STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT DOCUMENTATION PAGE

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16. ABSTRACT

The goal of this project was to create a test-bed to allow the University of California to conduct advanced traffic technology research in a designated, non-public, and controlled setting. Caltrans, with its associated research facilities on UC campuses, previously lacked a test-bed to conduct experimental development of advanced traffic technologies, e.g., intersection collision warning.

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Advanced Traffic Technology Test-Bed

Final Report

Division of Research
& Innovation

Report CA04-0281
December 2008

Advanced Traffic Technology Test-Bed

Final Report

Report No. CA04-0281

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Prepared For:

California Department of Transportation
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1227 O Street
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ADVANCED TRAFFIC TECHNOLOGY TEST-BED
Final Report

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Table of Contents

1. Executive Summary

The advanced traffic technology test-bed was built under Research Technical Agreement 65A0154 between the California Department of Transportation (Caltrans) and California Partners for Advanced Transit and Highways (PATH). The test-bad is located at the Richmond Field Station (RFS) of University of California at Berkeley (UC Berkeley). The goal of this project was to create a test-bed to allow the University of California to conduct advanced traffic technology research in a designated, non-public, and controlled setting. Caltrans, with its associated research facilities on UC campuses, previously lacked a test-bed to conduct experimental development of advanced traffic technologies, e.g., intersection collision warning.

A team of Caltrans engineers from District-3, located at Marysville, with the input of PATH researchers, provided the design, specification, and estimates for this test-bed. This site will be used as a communications, surveillance and human factors Test-Bed for the Intersection Decision Support project (Task Orders 4403, 5600, 5601) and for other future applications. Vehicle-to-vehicle and vehicle-to-infrastructure communications facilities and Driver-infrastructure-Interface (DII) devices will be utilized during the experiments conducted on this test-bed.

The office of Capital Projects of University of California at Berkeley supervised the bidding process as well as the actual construction of this test-bed. One outside subcontractor, Ransome Company, was selected and did the road work. A UC Berkeley electrician, Mr. Dean Gordon, was also hired to do the installation of various components of the test-bed. Fire marshals, UC Berkeley inspectors, and utility locators were hired for site assessments and quality control of this project. PATH's Project Manager, Ashkan Sharafsaleh, also supervised the building of the RFS test-bed roadwork as well as the installation of its different components. Many components used in the test-bed came from Caltrans donations. The remaining items were purchased by PATH with the exception of Microloops, which were donated by 3M.

The intersection test-bed is a unique facility in the entire Western United States. It has many distinctive features including, but not limited to, 3M Microloops installed in a longitudinal manner for the first time to provide continuous detection of approaching vehicles on one of its legs, the combination of ITS 340 Cabinet and 2070 Controller, and Driver-Infrastructure-interface or DII feature. This is the only research-designated intersection test-bed that we are aware of in the entire West Coast. This test-bed will serve Caltrans in general and the research community in particular in many productive ways for years to come.

The test-bed will be configurable to a certain degree: it can function as a signalized or non-signalized intersection by the way of covering different components of traffic signs or signals.

PATH's project manager would also like to acknowledge very significant contributions to this project from the following: Mr. Asfand Siddiqui, Mr. Steven Block, and Mr. David Hamamoto from Caltrans, Mr. Scott Shackleton and Mr. Ruben Mejia from the

Office of Capital Projects of UC Berkeley, and Mr. Ted Getchell from Richmond Field Station of UC Berkeley.

A set of design drawings in 11 x 17 paper size is folded at the end of the hard copy of this document.

2. Site Location

The intersection test-bed is a four-legged intersection with one 12-ft lane in each direction on each leg. The site is located at the intersection of Crow Drive and Owl Way of RFS. Crow Drive runs approximately east-west, and Owl Way runs approximately north-south. The intersection test-bed is a four-way intersection:

- Westbound approach runs from Egret Way to the intersection on Crow Drive
- Southbound approach runs from the PATH test track to the intersection on Owl Way
- Eastbound approach is a short segment from RFS Building 300 to the intersection on Crow Drive
- Northbound approach runs from Lark Drive to the intersection on Owl Way.

Attachment "A" shows the appearance of the site prior to the construction of this intersection test-bed.

3. Objectives

Current needs for this test-bed are:

- To test vehicle-vehicle and vehicle-infrastructure communications technologies
- To test communication architectures and protocols with *ad hoc* wireless networks involving dynamic multi-vehicle situations
- To conduct Driver-infrastructure-interface or DII experiments, with the provision of different signs and warning signals as drivers approach the test site
- To measure drivers' reactions in a controlled setting.

Future needs may encompass:

- Testing pedestrian and bicycle detection and warning technologies and algorithms.

4. Scope of work

The scope of work consisted of the following tasks:

Task 1:
Develop final plans, specification, and estimation for the test-bed. Caltrans provided PATH with preliminary plans, specification, and estimation. PATH provided Caltrans with their modifications for the final design.

Task2:
Build the test-bed at the Richmond Field Station site.

Task3:
Ascertain that the test-bed meets requirements.

5. Deliverables

Advanced Traffic Technology Test-Bed

Attachment "B" shows the site after the completion of this intersection test-bed. It also provides a picture of the ITS 340 cabinet and its components that are located at one corner of this intersection test-bed.

Attachment "C" shows a sensor diagram of RFS test-bed.

6. Schedule

This project began on January 8th, 2003 and was completed by January 8th, 2004. Concept creation and design was done in the first few months of 2003 and were mostly completed by the end of May 2003. UC Berkeley's Office of Capital Projects did the bidding and selection of subcontractors and the ground was broken in July 2003. See attachment "D" for the roadwork construction bidding results. The Ransome Co. won the subcontract with a winning bid of $83,193. It should be noted as the scope of work expanded to include the widening of Owl Way, an additional $10,185 was added to their original contract. The actual roadwork construction was completed by mid August 2003, and a complete installation of equipment components was accomplished by the end date of January 8th, 2004.

7. List of equipment

A list of equipment and construction components used at this test-bed is included as attachment "E" of this report.

8. Costs and Budget

The total budget for this project was $200,000.00. The budget was used to pay for the equipment, supervision of bidding process and construction by UC Berkeley's Office of Capital Projects, the cost of subcontractors, and the salary and benefits for Mr. Mohammad Ashkan Sharafsaleh, a PATH Development Engineer for his contribution as the project manager. An itemized list of cost expenditures is provided as attachment "F" of this report.

9. Functional Requirements

The Caltrans installed intersection at RSF will function as any standard four-legged signalized or non-signalized intersection. This intersection will be used as a communications, surveillance and human factors test-bed for the Intersection Decision Support project, as well as for other related potential applications. Vehicle-to-vehicle and vehicle-to-roadside communications facilities will be available. Moreover, driver-infrastructure-interface or DII will be part of the intersection. An erected opaque fence blocks the view of approaching drivers from the Owl Way from those approaching from the Crow Drive. This is intended to emulate real world urban intersections at which typically the view of approaching drivers is blocked by surrounding buildings. The intersection will be configurable to a certain degree; it can function as a signalized or non-signalized intersection by way of covering different components of traffic signs or signals.

9.1. During Signalized Configuration

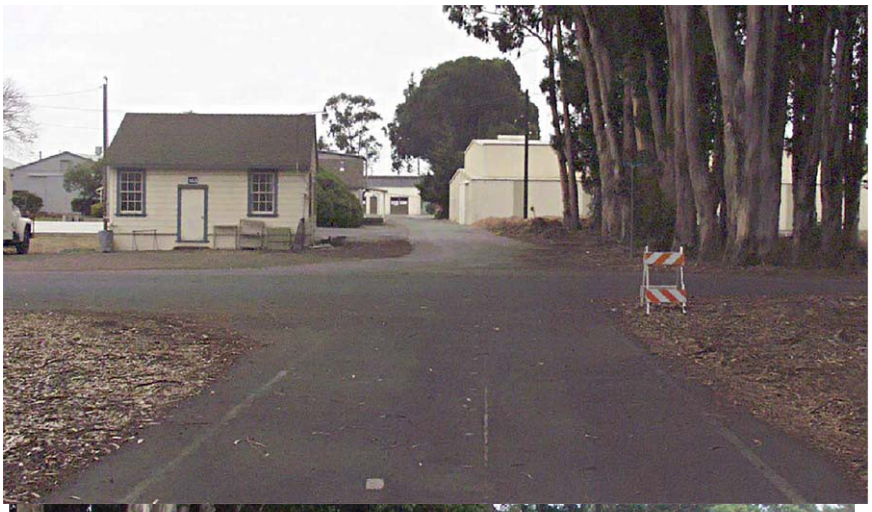
During signalized operation, a 2070 signal controller will be turned on. The duration of each cycle and its phases will be varied for different experimental scenarios. Safety and traffic condition information will be provided to the driver of the test vehicle. This information will come from vehicle –vehicle and vehicle-infrastructure communications. Also, a driver-infrastructure-interface or DII will be used to notify the driver of the oncoming traffic condition. Maximum speed for all traffic directions will be 40 mph.

9.2. During Non-Signalized Configuration

During non-signalized operation, the signal controller will be off. The intersection could function as either a no device or stop sign controlled intersection. Stop sign controlled configuration could be either two-way or four-way. Safety and traffic condition information will be provided to the driver of the test vehicle. This information will come from vehicle –vehicle and vehicle-infrastructure communications. Also, a driver-infrastructure-interface or DII will be used to notify the driver of the oncoming traffic. The maximum speed for all traffic directions will be 40 mph.

ATTACHMENT - A

The site of RFS Test-Bed before the construction



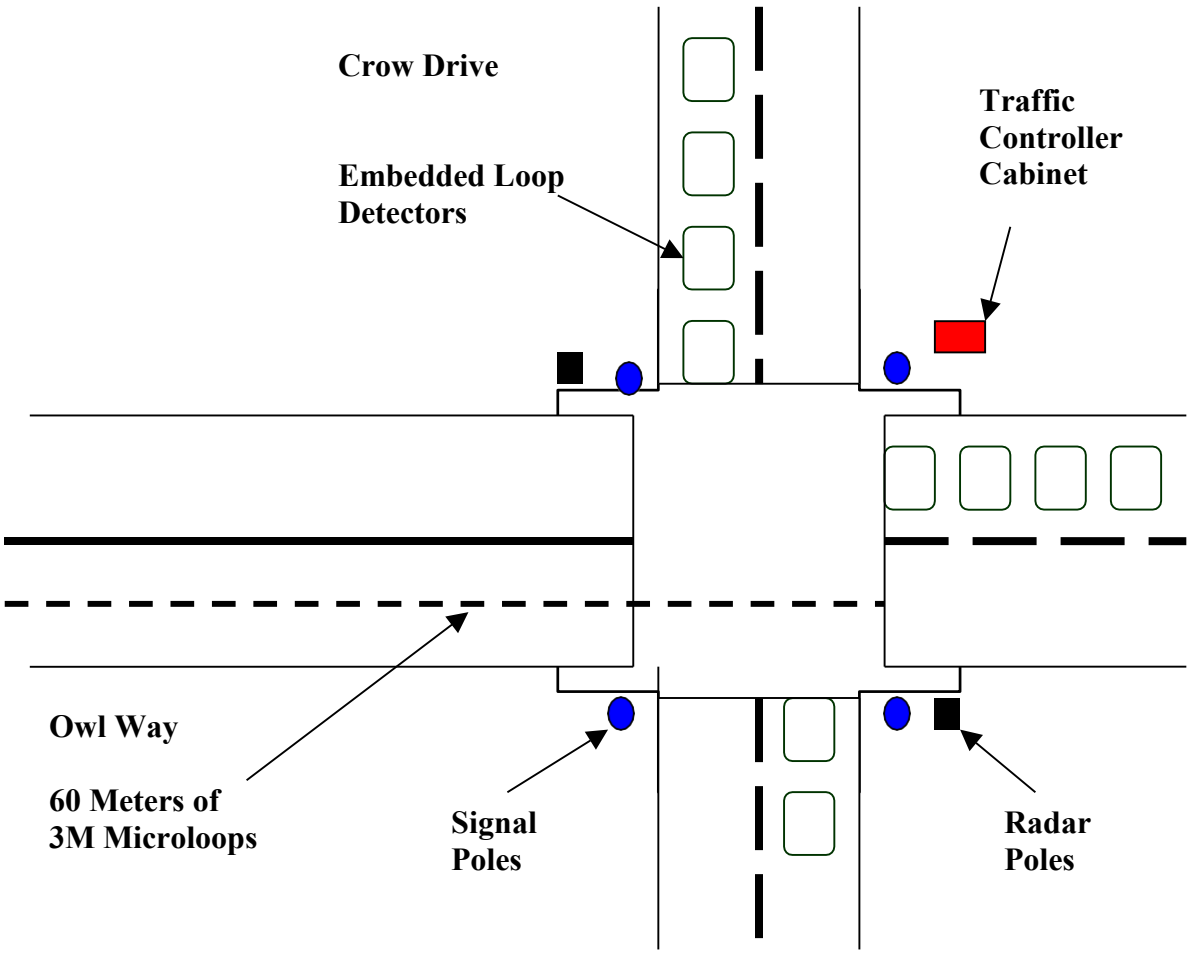
ATTACHMENT - B

The site of RFS Test-Bed after the construction

ITS 340 Cabinet with 2070 Controller

ATTACHMENT - C

Sensor Diagram at RFS Test-Bed



ATTACHMENT - D

Intersection Test-Bed at RFS – Construction Bid Results

Company	Base Bid	Add Alternative #1	Add Alternative #2	Total
Ransome Co.	**$64,893**	**$11,500**	**$6,800**	**$83,193**
J.H. Fitzmaurice	**$68,800**	**$13,100**	**$7,100**	**$89,000**
Mc Guire and Hester	**$0**	**$0**	**$0**	**$0**
Average	**$66,847**	**$12,300**	**$6,950**	**$86,097**

ATTACHMENT - E

List of equipment and construction components used at the Test-Bed:

1. ITS 340 Cabinet from Siemens
2. Eagle 2070 Controller from Siemens
3. Microloops from 3M
4. Signal Heads and their assemblies from Econolite
5. Pedestrian Signal Heads and push buttons and their assemblies from J A Momaney
6. 2 type A and 2 type 15 Signal Poles from Caltrans
7. 2 Light Fixtures with their bulbs and assemblies from Caltrans
8. Conduits, Pull Boxes, and Extensions from Rexel Norcal Valley
9. Opaque Fence by Bailey Fence Co.

ATTACHMENT - F

The itemized list of cost expenditures:

Sharafsaleh labor and benefits 11/03	$	2,239.05
Sharafsaleh labor and benefits 8/03	$	1,718.37
Sharafsaleh labor and benefits 7/03	$	2,985.97
Sharafsaleh labor and benefits 6/03	$	2,985.97
Sharafsaleh labor and benefits 5/03	$	2,982.46
Sharafsaleh labor and benefits 4/03	$	2,385.93
Sharafsaleh labor and benefits 3/03	$	2,385.93
Sharafsaleh labor and benefits 2/03	$	2,385.47
Sharafsaleh labor and benefits 1/03	$	1,789.45
Siemens Analytical X-Ray Instrument	$	18,099.40
Siemens Analytical X-Ray Instrument	$	3,511.63
Rexel Norcal Valley	$	1,444.08
Econolite Control Products	$	692.23
Econolite Control Products	$	(529.48)
Econolite Control Products	$	2,651.74
Econolite Control Products	$	(575.05)
Econolite Control Products	$	3,194.24
J A Momaney Services Inc	$	4,113.50
EHS construction recharges	$	202.00
EHS construction recharges	$	404.00
EHS construction recharges July/August 03	$	303.00
VLT	$	1,267.59
RMS	$	105.65
Bougler – Supplies	$	129.46
Capital Projects 8/31/03	$	478.95
Capital Projects 8/26/03	$	2,205.00
Capital Projects 7/31/03	$	70,000.00
Capital Projects 6/12/03	$	4,429.00
Capital Projects 4/23/03	$	1,237.50
RFS Intersection invoice (see attached pages)	$	6,520.21
RFS Intersection invoice (see attached pages)	$	12,995.61
RFS Intersection invoice (see attached pages)	$	4,562.11
Indirect costs	$	16,536.36
TOTAL	$	199,999.33

The $6,520.21 line item invoice from RFS – Facilities / Operations:

RFS - FACILITIES / OPERATIONS **Date:** 5/20/2004

Invoice No: 1312

INVOICE

Department Name: ITS-PATH
Address: Bldg. 452
Contact Person: Tony Brennan
Charge Account: 1-56339-20820-23929-44
ITS-PATH Owl & Crow Intersection
Project: 409
PROJECT DESCRIPTION
1301 SO. 46TH STREET,
BLDG. 175
RICHMOND, CA 84804
(510) 231-9501
(510) 231-9520 FAX

THIS COPY IS FOR YOUR RECORDS. PLEASE FORWARD A COPY TO YOUR ACCOUNT ADMINISTRATOR. IF YOU HAVE QUESTIONS, PLEASE CALL RFS OPERATIONS OFFICE AT 231-9501

Labor

Employee	Hours	Rate	Description	Line Total
Dean Gordon	Electrical Owl & Crow Test Bed	65	$44.00	$2,860.00
Dean Gordon	Electrical Owl & Crow Repackage Signal Hardw	2.5	$44.00	$110.00
Dean Gordon	Electrical Owl & Crow Fact Finding	12	$44.00	$528.00
Dean Gordon	Electrical Owl & Crow Test 3M Problem	4	$44.00	$176.00
Dean Gordon	Electrical Owl & Crow Test Bed-Problem w/wire t	4	$44.00	$176.00
Dean Gordon	Electrical Owl & Crow Test Bed	7	$44.00	$308.00
Dean Gordon	Electrical Owl & Crow Test Bed-Start Up Meetin	6	$44.00	$264.00
Dean Gordon	Electrical Owl & Crow Test Bed-Rack Change	3	$44.00	$132.00

Labor TOTAL: $4,554.00

Materials

Item	Qty	Each	Description	Line Total
Laner Electric	PVC	1	$361.43	$361.43
Laner Electric	Christy Traffic Signal	1	$627.58	$627.58
Laner Electric	Christy Box Ext.	1	$259.80	$259.80
Clifford of Vermont	1400’ Caltran cable	1	$694.40	$694.40
Laner Electric	Caution Tape	1	$22.73	$22.73

Materials TOTAL: $1,966.21

CREDIT ACCOUNT: 1-59000-69110-11431-64-X **INVOICE TOTAL: $6,520.21**

The $12,995.61 line item invoice from RFS – Facilities / Operations:

RFS - FACILITIES / OPERATIONS **Date:** 5/20/2004

Invoice No: 1250

INVOICE

Department Name: ITS-PATH
Address: Bldg. 452
Contact Person: Tony Brennan
Charge Account: 1-56339-20820-23929-44
ITS-PATH Owl & Crow Intersection

Project: 409

PROJECT DESCRIPTION
1301 SO. 46TH STREET,
BLDG. 175
RICHMOND, CA 84804
(510) 231-9501
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Labor

Employee Hours Rate Description Line Total
Dean Gordon Electrical labor/consultation/meetings 126.5 $44.00 $5,566.00
Dean Gordon Electrical labor/consultation/meetings 152 $44.00 $6,688.00
Labor TOTAL: $12,254.00

Materials

Item Qty Each Description Line Total
Laner Electric Supply Wire 1 $139.93 $139.93
Laner Electric Supply Wire 1 $57.20 $57.20
Laner Electric Supply Ground Rods 1 $28.64 $28.64
Truitt & White Lumber Misc Hardware 1 $20.46 $20.46
Graybar Electric Loop Detector Cable 1 $334.90 $334.90
Laner Electric Supply Wire-Misc. Hardware 1 $160.48 $160.48
Materials TOTAL: $741.61

CREDIT ACCOUNT: 1-59000-69110-11431-64-X **INVOICE TOTAL: $12,995.61**

The $4,562.11 line item invoice from RFS – Facilities / Operations:

RFS - FACILITIES / OPERATIONS **Date:** 5/20/2004

Invoice No: 1283

INVOICE

Department Name: ITS-PATH
Address: Bldg. 452
Contact Person: Tony Brennan
Charge Account: 1-56339-20820-23929-44
ITS-PATH Owl & Crow Intersection
Project: 409
PROJECT DESCRIPTION
1301 SO. 46TH STREET,
BLDG. 175
RICHMOND, CA 84804
(510) 231-9501
(510) 231-9520 FAX

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Materials

Item Qty Each Description Line Total
Laner Electric Supply Scotchcast Sealing, misc equip. 1 $374.81 $374.81
Laner Electric Supply Outlet covers 1 $17.30 $17.30
Laner Electric Supply Misc. Traffic Signal equipment 1 $2,229.95 $2,229.95
Laner Electric Supply Misc. Hardware, Traffic Box, Signal 1 $1,897.03 $1,897.03
Laner Electric Supply Misc. Hardware 1 $43.02 $43.02
Materials TOTAL: $4,562.11
CREDIT ACCOUNT: 1-59000-69110-11431-64-X **INVOICE TOTAL: $4,562.11**