Final Report

Florida Department of Environmental Protection's Large Scale Orthoimagery Feasibility Study

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Recommendations for improvements to available imagery: Orthoimagery serves practically all sections within the Florida Department of Environmental Protection (DEP). The business operations can be broadly categorized into inspections of features and habitat analysis. Digital Orthophoto Quarter Quads (DOQQ's) that capture color infrared (cir) imagery serves the later category, but it is only minimally meeting the needs of the former because of its 5-year acquisition cycle, delivery time lag, and resolution (1 M). Improvements in the currency of imagery (1 to 3 year) and to a lesser degree resolution, according to the image feasibility survey, can save 33 man years per year, principally in the sections that are responsible of regulations and inspections. More current imagery allows users to conduct *desktop site visits* significantly expediting many business operations. One-foot pixel resolution is desirable and needed for business functions in certain sections in DEP (Mining, Beaches and Shores, and Drinking Water). Panchromatic image type is an acceptable format to address business needs where currency is critical. Those sections that need color infrared for vegetation analysis have the 1994 and 1999 DOQQ's and a 2004 acquisition of DOQQ's is in progress. Currency does not appear to be as critical an issue for those business operations. Projection is not an issue with most users in DEP with the exception of State Lands which requires a State Plane Coordinate Projection.

The only source of imagery that meets the currency criteria is the large-scale imagery being collected for the county Property Appraiser by DOR. This imagery is collected at a 1-foot pixel resolution on a 3-year cycle. DOR has funding to create orthoimagery for approximately half of the counties that it collects imagery for in a given year. For a minimal cost, in comparison to cost of acquisition, existing imagery can be compiled into a statewide coverage that meets many of the regulatory and inspection needs (see *Strategy)*. This will provide imagery for 43 counties that represent 90% of the population.

The 2004 DOQQ acquisition will probably be the last 1-meter statewide acquisition. An effort is underway to develop a *Statewide Large-scale Orthoimagery Program (LSOP)* that will replace the DOQQ program and address both business needs of currency and image type. DOR's effort forms the foundation for LSOP. The following summarizes needed improvements: 1) acquire all counties as an orthoimagery product on a 3 year cycle; 2) each flying season will need to acquire contiguous county coverage; 3) the image type will need to provide a color infrared product; and 4) the image needs to be collected in a standard format. In addition to acquisition, consideration will need to be given to maintenance, documentation, distribution, and archiving. DEP BIS should

participate in the LSOP Workgroup to develop a program that will achieve these objectives.

Strategy

1. Acquire Albers projection for the 43 orthorectified counties. Co-process the projection in conjunction with DOT's projection of UTM. The estimated cost is $25,000.
2. Georeference Option 1: Acquire Albers projection for 24 georeferenced counties. Acquire the 24 georeferenced counties from DOT and convert to Albers. Some of the WMD's have expressed interest and may be willing to co-fund counties in their districts. The cost of twenty-four counties at $1,740/county is approximately $40,000.
3. Georeference Option 2: DOR will be acquiring orthoimagery for twenty-three counties in the 2003-04 flying season. Of those twenty-three, twelve counties do not currently have orthoimagery (Table C). Do not acquire georeferenced data for those counties, but wait until the orthoimagery is complete and create an Albers projection for these counties in the second year. This will delay the availability of these counties for only 6 to 9 months at a savings of $23,000. Users should be informed of this decision to determine if there is a significant benefit to have this imagery available 9 to 12 months earlier. *Note: The USGS may acquire large scale orthoimagery for Duval County in 2003-04.*
4. Determine if there is an interest from other sections in DEP to co-fund the acquisition or processing of imagery. Likely candidates are Mining, Beaches and Shores, and the regulatory sections.
5. Support the Florida Department of Revenue's Legislative Budget Request for orthoimagery for FY 2004-05.
6. Continue to participate with the Large-scale Orthoimagery Program Workgroup
7. Coordinate with the WMD's to implement Phase 2 option for orthoimagery acquisition and processing for FY 2004-05.
8. Anticipate conversion of 2004-05 imagery. Coordinate with the WMD's to co-fund processing and documentation.
9. Assess requirements, options, and costs of a Map Server/Map Library for historical imagery.
10. Assess requirements for archiving imagery.
11. Contact DOT to determine their willingness to create decade snap shot coverages of historical imagery.

Current Status:

- *DOR Schedule:* DOR has a program to collect large-scale orthoimagery for counties on a three-year cycle. Most of the imagery is collected as panchromatic at a 1-foot pixel resolution. They anticipate acquiring all of the imagery in FY 2003-04 as orthoimagery, but they currently have the funds to acquire only half of the imagery as ortho's in FY 2004-05. In the higher density areas counties are collecting data on a one and two year cycle, sometimes as color, sometimes at a

resolution better than one foot. All county imagery is being collected in State Plane Coordinates. The current schedule does not provide contiguous coverage.

- *Available Orthoimagery:* Currently forty-two counties have orthoimagery, with one county having rectified their imagery in-house. This makes orthoimagery available for forty-three counties. All of the more populated counties, with the exception of Duval County, have large-scale orthoimagery that is less than 3 years old.
- *DOT Conversion Imagery Project:* DOT is converting all of their imagery, back to the 1940's, into a digital format. Imagery that is not orthorectified is being georeferenced to quad sheets providing a horizontal accuracy of plus or minus 70ft.
- *DOQQ Acquisition 2003-04:* A third set of DOQQ's is currently underway with flights anticipated during the 2003-04 flying season. This is a cooperative effort between DEP, WMDs and the United States Geological Survey (USGS). This acquisition will probably use a digital camera, which will provide a multi-spectral product and faster turn around time.
- *Co-processing Opportunity:* DOT Planning is acquiring the first generation projection for the forty-three counties with existing orthoimagery. This provides an opportunity for DEP to co-process their projection at a cost savings.
- *Duval County Large-scale Orthoimagery Acquisition:* The USGS, as a part of the acquisition of data for the 133 cities, may be acquiring imagery for Duval County in the 2003-04 flying season. If this occurs it will be a new acquisition and should be figured into *Strategy 3*.

Return on Investment: The *Orthoimagery Feasibility Study* survey that was sent to the users focused on the value of improved imagery, specifically asking each work group to provide examples and overall savings/cost avoidance that could be acquired with improved imagery. Twenty-eight of the fifty-eight respondents indicated that they would save, in total, 67,000 hours per year or approximately 33 man years annually. A number of intangibles that would provide significant cost avoidance were also identified but due to the nature of the benefits they could not be calculated into cost savings. Specific examples are provided in the *Return on Investment Report*.

Cooperative Activities and Funding:

- DOR is currently funded at $675,000 per year to acquire imagery for counties. They require an additional $800,000 to ensure a uniform statewide zoned coverage. They anticipate making a request to legislature for FY 2004-05 for the needed funds.
- DEP and the Water Management Districts are moving forward with the acquisition of the 2004 DOQQ's. This image database is valuable because it is: a) statewide; b) collected in a single season; and c) it will collect imagery either as color-infrared or multi-spectral. The current county imagery does not provide contiguous coverage and very few counties collect true color or cir. This makes multi-county analysis difficult at best.

- The DOQQ acquisition, as previously mentioned, is a cooperative effort between DEP, WMD's and the USGS. This effort will reduce available funding for cooperative acquisition in FY 2003-04. Fortunately DOR anticipates having enough resources this year through cooperative projects with the counties to acquire all of the counties on the schedule as orthoimagery.
- The Water Management Districts do have an interest in entering into cooperative funding with DOR and in the processing of the data if their requirements can be met for CIR or multi-spectral acquisition and the flight schedule can be arranged to acquire contiguous zone coverages.

Processing: Once the data is acquired it needs to be mosaicked/tiled and converted into projections needed by the users. The estimated first time conversion of all sixty-seven counties is $120,000. The cost for the forty-three counties with existing ortho-imagery is $75,000, a second projection is $37,500, and co-processing a second projection is $25,000. Estimated turn around time is 6 months. The Florida Department of Transportation (DOT) currently has a project underway to re-project the forty-three counties to UTM Zone 17, producing the first generation projection for the state. DEP is the only agency that uses an Albers projection; the best opportunity for cost savings in 2003-04 is through co-processing the Albers projection with DOT's project.

User needs: The *Image Feasibility Survey* found that there is great value to having imagery that is one to three years old as opposed to DOQQ's, which are as much as four years old by they time they are delivered. Resolution does have significant value to some sections of DEP. The principle users in each of the regulatory sections were asked to weigh the advantages of currency against resolution. The results are illustrated in the Table 1.

Importance of Currency vs. Resolution		
Section	***Currentness of Imagery***	***Resolution***
ERP	90 – 80	20 - 10
WAFR	50	50
Drinking Water	20 – 30	80 - 70
Waste Management	25	75

Table 1 Comparing the importance of currency to resolution by section

The examples from each of the sections were based on the type of benefits would come from access to better imagery. Table 2, next page, illustrates those results.

Summary of the Classification of Benefits from Examples Provided on the Survey				
Category	**Hours per Year**	**Hours per Event**	**Count of Primary**	**Count All**
Desk Visits	33,605	279	33	33
Faster Results	2,000	412	5	22
Reduce permittee reporting requirements	1,000	3	3	7
Historic Verification	240	49	7	10
Reduce permiter reporting time	240	1	2	6
Map Creation & Quality	200	303	3	15
Acquisition of Feature Coordinate	200	0	1	2
Reconnaissance	100	116	5	9
Identification of Key Features	53	127	11	15
Measuring	0	106	2	3
PR and Demonstrations	0	10	2	6
Public Communication	0	8	1	10
Total	37,638	1,414	75	138

Table 2 Benefits by category in hours per year and event. Counts are of survey participants

Storage: Imagery requires a considerable amount of storage. Raw data for a statewide color infrared coverage is estimated at 5 terabytes. This can be substantially reduced by using only a single band, compressing the data, and reducing the resolution of the coverage. It is estimated that a statewide coverage of panchromatic imagery at 1.25 ft resolution would be 50 mb. Appendix B provides a table with more details on the storage requirements.

Partnerships within DEP: DEP's Mining and Beaches and Shores sections have a need for large-scale imagery. They have indicated a willingness to co-fund some of the imagery acquisition if it meets their business needs. The regulatory sections will derive great benefit from improved imagery and should be consulted if there is a need for additional funds.

Statewide Large-scale Orthoimagery Program: There is considerable interest by the Florida Department of Revenue (DOR), the Water Management Districts (WMD), DOT, and the Florida Department of Agriculture and Consumer Service (DOACS) in the development of a statewide program that is housed within a single agency. Many of the elements are in place but they are spread over three agencies: DOR provides contract management and is the liaison with the county Property Appraisers; DEP's Surveying and Mapping section provides technical support for improving ground control; and DOT,

as a part of its surveying and mapping activities, acquires approximately half of the county coverage for DOR. A statewide program will need to take into consideration acquisition, standards, processing, documentation, distribution, imagery library, archiving, and a liaison with state and local governments. A *Large-scale Orthoimagery Program* workgroup has been organized to develop a program and bring a proposal to the Legislature in the next three to five years. In the short-term some of these components can be funded through cooperative efforts with DEP and the WMDs, but there is a general consensus in the workgroup that an adhoc funding effort can not be sustained for more than a couple of years. A draft strategy has been developed; see *Draft Statewide Large-scale Orthoimagery Acquisition Program.*

Coverage: Appendix C provides a summary of the available imagery. A more detailed listing is included in *Imagery Inventory and Recommendations.* Forty-three counties are available this year and twelve of the twenty-three counties that will be acquired in FY 2003-04 will be in counties that currently do not have orthoimagery. The USGS, as a part of mapping of 133 cities, may be acquiring large-scale imagery for Duval County and parts of Nassau County in the coming year. Neither county has imagery at this time. That brings the total to 13.5 new counties that will be acquired in the FY 2003-04 flying season that can be brought online beginning in July 2004.

Georeferenced Images: DOT will be converting all of their imagery and georeferencing it to the USGS quads. This imagery goes back to the 1940's and it is estimated to take five years. The imagery is georeferenced to the USGS quad sheets in a state plane coordinate system with an accuracy of plus or minus 70 ft, but it is not processed into county coverages. They are beginning from the current date and working back sequentially until they are all complete. There are two considerations. 1) Historical imagery was identified by the regulatory sections as being highly important to their business operations. They would like to go back as far as possible to address "grandfather" clauses in legislation. DOT might be willing to change their schedule to acquire a decade snapshot. Some of the Water Management Districts are initiating projects to acquire a decade snapshot for their jurisdiction. 2) A second issue is that the horizontal accuracy of the imagery that is being georeferenced by DOT could be improved if there was better ground control. Teddy Harris at DOT says that 15 to 20 points per county would improve the horizontal accuracy from 70 ft to 10 ft. The cost per point is approximately $250[1]. The historical data will provide some challenges, but it may be worth exploring further. Improved ground control would certainly provide greater accuracy for the more recent georeferenced imagery.

[1] Vendor response to a Suwannee River Water Management District Request for Proposal (RFP) for ground control.

Appendix A
Estimated Costs Tables

Estimated costs for Imagery acquisition					
• *Ortho 1st gen +*	$220/sq mile 1/3 state = 18,000 sq miles`		3,960,000	3,960,000	
• *Otho 2nd gen*[2]	$120/sq mile – 1/3 state		2,160,00	2,160,000	
• *Acquisition from counties on 1 and 2 year cycle*		6,500	6,500	6,500	
• *Improve Georeferenced data*		0	0	0	
Processing costs are based on 43 counties that currently have orthoimagery.					
• *1st year start up*	Hardware	0	13,0000	0	
• *1st year start up*	Software	0	12,0000	0	
• *Processing 1st projection*	1st projection	75,000	75,000	75,000	
• *Processing 2nd projection*	2nd projection	37,500	37,500	37,500	
• *Co-processing*		25,000	25,000	25,000	
• *Processing*	State Plane - jpg	20,000	20,000	20,000	
• *Processing*	IMG -> 2nd format	7,500	7,500	7,500	
Totals					
Georeferenced Counties (24)	$1,750 per county				
Distribution	The preferred format for distribution is with a portable hard drive. The cost of producing DVD's for statewide coverage is $2,500.				
Available Funds for Image Acquisition		02-03	03-04	04-05	
• ***DOR Program***	Imagery acquisition	675,000	675,000	675,000	
• ***DOR LBR***				800,000	
Available Resources for Processing statewide coverage					
• ***DOT Planning***	Processing 1st projection: UTM Zone 17				

[2]Digital Terrain Models: 15 to 20 counties have DTM's better than the USGS.

Appendix B
Storage Requirements

Derived from DOQ storage estimates provided Eric	***Description***	***Value***	***Units***
DOQQ - 99 - jpg - Statewide coverage	40 gigabytes		
1 band = State coverage / # bands	40 by 3	13.3	gb
1 meter = sq ft/m	10.75 ft		
Estimate of storage requirements			
1 band at 1 foot = sq ft/m * gigabytes/band	10.76 * 13.3	143.0	sq ft/m
Calculation of storage requirements for Statewide DOQQ's			
1 DOQ = 150 mb 3 band	4000 DOQ's * 150 mb	600,000	mb
10 to 1 compression		60,000	mb
20 to one compression		30,000	mb
Calculation of storage requirements for statewide panchromatic (single band) and multispectral (3 band) imagery			
3 band image @ 1 ft resolution - 66,400 images -75 mb/image -5.00 - Terabytes			
	Terabytes Panchromatic (Single Band)	***Terabytes Multispectral (Three band)***		
Storage for 1 Foot Resolution				
1 band image (Terabytes/3)	1.667	5.00		
10:1 compression	0.170	0.51		
20:1 compression	0.085	0.255		
Storage for 1.25 Foot Resolution				
1.25 Ft resolution = File size/1.56				
10:1 compression	0.109	0.327		
20:1 compression	0.054	0.163		
Storage for 1.5 Foot Resolution				
1.5 ft resolution File Size/2.25				
10:1 compression	0.076	0.227		
20:1 compression	0.038	0.113		
Storage for 2 Foot Resolution				
2 ft resolution File Size/ 4				
10:1 compression	0.043	0.128		
20:1 compression	0.021	0.064		
Storage for 1 Meter Resolution				
1 Meter resolution File size/10.76				
10:1 compression	0.016	0.047		
20:1 compression	0.008	0.024		

Appendix C
Available Orthoimagery

Draft Contiguous Coverage and Current Flight Schedule

COUNTY NAME	Sq.Miles		1st year contiguous	2nd year contiguous	3rd year contiguous	Currently Exists	Curent Schedule 2003-04	Current Schedule 2004-05	Current Schedule - 2005-06	% Population in Counties w Imagery	% Population in Counties wo Imagery
ALACHUA	902	217955	902			x	x			0.014	
CHARLOTTE	705	141627		705		x	x			0.009	
CITRUS	570	118085		570		x	x			0.007	
CLAY	598	140814		598		x	x			0.009	
LAKE	954	210528		954		x	x			0.013	
LEVY	1100	34450		1100		x	x			0.002	
OKALOOSA	944	170498	944			x	x			0.011	
OSCEOLA	1350	172493			1350	x	x			0.011	
PASCO	751	344765		751		x	x			0.022	
WAKULLA	614	22863	614			x	x			0.001	
DESOTO	648	32209		648			x				0.002
FRANKLIN	545	11057	545				x				0.001
GILCHRIST	354	14437	354				x				0.001
HARDEE	630	26938		630			x				0.002
HERNANDO	585	130802		585			x				0.008
HOLMES	483	18564	483				x				0.001
JACKSON	932	46755	932				x				0.003
LIBERTY	838	7021	838				x				0.000
SANTA ROSA	1032	123135	1032				x				0.008
UNION	240	13442	240				x				0.001
WALTON	1046	40601	1046				x				0.003
WASHINGTON	597	20973	597				x				0.001
Subtotal						**10**				**0.10**	**0.03**
BREVARD	1031	476230			1031	x		x		0.030	
BROWARD	1218	1623018			1218	x		x		0.102	
FLAGLER	483	49832		483		x		x		0.003	
HAMILTON	514	13327	514			x		x		0.001	
HENDRY	1187	36210			1187	x		x		0.002	
HIGHLANDS	1041	87366			1041	x		x		0.005	
LEE	803	440888		803		x		x		0.028	
LEON	685	239452	685			x		x		0.015	
MARION	1617	258916		1617		x		x		0.016	
MIAMI-DADE	2054	2253362			2054	x		x		0.141	
SARASOTA	529	192695			529	x		x		0.012	
SEMINOLE	321	117743			321	x		x		0.007	
ST. JOHNS	617	325957		617		x		x		0.020	
CALHOUN	557	13017	557					x			0.001
DIXIE	688	13827	688					x			0.001
DUVAL	777	778879		777				x			0.049
GADSDEN	508	45087	508					x			0.003
GLADES	746	10576			746			x			0.001
LAFAYETTE	543	7022	543					x			0.000
NASSAU	650	57663		650				x			0.004
SUWANNEE	677	34844	677					x			0.002
TAYLOR	1032	19256	1032					x			0.001
Subtotal						**13**				**0.38**	**0.06**

Draft Contiguous Coverage and Current Flight Schedule

COUNTY NAME	Sq.Miles		1st year contiguous	2nd year contiguous	3rd year contiguous	Currently Exists	Curent Schedule 2003-04	Current Schedule 2004-05	Current Schedule - 2005-06	% Population in Counties w Imagery	% Population in Counties wo Imagery
BAKER	585	22259	585			x			x	0.001	
BAY	753	148217	753			x			x	0.009	
BRADFORD	293	26088	293			x			x	0.002	
COLLIER	797	251377			797	x			x	0.016	
ESCAMBIA	657	294410	657			x			x	0.018	
GULF	559	13332	559			x			x	0.001	
HILLSBOROUG	1040	998948		1040		x			x	0.063	
INDIAN RIVER	512	112947			512	x			x	0.007	
JEFFERSON	598	12902	598			x			x	0.001	
MADISON	702	18733	702			x			x	0.001	
MANATEE	688	264002		688		x			x	0.017	
MARTIN	599	126731			599	x			x	0.008	
MONROE	1946	79589			1946	x			x	0.005	
ORANGE	993	896344			993	x			x	0.056	
PALM BEACH	1978	1131184			1978	x			x	0.071	
PINELLAS	264	921482			264	x			x	0.058	
POLK	1861	483924		1861		x			x	0.030	
ST. LUCIE	588	365196			588	x			x	0.023	
SUMTER	561	53345		561		x			x	0.003	
VOLUSIA	1115	443343		1115		x			x	0.028	
COLUMBIA	786	56513	786						x		0.004
OKEECHOBEE	780	35910		780					x		0.002
PUTNAM	803	70423		803					x		0.004
Subtotal						**20**				**0.42**	**0.01**
TOTAL	**54,154**	**15,982,378**	**18,664**	**18,336**	**17,154**	**43**	**22**	**22**	**23**	**0.90**	**0.10**
Average	**808**										
Median	**688**										
Total Sq. Miles of Counties with No Orthos			**6,036**	**1,040**	**-**						
Count of Counties with No Orthos			**12**	**9**	**2**						
% Sq mils of Counties with No Orthos			**0.15**	**0.11**	**0.04**						