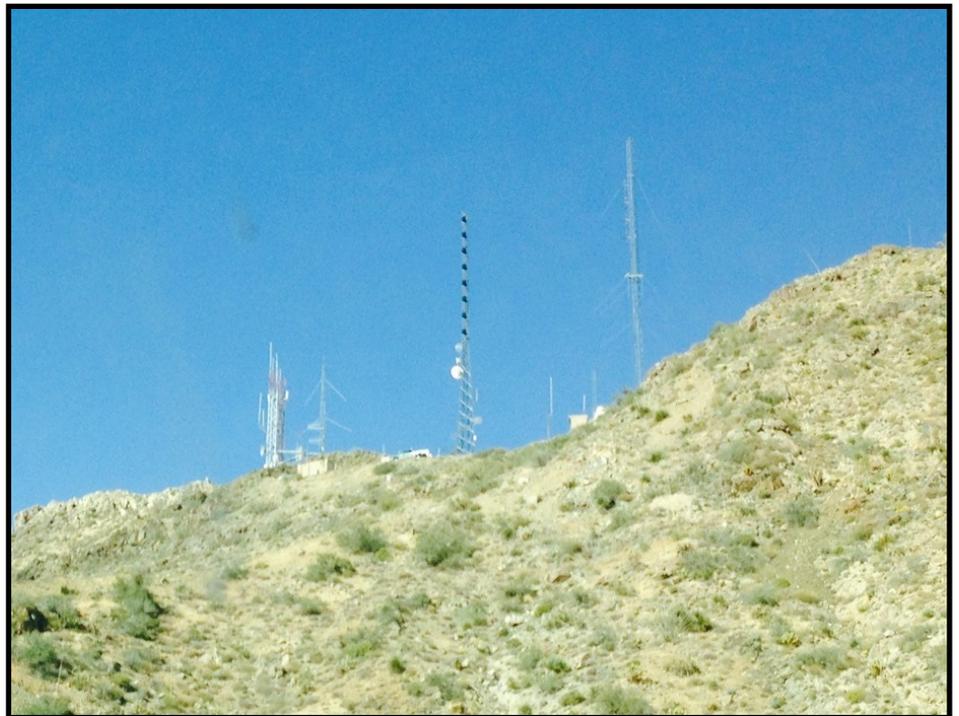


DRAFT

Crossman Peak Communication Site Field and Office Study



Desert Southwest Region
December 24, 2013

Executive Summary

The primary communication pathway for all transmission data traffic on the Western network between DSW headquarters in Phoenix, AZ and the Hoover Dam is the Western microwave system. This microwave system serves as the communication backbone between these two locations and is responsible for linking five generation stations and twenty-two substations to one another by providing a pathway for transmission relaying, metering, and RTU data throughout the Western system.

This microwave system operates within a specific frequency band regulated by the Federal Communications Commission. Legislation was presented in 2010 that reallocates this frequency band to a higher bandwidth range. As a result radios along Western's microwave system will require replacement to models that operate within the higher frequency range in order to accommodate this FCC mandate.

Analysis has shown that when the microwave path between Christmas Tree Pass and Metal Mountain is upgraded to the higher frequency band an interruption in the signal will occur from the mountainous terrain in the area severing the microwave path between these two communication sites. An investigation was performed within Western which identified Crossman Peak as a suitable location to bypass the source of interruption between these two points. An existing telecommunication site owned by Global Towers is located on Crossman Peak which Western could collocate their microwave equipment to and use as a bypass alternative. Due to security concerns it is preferred Western construct their own facility on Crossman Peak to prevent unauthorized access to the Western communication network.

A new Western owned communication site will include the land, equipment shelter, transmission tower, backup generator with fuel tanks, a distribution power line for primary power, and an access easement. This option would take approximately 10 months to construct and cost approximately \$1,008,000 to implement excluding environmental study costs, land acquisition, and new power distribution line.

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Table of Acronyms

| | |
|------|---|
| APS | ARIZONA PUBLIC SERVICE |
| BLM | BUREAU OF LAND MANAGEMENT |
| CIP | CRITICAL INFRASTRUCTURE PROTECTION |
| COOP | CONTINUITY OF OPERATION PLAN |
| CTP | CHRISTMAS TREE PASS |
| CSO | CORPORATE SERVICES OFFICE |
| DSW | DESERT SOUTHWEST |
| EA | ENVIRONMENTAL ASSESSMENT |
| FCC | FEDERAL COMMUNICATIONS COMMISSION |
| FERC | FEDERAL ENERGY REGULATORY COMMISSION |
| GIS | GEOGRAPHIC INFORMATION SYSTEM |
| GHZ | GIGAHERTZ |
| KV | KILOVOLT |
| LAN | LOCAL AREA NETWORK |
| MB | MEGABYTE |
| MDCC | MAINTENANCE DESIGN AND CONSTRUCTION COUNCIL |
| MEC | MOHAVE ELECTRIC COOPERATIVE |
| MHZ | MEGAHERTZ |
| MTM | METAL MOUNTAIN |
| NERC | NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION |
| ROW | RIGHT OF WAY |
| RTU | REMOTE TERMINAL UNIT |
| SEV | SOUTHEAST VALLEY |
| SRP | SALT RIVER PROJECT |
| WAN | WIDE AREA NETWORK |
| WECC | WESTERN ELECTRICITY COORDINATING COUNCIL |

Purpose

The purpose of this study is to describe the business need for the capital investment of constructing a new communication site at Crossman Peak as well as to evaluate the possible alternatives based on the evaluation factors defined by Western's Maintenance, Design and Construction Council (MDCC). This new communication site will support Western's primary microwave communication system between Phoenix and Hoover.

Western's microwave system between DSW headquarters in Phoenix, AZ and the Hoover Dam is the primary communication pathway for all transmission relaying, metering, RTU data, data traffic, voice, and WAN/LAN located within that area. This microwave pathway serves as the communication backbone between these two facilities linking five generation stations and twenty-two substations to each other and to the rest of Western's communication network.

An FCC mandated change in frequency band requirements combined with obsolete radio equipment has prompted upgrades along all the communication sites that make up this microwave backbone from Phoenix to Hoover (Figure 5). The last segment between Phoenix and Hoover to receive these necessary radio upgrades is located at Christmas Tree Pass and Metal Mountain. Computer analysis has identified that when this microwave path is upgraded to the higher frequency band an interruption in the signal will occur due to the mountainous terrain in the area severing the microwave connection between these two communication sites. Currently the microwave path between Christmas Tree Pass and Metal Mountain is behaving like a bottleneck since this pathway is the only segment between Phoenix and Hoover that's unable to function within the higher frequency band while still maintaining the required level of reliability.

An investigation was performed within Western between DSW and CSO to come up with options in getting this higher frequency signal from Christmas Tree Pass to Metal Mountain while maintaining the minimum level of reliability of 99.999%. The resulting option from that investigation was to bypass the mountain ridge currently interrupting the microwave signal by placing a new communication tower at Crossman Peak.

At the time of this study Crossman Peak is the only viable location found that successfully bypasses the mountainous terrain that would interrupt the microwave signal while still maintaining system reliability within this higher frequency band. An existing telecommunication site owned by Global Towers is located on Crossman Peak which could serve as a suitable bypass site if Western was to collocate onto their tower. Due to security concerns it is preferred Western construct their own facility on Crossman Peak to prevent unauthorized access to the Western communication network. A new Western owned communication site will include purchasing land for the communication site, the building for the telecommunication equipment to be housed, the tower to support the microwave antennas, a backup generator with fuel tanks, and a distribution power line to the site from MEC for primary power.

Crossman Peak Communication Site

As shown below in Figure 1, Crossman Peak is located between Christmas Tree Pass and Metal Mountain. Routing the microwave signal through Crossman Peak will create an interference free microwave path functioning within the higher frequency band allowing necessary communications between Phoenix and Hoover.

The new signal path will be from Christmas Tree Pass to Topock Substation to Crossman Peak to Metal Mountain.

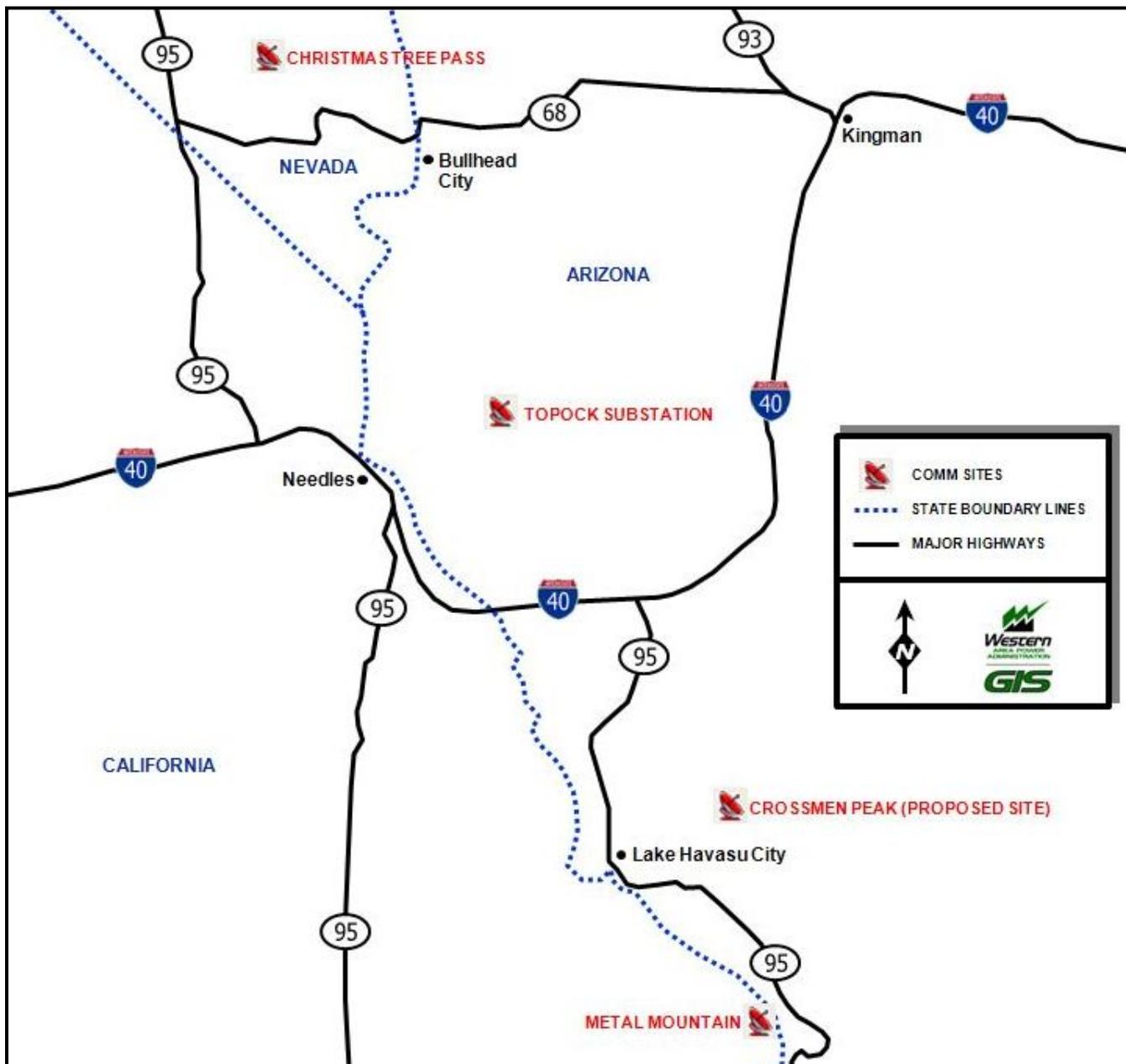


Figure 1: GIS Location Map (Not to Scale)

Business Need

The Federal Communications Commission (FCC) is the government agency responsible for regulating and licensing the use of radio frequencies known as spectrum in the United States. The FCC declared a spectrum shortage which prompted congress to request a comprehensive plan from the agency that would provide affordable broadband access throughout the United States. The National Broadband Plan was then presented to Congress in 2010 by the FCC with a goal of freeing up 500 MHz of spectrum for wireless broadband use by 2020. Within this plan one of many methods presented to accomplish this goal is for the FCC to reallocate approximately 20 MHz of underutilized government spectrum for commercial use. As a result microwave transmission on the Western network is in the process of being reallocated from the 2320-2345 MHz band up to the 7125-8025 MHz band.

It would be advantageous to Western to implement this reallocation as soon as possible since communication equipment operating within the lower frequency band does not have the available space for Western to obtain additional bandwidth, while equipment operating in the higher frequency range has sufficient space for Western to increase its bandwidth. Regardless of the frequency range Western's reliability standard for microwave transmission is five nines of reliability or 99.999%. This level of reliability is equal to approximately five minutes of outage time per year.

The existing radios between Christmas Tree Pass and Metal Mountain are the MDR4000 model which is no longer available by the manufacture for replacement or repair. Currently if any of the radios located at Christmas Tree Pass or Metal Mountain were to fail it would cut communications between these two sites severing Western's microwave backbone. In this unique situation replacing a failed radio unit with a current model MDR8000 radio will cause reliability of the signal between these sites to drop below the required minimum. This is due to the higher frequency band the MDR8000 operates within along with the geographical arrangement of this particular microwave path.

Increasing the frequency band alone will inadvertently cause an interruption in the microwave signal from Christmas Tree Pass to Metal Mountain. This existing microwave path will not support the upgraded radio's higher frequency band due to interference from mountainous terrain located between these two sites. The terrain currently does not interfere with the signal when operated within the 2GHz frequency band. However, when the frequency is increased into the 7GHz band the terrain becomes an issue by interrupting the signal.

A new communication site is recommended at Crossman Peak which is located between Christmas Tree Pass and Metal Mountain. This will allow Western to bypass the source of interruption and maintain its reliability standard. The new path will be from Christmas Tree Pass to Topock Substation to Crossman Peak to Metal Mountain.

Crossman Peak Communication Site

Crossman Peak is located east of Lake Havasu City in Mohave County, Arizona. Metal Mountain is located to the south of Parker Dam in San Bernardino County, California. Christmas Tree Pass is located near Davis Dam in Clark County, Nevada.

A microwave path currently exists between Christmas Tree Pass and Topock Substation. Adding this new communication site to the microwave backbone will create an interference free microwave path within the higher frequency band.

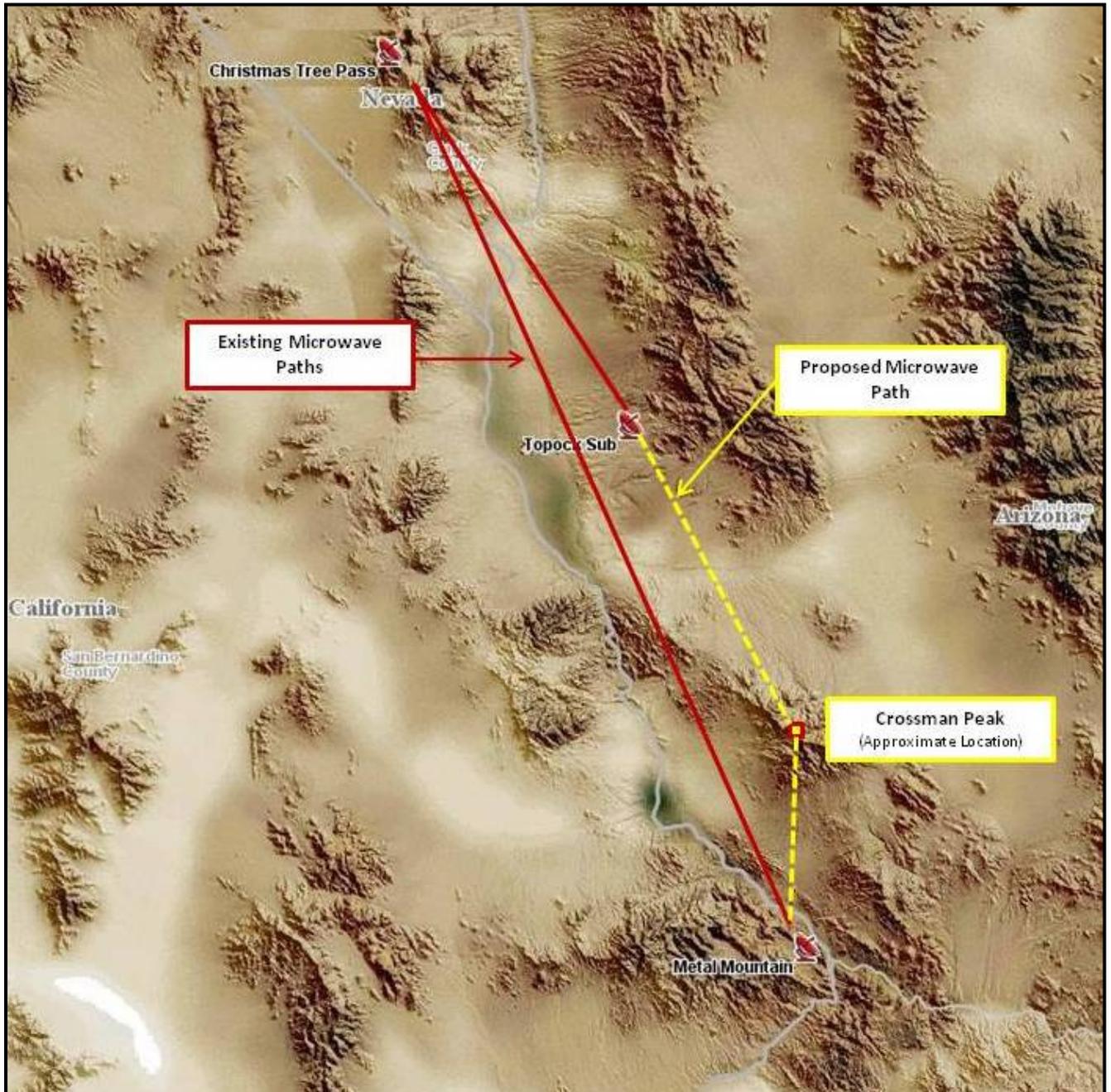


Figure 2: Existing and Proposed Microwave Paths

Critical Evaluation Factors

The proposed alternatives for improving the reliability with the communication network between Hoover and Phoenix will be evaluated using four evaluation factors: compliance, reliability, planning, and socio-economy.

The current condition of the microwave path between Christmas Tree Pass and Metal Mountain negatively impacts these four evaluation factors each to a different degree. The recommended option will best resolve any negative impacts along with achieving the goals mentioned in the purpose section of this document.

Compliance

The Western microwave system is the primary source of communication between Phoenix and the Hoover Dam and is used to carry the majority of communication traffic between these two points. This system is backed up by the fiber optic system, both of which are necessary in order to be compliant with NERC, FERC, and WECC which require having redundant paths of communication.

The existing radios at Christmas Tree Pass and Metal Mountain are considered obsolete and are no longer available or supported by the manufacture. A radio failure at either station would sever the microwave connection between the two sites causing a prolonged outage due to the unavailability of compatible equipment from the manufacture. Since this microwave path is a segment that makes up Western's microwave backbone an extended outage would cause Western to fall out of compliance. The microwave and fiber optic backbones provide redundant communication pathways for one another and both are required to be functioning simultaneously for Western to be compliant.

Western's communication network is contractually shared with the US Bureau of Reclamation and numerous other utilities providing secure, redundant communication among facilities in that area. These facilities include switchyards, control centers, and hydroelectric plants not only owned by Western but by other utilities with which Western contractual shares communication bandwidth.

Reliability

Western's reliability standard states that all microwave radios must have five nines (0.99999) of reliability, which equates to approximately five minutes of outage time per year. Since upgrading the current microwave path from 2 GHz to 7 GHz causes an interruption in the signal an alternate pathway was found through Crossman Peak.

The existing radios used between Christmas Tree Pass and Metal Mountain are no longer supported by the manufacture and any new replacement radios with larger capacity will not meet Western's minimum reliability due to the geographical nature of this path. Higher capacity radios currently available operate within a higher frequency band which allows for Western's desired increase in data transmission. An undesired

Crossman Peak Communication Site

result in using higher frequency radios, specifically between Christmas Tree Pass and Metal Mountain, is that the microwave signal would be interrupted by the mountainous terrain located between these two communication sites. Microwave signals are transmitted by line of sight and as shown below, the signal would be interrupted approximately 45 miles from Christmas Tree Pass. Currently microwave signals transmitted across this path are not interrupted when operated within the lower frequency range.

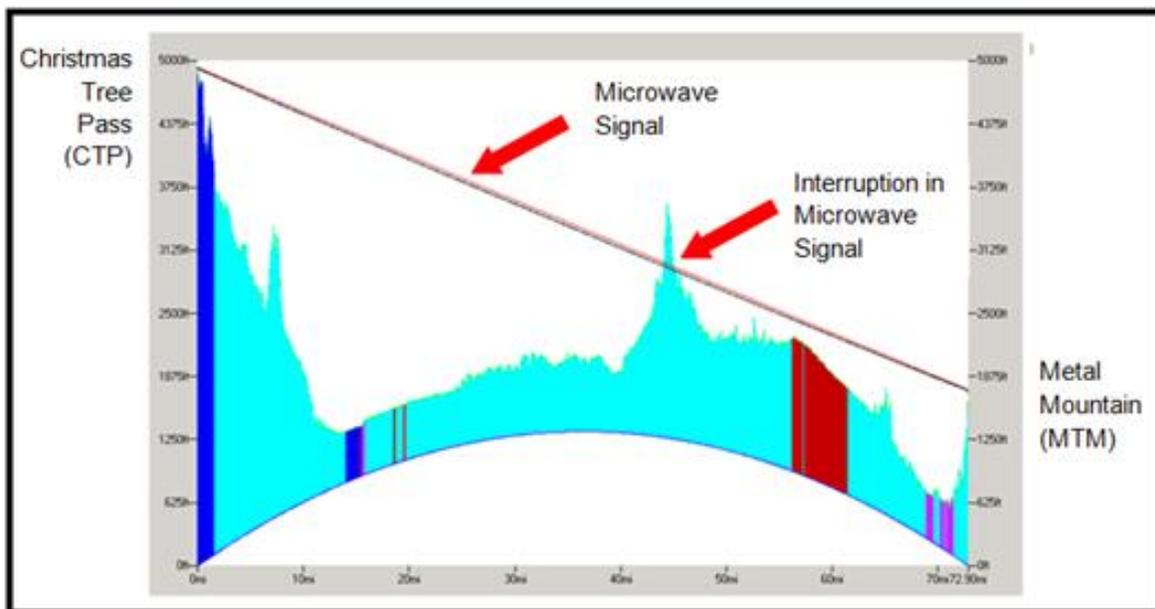


Figure 3: Christmas Tree Pass – Metal Mountain Path Profile

To meet the 99.999% reliability standard, an alternate microwave path must be used to get around this anticipated interruption in the signal. The alternate path proposed to get around the source of this interruption is from Christmas Tree Pass to Topock Substation to Crossman Peak to Metal Mountain. Reliability tests performed on this alternative path indicate that the microwave signal will transmit without interruption and maintain reliability well below the required minimum. As shown in Appendix E this path provides a reliability percentage of 99.999927364%. This is equal to twenty-three seconds of outage time per year, which is below the five minute minimum.

Planning

This primary microwave pathway that extends from Phoenix up to Hoover has had all the microwave equipment responsible for transmitting data from one site to the next upgraded to the new version of OC-3 radios. Because of the anticipated terrain interference this radio upgrade has not yet been implemented on the Christmas Tree Pass to Metal Mountain segment of the pathway leaving both sites operating with the older DS3 version radios. An older DS3 radio is capable of 10MB of data transmission while newer OC-3 radios are able to provide a maximum bandwidth of 30MB. As a result the communication pathway between Christmas Tree Pass and Metal Mountain is serving as a communication bottleneck as only a third of the maximum data is able to be transmitted between these two communication sites.

Socio-Economic

If the new communication site at Crossman Peak is not constructed the economic impacts to Western or its customers could include violating existing contractual obligations with one of the many entities Western currently shares communication bandwidth with in that area. Bandwidth is shared between the Mead-Phoenix Project for 500-kV & 345-kV transmission lines, as well as for SEV, APS, SRP, and other utilities.

Constructing this proposed communication site will also allow Western to finally release portions of the 2320-2345 MHz band for the National Telecommunications and Information Administration, which is part of the US Department of Commerce, to meet the government's goal of making 500 MHz of spectrum available for licensed commercial broadband use by 2020.

Assumptions & Constraints

Below is a list of assumptions & constraints used in developing this study and estimate:

- No power outages required for construction
- Rights to existing access road to Global Towers site to be obtained
- Estimate excludes environmental study costs, land acquisition, & distribution line.
- Project costs of Telegraph Pass Communication site used as estimate baseline.

Summary of Alternatives

Alternative No. 1 – Interim Site at Crossman Peak

Description

Western has already begun the process to gain access to the existing telecommunication site at Crossman Peak. Western plans to collocate at this existing telecommunication site, which is owned by Global Towers, temporarily until a permanent solution is implemented. It is estimated by DSW's G5300 group that Western will stage its communication equipment within Global Towers' site at Crossman Peak by March of 2014. Although this is not an ideal solution it will allow microwave transmission from Hoover to Phoenix within the 7125-8025 MHz band without interruption.

Western's equipment will be staged on the existing tower and within the existing shelter at Crossman Peak. There are multiple reliability concerns with using this interim site on a long term basis. Existing equipment at Crossman Peak is completely powered by a generator that requires refueling twice a day to stay operational. Communication outages caused by loss of power from generator failures is a major concern. Should there be any power outage at this interim site, Western would need to immediately start bypassing traffic from the microwave system to other systems to keep from dropping relaying, voice communications, and data that would affect DSW's operation of the five generation sites and twenty-two substations supported by this microwave backbone. Under a worst case scenario Western's Operations Group might be required to activate the COOP and man specific substations required for control of the power system.

Another concern with using this interim site on a long term basis is the security issue of staging Western's secure communication equipment within an unsecure facility. Global Towers' personnel along with any of their customers also collocating within their facility will have direct access to Western's communication equipment and network.

Advantages

- Lower upfront cost and shorter time to implement.
- Resolves interruption issue between CTP and MTM

Disadvantages

- Secure access to Western communication equipment not provided
- Reliable power source not provided.

Alternative No. 2 – Western Communication Site at Crossman Peak

Description

This option is to construct a new Western owned communication site at Crossman Peak. At the time of this study Crossman Peak is the only viable area found that successfully bypasses the mountainous terrain that would interrupt the microwave signal while still maintaining the minimum reliability standard.

The new path to bypass the source of interruption in the higher frequency signal will be from Christmas Tree Pass to Topock Substation to Crossman Peak to Metal Mountain. An existing microwave path already exists between Christmas Tree Pass and Topock Substation therefore only minor construction activities will be necessary at Topock, Christmas Tree Pass, and Metal Mountain to accommodate the new microwave path. The major construction effort for this proposed project will be constructing a new communication site at Crossman Peak. This will include purchasing the land for the site, the equipment shelter for the communication equipment to be housed, the tower to support the microwave antennas, the backup generator with fuel tanks for emergency power, and a distribution power line from MEC ran to the site for primary power.

The land ownership surrounding Crossman Peak is primarily BLM with some privately owned as well, see Figure 4. An environmental assessment will be required for access road rights through BLM land to Crossman Peak. A 50' by 50' land area will be needed to allow for Western to erect their communication tower and place an equipment shelter for housing the radio equipment. This area will be fenced for security. The existing access road that leads to the communication site owned by Global Towers is extremely rugged with extremely sharp switchbacks towards the top of Crossman Peak.

A distribution line from MEC to the communication site will be necessary to provide reliable power to the site. A backup generator and fuel tanks will also be installed to provide emergency power.

Advantages

- Provides an interruption free connection between CTP and MTM.
- Provides a secure facility for Westerns communication equipment.

Disadvantages

- Higher upfront cost to implement.
- Longer construction timeline.

Head-to-Head Comparison

In order to accommodate the FCC's mandate of reallocating government spectrum from the 2320-2345 MHz band up to the 7125-8025 MHz band the path between Christmas Tree Pass and Metal Mountain will have to be bypassed as the signal will not transmit in its current configuration. Western has already begun the process of implementing Alternative one and it's anticipated that the interim site within Global Towers' facility will be installed by March of 2014.

The disadvantage of using Global Towers' facility as a Western communication site is the lack of security to the Western system. Any other customer of Global Towers that has equipment at Crossman Peak will also have direct access to Western's communication network. Also this communication site has no security perimeter or barrier preventing unauthorized access to the facility. This communication site is also completely powered by a diesel generator that is refueled twice a day in order to stay operational. A generator malfunction or missed fueling would result in the site going off air.

Construction of a separate independent Western owned communication site on Crossman Peak would also provide the necessary operational benefit of bypassing the source of the signal interruption while also providing a secure and reliable facility to house Western's sensitive communication equipment.

Recommendation

Recommended Alternative

The microwave path from Christmas Tree Pass to Metal Mountain currently acts as a communication bottleneck and when the microwave frequency is increased to the band mandated by the FCC the signal will be interrupted by terrain located between these two sites. In order to meet the FCC's goal of reallocating underutilized government spectrum under the National Broadband Plan a solution to this must be implemented prior to 2020.

Because the microwave backbone is the primary communication pathway for all of the transmission lines between Mead and Phoenix, Western's ability to provide reliable power becomes threatened by using the current or interim site. The construction of a new Western owned communication site, as described in Alternative 2, ensures Western's ability to meet all required operational and security standards.

Appendices

A: Maps and General Arrangement



Figure 4: Global Towers Communication Site Location

Crossman Peak Communication Site

Hoover Dam

Christmas Tree Pass to Metal Mountain

DSW Headquarters in Phoenix, AZ

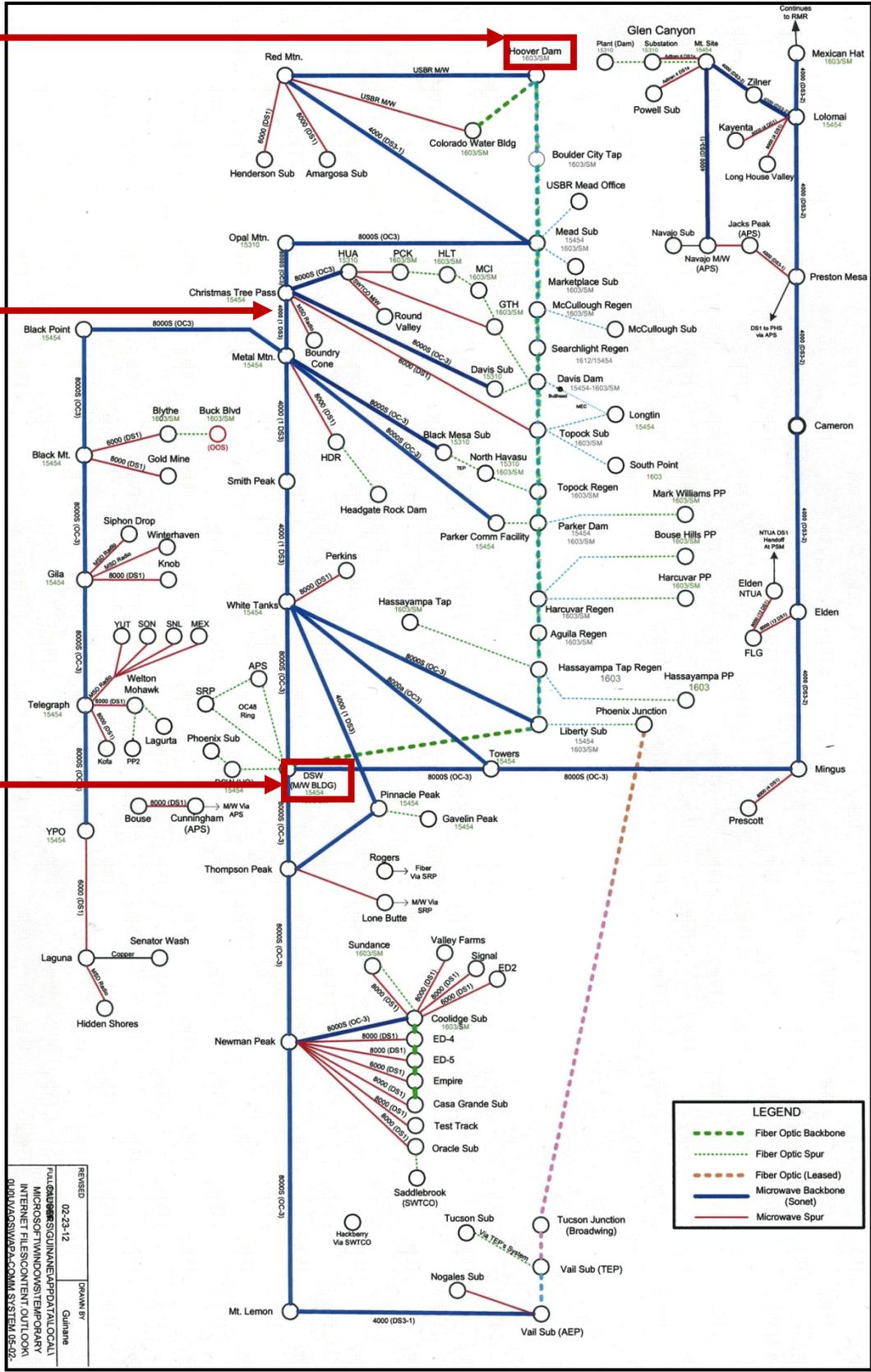


Figure 5: Microwave Backbone Path (Solid Blue Line)

B: Schedule

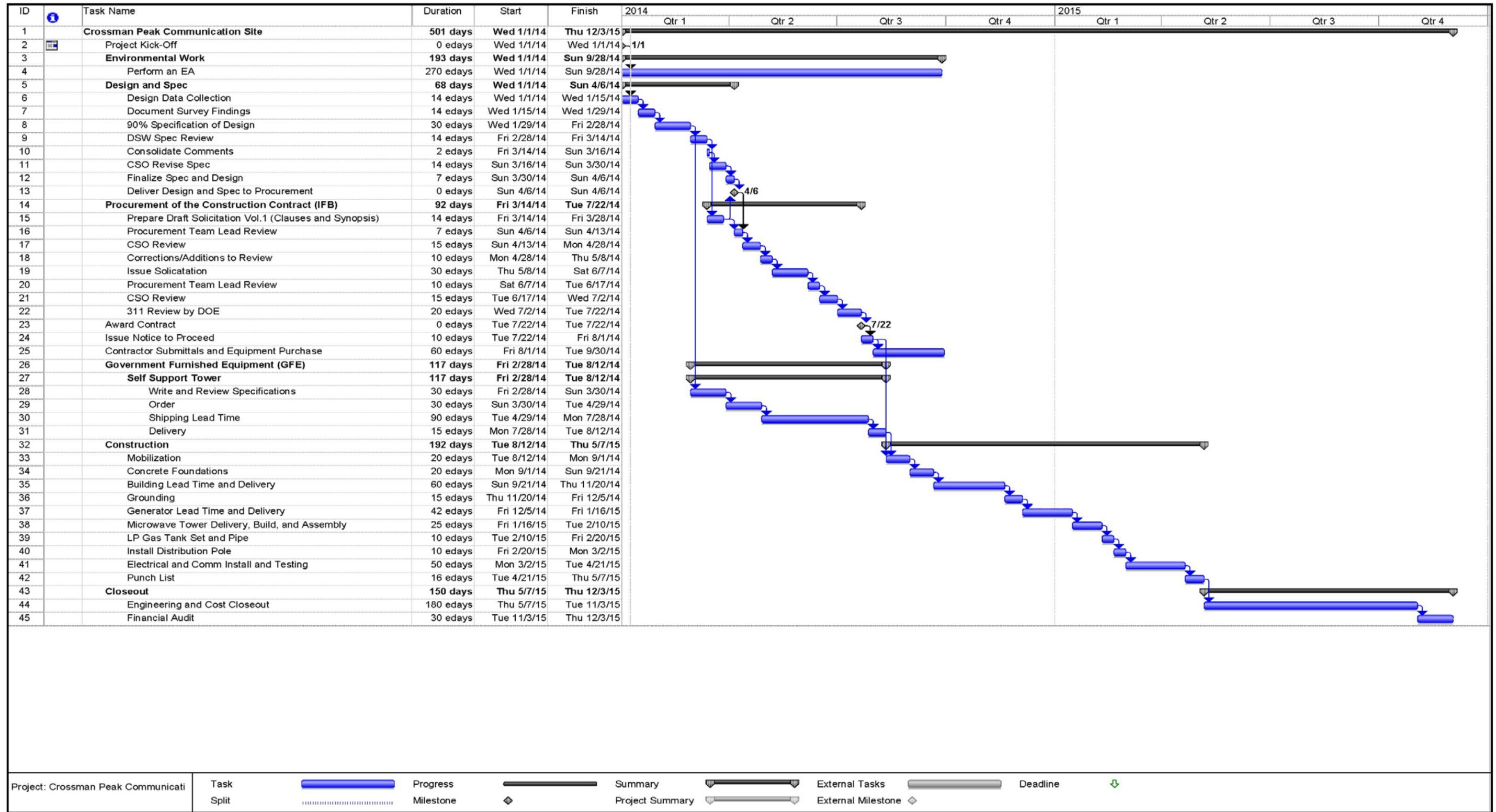


Figure 6: Proposed Schedule for Option 2

D. Additional Photographs



Figure 7 Global Towers Communications Site (North)



Figure 8 Global Towers Communications Site (South)

E. Proposed Microwave Path Profiles

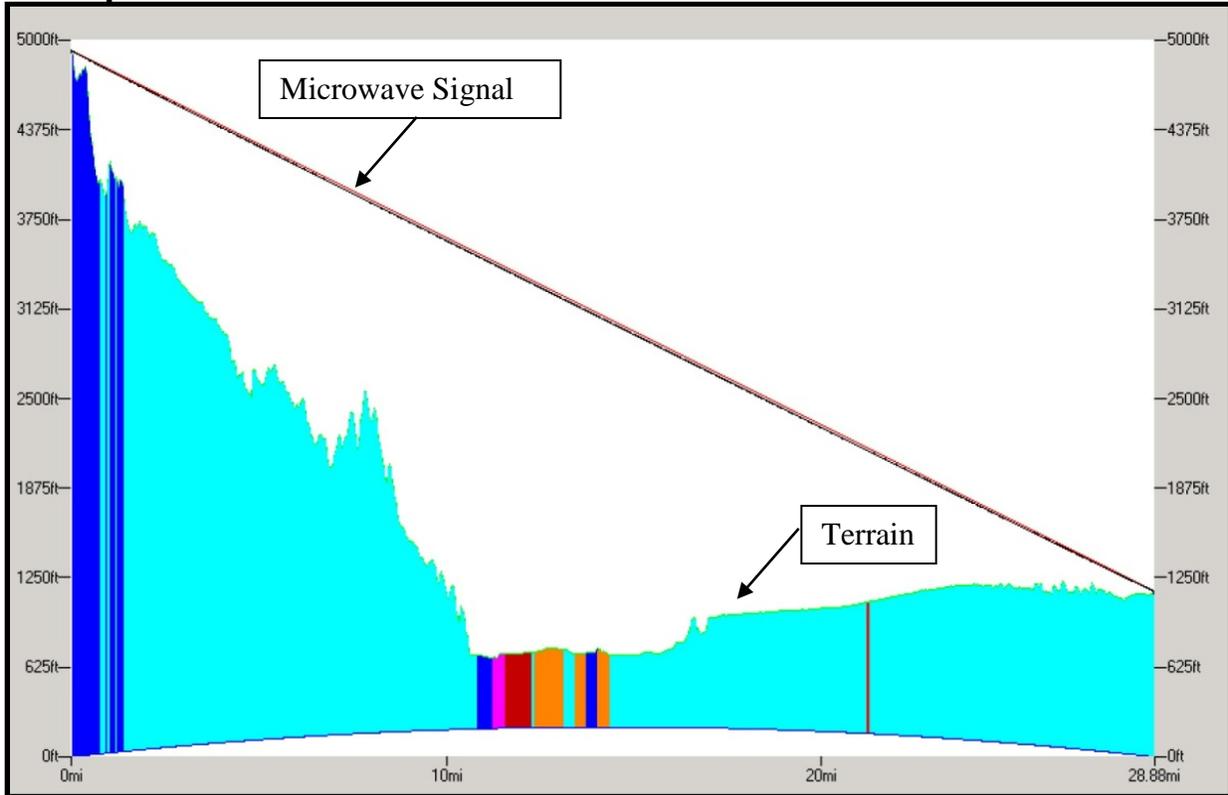


Figure 9 Path Profile from Christmas Tree Pass (left) to Topock (right)

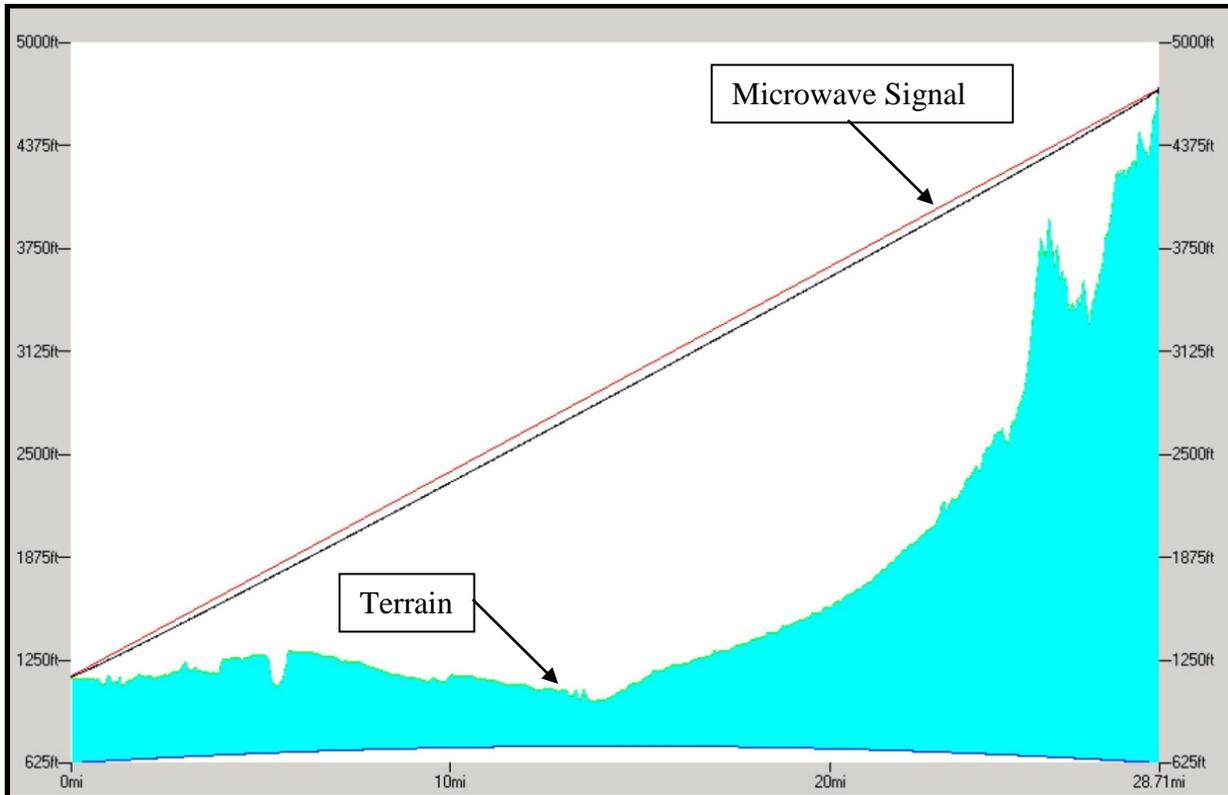


Figure 10 Path Profile from Topock (left) to Crossman Peak (right)

Crossman Peak Communication Site

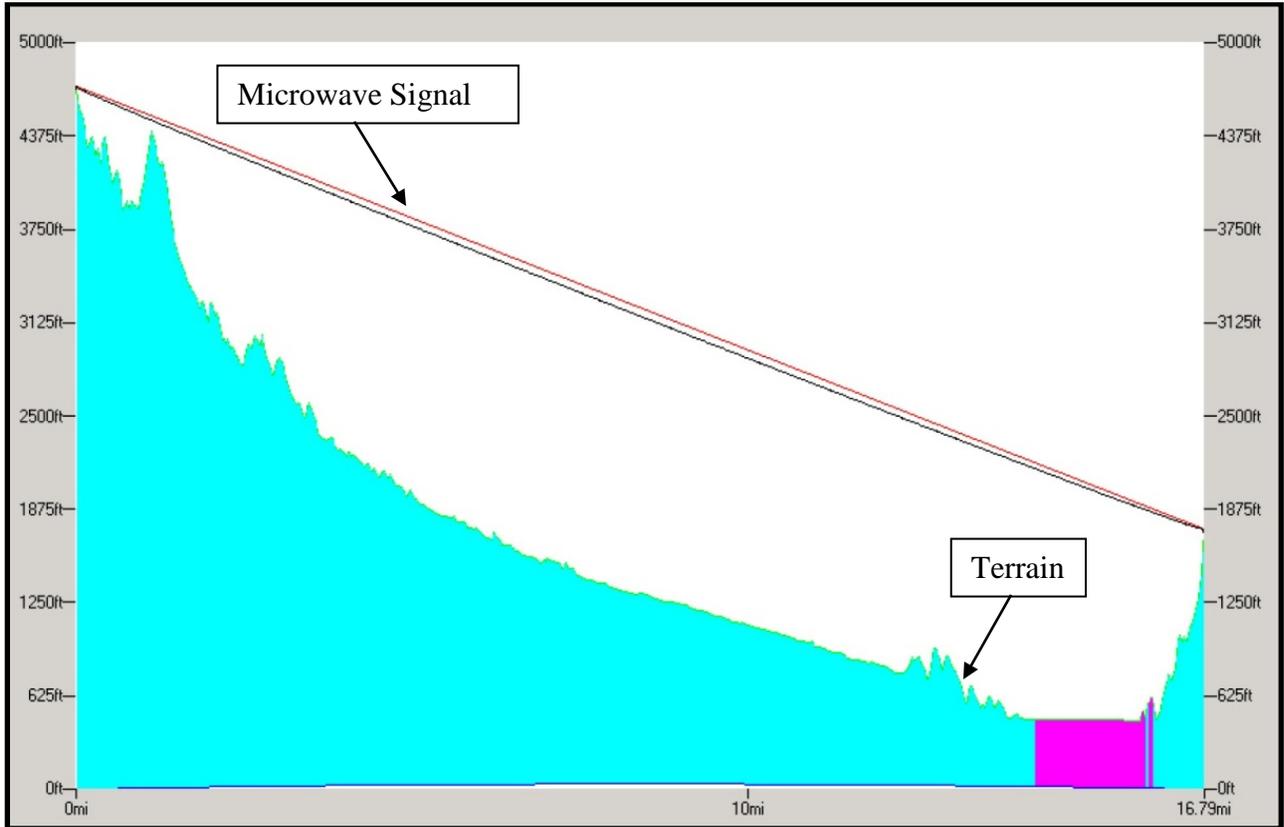


Figure 11 Path Profile from Crossman Peak (left) to Metal Mountain (right)

F. Alternative Comparison

Criteria for Evaluating Capital Projects and Ranking Them for Comparison

Ranking based on improvements of each issue.

(5=Great Improvement, 4=Above Average Improvement, 3=Average Improvement, 2=Minor Improvement, 1=No Improvement)

Crossman Peak Communication Site Study - Option 1

53.6% <<< Study overall percentage based on criteria listed below

| | | <u>Section</u> <u>Score (%)</u> | <u>Section</u> <u>Weight</u> |
|--------------------------------|---|------------------------------------|---------------------------------|
| Compliance (35%) | | 40.0% | 0.35 |
| 1 | Environmental | | |
| 4 | NERC | | |
| 1 | Safety | | |
| Reliability (25%) | | 72.0% | 0.25 |
| 1 | Equipment or Facility Condition | | |
| 5 | Availability of Replacement Parts | | |
| 4 | Impact on system if option implemented | | |
| 4 | Equipment Ratings Limit | | |
| 4 | Unexpected Load Growth | | |
| Planning (15%) | | 52.0% | 0.15 |
| 3 | Equipment/Facility Constraint of the Power System | | |
| 4 | Contractual need to meet Power Marketing agreements | | |
| 4 | An obligation for a path that meets a contractual requirement | | |
| 1 | Under Voltage Issue | | |
| 1 | Load Growth | | |
| Social/Economical (25%) | | 55.0% | 0.25 |
| 4 | Social and economic impacts of completing or not completing the project | | |
| 1 | Increased cost to the customer | | |
| 3 | Customer impact | | |
| 3 | Life cycle analysis of the facility or equipment | | |

Figure 12 Capital Projects Ranking for Alternative 1

Crossman Peak Communication Site

Criteria for Evaluating Capital Projects and Ranking Them for Comparison

Ranking based on improvements of each issue.

(5=Great Improvement, 4=Above Average Improvement, 3=Average Improvement, 2=Minor Improvement, 1=No Improvement)

Crossman Peak Communication Site Study - Option 2

65.5% <<< Study overall percentage based on criteria listed below

| | <u>Section</u> | <u>Section</u> |
|--------------------------------|---|----------------|
| | <u>Score (%)</u> | <u>Weight</u> |
| Compliance (35%) | | |
| 1 | Environmental | 46.7% |
| 5 | NERC | 0.35 |
| 1 | Safety | |
| | | |
| Reliability (25%) | | |
| 1 | Equipment or Facility Condition | 76.0% |
| 5 | Availability of Replacement Parts | 0.25 |
| 5 | Impact on system if option implemented | |
| 4 | Equipment Ratings Limit | |
| 4 | Unexpected Load Growth | |
| | | |
| Planning (15%) | | |
| 5 | Equipment/Facility Constraint of the Power System | 68.0% |
| 5 | Contractual need to meet Power Marketing agreements | 0.15 |
| 5 | An obligation for a path that meets a contractual requirement | |
| 1 | Under Voltage Issue | |
| 1 | Load Growth | |
| | | |
| Social/Economical (25%) | | |
| 5 | Social and economic impacts of completing or not completing the project | 80.0% |
| 1 | Increased cost to the customer | 0.25 |
| 5 | Customer impact | |
| 5 | Life cycle analysis of the facility or equipment | |

Figure 13 Capital Projects Ranking for Alternative 2