emerged that aims to maximize the potential for commercial success and community economic growth, while simultaneously minimizing infrastructure expense and safety risk.

JAA has outlined a vision that Cecil Spaceport will be developed to bring part of the commercial space industry to Northeast Florida, generating economic growth for the region, the Cecil Spaceport and JAA by building a thriving economic base of space-related industries.

1.5 MARKET ANALYSIS

There are a number of horizontally launched, reusable sub-orbital vehicles that have been proposed and developed to some extent in the last decade. Several of these, including the Romanian ARCA Orizont, the European EADS Astrium Space Tourism Project, Canadian PlanetSpace's Silver Dart, British Reaction Engines Ltd's Skylon, Space Adventures and Russian Federal Space Agency's C-21, and Rocketplane Kistler's Rocketplane XP, have seen some development progress, but have either had financial problems or the concepts have taken a back seat to other space-related business interests. As progress is made in horizontal RLV development these ideas could experience resurgence.

At this point in the development of vehicles with a horizontal takeoff and landing capability, there appear to be only two companies that are developing commercial vehicles that may become operational in the near term, with a third that has embarked on a well-funded effort to develop a vehicle in the short term.

The first company, Virgin Galactic, has already flown its mothership and captive vehicles (see Figure 1-2) and has sporadically reported progress in rocket motor testing. Short of serious design issues arising during the testing phase, Virgin Galactic could have SpaceShipTwo in commercial operation in 2013. Virgin Galactic is committed to Spaceship America in New Mexico for its beginning operations. It remains less certain that Spaceport America's remote location in the New Mexico desert can support the infrastructure that would be required by the space tourist market. That issue is covered in more detail in Chapter 5.

Figure 1-2 Virgin Galactic's WhiteKnightTwo and SpaceShipTwo

Source: Virgin Galactic LLC, June 2011

The second company actively developing a suborbital vehicle is XCOR Aerospace. The company has a range of products that are in demand by the existing space industry, which is generating cash for other development. It is using these resources to incrementally move the Lynx vehicle forward. XCOR plans to do its test flying at the Mojave Air and Space Port. It is not tied to any facility for operations and in fact is offering its vehicle to third-party operators under wet-lease terms. It wants to keep its costs low and will not need a significant amount of infrastructure to support its operations.

XCOR is developing the Lynx (see Figure 1-3) to operate from many areas. The business model the company is developing calls for multiple launches on a daily basis. The company is positioning itself more as a suborbital research and experimentation vehicle, but with the capability to carry passengers. While there is little current information about the market for suborbital research packages, there are indications that, as the cost per pound is reduced and launch frequency is increased, there will be tremendous growth in the suborbital research market.

Figure 1-3 XCOR Lynx Suborbital Vehicle

Source: XCOR Aerospace, June 2011

Cecil Spaceport is ideally suited to take advantage of both of these markets. It has a Launch Site Operator license from FAA/AST. It already has the infrastructure necessary to support operations by either company. By being involved in the Commercial Space Federation it is providing information to all developers of horizontal RLVs on its facilities and its readiness to do business with operators. If long-term forecasts of potential market growth are accurate, and if Cecil were able to gain 10 percent of the market, there could be more than 250 flights annually occurring from Cecil Spaceport within 20 years from the commencement of commercial operations.

The third company, Stratolaunch Systems, has announced development of a system similar to the WhiteKnightTwo/SpaceShipTwo, except much larger and geared toward launching orbital payloads. The company is backed by Paul Allen and Burt Rutan – the same team that developed the WhiteKnightOne/SpaceShipOne vehicle that made the first successful space launch of a manned, privately developed spacecraft. While in many respects this system appears to be an excellent fit for Cecil Spaceport, preliminary indications from the company are that the new carrier vehicle will be too large to effectively operate in an airport environment.

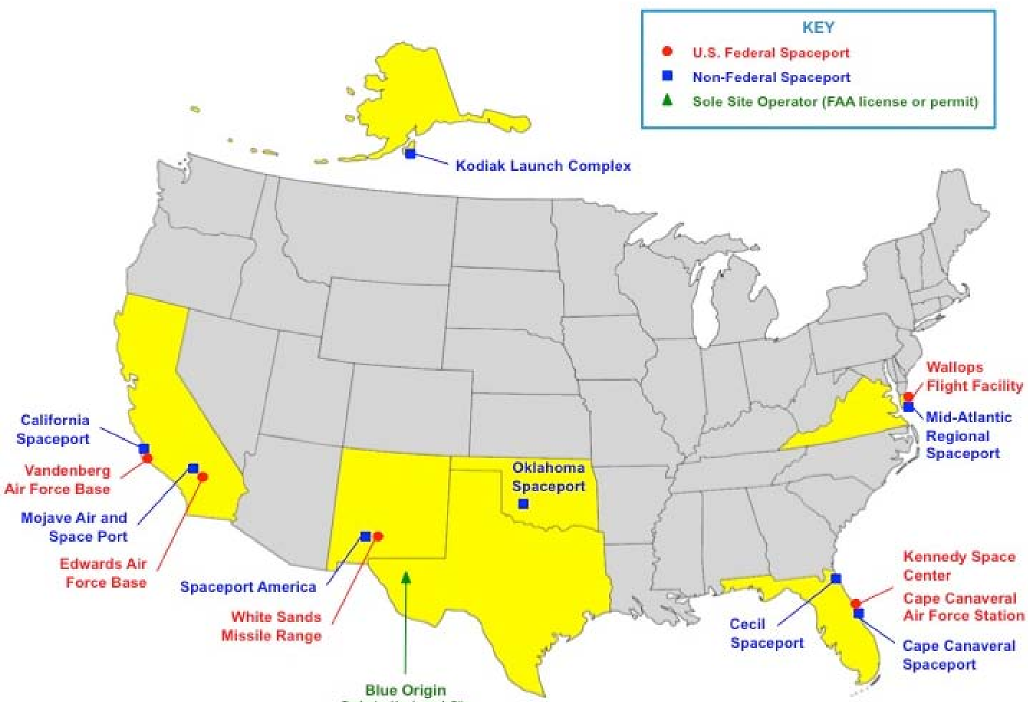
1.6 COMPETITOR ANALYSIS

Every spaceport in the nascent commercial space industry faces a similar hurdle: the lack of commercial manned space vehicle options. This is particularly true of spaceports that, like Cecil Spaceport, rely on horizontal takeoff and landing vehicles. Despite a wide variety of commercial space vehicles in the conceptual and design stages, operational commercial space vehicles are currently limited to vertical launch rockets that deliver unmanned payloads.

One of the primary factors driving the development of commercial spaceports is the shift by the federal government away from being a provider of launch services toward being a launch customer. Another driving force is the prospect of space tourism. In the short term, space tourism involves suborbital flights that cross the 62-mile-high Kármán line, the altitude assigned by the Fédération Aéronautique Internationale as the beginning of space. Longer term, space tourism may involve orbital flights, orbiting hotels, and recreational trips to the moon and beyond. Suborbital spaceflight may also give rise to point-to-point transportation at supersonic or hypersonic speeds.

The primary competitors of Cecil Spaceport are considered to be other spaceports with active horizontal launch licenses; however, additional consideration is given to spaceports with vertical launch licenses but the ability to handle horizontal launch traffic once appropriate vehicles are operational. Figure 1-3 depicts licensed U.S. spaceports. Vertical launch facilities with no runways – and therefore no ability to host horizontal launches – may be considered competitors in that the purchasers of launch services will choose to patronize whatever vehicle operator meets their needs. For example, someone who wants to launch a small microgravity experiment may choose a vehicle based on its flight profile or cost, and the resulting business may then support one kind of launch vehicle (and therefore launch facility) rather than another.

Figure 1-4 Licensed U.S. Spaceports



Source: FAA 2011 U.S. Commercial Space Transportation Developments and Concepts: Vehicles, Technologies and Spaceports, January 2011

Every existing commercial spaceport has its own unique combination of circumstances. While the specific horizontal-launch/recovery RLVs currently under development are not particularly demanding in terms of their facility requirements, long-term commercial spaceport success will depend on far more than simply providing an adequate runway and suitable airspace corridors. The determinants of success will include providing vehicle operators with an operating environment that meets their needs, at a cost they can afford, as well as creating an environment that provides the appropriate support for their customers.

In the case of space tourism, convenient commercial air service and an established tourism infrastructure may be keys to the long-term success of the venture. Successful scientific and commercial space access will rely on suitable employment base and workforce skills, as well as low launch costs. Compared to other facilities with existing commercial Launch Site Operator Licenses, Cecil Spaceport appears to be well-positioned in both of these areas.

Due to the current lack of operational vehicles and the limited number of launch service providers and flights anticipated in the near future, spaceports that rely solely on spaceflight operations are likely to experience difficult financial environments for the next several years. In addition, planned spaceports may come online in future years that will change the competitive balance as well. Cecil Spaceport plans to conduct spaceport operations as ancillary to its existing operation as a viable general aviation airport, which offers it the ability to remain a functional entity until vehicles are available and the market matures.

1.7 OPERATING AND DEVELOPMENT PLAN

The operational and development requirements of a spaceport are directly related to the specific launch vehicles that utilize the facility. Each RLV and operator has specific requirements that must be satisfied before a spaceport can support their needs. Facility requirements, dictated by launch vehicle type, include the specific requirements of propellant storage and loading, the housing of the RLV prior to and after flight, as well as processing, maintenance, and integration of vehicle components. Airfield facilities, such as runways and taxiways, also must meet the specific needs of each RLV. In addition, planned facilities should include a visitor center that will serve as a departure/arrival point for spaceflight participants and guests, mission control, a training/education center, and media access.

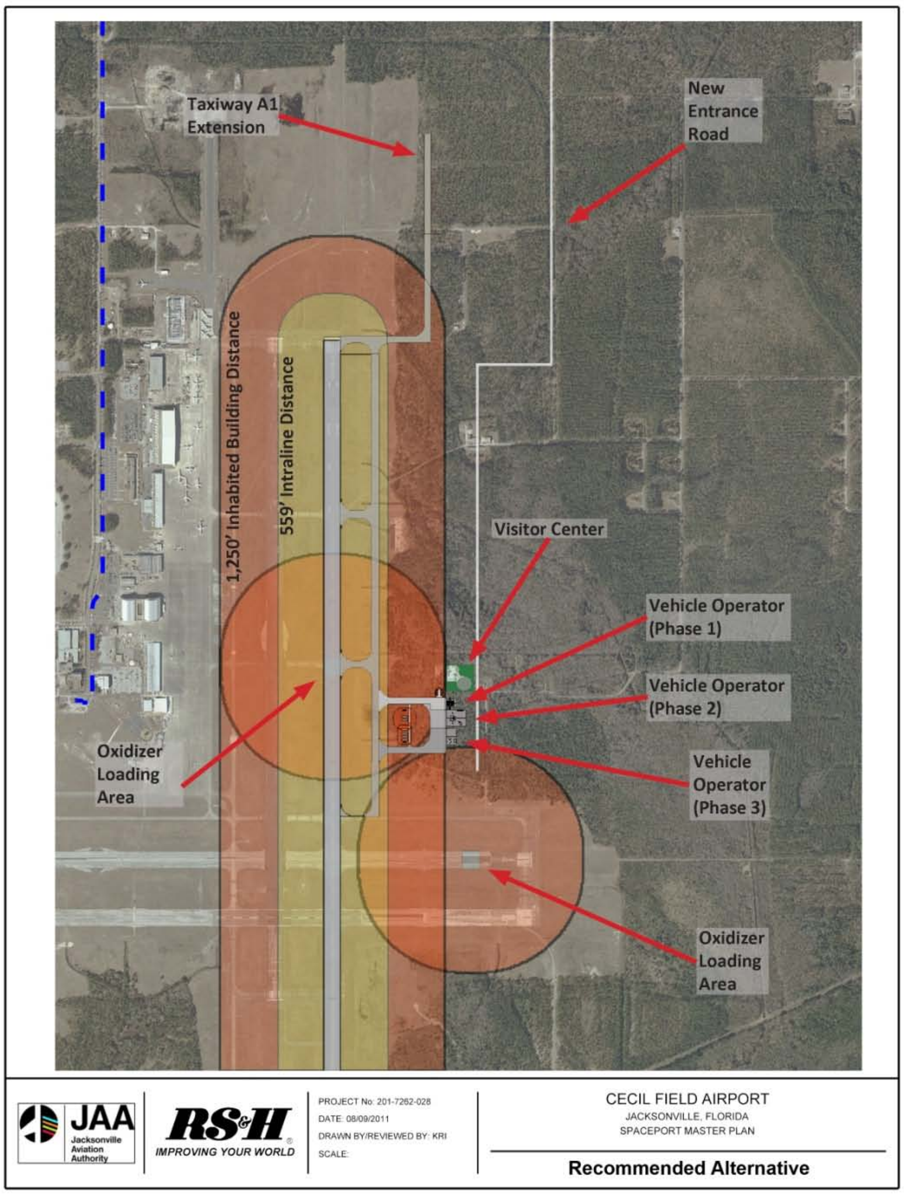
The existing airfield infrastructure at Cecil Airport is fully capable of supporting operations by any RLV operator identified in this study. Runway and taxiway capabilities meet or exceed the requirements set by RLV developers in all respects, with the possible exception of Stratolaunch. The primary focus has been to develop a viable spaceport operating plan that accommodates the need to isolate a space vehicle that is fully loaded with fuel and oxidizer, due to the potential for explosion. These setback requirements must be observed while keeping spaceport operations compatible with all other existing and planned activities and development at Cecil Airport. An additional focus is to plan facilities that could be converted to aviation use should spaceport activities prove not to be viable over the long term.

Facilities that should be built to support long-term Spaceport operations include hangars, parking aprons, offices, propellant (fuel and oxidizer) storage and a visitor center. In addition, oxidizer loading areas beyond what is currently approved in the FAA Commercial Launch Site Operator License should be identified to allow increased flexibility in meeting requirements to separate the launch vehicle from occupied buildings as well as providing space for an engine testing facility. Some of these issues may need approval from FAA/AST, as further detailed in Chapter 6.

Current estimates for when horizontal takeoff/landing RLVs might become operational put initial Spaceport operations in late 2013 or 2014. This schedule allows the planning, design and construction of some required infrastructure, but it is certainly possible that an RLV operator beginning commercial space flights from Cecil Airport in that time frame would be required to operate out of existing facilities and infrastructure.

For the long term, the recommended alternative is to develop the operator facilities and visitor center east of Runway 18L-36R and north of Taxiway B. One oxidizer loading area would be located off Taxiway B1, on concrete pavement recently abandoned with the shortening of Runway 9L-27R. A second oxidizer loading area would be on Runway 18L-36R at Taxiway A3 (see Figure 1-4). This combination best fulfills the required long-term goals of the Spaceport Master Plan by grouping the visitor center, operator facilities, oxidizer loading area and engine test stand, adding operational efficiencies as well as the perception of the overall complex as being a cohesive unit, with the potential to stimulate adjoining development. The recommended alternative would create the fewest conflicts with existing Airport operations, maximize the space for both aeronautical and non-aeronautical facilities on the east side of the airfield, and provide the most unified Spaceport environment.

Figure 1-5 Recommended Alternative



Source: RS&H, September 2011

1.8 IMPLEMENTATION PLAN

The Implementation Plan provides an approach to funding and implementing the preferred development alternative. The Implementation Plan consists of a project phasing plan and a Capital Improvement Plan (CIP). The CIP incorporates infrastructure improvements identified in the development alternatives outlined in previous chapters of this master plan. The recommended phasing plan incorporates the facility improvements and maintenance over a 20-year planning horizon.

1.8.1 Phasing Plan

As shown in Section 1.7, the recommended alternative best fulfills the required long-term goals of the Spaceport Master Plan by grouping the visitor center, operator facilities, oxidizer loading area and engine test stand close together. This option adds operational efficiencies as well as the perception of the overall complex as being a cohesive unit, with the potential to stimulate adjoining development.

The recommended alternative would create the fewest conflicts with existing Airport operations, maximize the space for both aeronautical and non-aeronautical facilities on the east side of the airfield, and provide the most unified Spaceport environment.

The ultimate development of the recommended alternative will include the following projects:
- Extend Approach Road and utilities
- Prepare operator landside/airside site and facilities
- Construct Taxiway E
- Reconstruct Taxiway B (partial)
- Reconstruct Runway 18L-36R
- Construct visitor center

Table 1-1 breaks the projects down in proposed time frame and provides estimated costs.

Table 1-1 Proposed Implementation

SHORT TERM	TIME FRAME	COST (Est.)
Extend Approach Road	2012-2016	$11,835,000
Extend Approach Road Utilities	2012-2016	$1,951,000
Operator 1 Site	2012-2016	$2,420,000
Operator 2 Site	2012-2016	$2,836,000
Operator 3 Site	2012-2016	$2,894,000
MEDIUM TERM		
Construct Taxiway E / Reconstruct Taxiway B	2017-2021	$17,796,000
LONG TERM		
Reconstruct Runway 18L-36R	2022-2031	$47,000,000
Construct Visitor Center	2022-2031	$1,665,000

1.8.2 Funding Alternatives

Funding from several sources may be available for Spaceport infrastructure projects, including FAA Airport Improvement Program (AIP) and State of Florida Department of Transportation (FDOT) Aviation grants as well as Jacksonville Aviation Authority cash and bond funds. There is also an FAA-AST (Commercial Space Transportation) grant program and potential Space Florida funding through FDOT that could be used for specific space-related projects. Because the Cecil Commercial Launch Site Operator License is limited to horizontal launch space vehicles that operate as aircraft during take-off and landing, several of the proposed projects in this plan should be fundable by the traditional airport funding sources.

RLV operations at Cecil Spaceport could commence using existing buildings and infrastructure. However for optimal long-term operation a number of infrastructure improvements are warranted, both to allow launches with minimal disruption to aviation operations and to optimize spaceport operational logistics.

The plan provides guidance on implementation of the recommended alternative, with acknowledgement that an operator may need to create a facility before the ultimate build-out of the infrastructure described in the preferred alternative. The implementation plan considers the demand-driven need for facilities, the need to integrate Spaceport operations into the daily airport activities and funding alternatives.

It is recommended that the implementation plan, including the Airport CIP, be utilized as a working tool. The plan should be updated regularly and include reassessment of project chronology within the three term phases: short-, medium- and long-term. Even though the figures contained herein present a reasonable forecast of needed initiatives to implement the Spaceport Master Plan recommendations, capital improvements, their associated costs, and financial projections should be re-examined periodically – perhaps biannually – throughout the planning period.

CHAPTER 2
INTRODUCTION

2.1 PROJECT BACKGROUND

The Cecil Spaceport Master Plan provides a comprehensive review of the facilities at Cecil Spaceport. It describes the strategic vision, market forces, competitors, operating/development plan, capital improvement plan and implementation plan required for Cecil Spaceport to meet the anticipated demands of operators of horizontal reusable launch vehicles (RLV) capable of delivering people, goods, and/or small satellites into a suborbital or orbital trajectory.

The Cecil Spaceport, located within Cecil Airport in Jacksonville, Florida, will utilize its existing 12,500-foot-long Runway 18L-36R to launch and recover horizontal launch space vehicles. Cecil Spaceport intends to conduct horizontal space launch operations using existing facilities to the extent possible. Dedicated facilities may be constructed by or for operators that commit to conduct substantial space flight operations from Cecil Spaceport.

The Cecil Spaceport was granted a Commercial Launch Site Operator License by the Federal Aviation Administration/Office of Commercial Space Transportation (FAA/AST) in January 2010. Federal law also requires commercial launch vehicle operators to hold individual licenses, either as permission for a single launch of a specific vehicle or a broader license to allow a specific model of vehicle to be launched by that operator from a specific facility.

2.1.1 Commercial Space

Access to space has historically been supplied by government owned and operated facilities, launching government-owned rockets. In the case of manned space vehicles, virtually all missions were determined by government entities – the National Aeronautics and Space Administration (NASA), in the case of the United States. In the case of commercial payloads such as communications satellites, the company operating the satellite would pay the government for launch services.

Constrained by budget, NASA has for years encouraged the development of launch capability by private companies. NASA has provided basic research and development grants to companies investigating designs that range from hypersonic aircraft to manned spacecraft for International Space Station resupply, and from lunar landers to long-term space habitats. That shift in focus culminated in June 2010 with a national policy statement[1] that pledges to shift the US government from a provider of launch services to a consumer of launch services. Private industry is encouraged to take over launch operations, and privately developed and operated rockets are poised to take over much of the satellite launch market in coming years.

The ability to launch humans into space is somewhat more complicated. Although the new commercial rockets are likely to eventually carry humans, access to space by people remains limited to either government-trained astronauts or one of the handful of people who have paid a reported $20 million apiece for rides aboard Russian rockets to the International Space Station. Despite that limited access, interest in “space tourism” is high, and many companies have been

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[1] *The entire National Space Policy statement can be downloaded from the White House web site: http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf*

investigating ways to send customers to the so-called Final Frontier. Only one company has so far succeeded in launching humans into space on a privately developed, privately operated spacecraft, but several others are making progress toward that goal.

2.1.2 Suborbital, Orbital, Point-to-Point

"Space flight" actually involves several kinds of flight profiles: suborbital, orbital (and beyond), and point-to-point. Each requires a different kind of vehicle. Speed, safety systems, life support systems and technological challenges vary greatly, depending on the specific mission at hand. Suborbital is the least complex, while point-to-point operations probably represent the most technically challenging and therefore the one with the longest time frame before deployment. Air traffic service procedures will also need to be modified to allow civilian flights in airspace that until now has been limited to military and government space launch traffic only.

Suborbital flights are "ballistic" flights in which the vehicle climbs until fuel is exhausted, then coasts upward in a parabolic arc until reaching apogee. The coasting at the top of the parabolic arc provides the "weightless" experience (see Figure 2-1). To be considered "space flight," the vehicle needs to climb higher than an altitude of 328,000 feet msl, which is 62 miles/100 km. That point is called the Karman Line. It is a rough approximation of the altitude at which an aircraft would have to fly faster than orbital velocity to generate enough aerodynamic lift to remain airborne. The actual height at which this would occur is slightly different and depends on the aircraft in question and the actual conditions aloft, but 100 km has been adopted by the international community as a standard. Suborbital launches typically involve flights at approximately Mach 3, or about 2,000 miles per hour.

Figure 2-1 Florida as viewed from space

Photo by NASA

Orbital flights involve much higher speeds, requiring substantially more thrust and increasing the challenges involved with atmospheric re-entry. The speed the vehicle flies will determine the height of its orbit. In a low Earth orbit (LEO) such as the Space Shuttle flies, orbital velocity is about 17,000 miles per hour. Flights outside of Earth orbit involve higher speeds. The Apollo vehicles that flew to the moon traveled about 24,000 miles per hour. Orbital flights (and beyond) would provide longer-duration weightlessness and require more life-support systems, tracking, and other logistical support. The higher re-entry speeds also require thermal shielding that historically has been problematic to develop and maintain.

Point-to-point space transportation will involve climbing to an altitude outside of most of the atmosphere, maintaining a high speed for a period of perhaps several hours, and then landing at a destination different from the launch point. This form of transportation envisions long-distance flights such as New York to Tokyo in about two hours. The technical challenges associated with maintaining such a high rate of speed and deploying a vehicle that would have the dispatch reliability required to make these flights commercially viable mean this type of vehicle is many years away.

2.1.3 Commercial Opportunities

When the privately funded and developed SpaceShipOne made two successful suborbital flights in two weeks in 2004, public awareness of the potential for space tourism increased substantially. Virgin Atlantic founder Richard Branson quickly capitalized on the interest, forming Virgin Galactic and taking monetary deposits for joy rides on a vehicle that is now in the intermediate stage of development. (Virgin Galactic is described more completely in Chapter 3.) Other vehicle developers have followed suit, with a wide variety of launch schemes proposed in the ensuing years. So far no commercial manned vehicles have performed full-scale, full-function test flights.

As the US government shifts its emphasis away from providing launch services, the need to accommodate privately developed spacecraft at commercial spaceports has become evident. FAA/AST has developed a Launch Site Operator License that enables the licensee to host commercial space launch operations. Whether the acceptable launches at any given facility are by conventional rocket or one of the new generation of horizontal launch vehicles depends on noise, blast areas, flight paths, airspace and facility infrastructure.

The prospect of horizontal takeoff and landing of space vehicles has been under development for decades, and is now on the verge of becoming a viable industry. With only a few exceptions, the length of time necessary to develop vehicles to the point where they can conduct routine commercial service is unknown. Additionally, the size of the market is dependent on the economic demand presented by space industry beneficiaries. Because of the relatively low payload capability of the current generation of horizontal-launch space vehicles, commercial opportunities in the near term will be limited to space tourism, short-duration microgravity research and potentially microsatellite deployment. Medium and heavy lift launches will continue to be made by conventional rockets. In the long term, the goal is for the industry to develop into a financially feasible transportation system that provides definite time savings that convert into positive economic impacts.

The parallel is often drawn between the state of commercial space travel now and the aviation industry shortly after the Wright brothers inaugurated powered flight. Just as they could not have foreseen the pace and direction of aviation development, so is it difficult now to see the path of space development. What is clear, however, is that commercial space vehicles are coming, and they will need facilities from which they can operate. Cecil Spaceport is one of the first facilities to embark on development plans to accommodate this nascent industry. Note that although Cecil Spaceport holds a Launch Site Operator License, the vehicle operator will be required separately to have a Mission Operator License or Mission-Specific License to conduct operations of a specific vehicle.

2.2 HISTORY OF SPACEPORT ACTIVITIES

In 2006 the Jacksonville Aviation Authority (JAA) determined to examine the feasibility of developing a commercial spaceport at Cecil Airport. An environmental assessment was conducted to study the existing natural and manmade environment in the vicinity of Cecil Airport defined by FAA order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*. That order outlined a number of categories of interest, including air and water quality, wildlife impacts, noise, and risks to population. The environmental assessment was completed in July 2009 and resulted in the FAA issuing a Finding of No Significant Impact (FONSI) for the project.

In 2007 JAA began work on an application for a Launch Site Operator License. The license study investigated the potential flight paths, flight trajectories, impact dispersion areas and casualty expectancy for the various types of vehicles. It also examined the potential impacts of explosive materials, including liquid oxygen, nitrous oxide, ethanol, RP-1 and solid propellants.

During the course of the two studies, operations by two different concepts of vehicles were considered. Concept X vehicles take off under jet power like a conventional jet and climb to altitude. Once there, rockets ignite and propel the vehicle out of the atmosphere. On descent, the vehicle glides to the origin spaceport or, in some concepts, returns under conventional jet engine power. Concept Z vehicles involve a carrier vehicle (sometimes called a mother ship) that carries a separately piloted captive vehicle. The carrier aircraft takes off like a conventional jet and climbs to altitude. Once there, the captive vehicle is released. Its rockets fire and the captive vehicle climbs into space. The carrier aircraft lands like a conventional jet. Upon completing the mission, the captive vehicle glides to the origin spaceport.

Operations by vertical launch rockets were not included in the studies, nor were Concept Y vehicles. Concept Y vehicles are those that take off horizontally like an aircraft, but are rocket-powered. They climb quickly out of the atmosphere, and then return to the origin spaceport like a glider. While these operations are not necessarily incompatible with Cecil Spaceport, they would need to undergo the same environmental assessment conducted for the other concept vehicles before operations could be approved.

JAA was granted a Launch Site Operator License in January 2010. Space Florida passed a resolution encouraging legislation to amend the Florida Statutes to designate Cecil a “Space Territory,” making Cecil eligible for FDOT funding for space transportation-related infrastructure. In conjunction with the Space Territory designation, Cecil Spaceport was also approved by the state of Florida as a planned Strategic Intermodal System (SIS) facility. SIS facilities are used to link multiple modes of transportation throughout the state, and the approval opens additional doors for infrastructure funding for spaceport facilities.

2.3 PURPOSE OF THE MASTER PLAN

The Cecil Spaceport Master Plan documents the basic elements of the facility, business and operational needs of the Spaceport over the long term, and prepares the basic elements of a traditional master plan for identifying the future infrastructure development requirements of the Cecil Spaceport. The master plan also outlines and describes the strategic/business plan elements that will be necessary for the long-term success of the Cecil Spaceport.

The master plan is intended to help guide the process of bringing the space industry to Northeast Florida, where it can provide economic growth for the Spaceport, JAA and the community as a whole. Through this process, JAA hopes to lay the groundwork that will allow it to attract enough commercial space operators to enable the development of a thriving economic base of space-related industries. For the time being, JAA's existing business plan for the Cecil Commerce Center and Airport Master Plan for Cecil Airport will remain as they are, with only a limited focus on space activities. However, that status will be revised as necessary as the Cecil Spaceport's business matures.

The master plan will focus on developing facility plans that can fulfill spaceport needs, but that are convertible to aviation use should spaceport operations not develop as forecast. Particular attention will be paid to using existing infrastructure whenever possible, and ensuring that any new infrastructure represents a sound investment on the part of JAA.

2.3.1 Goals and Objectives

The Cecil Spaceport Master Plan is intended to define the infrastructure, operating and business climate requirements to attract one or more horizontal RLV companies to offer suborbital flights, and to create a viable roadmap for executing that strategy. It is expected that Spaceport facilities will be planned in such a way that added infrastructure is convertible for aviation use, and that Spaceport operations will be planned to procude minimal conflicts with existing aeronautical tenants.

A strategic visioning session that included JAA, community and industry leaders was conducted April 19, 2011, to identify the proper role of Cecil Spaceport within JAA's network of airports and to ensure planned development was compatible with the surrounding community.

The visioning session determined that, in order to meet the goals and objectives of JAA and the community, the Spaceport Master Plan should:

- Be in sync with the community, in terms of both land use compatibility and the desire to provide business opportunities in support of Spaceport operations
- Identify the type and location of needed facilities
- Be used to educate JAA staff and the local community about the potential for the spaceport to enhance economic growth
- Identify ways to use the existence of a spaceport to encourage high school students to pursue math and science studies
- Define the core competencies of Cecil Spaceport and the surrounding community, and establish the competitive position of Cecil Spaceport relative to other commercial spaceports
- Create ties to universities, including but not limited to Florida State College of Jacksonville, the University of North Florida and Embry-Riddle Aeronautical University, similar to the FAA's Centers of Excellence program
- Identify the business case for operating a spaceport using a horizontal RLV company.

2.3.2 Elements of the Master Plan

The Cecil Spaceport Master Plan outlines the strategic vision for the future of the Spaceport. The document establishes a baseline of airport conditions, market conditions, competitors and the suborbital horizontal takeoff vehicle industry. As part of the process, stakeholders participated in a strategic visioning session that defined how the spaceport should be positioned, considered a mission statement, identified goals and objectives, and examined the strengths and weaknesses of Cecil Spaceport compared to other spaceports.

This master plan identifies and documents the target market for Cecil Spaceport facilities and identifies trends in the spaceport industry. Based on this research, the master plan develops a forecast of projected Spaceport activities for a 20-year-period. The master plan also analyzes and documents Cecil Spaceport's position in the spaceport industry by identifying competing spaceports, analyzing their strengths and weaknesses, and make recommendations on how Cecil Spaceport can capitalize on its advantages and the competitors' weaknesses.

The master plan identifies the operational and development requirements that will enable implementation of the recommendations contained in this report, including the actual facility requirements of several RLV manufacturers, such as propellant storage, fueling, vehicle housing, required Spaceport assembly/repair facilities, crew/passenger accommodations, payload storage, visitor viewing areas and media access points. Based on that research, the master plan identifies airfield and landside facilities that may be required and classifies each as to whether it is a short-term, intermediate, or long-term requirement. The document also outlines a Capital Improvement Plan (CIP) for implementing the recommended improvements.

2.4 EXISTING CONDITIONS

Cecil Airport, which served as a Naval Air Station from 1943 through 1999, is in northeast Florida, in Duval County, and within the Jacksonville city limits. The Airport is approximately 15 miles southwest of downtown Jacksonville. Cecil Spaceport, located within Cecil Airport, is six miles south of Interstate Highway 10 and seven miles west of Interstate Highway 295 along State Road 228 (Normandy Boulevard) and State Road 134 (103rd Street). The Airport is accessed directly from the intersection of State Roads 228 and 134 on New World Avenue or Aviation Avenue directly off State Road 134.

Cecil Airport is part of the Cecil Commerce Center, which occupies more than 17,000 acres. Cecil Airport covers approximately 6,000 acres of property. Facilities at the Airport include four runways, associated taxiways, numerous landside facilities, and aviation support infrastructure. There are two north/south oriented runways and two east/west oriented runways.

Cecil Airport is classified as a general aviation airport and is used for civilian and military flight training, maintenance, repair, and overhaul activities, and governmental operations. JAA leases most of the structures along the two flight lines to various companies and government organizations.

Cecil Airport maintains one primary runway and one secondary runway, both of which are 200 feet wide. The primary runway is 18L-36R, which measures 12,500 feet in length and will serve as the primary facility for conducting horizontal launch operations. The secondary runway is Runway 9R-27L, which measures 8,000 feet in length and is suitable as a backup for landing operations of a gliding suborbital spacecraft. Both runways are served by parallel 75-foot wide taxiways.

In addition to the primary and secondary runways, Cecil Spaceport also has two additional utility runways, one parallel to each primary runway. These runways, 18R-36L and 9L-27R, are unlit and are used for daytime operations only. Runway 18R-36L is 200 feet wide and 8,000 feet long. Due to maintenance cost considerations, the long range plan for this runway is to shorten it to approximately 6,000 feet. Until recently, Runway 9L-27R was 8,000 feet long, but was shortened to 4,439 feet. Neither of these runways will be used in spaceport operations, but their availability is important to minimizing the impact of spaceport operations on routine aircraft traffic.

The Airport is served by a full-service Fixed Base Operator (FBO), Jacksonville JetPort, which provides a variety of airport and aircraft services to tenant and transient aircraft, including aircraft fueling, maintenance, and other line services. The Jacksonville Fire and Rescue Department (JFRD) provides aircraft rescue and firefighting services to the Airport on a 24-hour-a-day, 7-day-a-week basis. The air traffic control tower is operated by Robinson Aviation under contract to the Federal Aviation Administration through the FAA's Contract Tower Program. An Automated Weather Observation System (AWOS) is located on the field and provides meteorological information to the air traffic control tower and the national airport weather reporting system via digital automated weather observation information.

2.5 ANTICIPATED ACTIVITIES

In the short term, the vehicles proposed for launch and reentry at Cecil Spaceport would be horizontally launched reusable launch vehicles (RLVs) using suborbital trajectories. Longer term, these operations may evolve into point-to-point transportation using space flight profiles. These vehicles, when operated out of Cecil Spaceport, could carry passengers, scientific experiments or satellite payloads.

JAA plans to develop facilities that will accommodate RLVs that use horizontal takeoff and landing. Cecil Spaceport’s existing environmental approval covers two types of vehicles that take off under conventional jet power, and then land either under conventional jet power or as unpowered gliders. Although JAA may in the future consider a vehicle type that takes off horizontally under rocket power and lands as an unpowered glider, at present such a vehicle falls outside of the existing environmental approval. Those vehicle types are described more completely in Chapter 4.

The proposed vehicles are currently considered experimental, but spaceport operations would not include the launch and reentry of any vehicles operating under an experimental permit. Only launch vehicles holding an FAA/AST Launch Operator license will be permitted to operate at Cecil Spaceport.

Spaceport activities are anticipated to fall into the following categories:

- Transporting the vehicle, vehicle components, and propellants to Cecil Spaceport via road, rail, air, or a combination of these methods
- Assembling the various vehicle components
- Conducting checkout activities
- Storing vehicle propellants
- Loading the propellants into the launch vehicle
- Loading the pilot, passengers, and other payload
- Towing or moving the launch vehicle to the proper launch or takeoff location
- Departing Cecil Spaceport as an aircraft
- Igniting the rocket engines once the vehicle has reached a designated area over the Atlantic Ocean or other approved flight corridor
- Removing any debris from the runway prior to another vehicle operating on the runway
- Recovering and transporting the launch vehicle from the runway after landing

2.6 SUMMARY

The Cecil Spaceport Master Plan is the first step in creating a viable commercial spaceport that will meet the evolving needs of commercial space launch industry. It will define and plan the facilities likely to be needed by horizontal-launch spacecraft and outline how those vehicle needs can be met over the next several years. The commercial space launch business is in its infancy, much like aviation was in the barnstormer days, and Cecil Spaceport finds itself on the ground floor of an emerging line of business.

Because of the developing nature of the commercial space launch business, particularly when it comes to horizontal-launch vehicles, infrastructure improvements at Cecil Spaceport must be carefully planned and justified to ensure they are both necessary and affordable. To that end, infrastructure improvements will need to meet the criteria of being suitable for aviation use should commercial space operations prove not viable, and they will need to demonstrate a suitable return on investment that renders them cost-effective.

The development of Cecil Spaceport provides an opportunity to establish a leading-edge facility unlike any other in the world. The Cecil Spaceport Master Plan provides a roadmap to turning that potential into reality, in a cost-effective manner that minimizes the financial risk to JAA and the community as a whole.

CHAPTER 3
CECIL SPACEPORT STRATEGIC VISION

Defining the proper strategic vision for Cecil Spaceport is a crucial task because the commercial space industry is in its infancy. The decisions made regarding how to develop and operate the Spaceport will set the stage, not only for future Cecil operations, but possibly the operations and methods of doing business at other spaceports around the world.

Commercial spaceports are an emerging business, much like aviation was a century ago during the barnstorming years. Developing the space business will require JAA and Cecil Spaceport to educate many different stakeholder groups about what a spaceport is and isn't, and what it will and will not do. Forecasting market demand requires a number of assumptions regarding pricing, timetable and payload capability. In addition, the emergence of competing launch technologies creates extreme uncertainty as to what the ultimate capabilities and requirements of the launch platforms may be.

Through the work and vision of numerous leaders at the Jacksonville Aviation Authority (JAA), the community, and the commercial space industry, a vision for the development of Cecil Spaceport has emerged that aims to maximize the potential for commercial success and community economic growth, while simultaneously minimizing infrastructure expense and safety risk.

3.1 VISION AND MISSION STATEMENT

The Cecil Spaceport will be developed to bring the space industry to Northeast Florida, generating economic growth for the region, the Cecil Spaceport and JAA by building a thriving economic base of space-related industries.

The existing business plan, vision statement and mission statement for JAA as a whole will remain as they are for the next few years, with a limited focus on space activities. However, that status will be revised as necessary as the Cecil Spaceport's business matures.

3.1.1 Strategic Visioning Session

The vision and mission statement arose from a Strategic Visioning Session held on April 19, 2011, that included members of JAA, the community and the commercial space industry. Participants defined the issues in the context that U.S. space policy is shifting from the view that government should be a provider of launch services to one that government should purchase space services from the private sector. Space Florida has been charged by the Florida Department of Transportation with creating a pathway to ensure Florida launch facilities are prepared to accommodate the shift from government launch facilities to commercial sites. Space Florida has created a master plan to guide that development, which will serve as a point of reference for this study. Space Florida and the Florida Department of Transportation are developing a Spaceport Systems Plan applicable to all Florida Spaceports.

Cecil Spaceport goals and objectives must be consistent with the statewide Spaceport Systems Plan. Space Florida indicates supplements will be published every year or two to capture the reality of the changing market and new transportation objectives.

Session participants identified the following keys to creating a successful Cecil Spaceport Master Plan that can guide the development of Cecil Spaceport:

- Embrace the long-term vision of Space Florida.
- The plan should be useful for JAA as a planning document, but should also contain qualities that can be used to attract users.
- Provide a direction for development, in terms of both infrastructure and business opportunities.
- Identify and describe the financial feasibility of the projects outlined within, including the source of revenue and the potential return on investment.
- Show how Cecil Spaceport will fit into the state and national space and air transportation systems.

3.1.2 Participants

Participants in the Strategic Visioning Session included representatives of JAA, the Florida Department of Transportation, Space Florida, University of Central Florida and community groups. A full roster of participants is included in Appendix A.

3.2 STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS

The formative nature of the commercial space industry generates substantial uncertainty as to how the industry will develop, which players are likely to be successful, and even what business elements will lead to success in the long run. Because of the uncertainty, JAA has attempted to draw parallels between planning the Cecil Spaceport and the more developed practices involved in planning airports, economic development, tourism, education and community relations. Based on those analyses, a variety of strengths, weaknesses, opportunities and threats were identified for the Cecil Spaceport.

3.2.1 Strengths

- Available infrastructure
- Significant land for future development
- Land use compatibility
- Highly skilled workforce
- Ease of access to multi-modal transportation networks
- Location and amenities. Cecil is located in a relatively more urban area than other commercial spaceports. It has good commercial airport access, and lodging/dining/cultural amenities that make it a more attractive place for space tourists to visit before/after a sightseeing flight
- Cecil is not located next to a military installation (such as White Sands Missile Range or Vandenberg Air Force Base), and so has fewer restrictions from outside influences. Competing spaceports may see unexpected airspace shutdowns by the military
- Community support
- Support from state agencies, including Space Florida and FDOT
- Existing spaceport license
- JAA owns the land and can tailor lease terms to suit potential users and their investments
- UPS and FedEx have existing cargo facilities in Jacksonville, which may eventually lead to suborbital point-to-point cargo delivery

- Cecil senior management and the FAA understand the commercial mindset, giving Cecil flexibility that may not be evident at cultures that evolved at NASA or Department of Defense facilities

3.2.2 Weaknesses

- Limited availability of capital funding
- Potential noise impacts, particularly if an operator of a rocket-powered horizontal takeoff vehicle wishes to conduct operations
- Lack of public awareness
- Limited vehicle types approved in the Cecil Spaceport EA
- Lack of existing facilities to accommodate some kinds of spaceport operations
- Population density
- The relatively busy airspace requires more coordination with FAA to facilitate operations

3.2.3 Opportunities

- Educational grants/university involvement
- Establish a connection with universities/research institutions that have links to space business
- Establish a link with existing space companies (i.e., Orbital Science, Zero G) to raise awareness as well as capture existing opportunities
- More federal funding likely for commercial space endeavors
- Host a meeting of the Sub-Orbital Research Group and/or Commercial Space Flight Federation
- To create a dynamic hub of space-related businesses. The vast majority of the companies that would find value in that kind of climate would not need access to launch facilities. Instead, they would provide services and support for those who do
- Create space-oriented incubator facilities to enable growth of small companies in the field

3.2.4 Threats

- JAA has limited funding resources for capital/infrastructure investment
- The proximity and established operations at Kennedy Space Center may make start-up operations at Cecil Spaceport a difficult "sell" to operators
- Lack of a proven launch vehicle. Spaceport operations must wait until vehicles are no longer considered experimental

3.3 PUBLIC WORKSHOP

The long-term success of the Cecil Spaceport Master Plan also hinges upon community acceptance of the community of spaceport operations. Upon the completion of a draft of this Spaceport Master Plan, a public workshop was held February 7, 2012. The public workshop was intended to introduce members of the community to the planned development of the Spaceport. Workshop attendees included members of the general public, community organizations and state agencies. The workshop was informal in nature, allowing attendees to ask questions and engage in discussions with any JAA representatives, the consultant team, or with other members of the public. No comments disagreeing with the logic, facts, forecasts or conclusions in the draft form of this document were made. No objections were raised to the proposed development of the spaceport. Attendees were invited to submit written comments for the record, but no written comments were submitted.

3.4 SUMMARY

Defining a strategy to develop a viable commercial spaceport involves a number of unknowns, due primarily to the industry's early stage of development. The exact elements that could combine to ensure the commercial success of Cecil Spaceport must be inferred from other industries, including airports, economic development, tourism, education and community relations.

JAA has outlined a vision that Cecil Spaceport will be developed to bring the space industry to Northeast Florida, generating economic growth for the region, the Cecil Spaceport and JAA by building a thriving economic base of space-related industries.

By conducting a group exercise in strategic visioning, JAA has combined the ideas of airports, state agencies, industry and the community to outline a variety of strengths, weaknesses, opportunities and threats. By capitalizing on the Spaceport's strengths and opportunities – and by seeking ways to minimize the impact of the Spaceport's weaknesses and threats – a number of strategies can be devised to stack the odds in Cecil's favor.

CHAPTER 4
MARKET ANALYSIS

4.1 OVERVIEW

This chapter will identify the target market for the Cecil Spaceport facilities and will identify trends in the space industry that may impact Cecil Spaceport's ability to develop a place in the space industry.

Commercial space operations are in their infancy – much like aviation was a century ago during the barnstorming years. There was no commercial market except for daredevils and thrill-seekers who wanted to be at the forefront of a new mode of transportation. But as the capabilities of the airplane have developed, the aviation industry has matured into a major mover of people and goods that impacts all facets of our lives.

Today there are no operational horizontal launch space vehicles, but there are several designs in development and testing, with some of the designs near deployment. These competing launch technologies create extreme uncertainty as to what the ultimate capabilities and requirements of the launch platforms may be. This also makes forecasting market demand a difficult task that requires a number of assumptions regarding pricing, timetable and payload capability.

There are several changes in national policy that are impacting the development of the commercial space industry. In June 2010, the United States issued a new space policy that commits the U.S. government to using commercial operations to meet government requirements and to seek private sector partnerships to enable commercial spaceflight capabilities. This will result in the government becoming a purchaser of services rather than a developer or operator, and is already fueling new private industry initiatives.

The Cecil Spaceport launch site operator license allows space launch operations that have been shown to have no significant environmental impact. So far, environmental impacts have only been studied for horizontal launch vehicles that begin their operation taking off horizontally from a runway like a conventional jet-powered aircraft. This limits the market from which Cecil Spaceport can draw to those companies that employ horizontal reusable launch vehicles (HRLV) for suborbital space and companies that use a jet-powered mother ship to carry a captive rocket that is later fired to put its payload into space. This means Cecil Spaceport needs to examine the space tourism and sub-orbital science markets.

As Dr. George C. Nield, FAA Associate Administrator for Commercial Space Transportation noted at the 14th Annual Commercial Space Transportation Conference held in February 2011, development of sub-orbital reusable launch vehicles for science missions and for space tourism is becoming a reality. "Several hundred people have already put down tens of millions of dollars in deposits, eager to be at the front of the line once those vehicles start flying commercially… so I'm pretty bullish about the suborbital market."

Suborbital space flights are poised to launch a new chapter in the commercial space industry, just as they introduced the space race by the United States and the Soviet Union in the 1960s.

4.2 SPACE TOURISM MARKET

Since early times man has dreamed of travel into space. Space travel has been imagined in many literary works and became a reality when Yuri Gagarin became the first human in space on April 12, 1961.

However, space travel has been available for a limited number people who, for the most part, have been trained by governments as astronauts, cosmonauts and space technicians. A little over 500 people have traveled into space, with only seven of these being privately funded space tourists. Only two have been on commercial sub-orbital space flights – the two test pilots for Scaled Composites' SpaceShipOne, which completed the first privately funded space flights in 2004 to win the Ansari X-Prize.

Most of the information on the potential space tourism market comes from a Futron Space Tourism Market Study conducted in 2002 and updated in 2006. Futron Corporation is an industry leader in forecasting space related markets. Futron based its analysis on a Futron/Zogby survey of people who could potentially afford to pay the projected cost for a trip into space. The Futron study concluded that, by 2021, between 13,000 and 25,000 people annually could be flying on sub-orbital flights. This number depends on the start date of flights with paying customers, the fitness requirements applied to these customers, the flight frequency and the cost of the flights.

One of the main drivers of development of the suborbital market will be cost. The cost to put a person into Earth orbit is currently in the $20 million to $30 million range. This has limited the number of privately funded space trips to the seven referenced above. This cost is anticipated to decrease to the $100,000 to $200,000 range for a suborbital flight and is expected to decrease to the $50,000 range as more vehicles are in actual operation. Virgin Galactic, the prospective operator of SpaceShipTwo, reports that more than 430 people have paid a $20,000 deposit toward the first flights at $200,000 per person. XCOR reports it has more than 100 customers for its vehicle, the Lynx, at a price of $95,000 per person. Futron projects that by 2021 the potential annual revenue from sub-orbital space tourism could be between $676 million and $1.26 billion.

The Futron report also predicts the suborbital market could quickly expand beyond space tourism to rapid package delivery and point-to-point passenger transport. However, they did not provide any activity forecasts for these operations.

4.3 SPACE SCIENCE MARKET

Another potential market is the sub-orbital science market. Both Virgin Galactic and XCOR report that their vehicles will be able to carry small payload micro-gravity experiments along with the researcher to run the experiment. In February 2011, the Southwest Research Institute signed deals for 17 research flights aboard both Virgin Galactic's SpaceShipTwo and XCOR's Lynx vehicle.

Allen Stern of the Southwest Research Institute notes "because of frequency of flight and the low cost" the research and education market may become the second bull market for suborbital vehicles

Another player in the field is Orbital Science Corporation, which has developed the Pegasus launch system, using a Lockheed L-1011 as the launch vehicle. Orbital Science already has a number of launch sites around the world. However, the market forecast for small satellite launches from the latest FAA forecasts indicates two annual launches annually, with little potential for growth. There is also a high cost associated with launches using the Pegasus system.

4.4 VEHICLES

There are a number of horizontally launched, reusable sub-orbital vehicles that have been proposed and developed to some extent in the last five years. Several of these, including the Romanian ARCA Orizont, the European EADS Astrium Space Tourism Project, Canadian PlanetSpace's Silver Dart, British Reaction Engines Ltd's Skylon, Space Adventures and Russian Federal Space Agency's C-21, and Rocketplane Kistler's Rocketplane XP, have seen some development progress, but have either had financial problems or the concepts have taken a back seat to other space-related business interests. As progress is made in horizontal RLV development these ideas could experience resurgence.

The two vehicles with the most immediate market promise are Virgin Galactic/Scaled Composites SpaceShipTwo and XCOR Aerospace's Lynx. These vehicles will be described in more detail in the following sections. Both companies have signed contracts with NASA to provide flight opportunities for scientists, engineers and other researchers to fly technology payloads. Both companies' agreements include partner arrangements with a variety of payload integration and flight service companies. A third vehicle, announced by Stratolaunch Systems in December 2011, holds promise but may be too large to effectively operate at Cecil Spaceport.

4.4.1 SpaceShipTwo

SpaceShipTwo is being developed by Scaled Composites. Established in 1982 by Burt Rutan, a famed aircraft designer, Scaled Composites develops experimental aircraft, concept aircraft and prototype fabrication processes for aircraft and other vehicles. The company was sold to Beech Aircraft Corporation in 1985 and worked with Beech to develop the Beech Starship business aircraft. In 1988, the company was sold back to Rutan and has gone through several changes in structure, but always with Rutan as the senior manager. The company was one of 17 companies that entered a vehicle in the Ansari X Prize competition for the first private manned spaceflight. On December 17, 2003, the company announced that the WhiteKnight carrier vehicle had successfully launched SpaceShipOne on its first supersonic flight. Paul Allen, one of the founders of Microsoft provided much of the funding for the SpaceShipOne development. The first privately funded human space flight was completed on June 21, 2004. On October 4, 2004, after completing two private manned space flights within a two-week period, Scaled Composites won the $10 million X-Prize. In August 2007 the company was acquired by Northrop Grumman.

In 2005, Rutan and Sir Richard Branson formed The Spaceship Company to manufacture and own the technology produced during the development of the WhiteKnightTwo carrier aircraft and the SpaceShipTwo spacecraft. Virgin Galactic was formed within the Virgin Group of Branson's companies to provide suborbital spaceflights to the general public. Virgin Galactic also plans to offer suborbital space science missions and a more cost-efficient launch capability for small satellites. The company is also planning a SpaceShipThree to provide an orbital or point-to-point launch capability once SpaceShipTwo is a proven vehicle. Virgin Galactic has a contract with The Spaceship Company to purchase five SpaceShipTwo vehicles and two WhiteKnightTwo carrier aircraft. Scaled Composites is developing the prototypes of the WhiteKnightTwo and SpaceShipTwo under contract to The Spaceship Company. The Spaceship Company is building a 68,000 square foot assembly plant at the Mojave Air and Space Port to begin commercial assembly of SpaceShipTwo and WhiteKnightTwo aircraft. Virgin Galactic will have exclusive use of the SpaceShipTwo suborbital system for 18 months of commercial passenger operations. After that point the system may be acquired by other companies interested in the suborbital commercial space business.

4.4.1.1 SpaceShipTwo and the WhiteKnightTwo Carrier Aircraft

SpaceShipTwo is a suborbital rocket plane that is carried to the launch point by a purpose-built carrier aircraft, the WhiteKnightTwo (see Figure 4-1). SpaceShipTwo operates like the Concept Z vehicle discussed in JAA's 2009 Environmental Assessment conducted for the Cecil Spaceport Launch Site Operator license application. The craft has a crew of two pilots and capacity for six passengers. It is 60 feet in length with a 15-foot tail height and a 27-foot wingspan. SpaceShipTwo will use a liquid/solid hybrid rocket engine which is ignited after the craft is dropped from the WhiteKnightTwo at approximately 52,000 feet. Once separated from the mother ship, the rocket will fire for approximately 60 seconds. The craft will go supersonic within 8 seconds and will reach over 2,600 mph. After the rocket cuts off, SpaceShipTwo will continue to coast upward to an altitude of approximately 70 miles. During this period, the passengers will experience approximately six minutes of weightlessness where they will be able to release from their seats and get a dramatic view of the curvature of the earth from space. Because of the low suborbital speed, SpaceShipTwo is able to avoid heavy and expensive Space Shuttle-like heat shielding and use a unique “feathering” reentry system. Once out of the atmosphere, the twin tail section of the craft is rotated up approximately 65 degrees to the "feathered" position, allowing the body of the craft to act as a braking system on reentry to the upper atmosphere. Once the craft is at around 70,000 feet the tails return to their original position to enable the craft to glide back to the takeoff airport for landing. The duration of the flight from release from WhiteKnightTwo to the glide landing will be approximately 35 minutes, with a total flight duration of around 2.5 hours.

Figure 4-1 WhiteKnightTwo and SpaceShipTwo

Source: Virgin Galactic LLC, June 2011

The WhiteKnightTwo is a unique purpose-built carbon composite aircraft with a 140-foot wingspan and twin fuselages, powered by four Pratt and Whitney PW308A turbofan engines. It was designed as the carrier aircraft for SpaceShipTwo but can also carry other large payloads to high altitudes and can be used for other pre-space flight, positive G and zero G training. The aircraft has flown 78 times as of January 30, 2012, including 16 air launches of SpaceShipTwo. The aircraft will have room for friends and family of the space travelers to view the launch, re-entry and landing of SpaceShipTwo and room for other cargo or experiments.

4.4.1.2 SpaceShipTwo Operations

Scaled Composites is currently operating SpaceShipTwo from the Mojave Air and Space Port in California during the SpaceShipTwo flight test program. Virgin Galactic has proposed a seven-phase test program before commercial use of the vehicle can begin. The company is currently in phase three, the unpowered glide test phase. Sixteen glide test flights have been completed, including testing the feathered reentry system. Flight tests without rocket power require an FAA experimental airworthiness certificate, which was acquired by Scaled Composites in 2008.

The next step will be to install the rocket motor and begin subsonic testing with rocket power. Serra Nevada Corporation is developing the rocket for Scaled Composites The rocket has completed eight full-scale hot fire tests, all with reported satisfactory results. This will be a critical phase in the development. During an early test phase of a prototype rocket design in 2007, an explosion killed three employees. Virgin Galactic reports the rocket motor development program has been successful and that the company is working on integrating the motor and spacecraft. As of December 2011, the motor and space vehicle were being integrated, with short-duration burns planned for early 2012 and suborbital test flights anticipated by the end of 2012.

Following successful subsonic testing there will be supersonic testing, rocket to suborbital testing and finally a detailed test with FAA/AST to obtain a commercial launch license.

While Virgin Galactic is not providing an expected operational date, it would appear that operations could start in 2013-2014 if no significant problems arise during the remainder of the test program. The first commercial operations are scheduled to take place from Spaceport America in the New Mexico desert. Virgin Galactic is the anchor tenant for the new spaceport.

Once Virgin Galactic has begun operations at Spaceport America, there may be plans to locate other vehicles at other airports throughout the world possibly in the UK, Sweden, Dubai and elsewhere. As previously mentioned, Virgin Galactic has received $20,000 deposits from 430 people who will pay $200,000 each for the opportunity to join fellow astronauts on the first commercial ventures into space.

In addition to space tourism, Virgin Galactic envisions the following other potential uses for the SpaceShipTwo system:

- Scientific research including human-in the loop suborbital science and automated research experiments
- Space training for astronauts and researchers
- Technology test and demonstration
- Small satellite orbital launch potential
- Follow-on technology to provide long distance global travel outside of earth atmosphere

4.4.2 XCOR Lynx

The Lynx vehicle is a design of XCOR Aerospace, which was founded in 1999 by former members of the Rotary Rocket Roton rocket motor development team. Headed by Jeff Greason, XCOR's vision is to develop a safe, reusable rocket powered vehicle for sub-orbital exploration. The company has developed and built 12 different rocket motor designs and is one of the leaders in small rocket technology.

XCOR has already built and flown two rocket-powered test aircraft, the EZ-Rocket and the X-Racer, and has conducted 67 aircraft flights under rocket power, which proves the concept behind the Lynx sub-orbital vehicle.

Using its propulsion expertise, XCOR is working with several aerospace prime contractors on rocket propulsion systems. The company recently teamed with United Launch Alliance (ULA), a 50/50 joint venture between Lockheed Martin and The Boeing Company, to design and build a flight ready liquid oxygen/liquid hydrogen upper stage motor for satellites at a significantly lower cost than competing technologies. The motor uses similar technology planned for XCOR's Lynx sub-orbital space vehicle.

According to Andrew Nelson, XCOR Chief Operating Officer, "This contract validates XCOR's business mantra of 'stay focused on propulsion, Lynx and the customer' and ULA is a great customer." XCOR is using the funds and technology generated from its successful propulsion program and other work to continue development of its number one vision, the Lynx vehicle.

4.4.2.1 Lynx I/Lynx II

The Lynx (see Figure 4-2) is a suborbital horizontal takeoff and landing rocket plane designed to carry one pilot and one passenger plus scientific payloads into suborbital space. The vehicle will be powered by four 5K18 liquid oxygen/kerosene rocket engines. While the vehicle is still in the design phase, the 5K18 rocket motor successfully completed hot firing tests in 2008 and rocket motor/aluminum nozzle integrated test firings in March 2011.

Figure 4-2 XCOR's Lynx II

Source: XCOR Aerospace, June 2011

In 2010, a scale model of the Lynx vehicle successfully completed two rounds of wind tunnel tests at NASA's Marshall Space Flight Center. Test flights of a full-scale Lynx I could begin as early as late 2012, with between 20 to 50 test flights required before the vehicle would be considered ready for commercial operations. XCOR believes its previous experience with the FAA in licensing its EZ Rocket and X Racer aircraft will expedite FAA licensing of the Lynx once flight testing is completed.

The Lynx I prototype will have a maximum altitude of about 62 km, which is 203,000 feet or approximately 38.5 miles. It will carry an internal payload of 260 lbs and has an external dorsal mounted payload space capable of carrying 620 lbs. The follow-on Lynx II production model will have a maximum altitude of more than 100 km (330,000 feet or 62 miles). This is above the Kármán line[2], the altitude assigned by the Fédération Aéronautique Internationale[3] as the beginning of space. Lynx III will have an external payload capability of 1,400 lbs and could hold a two-stage carrier that would allow microsatellite launch into low earth orbit. The Lynx II could be operational approximately 18 months after the Lynx I test program is completed. XCOR plans to be able to fly the vehicle up to four times a day and keep prices low with low-cost propellants and long-life components. This will allow XCOR to provide a very low cost-per-pound operation.

The Lynx's single-stage-to-space rocket propulsion system will require the vehicle to be towed to the end of the runway. Once the pilot receives clearance for takeoff, the four rocket engines are ignited, and the spacecraft begins a steep climb as soon as the landing gear is retracted. As the vehicle passes 42 km (138,000 feet or 26 miles), it will reach a speed of Mach 2. At that point the rockets will shut down and the vehicle will continue an unpowered climb to its maximum altitude. The flight profile will include approximately four minutes of weightlessness before reentry into the earth's atmosphere. During reentry the occupants will experience approximately 4g, or a weight of four times the force of gravity. After reentry the Lynx will glide back to the launch airport for an unpowered landing. The total flight will take approximately 25 to 30 minutes.

The Lynx will operate like the Concept Y vehicle discussed in JAA's 2009 environmental assessment conducted for the Cecil Spaceport Launch Site Operator license application. The Concept Y vehicle was not included in the EA's proposed action because of the unknown variables of noise and airspace concerns. Should JAA wish to explore the viability of operations of the Lynx II vehicle at Cecil Spaceport, an additional environmental assessment and license amendment will be required to outline an acceptable flight path and examine the noise implications and blast patterns associated with the vehicle's flight path.

4.4.2.2 XCOR/Lynx Operations

Once testing on the Lynx vehicle is complete, XCOR plans to lease or sell the vehicles to independent owner-operators that will provide the customer experience. XCOR does not intend to operate the vehicle in commercial operations. In 2008, Jules Klar, founder of RocketShip Tours formed a partnership with XCOR and began selling rides on the XCOR Lynx for $95,000, with a $20,000 deposit. In 2009 XCOR signed a $30 million deal with Yecheon Astro Center in South

[2] *The Kármán line is the point at which the Earth's atmosphere becomes too thin for aeronautical purposes. A vehicle above this altitude would have to travel faster than orbital velocity in order to generate enough aerodynamic lift to support itself.*

[3] *The Fédération Aéronautique Internationale (FAI) is a non-governmental, non-profit international organization founded in 1905 with the basic aim of furthering aeronautical and astronautical activities worldwide. FAI now includes more than 100 member countries. FAI activities include establishing rules for certification of world records involving aviation and space flight.*

Korea to be a preferred supplier of space launch services through an operational lease agreement. In October 2010, XCOR and Space Experience Curaçao (SXC) of the Netherlands Antilles signed a wet lease partnership to allow SXC to market space tourism flights from Curaçao. It is expected these flights will begin in 2014. Both of these agreements are being reviewed by the US Department of State to ensure the agreements comply with US export controls.

In 2011, XCOR announced that it was forming a group of payload integration firms to take orders and facilitate experiment development and integration for commercial, educational and government suborbital research missions. The first group of Lynx payload integration specialist firms include the following (in alphabetical order): the African Space Institute of Durban, South Africa; Cosmica Spacelines of Toulouse, France; NanoRacks of Lexington, Kentucky and Washington, D.C.; the Southwest Research Institute (SwRI) in Boulder, Colorado; Space Chariots in Oxon, England; Space Experience Curaçao of the Netherlands and the Caribbean island of Curaçao; Spaceflight Services in Tukwila, Washington; Valencia, California; and Huntsville, Alabama; and Yecheon Astro Space Center, Yecheon, South Korea.

The Southwest Research Institute (SwRI) also announced it had purchased six research flights on Lynx with an option for three more flights. SwRI cited the low cost and expected rapid turnaround as some of the key factors in selecting the Lynx as its primary research vehicle.

Jeff Manber, the CEO of NanoRacks, LLC, noted, "Having over 50 payloads from multiple nations already booked for the U.S. National Lab, we expect XCOR's platform to be a solid first step for many of our customers to validate experiments that will go on to the Space Station. The ability to fly, test, learn, then adjust payloads on the ground and re-fly is extremely useful when perfecting a payload. You don't have to be a rocket scientist to understand XCOR's value proposition."

4.4.3 <u>Stratolaunch</u>

Stratolaunch Systems has unveiled plans to create a Concept Z vehicle capable of launching payloads into a variety of orbits. The company teams Scaled Composites (designer of the WhiteKnight and SpaceShip vehicles), Space Exploration Technologies (Space X), and Dynetics. The company will combine Scaled Composites' vehicle design expertise, a rocket derived from Space X's Falcon 9, and Dynetics experience developing vehicle mating and integration systems to create the largest aircraft ever flown. The company expects to begin test flights by 2015.

Figure 4-3 Stratolaunch Vehicle

Source: Stratolaunch, December 2011

The Stratolaunch (see Figure 4-3) will feature the same twin-fuselage aircraft mated with a captive vehicle found in WhiteKnightTwo/SpaceShipTwo, except the Stratolaunch is envisioned to have a wingspan of 385 feet and maximum gross takeoff weight of about 1.2 million pounds. It will be powered by six engines that are similar to those that power Boeing 747s.

Cecil Spaceport is one of the few licensed spaceports with the required 12,000-foot runway and could likely obtain the necessary modifications of standards to accommodate the vehicle's wingspan. However, initial concept drawings of the vehicle appear to show a landing gear track of approximately 120 feet, which creates problems operating from Cecil Spaceport due to runway width and the likely turning radius of such a large vehicle.

4.4.4 Other vehicles

4.4.4.1 Rocketplane

Figure 4-4 RocketPlane XP

Source: RocketPlane Ltd

Rocketplane Limited was a company formed in Oklahoma in 2001 to build a space plane, the Rocketplane XP, for space tourism (see Figure 4-4). The Rocketplane XP design looks like a corporate jet and would use the jet engines to take-off and land under its own power. Once in the operating area it would use a rocket to accelerate to suborbital speed in a steep ascent. When the rocket fuel was expended, the vehicle would continue to coast into space and passengers would experience around four minutes of weightlessness. After reentry, the pilot would relight the jet engines and return to the takeoff airport under its own power. This operation is consistent with the Concept X vehicle discussed in JAA's 2009 environmental assessment conducted for the Cecil Spaceport Launch Site Operator license application.

The company had an agreement with the State of Oklahoma to develop its spacecraft at the Oklahoma Spaceport and had received $18 million in investment tax credits from the state for the development of the Rocketplane XP. In 2006 it received a contract from the NASA Commercial Orbital Transportation Services program to begin initial development of its vehicle. By 2007, the company was experiencing financial difficulties, and faced several lawsuits and canceled contracts. It fell short of NASA performance milestones, leading to a loss of the NASA contract. By 2009, Rocketplane had vacated its Oklahoma City headquarters building and the company entered Chapter 7 bankruptcy liquidation in 2010. The basic design resurfaced in 2011 under the name Spacelinq, with development tied to EU Spaceport Lelystad near Amsterdam, Netherlands.

4.4.4.2 EADS Astrium

Figure 4-5 EADS Astrium Spaceplane

Source: EADS

The EADS Astrium Space Tourism Project was begun in 2006 and publicly revealed in 2007. The vehicle would be a concept much like the Rocketplane XP, with takeoff under jet power and a methane/oxygen rocket motor for the suborbital ascent portion of the flight (see Figure 4-5). EADS is a large European aerospace and technology company. Its main product has been Airbus aircraft. Through its space technologies division, Astrium, it has developed the Ariane series of launch vehicles and other space-related technologies. In early 2011 EADS announced a development deal with a consortium of companies in Singapore to build a small scale demonstrator, and EADS Astrium CEO Francois Auque later publicly stated, "The spaceplane concept is very mature. We are now looking for development money." Industry estimates are that developing the craft could cost about $1 billion.

Astrium is approaching development of the spaceplane as it would any commercial aircraft. It has spent approximately $13.6 million per year on development since the project was begun, but more aggressive development will not begin until a launch customer is signed. In addition, Astrium intends to pursue EASA certification – a process that would take at least seven years.

4.4.4.3 Vertical launch vehicles

While the Cecil Spaceport can only accommodate horizontal launch vehicles at this time, there are several commercial vertical launch vehicles under development. These vehicles are primarily planned to provide orbital launch services but could also provide suborbital services. These vehicles include designs by Blue Origin, Armadillo Aerospace and Masten Space Systems, Boeing's CST-100, Space X's Dragon and Serra Nevada's Dream Chaser. If some of these vehicles reach routine commercial operations, they could pull demand from the horizontal launch systems that could operate from Cecil Spaceport. However, these systems would probably have higher operational costs that would limit their competition with the horizontal launch market.

4.5 SUMMARY

At this point in the development of vehicles with a horizontal takeoff and landing capability, there appear to be only two companies that are developing commercial vehicles that may become operational in the near term.

The first company, Virgin Galactic, has already flown its vehicle and has sporadically reported progress in motor testing. Short of serious design issues arising during the testing phase, Virgin Galactic could have SpaceShipTwo in commercial operation by 2013. Virgin Galactic is committed to Spaceship America in New Mexico for its beginning operations. It remains less certain that Spaceport America's remote location in the New Mexico desert can support the infrastructure that would be required by the space tourist market. That issue is covered in more detail in Chapter 5.

The second company that seems to have the technological wherewithal and the financial stability to support suborbital vehicle development is XCOR Aerospace. The company has a range of products that are in demand by the existing space industry, which is generating cash for other development. It is using these resources to incrementally move the Lynx vehicle forward. While XCOR will do its test flying at the Mojave Air and Space Port, it is not tied to any other facility for operations. It wants to keep its costs low and will not need a significant amount of infrastructure to support its operations.

XCOR is developing the Lynx to operate from many areas. The business model the company is developing calls for multiple launches on a daily basis. The company is positioning itself more as a suborbital research and experimentation vehicle. While there is little current information about this market, there are indications that, as the cost per pound is reduced and frequency to launch is increased, there will be tremendous growth in the suborbital research market.

Cecil Spaceport is ideally suited to take advantage of both of these markets. It has a Launch Site Operator license from FAA/AST. It already has most of the infrastructure necessary to support operations by either company. By being involved in the Commercial Space Federation it is providing information to all developers of horizontal RLVs on its facilities and its readiness to do business with operators. If the Futron forecast for long-term growth in the space tourism market is valid and Cecil were able to gain 10 percent of the market, there could be over 250 flights annually occurring from Cecil Spaceport within 20 years from the commencement of commercial operations.

CHAPTER 5
COMPETITOR ANALYSIS

5.1 INTRODUCTION

Commercial spaceports in the United States are licensed by the FAA's Office of Commercial Space Transportation (FAA/AST). There are currently eight active launch site operator licenses. Federal launch facilities do not need commercial launch site operator licenses, even though several of them do provide launch services and facilities for commercial customers.

This chapter summarizes the assets, location and operational dynamics of the U.S. commercial spaceports holding active licenses, several of the federal facilities that offer commercial launch services, proposed or inactive commercial spaceports, and international spaceports. Finally, this chapter contains a discussion of the competitive position of Cecil Spaceport relative to the other spaceports discussed.

5.2 OVERVIEW

Every spaceport in the nascent commercial space industry faces a similar hurdle: the lack of commercial manned space vehicle options. This is particularly true of spaceports that, like Cecil Spaceport, rely on horizontal takeoff and landing vehicles. Despite a wide variety of commercial space vehicles in the conceptual and design stages, operational commercial space vehicles are currently limited to vertical launch rockets that deliver unmanned payloads.

One of the primary factors driving the development of commercial spaceports is the shift by the federal government away from being a provider of launch services toward being a launch customer. Another driving force is the prospect of space tourism. In the short term, space tourism involves suborbital flights that cross the 62-mile-high Kármán line, the altitude assigned by the Fédération Aéronautique Internationale as the beginning of space. Longer term, space tourism may involve orbital flights, orbiting hotels, and recreational trips to the moon and beyond.

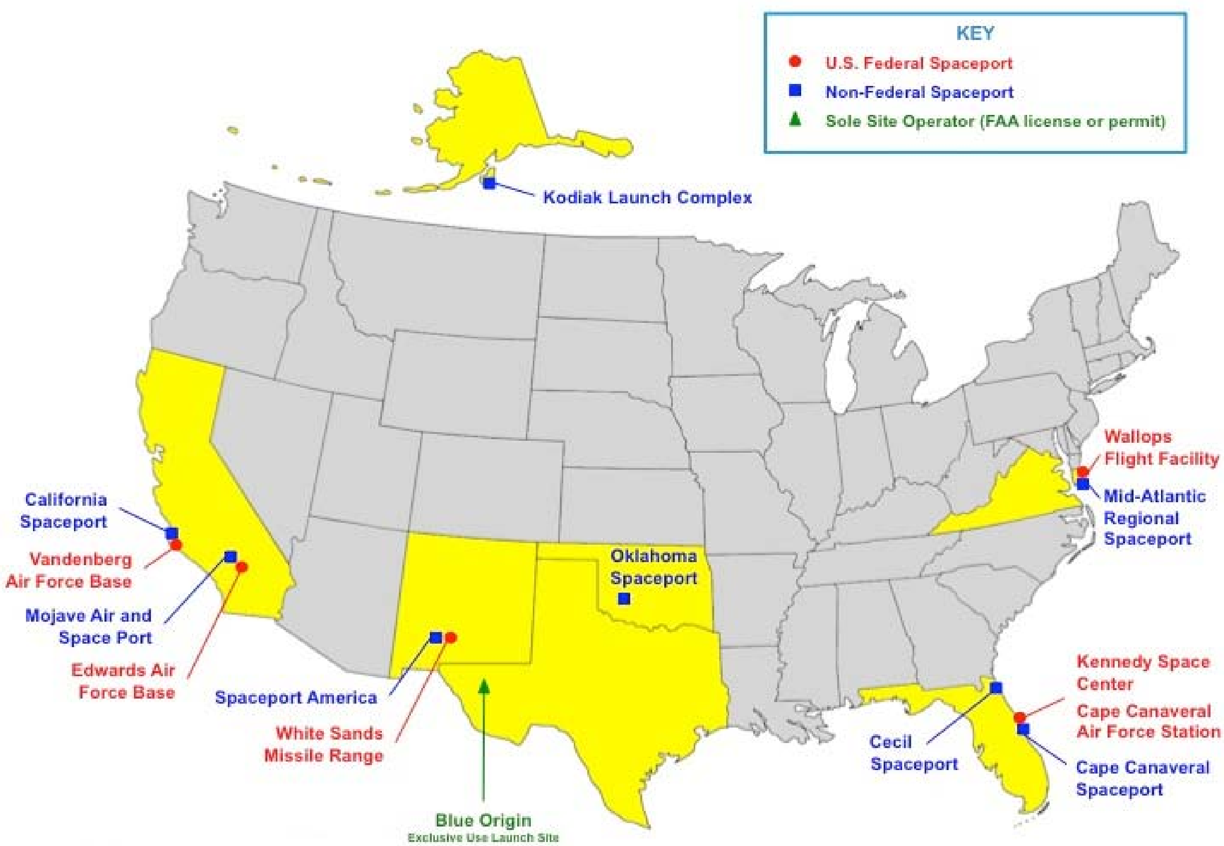
The primary competitors of Cecil Spaceport are considered to be other spaceports with active horizontal launch licenses; however, additional consideration is given to spaceports with vertical launch licenses but the ability to handle horizontal launch traffic once appropriate vehicles are operational. Vertical launch facilities with no runways – and therefore no ability to host horizontal launches – may be considered competitors in that the purchasers of launch services will choose to patronize whatever vehicle operator meets their needs. For example, someone who wants to launch a small microgravity experiment may choose a vehicle based on its flight profile or cost, and the resulting business may then support one kind of launch vehicle (and therefore launch facility) rather than another.

Several spaceports have joint development deals with vehicle developers, guaranteeing launch operations at that facility when and if the vehicle becomes operational. The downside of the arrangement is that the success of the vehicle will largely determine the viability of the spaceport, at least in the short term. The Cecil Spaceport does not currently have development deals with any vehicle designer, leaving it free to negotiate the best deals possible with any appropriate vehicle operators.

The market is expected eventually to develop much like modern airports, with vehicle manufacturers separate from operators, and spaceports free to negotiate agreements with multiple operators. In addition, future spaceport opportunities will include point-to-point services that will turn some current competitors into partners. In the early stages, however, the relative rarity of launches, the small number of operators, and the launch-and-return strategy of suborbital operations will put Cecil Spaceport in direct competition with other spaceports.

Although spaceports are licensed by the FAA, there are other dynamics at play that may help determine the long-term viability of individual spaceports, including geography, the local political and economic climates, existing infrastructure, and airspace complications. Figure 5-1 shows the eight commercial launch site operator licenses granted by the FAA, as well as federal spaceports that are in some cases co-located with the commercial ones.

Figure 5-1 Commercial Launch Sites



Source: FAA 2011 U.S. Commercial Space Transportation Developments and Concepts: Vehicles, Technologies and Spaceports, January 2011

The developmental nature of the industry has led to laws in Florida, New Mexico, Virginia and Texas to protect commercial space flight providers from being sued in the event of an accident, except in cases of gross negligence. Without the legal indemnification put into place by those states, tort liability would be a significant concern, given the unproven nature of the vehicles, the infancy of operational procedures, and the harsh conditions involved in traveling outside the Earth's atmosphere. The third-party indemnification granted by those four states is based on the premise that it is in the government's best interest to protect the vehicle manufacturer, operator and launch site. An additional premise is that the passengers on initial flights are aware of the developmental nature of the industry and are implicitly acknowledging its risks.

5.3 COMPETITORS

The identification of a particular spaceport as a competitor hinges on several criteria: existence of an active commercial site operator license, federal launch facilities accessible to commercial customers, and expressed interest in developing a commercial spaceport. Each of the eight licensed commercial spaceports competes with the others, but a competitor may also be a facility that has expressed interest in obtaining a commercial launch license but has not yet completed the process. Note that commercial spaceports that can accommodate only vertical launches are included. This is due to the fact that researchers, satellite customers, tourists and other end users are likely to select vehicles on criteria other than whether it launches horizontally or vertically. Therefore, the viability of a specific spaceport will depend on a variety of factors, of which the orientation of the launch is generally only a secondary concern.

Spaceports with attractive operating environments may, in the near term, help determine which vehicles gain the market acceptance they need for the vehicle operator to remain viable. For example, unfavorable airspace may lead to launch delays that discourage customers from using a particular spaceport that would otherwise be viable. If a vehicle operator is tied to that specific spaceport through a legal agreement, that operator would lose business through no fault of its own. Conversely, a spaceport with readily usable airspace will be attractive to vehicle operators because it would remove one potential complication. Operators are therefore expected to examine potential locations carefully to ensure maximum usability. Considerations in addition to airspace include existing infrastructure, launch customer amenities (which will vary by customer type), attractiveness of geographic location for the flight profile desired, climate suitability, political/regulatory environment, economic climate and cost. Each spaceport location has its own strengths and weaknesses, which are outlined more specifically in the following sections.

5.3.1 Current U.S. Spaceports

The FAA/AST has issued eight commercial launch site operator licenses. Early licenses were good for 10 years; under current standards licenses are good for five years. The spaceports listed below (plus Cecil Spaceport) hold launch site operator licenses. The license does not limit the operator to vertical or horizontal operations. Instead, those limitations are determined by the infrastructure in place and the results of an environmental assessment submitted with the site's license application.

Each US spaceport description includes a table that evaluates that spaceport in each of six areas: commitments with a vehicle developer, existing spaceport infrastructure, potential for a positive tourism experience, the presence of an adequately educated technical workforce, general geographic location in relation to the amenities customers and workers might value, and airspace. Each of these attributes was scored as either a strength or weakness for each spaceport, allowing a quick comparison of each competitor.

5.3.1.1 Spaceport America

Spaceport America is arguably the highest-profile of the new purpose-built commercial spaceports. Located near the White Sands Missile Range in New Mexico, Spaceport America is building a showcase spaceport terminal, with the anticipated completion date of late 2011 now having slipped to spring 2012. The Spaceport's 10,000-foot runway was completed in 2010.

The development of Spaceport America is tied to a 20-year operating agreement it has with Virgin Galactic for basing WhiteKnightTwo and SpaceShipTwo operations at the spaceport. Spaceport America was created in 2005 when Virgin Galactic and the State of New Mexico reached an agreement under which the State would spend $200 million to build a spaceport on 27 acres in southern New Mexico, and Virgin Galactic would establish its headquarters and operate its space flights there.

Spaceport America was granted a commercial launch license in 2008, and has conducted several vertical launches of sounding rockets. FAA approval of horizontal launches has not yet been granted, but is expected before Virgin Galactic operations begin.

Spaceport America

Runway	10,000' x 200'
Vertical Launch	Yes
FAA/AST License Granted	12/14/2013
Operator	New Mexico Spaceport Authority

	Strength	Weakness
Agreement with Vehicle Developer	✓	
Existing Infrastructure	✓	
Tourism Potential		✓
Technical Workforce		✓
Geographic Location		✓
Airspace		✓

Despite its apparent head start, Spaceport America operations may be hindered to some degree by the presence of the restricted military airspace associated with White Sands Missile Range. The overlying airspace is a restricted area that can range from the surface to 13,000 feet mean sea level (MSL) or from 13,000 feet MSL to unlimited. The military retains the right to close the airspace with only 12 hours advance notice, potentially wreaking havoc with commercial space operation schedules.

Spaceport America also faces challenges due to its remote location. While being located away from population centers is an advantage for launches, remote areas do not have the infrastructure often desired by the kinds of affluent tourists who are willing to pay for the suborbital flights marketed by Virgin Galactic. The hotels/resorts, dining and other attractions that might be appealing to space tourists have not yet been built. Customers traveling by airline will likely fly into Albuquerque (150 miles away) and need to be transported to Spaceport America. Considering the possibility of airspace restrictions, the use of chartered aircraft to get customers to the launch site remains a question. Those customers traveling by private aircraft can fly into Truth or Consequences, N.M., or Las Cruces, N.M., both of which are about 50 miles away, but again the transportation issue arises.

5.3.1.2 Mojave Air and Space Port

Mojave Air and Space Port

Runway	12,000' x 200'
Vertical Launch	Yes
FAA/AST License Expires	6/16/2014
Operator	East Kern Airport District

	Strength	Weakness
Agreement with Vehicle Developer		✓
Existing Infrastructure	✓	
Tourism Potential		✓
Technical Workforce	✓	
Geographic Location		✓
Airspace		✓

East Kern Airport District was issued a commercial spaceport license in 2004 and the Mojave Air and Space Port in California was the first successful privately funded suborbital launch four days later. SpaceShipOne made three flights into space from Mojave and earned its manufacturer, Burt Rutan's Scaled Composites, the Ansari X Prize.[4]

Mojave is the home of a number of aviation and aerospace companies, including Scaled Composites, XCOR Aerospace, and the manufacturing firms tied to Virgin Galactic. In addition, the spaceport houses the National Test Pilot School and a number of other companies involved in flight testing and propulsion development. Of the 40 companies with facilities at the airport, about a quarter of them are identified by the East Kern Airport District as actively involved in aerospace testing. That's enough that some have begun to draw parallels between Mojave and another California industrial juggernaut, Silicon Valley. Regulatory processes appear to be more business-friendly than in other parts of California.

Mojave is located in desert terrain approximately 75 miles due north of Los Angeles, which gives it access to all of the suppliers, workforce and amenities required for projected spaceport operations. At the same time, the relatively remote physical location enables flight testing and product development to go on unimpeded by concerns about noise and potential blast debris. Mojave says it has 3,300 acres of aviation and industrial land available for development. The Spaceport also lists about 20 buildings/offices ranging in size from 89 square feet to 31,000 square feet available for lease. It boasts a main runway that's 12,500 feet long and 200 feet wide.

Mojave is located underneath Military Operations Area (MOA) airspace and adjacent to restricted airspace affiliated with Edwards Air Force Base. Mojave is a scant 18 miles from the runway at Edwards. Although the military airspace comes with limitations, it also means that there are supersonic corridors available, while most other spaceports require supersonic flight to be limited to oceanic airspace. The military airspace brings some benefits with it, but also raises the possibility that military schedules will interfere with the private launch schedules, in which case the military schedule will take priority.

5.3.1.3 Oklahoma Spaceport

The Oklahoma Spaceport in Burns Flat, Oklahoma, received its launch site operator license in 2006. The spaceport was the first spaceport to receive a commercial license without having to use military airspace.

[4] The Ansari X-Prize was a $10 million prize awarded in for the first privately funded reusable vehicle that could make two manned suborbital flights within a two-week period. It was awarded in 2004.

Oklahoma Spaceport

Runway	13,500' x 300'
Vertical Launch	No
FAA/AST License Expires	6/11/2016
Operator	Southwestern Oklahoma Development Authority

	Strength	Weakness
Agreement with Vehicle Developer		✓
Existing Infrastructure	✓	
Tourism Potential		✓
Technical Workforce		✓
Geographic Location		✓
Airspace	✓	

Operated by the Southwestern Oklahoma Development Authority and owned by the Oklahoma Space Industry Development Authority (OSIDA), the Oklahoma Spaceport is a 2,700-acre facility about 95 miles west of Oklahoma City. The former Strategic Air Command base features a 13,500-foot-long by 300-foot-wide runway and 96 acres of parking ramp. It also boasts a 50,000-square-foot manufacturing facility with loading docks adjacent to a main line rail spur.

OSIDA is using the spaceport as a way to focus public education on the possibilities of space technologies and commerce, to create a space technician vocational education curriculum, to serve as a test-bed for space technologies, and to enhance and promote space education in public schools. The Authority is promoting a variety of job creation, tax and training incentives, as well as such economic-development-oriented benefits as quality workforce, low cost of living and quality of life. Southwest Oklahoma also boasts 300 days of clear weather flying per year.

Oklahoma Spaceport assets are more compatible with industrial development tied to its space launch capability than space tourism or actual customer launch services. Its relatively remote location may allow it to provide lower-cost launch services to vehicle operators, but those costs are likely to be only a small fraction of overall launch costs. Instead, this location appears better suited as a potential site for vehicle designers to conduct developmental work and vehicle manufacturers to conduct tests.

5.3.1.4 Kennedy Space Center and Cape Canaveral Spaceport

There is perhaps no location more closely identified with space flight than the Kennedy Space Center (KSC) and the adjacent Cape Canaveral Air Force Station (CCAFS). Since Alan Shepard's 1961 flight inaugurated manned space flight in the United States, the central Florida launch complex has been the home of the U.S. space program's greatest triumphs. With the end of the Space Transportation System (aka the Space Shuttle) program, the National Aeronautics and Space Administration (NASA) is considering how to best make use of the assets built to support the Shuttle program and its Apollo, Gemini and Mercury precursors. As federal facilities, KSC and CCAFS do not need FAA licenses to conduct launch operations, although Space Florida has received a commercial launch site operator license for three launch pads co-located at KSC and CCAFS.

The Shuttle Landing Facility runway, at 15,000 feet by 300 feet, is one of the longest runways in the world. CCAFS is currently planning to extend its runway from 10,000 feet to 15,000 feet. Either runway would be more than adequate for any of the commercial space vehicles under development that require horizontal landings.

NASA is offering many of its facilities to commercial ventures in order to eliminate its costs for maintaining and operating them. KSC has created a planning and development office to coordinate requests from commercial entities seeking temporary or permanent access to NASA's physical assets, labs and technical facilities. Facilities such as the runway, orbiter processing facility, and many of the other ancillary buildings became surplus when the Shuttle program ended. NASA says it will retain all of the existing facilities it will continue to need for on-going operations, but will also allow outside companies to use some of those facilities when they are not needed for NASA projects. In addition to the buildings it is willing to convey to commercial operations, KSC also has land available that was previously used for support operations and has utilities in place, with the buildings already removed.

Kennedy Space Center/Cape Canaveral

Runway	15,000' x 300'
Vertical Launch	Yes
FAA/AST License Expires	6/30/2015
Operator	Space Florida

	Strength	Weakness
Agreement with Vehicle Developer	✓	
Existing Infrastructure	✓	
Tourism Potential	✓	
Technical Workforce	✓	
Geographic Location	✓	
Airspace	✓	

CCAFS will allow use of its runway, but extensive ancillary facilities will not be available there due to lack of space.

Although both KSC and CCAFS have runways and other infrastructure that could serve the commercial space launch industry, both facilities have a long history of operating within the federal government, and lack the "commercial mindset" operating culture present at other facilities. In addition, KSC and CCAFS have to deal with entities like Congress and the Department of Defense as a normal course of business, which removes some of the facilities' operating flexibility and may affect project timetables.

5.3.1.5 Mid-Atlantic Regional Spaceport

The Mid-Atlantic Regional Spaceport (MARS) has two medium/heavy lift launch pads for low earth orbit access. The facility is co-located with the Wallops Flight Facility, a NASA facility that has launched more than 16,000 rockets over more than six decades. Located on a barrier island near the Virginia/Maryland border approximately 80 miles northeast of Norfolk, MARS also has access to a nearby instrumented, heavy-lift airport with an 8,700-foot runway.

MARS is owned and operated by the Virginia Commercial Space Flight Authority, which was granted an FAA

Mid-Atlantic Regional Spaceport

Runway	No
Vertical Launch	Yes
FAA/AST License Expires	12/18/2012
Operator	Virginia Commercial Space Flight Authority

	Strength	Weakness
Agreement with Vehicle Developer	✓	
Existing Infrastructure		✓
Tourism Potential		✓
Technical Workforce	✓	
Geographic Location	✓	
Airspace		✓

license for commercial launches in 1997. Since 2004 the Authority has worked as a partnership between the state governments of Virginia and Maryland. The facility has a Foreign Trade Zone designation and includes business incentives, such as various tax breaks.

Since obtaining its commercial license, MARS has been the site of several rocket launches, including launching two different rockets from the same launch pad within six months. Orbital Sciences Corp. is based at MARS and plans to launch its Taurus II medium rocket from the facility sometime in 2012. Orbital Sciences has designed the Pegasus launch vehicle that launches from underneath a modified Lockheed L1011 and builds the Minotaur series of rockets that have launched successfully from other launch facilities.

Facilities at MARS include three suborbital rail launchers, a dual-bay horizontal integration facility, vehicle/payload storage, processing and launch facilities, a federal launch range and a workforce that includes experienced space technicians and engineers. The spaceport has a vehicle service tower, state-of-the-art processing facility, and both stationary and mobile liquid fueling facilities. MARS also provides launch vehicle flight certification through NASA, range scheduling, provision of supplies and consumables, accommodation for launch customer personnel, and coordination of public affairs.

5.3.1.6 <u>Kodiak Launch Complex</u>

Owned and operated by the Alaska Aerospace Corp. (AAC), the Kodiak Launch Complex (KLC) provides vertical (rocket) launches only, with 15 successful launches since 1998. KLC was the first commercial launch site located outside of a federal facility.

Kodiak Launch Complex

Runway	No
Vertical Launch	Yes
FAA/AST License Expires	9/24/2013
Operator	Alaska Aerospace Development Corporation

	Strength	Weakness
Agreement with Vehicle Developer		✓
Existing Infrastructure	✓	
Tourism Potential		✓
Technical Workforce	✓	
Geographic Location		✓
Airspace	✓	

KLC is the highest latitude full service spaceport, with indoor processing facilities to eliminate weather-related processing delays. KLC has been specifically designed to support launches to polar and high-inclination orbits, including the elliptical Tundra and Molniya orbits used for communications satellites.[5] Currently KLC can launch only small lift solid fuel rockets, including the Minotaur IV, Athena II and Taurus XL. Expansion is underway to launch medium-lift Taurus II and Falcon 9 rockets.

State subsidies have been required the last three years due to launch revenues being insufficient to cover both operating costs and capital improvements. From 2009 through 2011, state funding has totaled $11 million. However, the Kodiak Launch Complex has spent the bulk of that money (as well as federal grants) making capital upgrades. Note that the Kodiak Launch Complex does not have other sources of revenue besides launch services, making it extremely vulnerable to lulls in the launch market.

[5] Polar and high-inclination orbits are used for some kinds of satellites, and a high-latitude launch site makes those orbits more easily accessible.

AAC does not consider horizontal launch spaceports to be competing service providers for "the foreseeable future" because the anticipated payload of horizontal launch vehicles is too small. AAC considers the launch facilities at Vandenberg Air Force Base, California, to be its primary competitor. To that end, AAC has begun working harder to develop relationships with the manufacturers of small and medium rockets, including Space X, Orbital, Lockheed Martin, Boeing, ATK and others.

Notably, Alaskan Gov. Sean Parnell signed an executive order in January 2011 moving the governance of AAC from the Department of Commerce, Community and Economic Development to the Department of Military and Veterans Affairs. In announcing the move, the governor cited a shift in focus from commercial business development to "development of a unique niche market driven by government and military customers."

5.3.1.7 <u>California Spaceport</u>

The California Spaceport is a commercial launch complex located on Vandenberg Air Force Base and is owned and managed by Spaceport System International (SSI), a division of ITT. In 1996, California Spaceport received the first commercial spaceport license from the FAA. The spaceport provides commercial payload processing and launch services for customers with either polar or ballistic space launch programs. The facility is designed for simultaneous use by multiple customers, spreading costs over a larger and more diverse customer base than single-use, government subsidized launch facilities.

California Spaceport

Runway	No
Vertical Launch	Yes
FAA/AST License Expires	9/18/2016
Operator	Spaceport Systems Int'l

	Strength	Weakness
Agreement with Vehicle Developer		✓
Existing Infrastructure	✓	
Tourism Potential	✓	
Technical Workforce	✓	
Geographic Location	✓	
Airspace		✓

The U.S. Air Force awarded SSI a 25-year lease in 1995 that included a payload processing facility and more than 100 acres of land for commercial launch facility construction. The California Spaceport uses Vandenberg's existing launch pads, payload processing facilities, telemetry and tracking equipment. Thousands of rockets have been launched from Vandenberg since 1959.

The commercial launch facility site is located just south of Space Launch Complex 6 next to the evaporation ponds. The Integrated Processing Facility was originally built for the Space Shuttle program at a cost of more than $300 million. Like other commercial launch facilities that are located on or near military launch sites, restricted airspace and occasionally unpredictable airspace access will continue to pose challenges.

5.3.1.8 Blue Origin – Sole Site Operator License

Blue Origin owns and operates a site in Pecos County, 15 miles north of Van Horn, Texas, that has been granted an operator license to conduct developmental testing and launches. This license allows it to conduct developmental activities, but it is not a commercial launch site operator license. No other operations are expected to take place on the remote 165,000-acre site in West Texas. Two different vehicles made three flights from the facility, but in August 2011 the second developmental vehicle was lost during testing.

5.3.2 Proposed/Planned U.S. Spaceports:

Commercial spaceport development in the United States remains an item of interest by operators of large underused airports and former military facilities. In addition, spaceports are seen as having the potential to enhance economic development and capitalize on the the attractiveness of tourist destinations. Obtaining a commercial launch site operator license depends primarily on identifying the appropriate facility and conducting an environmental assessment that indicates spaceport operations will not create undue noise, environmental hazard and blast hazard.

Several sites have publicly expressed interest in obtaining a launch site operator license and/or obtained funding for it, but have not yet completed the process. Other sites began the process, but never completed the license application to FAA/AST. Several of the proposed and inactive initiatives are outlined in the following sections.

5.3.2.1 Ellington Airport - Proposed

In May 2011, Mario Diaz, the City of Houston’s Director of Aviation, publicly announced the Houston Airport System’s interest in pursuing a Commercial Launch Site Operator license for Ellington Airport, a former military base now operating under a joint-use agreement 15 miles southeast of downtown Houston. The initiative hopes to capture space-flight expertise in the Houston area as a result of the presence of Johnson Space Center in the area since the early days of manned space flight. The Airport is actively used by the Texas Air National Guard, Texas Army National Guard and Coast Guard. A large, multifaceted expansion program is under way.

5.3.2.2 Colorado Spaceport - Proposed

Colorado Gov. John Hickenlooper announced in December 2011 that the state would pursue commercial spaceport licensure from the FAA, most likely at Front Range Airport, a 4,000-acre airport located in the center of a 6,000-acre industrial park just outside of Denver. Colorado cites among its attributes the fact that there are more than 140 aerospace companies based in Colorado, as well as the headquarters of the Air Force Space Command and the North America Aerospace Defense Command (NORAD). Denver’s high elevation is also called an advantage, giving vehicle operators the first mile of altitude “free.”

5.3.2.3 Spaceport Hawaii - Proposed

The Hawaii Legislature passed a bill in May 2011 that authorizes the state to pursue an FAA spaceport license over fiscal 2011-2012 and 2012-2013. The new law authorizes the state’s Office of Aerospace Development to conduct the environmental and safety assessments that are required for the license. No specific site was identified. A similar measure authorizing expenditures of $250,000 was passed by the Legislature in 2009, but funds were not released by then-Gov. Linda Lingle. The enabling legislation makes significant reference to space tourism opportunities presented by Virgin Galactic and similar operators, with no reference to the scientific and industrial opportunities.

5.3.2.4 Spaceport Indiana - Proposed

Located at Columbus Municipal Airport, Spaceport Indiana has been testing small rocket engines up to 3,000 pounds thrust and has conducted a small number of sounding rocket launches. The private company does not have a launch site operator license from the FAA and at this point has extremely limited facilities. At 6,400 feet, the longest runway is not suitable for glide return reusable launch vehicles, nor is the airspace compatible with horizontal suborbital launches.

5.3.2.5 Spaceport Sheboygan (Wisconsin) - Proposed

Spaceport Sheboygan was originally conceived as a potential location for an operator such as Rocketplane. It is located at the former Sheboygan Armory and has begun operating under the name Great Lakes Aerospace Science and Education Center. For the near term, its mission is focused on education and “space camps.” It serves as a site for hobby rocketry, although it has occasionally been the launch site for sounding rockets that climb to an altitude of about 50 miles. Spaceport Sheboygan counts among its assets the proximity of 5,000 square miles of restricted airspace over Lake Michigan.

5.3.2.6 Chugwater Spaceport (Wyoming) - Inactive

The Chugwater Spaceport was originally an Atlas E missile base outside of Chugwater, Wyoming, built in 1960 and decommissioned in 1965. Designed to store and launch a complete Atlas E intercontinental ballistic missile, the facilities are designed with many amenities suitable for modern rocketry. In March 2006, Frontier Astronautics bought the property and began renovation to use it as a launch site. Two small companies used the site to work on development of a vehicle to compete in the Northrop Grumman Lunar Lander Challenge, but no apparent action toward licensing has been made since 2007.

5.3.2.7 Gulf Coast Regional Spaceport – Inactive

Brazoria County, Texas, created the Gulf Coast Regional Spaceport Development Corp. in 2000 to compete for commercial space operations, anticipating that the facility 40 miles from Houston could be a hub for space tourism or a takeoff and landing site for a successor to the Space Shuttle.

The spaceport development organization received about $1 million in planning grants through the state of Texas over the course of the next few years, but ultimately made no concrete progress toward implementation. The Gulf Coast Regional Spaceport Development Corp. was dissolved in early 2007 and no apparent effort has been made to continue or revive its work.

5.3.2.8 South Texas Spaceport - Inactive

Development studies began in 2002 to determine the feasibility of developing a commercial spaceport near Port Mansfield, Texas. Launch activities were kicked off with the launch in 2003 of a 22-pound rocket. After spending about $675,000 studying the concept, the spaceport idea was shelved. There has been no noteworthy activity at this site for more than five years.

5.3.2.9 Spaceport Alabama - Inactive

Spaceport Alabama was a proposal floated by the Spaceport Alabama Program Office at Jacksonville State University. No legislative activity to support the spaceport has taken place and the Alabama Commission on Aerospace, which supported the proposal, appears inactive.

5.3.2.10 Spaceport Washington - Inactive

A proposal to build a spaceport adjacent to Grant County International Airport in Moses Lake, Washington, would have capitalized on the experience of Lockheed Martin's former Venture Star development team. Proposals in the Washington Legislature to create a spaceport designation within the state's existing public ports charter failed, and no further development has occurred.

5.3.3 International Spaceports

Interest in the commercial exploitation of space is reflected in the planned development of commercial spaceports around the world. The dynamics of commercial developments are similar to those identified in the United States, falling into two primary categories: commercial use of existing government facilities and specialized developments keyed to space tourism. Like their U.S. counterparts, most of the international spaceports are waiting for appropriate vehicles. Exceptions are the vertical launch sites of medium and heavy-lift commercial satellite rockets and the Russian Baikonur Cosmodrome, which more closely follow the conventional U.S. model of a government-owned launch site providing launch services for both government and commercial rockets.

The international spaceports raise the possibility of creating long-term partnerships that will enable point-to-point hypersonic flight for international travel. However, that market is anticipated to take decades to develop, during which time the spaceport dynamic is likely to change considerably. Following are sites that have publicly revealed plans to pursue suborbital and tourist space flights.

5.3.3.1 Spaceport Sweden

Following the lead of Spaceport America in positioning the spaceport for high-end tourists buying suborbital joyrides, Spaceport Sweden plans to use the airport outside of the northern Swedish town of Kiruna and the nearby Esrange Space Center to support suborbital spaceflights. The project has an initial agreement with Virgin Galactic to host SpaceShipTwo flights, and Spaceport Sweden has a "sister spaceport" agreement with Spaceport America.

Spaceport Sweden is a joint project by the Swedish Space Corporation (which operates Esrange Space Center), the LFV Group (which operates Kiruna Airport), Progressum (which promotes business development in Kiruna), and Icehotel. The organizations created Spaceport Sweden in 2007.

Space operations in Kiruna hark back to the 1950s, when scientists began launching sounding rockets and large stratospheric balloons. Space development continued with satellite operations and control, and testing of satellites and unmanned aerial vehicles. Esrange Space Center houses one of the world's busiest civilian satellite ground stations, communicating with about 35 different satellites as part of a global ground station network. In addition, Esrange parent company Swedish Space Corp. operates the Vidsel Test Range and markets test services for air and space vehicles through the Northern European Aerospace Test Range program.

The Kiruna area is no stranger to high-end tourism. In the winter, Icehotel takes shape there, offering a unique experience for tourists who want to stay in a building made primarily of frozen water. In the summer, visitors can marvel over the midnight sun. The aurora borealis is visible in January through March.

Spaceport Sweden expects to make three to four Virgin Galactic flights per week from Kiruna Airport's 8,200-foot runway once operations begin there. The original timetable was set for 2012, but that date was set in 2009, when commercial suborbital flights were considered imminent.

5.3.3.2 <u>Caribbean Spaceport</u>

Conceived in 2005, Caribbean Spaceport is a development in Curacao, Netherlands Antilles, that combines the efforts of governmental, academic and business interests to develop and operate a spaceport from the 11,500-foot runway at Hato International Airport.

Planning and feasibility studies, as well as developmental planning, have been conducted by the Netherlands Ministry of Economic Affairs, the government of the island of Curacao, the Curacao Airport Holding Company, the Delft University of Technology's Faculty of Space and Aerospace Engineering, the Leiden University's International Institute of Air and Space Law, JansenendeJong Construction Consultants, Remco System Construction and DDOCK Design Development.

The Caribbean Spaceport has concluded its feasibility studies, requirements analyses and business planning and is seeking funding. Caribbean Spaceport has signed a vehicle lease agreement with XCOR for a Lynx II vehicle and is in contact with other potential space-line operators and spacecraft developers concerning future operations. Caribbean Spaceport reports it "is confident" it will begin to host personal and scientific commercial suborbital launches beginning in 2013.

5.3.3.3 <u>EU Spaceport Lelystad</u>

Initial development plans are underway to investigate the potential for creating EU Spaceport Lelystad near Amsterdam, Netherlands. A public-private partnership called the Spaceport Development Working Group began in November 2010 to conduct environmental studies, safety studies, planning studies and economic forecasts. The group includes the municipality of Lelystad, the Lelystad Airport, the Schiphol Group, OMALA Development Group, the European Space Agency, SpaceLinq NV, and the International Space Transport Association. The group is seeking support from the Dutch government and nearby technical universities such as TU Delft, the Hogeschool van Amsterdam, and the Leiden University International Institute of Air & Space Law.

The spaceport would be built at Lelystad Airport, a small general aviation airport about 25 miles from Amsterdam. Although the existing infrastructure is lacking, with only a 4,100-foot x 100-foot existing runway, the site would allow departing horizontal launch vehicles to proceed directly over the North Sea. Such quick access to open water may be important in accommodating the anticipated suborbital flight profiles in Europe's crowded airspace. Another advantage of a site near Amsterdam is close proximity to travel-savvy, affluent consumers in Germany, Netherlands, France and other areas of Western Europe.

Development of the spaceport has been prompted in part by a commitment by SpaceLinq to locate its headquarters at Lelystad. SpaceLinq is headed by Chuck Lauder, founder of RocketPlane, a planned suborbital vehicle that featured two conventional jet engines like a small business jet plus a rocket engine in the tail. SpaceLinq is a similar design, promising a single vehicle that takes off like a conventional aircraft, fires its rocket to fly its suborbital mission, and then lands under jet power like a conventional aircraft.

Initial concepts merge the spaceport with the existing National Aviation Theme Park and Museum Aviodrome and a planned Space Center that would consist of a space expo, an education center and an astronaut training academy. The Space Center would cater to adventurers looking for an astronaut training course, tourist and scientific passengers who need to be trained and certified before a spaceflight, schools scheduling educational trips, and the general public using the state-of-the-art spaceflight simulators.

5.3.3.4 Yecheon Astro Space Center

In December 2009, South Korea entered the picture with plans by the Yecheon Astro Space Center to host operations of XCOR's Lynx vehicle. Yecheon Astro Space Center is a non-profit entity that operates multiple space-related activities including an aerospace training center, astronomy research center, planetarium and commercial space camp with centrifuge. The six-year-old center is located about 150 miles southeast of Seoul.

Yecheon Astro Space Center has formed a broad coalition of regional and national entities to fund the approximately $30 million project to bring the Lynx to Yecheon for space tourism, educational, scientific and environmental monitoring missions. Under the envisioned arrangement, Yecheon will be the exclusive Lynx operational site in Korea. The center anticipates beginning suborbital flights in 2013.

Unlike the conventional concept of a commercial spaceport, the Yecheon Astro Space Center is closer to a high end theme park. The Center is home to an astronomical research center that houses a collection of research telescopes and other research apparatus, a space camp training center with centrifuge, reduced gravity simulators, a planetarium, a conference center and dormitories, and a helicopter tour operation.

5.3.3.5 Woomera Test Range

Southern Australia lays claim to the Woomera Test Range, the largest land-based rocket testing area in the world at nearly 50,000 square miles. Woomera launched its first rocket in 1967. It was used for the testing of long-range missiles and rockets during the Cold War, and at one point was the second-busiest launch facility in the world after Cape Canaveral. In addition to its launch facilities, it was also host to a spacecraft tracking station during the Mercury, Gemini and Apollo space programs.

Today, the Woomera Test Range is used mainly for aerospace test and evaluation activities. It hosts a wide spectrum of ground, air and space activities for Australian and international government and commercial organizations. The range is managed and operated by the Aerospace Operational Support Group of the Royal Australian Air Force.

The Space Industry Association of Australia (formerly the Australian Space Industry Chamber of Commerce) has begun efforts to re-brand the facility as Spaceport Australia. So far no concrete plans have been announced.

5.3.3.6 Baikonur Cosmodrome

Russia's premier launch facility is located in Kazakhstan, near the city of Tyuratam. The site was named after the small mining town of Baikonur, 200 miles away, during the Cold War as a misdirection. Although it has since officially been renamed the Tyuratam Cosmodrome, it is still commonly referred to as the Baikonur Cosmodrome. The site has been the primary Russian launch complex since Sputnik I was launched in 1957.

Although Russia has also developed smaller scale spaceports (Plesetsk Cosomodrome, Svobodny Cosmosdrome, and Yasny Cosmosdrome, Baikonur), all Russian crewed missions, as well as all geostationary, lunar, planetary and ocean surveillance missions are launched from Baikonur. Baikonur is a large cosmodrome with nine launch complexes encompassing fifteen launch pads.

5.3.3.7 Spaceport Scotland

On the north coast of Scotland lies the Royal Air Force's Lossiemouth Air Base, an area with a long history of housing some of the RAF's most elite squadrons and a potential service location identified by Virgin Galactic as a place to operate suborbital flights. The possibility, first raised in 2006, obtained some traction over the next three years, with the RAF signing off on use of the facility. The Scottish government has not yet decided whether it will fund a portion of the effort.

The organization efforts at Lossiemouth were unique in that they have addressed the space tourism aspect usually associated with Virgin Galactic, but also referenced the less-glamorous and less-developed SpaceShipFour concept, which would be used to launch satellites and other scientific payloads from the Virgin Galactic mother ship. The high latitude of the site would be suitable for launches into polar orbit.

Spaceport Scotland has been created as an initiative by people, companies and organizations to stimulate interest in the possible use of a Scottish location for the UK's first operational spaceport.

5.4 COMPETITIVE POSITION

The success of Cecil Spaceport will depend on successfully leveraging its strengths to take full advantage of a market forecast to develop slowly for the next several years, but then diversify and grow rapidly as launch technologies mature and prices drop. The challenge for any spaceport is to anticipate the requirements of the launch operators and put into place programs, support systems and infrastructure that allow the spaceport to capitalize on the opportunities presented by the launch operators while minimizing the roadblocks to the operators' success.

Cecil Spaceport

Runway	12,500 x 200
Vertical Launch	No
FAA/AST License Expires	1/10/2015
Operator	Jacksonville Aviation Authority

	Strength	Weakness
Agreement with Vehicle Developer		✓
Existing Infrastructure	✓	
Tourism Potential	✓	
Technical Workforce	✓	
Geographic Location	✓	
Airspace	✓	

The Cecil Spaceport is positioned uniquely among the competing spaceports studied. It combines useful existing infrastructure with excellent geographic position and a good working relationship with the federal, state and local officials and agencies that will be instrumental in the Spaceport's long-term development. The administrative processes at Cecil Spaceport are oriented toward commercial operations, giving the facility flexibility that may not be evident at facilities that maintain cultures that value prescribed processes, as might be found at NASA or Department of Defense operations.

However, the Spaceport should expect challenges in securing funding for anticipated specific infrastructure improvements, particularly in the near term as the industry awaits operational launch vehicles.

5.4.1 Geographic Location

Cecil Spaceport is co-located with Cecil Airport, a former U.S. Naval Air Station that was founded in 1941 and decommissioned after a 1993 recommendation of the Base Realignment and Closure Commission. Taken over by the city of Jacksonville in 1999, Cecil Airport is being redeveloped as a key component of Cecil Commerce Center, a master-planned 8,300-acre development that includes the Airport, access to multi-modal transportation systems, heavy and light industrial areas, and areas for distribution facilities.

Located on the west side of Jacksonville, the Cecil Spaceport is accessible from Interstate 10 and Interstate 95. Jacksonville International Airport, the closest commercial airport, is approximately 20 miles northeast. At 30 miles from the Atlantic Ocean, Cecil Spaceport is convenient to the kind of tourism infrastructure common in Florida, including beach resorts, fishing, golf and other amenities.

5.4.1.1 Florida

The state of Florida is unique in that it is home to three spaceports: Cecil Spaceport, Kennedy Space Center and the Cape Canaveral Air Force Station. Although that may raise the prospect of the three facilities competing with each other for business, the state of Florida is taking steps to ensure the three facilities complement each other rather than compete.

Space Florida was created by the Florida Legislature to drive aerospace-related economic development across the state. Space Florida also coordinates efforts with the Florida Department of Transportation to identify and fund potential infrastructure improvements related to spaceport operations. The agency has developed a Spaceport Master Plan that outlines strategies to modernize and expand space transportation infrastructure in Florida, and to leverage the experience and capabilities of the 50,000-plus workers already tied to the aerospace industry in the state.

Florida’s long history of innovation in space is reflected in other areas as well. Despite the presence of a large amount of military airspace over central Florida, offshore areas usable by spacecraft are largely unencumbered. Communications channels between the FAA and launch operators to identify airspace closures and air traffic re-routings associated with launches are well-developed. Some spacecraft developers have reported reluctance on the part of military air traffic controllers to accommodate commercial launch operations in military airspace, which does not come into play in the anticipated Cecil Spaceport operations.

5.4.1.2 Northeast Florida

Cecil Spaceport is located at a working general aviation airport, which is one of four airports owned by the Jacksonville Aviation Authority. This inclusion in a larger group of facilities takes some of the pressure off of the facility to become financially self-sufficient in the short term through spaceport operations. However, the Authority has made clear its desire for the Spaceport to operate in a businesslike fashion and to deliver an acceptable return on investment. Balancing the long-term objectives and short-term realities will remain an operational and political challenge for the near future, as launch vehicles become operational and the suborbital launch market matures. The uncertainties involved in forecasting the size of the market and the timing of its major milestones underscore the importance of considering the Cecil Spaceport a long-term investment.

Because Cecil Spaceport is located in a relatively more urban area than most of its competitors, it is better equipped with the amenities required to sustain both tourist and scientific space operations. These include commercial airport access, workforce availability, and the lodging/dining/cultural amenities that will be required for the space tourism market.

However, the northeast Florida location also introduces several challenges. Due to the Spaceport's location on the west side of Jacksonville and an intended flight path to the Atlantic Ocean to the east, operators will have to fly a route that takes them over areas that are relatively sparsely populated now but that may see future growth. While increasing population density may not represent an issue because of the use of conventional jet power for the flight's transition from the Spaceport to the offshore rocket ignition area, the potential for objections by future residents cannot be completely dismissed.

5.4.2 Facilities

The existing facilities at Cecil Spaceport put the physical facility roughly on par with the Mojave Spaceport. It has an existing spaceport license and sufficient conventional aviation activity that its financial viability does not depend entirely on spaceport operations. The property, owned by the Jacksonville Aviation Authority, has significant land available for future development. The Authority is willing to tailor lease terms to suit potential users and their required infrastructure investments. The surrounding area is industrial and commercial in nature, making it compatible with spaceport operations from a land-use perspective.

The Cecil Spaceport is clear of any significant military airspace. A small, low-altitude military operation area does exist about 25 miles northeast of the Spaceport, but it is well below and north of the projected flight paths outlined for suborbital operations. A moderately busy north/south aviation corridor exists between the Spaceport and the launch area over the Atlantic Ocean. Cecil Spaceport and the FAA have worked out coordination protocols to verify launches will not conflict with air traffic, and those procedures have been practiced in real time to ensure they are valid.

5.4.2.1 Existing Infrastructure

In addition to the 12,504-foot-long Runway 18L-36R identified for use by commercial launch operators, the Cecil Spaceport has in place adequate infrastructure for a viable commercial spaceport to become a reality. Such infrastructure includes:

- Hangars for processing bays and the storage of nonhazardous materials
- Facilities for storing, processing and supplying hazardous materials
- Power and data links
- Ground and range safety systems
- Proper road access for the transportation of launch vehicles
- Primary and crosswind runways of sufficient length for anticipated vehicles
- Standard weather services to collect high-altitude wind data

Design work is under way for airfield improvements on the east side of Runway 18L-36R, including an access road, taxiway and apron area. The planned improvements would be suitable for Airplane Design Group IV, an FAA-designation for aircraft with a wingspan up to 171 feet, such as the

Boeing 767-400. Such infrastructure would be usable for either spaceport or aircraft operations. Should spaceport operations begin in the near term, it would be possible to temporarily bifurcate the airfield by dedicating the east side to the spaceport and the west side to the airport.

Currently no dedicated facilities exist for accommodating spaceport operations crew, passengers, visitors, media, etc. Such required facilities will be described in more detail in Chapter 6. Existing Fixed Base Operator facilities and similar facilities could be used in the interim until dedicated facilities are constructed.

5.4.2.2 Launch Limitations

The facilities at Cecil Spaceport led JAA to pursue only space vehicles that make horizontal takeoffs and landings. During the initial planning and environmental review process, it was determined that acceptable vehicle configurations would be Concept X and Concept Z vehicles. A Concept X vehicle is a single vehicle powered by conventional jet engines for takeoff and climb to the offshore launch area, one or more rocket motors for the suborbital climb, and either an unpowered landing or a landing under conventional jet power. A Concept Z vehicle is one that employs a jet-powered carrier aircraft to lift the launch vehicle to the offshore ignition area. The launch vehicle then separates from the carrier and employs rockets to make the suborbital flight. The carrier vehicle lands like a normal jet, while the launch vehicle glides to a landing.

An additional vehicle type, Concept Y, involves a vehicle that makes a horizontal takeoff under rocket power, followed by a suborbital journey and an unpowered landing. The noise profile and flight path of such a vehicle was not considered in the environmental assessment conducted for the launch site operator license at Cecil Spaceport, but could be studied if an appropriate operator was interested. No vertical rocket launches are anticipated to be conducted from Cecil Spaceport. The noise produced by rockets, flight path of the vehicle and blast pattern in the event of a major malfunction would need to be studied further in order to determine the acceptability of any rocket-powered launches at Cecil Spaceport.

Rocket-powered vertical launch operations comprise the vast majority of the commercial suborbital and orbital launches conducted to date. Horizontal takeoff vehicles that have the capability to reach suborbital altitudes remain, with only a couple of exceptions, concepts rather than actual air/spacecraft. At Cecil Spaceport, meaningful commercial spaceport operations will have to wait until launch vehicles are “proven,” that is, have either an operational launch license from the FAA or are otherwise certified as non-experimental.

5.4.3 Economics

Cecil Spaceport will rely heavily on existing facilities, and will construct specific infrastructure only if it is either usable for aviation activities should spaceport operations not materialize or else tied to a specific operator with concrete plans to conduct operations at Cecil. Cecil Spaceport will pay particular attention to projects that provide a reasonable return on investment. Operating/development plans and a capital improvement plan are outlined more completely in Chapters 6 and 7.

5.4.4 Demographics

Cecil Spaceport's location puts it in a unique position among commercial U.S. spaceports. Located on the outskirts of a metropolitan statistical area with a 2010 population of more than 1.3 million people, Cecil offers the best of both worlds: the amenities and workforce of an urban area with the land compatibility of a rural area. Table 5-1 shows a snapshot of area population, employment and per capita income forecasts.

Table 5-1 Jacksonville MSA Population Demographics

	2010	2020	2030	2040
Population	1,351,000	1,544,000	1,743,000	1,944,000
Employment	838,000	962,000	1,105,000	1,271,000
Per Capita Income (2004 dollars)	$34,800	$39,600	$45,800	$53,500

Source: Woods & Poole Economics Inc.

The Jacksonville area is home to several naval bases, including Naval Air Station Jacksonville, Mayport Naval Air Station, and Kings Bay Submarine Base in nearby St. Mary's, Georgia. The Jacksonville area's long tradition with the U.S. Navy and naval aviation means there is a large number of people experienced with aerospace and high-performance aircraft. Of the 6,000 people that exit the military every year in Jacksonville, more than 80 percent choose to remain in Northeast Florida. Due in part to this large retention of ex-military personnel, the median age of Jacksonville residents is less than 34 – substantially lower than the median age for Florida as a whole, which is nearly 39.

Jacksonville is a transportation hub, with four airports, three seaports, and a rail system served by three railroads, and Cecil Spaceport has convenient access to multiple interstate highways. In addition to the logistics network, the area has a strong technical and manufacturing base that is less than 2 percent unionized. Table 5-2 shows a sample of the number of jobs and hourly wages for a variety of occupations that may come into play during spacecraft fabrication and preparation, payload processing and other support activities.

In addition to the existing workforce, Cecil Spaceport could reasonably expect to be a relocation destination for workers displaced from the Space Shuttle program as United Space Alliance (USA) winds up orbiter operations at Kennedy Space Center. While USA employed more than 10,000 workers in Florida, Texas and Alabama three years ago, it has reduced to fewer than 2,800 today. More than 3,000 of the jobs eliminated were from USA's Florida operations.

The Jacksonville area is also equipped with the kinds of tourist amenities that might be expected by the affluent people who choose to experience recreational suborbital flights. The area hosts nearly 3 million overnight visitors per year, which accounts for approximately $1.6 billion in spending and supports about 10 percent of the local workforce. The tourism infrastructure offers a wide range of accommodations, dining and recreational activities that would support a suborbital tourism initiative.

Table 5-2 Jacksonville MSA Occupational Employment and Wages

Occupational Code	Title	2010 Employment	Hourly Wage $ in 2011 Mean	Median
00-0000	Total all occupations	569,260	19.96	15.74
17-2011	Aerospace Engineers	N/R	40.25	41.37
49-3011	Aircraft Mechanics and Service Technicians	940	24.36	24.14
51-2099	Assemblers and Fabricators	N/R	12.19	11.35
49-2091	Avionics Technicians	170	23.84	24.69
15-1132	Computer Software Engineers, Applications	2,140	38.87	38.99
15-1133	Computer Software Engineers, Systems Software	980	48.19	45.46
15-1150	Computer Support Specialists	4,790	20.91	20.38
17-3023	Electrical and Electronic Engineering Technicians	700	27.68	28.26
51-2022	Electrical and Electronic Equipment Assemblers	300	15.67	14.12
51-2091	Fiberglass Laminators and Fabricators	50	17.13	17.87
49-9041	Industrial Machinery Mechanics	1,020	23.10	23.29
17-3027	Mechanical Engineering Technicians	130	23.56	23.02
49-9069	Precision Instrument and Equipment Repairers	110	24.53	25.27
51-2041	Structural Metal Fabricators and Fitters	390	15.74	15.81

Source: Florida Agency for Workforce Innovation

5.5 SUMMARY

Every existing commercial spaceport has its own unique combination of circumstances. While the specific horizontal-launch/recovery reusable launch vehicles currently under development are not particularly demanding in terms of their facility requirements, long-term commercial spaceport success will depend on far more than simply providing an adequate runway and suitable airspace corridors. The determinants of success will include providing vehicle operators with an operating environment that meets their needs, at a cost they can afford, as well as providing an environment that provides the appropriate support for their customers.

In the case of space tourism, convenient commercial air service and an established tourism infrastructure may be keys to the long-term success of the venture. Successful scientific and commercial space access will rely on suitable employment base and workforce skills, as well as low launch costs. Compared to those facilities with existing commercial Launch Site Operator Licenses, Cecil Spaceport appears to be well-positioned in both of these areas.

Due to the current lack of operational vehicles and the limited number of launch service providers and flights anticipated in the near future, spaceports that rely solely on spaceflight operations are likely to experience difficult financial environments for the next several years. In addition, planned spaceports may come online in future years that will change the competitive balance as well. Cecil Spaceport plans to conduct spaceport operations as ancillary to its existing operation as a viable general aviation airport, which offers it the ability to remain a functional entity until vehicles are available and the market matures.

CHAPTER 6
OPERATING AND DEVELOPMENT PLAN

6.1 INTRODUCTION

The operational and development requirements of a spaceport are directly related to the specific launch vehicles that utilize the facility. Each Reusable Launch Vehicle (RLV) and operator has specific requirements that must be satisfied before a spaceport can support their needs. Facility requirements, dictated by launch vehicle type, include the specific requirements of propellant storage and loading, the housing of the RLV prior to and after launch, as well as processing, maintenance, and integration of vehicle components. Airfield facilities, such as runways and taxiways, also must meet the specific needs of each RLV. In addition, planned facilities should include a visitor center that will serve as a departure/arrival point for spaceflight participants and guests, mission control, a training/education center, and media access.

This chapter summarizes the airfield and landside facilities anticipated to be required to support an operational spaceport. The facility requirements have been established based on interviews with RLV developers and through research on the current state of the industry. Questionnaires were submitted to Virgin Galactic, XCOR Aerospace and Rocketplane Global, and returned by XCOR and Rocketplane. A follow-up conversation with Randall Clague, Government Liaison with XCOR Aerospace provided additional information. Subsequent email correspondence with Jonathon Firth, Director of Operations and Projects at Virgin Galactic; Chuck Lauer, Vice President of Business Development for Rocketplane Global, and XCOR's Randall Clague provided most of the operator requirements included in this section. Other information was derived from public sources.

6.2 AIRFIELD REQUIREMENTS

Cecil Airport currently provides substantial airfield infrastructure and facilities in support of commercial and general aviation that can also be utilized by potential RLV operators that employ horizontal takeoffs and landings. These facilities include existing runways, taxiways, and aprons for propellant storage/loading and RLV operations.

6.2.1 Existing Runways

The airfield facilities shown in Figure 6-1 include runways, taxiways, aprons and existing facilities. The runway system consists of two north/south oriented runways and two east/west oriented runways. The primary runway at Cecil Airport is Runway 18L-36R, which is oriented in a north/south direction and is 12,504 feet long and 200 feet wide. Approximately 5,460 feet of the runway is concrete; the remaining 7,040 feet is asphalt. The runway is equipped with a high-intensity runway edge lighting system and precision runway markings.

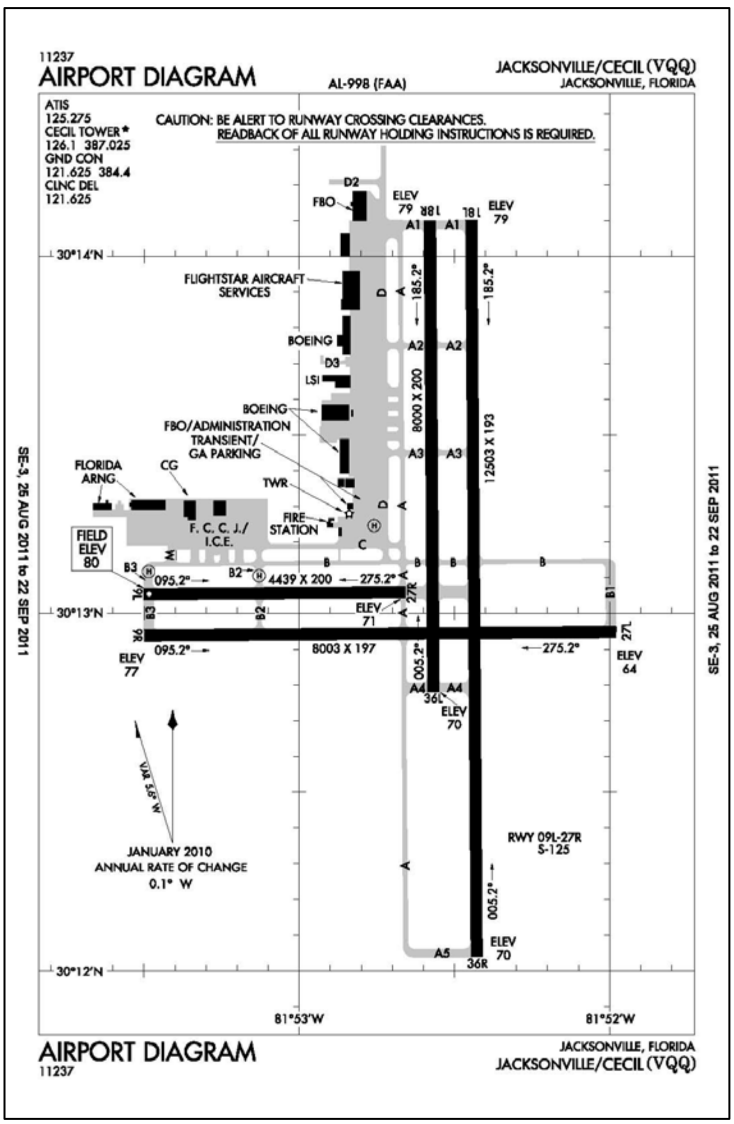
Runway 18R-36L, 700 feet west of the primary runway, is 8,003 feet long and 200 feet wide. The runway is constructed of both asphalt and concrete and has non-precision runway markings, but no runway edge light system. This runway is planned to be shortened to approximately 6,000 feet in length and narrowed to 75 feet wide.

Runway 9L-27R was recently shortened to 4,439 feet long and will eventually be narrowed to 75 feet wide. The runway formerly was 8,002 feet long and the existing pavement is 200 feet wide. The shortened distance was removed from the east end of the runway and the abandoned pavement remains. The runway is constructed of both asphalt and concrete and has non-precision runway markings, but no runway edge lights.

Runway 9R-27L is 8,003 feet long and 200 feet wide, and is constructed of both asphalt and concrete. The runway is equipped with a high-intensity runway edge lighting system and is a non-precision runway. Touchdown zone markings are included on the Runway 9R end only.

Each of the runways at Cecil Field is designed for a weight-bearing capacity of single wheel 105,000 pounds, dual wheel 165,000 pounds, and dual tandem wheel 315,000 pounds. Under the current Launch Site Operator License issued by the Federal Aviation Administration (FAA), the only runway available for RLV use is Runway 18L-36R. Consideration should however be given toward examining the potential for long-term RLV operations on Runway 9R-27L and pursuing a Launch Site Operator License amendment to provide improved operational flexibility.

Figure 6-1 VQQ Airport Diagram



Source: FAA Terminal Procedures Publication, retrieved September 2011

6.2.2 Runway Requirements

The runway requirements are evaluated based on "typical" space vehicles that could be expected to operate from Cecil Airport, as well as their potential launch vehicles. The parameters evaluated include the runway length, width, strength, pavement type, and obstacle clearance requirements.

Although a number of horizontal-takeoff RLVs are reported to be under development, three have progressed to the point that initial operational requirements can be identified with some degree of confidence. Those three RLVs are documented in Table 6-1, and their operational requirements are compared to those of the Boeing 767-400[6]. The result of this comparison is that all three RLVs are significantly smaller and lighter than the "Critical Aircraft," and the current dimensions of Runway 18L-36R satisfy all operational requirements of the RLVs. A summary of runway requirements is found in Table 6-2.

Table 6-1 RLV Runway Requirements

	Rocketplane	**Lynx**	**SpaceShipTwo / WhiteKnightTwo**	**Boeing 767-400 (Critical Aircraft)**
Aircraft Design Group	I	I	I / IV	IV
Min. Runway Length	10,000 ft	7,000 ft	10,000 ft	11,500 ft
Min. Runway Width	100 ft	100 ft	100 ft / 150 ft	150 ft
Compatible Pavement	Concrete	Concrete	Concrete	Concrete & Asphalt
Wingspan	29 ft	24 ft	60 ft / 141 ft	170 ft 4 in
Max. Takeoff Weight	22,350 lbs	11,000 lbs	120,000 lbs (est.)	450,000 lbs

Sources: Rocketplane information provided by Rocketplane Global, Inc., June 2011; Lynx information provided by XCOR Aerospace, Inc., May 2011; SpaceShipTwo/WhiteKnightTwo information gathered from public sources and/or estimated by RS&H, June 2011.

Although Runway 18L-36R at Cecil Airport is of sufficient length and width to support RLV operations without any modifications, one issue that warrants further discussion and consideration is the type of runway surface, which is a combination of concrete and asphalt.

Asphalt and liquid oxygen (which is one of several types of "oxidizers" necessary to supplement the fuel mixture for an RLV) is a potentially explosive combination. Therefore, it may be advisable that a fully loaded RLV remain off of any asphalt surface to the extent possible. Under the current FAA Launch Site Operator License requirements, while the vehicle is being loaded with an oxidizer and waiting for takeoff clearance, it will be stationed on the concrete section of Runway 18L. In the

[6] The Boeing 767 has been defined as the 'Critical Aircraft" for Cecil Airport. The 'Critical Aircraft" is the most demanding aircraft to make at least 500 takeoffs and landings at the airport annually.

unlikely event of an oxidizer leak during the takeoff run, some asphalt could possibly be affected farther down the runway. However, the vehicle's velocity during the time it is on asphalt would minimize the risk to the vehicle and its occupants. With the current construction of the runway surface, fire rescue personnel should be trained to deal with potential oxidizer leaks on asphalt surfaces. Additionally, during the next scheduled complete rehabilitation of the runway, strong consideration should be given to reconstructing the entire runway length with a concrete surface.

Table 6-2 Runway Requirements Summary

	RLV Requirement	**Runway 18L/36R**	**Requirement Satisfied**
Aircraft Design Group	I & IV	IV	Yes
Min. Runway Length	10,000 ft	12,500 ft	Yes
Min. Runway Width	150 ft	200 ft	Yes
Compatible Pavement	Concrete	Concrete & Asphalt	No. Liquid oxygen on asphalt is potentially explosive.
Wingspan	60 ft / 141 ft	>170 ft	Yes
Max. Takeoff Weight	22,350 lbs / 120,000 lbs (est)	450,000 lbs	Yes

Source: RS&H, June 2011

6.2.3 Existing Taxiways

The airfield taxiways provide access to and between the runways. As shown in Figure 6-1, there are two primary parallel taxiways – A and B. In addition, there are several taxiway connectors that connect the parallel taxiways to the runways and adjoining apron areas.

Taxiway A serves as a parallel taxiway to Runways 18R-36L and 18L-36R with a centerline separation from Runway 18R-36L of 500 feet and a separation of 1,200 feet from Runway 18L-36R. The taxiway is approximately 12,504 feet long and 75 feet wide, and is constructed of asphalt.

Taxiway B serves as a full-length parallel taxiway to Runways 9R-27L and 9L-27R. The taxiway is approximately 8,000 feet long and 75 feet wide and is constructed of asphalt.

Taxiway C extends from the westernmost apron edge and terminates at its intersection with Taxiway A. The taxiway is 3,995 feet long and 75 feet wide, and is constructed of concrete.

Taxiway D serves as a partial, parallel taxiway to the north/south oriented runways. The taxiway is 5,750 feet long and 75 feet wide, and is constructed of concrete.

6.2.4 Taxiway Requirements

The taxiway requirements were also evaluated based on "typical" space vehicles that could be expected to operate from Cecil Airport, as well as their potential launch vehicles. The parameters evaluated include the taxiway width, strength, pavement type, and obstacle clearance requirements. A description of taxiway requirements is shown in Table 6-3 and summarized in Table 6-4.

Table 6-3 RLV Taxiway Requirements

	Rocketplane	**Lynx**	**SpaceShipTwo / WhiteKnightTwo**	**Boeing 767-400 (Critical Aircraft)**
Aircraft Design Group	I	I	I / IV	IV
Min. Taxiway Width	25 ft	25 ft	25 ft / 75 ft	75 ft
Min. Taxiway Turn Radius	75 ft	75 ft	75 ft / 150 ft	150 ft
Compatible Pavement	Concrete	Concrete	Concrete	Concrete & Asphalt
Wingspan	29 ft	24 ft	60 ft / 141 ft	170 ft 4 in
Max. Takeoff Weight	22,350 lbs	11,000 lbs	120,000 lbs (est.)	450,000 lbs

Sources: Rocketplane information provided by Rocketplane Global, Inc., June 2011; Lynx information provided by XCOR Aerospace, Inc., May 2011; SpaceShipTwo/WhiteKnightTwo information gathered from public sources and/or estimated by RS&H, June 2011.

The existing taxiways are capable of supporting the RLVs identified in Table 6-3. As previously mentioned, asphalt and oxidizers make a potentially explosive combination, indicating that the fully loaded vehicle should remain off of asphalt taxiways to the extent possible. It is recommended that new taxiways built in areas dedicated for Spaceport use be constructed of concrete.

Table 6-4 Taxiway Requirements Summary

	RLV Requirement	**Existing Taxiways**	**Requirement Satisfied**
Aircraft Design Group	I & IV	IV	Yes
Min. Taxiway Width	75 ft	75 ft	Yes
Min. Taxiway Turn Radius	150 ft	150 ft	Yes
Compatible Pavement	Concrete	Concrete & Asphalt	No. Liquid oxygen on asphalt is potentially explosive.
Wingspan	141 ft	>170 ft	Yes
Max. Takeoff Weight	22,350 lbs / 120,000 lbs (est)	450,000 lbs	Yes

Source: RS&H, June 2011

6.2.5 FAA-Approved Oxidizer Loading Areas

During the process of obtaining an FAA Launch Site Operator License, an explosive site plan was developed for Cecil Airport which identified proposed propellant loading areas (See Figure 6-2). Two propellant loading areas were previously identified, one for loading fuel and the other for loading the liquid oxygen (also commonly referred to as an “oxidizer”).

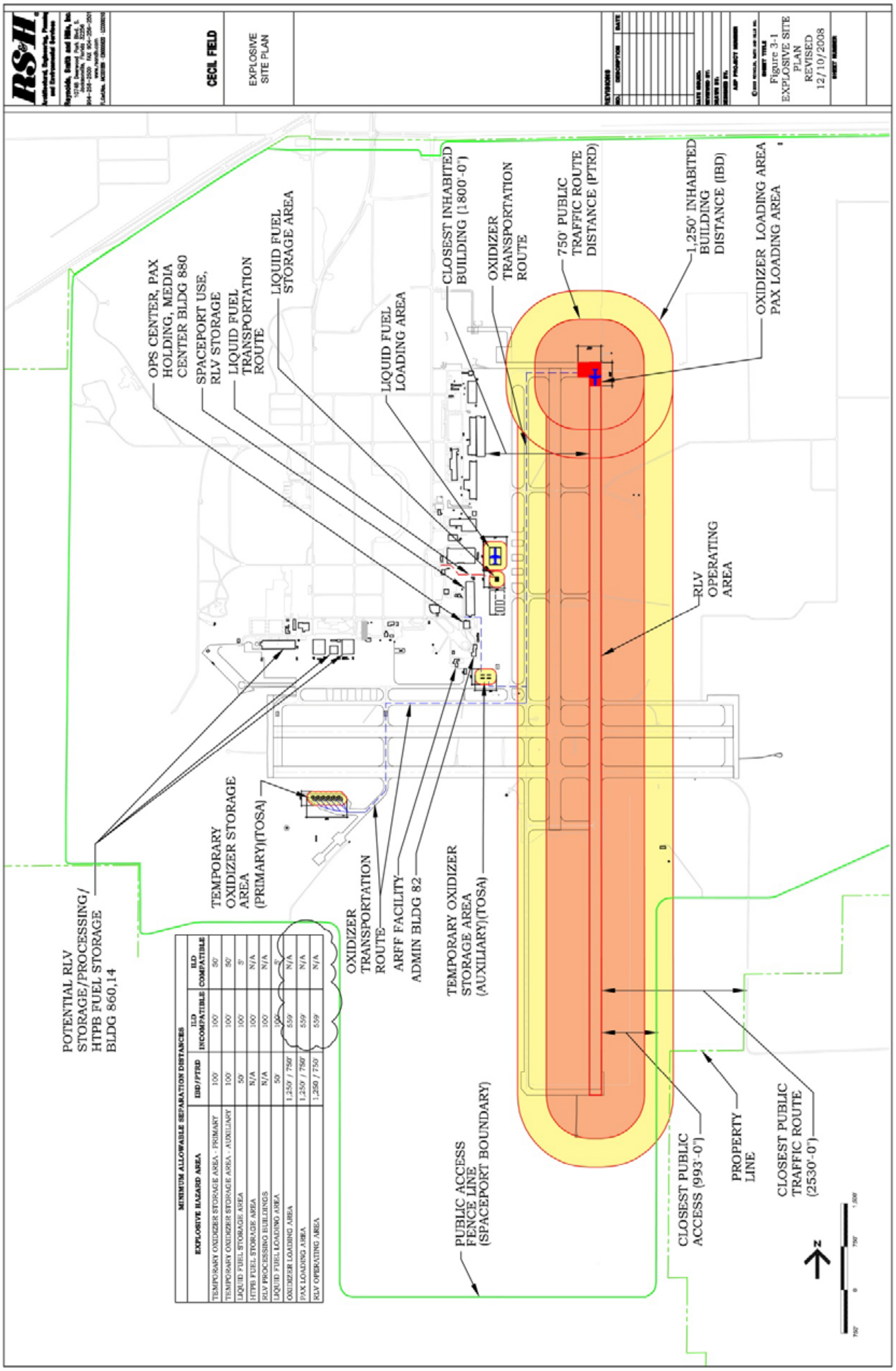
The approved Liquid Fuel Loading area was located to the west of Runway 18R-36L, on the apron between Taxiway A2 and Taxiway A3. The approved Oxidizer Loading area is located at the northern end of Runway 18L-36R. The moment that that oxidizer loading operations begin on a fueled spacecraft, a substantial separation distance, called the “Inhabited Building Distance” (IBD) is required due to the co-location of the fuel and oxidizer and the resulting potential explosive hazard.

The Inhabited Building Distance (IBD) is the distance to be maintained between a loaded RLV and any inhabited building. Other separation distances also apply to loading of the oxidizer into the RLV. They include the Public Traffic Route Distance (PTRD) and the Intraline Distance (ILD). The PTRD is the distance to be maintained between the loaded RLV and any public street, road highway, navigable stream, or passenger railroad, including roads on a military reservation used routinely by the general public for through traffic. The ILD is the distance to be maintained between two explosive related buildings or sites. All of these separation distances are noted on Figure 6-2.

The placement of the fuel and oxidizer loading areas in the Launch Site Operator License application resulted from the desire to utilize existing real estate and facilities to accommodate spaceport operations. One negative result of the location of the oxidizer loading area at the northern end of Runway 18L-36R is that the separation distances incurred during oxidizer loading require both Runway 18L-36R and Runway 18R-36L to be closed from the time the loading begins until after RLV takeoff.

One goal of the Spaceport Master Plan was to identify suitable oxidizer loading areas that would avoid the requirement to close multiple runways during oxidizer loading operations, and that would prevent the need to evacuate adjacent buildings during oxidizer loading operations and subsequent taxi/tow to the takeoff position. During the development of alternatives for the placement of spaceport operator facilities, several alternative oxidizer loading areas were evaluated, and will be presented later in this section. Altering the oxidizer loading area location will require FAA approval through an amendment to the Explosive Site Plan of the Launch Site Operator License.

Figure 6-2 Original Explosive Site Plan



Source: RS&H, December 2008

6.2.6 Fuel/Oxidizer Loading Requirements

Spaceport operations are different from aviation operations in several respects, but one of the most important differences stems from the fact that the RLV must carry oxidizer as well as fuel, whereas an aircraft uses oxygen from the atmosphere as an oxidizer to enable the fuel burn. Two of the RLV's examined use a fuel very similar to conventional Jet A, while the third uses a pulverized rubber compound that is essentially inert without the presence of concentrated oxidizer.

The co-location of a pressurized tank of oxidizer and fuel within the RLV creates an explosive hazard that is not found in typical aircraft operations. Cecil Airport must, therefore, designate a suitable oxidizer loading area, with preference given to an area more than 1,250 feet from the runway, so as to prevent runway closures during the oxidizer loading operation. The oxidizer loading area would need to be concrete, due to the fact that liquid oxygen and asphalt are a potentially explosive combination.

Table 6-5 shows the approximate quantities of fuel and oxidizer that will be carried by each type of vehicle on each flight. The RLVs will be fueled at their respective operator facilities, and then taxi or be towed to the oxidizer loading area. Once the oxidizer is loaded onto the vehicle, it must be surrounded by a "protective bubble " (i.e., the IBD and PTRD) until it either departs or the oxidizer or fuel is unloaded. Only required ground personnel, RLV crew and spaceflight participants are allowed within the "protective bubble" of the loaded RLV. This "protective bubble" moves with the RLV, and any building or roadway the RLV passes that falls within the bubble must be evacuated until the RLV clears the area.

Because of the mobile and transient nature of the IBD and PTRD, an oxidizer loading area (or taxi route for a fully loaded RLV) more than 1,250 feet from a runway or building, or 750 feet for a roadway would, for example, allow that runway, building or roadway to remain open while the RLV was being loaded.

Table 6-5 RLV Propellant Requirements for 1 Mission

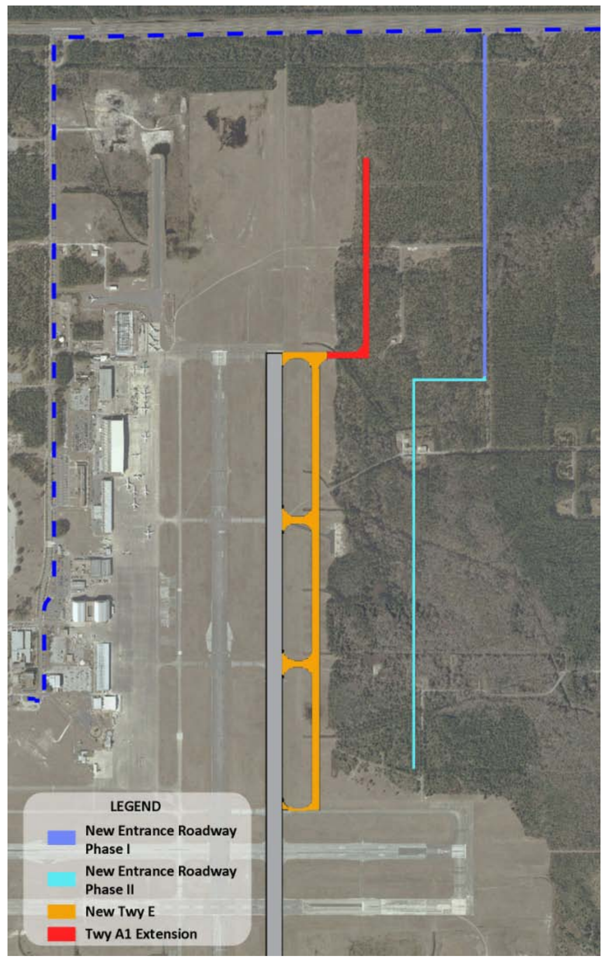
	Rocketplane	**Lynx**	**SpaceShipTwo / WhiteKnightTwo**
Propellant Type	Liquid	Liquid	Hybrid
Aviation Fuels	Jet A 2,300 lbs (343 gal)	None	Jet A 32,000 lbs (4,923 gal)
Rocket Fuels	RP-1 2,500 lbs (368 gal)	Kerosene Blend 2,059 lbs (318 gal)	HTPB CTN 1,500 lbs
Oxidizers	Liquid Oxygen 6,500 lbs (685 gal) Hydrogen Peroxide 300 lbs (26 gal)	Liquid Oxygen 5,267 lbs (555 gal)	Nitrous Oxide 13,500 lbs (2,248 gal)
Other Commodities	GN2, LH2, GHe	GHe, GN2	

Sources: Rocketplane information provided by Rocketplane Global, Inc., June 2011; Lynx information provided by XCOR Aerospace, Inc., May 2011; SpaceShipTwo/WhiteKnightTwo information gathered from public sources and/or estimated by RS&H, June 2011.

As previously mentioned, the Explosive Site Plan of the FAA Launch Site Operator License identifies the approach end of Runway 18L as the only “approved” oxidizer loading area. Use of the approach end of Runway 18L for oxidizer loading will effectively shut down both north-south runways for significant periods of time, potentially negatively impacting ongoing aircraft operations (see Figure 6-2). In order to avoid shutting down both runways during oxidizer loading operations, an alternative oxidizer loading area would need to be identified, and the FAA Launch Site Operator License amended. Various locations were examined around the airfield and will be discussed below.

The Cecil Airport Master Plan identifies the development of a future parallel taxiway east of Runway 18L-36R, designated Taxiway E (see Figure 6-3). In addition, an extension of Taxiway A1 is currently under design which would extend north of the runway threshold and located so as not to impact the Runway Safety Area. These two taxiways, along with a new access road also under design and scheduled for construction in 2012, are intended to open the east side of the Airport to future aviation and spaceport related development.

Figure 6-3 Planned Roadway and Taxiway Development

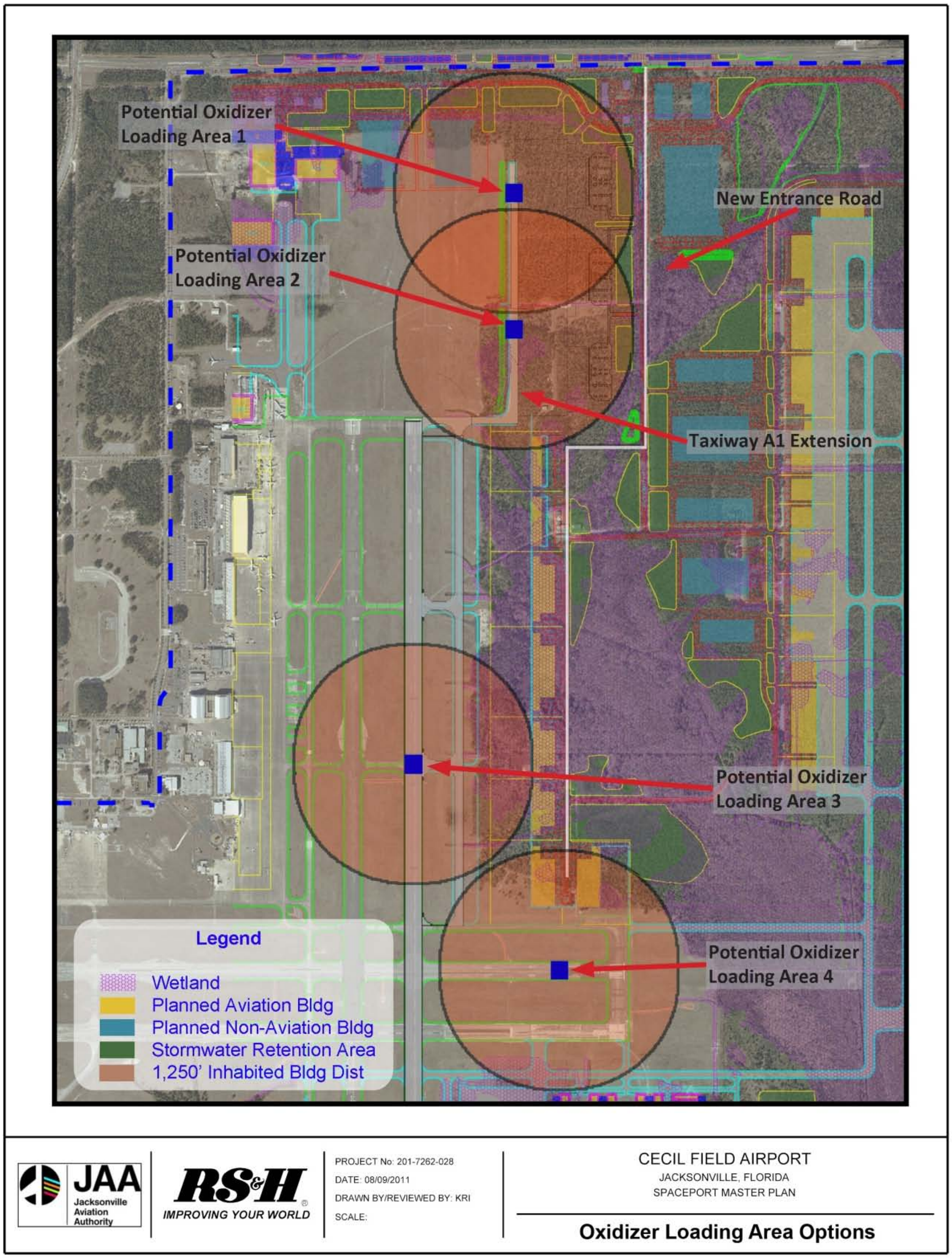


Source: RS&H, September 2011

Using the planned east side infrastructure, a number of alternative sites were examined to determine their suitability for use as an oxidizer loading area. By moving the oxidizer loading areas off of Runway 18L-36R, the length of time the north-south runway complex is closed for a launch is reduced from approximately one hour or more, to under 10 minutes. The exact closure time would depend on the vehicle involved due to variations in the amount of oxidizer and passengers to load, as well as the final location of the oxidizer loading area, taxi/tug speed and air traffic control considerations.

Additional oxidizer loading area locations were assessed for their impact on vehicle traffic, aircraft operations, building occupancy, emergency egress and operator convenience. Two locations along the extension of Taxiway A1 were assessed, along with a location adjacent to Taxiway B1 and a secondary loading area on Runway 18L-36R. Figure 6-4 identifies the potential oxidizer loading areas examined and a brief discussion of each follows in this section.

Figure 6-4 Potential Oxidizer Loading Areas



Source: RS&H, September 2011

6.2.6.1 Oxidizer Loading Area 1

Oxidizer Loading Area 1 is located at the north end of the extension of Taxiway A1, in what is currently an unused part of the Airport. This location would move oxidizer loading operations as far as possible from active runways, and provide the least impact to airfield operations. It would require Taxiway A1 to be constructed of concrete or, at a minimum, a concrete pad of approximately 200 feet-by-200 feet to be constructed on which loading operations could be conducted. The exact size of the pad required would depend on the specific RLV considered.

Oxidizer Loading Area 1 would be available in the near term, as the extension of Taxiway A1 and Phase 1 of the entrance road are currently being designed and will be constructed in 2012. Other location alternatives rely on future construction of Taxiway E and the extension of the entrance road farther south.

The limitations created by this location are substantial. Land use along 103rd Street would be limited by the need to retain evacuation zones during spaceport operations. Development along the west side of the new entrance road and the east of the extension of Taxiway A1 would be affected by the need to have buildings be uninhabited during the taxi of a fully loaded RLV from the oxidizer loading area to the runway. The entrance road would need to be closed during the taxi of a fully loaded RLV as the IBD crosses the entrance road's east/west section. Furthermore, in the case of an accident during oxidizer loading or while taxiing to the runway, it is possible that anyone south of the accident site may be unable to egress the area due to the access road being closed by emergency response vehicles or debris. As result of these potential impacts, Oxidizer Loading Area 1 is not a recommended alternative.

6.2.6.2 Oxidizer Loading Area 2

Oxidizer Loading Area 2 is located just south of the midpoint of the extension of Taxiway A1. This location would share the advantages of Oxidizer Loading Area 1, but would allow various land uses along 103rd Street. Like Oxidizer Loading Area 1, it would require Taxiway A1 to be constructed of concrete or, at a minimum, a concrete pad of approximately 200 feet-by-200 feet be constructed on which loading operations could be conducted. The exact size of the pad required would depend on the specific RLV considered.

This site also presents several important limitations. Development along the west side of the new entrance road and the rest of the extension of Taxiway A1 would be affected by the need to have buildings to be uninhabited during the taxi of a fully loaded RLV from the oxidizer loading area to the runway. The entrance road would also need to be closed during the taxi of a fully loaded RLV as the IBD crossed the entrance road's east/west section. Furthermore, in the case of an accident during oxidizer loading or while taxiing to the runway, it is possible that anyone south of the accident site may be unable to egress the area due to the access road being closed by emergency response vehicles or debris. Therefore, similar to Oxidizer Loading Area 1, Oxidizer Loading Area 2 is not a recommended alternative.

6.2.6.3 Oxidizer Loading Area 3

Oxidizer Loading Area 3 is located on Runway 18L-36R, at the intersection with Taxiway A3. This location is central to all anticipated RLV operator site alternatives, minimizing taxi time and distance from the operators' facilities to the oxidizer loading area and then to Runway 18L-36R for departure.

This location would not be recommended for use when weather conditions dictate the use of the north/south runways for aircraft traffic, as both runways would be closed for an extended period of time during oxidizer loading operations. However, if the FAA Launch Site Operator License is amended to allow the operational use of Runway 9R/27L, this option becomes a viable alternative which can be used if aircraft operations favor the east/west runway system. It is also recommended that Runway 18L-36R be reconstructed with concrete or a suitable concrete pad constructed for oxidizer loading area use, due to the potential incompatibility of an asphalt surface and oxidizer loading operations.

6.2.6.4 Oxidizer Loading Area 4

Oxidizer Loading Area 4 is located adjacent to Taxiway B1, on concrete pavement where Runway 9L-27R previously ended before that runway's recent shortening. This area allows full development of Taxiway E, the extension of Taxiway A1, the entrance road and the non-aeronautical use properties along 103rd Street, without limitations caused by the IBD surrounding the loaded vehicle. This location is located outside of the runway safety area for Runway 9L-27R, yet much of the area falls within the RSA for Runway 9R-27L.

This area will be used when weather conditions warrant the use of Runway 18L-36R and Runway 18R-36L, meaning the closure of the two east/west runways will not adversely affect aircraft operations. Both north/south runways would remain open.

Practicality would require the fully loaded launch vehicle to use Runway 18L-36R for taxi instead of Taxiway E, as use of Taxiway E may require some facilities located along the taxiway to be evacuated during movement of the fully loaded launch vehicle. However, taxi and tow operations would be conducted along Taxiway E prior to oxidizer loading, to and from Oxidizer Loading Area 4, in order to remain clear of the runway.

Other limitations created by this site include the fact that two previously planned aviation-related buildings would be affected by the IBD, as shown in Figure 6-4. In addition, vehicle taxi/tow distances would be relatively long if the operator facilities were located on Taxiway A1 or near the north end of Runway 18L-36R. However, Oxidizer Loading Area 4 is a viable option and enhances operational flexibility of the facility. Therefore, the construction of Taxiway E and extension of the entrance road to approximately the midpoint of Runway 18L-36R is recommended as part of the long-term Spaceport development.

6.2.6.5 Oxidizer Loading Area Recommendations

The operational considerations for determining the oxidizer loading area(s) must combine the needs of spaceport operations, aviation users, spectators, environmental concerns, and non-aeronautical development. Therefore, Oxidizer Loading Areas 3 and 4 are the preferred locations, depending upon weather conditions and operational requirements. Accommodating these locations may require amendment to the Launch Site Operator License.

6.2.7 Fuel/Oxidizer Storage Requirements

The rocket fuels identified by several manufacturers are similar to conventional jet fuel in terms of handling, storage and safety requirements. Virgin Galactic uses a solid, rubber-like polymer that, while flammable, requires very high ignition temperatures, making it functionally inert without a chemical oxidizer present. It is anticipated that each operator will store its own fuel in tanker trucks parked on 75-foot-by-15-foot concrete pads adjacent to their facilities in the near term, with permanent tanks installed at those locations in the future. The solid-fuel rockets used by Virgin Galactic do not require isolated storage and can be stored within the vehicle's hangar.

The oxidizers required by the vehicle developers studied include liquid oxygen, hydrogen peroxide and nitrous oxide. It is anticipated that, in the near term, each operator will store its own oxidizer in tanker trucks parked on 75-foot-by-15-foot concrete pads adjacent to their facilities, with permanent tanks installed at those locations in the future.

While the concept of operations and the anticipated launch rates for each RLV are unique, the storage areas will be sized to accommodate up to 10 missions of each RLV. XCOR has requested storage provisions to support 20 missions. Table 6-6 and Table 6-7 provide a summary of the estimated propellant storage requirements for 10 missions of each RLV. Note that these estimates are the best available given the current state of vehicle development, and may change significantly as the vehicles make their way toward operational status.

Table 6-6 Total Propellant Requirements for 10 Missions

Propellant	**Approx. Net Weight** (lbs)	**Approx. Net Volume** (gal)
Oxidizers		
LOX*	65,000 lbs*	6,845 gal*
N_2O	135,000 lbs	20,930 gal
Fuels		
RP-1	25,000 lbs	3,676 gal
Kerosene Blend*	42,000 lbs*	6,360 gal*
Jet-A	23,000 lbs	34,400 gal
HTPB	15,000 lbs	

* XCOR has requested storage requirements to support 20 missions. 105,000 lbs / 11,000 gal of LOX is therefore required. The proprietary kerosene blend quantities are for 20 missions.

Sources: Rocketplane information provided by Rocketplane Global, Inc., June 2011; Lynx information provided by XCOR Aerospace, Inc., May 2011; SpaceShipTwo/WhiteKnightTwo information gathered from public sources and/or estimated by RS&H, June 2011.

Table 6-7 Onsite Propellant Storage Requirements

Propellant	**Quantity (gal or lbs)**	**Storage Required**
Oxidizers		
LOX	13,500 gal	3 Tanker Trucks @ 6,500 gal each (4,500 gal delivered)
N_2O	22,000 gal	4 Tanker Trucks @ 5,800 gal each (5,500 gal delivered)
Fuels		
RP-1 or Ethanol	5,000 gal	2 Tanker Trucks @ 3,000 gal each (2,500 gal delivered)
Kerosene Blend*	7,500 gal	3 Tanker Trucks @ 3,000 gal each (2,500 gal delivered)
HTPB	15,000 lbs	10 SpaceShipTwo Solid Motor CTN @ 1,500 lbs each

*Proprietary Blend of Kerosene
Source: RS&H, September 2011

The onsite storage recommendations have been used for sizing both temporary storage and permanent storage tanks. Initially, while flight rates are low, temporary storage can be used. As flight rates increase, fixed storage tanks should be installed. The temporary and permanent facilities both occupy approximately the same footprint. The permanent sites will include tanks, aprons, fill connections, discharge connections, vacuum jacketed piping (for cryogenic propellants) to fill/discharge locations, valve skid and instrumentation, deluge water system, lighting and grounding.

The quantities delivered by tanker trucks are estimates. It may take more or fewer trucks to provide the recommended storage quantities.

The approximate storage envelope for a SpaceShipTwo Solid Motor CTN (Case, Throat and Nozzle) is 10 feet in length, with a nozzle diameter of 3 feet.

To avoid combustion and explosive hazards, both fuels and oxidizers have required separation distances during storage. Table 6-8 provides a summary of required separation distances, including the Inhabited Building Distance, the Public Traffic Route Distance, and the Intraline Distance for fuel and oxidizer storage.

Table 6-8 Propellant Storage Separation Distances

Propellant	IBD/ PTRD	ILD	Notes
Liquid Oxygen	100’	100’	Unlimited quantity, but no less than 100 ft
Nitrous Oxide	50’	50’	NFPA Oxidizer Class 2, distance is 50 ft
Hydrogen Peroxide (90%)	75’	75’	NFPA Oxidizer Class 3, distance is 75’ for up to 400,000 lbs
RP-1 or Ethanol	25’	25’	25 ft for less than 100,000 gal tank
HTPB	N/A	N/A	Essentially rubber (inert) – Safe to transport and store

Source: DoD Ammunition and Explosive Safety Standards, DoDM 6055.09-M administratively reissued on August 4, 2010.

6.3 RLV OPERATOR REQUIREMENTS

RLV operator facilities include hangars, processing and assembly buildings, office space and storage, as well as other ancillary facilities, such as a visitor center, that may be required to support both the RLV missions and their respective spaceflight experiences. Initially, the facilities would be housed in conventional aircraft hangar buildings with integral or adjacent office space that, if not supporting RLV operations, could potentially be used for other aviation-related activities. The visitor center could be modeled after, or co-located with, a Fixed Base Operator facility. Such an approach would easily allow the conversion of spaceport facilities to conventional aviation facilities should the commercial space operation prove slow to mature, or prove to be non-viable over the long-term.

Each RLV and manufacturer has different facility requirements, and those requirements are summarized in Table 6-9. The data shown in the table has been compiled from interviews, manufacturer websites, and press releases.

Table 6-9 Landside Facility Requirements & Preferences

	Rocketplane	Lynx	SpaceShipTwo / WhiteKnightTwo
Processing & Assembly	25,000 sf – 30,000 sf	> 5,000 sf	47,000 sf
Ancillary Storage	For GSE	--	--
Onsite Training	Preferred with flight simulators and centrifuge	--	--
Payload Processing	Class 10,000 Clean Room (est. < 1,000 sf)	Class 10,000 Clean Room (est. < 1000 sf) Bench space & lockers	--
Engine Testing	Horizontal Test Stand 40,000 lb thrust on concrete slab	--	--
Tourism & Visitor Center	60,000 sf – 100,000 sf	--	--
Mission Control	Yes, adjacent to visitor center	--	--
Types of GSE	1) Military Jet Air Start Cart 2) Propellant Cart 3) Tow Vehicle w/ tow bar	1) GA Tug for 11,000 lb A/C	1) Propellant Skid
Perimeter Security	Existing security is adequate	--	--
Viewing Area	Yes	--	--
# of Personnel	60-100	--	--
Data/Comm	Radio uplink & tracking antenna	Telemetry would be useful	--

Sources: Rocketplane information provided by Rocketplane Global, Inc., June 2011; Lynx information provided by XCOR Aerospace, Inc., May 2011; SpaceShipTwo/WhiteKnightTwo information gathered from public sources, June 2011.

6.3.1 Hangar/Facility Requirements

The hangar requirements of the vehicles examined are not particularly demanding and are consistent with a typical aircraft hangar. Hangar size would be dictated by the type of operation, with the Lynx vehicle being the least demanding with respect to hangar size and the SpaceShipTwo/WhiteKnightTwo would be the most demanding. The hangar area would handle spacecraft processing and assembly, payload processing, clean room access, ground service equipment storage, and necessary office space.

XCOR has stated that a hangar of 100 feet-by-125 feet will be sufficient to house the vehicle, vehicle processing/assembly, payload processing and office space necessary to conduct operations. Rocketplane expressed the need for a 200-foot-by-125-foot hangar, in part due to its desire for a 1,000-square-foot Class 10,000 clean room, and 25,000 to 30,000 square feet for spacecraft processing and assembly. Virgin Galactic declined to specify its space requirements. For planning purposes, a 200-foot-by-235-foot hangar should be sufficient for the Virgin Galactic vehicle and was approximated from the dedicated Virgin Galactic hangar developed at Spaceport America.

None of the companies researched provided estimates for the number of employees expected to be based at the facility. Virgin Galactic's public statements regarding employment at Spaceport America indicate employment at Cecil Spaceport should total 80-150 workers for Virgin Galactic. That employment total would lead to a need for approximately 40-75 employee parking spaces per facility.

6.3.2 Apron and Airfield Access Requirements

Because the WhiteKnightTwo is the most demanding horizontal takeoff RLV under development, its requirements drive many of the planning criteria related to initial spaceport development. As an ADG IV aircraft, WhiteKnightTwo requires 75-foot-wide taxiways with 150-foot centerline radius taxiway turns. If taxiway exit fillets and the taxiways that connect Taxiway E to the apron are built to ADG IV standards, the facility would be able to accommodate both WhiteKnightTwo in Spaceport operations and the Airport's design aircraft should the facility be converted to aviation use.

Apron space is more difficult to plan, given the disparate sizes of the largest potential vehicle and the smallest. Using existing FAA guidelines for aircraft as outlined in Advisory Circular 150/5300-13, the required apron area for the Rocketplane and Lynx vehicles would be about 360 square yards per vehicle, and facilities should be sized to accommodate two of each operator's vehicles, or about 720 square yards per operator. The apron area required by the WhiteKnightTwo vehicle would be about 3,700 square yards. However, the unique staging requirements of the RLVs argue in favor of slightly exceeding these aircraft figures.

The mated WhiteKnightTwo/SpaceShipTwo will likely egress the hangar as one vehicle, but return as two separate vehicles. This dynamic argues in favor of providing at least 4,400 square yards of apron to provide adequate room for both vehicles when separated, plus circulation and maneuvering space. These vehicles will require apron space extending approximately 200 feet from the hangar. For planning purposes, therefore, it is logical to size the operators' apron to be the width of the planned hangar, extending 200 feet toward the taxiway. This allows maximum flexibility for the operator facilities to accommodate various Spaceport operators or convert to adequate aviation facilities should such a conversion be required.

Because oxidizer trucks will be parked near the operator facilities and will use taxiways to access the RLVs for loading operations, it is recommended all affected taxiways and aprons be constructed out of concrete.

6.3.3 Visitor Center

Due to the anticipated public interest in commercial space operations and the likelihood that many participants will bring friends and family with them who do not actually participate in the flight, RLV facility planning should incorporate a visitor center that would serve as a viewing area, departure/arrival facility, gathering spot and educational/training facility. Depending on operator preference, the visitor center could also include a spectator-friendly mission control facility.

Ideally the visitor center would be centrally located on the Airport in order to provide the best view of takeoff and landing. It would serve as the departure/arrival point for the flight and include facilities that allow spectators to view and photograph the flight, media access, gift shop, educational displays and food service. The visitor center would require approximately 5,000 square feet of space. Using the standard of one parking space for every 300 square feet of space for many different types of public buildings, the visitor center would require approximately 17 parking spaces.

For initial operations, existing aviation facilities such as the general aviation terminal building on the west side of the Airport may be sufficient for use as a visitor center. Longer term, a dedicated FBO-type building may be appropriate within the east side development.

6.3.4 Engine Test Facility

An engine test facility may be useful given the developmental nature of the industry. Rocketplane expressed interest in a horizontal test stand for a 40,000-pound-thrust engine. The four XR-5K18 engines used on the Lynx vehicle generate 2,900 pounds of thrust each. Published reports estimate the rocket engine on SpaceShipTwo will generate approximately 50,000 pounds of thrust.

Horizontal test stand operation may affect airport operations, depending on the location of the test stand. The test facility would be subject to the same setback requirements as the oxidizer loading area, and should be located outside of any runway/taxiway object free area or runway/taxiway safety area. Because of anticipated non-spaceport development at Cecil Airport, co-locating the engine test facility with the oxidizer loading area would maximize the compatibility of spaceport operations with aviation operations. The need for an engine test facility is highly operator-dependent, and provisions for its location can be deferred until such time as it is required.

6.3.5 Specialty Facilities

Specialty facilities such as clean rooms and training facilities would be constructed in conjunction with the office space by the RLV operator, and functional space requirements will vary by operator.

Training facilities, including centrifuges, altitude chambers, water ditching simulators and other specialty operations may be requested by some operators. One company, National AeroSpace Training and Research Center (NASTAR) has expressed interest in developing a 25,000-square-foot, $30 million air- and space-training facility. Such facilities would not necessarily be tied to the Launch Site Operator License of Cecil Airport, and would be evaluated based on their intrinsic requirements. Such ventures could be included as non-aeronautical use facilities because they do not require direct access to the airfield or spaceport facilities.

6.3.6 RLV Operator Facility Requirements

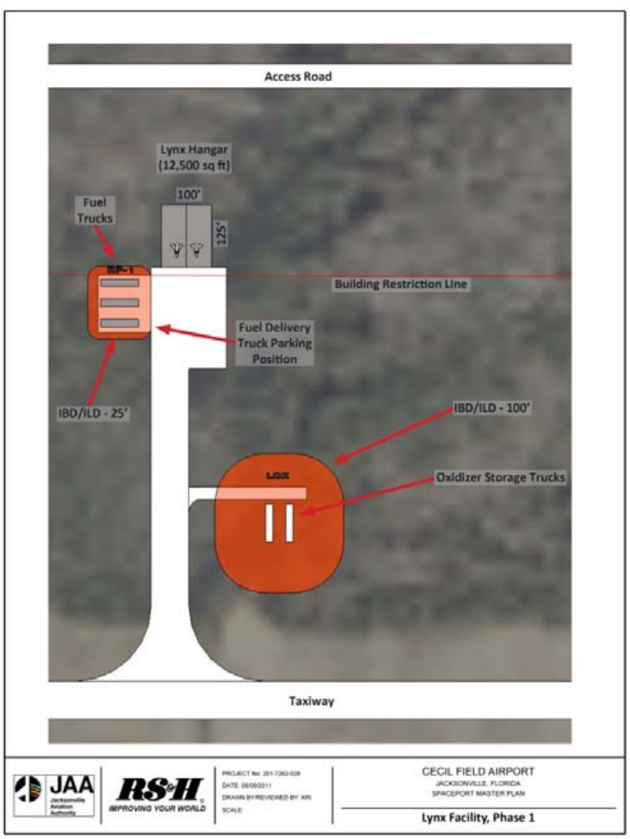
Development options for facilities associated with each RLV operator are depicted in Figure 6-5, Figure 6-6 and Figure 6-7. In developing each option, consideration has been given to allow multiple operator facilities to be located adjacent to each other, to stand independently, or for one operator's facility to be re-used by another. For that reason, all taxiway, taxilane and ramp dimensions anticipate use by the largest potential RLV component aircraft: WhiteKnightTwo. One potential ultimate development that includes three different operators at adjacent facilities is shown in Figure 6-8.

6.3.6.1 Lynx

Using the requirements outlined by XCOR Aerospace and the facility, taxiway and apron requirements defined earlier, a conceptual plan was developed to illustrate one possible way to accommodate the Lynx RLV at Cecil Spaceport, as shown in Figure 6-5. Although XCOR stipulated modest hangar requirements of approximately 5,000 square feet, this conceptual plan increases the hangar size to 12,500 square feet. The larger size would accommodate multiple RLVs, future growth, clean room, office space and payload integration space, while creating a versatile facility that would have maximum reusability.

The plan allows parking for two fuel trucks, with a third parking position for a fuel delivery truck to be used to refill the fuel trucks used for operations. Oxidizer loading trucks would be parked on a dedicated spur coming off the connector taxiway. This strategy allows either the apron or the parking positions to be expanded as necessary without affecting other components. Due to uncertainty over the long-term operations, the connector taxiway should be sized to ADG IV standards.

Figure 6-5 Lynx Facility Requirements

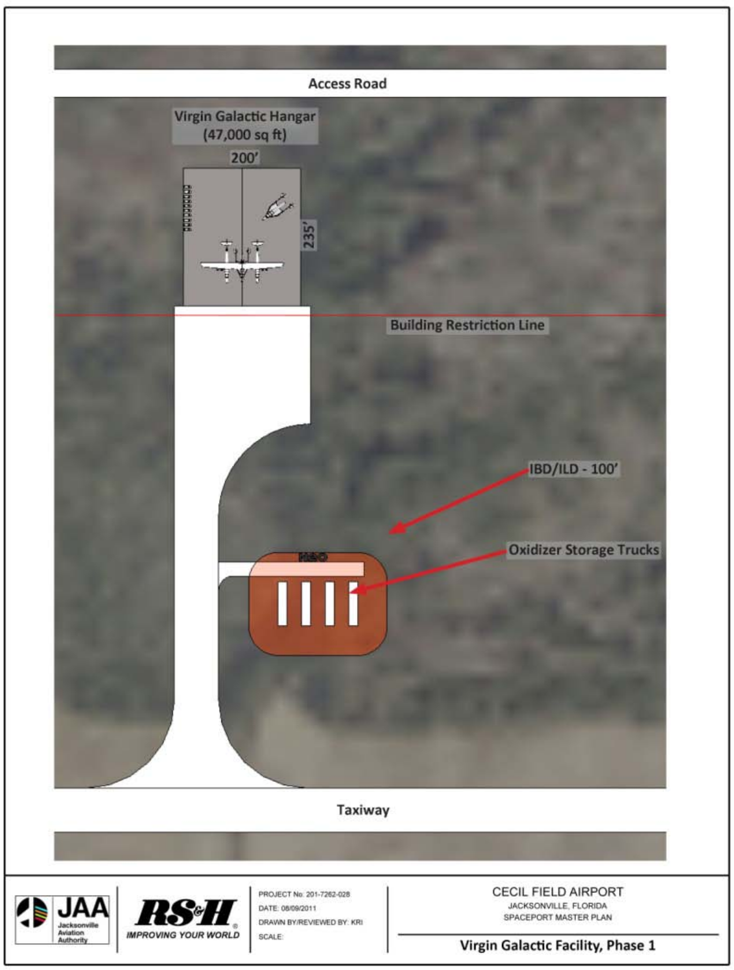


6.3.6.2 Virgin Galactic

Using the anticipated requirements of Virgin Galactic and the facility, taxiway and apron requirements defined earlier, a conceptual plan for accommodating WhiteKnightTwo and SpaceShipTwo was developed. Figure 6-6 illustrates general facility requirements for hangar space, oxidizer storage and rocket motor storage. Note that WhiteKnightTwo is fueled by conventional Jet-A, which could be retained in dedicated fuel trucks parked at the facility or supplied by fuel suppliers already operating at Cecil Airport. For simplicity, dedicated Jet-A storage is not included in the conceptual plan.

Oxidizer loading trucks would be parked on a dedicated spur coming off the connector taxiway. This strategy allows either the apron or the parking positions to be expanded as necessary without affecting other components. The connector taxiway would be sized to ADG IV standards to accommodate the carrier aircraft.

Figure 6-6 Virgin Galactic Facility Requirements

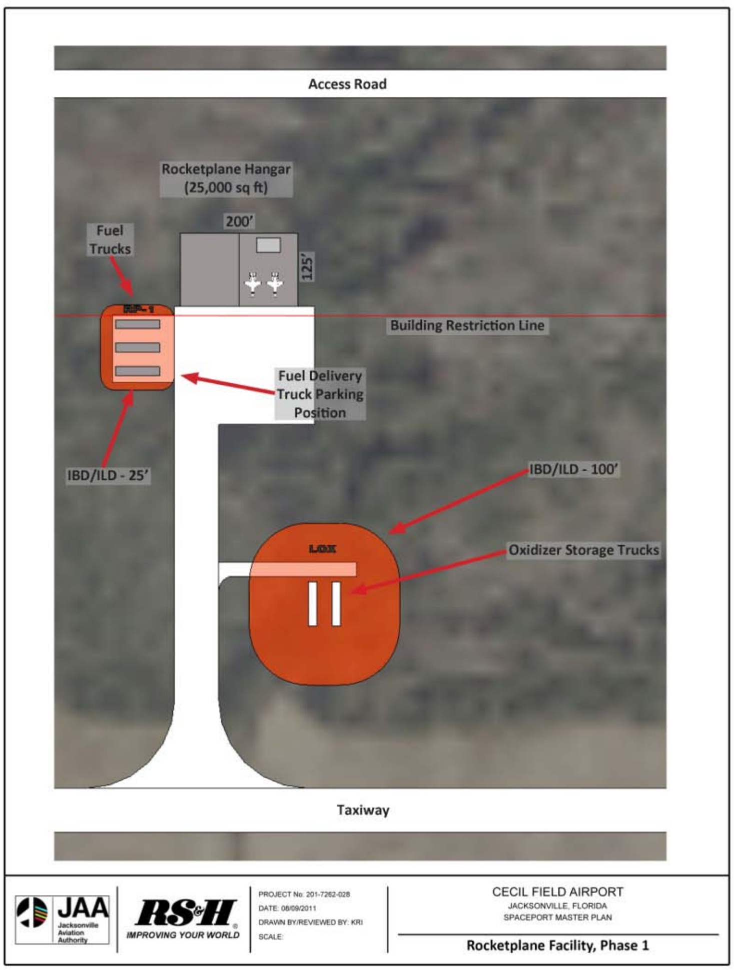


6.3.6.3 Rocketplane

Using the requirements outlined by Rocketplane Global and the facility, taxiway and apron requirements defined earlier, the conceptual plan shown in Figure 6-7 illustrates a potential layout of Rocketplane facilities. Note that Rocketplane is a dual-fuel vehicle, using conventional Jet-A for takeoff and flight to the ignition area, and potentially for return to the airport after the mission. Jet-A could be stored by Rocketplane at its own dedicated storage area or provided by fuel suppliers already operating at Cecil Airport. For simplicity, dedicated Jet-A storage is not included in the conceptual plan.

The plan allows parking for two fuel trucks containing rocket fuel, with a third parking position for a fuel delivery truck to be used to refill the trucks used for operations. Oxidizer loading trucks would be parked on a dedicated spur coming off the connector taxiway. This strategy allows either the apron or the parking positions to be expanded as necessary without affecting other components. Due to uncertainty over the long-term operations, the connector taxiway should be sized to ADG IV standards.

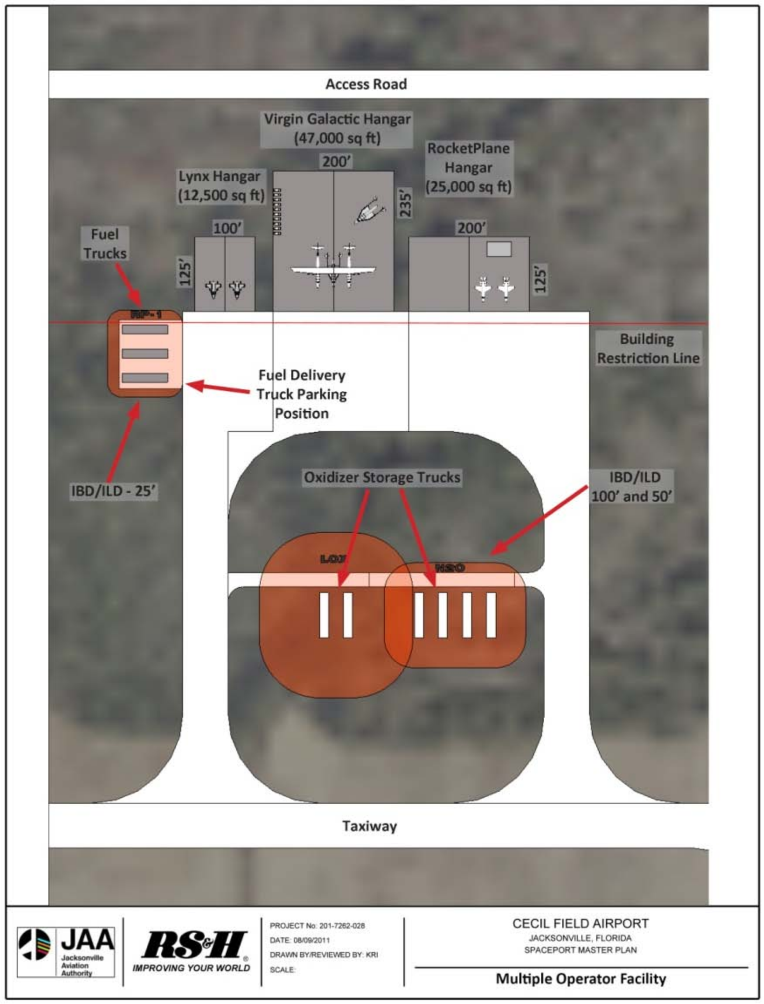
Figure 6-7 Rocketplane Facility Requirements



6.3.6.4 Ultimate Development

Figure 6-8 illustrates a potential ultimate development of the RLV operator facility, with multiple RLV operators sharing ramp space, taxiways, oxidizer storage areas and fuel storage areas. While such a layout would create the most efficient use of available area and infrastructure, some operators may choose to develop separate facilities.

Figure 6-8 Ultimate RLV Operator Facility



6.4 RLV FACILITY SITE ALTERNATIVES

Based on the identification of overall facility requirements, four spaceport alternatives have been developed for Cecil Airport. Three spaceport alternatives – Options A, B and C – are located in the northeastern portion of Cecil Airport in the area immediately to the northeast of the intersection of Runway 18L-36R and Runway 9L-27R. The fourth alternative, Option D, is located in the southeastern quadrant of the Airport in the area immediately southeast of the intersection of Runway 18L-36R and Runway 9R-27L.

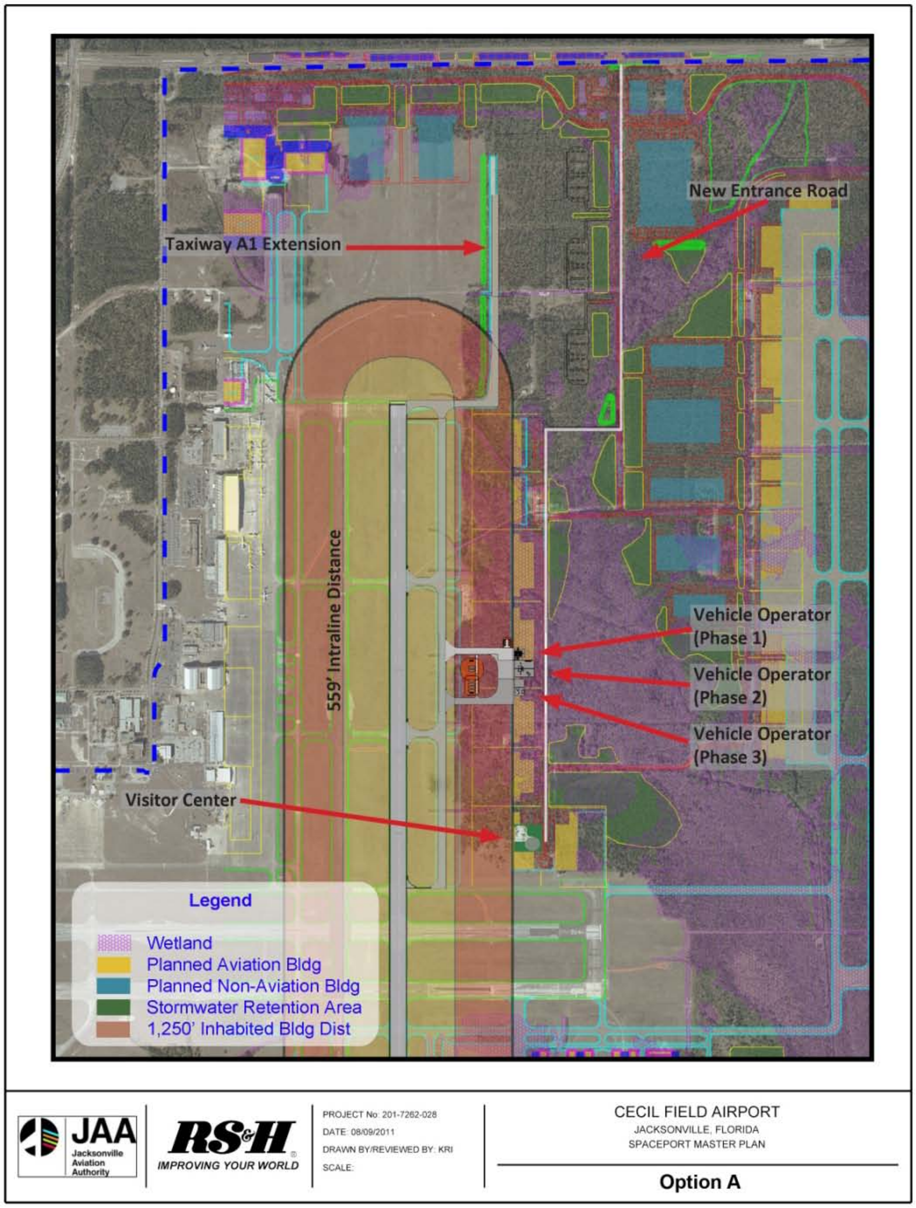
All options contain similar requirements for an oxidizer loading area, visitor center, and a vehicle operator ramp/building area that would be constructed in phases as demand warrants.

6.4.1 <u>Spaceport Facilities Option A</u>

Option A (See Figure 6-9) locates the operator facilities at the midpoint of the length of Runway 18L-36R that is north of the runway intersection with Runway 9L-27R. This location allows the RLV operator(s) to be centrally located near the support companies, both those that require airfield access and those that do not, that may choose to locate within this development corridor. This central location would help to identify the east side of the airport as the "Spaceport" side, which may have the further effect of helping to create a critical mass of space-related businesses.

This location would require the construction of additional infrastructure, to include Taxiway E, Phase 2 of the entrance road, and the extension of underground utilities.

Figure 6-9 Spaceport Facilities Option A

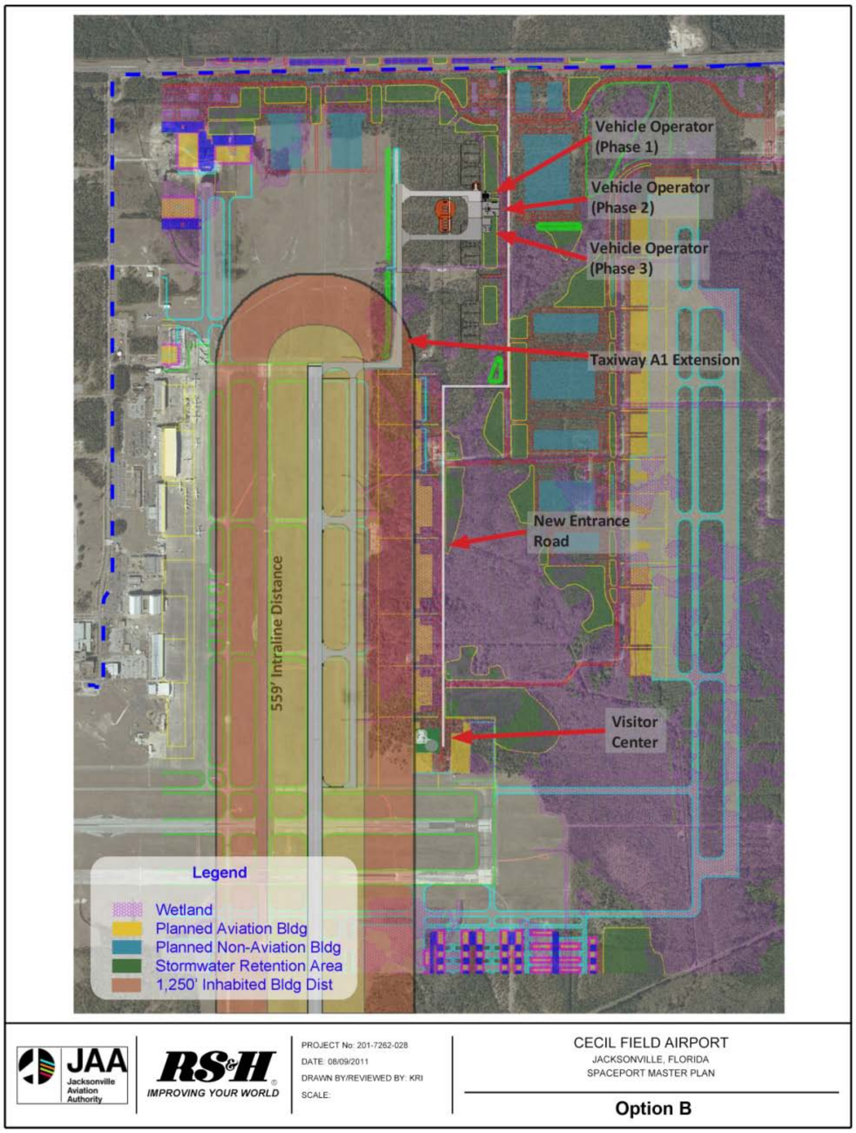


6.4.2 Spaceport Facilities Option B

Option B locates the operator facilities at or near the northern end of Taxiway A1. This location creates the opportunity to develop a high-profile, space-related entryway at the new entrance road leading to the east side of Cecil Spaceport. Such an environment would be useful in helping to raise the public awareness of the commercial spaceport and the business opportunities it represents. The location also uses roadway and taxiway infrastructure already in the design phase, shortening the development time required to bring the facilities to an operational status. Figure 6-10 shows the layout of facilities under Option B.

Depending on the oxidizer loading area selected, this northern location could result in lengthy taxi/tow distances. The acceptability of this option would depend on the oxidizer loading area location and the preference of the operator in using the facility as a staging area for revenue flights. The relatively long distance between the operator facilities and the visitor center could complicate transportation and logistics such as telemetry sharing between those two facilities.

Figure 6-10 Spaceport Facilities Option B

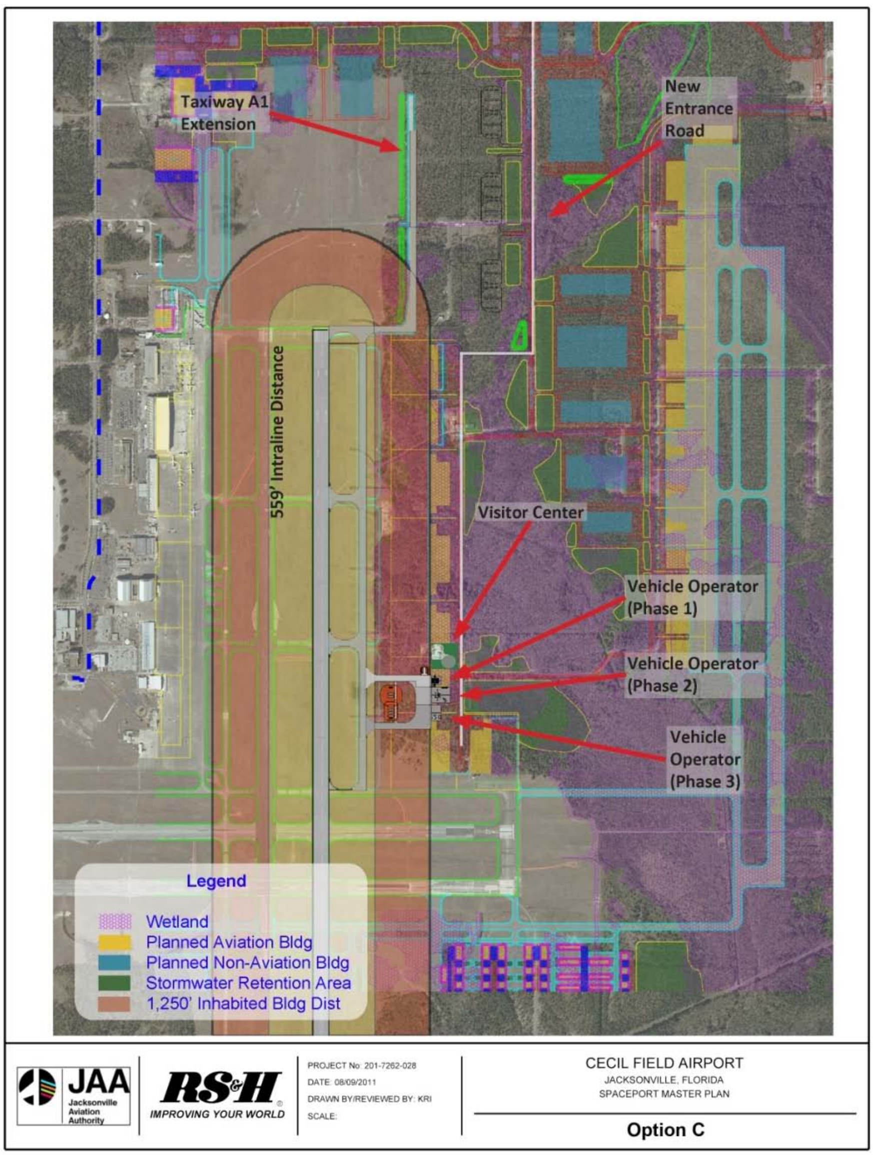


6.4.3 Spaceport Facilities Option C

Option C locates the operator facility and visitor center in relatively close proximity to the northeast corner of the intersection of Runway 18L-36R and Runway 9L-27R. This option, shown in Figure 6-11, has the benefit of grouping the RLV facilities and future visitor center close together, adding operational efficiencies as well as the perception of the overall complex as being a cohesive unit.

Option C would create the fewest conflicts with existing Airport operations, maximize the space for both aeronautical and non-aeronautical facilities on the east side of the airfield, and provide the most unified Spaceport environment, particularly if combined with the recommended oxidizer loading facilities. At the same time, the Spaceport facilities would remain convenient to other aeronautical facilities should commercial Spaceport operations not materialize and the area is returned to aviation use. This option would require the infrastructure east of Runway 18L-36R to be fairly mature, including Taxiway E and the extension of the entrance road nearly to Taxiway B. However, in return Option C offers the best balance between the completion of a dedicated spaceport complex and the flexibility to convert the facility to aviation use if required.

Figure 6-11 Spaceport Facilities Option C

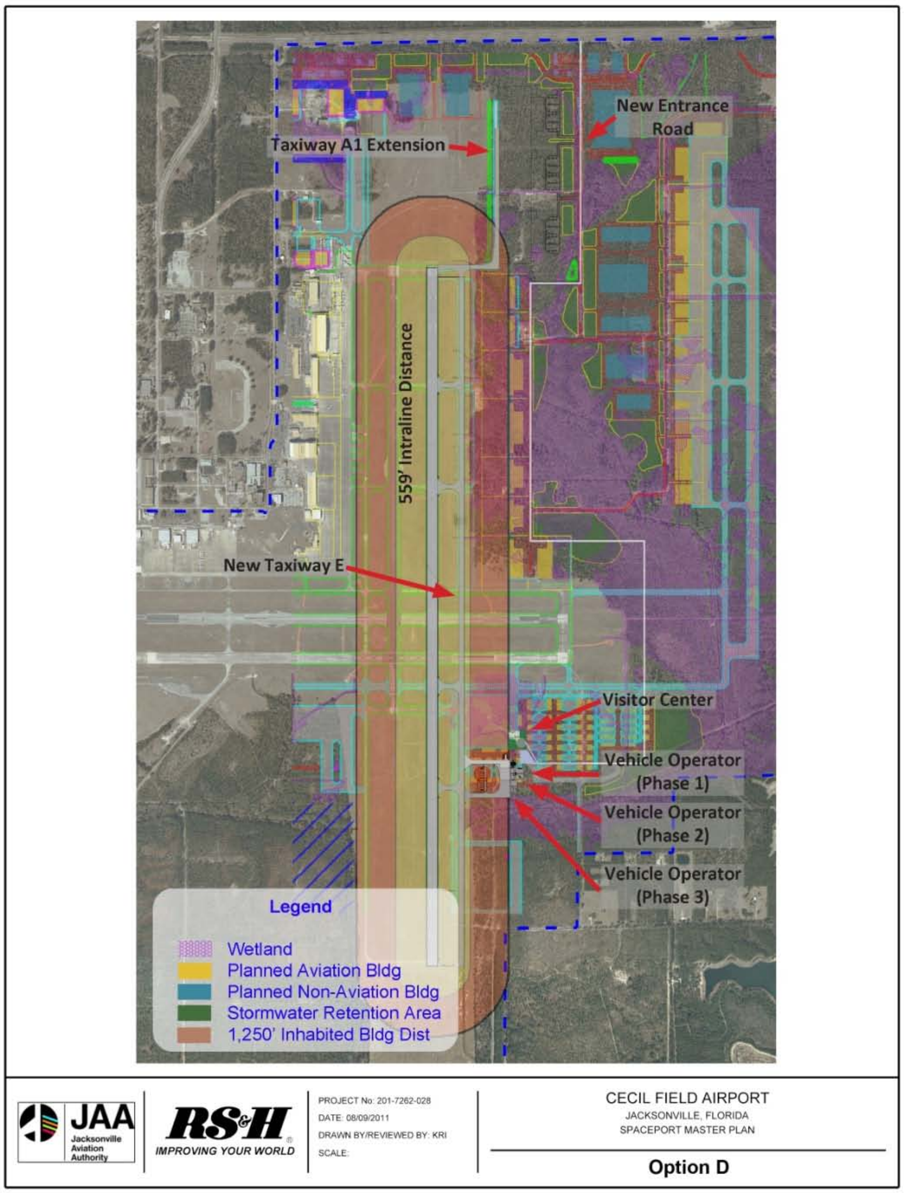


6.4.4 Spaceport Facilities Option D

Option D locates the vehicle operator facilities and the visitor center in the southeast quadrant of the airfield. The entrance roadway would have to be routed outside the runway safety area of the two east/west runways and then back toward Taxiway E, or else an access road tying into other roadways in the southwest quadrant would have to be constructed.

This location would isolate the Spaceport facilities from the aviation facilities to the greatest degree, as shown in Figure 6-12. While that goal may seem desirable, the isolated location would also be the least convenient for visitors. In addition, being located so far from aviation development would be a handicap should Spaceport operations be suspended and the facilities reverted to aviation use. In addition, the location would require more extensive roadway construction in a shorter time frame than is currently envisioned.

Figure 6-12 Spaceport Facilities Option D



6.4.5 Preferred Option

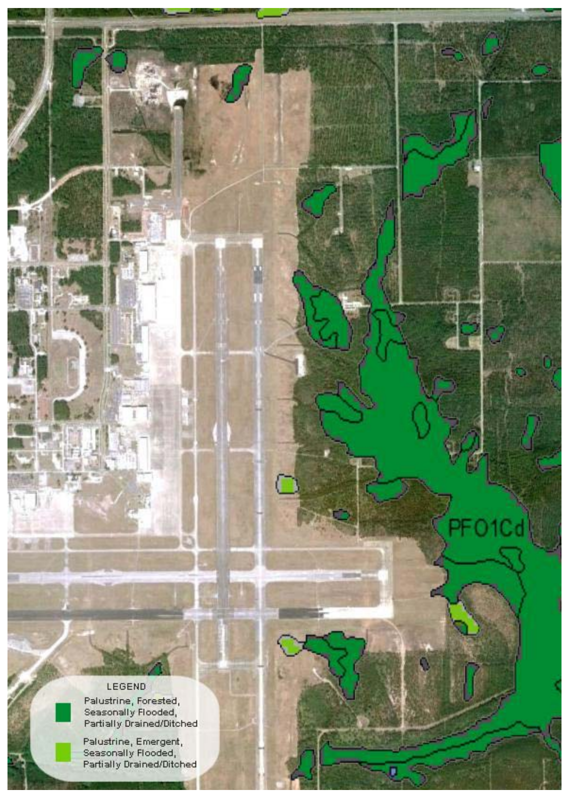
For the long term, the recommended alternative is to develop Facility Option C. This location best fulfills the required long-term goals of the Spaceport Master Plan. The recommended alternative best groups the visitor center and operator facilities to maximize the objectives of each, while creating a cohesive operating environment that minimizes logistical issues.

Like all of the proposed development on the east side of Runway 18L-36R, Facility Option C must be examined for potential environmental impacts, which are discussed in the following section.

6.5 ENVIRONMENTAL OVERVIEW

An environmental overview of developing the Cecil Spaceport was summarized in the *Cecil Field Spaceport Launch Site Operator License Application* and the *Master Plan Update for Cecil Field* (May 2008). This Spaceport Master Plan does not reproduce the earlier broad environmental overview with respect to Airport or Spaceport operations. Instead, this environmental overview briefly describes the potential environmental impact to wetlands, floodplains, and wildlife as a result of the proposed Spaceport development under the preferred option (i.e., Option C). When this project is ripe for execution, the appropriate National Environmental Policy Act (NEPA) environmental documentation for the Spaceport development would be conducted under a separate planning process.

Figure 6-13 Wetland Areas



Source: National Wetlands Inventory, 2004, U.S. Fish and Wildlife Service

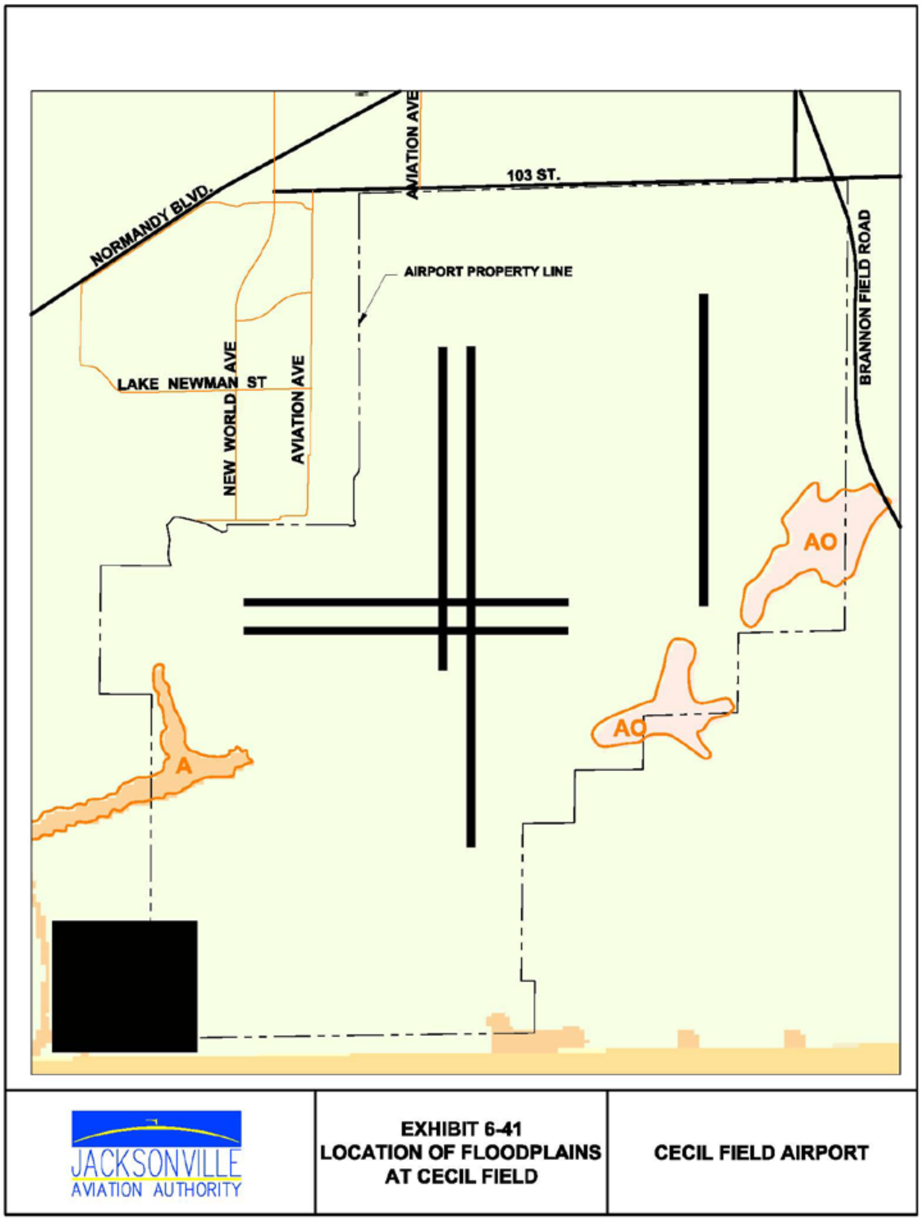
6.5.1 Wetlands

As shown in Figure 6-13, the area east of Runway 18R-36L contains an expanse of Palustrine wetland habitat, both forested and emergent, that is seasonally flooded and partially drained/ditched. Spaceport development Option C has the potential to directly impact approximately 3 acres of an emergent wetland east of Runway 18L-36R and north of Runway 9R-27L, but this impact will be minimized during overall site planning. This option would not impact the forested wetland further to the east.

6.5.2 Floodplains

Three floodplain areas within the Cecil Airport property boundary were identified in the 2008 Cecil Field Master Plan Update. One, Zone A, is on the southwest corner of the property and would not be affected by the proposed development. The second lies south of Runway 9R-27L and east of Runway 18L-36R. This area is classified "AO," which corresponds to shallow flooding of 1 foot to 3 feet during a 100-year storm. The third floodplain, also classified "AO," is located much farther east than any spaceport-related development. As shown in Figure 6-14, the three floodplain areas on the Airport property would not be affected the spaceport development.

Figure 6-14 Floodplain Areas



Source: Master Plan Update for Cecil Field, May 2008

6.5.3 <u>Wildlife</u>

The 2008 Master Plan Update identified the gopher tortoise, Sherman's fox squirrel and Bachman's sparrow (federal and state protected threatened, endangered or species of special concern) having been previously observed on Cecil Airport property.

Future development at Cecil Airport would require additional consultation with the United States Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission based on the presence of listed species and suitable habitats, prior to any construction activities. New development on the Airport property would be subject to environmental review, compliance and approval through NEPA and the local permitting process to ensure development consistent with city conservation policies.

6.6 AIR TRAFFIC CONTROL TOWER

Air traffic control services at Cecil are provided through the use of an air traffic control tower (ATCT), which is attached to the administration building located in the northwest quadrant of the airfield. The administration building (a.k.a. Building 82) and ATCT was constructed in 1952. Since that time both facilities have undergone multiple rehabilitation and revitalization projects. The ATCT is now in need of an upgrade to address multiple issues including building standards relative to federal and state regulatory compliance.

The tracking of both horizontal and vertical launch vehicles is conducted through the use of optical and telemetry equipment. Currently, each vehicle operator provides the tracking functions for the operation of their individual vehicles. It is anticipated in the future tracking services for horizontal launch activities will be provided through a single entity. Although it is not currently confirmed, future tracking will in all likelihood include the incorporation of the FAA-Air Traffic Services.

Considering the condition of the existing air traffic facility currently serving Cecil Spaceport and the need to plan for the future tracking of horizontal launch vehicles, it is recommended JAA complete a feasibility study and site selection study to identify the location of a new ATCT. Once a site for a new ATCT has been identified and approved by FAA, it is further recommended JAA initiate the design and construction of a new ATCT, which will include the space and equipment necessary to provide the air traffic services currently being provided at Cecil as well as accommodate additional personnel and equipment that may be required for tracking horizontal launch vehicles.

6.7 ADDITIONAL RECOMMENDED ACTIONS

The Cecil Spaceport Master Plan intends to create a vision for allowing Cecil Spaceport to serve the horizontal-launch commercial space industry over the long term. The vehicle characteristics and calculations used to develop the recommended alternatives have been based on the existing Commercial Launch Site Operator License. However, as the industry evolves the vehicles are likely to change substantially. For example, examining the feasibility of the Concept Y vehicle during the original license application was impractical due to the lack of realistic performance and noise data. In addition, the introduction of the Stratolaunch vehicle raises the possibility of additional Concept Z vehicles that are larger than the WhiteKnightTwo/SpaceShipTwo pair used in this study.

For the master plan to retain its long-term validity, it is recommended that the Jacksonville Aviation Authority:

- Conduct the necessary investigations into the environmental, noise and air traffic impacts of a typical Concept Y vehicle to enable operations of a Concept Y vehicle and/or to set a baseline against which future vehicles can be assessed.
- Investigate the feasibility of adding Runway 9R-27L to the approved spaceport operation area to add operational flexibility for various weather conditions.
- Assess the maximum Intraline Distance and Inhabited Building Distance available given the current location of Cecil Airport buildings and infrastructure, and then determine the maximum quantities of fuel, oxidizer and other energetic liquids that can be located at Cecil Spaceport. These quantities can then be used to determine whether future vehicles are compatible with Cecil Airport infrastructure and operations.
- Amend the Commercial Launch Site Operator License to reflect these potential developments.

6.8 SUMMARY

The existing airfield infrastructure at Cecil Airport is fully capable of supporting operations by any RLV operator identified for this study. Runway and taxiway capabilities exceed the requirements set by RLV developers in all respects. The primary focus has been to develop a viable spaceport operating plan that ensures the setback requirements for the vehicles when fully loaded with oxidizer and fuel, is compatible with all other existing and planned activities and development at Cecil Airport. A secondary focus is to plan facilities that could be converted to aviation use should Spaceport activities prove not to be viable over the long term.

Facilities that should be built to support Spaceport operations include hangars, parking aprons, offices, propellant (fuel and oxidizer) storage and a visitor center. In addition, an oxidizer loading area needs to be identified that will provide required separation of the launch vehicle from occupied buildings as well as providing space for an engine testing facility.

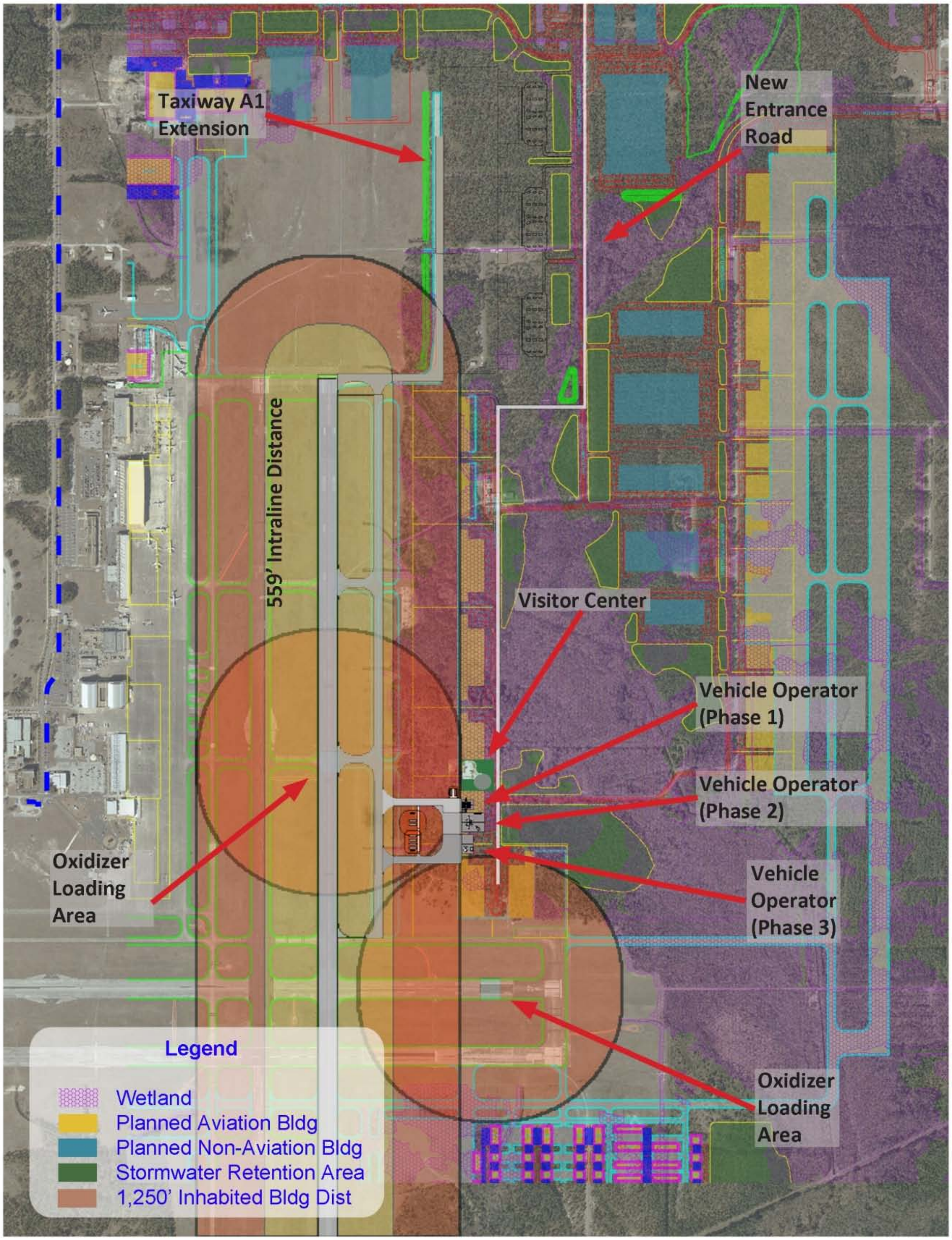
Current estimates for when horizontal takeoff/landing RLVs might become operational put initial Spaceport operations in late 2013 or 2014. This schedule allows the planning, design and construction of some required infrastructure, but it is certainly possible that an RLV operator beginning commercial space flights from Cecil Airport in that time frame would be required to operate out of existing facilities and infrastructure.

For the long term, the recommended alternative is to develop Facility Option C, with Oxidizer Loading Area 4 as the primary oxidizer loading area and Oxidizer Loading Area 3 as a secondary oxidizer loading area (see Figure 6-15). This combination best fulfills the required long-term goals of the Spaceport Master Plan. The recommended alternative best groups the visitor center, operator facilities, oxidizer loading area and engine test stand close together, adding operational efficiencies as well as the perception of the overall complex as being a cohesive unit, with the potential to stimulate adjoining development.

The recommended alternative would create the fewest conflicts with existing Airport operations, maximize the space for both aeronautical and non-aeronautical facilities on the east side of the airfield, and provide the most unified Spaceport environment. The cost of developing Option C, proposed schedule, and potential funding strategies are discussed in Chapter 7.

In addition, it is recommended that JAA explore the possibility of replacing the air traffic control tower, determine the feasibility of operations by Concept Y vehicles, investigate the possibility of using Runway 9R-27L when weather conditions warrant, assess the maximum allowable quantities of fuel and oxidizer that are compatible with current and planned buildings and infrastructure, and modify the Commercial Launch Site Operator License to reflect these potential developments.

Figure 6-15 Recommended Alternative



JAA Jacksonville Aviation Authority

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PROJECT No: 201-7262-028
DATE: 08/09/2011
DRAWN BY/REVIEWED BY: KRI
SCALE:

CECIL FIELD AIRPORT
JACKSONVILLE, FLORIDA
SPACEPORT MASTER PLAN

Recommended Alternative

CHAPTER 7
IMPLEMENTATION PLAN

7.1 INTRODUCTION

The plan described in this chapter provides an approach to funding and implementing the preferred development alternative. The Implementation Plan consists of a project phasing plan and a Capital Improvement Plan (CIP). The CIP incorporates infrastructure improvements identified in the development alternatives outlined in previous chapters of this master plan. The recommended phasing plan incorporates the facility improvements and maintenance over a 20-year planning horizon.

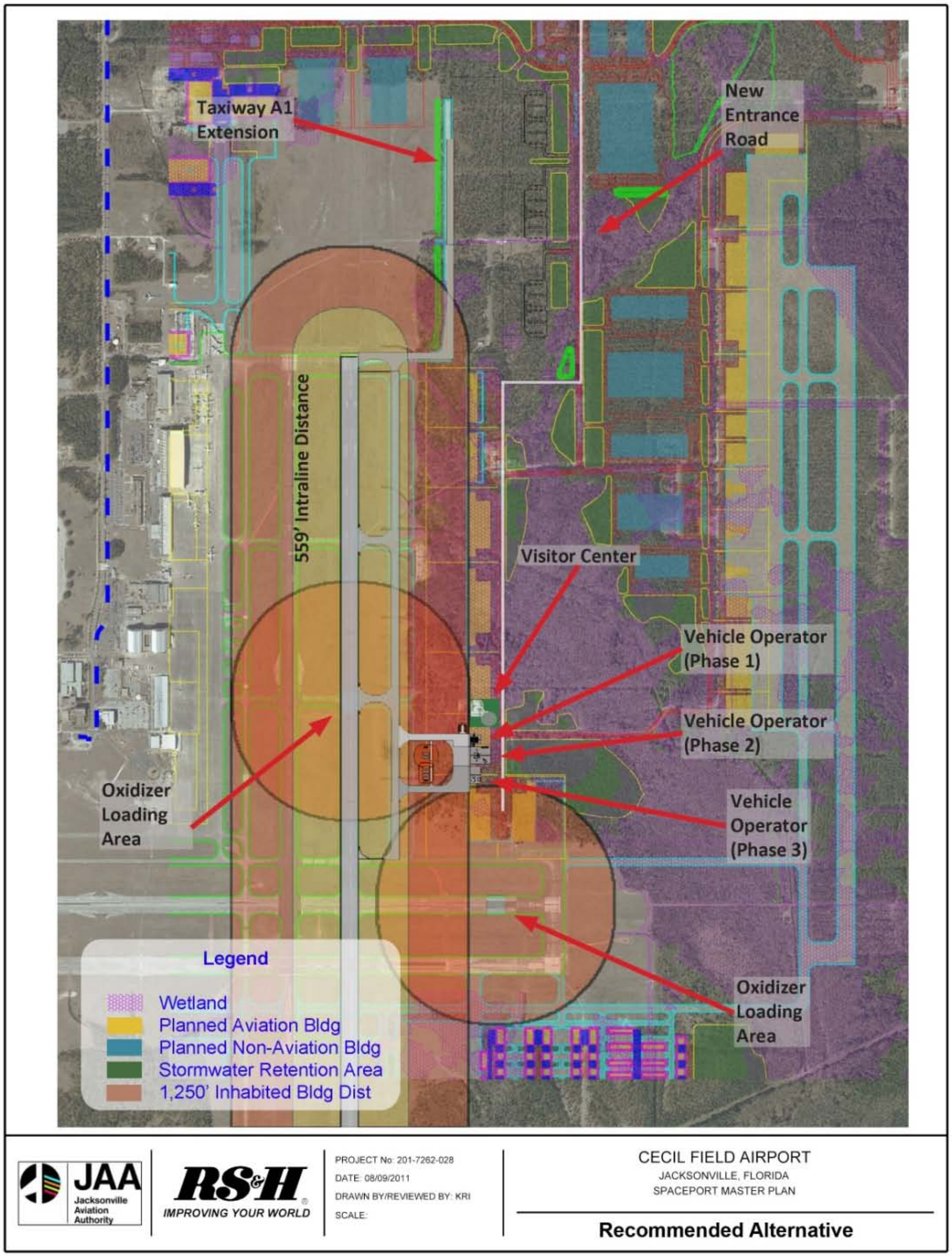
For the long term, the recommended alternative is to use Facility Option C, with Oxidizer Loading Area 4 as the primary oxidizer loading area and Oxidizer Loading Area 3 as a secondary oxidizer loading area (see Figure 7-1). This combination best fulfills the required long-term goals of the Spaceport Master Plan by grouping the visitor center, operator facilities, oxidizer loading area and engine test stand close together. This option adds operational efficiencies as well as the perception of the overall complex as being a cohesive unit, with the potential to stimulate adjoining development.

The recommended alternative would create the fewest conflicts with existing Airport operations, maximize the space for both aeronautical and non-aeronautical facilities on the east side of the airfield, and provide the most unified Spaceport environment.

The ultimate development of the recommended alternative will include the following projects:

- Extend Approach Road
- Construct Taxiway E
- Revise Spaceport Environmental Assessment
    - Incorporate environmental impacts resulting from the Concept Y vehicle
    - Define the Flight Corridor and Operating Range to accommodate the Concept Y vehicle
    - Review the existing Explosive Site Plan
- Modify the Cecil Spaceport Launch Site Operators License Application to incorporate Concept Y vehicle
    - In accordance with FAA-AST Expected Casualty Thresholds, complete a Risk Analysis taking into consideration operations performed by the Concept Y vehicle and associated Flight Corridor and Operating Range
    - Establish an Airspace Letter of Agreement with FAA-Air Traffic and other parties to operate within the Concept Y Flight Corridor and Operating Range
    - Amend the existing Explosive Site Plan to accommodate greater Quantity Explosive Distances required by vehicles with greater propellant capacity
- Prepare vehicle operator Landside/Airside Facilities
    - Design and construct RLV storage and assembly facilities
    - Design and construct associated vehicle apron and taxiways
    - Design and construct oxidizer and propellant storage areas
- Reconstruct Taxiway B (partial) to facilitate oxidizer loading
- Reconstruct Runway 18L/27R to facilitate oxidizer loading
- Construct visitor center

Figure 7-1 Recommended Alternative



The plan provides guidance on implementation of the recommended alternative, with acknowledgement that an operator may need to create a facility before the ultimate build-out of the infrastructure described in the preferred alternative. This implementation plan considers the demand-driven need for facilities, the need to integrate Spaceport operations into the daily airport activities and funding alternatives.

It is recommended that the implementation plan, including the Airport CIP, be utilized as a working tool. The plan should be updated regularly and include reassessment of project chronology within the three term phases: short-, medium- and long-term. Capital improvements, their associated costs, and financial projections should be re-examined periodically throughout the planning period even though the figures contained herein present a reasonable forecast of needed initiatives to implement the Spaceport Master Plan recommendations.

Funding from several sources may be available for Spaceport infrastructure projects, including FAA Airport Improvement Program (AIP) and State of Florida Department of Transportation (FDOT) Aviation grants as well as Jacksonville Aviation Authority cash and bond funds. There is also an FAA-AST (Commercial Space Transportation) grant program and potential Space Florida funding through FDOT that could be used for specific space-related projects. Because the Cecil Commercial Launch Site Operator License is limited to horizontal launch space vehicles that operate as aircraft during take-off and landing, several of the proposed projects in this plan should be fundable by the traditional airport funding sources.

The implementation plan can be dramatically impacted by unpredictable events such as inflation, changing demand profiles, developing spacecraft technology, local or national economic health, or legislative changes. Financial projections should be viewed accordingly.

7.2 PROPOSED IMPLEMENTATION PLAN BY PHASE

This section presents the three time phases of the Spaceport Master Plan, including operating alternatives at each stage to allow spacecraft operators to utilize the facility before the ultimate build-out of spaceport facilities is completed. Details of each cost estimate are included in Appendix C.

The Cecil Spaceport could accommodate an RLV operator immediately based on the use of existing facilities and infrastructure as described in the Cecil Spaceport Launch Site Operator License Application. However, accommodating an RLV operator over a longer term would require less disruption to aviation operations by providing infrastructure more suitable for spaceport operations.

Phase 1 of the new access road and the extension of Taxiway A1 are currently being designed and are scheduled for construction in 2012 (See Figure 7-2). Those two projects will allow development on the east side of Runway 18L-36R. An interim RLV operator facility could be constructed along Taxiway A1 and then relocated upon the construction of Phase 2 of Approach Road, with the interim facility converted to conventional aviation use.

7.2.1 Short-Term Development (2012-2016)

During the 5-year period, the oxidizer loading area would be located at either the north end of Runway 18L-36R or adjacent to Taxiway B1 on the abandoned concrete pavement that formerly was the approach end of Runway 27R. As noted in the oxidizer loading area discussion in Chapter 6, these positions will require runway shutdowns when the launch vehicle is fully loaded. Taxiing/towing the loaded launch vehicle on Runway 18L-36R is consistent with the Launch Site Operator License. As noted earlier, an amendment to the Explosive Site Plan in the Launch Site Operator License should be pursued to accommodate additional oxidizer loading areas.

Three projects should be programmed for construction during the 5-year horizon. They include extending Approach Road south to near the intersection of the Runway 18L-36R and Runway 9L-27R, installing utilities along that corridor, and preparing a site for airside and landside development by an RLV operator. The projects include:

Extend Approach Road – See Figure 7-3. This project involves constructing Phase 2 of Approach Road. Phase 2 is that segment of the road that extends from the currently designed end of Phase 1 south to an area near the intersection of the north/south and east/west runways. This is an enabling project that opens the area east of Runway 18L-36R for development. Estimated construction cost is **$11,835,000**.

Extend Approach Road utilities – This project extends water and sanitary sewer the length of the Phase 2 roadway. Estimated construction cost is **$1,951,000**.

Operator airside/landside site(s) – See Figure 7-4, Figure 7-5, Figure 7-6. Preparing the site for an operator facility includes constructing a concrete connector taxiway, creating a Portland cement concrete apron, constructing parking pads for fuel and oxidizer trucks, and associated drainage and other site work. The conceptual drawings shown include taxiway work that would be compatible with the geometry required in the ultimate construction of Taxiway E. Estimated construction cost is **$4,077,000 - $4,540,000**.

Figure 7-2 Taxiway and Approach Road Phase 1

Figure 7-3 Approach Road Phase 2

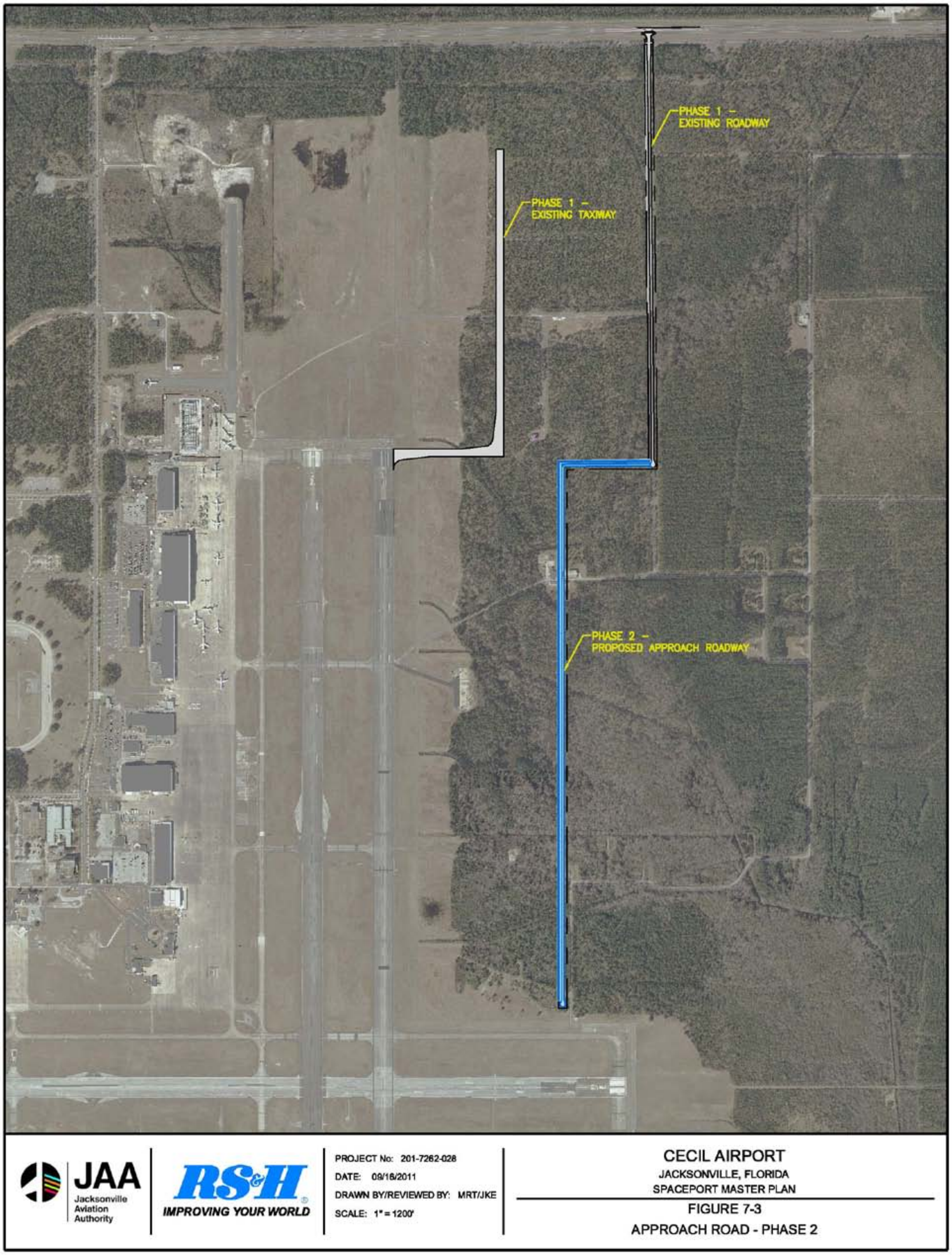


Figure 7-4 Lynx Hangar Development

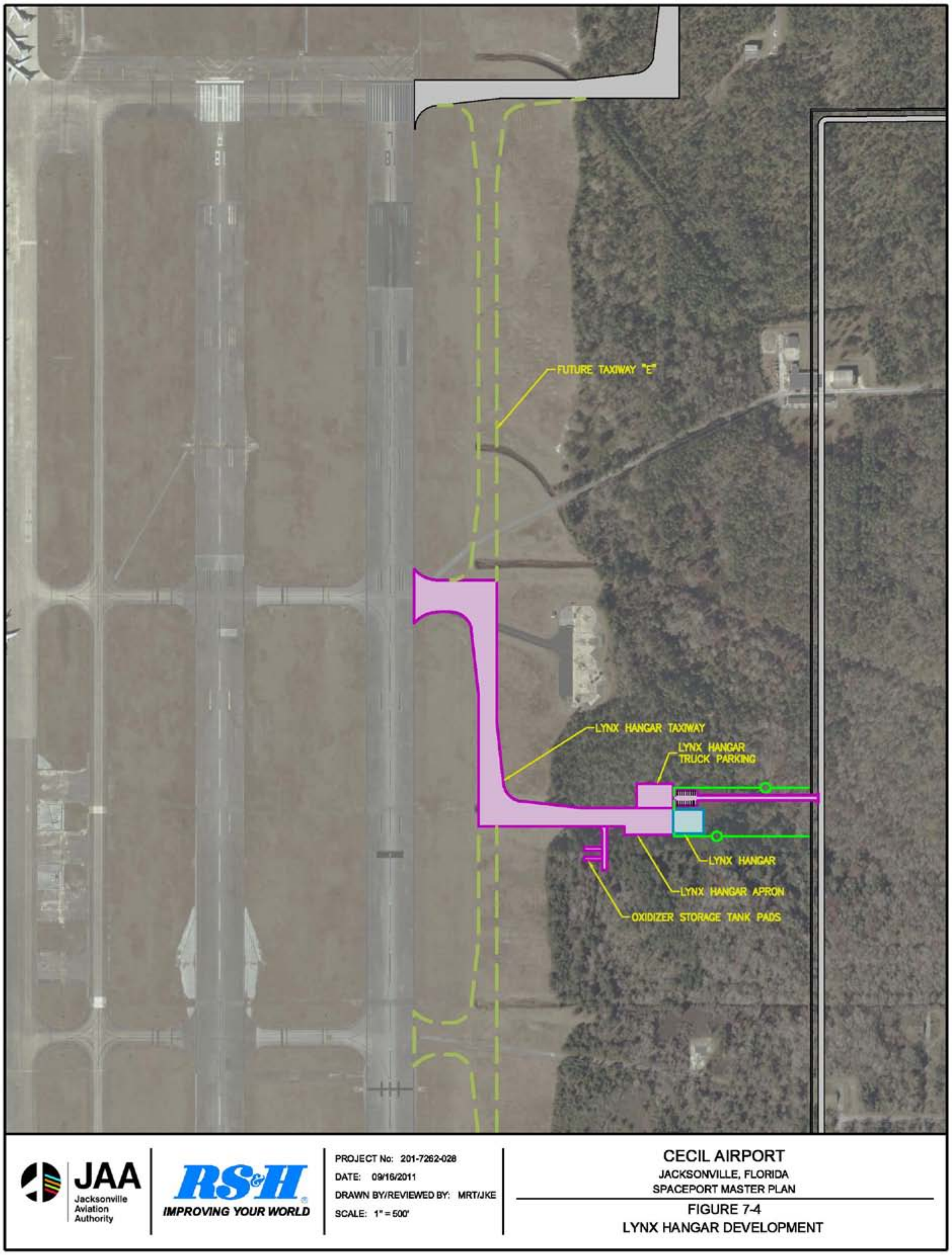


Figure 7-5 Virgin Galactic Hangar Development

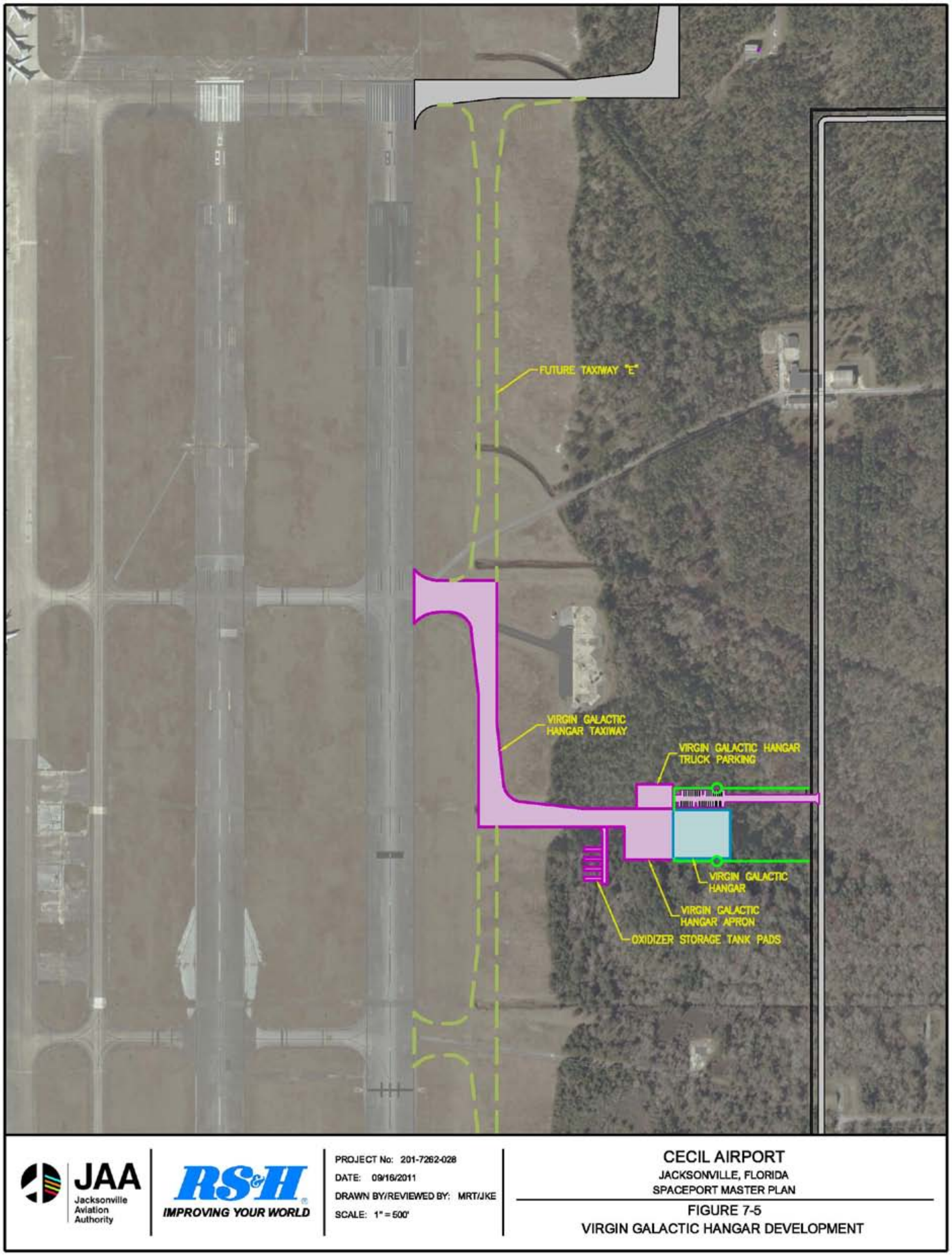
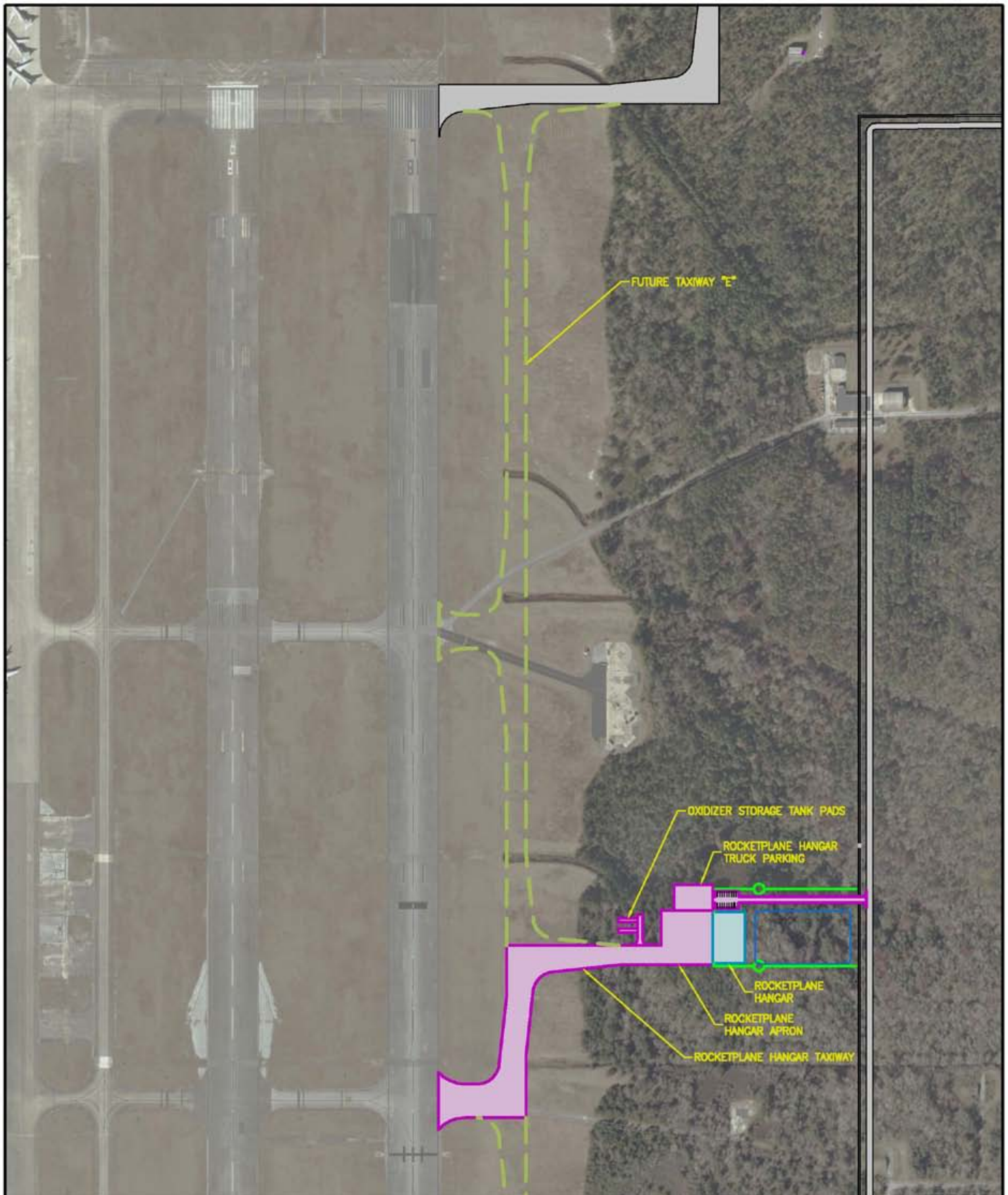


Figure 7-6 Rocketplane Hangar Development



JAA Jacksonville Aviation Authority

RS&H IMPROVING YOUR WORLD

PROJECT No: 201-7262-028
DATE: 09/16/2011
DRAWN BY/REVIEWED BY: MRT/JKE
SCALE: 1" = 500'

CECIL AIRPORT
JACKSONVILLE, FLORIDA
SPACEPORT MASTER PLAN

FIGURE 7-6
ROCKETPLANE HANGAR DEVELOPMENT

7.2.2 Medium-Term Development (2017-2021)

During the five- to 10-year period, parallel Taxiway E should be constructed from the approach end of Runway 18L-36R to Runway 9L-27R. This project should be combined with a reconstruction of Taxiway B from Runway 18L to Taxiway B1. Together, these two projects enable the full development of the area northeast of the existing runway complex for both spaceport activities and aviation use. Because the northwest area of the airfield is essentially fully developed, this project allows further development for spaceport operations as well as sets the stage for the next phase of aviation-oriented development.

Construct Taxiway E, reconstruct Taxiway B – See Figure 7-7. This project would allow aircraft taxi operations on the east side of Runway 18L-36R from the approach end of Runway 18L-36R to the midfield intersection, further opening the area to spaceport and aviation operations. The Taxiway B reconstruction would replace the asphalt pavement from Taxiway E to the recommended oxidizer loading area adjacent to Taxiway B1 with concrete pavement. Estimated construction cost is **$17,796,000**.

7.2.3 Long-Term Development (2022-2031)

The ultimate development of the Cecil Spaceport includes a visitor center and a concrete runway. For the near and medium terms, the existing terminal building can be used as a visitor center. Operators have expressed interest in a facility that can include training facilities and educational exhibits and serve as a mission control facility. An additional need on the east side of Runway 18L-36R may be a fixed-base operator (FBO) to accommodate aviation users that locate on the east side of the Airport. A flexible facility that fulfills the role of both a visitor center and an FBO may best fulfill those two needs over the long term. The two facilities would share many of the same requirements, including both airside and landside access, waiting areas, conference rooms and offices. Additional spaceport-oriented facilities such as "mission control", training facilities, food service and gift shop are not incompatible with shared aviation use. In addition, reconstruction of Runway 18L-36R with a concrete surface would be desirable, as it eliminates a potential hazard due to the incompatibility of asphalt pavement and liquid oxygen.

Reconstruct Runway 18L-36R – See Figure 7-8. The reconstruction of Runway 18L-36R with a concrete surface would ensure compatibility with a spacecraft using liquid oxygen as an oxidizer. Estimated construction cost is **$47,000,000**.

Visitor center – A building similar to a medium-sized general aviation terminal would serve the needs of the visitor center and could be outfitted to also serve the FBO needs of east side aviation users. A sophisticated, energy-efficient 5,000-square-foot building would fulfill those needs. Estimated construction cost is **$1,665,000**.

Figure 7-7 Taxiway E Construction/Taxiway B Reconstruction

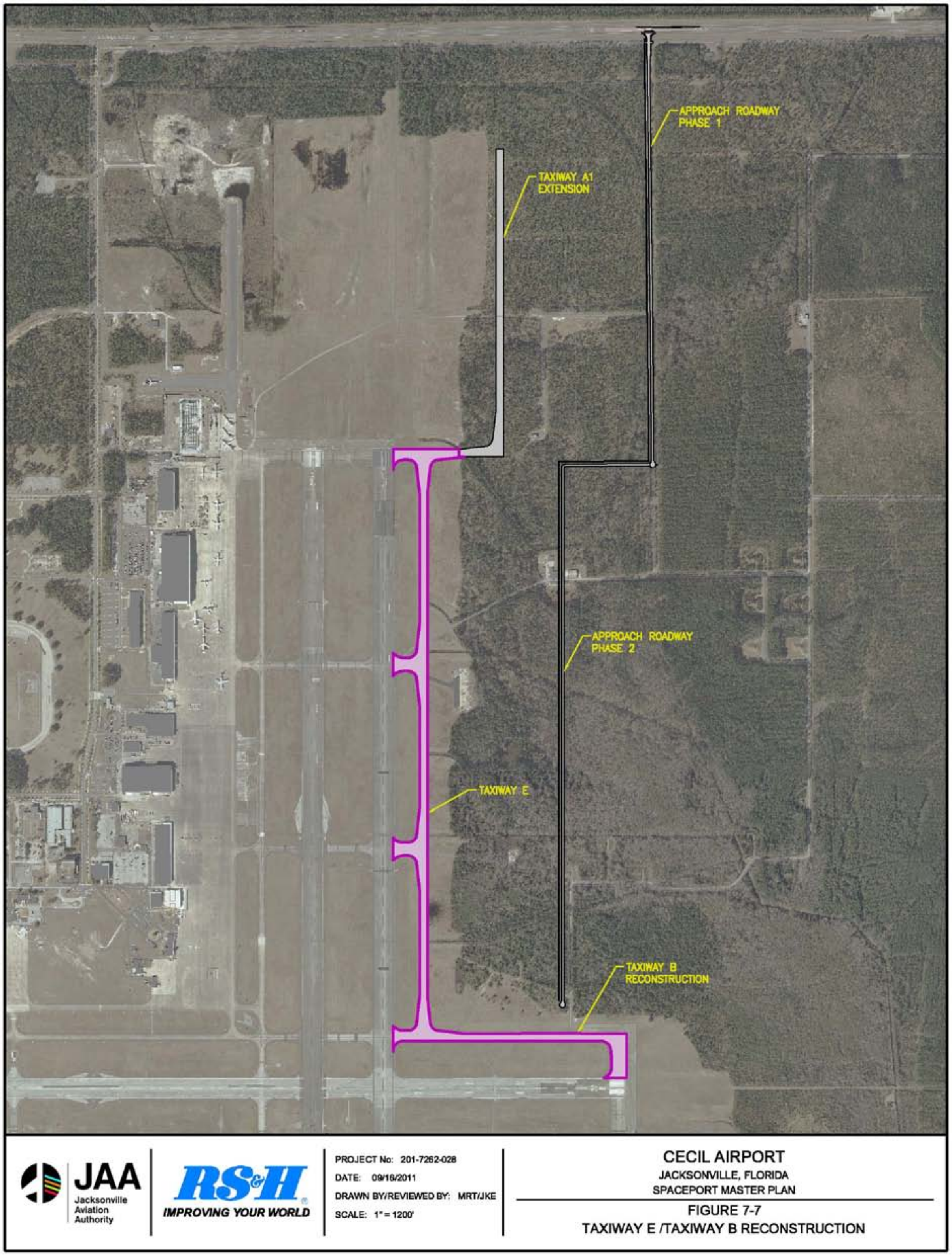
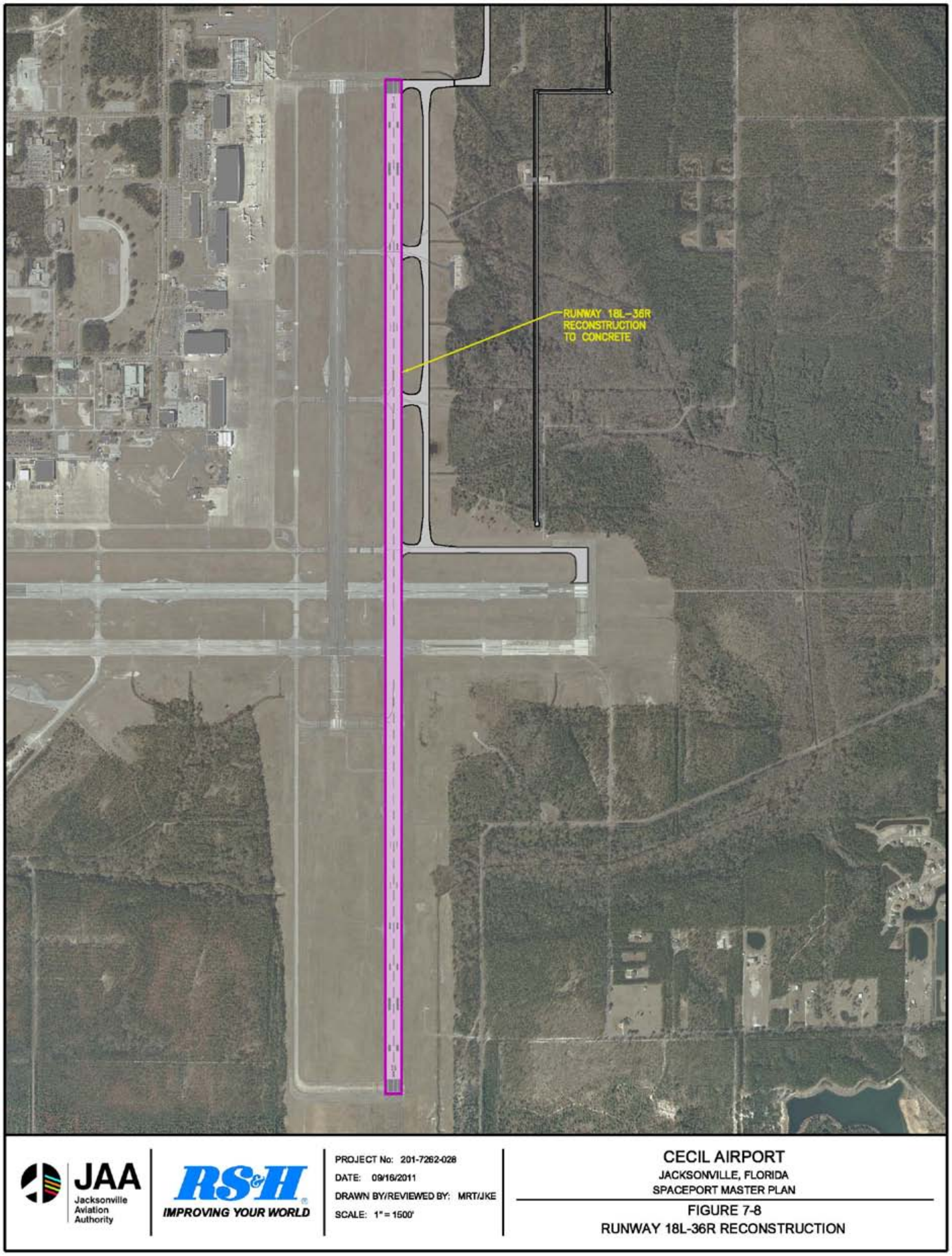


Figure 7-8 Runway 18L-36R Reconstruction



7.3 FUNDING SOURCES FOR SPACEPORT DEVELOPMENT

In reviewing the potential sources for funding the spaceport development proposed in the Cecil Spaceport Master Plan, it is important to understand the types of projects included in the plan and the current status of state and federal rules that dictate how such projects can be funded. Because the Cecil Airport Commercial Launch Site Operator License is limited to horizontal launch space vehicles that operate as aircraft during takeoff and landing, several of the proposed projects in this plan should be fundable by the traditional airport funding sources.

This is particularly true for taxiway, apron and hangar development that would accommodate conventional aircraft as well as horizontal launch space planes. These funding sources could include FAA Airport Improvement Program (AIP) and State of Florida Department of Transportation (FDOT) Aviation grants as well as Jacksonville Aviation Authority cash and bond funds. There is also an FAA-AST (Commercial Space Transportation) grant program and potential Space Florida funding through FDOT that could be used for specific space-related projects.

7.3.1 FAA Airport Improvement Program

The FAA Airport Improvement Program (AIP) is authorized by Chapter 471 of Title 49 of the United States Code (U.S.C.), whose primary objective is to provide funding for the development of a nationwide system of public-use airports. The AIP provides funding from the Airport and Airway Trust Fund for airport planning and development projects at airports that are included in the National Plan of Integrated Airport Systems (NPIAS). In the 2011-2015 NPAIS, Cecil Field is listed as a non-primary general aviation airport. This is a change in status from that reported in the 2008 Cecil Field Airport Master Plan Update and affects, to some degree, the AIP funds available for Cecil Airport.

As a non-primary general aviation airport, Cecil Airport is entitled to annual FAA AIP funding equal to 20 percent of the airport's 5-year cost of need listed in the most recent NPAIS, capped at $150,000. This level is available so long as AIP is funded at $3.2 billion or more. If annual AIP funding is below $3.2 billion, the amount of AIP available as entitlement funds to general aviation airports is reduced and is allocated based on an area/population formula. Should AIP funding be decreased, the $150,000 annual entitlement projected for Cecil Airport would probably be reduced. This decreased funding could occur in 2012 as Congress deals with the need to reduce the federal budget in response to current federal deficit spending.

Cecil Airport is also eligible for FAA-AIP discretionary funding. Approximately 25 percent of annual AIP funding is discretionary, with approximately 45 percent of this amount directed at projects that meet FAA capacity, safety, security and noise goals. Of the remaining amount, 35 percent is programmed to noise set-aside projects, 4 percent to the Military Airport Program (MAP), less than 1 percent to reliever airports and 15 percent to pure discretionary projects at any airport. Projects funded with discretionary AIP funds are awarded based on a national priority system. The ranking system is based on FAA Order 5100.39A. Because of the low number of based aircraft and civil itinerant operations at the airport, Cecil projects will generally score a lower ranking. This will decrease the likelihood of getting discretionary projects funded at the airport. Also new taxiways and aprons needed to support new activity at Cecil score lower than safety/security and reconstruction projects.

Cecil Airport is both positively and negatively impacted by the number of operations conducted by military aircraft. These military aircraft operations are not included in FAA project ranking formula and cannot be used as a justification for AIP funded projects. However, these operations bring fuel revenues to the FBO and increase the operational counts that support tower operations. At airports where military aircraft conduct a significant level of activity, the Department of Defense (DoD) can enter into a Joint Use Agreement with the local authority to pay for costs related to military use of the airfield.

Because Cecil Airport is a closed military airport converted to civilian use, the airport has enjoyed additional funding under the FAA AIP Military Airport Program (MAP) for several years. However the airport is no longer in this program. The airport is a local and state priority and this priority can be factored into FAA project priority ranking decisions. While some FAA AIP funding will be available for Cecil Airport projects, these funds may not be available for infrastructure to support new activity.

7.3.2 FAA Commercial Space Transportation Grants Program

The Office of Commercial Space Transportation was established in 1984 as a part of the Department of Transportation and was transferred to the FAA in 1995 to regulate the U.S. commercial space transportation industry and to ensure the safety of space operations. In addition to regulation, FAA-AST is responsible for the promotion of commercial space launches and reentries by the private sector and for strengthening and expanding the U.S. space transportation infrastructure.

The FAA AST Space Transportation Infrastructure Match Grant program (STIM) was authorized by Chapter 703 of Title 49 of the United States Code (U.S.C.) in 1994 to fund space transportation infrastructure. The program did not receive any appropriations to fund projects until 2010.

The program provides up to 50 percent of the total project cost in conjunction with state and local government funding. A minimum of 10 percent of the funding must come from private sources. The program received an additional appropriation in 2011.

Since 2010, approximately $1 million in funding ($500,000 per year) has been awarded to five commercial spaceport authorities. Cecil Airport was awarded $105,000 in 2010 for the Cecil Spaceport Master Plan. The largest grant was for $249,000 to Spaceport America in New Mexico for a Roll Back Vehicle Integration Building. Other projects include a $43,000 Automated Weather Observation System at Spaceport America, a $125,000 Physical Security and Remote Monitoring Surveillance System at the Virginia Commercial Spaceport Authority Wallops Island Flight Facility, a $125,000 Emergency Response Vehicle and a $125,000 Supplemental Environmental Assessment for the East Kern Airport District Mojave Air and Spaceport and a $247,000 Rocket Motor Storage facility to the Alaska Aerospace Corporation Kodiak Launch Complex.

In the 2012 proposed budget, FAA-AST has requested an $11 million increase in total funding to $26 million. However, there has been some pushback in Congress with the House Appropriations Committee voting to support a $2 million decrease to $13 million. Therefore, there is no certainty that the STIM program will continue in 2012. If the program is continued, it will probably remain at current $500,000 annual amount, which could constitute the total funding for spaceport infrastructure for all US commercial spaceports. While JAA could anticipate that projects like rocket motor storage and oxidizer fuel storage projects would be eligible for STIM funding when these project are required, it is not certain this funding will be available when the need arises.

7.3.3 Florida Department of Transportation (FDOT) Aviation Grant Program

The FDOT Aviation Grant program is authorized in Florida Statutes, Chapter 332. The law allows FDOT to fund any capital project on airport property, provided the project is consistent with the role defined in the Florida Aviation System Plan and is consistent with the approved local comprehensive plan to the maximum extent feasible. The project must also be included in an FDOT-approved airport master plan and airport layout plan.

Florida Statute Chapter 332 has one restriction relevant to spaceport development. Chapter 332.009 states, "Nothing in this chapter shall be construed to authorize the expenditure of aviation fuel tax revenues on space transportation projects. Nothing in this chapter shall be construed to limit the department's authority under s.331.360." Florida statue 331.360 charges FDOT with the responsibility to promote the further development and improvement of aerospace transportation facilities and to assist Space Florida in developing a spaceport master plan for expansion and modernization of space transportation facilities within spaceport territories as defined in s.331.303. Space Florida will be discussed in more detail in Section 7.3.4.

Discussion was held with FDOT Aviation on the provisions of s.332.009 and the impact on projects included in the Cecil Spaceport Master Plan. Most of the projects proposed – such as taxiways, aprons and hangars – will be facilities that can be used jointly by aircraft and by the horizontal launch space planes that Cecil's Commercial Launch Site Operator License covers. These facilities should be eligible under the FDOT Aviation grant program.

FDOT usually provides up to 50 percent of the non-federal share of projects within the JAA airport system that are included in the FDOT 5-year work plan. The work plan is based on projects that JAA has included in the FDOT Joint Automated Capital improvement Plan and the priority for these projects that JAA and the FDOT District Two office develop during close annual coordination. The highest priority for FDOT funding goes to commercial service airports where there is more need for capacity to meet aviation and passenger demand.

FDOT also invests significant resources into general aviation projects. Over the last 10 years, Cecil Airport has averaged between $500,000 and $1 million in FDOT funding for priority projects in the JACIP. FDOT has also indicated a willingness to support at higher levels certain high-profile projects that promise to bring major employment and private development to Jacksonville and Northeast Florida, provided JAA can provide the 50 percent match. These projects have ranged from $3 million to $6 million.

7.3.4 Space Florida

Space Florida is an independent special district of the State of Florida, created by Florida Statute, Chapter 331, Part II, to foster the growth and development of the aerospace industry within Florida. Space Florida is to consult with Enterprise Florida in developing a space tourism marketing plan. Space Florida can finance aerospace business development projects or initiatives using funds provided by the Legislature. While Space Florida has the primary responsibility to redevelop and grow the facilities at Cape Canaveral Air Force Station and Kennedy Space Center, it is also charged with the development of commercial spaceports throughout the state through partnerships with counties or municipalities, the federal government, or private entities.

In Florida Statue 331.360, the FDOT is charged with the responsibility to promote the further development and improvement of aerospace transportation facilities and to develop joint-use facilities and technology that support aviation and aerospace operations. The FDOT may enter into a joint participation agreement with and otherwise assist Space Florida in carrying out Space Florida's responsibilities. FDOT may allocate funds in its 5-year work program to support the capital development costs of Space Florida.

Space Florida must develop a spaceport master plan for expansion and modernization of space transportation facilities within established spaceport territories and submit the plan to FDOT for incorporation in the FDOT 5-year work program of qualifying aerospace discretionary capacity improvement projects. Funding of any project in the plan is subject to the availability of appropriated funds as approved in the annual legislative budget request.

The Cecil Spaceport is included in the 2010 Space Florida Spaceport Master Plan as a proposed non-federal spaceport. The Space Florida master plan was developed prior to Cecil receiving the Final Launch Site Operators License (LSO 09-12) from FAA in January 2010. Several spaceport development projects are listed in the master plan. These include an RLV fueling facility, a taxiway and apron and an RLV Hangar. On June 9, 2011, Cecil Airport was designated a Space Territory by Space Florida and was included in the State Intermodal System (SIS) as a planned spaceport facility.

While Space Florida and the SIS designation bring additional funding opportunities to Cecil Spaceport, both of these programs are dependent on the state's general revenue fund to pay for recommended projects. So long as state revenues are under the current economic pressures, Space Florida and the SIS will only be able to seek funding for the highest priority projects with the best chance of bringing increased economic development to Florida.

In 2011, the Florida Legislature committed more than $43 million for growth of the space industry in Florida. Of this amount, $16 million was provided by FDOT working in conjunction with Space Florida for infrastructure development of launch support facilities at Kennedy Space Center and Cape Canaveral, and $10 million was appropriated directly to Space Florida to recruit new business and expand existing businesses in the space industry.

7.3.5 Jacksonville Aviation Authority (JAA)

JAA must provide the local match for all of the funding sources discussed above. JAA is a well-managed and financially sound independent aviation authority. The Authority runs a system of four airports including Jacksonville International Airport, a medium hub commercial service airport and three general aviation airports: Jacksonville Executive at Craig Airport, Herlong Recreational Airport and Cecil Airport. The Fiscal Year 2010 Annual Financial Report indicates that the Authority's assets have exceeded liabilities for the three years included in the report and has maintained unrestricted net assets exceeding $40 million during this period. JAA may use these funds for any lawful purpose as directed by the JAA Board of Directors.

JAA has consistently generated the necessary cash to support a strong capital improvement that has enabled JAA to expand to meet increasing traffic demands, support economic development of Authority property and contribute to economic prosperity in Northeast Florida. JAA should be able to meet the matching requirements of any of the above programs and can also undertake projects using Authority funds alone when there is appropriate return on Authority investments.

7.3.6 Funding Summary

JAA has several sources that can be used to support development of aviation and spaceport projects at Cecil Airport. JAA will have to work closely with FAA and FDOT to develop projects that can meet the priority requirements of each agency. For projects that are specifically for space transportation JAA must work with Space Florida and FAA-AST to determine availability of funds, as these funds are not assured. JAA has endeavored to keep costs associated with launching horizontal space vehicles from Cecil Spaceport as low as possible. It remains to be seen if this approach will attract a user to operate from Cecil Spaceport. When this user is identified, JAA has the financial resources to assist the user in developing the necessary facilities.

7.4 SUMMARY

RLV operations at Cecil Spaceport could commence using existing buildings and infrastructure, however for optimal long-term operation a number of infrastructure improvements are warranted, both to allow launches with minimal disruption to aviation operations and to optimize spaceport operational logistics.

The ultimate development of the recommended alternative will include three major projects – extending Approach Road and utilities, constructing an east-side parallel taxiway, and reconstructing Runway 18L-36R. In addition, sitework necessary to prepare the area for one or operator facilities has also been assessed. The time frame and projected order-of-magnitude costs are presented in Table 7-1:

Table 7-1 Proposed Implementation

SHORT TERM	TIME FRAME	COST (Est.)
Extend Approach Road	2012-2016	$11,835,000
Extend Approach Road Utilities	2012-2016	$1,951,000
Operator 1 Site	2012-2016	$2,420,000
Operator 2 Site	2012-2016	$2,836,000
Operator 3 Site	2012-2016	$2,894,000
MEDIUM TERM		
Construct Taxiway E / Reconstruct Taxiway B	2017-2021	$17,796,000
LONG TERM		
Reconstruct Runway 18L-36R	2022-2031	$47,000,000
Construct Visitor Center	2022-2031	$1,665,000

Funding for the proposed projects may come from a number of potential sources, including the FAA Airport Improvement Program (AIP), State of Florida Department of Transportation (FDOT) Aviation grants, FAA-AST (Commercial Space Transportation) grant program, Space Florida funding through FDOT, and Jacksonville Aviation Authority cash and bond funds.

APPENDIX A
STRATEGIC VISIONING SESSION ATTENDEES

Cecil Airport

Cecil Spaceport Master Plan
Strategic Visioning Session
Cecil Airport – Jacksonville, Florida
April 19, 2011

	Attendee	Organization	Phone	Email Address
1	Kelly Dollarhide	JAA / Cecil Ops	573-1604	kdollarhide@jaa.aero
2	Roland Luster	FDOT	(386) 961-7855	roland.luster@dot.state.fl.us
3	Steve Grossman	JAA / CEO	741.2069	sgrossman@JAA.AERO
4	Bob Molle	JAA	741-2405	BMOLLE@JAA.AERO
5	Pat McCarthy	Space Florida	(321) 730 5301 x232	pmccarthy@spaceflorida.gov
6	Linsley Pietsch	Space Florida	321 730 5301 x245	lpietsch@spaceflorida.gov
7	Chip Seymour	HES Global Services	904 591 8065	chipatse@yahoo.com
8	Todd Bradley	UCF	407-823-0631	tbradley@physics.ucf.edu
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11	Todd Lindner	JAA	904-741-2228	TLINDNER@JAA.AERO

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12	Tony Cugno	JAA	741-2075	tcugno@JAA.AERO
13	Rusty Chandler	JAA	573-1613	RCHANDLER@JAA.AERO
14	Alberta Hipps	Hipps Group Inc.	904-781-2654	alberta@hippsgroupinc.com
15	Rosa Beckett	JAA	904 573 1604	rbeckett@jaa.aero
16	Kimberly Hair	JAA	904 741 8743	khair@jaa.aero
17	Bill Sandifer	RS&H	904.256.2108	bill.sandifer@rsandh.com
18	KEN IBOLD	RS&H	904 256 2297	ken.ibold@RSANDH.COM
19				
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APPENDIX B
SPACEPORT OPERATOR QUESTIONNAIRE

Cecil Spaceport Master Plan Operator Questionnaire

The Jacksonville Aviation Authority is developing a Spaceport Master Plan to identify the facility requirements and any other issues necessary to support the operations of suborbital horizontal reusable launch vehicles (RLV) from the Cecil Airport in Jacksonville Florida. The baseline flight profile provides arrival and departure routes to and from an Offshore Warning Area in the Atlantic Ocean that has been coordinated for spaceflight operations. The Jacksonville Aviation Authority received a Spaceport Operations license from the FAA in January 2010 for these operations.

We have followed the development of your RLV and would like your input to insure that your vehicle could operate at Cecil at some time in the future. We would appreciate your assistance with answering the following questions:

1. Cecil has a 12,500 foot long by 200 foot wide runway. Will this runway accommodate your vehicles expected operational requirements?

2. The designated ignition point for RLV operations is currently located approximately 105 nmi (120 mi) from Cecil Field. Can you RLV make it to this point, if not what is the maximum distance that you can support?

3. Will your vehicle use any propellants that will require special facilities or handling? Please describe what will be required.

4. What ground support equipment is required to support your RLV? What are the facility requirements to store/support this equipment?

5. Are there any specialized facilities required to assemble or ready your vehicle for launch?

6. What size hangar facility will be required to house your vehicle?

7. Are any specialized facilities required for staff, crew, passengers, visitor viewing or media?

8. Does your vehicle provide the future capability to support small orbital payload missions?

9. Are any specialized facilities required for payload storage or preparation?

10. Are any specialized facilities required during the RLV mission to monitor vehicle/crew/passenger performance during flight? What are the requirements of the facility?

11. The Jacksonville area has ample hotel and guest accommodations with access to many tourist activities. Are there any specialized facilities or activities that your operation would require?

12. Can you provide an estimate of when you will begin full operational testing of your vehicle and when you anticipate having a certified vehicle for flight?

13. Can you provide a point of contact we can follow-up with on your operational requirements?

APPENDIX C
COST ESTIMATES

CECIL FIELD AIRPORT

SPACEPORT MASTER PLAN

APPROACH ROAD EXTENSION (PHASE 2)

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$542,377.50
	Safety and Security	1	LS		$116,223.75
	Project Survey and Stakeout	1	LS		$116,223.75
	Temporary Construction Items	1	LS		$426,153.75
	EARTHWORK & ENVIRONMENTAL (ROADWAY)				
	Remove Existing Fence	900	LF	$30.00	$27,000.00
	Clearing and Grubbing	13.0	AC	$7,500.00	$97,500.00
	Unclassified Excavation	67,000	CY	$5.00	$335,000.00
	Borrow Excavation	39,350	CY	$10.00	$393,500.00
	Silt Fence	13,000	LF	$2.50	$32,500.00
	Seeding and Mulching	7.00	AC	$3,000.00	$21,000.00
	Sodding	38,500	SY	$2.50	$96,250.00
	Fencing	12,000	LF	$30.00	$360,000.00
	EARTHWORK & ENVIRONMENTAL (SITE DEVELOPMENT AREA)				
	Clearing and Grubbing	125.0	AC	$7,500.00	$937,500.00
	Unclassified Excavation	233,500	CY	$5.00	$1,167,500.00
	Borrow Excavation	233,500	CY	$10.00	$2,335,000.00
	Silt Fence	7,600	LF	$2.50	$19,000.00
	Seeding and Mulching	125.00	AC	$3,000.00	$375,000.00
	PAVING				
	Compact Existing Subgrade	18,100	SY	$2.50	$45,250.00
	Limerock Base Course, 8" Thick (Roadway)	17,400	SY	$15.00	$261,000.00
	Superpave AC, Traffic C" Thick (Taxiway)	1,500	TONS	$120.00	$180,000.00
	Sidewalk	4,150	SY	$45.00	$186,750.00
	Pavement Marking	19,000	SF	$1.50	$28,500.00
	DRAINAGE				
	Storm Drainage System	1	LS	$850,000.00	$850,000.00
	Roadway: Subtotal of Probable Construction Cost				**$4,115,229**
	Site Development Area: Subtotal of Probable Construction Cost				**$4,834,000**
	15% Construction Cost Contingency				**$1,342,384**
	15% Estimated Design Fee				**$1,543,742**
	Total Probable Phase 2 Roadway Expansion Cost				**$11,835,355**

CECIL FIELD AIRPORT

SPACEPORT MASTER PLAN

APPROACH ROAD EXTENSION (PHASE 2) UTILITIES

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.

RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$73,059.00
	Safety and Security	1	LS		$15,655.50
	Project Survey and Stakeout	1	LS		$15,655.50
	Temporary Construction Items	1	LS		$57,403.50
	UTILITIES				
	8" PVC Water Main	6,300	LF	$50.00	$315,000.00
	4" PVC Water Main	350	LF	$40.00	$14,000.00
	Fire Hydrant Assembly	13	EA	$5,000.00	$65,000.00
	8" Gate Valve and Box	13	EA	$1,400.00	$18,200.00
	4" Gate Valve and Box	4	EA	$1,000.00	$4,000.00
	10" PVC Sanitary Sewer	6,300	LF	$55.00	$346,500.00
	8" PVC Sanitary Sewer	840	LF	$50.00	$42,000.00
	Sanitary Sewer Manhole	16	EA	$4,000.00	$64,000.00
	Lighting	1	LS	$175,000.00	$175,000.00
	UTILITIES (DESIGN ALTERNATE)				
	4" PVC Sanitary Force Main	3,000	LF	$40.00	$120,000.00
	Sanitary Lift Station	1	LS	$150,000.00	$150,000.00

Roadway Utilities: Subtotal of Probable Construction Cost	**$1,205,474**
Roadway Utilities Design Alternate: Subtotal of Probable Construction Cost	**$270,000**
15% Construction Cost Contingency	**$221,321**
15% Estimated Design Fee	**$254,519**
Total Probable Phase 2 Roadway Expansion Utilities Cost	**$1,951,314**

CECIL FIELD AIRPORT
SPACEPORT MASTER PLAN
Lynx Hangar Development

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$189,828.10
	Safety and Security	1	LS		$40,677.45
	Project Survey and Stakeout	1	LS		$40,677.45
	Temporary Construction Items	1	LS		$149,150.65
	EARTHWORK & ENVIRONMENTAL				
	Remove Existing Fence	200	LF	$30.00	$6,000.00
	Unclassified Excavation	2,700	CY	$5.00	$13,500.00
	Borrow Excavation	5,500	CY	$10.00	$55,000.00
	Silt Fence	5,000	LF	$2.50	$12,500.00
	Seed and Mulch	3	AC	$3,000.00	$9,000.00
	PAVING				
	12" Compacted Existing Subgrade	27,430	SY	$2.50	$68,575.00
	Airside				
	Econocrete Base Course (6" Thick)	24,100	SY	$25.00	$602,500.00
	Concrete Pavement (15" Thick)	21,750	SY	$70.00	$1,522,500.00
	8" Portland Cement Concrete	2,330	SY	$70.00	$163,100.00
	Pavement Marking	1,250	SF	$1.50	$1,875.00
	Pavement Marking (Black Enhance)	2,600	SF	$0.50	$1,300.00
	Landside				
	10" Limerock Base Course	1,940	SY	$17.00	$32,980.00
	Superpave AC, Traffic Level "C"	225	TONS	$120.00	$27,000.00
	DRAINAGE				
	24" RCP, Class III	105	LF	$100.00	$10,500.00
	36" RCP, Class III	1,100	LF	$110.00	$121,000.00
	Drainage Inlet	4	EA	$3,000.00	$12,000.00
	Aircraft Rated Drainage Manhole	2	EA	$9,000.00	$18,000.00
	MISCELLANEOUS (LANDSIDE)				
	New Chainlink Fence	1,150	LF	$30.00	$34,500.00
	Parking Lot Lighting System	1	LS	$15,000.00	$15,000.00
	Parking Lot Miscellaneous (wheel stops, striping, etc…)	1	LS	$10,000.00	$10,000.00
	Landscaping	1	LS	$10,000.00	$10,000.00
	Airside: Subtotal of Probable Construction Cost				**$3,037,684**
	Landside: Subtotal of Probable Construction Cost				**$129,480**
	15% Construction Contingency				**$475,075**
	15% Estimated Design Fee				**$546,336**
	Total Probable Construction Cost				**$4,188,574**

CECIL FIELD AIRPORT

SPACEPORT MASTER PLAN

Virgin Galactic Hangar Development

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

RS&H IMPROVING YOUR WORLD Reynolds, Smith and Hills, Inc.

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$205,933.00
	Safety and Security	1	LS		$44,128.50
	Project Survey and Stakeout	1	LS		$44,128.50
	Temporary Construction Items	1	LS		$161,804.50
	EARTHWORK & ENVIRONMENTAL				
	Remove Existing Fence	300	LF	$30.00	$9,000.00
	Unclassified Excavation	4,275	CY	$5.00	$21,375.00
	Borrow Excavation	7,750	CY	$10.00	$77,500.00
	Silt Fence	4,400	LF	$2.50	$11,000.00
	Seed and Mulch	3.5	AC	$3,000.00	$10,500.00
	PAVING				
	Airside				
	12" Compacted Existing Subgrade	29,200	SY	$2.50	$73,000.00
	Econocrete Base Course (6" Thick)	23,975	SY	$25.00	$599,375.00
	Concrete Pavement (15" Thick)	23,975	SY	$70.00	$1,678,250.00
	8" Portland Cement Concrete	2,700	SY	$70.00	$189,000.00
	Pavement Marking	1,300	SF	$1.50	$1,950.00
	Pavement Marking (Black Enhance)	2,600	SF	$0.50	$1,300.00
	Landside				
	10" Limerock Base Course	2,300	SY	$17.00	$39,100.00
	Superpave AC, Traffic Level "C"	270	TONS	$120.00	$32,400.00
	Curb and Gutter	1,420	LF	$20.00	$28,400.00
	DRAINAGE				
	24" RCP, Class III	105	LF	$100.00	$10,500.00
	36" RCP, Class III	900	LF	$110.00	$99,000.00
	Drainage Inlet	4	EA	$3,000.00	$12,000.00
	Aircraft Rated Drainage Manhole	2	EA	$9,000.00	$18,000.00
	MISCELLANEOUS (LANDSIDE)				
	New Chainlink Fence	1,210	LF	$25.00	$30,250.00
	Parking Lot Lighting System	1	LS	$15,000.00	$15,000.00
	Parking Lot Miscellaneous (wheel stops, striping, etc…)	1	LS	$10,000.00	$10,000.00
	Landscaping	1	LS	$10,000.00	$10,000.00
				Airside: Subtotal of Probable Construction Cost	**$3,267,745**
				Landside: Subtotal of Probable Construction Cost	**$165,150**
				15% Construction Contingency	**$514,934**
				15% Estimated Design Fee	**$592,174**
				Total Probable Construction Cost	**$4,540,003**

CECIL FIELD AIRPORT
SPACEPORT MASTER PLAN
RocketPlane Hangar Development
ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST
September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$185,632.48
	Safety and Security	1	LS		$39,778.39
	Project Survey and Stakeout	1	LS		$39,778.39
	Temporary Construction Items	1	LS		$145,854.09
	EARTHWORK & ENVIRONMENTAL				
	Remove Existing Fence	300	LF	$30.00	$9,000.00
	Unclassified Excavation	5,650	CY	$5.00	$28,250.00
	Borrow Excavation	9,500	CY	$10.00	$95,000.00
	Silt Fence	5,000	LF	$2.50	$12,500.00
	Seeding and Mulching	4	AC	$3,000.00	$12,000.00
	PAVING				
	Airside				
	12" Compacted Existing Subgrade	23,900	SY	$2.50	$59,750.00
	Econocrete Base Course (6" Thick)	21,110	SY	$25.00	$527,750.00
	Concrete Pavement (15" Thick)	21,110	SY	$70.00	$1,477,700.00
	8" Portland Cement Concrete	2,220	SY	$70.00	$155,400.00
	Pavement Marking	1,125	SF	$1.50	$1,687.50
	Pavement Marking (Black Enhance)	2,250	SF	$0.50	$1,125.00
	Landside				
	10" Limerock Base Course	1,940	SY	$17.00	$32,980.00
	Superpave AC, Traffic Level "C"	225	TONS	$120.00	$27,000.00
	Curb and Gutter	1,350	LF	$20.00	$27,000.00
	DRAINAGE				
	24" RCP, Class III	105	LF	$100.00	$10,500.00
	36" RCP, Class III	900	LF	$110.00	$99,000.00
	Drainage Inlet	4	EA	$3,000.00	$12,000.00
	Aircraft Rated Drainage Manhole	2	EA	$9,000.00	$18,000.00
	MISCELLANEOUS (LANDSIDE)				
	New Chainlink Fence	1,210	LF	$25.00	$30,250.00
	Parking Lot Lighting System	1	LS	$15,000.00	$15,000.00
	Parking Lot Miscellaneous (wheel stops, striping, etc…)	1	LS	$10,000.00	$10,000.00
	Landscaping	1	LS	$10,000.00	$10,000.00

Airside: Subtotal of Probable Construction Cost	**$2,930,706**
Landside: Subtotal of Probable Construction Cost	**$152,230**
15% Construction Contingency	**$462,440**
15% Estimated Design Fee	**$531,806**
Total Probable Construction Cost	**$4,077,183**

CECIL FIELD AIRPORT
SPACEPORT MASTER PLAN
TAXIWAY E CONSTRUCTION/TAXIWAY "B" RECONSTRUCTION

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$857,967.25
	Safety and Security	1	LS		$183,850.13
	Project Survey and Stakeout	1	LS		$183,850.13
	Temporary Construction Items	1	LS		$674,117.13
	EARTHWORK & ENVIRONMENTAL				
	Unclassified Excavation	6,000	CY	$5.00	$30,000.00
	Borrow Excavation	88,300	CY	$10.00	$883,000.00
	Silt Fence	7,800	LF	$2.50	$19,500.00
	Seeding and Mulching	48.00	AC	$3,000.00	$144,000.00
	Sodding	155,000	SY	$2.50	$387,500.00
	PAVING				
	Bituminous Pavement Removal	32,050	SY	$6.00	$192,300.00
	Compact Existing Subgrade	98,750	SY	$2.50	$246,875.00
	Econocrete Base Course (6" Thick)	97,700	SY	$25.00	$2,442,500.00
	Concrete Pavement (15" Thick)	96,600	SY	$70.00	$6,762,000.00
	Pavement Marking	9,000	SF	$1.50	$13,500.00
	Pavement Marking (Black Enhance)	21,000	SF	$0.50	$10,500.00
	DRAINAGE				
	Storm Drainage System	1	LS	$425,000.00	$425,000.00
	AIRFIELD ELECTRICAL				
	Airfield Electrical System	1	LS	$700,000.00	$700,000.00
				Subtotal of Probable Construction Cost	**$13,456,460**
				15% Construction Contingency	**$2,018,469**
				15% Estimated Design Fee	**$2,321,239**
				Total Probable Construction Cost	**$17,796,168**

CECIL FIELD AIRPORT

SPACEPORT MASTER PLAN

RUNWAY 18L-36R RECONSTRUCTION

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE CONSTRUCTION COST

September 16, 2011

Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	ITEM COST
	GENERAL				
	Mobilization and General Conditions	1	LS		$2,344,762.00
	Safety and Security	1	LS		$502,449.00
	Project Survey and Stakeout	1	LS		$502,449.00
	Temporary Construction Items	1	LS		$1,842,313.00
	EARTHWORK & ENVIRONMENTAL				
	Unclassified Excavation	30,000	CY	$5.00	$150,000.00
	Silt Fence	20,000	LF	$2.50	$50,000.00
	PAVING				
	Bituminous Pavement Removal	167,900	SY	$6.00	$1,007,400.00
	Concrete Pavement Removal	110,050	SY	$12.00	$1,320,600.00
	Compact Existing Subgrade	280,600	SY	$2.50	$701,500.00
	Econocrete Base Course (6" Thick)	277,800	SY	$25.00	$6,945,000.00
	Concrete Pavement (15" Thick)	277,800	SY	$70.00	$19,446,000.00
	Runway Grooving	249,600	SY	$1.50	$374,400.00
	Pavement Marking	158,500	SF	$1.50	$237,750.00
	Pavement Marking (Black Enhance)	27,900	SF	$0.50	$13,950.00
	DRAINAGE				
	Storm Drainage System	1	LS	$100,000.00	$100,000.00
	AIRFIELD ELECTRICAL				
	Airfield Electrical System	1	LS	$3,150,000.00	$3,150,000.00
				Subtotal of Probable Construction Cost	**$35,538,573**
				15% Construction Contingency	**$5,330,786**
				15% Estimated Design Fee	**$6,130,404**
				Roadway: Total Probable Construction Cost	**$46,999,763**

CECIL FIELD AIRPORT

SPACEPORT MASTER PLAN

VISITOR CENTER BUILDING

October 25, 2011

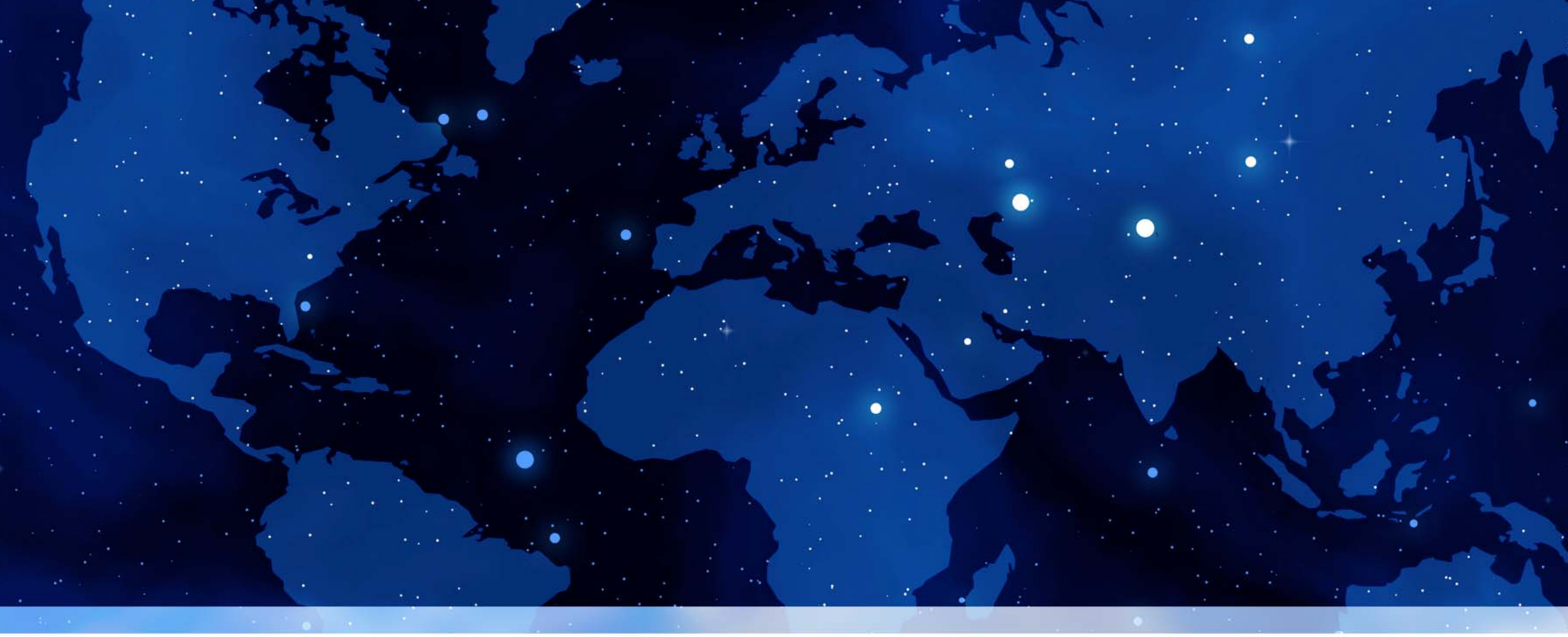
Prepared By: Reynolds, Smith and Hills, Inc.
JAA Project No.
RS&H Project No. 201-7262-028

RS&H IMPROVING YOUR WORLD Reynolds, Smith and Hills, Inc.

ITEM	NEW/REPLACEMENT TERMINAL FACILITY COSTS	AREA/TYPE	UNIT	S.F. COST	TOTAL
	Visitor Center				
	Building Terminal - Enclosed Space	5,000	s.f.	$255.00	$1,275,000.00
	Building Terminal - Canopy Area	500	s.f.	$95.00	$47,500.00
	Building Site Prepearation	Allowance			$50,000.00
	Site Utilities	Allowance			$75,000.00
	Pre-Contingency Building Cost				$1,447,500.00
	Project Contingency	15%			$217,125.00
	Total Construction Cost Estimate (Excluding A/E and Permit Fees) (Includes Contract Bond, Markups and Overhead and Profit)				**$1,664,625.00**

Comparable Terminal Actual Costs

	TERMINAL / YEAR BUILT	BID PRICE	AREA	S.F. COST	NOTES
	Greenville-Spartanburg International Airport / 2010	$1,250,000	4,864	$257.00	New GA Terminal Building
	Lynchburg Regional Airport / 2009	$1,222,000	5,557	$220.00	New ARFF Building
	Asheville Regional Airport / 2009	$7,849,000	31,223	$251.00	Landside Terminal Expansion
	Saint George Municipal Airport	$6,482,751	33,557	$193.00	New Passenger Terminal Building



RS&H

IMPROVING YOUR WORLD

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