Walters Hill Alternate Site Suitability Report

City of Portland, Oregon Public Safety Systems Revitalization Project

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1. Introduction

The City of Portland (City) is currently engaged in contract negotiations with Motorola Solutions Incorporated (Motorola) for a radio network designed to the City's requirements per the Public Safety Systems Revitalization Program Project Charter (Charter) and subsequent Request for Proposal (RFP) # 115097 released November 19, 2012. One of the key objectives of the project as defined in the Charter is to provide radio system users with at least the same level of coverage that the existing system provides. The Charter also states the project does not include:

- New radio communication sites including towers, land acquisitions, and permitting
- Complete redesign of the radio system such as identifying alternative tower sites for which land must be acquired and towers constructed

Therefore, the RFP required proposers to offer a design that provides a mission critical voice communications system meeting the expressed needs of the first responders who use the system and guarantee the coverage, reliability, and performance by using existing City sites.

Following the award of the contract for the system to Motorola, the City indicated that the Mayor of Gresham, Oregon, expressed concerns regarding the proposed 180-foot tower at the site known as Walters Hill, owned by the City of Portland. The current antenna support structure at Walters Hill comprises telephone poles, approximately 50 feet in height that are obstructed by 45-foot to 80-foot trees in the immediate surrounding area.

Radio propagation studies reveal that the proposed self-supported tower at this location would provide enhanced overage in the City of Gresham. The tower also permits integration of this radio site into the proposed loop-configured microwave radio communications network. Due to the inherent redundancy associated with the design, loop-configured microwave radio systems generally provide the highest level of reliability for radio system connectivity when compared to other configurations or land-based leased telephone circuits.

In response to the concerns expressed by the Mayor of Gresham, the City, based on the results of studies conducted early in the project to determine the minimum heights required for microwave radio connectivity, offered to lower the tower height to 140 feet. The modified design calls for mounting the voice radio system antennas at the top of the tower and the microwave radio antennas at the 120-foot level. The mounting height

chosen for the microwave radio antennas creates a clear path for microwave radio connectivity to the Prune Hill and City of Portland Bureau of Emergency Communications (BOEC) tower sites. This height also allows for tree growth that could otherwise obstruct the path in future years.

The information contained in this report addresses the potential suitability of several alternate sites for use in the proposed Motorola radio network and the impact of each site on the design. This study focuses on the East Simulcast Cell microwave radio connectivity and radio coverage in the City of Gresham. A full evaluation of the suitability for a given radio site requires analysis of myriad items that surpasses the scope of this report.

1.1 Task Description

The City contracted Federal Engineering, Inc. (***FE***) to evaluate alternate sites as potential replacements for the Walters Hill location. For this evaluation, the City requested that ***FE*** use the same tower and antenna configuration as that proposed at Walters Hill. The City provided a list of alternate sites for evaluation. ***FE*** suggested to the City that they also include the Multnomah County Maintenance Yard in the evaluation.

FE's first step was to perform an analysis of the microwave paths for each alternate site. If the results of the microwave path profile indicated that a clear path exists for a given alternate site to connect to the at least two sites in the proposed microwave radio loop, ***FE*** performed a radio propagation (coverage) analysis for the site. These analyses illustrate the impact on radio coverage within the Gresham city boundaries for each potentially suitable alternate configuration. For comparison, ***FE*** conducted a radio coverage analysis to establish baseline coverage in the City of Gresham when using a 140-foot radio tower at Walters Hill.

For this report, ***FE*** considered the following sites and configurations:

- Mount Hood Community College Campus replaces Walters Hill
- Multnomah County Maintenance Yard replaces Walters Hill
- Polivka Hill replaces Walters Hill
- Powell Butte replaces Walters Hill
- Powell Butte plus Walters Hill at the current height (adds a site to the design)
- East of Regner Road replaces Walters Hill
- Rocky Butte replaces Walters Hill
- Water Tank Southeast of Walters Hill replaces Walters Hill

1.2 Methodology

FE and the City jointly defined the technical parameters and assumptions applicable to the analysis. The parameters, based on the requirements of the RFP, include 99.999% microwave radio path reliability and 95% or better coverage for mobile radios at a Delivered Audio Quality (DAQ) of 3.4. All radio coverage models are in accordance with the guidelines put forth in the latest revision of the Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin (TSB) #88, *Wireless Communications Systems Performance in Noise-Limited Situations*

The definition of a suitable site is one that has a direct path to other specified sites in the microwave loop configuration design, which is clear of obstructions and can potentially. ***FE*** analyzed the microwave radio paths between each alternative site location to other microwave sites in the proposed design determine if an unobstructed path exists.

To establish the proposed baseline radio coverage for the existing City of Portland Walters Hill site, ***FE*** used Motorola's preliminary radio system design parameters adjusted to 140 feet above ground level (AGL). The technical supplement in Appendix B of this report provides the coverage modeling maps for each candidate site.

1.3 Deliverables

FE's microwave radio backhaul models incorporate urban (building) and terrain clutter. The technical supplement associated with this report provides individual path profiles between each of the suggested alternate sites and the other microwave sites in Motorola's proposed microwave loop configuration design.

For each alternate site capable supporting primary and redundant microwave connectivity to the proposed Motorola microwave radio backhaul network, ***FE*** generated two simulcast voice radio system coverage maps for the East simulcast cell. These composite maps represent mobile talk-in, mobile talk-out, portable talk-in, and portable talk-out coverage. For the portable radio studies, ***FE*** modeled both on-street coverage and in-building coverage (with 12 dB of building loss, simulating a "medium" density building). The maps display coverage of 97% reliability with a DAQ of 3.4.

This report summarizes the results of the microwave radio path analyses and Land Mobile Radio (LMR) coverage studies conducted for each potentially suitable alternate site. In addition to this report, ***FE*** provides a separate technical supplement containing all of the supporting technical data, including site parameters, path profiles and coverage maps for each site.

2. Microwave Radio Connectivity Analysis

2.1 Microwave Radio Path Profiles

FE performed software-based path profile studies for each Walters Hill alternate to determine its' suitability. In order for an alternate site to be suitable, it must have potential for use in the proposed loop-configured, microwave radio network using 120 feet as the mounting height for the microwave antenna. The path profile must show that a clear microwave radio path exists to at least two other proposed locations in the loop for redundant connectivity.

2.2 Analysis Results

Table 1 presents feasibility of the alternate sites' connectivity to the microwave radio network. Sites listed in the heading row across the top are sites included in the proposed design. Sites listed in the first column on the left include Walters Hill as a baseline and the alternate sites under consideration. The red, yellow, or green colored cells indicate the rating of the suitability of each site in the first column to connect to each of the sites listed in the heading row.

Table 1 – Results of Evaluated Microwave Radio Paths

Site name	Mt. Scott	BOEC/ 911	Prune Hill	Biddle Butte	Lookout Point
Baseline - Walters Hill at 120 ft.	N/A	PASS	PASS	N/A	N/A
Multnomah County.	PASS	PASS	PASS	PASS	PASS
Mt Hood CC	PASS	PASS	PASS	FAIL	PASS
Powell Butte	PASS	FAIL	PASS	PASS	PASS
Regner Road	PASS	FAIL	PASS	PASS	PASS
Rocky Butte	PASS	FAIL	PASS	N/A	N/A
Polivka	PASS	FAIL	FAIL	PASS	PASS
Water Tank	FAIL	FAIL	FAIL	PASS	PASS

PASS (Green box): Meets minimum path clearance requirements to at least two sites without known tower issues

PASS (Yellow Box): Meets minimum path clearance requirements, however, according to the City, site issues exist which are detailed in Appendix B

FAIL (Red Box): Does not meet minimum path clearance requirements (Line of sight, Fresnel Zone)

N/A: Paths not evaluated due to excessive distance between locations or not part of baseline design

Based on the results shown in Table 1, four of the seven sites analyzed appear to have sufficient path clearance to at least two other sites without known site limitations. These sites could be suitable for integration into the proposed loop-configured network. These sites are:

- Mount Hood Community College
- Multnomah County Maintenance Yard
- Powell Butte
- East of Regner Road

Figure 1 provides a visual representation of the microwave radio paths for each alternate site discussed herein, which appear to have clear paths for connection to at least two other sites in the East Simulcast Cell. Paths shown in blue represent the Motorola-proposed microwave radio network, paths shown in orange represent the originally proposed Walters Hill paths, and paths shown in green represent the alternate site microwave paths that, based on the results of our analyses, appear suitable for use in East Simulcast Cell microwave radio network.

***FE** recommends that the City conduct a physical path survey to determine the actual viability of a microwave radio path*

Figure 1 – Potentially Suitable Alternate Site Microwave Radio Paths and Motorola-Proposed Microwave Radio Ring

3. Radio Coverage Analysis

3.1 Baseline Radio Coverage of Walters Hill

The maps in this section represent predicted "talk-in" radio coverage, or the predicted coverage from a user's portable or mobile radio back to the tower sites. This is the most "limited path," because talk-in coverage tends to be a smaller coverage footprint than talk-out due to the lower power output of the mobile or portable unit and the lower elevation of the antenna associated with the mobile or portable unit when compared to the transmitter at a radio tower. The technical supplement for this report (Appendix B) contains individual talk-in and talk-out coverage maps for each potentially suitable alternate site.

Figure 2 shows the baseline coverage of the Motorola-proposed East Simulcast Cell, comprising Biddle Butte, Lookout Point, and the Walters Hill site using the proposed 140-foot tower height. The black dashed line outlines the City of Gresham. ***FE*** modeled this coverage using technical parameters extracted from Motorola's radio system proposal.

Figure 2 – Predicted East Simulcast Cell Coverage using Walters Hill at 140-Feet

3.2 Alternate Site Radio Coverage

Maps presented here predict radio coverage using the four potentially suitable alternate sites resulting from the microwave path analyses. Four of the maps show a three-site simulcast cell, consisting of Biddle Butte, Lookout Point, and one of the four potential

alternate sites. A fifth map shows the predicted coverage a four-site cell, consisting of Biddle Butte, Lookout Point, Powell Butte, and Walters Hill using the approximate height of the current antenna support structure. Talk-in and talk-out simulcast coverage maps for each of the alternate sites are located in the technical supplement included with this report.

Figure 3 – Predicted East Simulcast Cell Coverage using Powell Butte and Walters Hill at 50'

Figure 4 – Predicted East Simulcast Cell Coverage using Powell Butte

Figure 5 – Predicted East Simulcast Cell Coverage using Regner Rd.

Figure 6 – Predicted East Simulcast Cell Coverage using Multnomah County Maintenance Yard

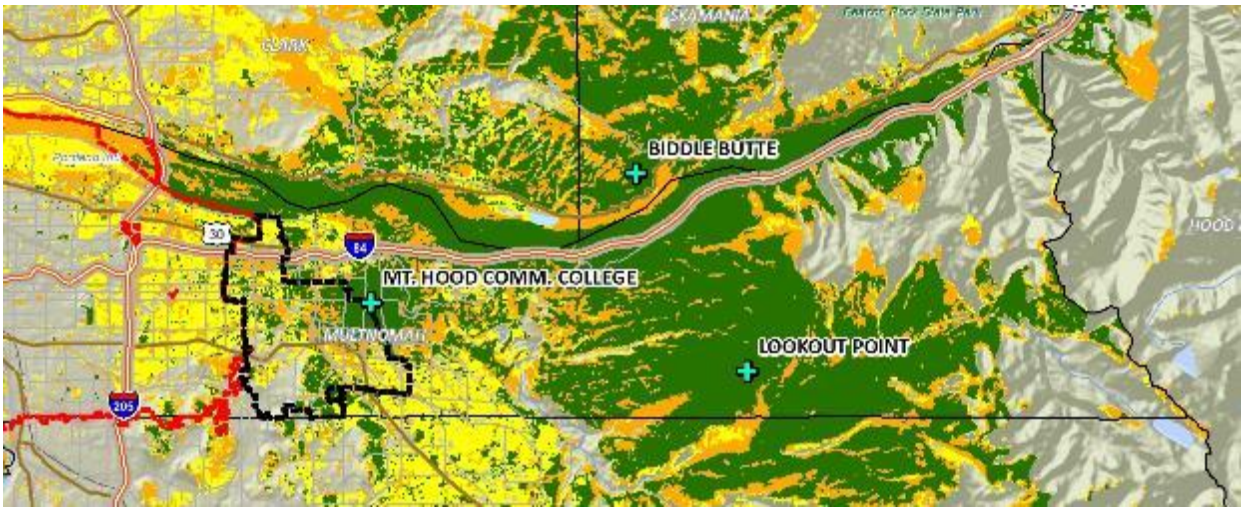


Figure 7 – Predicted East Simulcast Cell Coverage using Mt. Hood Community College

3.3 Radio Coverage Statistics

The decision concerning Walters Hill site will significantly affect the City of Gresham radio coverage. ***FE*** illustrates this in Table 2 by showing the percentage of radio coverage at 97% reliability with a DAQ of 3.4 in the City of Gresham using the site configurations analyzed in this report.

The first row in Table 2 represents ***FE's*** baseline coverage prediction in the City of Gresham from the East Simulcast Cell using a 140-foot tower at Walters Hill.

Table 2 – Predicted City of Gresham Radio Coverage from East Simulcast Cell

Site Configuration	Number of Simulcast Sites	City of Gresham Radio Coverage Percentages					
		Mobile		Portable On-Street		Portable In 12 dB (Light – Medium) Building	
		Talk-Out	Talk-In	Talk-Out	Talk-In	Talk-Out	Talk-In
Baseline Coverage East Simulcast Cell Walters Hill at 140'	**3**	**98**	**99**	**97**	**95**	**81**	**65**
Powell Butte plus Walters Hill at 40' TX, 50' RX (adds a site to the design)	4	98	99	96	95	75	64
Regner Rd. replaces Walters Hill	3	91	92	89	85	68	57
Powell Butte replaces Walters Hill	3	93	92	81	74	52	41
Multnomah County Maintenance Yard replaces Walters Hill	3	89	88	75	69	59	42
Mt. Hood Community College replaces Walters Hill	3	78	79	62	55	35	30

3.4 Simulcast Radio Interference

When designing a simulcast cell, time-delay interference (TDI) is a major consideration. TDI occurs when comparably strong signals from two or more simulcast sites arrive at a radio at significantly different times. Radio receivers are very sensitive, and as a result, these delay times can be significant and cause reception problems if one site's signal arrives in as little as 60 millionths of a second after another site's signal.

FE analyzed the possibility of simulcast TDI from all site configurations listed in Table 2, and found no significant TDI in any of the configurations.

4. Conclusion

Based on the results of our analyses, ***FE*** concludes that four of the proposed Walters Hill alternate sites appear to meet the minimum path clearance requirements for connectivity to the Motorola-proposed microwave radio network. These sites are:

- Mount Hood Community College
- Multnomah County Maintenance Yard
- Powell Butte
- East of Regner Road

For each of these potential alternate sites as well as Walters Hill. ***FE*** conducted multiple radio propagation analyses to predict the portable and mobile radio coverage in the City of Gresham. To establish a baseline model for comparison, ***FE*** produced a radio coverage model using the proposed 140-foot tower at Walters Hill. The individual talk-in and talk-out coverage maps for each potentially suitable alternate site are located in the technical supplement for this report (Appendix B).

The results from all of these analyses clearly show the radio coverage predicted in the City of Gresham using a 140-foot tower at Walters Hill is greater than the coverage offered by any of the potential alternate solutions. Figures 8 and 9 visually portray the coverage results provided earlier in Table 2 of this document.

Figure 8 – Predicted Talk-In Coverage of the East Simulcast Cell for Various Configurations – City of Gresham

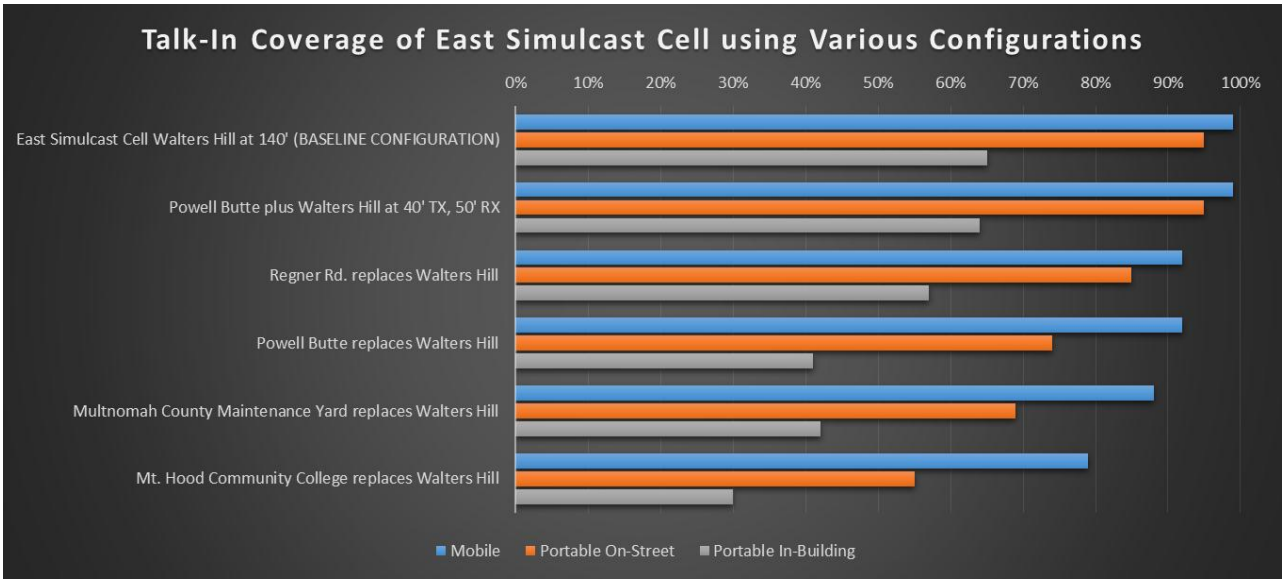
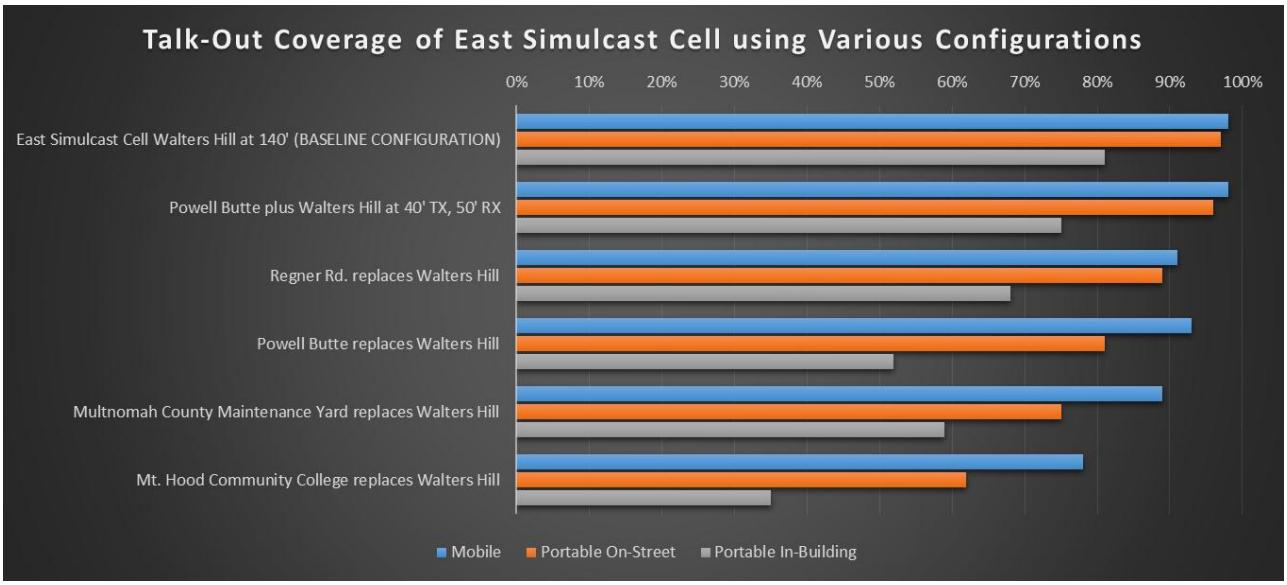


Figure 9 – Predicted Talk-Out Coverage of the East Simulcast Cell for Various Configurations – City of Gresham



Appendix A – Terms and Acronyms

Acronym	Definition	
AGL	Above Ground Level	
BOEC	Bureau of Emergency Communications	
DAQ	Delivered Audio Quality	
	DAQ 1	Unusable, speech present but unreadable
	DAQ 2	Understandable with considerable effort. Frequent repetition due to noise/distortion
	DAQ 3	Speech understandable with slight effort. Occasional repetition required due to noise/distortion
	DAQ 3.4	Speech understandable with repetition only rarely required. Some noise/distortion
	DAQ 4	Speech easily understood. Occasional noise/distortion
	DAQ 5	Speech easily understood
dB	A logarithmic unit commonly used to express gain or attenuation	
Fresnel Zone	A defined elliptical radiation pattern	
LMR	Land Mobile Radio	
microwave	In RF engineering, radio frequencies that range between 1 GHz and 100 GHz	
RX	Abbreviation for “receive” in reference to RF signals	
simulcast	Signaling technique that transmits the same signal from multiple sites.	
TDI	Time-delay interference which refers to RF interference resulting from the relative time at which multiple signals reach an RF receiver	
TIA	Telecommunications Industry Association	
TSB	Telecommunications Systems Bulletin	
TX	Abbreviation for “transmit” in reference to RF signals	

Appendix B – Technical Supplement

See separate file: *PRTLD Walters Hill alternate Site Suitability Report Technical Supplement*