NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: UT

Data description

Data type: Precipitation depth **Units:** English **Time series type:** Partial duration

Select location

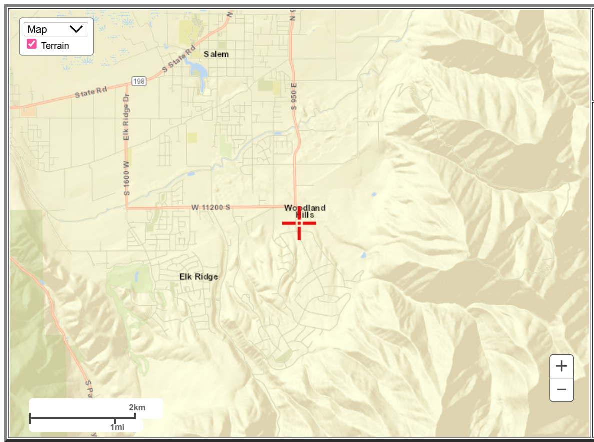
1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: Longitude: Submit

b) By station (list of UT stations): Select station

c) By address Woodland Hills, UT, USA

2) Use map:



a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Location information:
Name: Salem, Utah, USA*
Latitude: 40.0244°
Longitude: -111.6528°
Elevation: 4720 ft**

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 1, Version 5

PF tabular PF graphical Supplementary information Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.131** (0.114-0.156)	**0.168** (0.146-0.199)	**0.232** (0.199-0.275)	**0.288** (0.245-0.342)	**0.376** (0.312-0.448)	**0.454** (0.368-0.544)	**0.545** (0.432-0.656)	**0.650** (0.499-0.791)	**0.816** (0.598-1.01)	**0.964** (0.681-1.22)
10-min	**0.200** (0.173-0.237)	**0.256** (0.222-0.303)	**0.353** (0.303-0.418)	**0.439** (0.373-0.521)	**0.572** (0.474-0.682)	**0.691** (0.561-0.828)	**0.829** (0.657-0.999)	**0.989** (0.759-1.20)	**1.24** (0.910-1.54)	**1.47** (1.04-1.85)
15-min	**0.248** (0.214-0.294)	**0.317** (0.274-0.376)	**0.438** (0.375-0.518)	**0.544** (0.462-0.646)	**0.709** (0.588-0.846)	**0.857** (0.695-1.03)	**1.03** (0.814-1.24)	**1.23** (0.941-1.49)	**1.54** (1.13-1.91)	**1.82** (1.29-2.30)
30-min	**0.334** (0.288-0.396)	**0.427** (0.370-0.506)	**0.589** (0.505-0.698)	**0.733** (0.623-0.870)	**0.955** (0.792-1.14)	**1.15** (0.936-1.38)	**1.39** (1.10-1.67)	**1.65** (1.27-2.01)	**2.07** (1.52-2.57)	**2.45** (1.73-3.09)
60-min	**0.413** (0.357-0.490)	**0.528** (0.458-0.626)	**0.729** (0.625-0.864)	**0.907** (0.771-1.08)	**1.18** (0.980-1.41)	**1.43** (1.16-1.71)	**1.71** (1.36-2.06)	**2.04** (1.57-2.49)	**2.57** (1.88-3.18)	**3.03** (2.14-3.83)
2-hr	**0.522** (0.459-0.607)	**0.657** (0.577-0.765)	**0.867** (0.758-1.01)	**1.06** (0.914-1.23)	**1.36** (1.15-1.59)	**1.63** (1.35-1.91)	**1.94** (1.56-2.30)	**2.29** (1.80-2.76)	**2.86** (2.14-3.51)	**3.38** (2.43-4.22)
3-hr	**0.608** (0.542-0.698)	**0.759** (0.676-0.870)	**0.967** (0.859-1.11)	**1.16** (1.02-1.33)	**1.46** (1.26-1.68)	**1.71** (1.45-1.99)	**2.02** (1.67-2.36)	**2.37** (1.92-2.81)	**2.95** (2.29-3.57)	**3.47** (2.60-4.28)

BYU ENGINEERING
Civil & Construction Engineering

CAPSTONE

WOODLAND HILLS STORMWATER RUNOFF SOLUTIONS
PROJECT ID: CEEN_CPST_0 04

by

Ashley Lott
Logan Hockema
Mahina Piena

A Capstone Project Report

Submitted to

Ted Mikelsen
Jones and DeMille

Department of Civil and Construction Engineering
Brigham Young University

April 17, 2023

Executive Summary

PROJECT TITLE: WOODLAND HILLS STORMWATER RUNOFF SOLUTIONS
PROJECT ID: **CEEn_CPST_0** 04
PROJECT SPONSOR: Ted Mikelsen
TEAM NAME: V-flow

The main purpose of this project was to determine detention volume for post-development conditions in Woodland Hills. The construction of new improvements resulted in a higher percentage of impervious land, which increased water runoff. This led to flooding in the Salem area. We determined the proper size and location of a possible detention pond. Deliverables from this project are as follows:

- Short regular status reports documenting challenges, solutions & progress
- A final report with design alternatives for the project that include economic and environmental considerations
- A poster reflecting a summary of the project to be presented to students, faculty and other interested individuals in the final undergraduate seminar
- A presentation summarizing the project to be presented to the sponsor

Table of Contents

List of Tables

Introduction

The city of Woodland Hills was founded in 1970 and became an incorporated city in 2000.[1] Woodland Hills sits on a very steep hill in a mountainous area outside of Heber City. The city faced issues of excess stormwater runoff with risk of potential flooding in the suburban areas. Consequently, a focus to identify stormwater runoff solutions became a priority issue to address.

Woodland Hills contracted Jones and DeMille Engineering to contribute solutions to better control the stormwater runoff. Jones and DeMille designed detention basins to store the necessary volume of water. This report provides an analysis of the pre and post conditions of a watershed in the Woodland Hills municipal boundary. Data was taken from the United States Geological Survey (USGS), National Oceanic and The analysis was modeled using the water modeling system, TR-55 in HEC. Watersheds were delineated using contours of a contour map in ArcGIS. The vegetation and percent impervious areas were then determined. The soil classification, land cover, rainfall intensity, and precipitation data were also gathered. One of the watersheds that seemed the most problematic drainage for flood conveyance and detention measures was selected for further evaluation. was selected for further analysis to begin to find a detention basin location. The contribution of flows and volumes due to hardscape developments were calculated. Then, the historical amounts of water and flows prior to proposed development were compared to the contribution of current development. The limiting

Commented [AL1]: we got all of our data from wms (usgs)

[1] utahvalley.com/listing/woodland-hills-city/1573/

factors for downstream capacities were then considered and included in the summary of the findings, analysis, and proposed recommendation.

The Vflow team held weekly meetings to discuss next actions, accomplish tasks, coordinate efforts and troubleshoot errors. Meetings were organized and held directly with the sponsor approximately every 2-3 weeks.

Schedule

Date	Purpose
October 14, 2022	Sponsor dinner
November 22, 2022	Field visit to Woodland Hills
December 15, 2022	Data collection
January 25, 2022	Data inputted into GIS; area calculations
February 9, 2023	Watershed delineation
March 11, 2023	TR-55 analysis and records of results
March 25, 2023	Figures created; report drafted

Assumptions & Limitations

The area calculation for percent impervious (hardscapes) within the Woodland Hills municipal boundary was found using an average of five hardscape areas multiplied by the total number of hardscapes, and the tools used to measure dimensions digitally may not always reflect present-day, physical conditions.

The analysis results and consequent detention basin location recommendation is based on the hydrology data only. The recommendation does not consider the soil data specific to the basin coordinates. Further data collection and analysis must be conducted in the soil work in order to verify this location is conducive to basin construction.

If further analysis is done to determine the exact coordinates for a detention basin, the analysis must take into consideration that this report did not account for the specific locations of buildings that may be limiting factors in downstream capacity.

For the purposes of watershed analysis, it is assumed that the effect of the flow released from the existing detention basin on the developed flow was negligible.

Design, Analysis & Results

Steps

The current design was accomplished using WMS, with HEC and TR-55 as analysis methods. Detailed steps and figures of the process are shown in the appendix. WMS automatically calculates important variables using a wide variety of input data. We used US topographic maps, soil data maps, land usage data maps, and precipitation data as the primary inputs. We also used an elevation map of Woodland Hills from our sponsor. To compare the post-developed land, the only measurement we had to take was an approximate hardscape area in google maps (Table 1).

The first step of our calculation was to delineate the watersheds using contours (Figure 1). This can be done easily using WMS and a topo map. Because this gives us watersheds that are outside of the Woodland Hills boundary, and we are only considering land in woodland hills, we clipped the area to fit inside municipal boundaries. We also only considered the watershed that would be directly contributory to the detention pond (Figure 3).

After inputting more data and finding possible flow paths, WMS calculates the curve number (Table 2). This will change if hardscape is added. The time of concentration and hydrograph is then calculated (Figure 2). From this output, we determined the total volume of flow (Table 3) for both undeveloped and developed conditions, which gives us our detention volume.

After meeting with our sponsor for recommendations, we determined an ideal location for the detention basin, its volume, and the flow that it would be required to sustain for both inlet and outlet. We also approximated the shape using nearby detention ponds as an example. Our final numbers and figures are below.

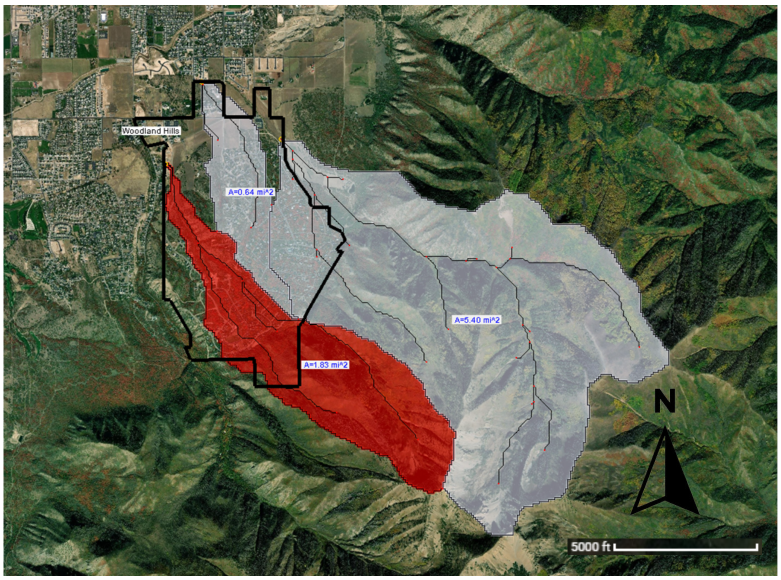


Figure 1. Watersheds Supplementary to Woodland Hills (Red was Analyzed).

Figure 2. Outline of the selected watershed for further hydraulic modeling analysis.

Formatted: Font: 9 pt, Italic, Not Highlight

Formatted: Font: (Default) +Body (Cambria), 9 pt, Italic

Table 1: Post-Development Hardscape Areas in Primary Watershed

Post-Development			
	Hardscape	**City**	**Watershed**
Area (ft^2)	3,221,680	78,059,520	-
Area (mi^2)	0.12	2.80	0.55
Hardscape Area of Watershed			0.02
Remaining Area of Watershed			0.53

Table 2: Curve Numbers

	CN
Pre-Development	70.2
Post-Development	71.4

Table 3: Peak Flows and Volumes

	Peak Discharge (cfs)	Volume (ft^3)	Volume (ac-ft)
Pre-Developed	71.9	930,000	21.4
Post-Developed	80.9	1,000,000	23.0
Excess	9.04	70,000	1.60

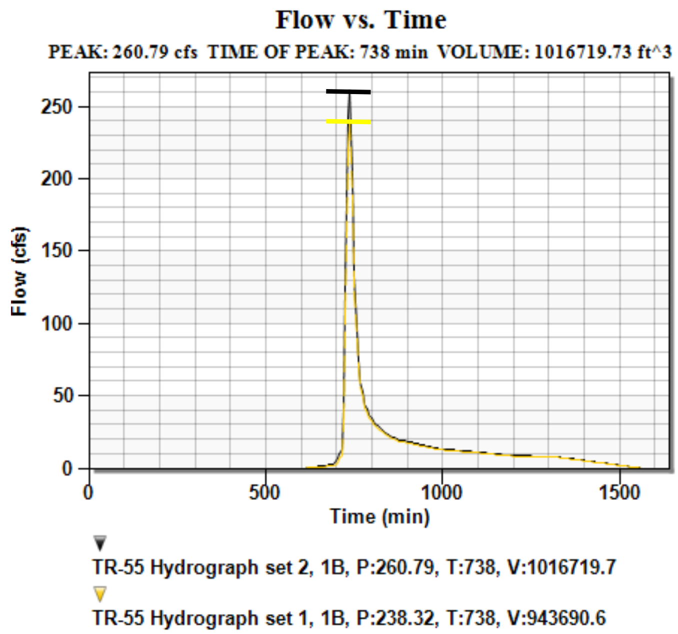


Figure 3. Hydrograph of flow vs time for post-development (black) and pre-development (yellow) conditions.

Figure 4. Recommended detention pond location

Formatted: Centered, Line spacing: Multiple 1.15 li, Keep with next

Related Issues

There are safety factors involved, both positive and negative for the neighborhood. On the positive, there is less risk for flooding and water-related hazards in Salem and Woodland Hills. On the negative, the detention pond could pose a drowning hazard for residents in the area, especially young children, and animals. The pond could also be a health hazard, attracting more pests and unwanted life to the area. This could consequently cause destruction to surrounding vegetation.

There may also be cultural and aesthetic effects to the community. The placement of this detention pond is in a very visible part of the city, which may increase or decrease the aesthetics of the area. Residents and the city may also find alternative uses for this pond, such as turning this area into a park, or use for a municipal water system.

Placing a pond within the community will cause a significant increase in mosquitoes. However, this should only impact a small number of homes nearby because the pond will be approximately 0.5 miles from the nearest street.

The value of land may go down or up due to all these factors. Water features are a liability, but they are also a beautification of the area and project community wealth. It will mostly depend on how the land develops after the pond is finished.

Lessons Learned

Over the course of our project meetings, our team encountered a few challenges that required us to learn important lessons. The first challenge we faced was finding which method to use in order to be efficient. We spent a fair amount of time trying to use ArcGIS and its analysis tools. However, we found that it was an inefficient use of our team because technical issues caused us to have to almost restart our project every time we met. Eventually, we agreed that ArcGIS was not going to be very beneficial to our project and we decided to learn a new program, WMS.

Deciding to learn WMS was another challenge we faced. Learning a new program always comes with a steep learning curve. We referred to faculty and the internet for advice in order to learn and ensure that we were using the program correctly.

Another important lesson we learned was to delegate responsibilities. For a bigger project, we couldn't all be working on the same thing all the time together because it would take too long. We also had to take responsibility for different parts because there were many times not all of us could meet at the same time or same place.

Most of all, we learned to work as a team through this project. There were many times we had to depend on each other to do his/her part in order to complete the project. We had to trust each other and trust that each of us did our part correctly.

Conclusions

The development of Woodland Hills caused water runoff volume to increase, leading to flooding in the Salem area. In order to prevent this, we completed an analysis comparing the pre-development and post-development conditions. After finding the difference in runoff volume, we were able to determine the potential size and location of a detention pond to hold the excess runoff.

Recommendations

After analysis of the watershed runoff, we recommend that the detention pond be located east of Summit Creek Road and north of Nebo Street. The post-developed runoff exceeds the pre-developed runoff flow by a capacity of 238 cfs and a volume of approximately 1.6 acre-feet. We recommend the detention basin be constructed to hold about this volume and the outlet structure be designed to accommodate this flow rate.

Appendix A – WMS Output

Basin Name	1B
Time of Concentration (TC) (hr)	0.252
Compute Tc - Basin Data	Compute...
Compute Tc - Map Data	Compute...
Drainage Area (Am)(mi^2)	0.548
Rainfall (P) (in)	3.040
Runoff Curve Number (CN)	71.400
Pond and Swamp Area (%)	0.000
Rainfall Distribution	Type II
Unit Peak Discharge Computation Method	Normal
Potential Maximum Retention (S) (in)	4.006
Runoff (Q) (in)	0.803
Initial Abstraction (Ia) (in)	0.801
Initial Abstraction / Rainfall (Ia/P)	0.264
Unit Peak Discharge (Qu) (cfs/mi^2/in)	643.431
Pond and Swamp Factor (Fp)	1.000
Peak Discharge (Qp = Qu*Am*Q*Fp) (cfs)	283.162
Compute Hydrograph	Compute...

Figure 2. Time of Concentration

```
11, "Residential", 57,72,81,86
12, "Commercial and Services", 89,92,94,95
13, "Industrial", 81,88,91,93
14, "Transportation Communications and Utilities", 83,89,92,93
15, "Industrial and Commercial Complexes", 84,90,92,94
16, "Mixed Urban or Built-up Land", 81,88,91,93
17, "Other Urban or Built-up Land", 63,77,85,88
21, "Cropland and Pasture", 49,69,79,84
22, "Orchards Groves Vineyards Nurseries and Ornamental Horticultural Areas", 45,66,77,83
23, "Confined Feeding Operations", 68,79,86,89
24, "Other Agricultural Land", 59,74,82,86
31, "Herbaceous Rangeland", 49,69,79,84
32, "Shrub and Brush Rangeland", 35,56,70,77
33, "Mixed Rangeland", 35,56,70,77
41, "Deciduous Forest Land", 36,60,73,79
42, "Evergreen Forest Land", 36,60,73,79
43, "Mixed Forest Land", 36,60,73,79
51, "Streams and Canals", 0,0,0,0
52, "Lakes", 0,0,0,0
53, "Reservoirs", 0,0,0,0
54, "Bays and Estuaries", 0,0,0,0
61, "Forested Wetland", 30,55,70,77
62, "Nonforested Wetland", 30,58,71,78
71, "Dry Salt Flats", 74,84,90,92
72, "Beaches", 50,50,50,50
73, "Sandy Areas other than Beaches", 63,77,85,88
74, "Bare Exposed Rock", 98,98,98,98
75, "Strip Mines Quarries and Gravel Pits", 77,86,91,94
76, "Transitional Areas", 77,86,91,94
77, "Mixed Barren Land", 77,86,91,94
81, "Shrub and Brush Tundra", 48,67,77,83
82, "Herbaceous Tundra", 68,79,86,89
83, "Bare Ground Tundra", 77,86,91,94
84, "Wet Tundra", 35,56,70,77
85, "Mixed Tundra", 35,56,70,77
91, "Perennial Snowfields", 0,0,0,0
92, "Glaciers", 0,0,0,0
```

```
================================================================================
                           Runoff Curve Number Report
                               (Generated by WMS)
================================================================================

Sat Mar 04 16:16:44 2023


Runoff Curve Number Report for Basin 1B

HSG  Land Use Description                              CN  Area        Product
                                                           mi^2        CN x A

C    Cropland and Pasture                              79       0.023        1.852
C    Shrub and Brush Rangeland                         70       0.516       36.117
B    Shrub and Brush Rangeland                         56       0.009        0.495


CN (Weighted) = Total Product \ Total Area
==========================================
                                   70.1591
```

Appendix B – Precipitation Data

www.nws.noaa.gov

NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

Home Site Map Organization Search NWS All NOAA Go

General Information
Homepage
Progress Reports
FAQ
Glossary

Precipitation Frequency
Data Server
GIS Grids
Maps
Time Series
Temporals
Documents

Probable Maximum Precipitation
Documents

Miscellaneous
Publications
Storm Analysis
Record Precipitation

Contact Us
Inquiries

USA.gov

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: UT

Data description

Data type: Precipitation depth **Units:** English **Time series type:** Partial duration

Select location

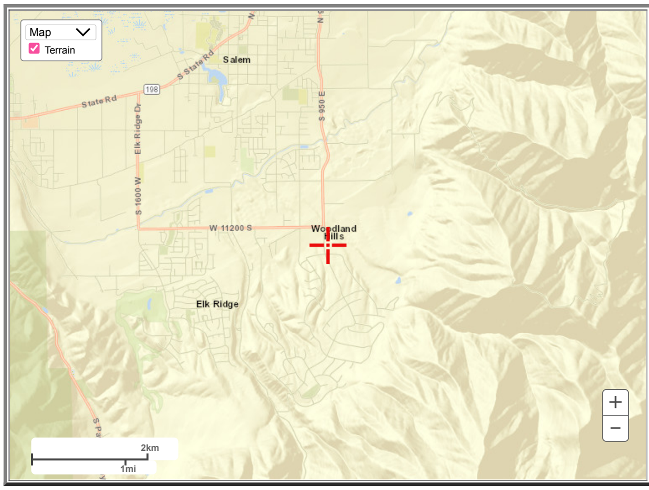
1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: Longitude: Submit

b) By station (list of UT stations): Select station

c) By address Woodland Hills, UT, USA

2) Use map:



a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Location information:
Name: Salem, Utah, USA*
Latitude: 40.0244°
Longitude: -111.6528°
Elevation: 4720 ft**

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 1, Version 5

PF tabular PF graphical Supplementary information Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.131** (0.114-0.156)	**0.168** (0.146-0.199)	**0.232** (0.199-0.275)	**0.288** (0.245-0.342)	**0.376** (0.312-0.448)	**0.454** (0.368-0.544)	**0.545** (0.432-0.656)	**0.650** (0.499-0.791)	**0.816** (0.598-1.01)	**0.964** (0.681-1.22)
10-min	**0.200** (0.173-0.237)	**0.256** (0.222-0.303)	**0.353** (0.303-0.418)	**0.439** (0.373-0.521)	**0.572** (0.474-0.682)	**0.691** (0.561-0.828)	**0.829** (0.657-0.999)	**0.989** (0.759-1.20)	**1.24** (0.910-1.54)	**1.47** (1.04-1.85)
15-min	**0.248** (0.214-0.294)	**0.317** (0.274-0.376)	**0.438** (0.375-0.518)	**0.544** (0.462-0.646)	**0.709** (0.588-0.846)	**0.857** (0.695-1.03)	**1.03** (0.814-1.24)	**1.23** (0.941-1.49)	**1.54** (1.13-1.91)	**1.82** (1.29-2.30)
30-min	**0.334** (0.288-0.396)	**0.427** (0.370-0.506)	**0.589** (0.505-0.698)	**0.733** (0.623-0.870)	**0.955** (0.792-1.14)	**1.15** (0.936-1.38)	**1.39** (1.10-1.67)	**1.65** (1.27-2.01)	**2.07** (1.52-2.57)	**2.45** (1.73-3.09)
60-min	**0.413** (0.357-0.490)	**0.528** (0.458-0.626)	**0.729** (0.625-0.864)	**0.907** (0.771-1.08)	**1.18** (0.980-1.41)	**1.43** (1.16-1.71)	**1.71** (1.36-2.06)	**2.04** (1.57-2.49)	**2.57** (1.88-3.18)	**3.03** (2.14-3.83)
2-hr	**0.522** (0.459-0.607)	**0.657** (0.577-0.765)	**0.867** (0.758-1.01)	**1.06** (0.914-1.23)	**1.36** (1.15-1.59)	**1.63** (1.35-1.91)	**1.94** (1.56-2.30)	**2.29** (1.80-2.76)	**2.86** (2.14-3.51)	**3.38** (2.43-4.22)
3-hr	**0.608** (0.542-0.698)	**0.759** (0.676-0.870)	**0.967** (0.859-1.11)	**1.16** (1.02-1.33)	**1.46** (1.26-1.68)	**1.71** (1.45-1.99)	**2.02** (1.67-2.36)	**2.37** (1.92-2.81)	**2.95** (2.29-3.57)	**3.47** (2.60-4.28)