INDIVIDUAL TECHNICAL ASSISTANCE REPORT

In Response to a Request for Technical Assistance

by the

Utah County, Utah, Law Enforcement Planning Agency

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Prepared by:

Public Administration Service
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Chicago, Illinois 60637

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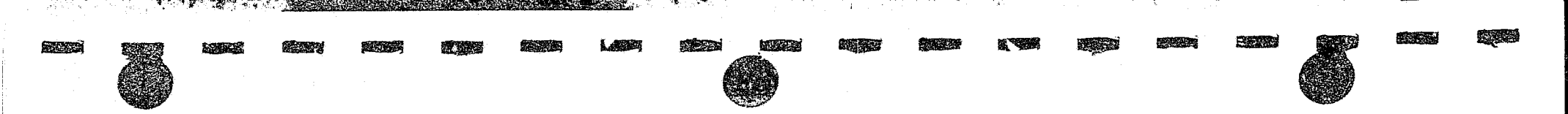
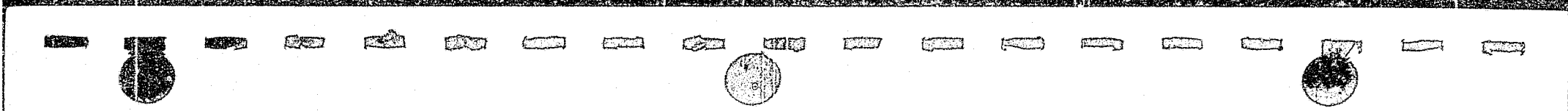




CONSULTANT'S REPORT

UTAH COUNTY, UTAH, RADIO COMMUNICATION STUDY

This report will cover the findings from a study of the communication systems used by the approximately 13 incorporated village or town area police departments and the County Sheriff's Department. At the time this survey was initiated, the majority of all radio communication dispatching for these several towns and the Sheriff's Department was being done by the Utah Highway Patrol District 6 Radio Dispatch Center in Provo. This dispatch service provided by the Utah Highway Patrol has placed an increasingly heavy burden on its radio communication facilities to the point where it is now estimated that approximately 50 percent of the communication over the District 6 station is for the county activities. While there are certain positive aspects to this cooperative arrangement between the Highway Patrol and the county law enforcement agencies, it is found that the activities of the Highway Patrol are centered largely on highway safety while those of the county police groups are largely law enforcement. As such, such simple matters as the type of "ten" signals used by the Highway Patrol in many cases have no application to the Sheriff and city communication requirements.

It is becoming increasingly apparent to many of the towns that more efficient handling of local law enforcement problems can be achieved by a local dispatcher who is familiar with the area and the people. Many of the places to which a car is dispatched can be described in terms known only to the local people such as names of a farm, a ranch, or some local name for a pond. Therefore, many of the towns have their own communications for short-range purposes. This, however, has resulted in some of the towns sharing their police communication on other local government radio channels. This has not proved satisfactory since now the police activities are monitored by city maintenance vehicles and dispatching is often done by the city maintenance personnel rather than a policeman. Two towns in the County, Provo and Orem, have provided elaborate communication systems since their problems are of an urban nature. Both of these towns provide 24-hour dispatching and, in the case of Provo, dispatching is divided between city patrol and city traffic. Only one of the rural area towns has 24-hour dispatching and that is the Town of Springville. The other towns have no dispatching or limited-hour dispatching.

The result of this multiple approach to communication in the various towns and the County is that the public is faced with having to select between up to four different telephone numbers to request police assistance. For example, in Goshen the telephone book lists a number for police which if one calls he would reach the local police office located next to the fire station. However, since the Marshall only serves part-time in the police activities and is a full-time city employee, this office is not always attended. The telephone book then instructs the caller that if there is no answer he should call a second listed number. This number reaches the Marshall's home. The Marshall's wife is now faced with the task of locating the Marshall, and if this is not possible, she must call the highway patrol dispatcher. The public, however, has two more numbers which they may call for police assistance. One is the Sheriff's office, and calling this number is a long distance charge for the caller and the call reaches the Highway Department. The public has still another number listed as the Utah Highway Patrol. This number reaches the same dispatcher and is a local charge to call. The confusion to the public can well be appreciated. One dialing the Sheriff's number, for example, may find the dispatcher answering the phone "Utah Highway Patrol."

The caller may think he has dialed the wrong number. The toll-free call is provided for by a leased line which is shared among the several towns and provides direct dialing for the town into the Provo Dispatch Center. However, there are times when this phone is used by officers to make calls in the opposite direction, and this, of course, ties up the emergency police lines for nonpolice business.

In towns trying to achieve independent radio dispatching in their local area it was found that in almost every case the range of communication required was at the maximum two miles from the Dispatch Center. However, as soon as a town goes on a separate frequency the adjacent towns equip themselves with monitor receivers for all of the nearby frequencies so that coordination among them can be obtained by monitoring each other's frequencies and transmitting on ones assigned frequency. This results in as many as eight monitor receivers being employed in some cases and is a very cumbersome method. However, the close distance between many of the towns often results in a vehicle being chased across town or city boundaries and, therefore, the need for assistance from the adjacent town. It is a very real requirement.

I. TO SUMMARIZE THE PROBLEM IN UTAH COUNTY

There is a need for cooperative combining of communication equipment which will permit the easy deployment of assistance from nearby departments while at the same time providing a means for a degree of autonomy in local communications.

Attached are two exhibits which summarize the present communication facilities in Utah County. Exhibit I illustrates the radio frequencies used by base and mobile equipment and the dispatch hours. Exhibit II summarizes the telephone numbers printed in the directory and the hours these numbers could be expected to be answered. The reader's attention is directed to the listing of mobile frequencies in Exhibit I and in particular the order of frequencies for channel positions 1, 2, 3, and 4 in the various police agencies. In almost every radio the frequencies 155.505 and 155.625 are used, but they are in different positions in the radio in many of the towns. This one point illustrates clearly how the independent decisions by each of the various towns has resulted in a nonuniformity in operation and points to a need for a cooperative program in the communication for Utah County police activities that will provide greater efficiency in communications, uniformity in dispatch procedures, uniformity in purchasing requirements, easier training of operators, and enable operators to transfer from department to department with a minimum of confusion.

II. FACTS BEARING ON THE PROBLEM

Communication Range Requirements

As already mentioned in the report, city and town communication requirements are normally within two miles of the radio dispatch point. However, for investigative problems countywide communication is required. At the present time each of the larger cities employs its own investigative force, and cases often take the officer up to the mountainous regions of the County. Thus, investigative officers should have the ability to communicate to some base station from any place in the County.

Sheriff's vehicles roam the entire County and must have countywide communication. Vehicles transporting prisoners must have countywide communication on occasion.

The present Utah Highway District 6 radio installation consists of a base station atop a peak in the Lake Mountains and controlled from Provo by a microwave radio link. This is a simplex radio station operating on the frequency 155.625 MHz, and good base-to-mobile communication range is obtained over most of the County. All car-to-car communication is direct, and there is no provision for repeating car-to-car communications.

Geography and Terrain of the County

All of the incorporated towns of the County are along the east shore of Utah Lake in a relatively level valley bounded on the east by the Wasatch Mountain Range which extends above the valley floor up to 5,000 feet. Canyons into the Wasatch Mountain Range have roads leading up to the back country where there are unincorporated settlements throughout the mountainous regions of the County. Communication in the canyon road is often difficult due to the severe shadow loss when a vehicle is in a sharp depression. All of the towns except Goshen have a generally unobstructed point-to-point communication path. Goshen is obstructed by the West Mountain Range which extends up approximately 2,100 feet above the valley floor and is located on the east side of Utah Lake.

Existing Municipal Dispatch Centers

In-the-field studies made it appear that the towns of Orem and Provo have a well-organized communication facility and that they operate a sufficient number of vehicles to provide a reasonable amount of load to their use of individual frequencies. Therefore, a fact considered in reviewing the cooperative communication system is that these two towns should operate essentially in their present mode but should fit into an "overlay" communication network which will provide them both their autonomy of operation and the ability to obtain assistance throughout the County when required. Specific details on this operation are covered under "Recommended Communication System and Course of Action."

Available Radio Frequency Channels

A fact having a significant bearing on the overall communication system is the choice of radio frequencies. Already the pattern has been set in the use of high-band frequencies by most agencies in the County. However, Utah faces the same problem as do other states in that these frequencies are already heavily used not only in Utah but in the surrounding states. The mountainous regions often cause frequencies to be heard for several hundred miles if a station is located at a high elevation. It was determined, however, that a fine job of radio frequency coordination is being done in the State and that a printed listing of frequency assignments in the public safety services was available from the Utah Frequency Advisory Committee. For reference in this report, Exhibit IV is a tabulation of the local government, fire, special emergency, and police radio frequencies presently assigned by government subdivisions in the County.

III. ANALYSIS OF PROBLEMS

Communication Range

These questions were considered with respect to communication range.

1. Could one mountaintop station cover the entire County?

2. Could two or three base stations strategically located in the County be placed such that a mobile any place in the County could reach one of them directly?

3. What would be the best location for a mountaintop or a base station transmitter?

It was observed that West Mountain offered a commanding view of the valley and already has located on it a station used by the U.S. Forest Service. While this location is not in the center of the County, it has these advantages:

1. It is removed from the Lake Mountain Highway Patrol radio station site by approximately 12 miles, thus minimizing the possibility of interaction between the Highway Patrol and a county cooperative radio system.

2. It provides an antenna elevation of approximately 2,100 feet above the floor of the valley.

3. It has already an available road and power on the mountaintop since the telephone company also operates a relay station up there.

4. While located in the south of the County, it has a clear shot to the north of the County since most of the path to the north would be over Utah Lake.

A trip was made to the top of West Mountain through the cooperation of Chief Ashley Graham of Springville. Access was relatively easy. From the top of the mountain radio tests were conducted using a low-powered, hand-held portable radio of approximately one and one-half watts power output, and communication was easily achieved to a car north of Provo. Time was not available for an extensive radio communication survey from this location at that time, but observation indicated that the site looked directly into Pole Canyon, Santaquin Canyon, and Hobble Creek Canyon. This visual observation and actual

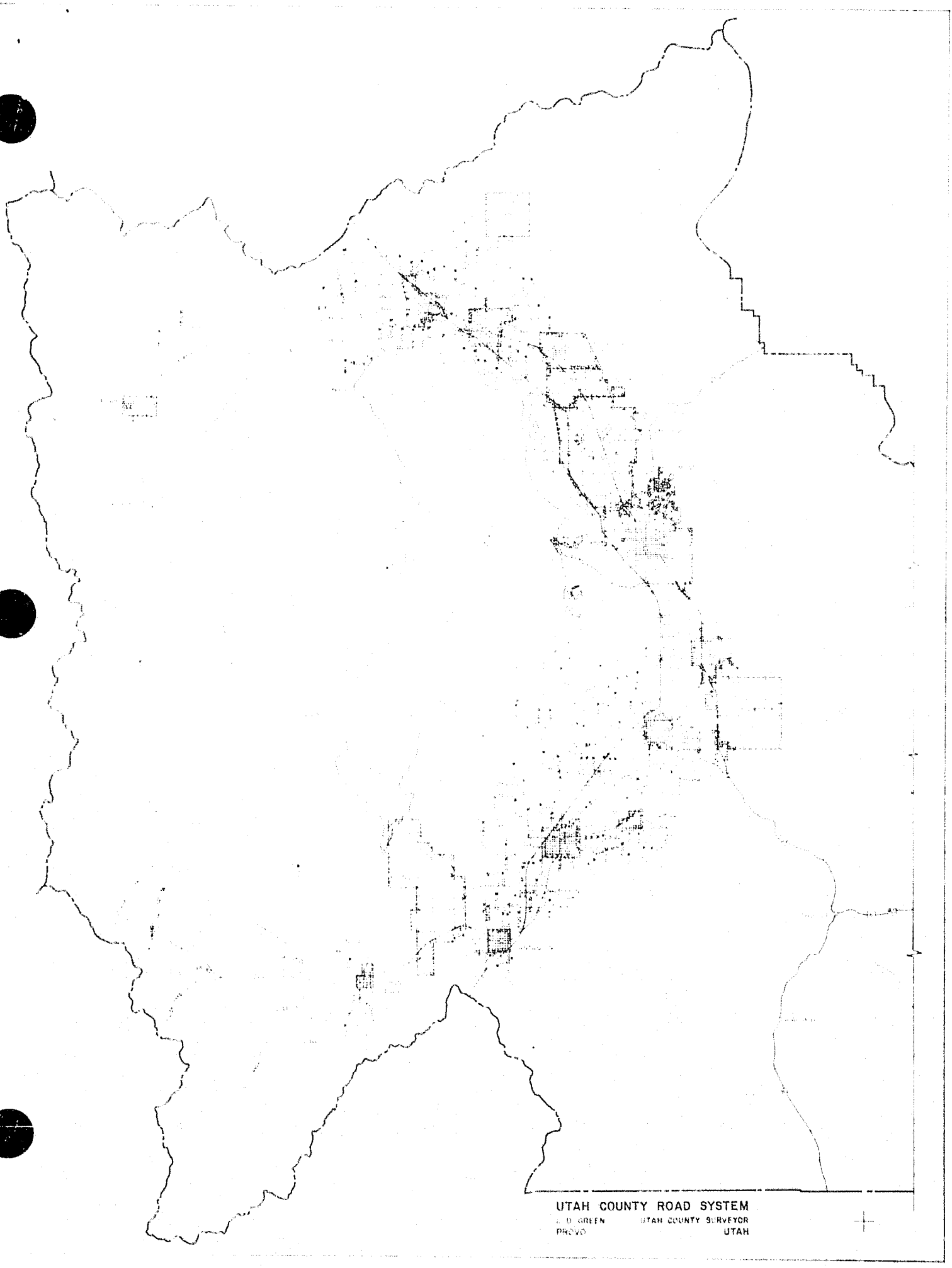
communication test were supplemented with plotting of profiles from the West Mountain location to various spots in the canyons coming off the valley. The results of the estimated radio communication path losses are tabulated in the charts accompanying this report. In summary, it was found that complete coverage of the County could not be achieved from this one location since shadow losses anticipated in locations throughout American Fork Canyon, Provo Canyon, and Spanish Fork Canyon were such that communication could be spotty in some of these areas. Therefore, secondary communication points to these canyons were to be explored. The result of this study was that a southern station serving a precinct area covering those towns south of Provo could be most advantageously located at a point of intersection of lines drawn out of Hobble Creek Canyon and out of Spanish Creek Canyon. The intersection of lines so drawn would place a station just north of Spanish Fork. The exact location would be in the northwest quarter of the northeast quarter of Land Section 18, which covers the northern half of Spanish Fork as shown on the *Utah Planning Topographic Survey Map.*

In the northern portion of the County the area requiring communication assistance would be in American Fork Canyon. The present location of the Lehi Police Department would provide one possible location for communication into American Fork Canyon, but it appears that a better location would be at a point somewhat in the center of a triangle connecting the towns of Lehi, American Fork, and Alpine. Identifying the preferable site by the street numbering system, it would be at a point approximately 7100 West and 10000 North, using the numbering scheme used on the Utah County Road System Map.

Thus, considering these communication sites, that is, a base station at a point north of Spanish Fork, a base station north of Lehi, and the West Mountain repeater site, most of the County could be covered quite adequately. Naturally, in a mountainous terrain of this type, one cannot predict solid communication coverage, and certainly one may have to pick the best location in any given general area. Some question as to the reliability of communication in Provo Canyon from West Mountain became obvious in the analysis made. However, the Orem city police station is on a line drawn directly from Provo Canyon and could provide a secondary communication point for vehicles operating in this area.

Communication System——Utah County, Utah

Following is a tabulation of canyon communication showing the primary and secondary points. Following also is a table tabulating the estimated radio communication path losses from the various stations or mountains to some selected spots in the canyons or other towns and remote areas. On this table has been tabulated an estimated signal margin above a one-microvolt level. It should be noted that this tabulation is for "unity-gain" antennas. In the final system design higher-gain antennas will be used at some of the sites thereby increasing these margins by from three to nine decibels. This table shows estimated margins for both high-powered mobile units and portable units, and it illustrates the advantage of a mountaintop station in the system for providing communication to portable units for missions which take the police personnel into remote regions on foot or horseback.


UTAH COUNTY ROAD SYSTEM
J. D. GREEN
PROVO
UTAH COUNTY SURVEYOR
UTAH

Type of Mountaintop Station

The alternatives were to consider a simplex mountaintop repeater similar to that used by the Highway Patrol or a mobile relay type station.

Considering first the simplex type operation, this configuration would have required some sort of an operational fix station to control the mountaintop from the Lehi and the Spanish Fork precinct centers. While such an operation is possible, it seemed to add unnecessary cost to the system. In addition, the overriding factor was that a mobile relay type station could give countywide mobile-to-mobile or mobile-to-portable or portable-to-portable communication, and in view of the need of the Sheriff's Department and the investigative forces to cover the entire County, the decision was made in favor of a mobile relay type station. Use of the mobile relay type station also permits smaller towns to have a control station which they can use to obtain extended range communication when their mobile units have left their assigned location. However, the choice of frequencies, which is discussed in the following paragraphs, must be such that the entire operation is not disrupted should there be a failure in the mobile relay station; this possibility has been carefully considered. Furthermore, means were considered for providing deactivation of the relay station from the Spanish Fork base station. Here it was practical to consider the use of an operational fixed frequency in the 960 MHz range so that the mobile relay station could be operated as merely a duplex base station and the repeat function disabled by the dispatcher at Spanish Fork. This then permits the dispatcher to disable the relay function if it is being abused or should skip interference signals come into the area and cause unnecessary interference. It was felt that this control capability could be best put on a separate operational fixed radio channel so as to provide positive control which might not be possible were it handled on the existing high-band relay station receiver frequency. It was not felt necessary to give the operational fix station control also to the Lehi radio dispatcher. The Lehi radio dispatcher could talk through the mobile relay station on the mobile service transmit frequency.

Type of Squelch

It would be desirable to use tone-coded squelch in all systems located throughout the County. However, it is recognized that this is not a practical matter at this time since many systems are already operating using standard squelch units. The alternatives would be either to purchase all new mobile and base equipment or to gradually replace equipment with the capability of conversion to tone-coded squelch as the need arises. Then, should future frequency congestion in the County result in interference to the West Mountain repeater station or to other stations in the system, the components needed to convert all equipment to tone-coded squelch would be added. In this regard it should be considered that the entire County would operate on a single tone-coded squelch frequency on all radio frequencies. This would be to provide compatibility between all systems, and it is a very important consideration. The exception to this would be when operating on the frequency 155.505 MHz, which is the statewide interdepartmental coordination frequency. If there were a disaster requiring the assemblage of units from various departments, the tone-coded

squelch capability would be disabled by a switch provided as standard equipment on all tone-coded squelch models. At the present time, however, it appears that a set of frequencies can be found that will not receive outside interference at the repeater site.

Selection of Radio Frequencies

For the mobile relay station, two options are open:

1. Wide space radio frequencies so that the transmit and receive frequencies are approximately four to five megacycles apart, so the repeater station can be operated without extensive attention to desensitizing problems caused by closer space frequencies. Use of frequencies spaced this far apart, however, requires more costly mobile units if the mobile unit is to have the capability to transmit on the repeater station frequency and thereby talk around a repeater in a simplex mode.

2. The second alternative is to use repeater frequencies spaced approximately 1 percent apart, give attention to preventing desensitizing at the repeater station with necessary filtering and carefully spaced antennas, but achieve the benefit of being able to use standard multifrequency mobile radio units and portable units.

The number of existing units already in service dictates that the latter option should be used unless one is to replace all mobile radio units now in service in the County. Examining the available frequencies and considering a separate channel devoted for countywide general police activities and a second pair of frequencies devoted to investigative use, the following radio channels are recommended for mobile relay operation:

General Police Activity Channel Mobile Transmit——155.850
Base Transmit——154.740
Investigative Channel Mobile Transmit——155.910
Base Transmit——154.860

In both cases the mobile transmit frequency is one designated by the FCC as a Mobile Only frequency. Thus the chances of competition from other mountaintop base stations is minimized, and only other mobile units will be competing for the receiver. The FCC does permit control stations associated with a mobile relay station to use the mobile service frequency, and advantage will be taken of this in the final system analysis as discussed in the recommended plan of action.

IV. RECOMMENDED COMMUNICATION SYSTEM AND COURSE OF ACTION

A cooperative and shared communication system that will provide 24-hour dispatch facilities at the Spanish Fork and Lehi locations is recommended for the County. These dispatch locations will cover, on a 24-hour basis, all towns in the County and the Sheriff's Department, except Provo and Orem. It is felt that the urban nature of these places and the traffic volume already experienced is such that they continue with their existing communication facilities with slight modification in mobile frequency arrangements to provide compatability for working into this cooperative radio system. In addition to the Spanish Fork and Lehi stations providing 24-hour dispatch capability, the individual towns may dispatch locally using a low-powered auxiliary base station operating in a simplex mode. Exhibit VII illustrates the overall communication system plan. The two precinct control centers will have the ability to talk directly to mobile units on either the patrol or investigative radio channel. Here it is appropriate to state that it is recommended that all investigations be combined in a single investigative unit operating as a cooperative venture for the entire County. It seems that the number of incidents for any individual town could well be combined in a single investigative unit. This further relieves unnecessary radio traffic from each individual town which, with its own individual investigative unit, requires it to have extensively wider range communication for a very small occurrence of investigative cases handled. This is also conservative of radio frequency spectrum since rather than each town having a separate investigative radio control channel now they may all be combined into one channel providing both countywide and local communication. It will be viewed on the diagram that investigative units may talk car-to-car over the investigative mobile relay station located on West Mountain, or they may talk on a simplex basis directly between cars, or they may talk from a car directly to the southern precinct or the northern precinct control station. For those rare occasions where they may be out of range of one of these three locations, they may revert to the standard patrol radio channel and talk to any existing base or auxiliary dispatch station on a simplex basis using a common radio patrol channel.

The basic mode of operation in the regular patrol would be to operate on a simplex basis through the home town base station when it is being manned. When it is not being manned, dispatching can be made from either of the two precinct dispatch centers. Dispatch capabilities from the smaller towns would be recommended through the use of a 10-watt or at the most a 30-watt desktop base station having capabilities for transmitting on the repeaters or the simplex radio channel. Antennas at these stations would be located no more than 20 to 30 feet above the ground and use a standard unity-gain antenna in order to limit communication range to the one or two miles normally required. In those cases where extended range is required, these dispatch stations in the smaller towns would retransmit via the relay station on West Mountain. Thus, a single station would have the capability for countywide communication through the West Mountain relay station when required.

As mentioned earlier, in order to discipline operation of the repeater station, the dispatcher at the Spanish Fork station would have a 960-megacycle radio link to West Mountain over which he could send the necessary tone to disable the repeater and have it operate as a mountaintop two-frequency base from the Spanish Fork Center. It is expected that the normal mode of operation would be to leave the mountaintop relay stations in the relay mode of operation. In this way, the Sheriff's Department radio station could consist of a control station to which he could talk to Sheriff's radio units throughout the County when required.

For coordination with the State, it is recommended that base stations operating on frequency 155.505 MHz be located at Spanish Fork and at the Lehi and Sheriff's Department radio facility. In the smaller towns, it is not felt necessary to operate the stations on 155.505 since this provision will be in all of the mobile units and, should there be a national disaster, dispatch could be handled out of one of the main dispatch points. Monitoring of frequency 155.625 MHz at the two 24-hour dispatch points and also at the Sheriff's Department is recommended in order to keep abreast of current happenings in the highway department system. These receivers could be operated at a reduced volume level.

Mobile Units

In order to standardize on the channel numbering system used in mobile units, the following scheme is recommended. Four-frequency radio units will have the positions identified in general as follows.

1. Statewide coordination (155.505 MHz).
2. Countywide simplex frequency for car-to-car and car-to-base.
3. Countywide relay frequency (investigative cars will be on investigative channel repeat mode in this position).
4. Local frequencies.

The local frequency may be either a frequency now used for normal city dispatching or in the case of the smaller towns may be the local government channel which is presently used to contact the Highway Maintenance Department or others for assistance. The local government channel will not be used as a dispatch channel in the rural cars but merely one on which they can request assistance.

A run-down of actual frequencies recommended for the various categories of vehicles is shown on the system drawing.

Portable Units

All portable units, except those used for investigative service, will operate on the same four frequencies as the mobile radio units. In this case, it is recommended that the portables be capable for five- or six-frequency operation and that the latter two frequencies

be assigned as special stake-out frequencies and used on an unlicensed basis as provided for under FCC Rule Paragraph 89.309C2. Portable radio units used for this service should have a power output not exceeding two watts in order to comply with this FCC Rule Paragraph.

Scanner Receivers

It would be desirable for cars in urbanized areas to incorporate channel scanning circuitry that would monitor both their local frequency and the countywide simplex frequency. In this way cars requesting assistance and coming into the adjacent area could immediately switch to this frequency and be heard by the mobile units in range directly. However, it is recognized that many radios are already in service that do not have the scanning feature. The equipment used in Orem and in Provo may be of a type that can be adapted for scanner operation, and the radio supervisors there should check with the manufacturer. It is recommended that any new equipment be capable of scanning these two frequencies. Existing equipment that is converted to conform to this frequency plan would operate in the same mode as they are presently operating. That is, the dispatcher would advise the mobile units when to switch to the other frequency (channel 2 or 3).

Mode of Operation—Mobile Units

It will be noted on the system diagram that an asterisk has been placed to indicate the normal channel position of operation for the various cars. Reasoning for this is discussed here:

Investigative Cars. Investigative cars are recommended to normally operate on the investigative unit simplex frequency which will give them direct communication with Spanish Fork or Lehi cooperative dispatch station. Note that the positions 3 and 4 in these cars both receive the investigative base transmit frequency so that when operating in either position cars will hear either the mobile relay station, other simplex base stations, or other cars calling them. The only time investigative cars need use the other channels is when they request assistance from an existing local base dispatch point, and this can be done on the normal police frequency on a simplex basis. For major disasters or when assistance from the State Highway Patrol is required, these cars switch to frequency position 1 and coordinate 155.505 MHz, the statewide frequency.

Metropolitan City Cars. These cars would normally operate in their local city frequency as indicated on the diagram. It is recommended that the traffic cars in Provo be equipped with 155.01 and the Provo patrol cars be equipped with 155.190 and that the traffic and patrol cars not be equipped with the complimentary channel used for the other service in these cities. Rather, when assistance is required, it is recommended that these cars switch to their channel position 3. In this mode they would automatically be heard at the stations and mobiles throughout the County via the mobile relay station, and they would also be heard on the monitor receiver operating on the mobile transmit frequency. This monitor receiver would be located at the existing headquarters in Orem, Provo, and Brigham Young University Centers, respectively. By using this mode of operation, it will be possible

Mode of Operation--Spanish Fork Control Center

Spanish Fork should be equipped with an operator's console to have the capability of controlling the "Patrol" base station (which would be equipped locally with both the base and mobile transmit frequencies) and an "Investigative" base station--also equipped with the base and mobile control frequencies. Normal operation of the West Mountain repeater would be on the mobile service frequency. For communications not requiring repeater operation, these stations would talk directly to the mobile units. The direct simplex mode also serves as a backup communication in case the repeater should have some equipment or power failures. Thus, the system is not dependent entirely upon the repeater; it merely provides for countywide coverage from a single station under normal operation. Redundancy is built into the system through the several dispatch stations and also the main control stations, and the loss of any one station will not completely disrupt communication in the County. The point-to-point, 960-megacycle link from Spanish Fork to West Mountain would control and set up the mountaintop units as base stations or as repeaters, and tone signaling would be used to key the stations and perform the switching functions. When the mountaintop stations are set up for base operation (no mobile relay), Spanish Fork would control and talk out over them on the 960 MHz frequency pair. This mode prevents other cars from hearing mobile transmissions.

Northern Precinct Control Operation--Lehi

This station would be identical to the Spanish Fork station with the exception of the 960-megacycle control link to West Mountain.

Use of Alert Monitor Receivers

It is recommended that a "dual-tone" type tone encoder be installed at the Spanish Fork and Lehi Radio Dispatch locations. This will permit receivers at fixed locations to be used for alerting purposes. Some examples of this would be to place receivers in hospitals, civilian defense installations, volunteer and auxiliary personnel homes, or any other facilities where it is felt desirable to alert personnel of specific instances requiring their assistance. These receivers would not hear the normal dispatch but would only be activated upon reception of the proper tone code. Discussion with the cities involved, when this communication system gets to the implementation stage, can best determine what use can be made of alert monitor receivers in the network. They do provide a great degree of auxiliary communication at a very nominal increase in overall system cost, and the benefits to be derived should not be overlooked.

Jeep Patrol

This is an auxiliary aid force. The Jeep Patrol should be incorporated into this network by adding a base station both at Spanish Fork and Lehi on the local Jeep Patrol frequency of 47.50 MHz. Here again, the value of coordinating with the Jeep Patrol can be discussed among the police chiefs associated with this cooperative network to determine the values to be received from the additional expense.

Citizen Telephone Calling

Since the 24-hour dispatch capabilities will now be at four places, a single number for all towns other than Orem and Provo should be listed in the telephone directories. It is recommended that dedicated telephone lines run from each town to the nearest dispatch center (north or south) and that these lines terminate in a telephone company supplied console which will indicate the town calling. In this way the dispatcher can answer as the police department for the town requesting assistance. For those times when the Marshall is in his office, his telephone, which would be in parallel with this dedicated line at the control center, could be answered personally by him or his assistants. He could then handle the complaint directly when available. In this way, the smaller towns can realize safety benefits to citizens and the economy of centralized 24-hour cooperative dispatch centers. If and when all fire department systems can be incorporated in the single communication system as recommended, the County could convert to a 911 calling system and then all emergency calls would either go into the northern or southern dispatch center, with the exception of Orem and Provo. Fire dispatching could then be done on a point-to-point basis to the individual rural fire houses.

County Fire Department Communications

A review of the exhibits showing the public safety frequencies used in Utah County indicates that there are individual fire frequencies for Orem, Provo, Lehi, and Springville. There also may be other fire departments working on their local government frequencies that will not show up in this listing. Rather than have each fire department operation on a separate channel it would be desirable to pick two of these frequencies, use one for a base talk-out and the other for a mobile talk-back and point-to-point calls. All fire agencies in the County can, therefore, coordinate at a fire. The present system makes it very difficult to do this, and it is highly recommended that this consolidation of radio channels be seriously considered. Exhibit X illustrates this operation. There is no need for countywide communication, but there should be the ability for the towns to cooperate on a fire when required. Note that normal calls from a fire base to its mobile units would not be heard by other base stations. The second transmit channel would be for calls to other departments. Coordinating calls to the fire department in this manner would permit two main county dispatch centers to coordinate the fire and police communications at a future date.

Civilian Defense

The Utah Civilian Defense operates on radio frequency 155.025. At the present time Provo City has an installation capable of operating by batteries on this frequency, and consideration should be given to operating on this frequency for the county network dispatch centers.

Emergency Power

The Spanish Fork and Lehi stations should be equipped with auxiliary power to sustain operations for extended periods in case of power failure. At West Mountain equipment could be operated in emergencies from batteries; or the county cooperative could investigate whether the telephone company has emergency power at their microwave installation which they would permit this system to use in an emergency.

West Mountain Repeater——Beeper Signal

In order for the mobile units to be aware when they are receiving the West Mountain repeater, it is recommended that this station be equipped with an audible beeper tone pulsed at approximately one pulse per second so that mobiles receiving this signal will know to call back on the repeater channel.

Summary Comments——System Operation

The system proposed retains the metropolitan communication networks now operating satisfactorily and supplements the County with a countywide coordination system. At the same time, the Utah Highway Patrol is relieved of the excessive dispatching for county activities. Coordination through the Highway Patrol for assistance will be achieved on 155.505 from the dispatch centers at Lehi and American Fork. At any time one of the cities expands to where it can justify its own police service operating channel, this frequency would be put in mobile channel position 4. Cities making this change would then have their local dispatching done on their own frequency as is previously described for Provo and Orem. Thus, the system provides for orderly growth in the County.

Proposed Plan of Action

1. The police chiefs in the various cities involved should review this plan for a complete network to make sure it solves all of their local requirements as they know them.

2. The frequencies recommended should be submitted to the State Frequency Coordinating Committee as soon as possible to receive their concurrence for use.

3. FCC license application should be submitted as soon as possible. The system should be fully described.

4. The specifications for any future mobile radio equipment purchased should have the capability of being modified for tone-coded squelch operation and should also have available an option for scanning equipment on the receiving frequencies.

5. Mobile units which will require countywide operation should have 100-watt power output. Mobile units that will be used for local operation in a smaller town only or occasional cross-county operation may be 30- or 50-watt power output.

6. Portable radio units should be of the highest power output available (four- or five-watt) with the exception of those radios used by the investigative services. These radios should be two-watt units to comply with the FCC requirements for unlicensed operation on the surveillance frequency.

EXHIBITS

Exhibit I

EXISTING RADIOS AND DISPATCH HOURS
UTAH COUNTY, UTAH

City and Population	Base Station		Quantity Mobiles	Mobile Frequency		Quantity Portables	Portable Frequency		Dispatch from City	Remarks
	T	R		T	R		T	R		
Goshen 459	None		1	(1) 155.505 (2) 155.625 (3) 155.745	155.505 155.625 155.745	0	None		None	Part-time Marshall (needs to be paged at night)
Santaquin 1,236	None		1	Citizen Band (1) 155.505 (2) 155.625 (3) 155.745	155.505 155.625 155.745	0	None		None	Marshall's home(day or night highway patrol)
Payson 4,501	45.56(L.G.)	45.56	8 3 3	45.56 (1) 155.505 (2) 155.625 (3) 155.745	45.56 155.505 155.625 155.475	0	None		Yes	Remote from L.G. radio (gives ability for local dispatch)
Salem 1,081	None		1	(1) 155.505 (2) 155.625 (3) 155.745	155.505 155.625 155.745	0	None		No	Marshall operates from home
Spanish Fork 7,284	155.820	155.820	4 (2 per shift)	(1) 155.625 (2) 155.745 (3) 155.505 (4) 155.820	155.625[a/] 155.745 155.505 155.820[a/]	0	None		Yes	Note difference in order of frequency than other towns (L.G. channel)

a/ Scanner.

Exhibit I (continued)

City and Population	Base Station T	Base Station R	Quantity Mobiles	Mobile Frequency T	Mobile Frequency R	Quantity Portables	Portable Frequency T	Portable Frequency R	Dispatch from City	Remarks
Springville (fire L.G.) 8,790	155.535 155.940	155.535 155.940	4	(1) 155.535 (2) 155.730 (3) 155.625 (4) 155.505	(1) 155.535 (2) 155.730 (3) 155.625 (4) 155.505	4	(1) 155.535 (2) 155.730 (3) 155.625	155.535 155.730 155.625	Yes 24 hour service	Mobile channel numbers difference than state.
Provo 53,131	155.01 155.19 155.505 CD155.025	155.01 155.19 155.505 155.025 154.965[b] 155.430[b] 155.730[b] 154.190[b]	29 (10 per shift) (B.Y.U.) Orem Springville Fire	155.01 155.19 155.505 154.965	155.01 155.19 155.505 154.965	8	155.01 155.19 155.505[c] 154.965[c]	155.01 155.19 155.505 154.965	Yes 24 hours	Traffic on 155.01 Patrol on 155.190
Orem 25,729	Unit 1 T and R Unit 2	155.430 155.625 155.880	23	(1) 155.505 (2) 155.625 (3) 155.190 (4) 155.430	155.505 155.625 155.190 155.430	1			Yes 24 hours	Considering going to 911 system.
American Fork 7,713	154.100	154.100	5	154.100 155.625 155.745 155.505	simultaneous monitor 155.745 155.505	5	154.100 155.625 155.745		Yes[b] 10 calls per day average	Dispatching now from hospital-- not satisfactory for police work.[b]

[b] Monitors.

[c] On the four frequency units only.

Exhibit II

TABULATION OF PUBLIC TELEPHONE NUMBERS FOR POLICE
UTAH COUNTY, UTAH

City and Population	Telephone Numbers Public Calls	Listed As	Public Gets	Public Pays For Local or Long Distance	Hours Number Attended	Remarks
Goshen	274-3410	Police	Police office	local	Intermittent	Marshall works telephone book says to call
459	274-3371	T. Taylor	Marshall or wife	local	Intermittent	if no answer on police number.
	373-4690	Sheriff	Highway dispatch	long distance	24 hours	
	373-9553	Highway patrol	Highway dispatch			
Santaquin	754-3324	Police	Police office	local	Intermittent	Marshall usually out and no alternate
1,236	373-4690	Sheriff	Highway dispatch	long distance	24 hours	number listed.
	798-2721	Highway patrol	Highway dispatch	local	24 hours	
Payson	465-2488	Police	Police office	local	Intermittent	
4,501	798-2721	Police	Spanish Fork Police	local	Intermittent	
	373-4690	Sheriff	Highway dispatch	long distance	24 hours	
	798-2721	Highway patrol	Highway dispatch		24 hours	
Salem	798-6745	Police	Marshall home	local	24 hours	Wife receives calls.
1,081	373-4690	Sheriff	Highway dispatch	long distance	24 hours	
	798-2721	Highway patrol	Highway dispatch			
Spanish Fork	798-2721	Police	Police department	local	10:30-5:30	Five days a week.
7,284	373-4690	Sheriff	Highway dispatch	long distance	24 hours	
	798-2721	Highway patrol	Highway dispatch	local	24 hours	

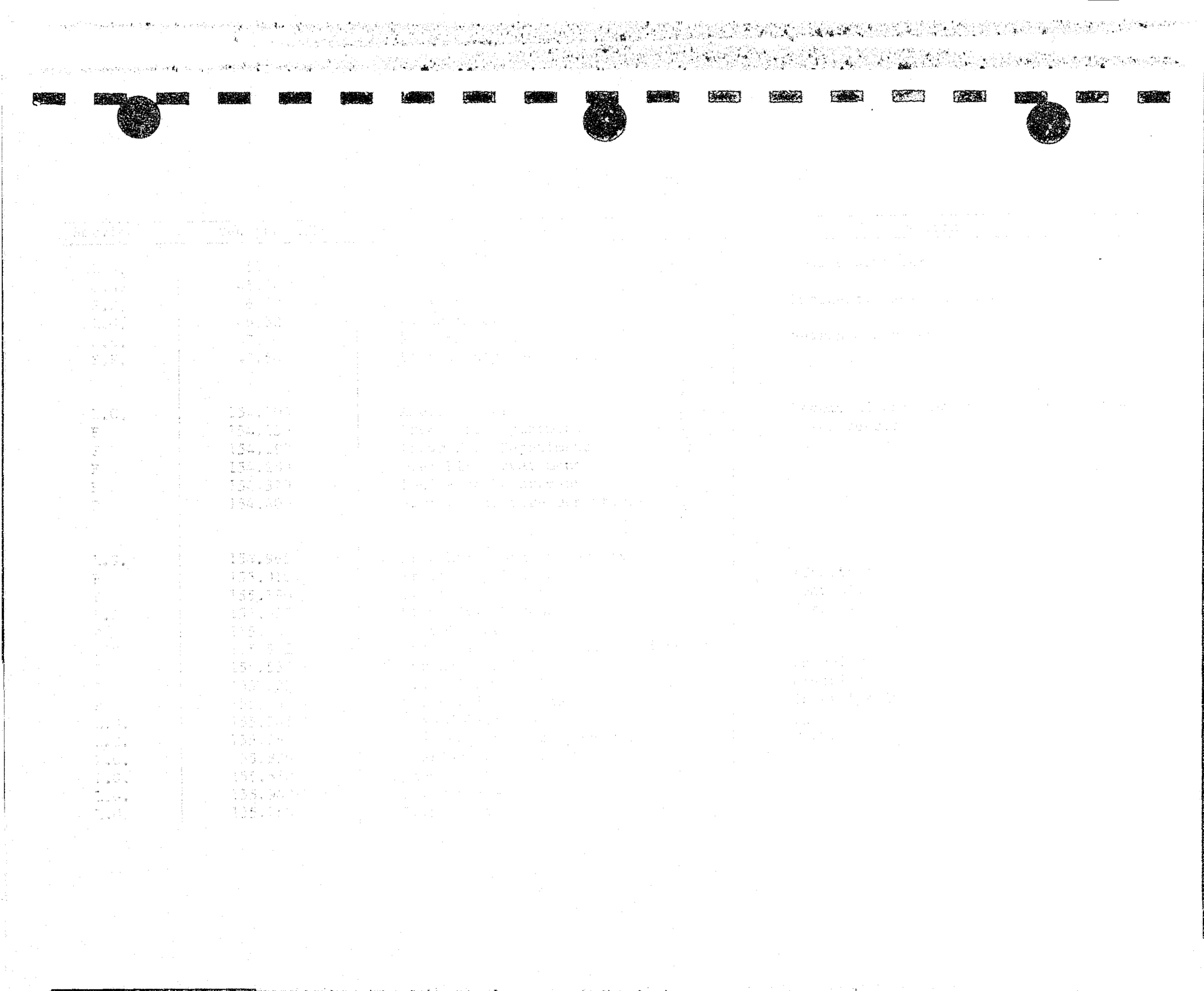


Exhibit V

TABULATION OF DISPATCH POINTS FOR CANYON COMMUNICATION
UTAH COUNTY, UTAH

Canyon	Station Proposed for Best Communication into Canyon[a/]	Secondary Communication Possible from These Stations[a/]
Pole Canyon	West Mountain	Santaquin Station
Santaquin Canyon	West Mountain	Santaquin Station
Spanish Fork	Spanish Fork Base	West Mountain--from selected locations
Hobble Creek Canyon	Spanish Fork Base or West Mountain	Springville Base
Provo Canyon	West Mountain	Orem--Police channel only
American Fork	Lehi Base	West Mountain

[a/] When West Mountain is shown, any control or dispatch station in system can be reached through the mobile relay station.

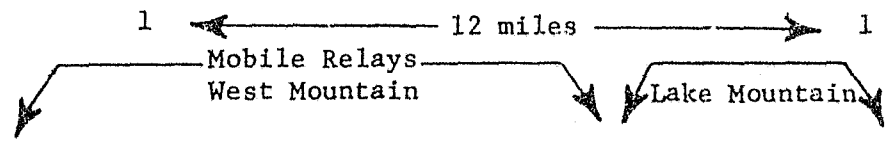
Exhibit VI

ESTIMATED PATH LOSS AND OPERATIONAL MARGINS FOR VARIOUS COMMUNICATION PATHS
UTAH COUNTY, UTAH

To Mobile At:	From Base At:	Path Loss to a Point in Canyon	Decible Margin Above One Microvolt for Various Transmitter Powers (Unity Gain Antennas)		
			100 watt	50 watt	2 watt
Pole Canyon	West Mountain	95 decibels	62	59	45
Pole Canyon	Santaquin	135 decibels	22	19	5
Santaquin Canyon	West Mountain	131	26	23	9
Provo Canyon (Vivian Peak)	West Mountain	143	14	11	(-3)
Provo Canyon (Nunns)	West Mountain	134	23	20	6
Provo Canyon	Orem Base	134-142	23/15	20/12	6/(-2)
Goshen	West Mountain	128	29	26	12
Goshen	Spanish Fork Base	160	(-3)	(-6)	(-20)
American Fork Canyon	West Mountain	147	10	7	(-7)
American Fork	Lehi	145	12	9	(-5)
Castilla-Spanish Fork Canyon	Spanish Fork Base	134	23	20	6
Castilla-Spanish Fork Canyon	West Mountain	147 decibels	10	7	(-7)
Allens Ranch	Spanish Fork Base	140-150	17/7	14/4	0/(-10)
Allens Ranch	West Mountain	97 decibels	60	57	43
Birdseye	Spanish Fork Tower	160	(-3)	(-6)	(-20)
Birdseye	West Mountain	150	7	4	10

Exhibit VIa

INTERMODULATION ANALYSIS AND DESENSITIZING
UTAH COUNTY PROPOSED FREQUENCIES AND UTAH HIGHWAY PATROL EXISTING FREQUENCIES
UTAH COUNTY, UTAH



Police Investigative

	T 154.74	R 155.85	T 154.86	R 155.910	T+R 155.625	T+R 155.505
T 155.74		1.110	.120	1.170	.885	.765
R 155.85	1.110		.990	.060	(.225)	.345
T 154.86	.120	.990		1.050	(.765)	.645
R 155.91	1.170	.060	1.050		.285	.405
155.625	.885	.225	.765	.285		.120
155.505	.765	.345	.645	.405	.120	

Desensitizing
155.625 vs 155.85

Free space
loss @ 12 miles
97 decibels

XMTR noise @
.225 KHZ
-90 decibels

250wt +24DWB
space -97
noise -90
net -162DWB
no desensitizing

1. No third order intermodulation combinations

2. One close higher order (within 15 KHZ)
   A. 155.625 = Utah highway patrol base and mobile transmit
   B. 155.850 = Proposed mobile transmit
   C. 154.860 = Proposed mobile receiver (investigation)

   4(155.625) - 3(155.850) = 154.850 which is 10 KHZ from 154.860.
   10 KHZ selective loss estimated -80 decibels
   mixing loss -50 decibels
   -130

   with 100 w transmitter +20
   recur threshold -156
   176

   176 - 130 = 46 decibels for 46 decibels free space units must be within 150 feet for intermodulation.

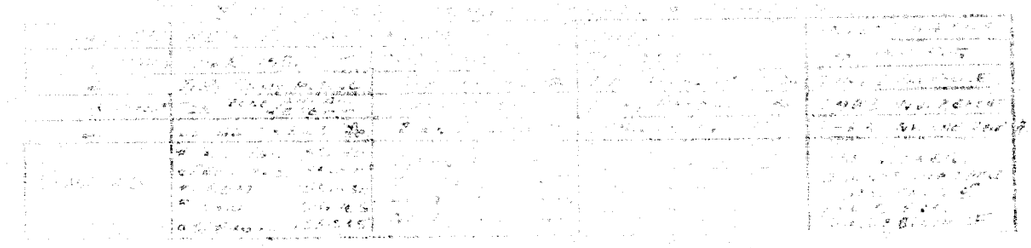


Exhibit VIII

BASIC COMMUNICATION CAPABILITIES
IN PROPOSED SYSTEM
POLICE PATROL
UTAH COUNTY, UTAH

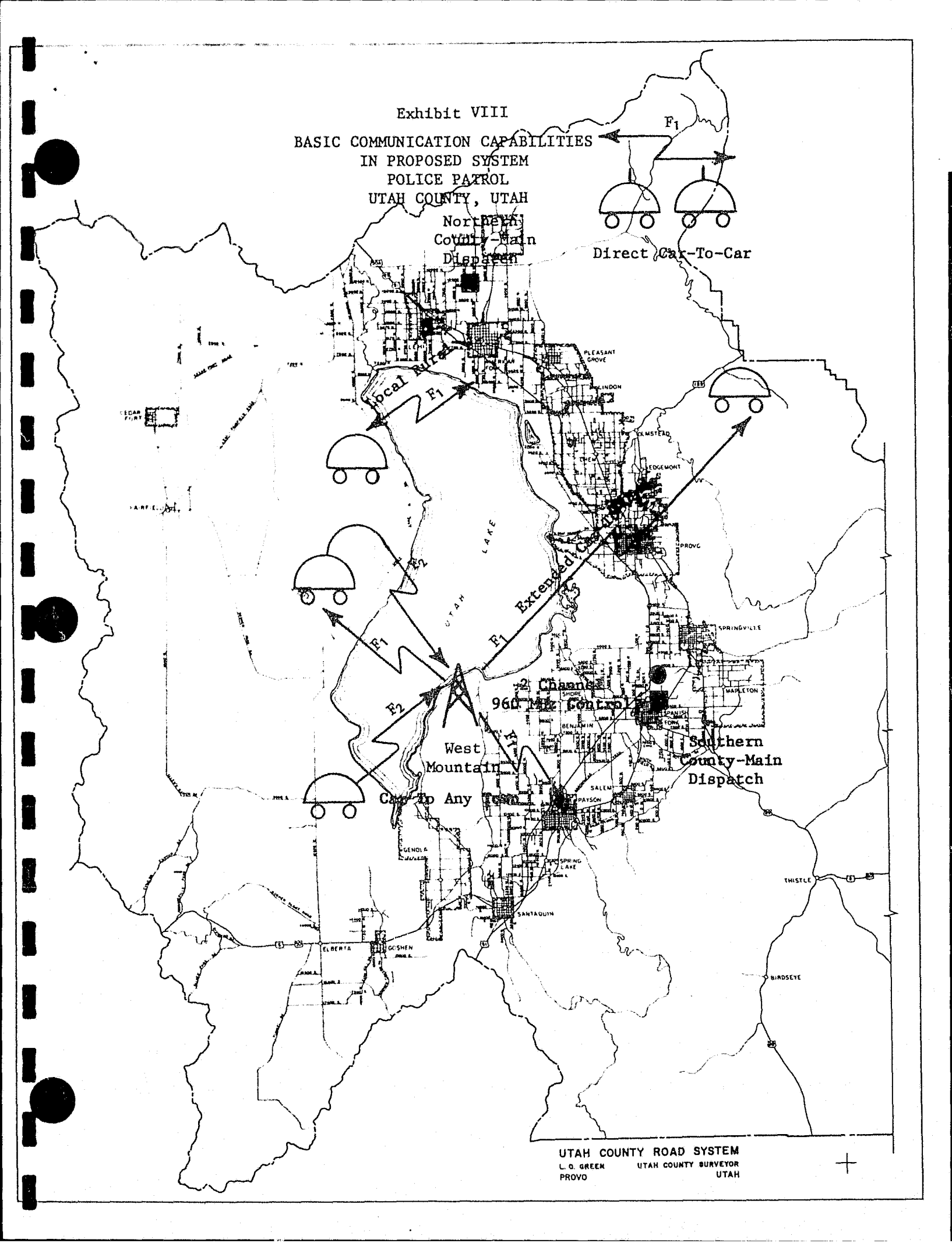


Exhibit IX

MAJOR CONTROL AND
DISPATCH POINTS PROPOSED
UTAH COUNTY, UTAH

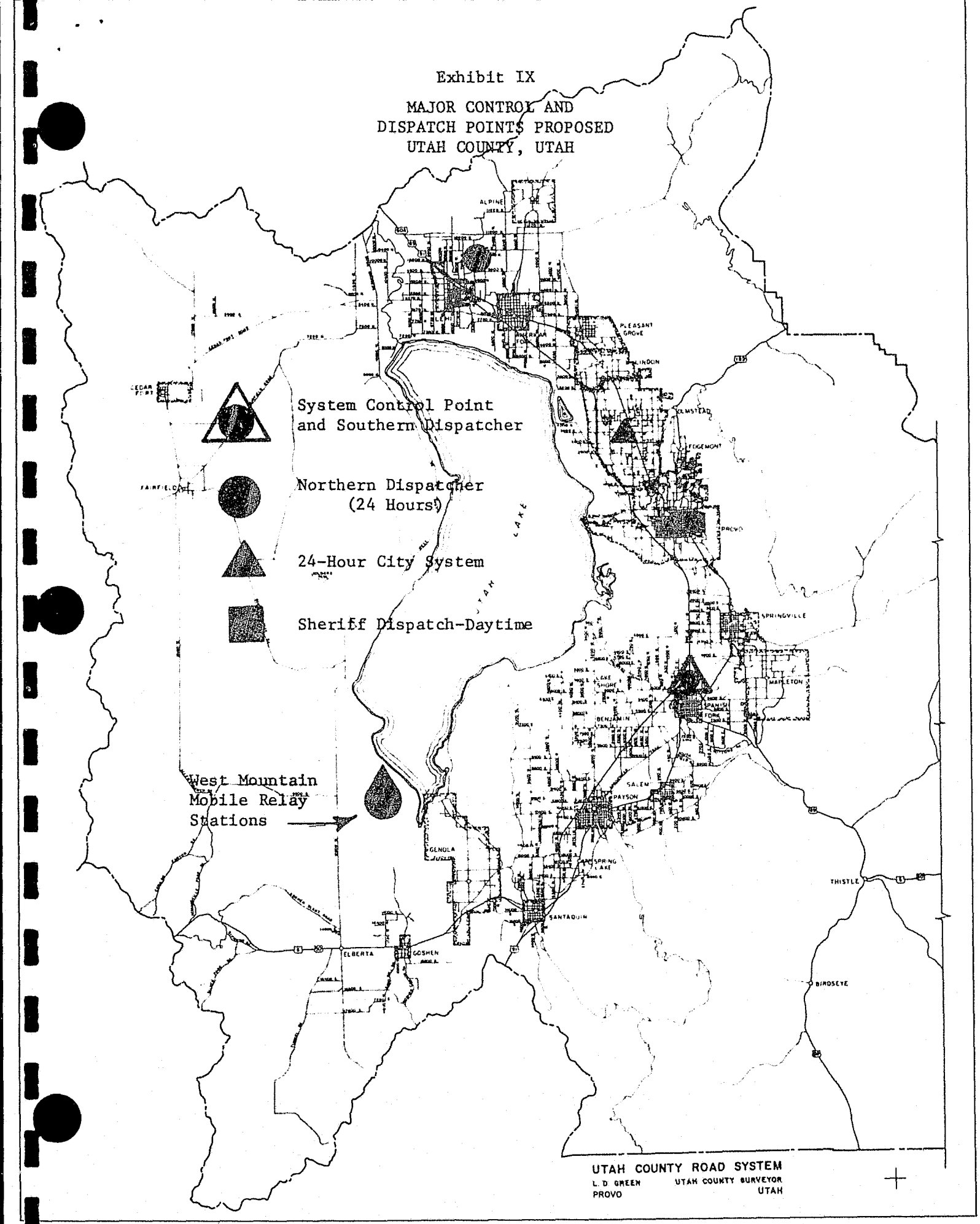
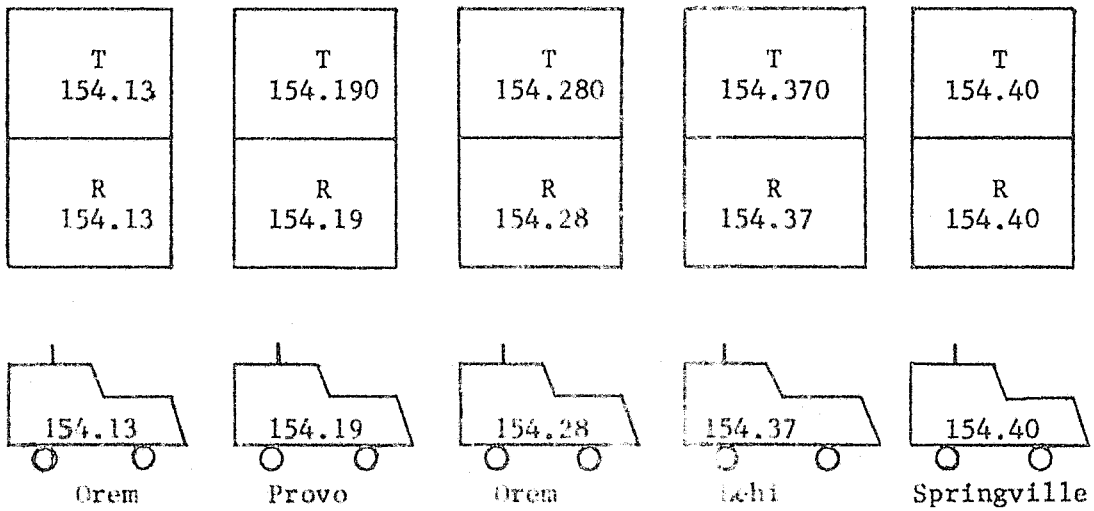


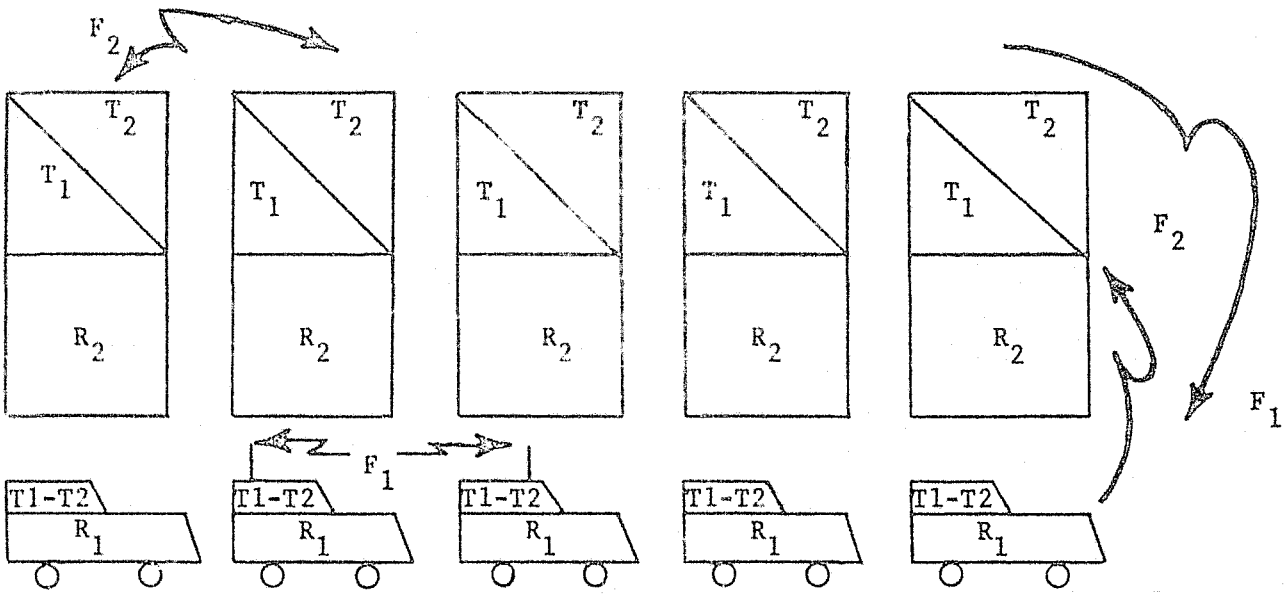
Exhibit X

ANALYSIS OF FIRE RADIO FREQUENCY IN COUNTY
UTAH COUNTY, UTAH



A-Present:

Several systems with different radio channels. None can talk to the other.



B-Proposed

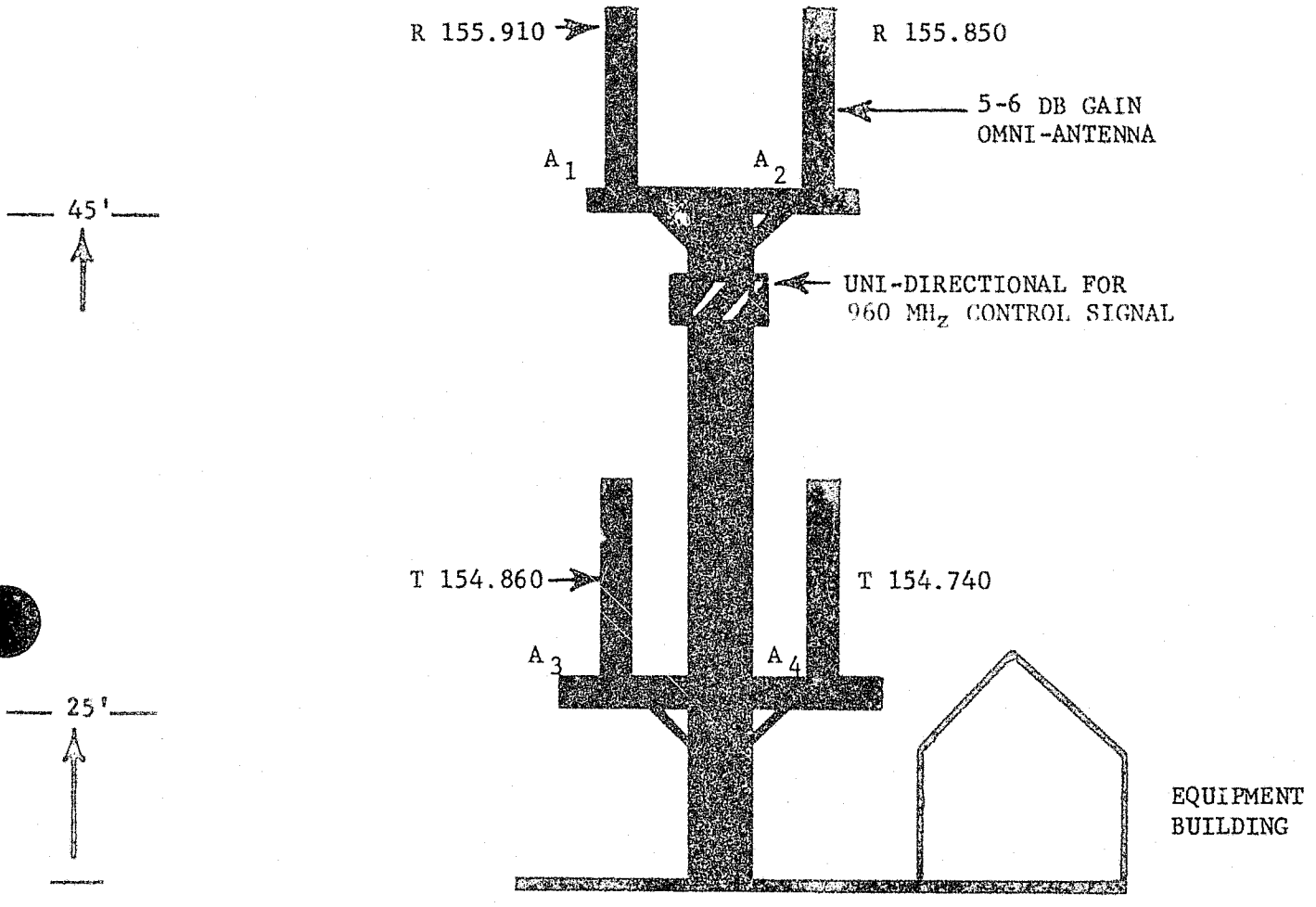
Use two of the frequencies countywide for all fire departments.

Example F_1 = 154.13 F_2 = 154.40

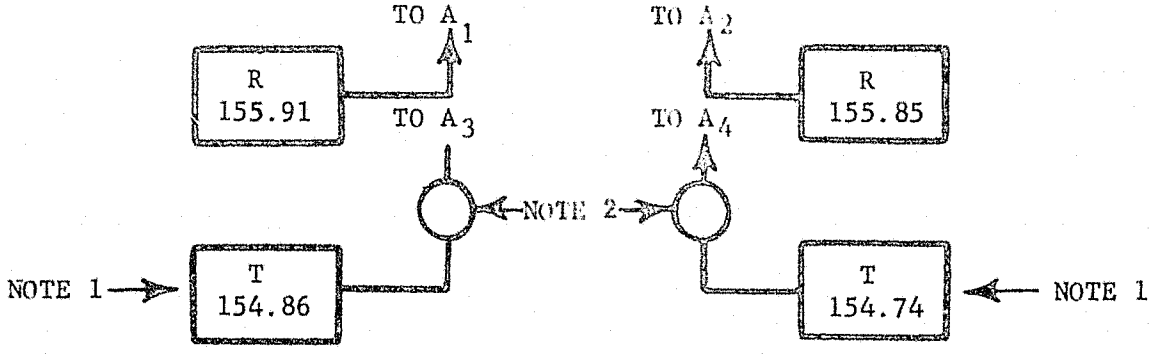
This provides local dispatch, point-to-point and car-to-car throughout county.

Exhibit XI

UTAH COUNTY, UTAH



WEST MOUNTAIN REPEATER



NOTES:

1. TRANSMITTER SPECIFICATION TO MEET SIDEBAND NOISE -100 DB AT 1 MHz.
2. CAVITY RESONATOR-BAND PASS-1 DB LOOP.
3. CO-AXIAL CABLES TO FLEXIBLE-AIR DIELECTRIC

END