AMENDMENT NO. 2 TO THE AGREEMENT BY AND BETWEEN CLARK COUNTY, NEVADA AND THE BOARD OF REGENTS OF THE NEVADA SYSTEM OF HIGHER EDUCATION OBO UNIVERSITY OF NEVADA, RENO

This Amendment No. 2 to the Agreement by and Between Clark County, Nevada and The Board of Regents of the Nevada System of Higher Education obo University of Nevada, Reno is entered into and effective as of the date signed by all parties, by and between Clark County , a political subdivision of the State of Nevada (County), and the Board of Regents of the Nevada System of Higher Education, obo the University of Nevada, Reno, an institution of higher education of the State of Nevada (University).

RECITALS

WHEREAS, the County and University entered into an Interlocal Contract dated August 2, 2016 ("Agreement") one copy of which is attached hereto as Exhibit 1, and

WHEREAS, as a result of the Covid 19 pandemic, additional time was needed to complete the terms of the Agreement; and

WHEREAS, the County and University entered into an Amendment No. 1 to the Agreement, one copy of which is attached hereto as Exhibit 2, thereby extending the period of performance of the Agreement until December 31, 2021 and extending the Budget Period until January 31, 2022; and

WHEREAS, additional time is needed to complete the terms of the Agreement.

NOW, THEREFORE, County and University, for and in consideration of the mutual covenants, conditions and undertakings herein set forth, do agree as follows:

Paragraph 2 of the Agreement is hereby amended to provide:

> 2. Period of Performance. The Project period under the Interlocal Contract commenced on August 9, 2016 and will continue until December 31, 2022. The Budget Period commenced on August 9, 2016 and shall continue until January 31, 2023 ("Initial Term"). The Period of Performance may be extended for additional periods of performance beyond the Initial Term, upon written approval by County and University.

Except to the extent modified pursuant to this Amendment No. 2, all other terms and conditions of the Agreement shall remain unchanged, in full force and affect and are hereby affirmed and ratified.

IN WITNESS WHEREOF, the County and University have caused this Amendment No. 2 to the Agreement to be executed by their duly authorized representatives effective as of the day and year first written above.

BOARD OF REGENTS, NSHE ODO
UNIVERSITY OF NEVADA, RENO

County Clerk

By: ---------- Signature

Name: _____
Jim Gibson, Chair of BCC

Title: _____
Chair
Board of County Commissioners, Clark County

Date: _____

By: Cathy McAdoo ---------- Signature

Name: _____
Cathy McAdoo

Title: _____
Chair

Date: August 25, 2022

Recommended by: _____
Brian Sandoval, President,
University of Nevada, Reno

Recommended by: DocuSigned by: Mridul Gautam B6A23F0C699C40C...
Mridul Gautam, Vice President
Research and Innovation
University of Nevada, Reno

EXHIBIT 1

EXHIBIT 1

AGREEMENT NO. _____

BY AND BETWEEN

CLARK COUNTY, NEVADA
AND
THE BOARD OF REGENTS OF THE NEVADA SYSTEM OF HIGHER EDUCATION
OBO UNIVERSITY OF NEVADA, RENO

This Interlocal Contract (Agreement) is entered into and effective as of August 2, 2016, by and between Clark County (County), a political subdivision of the State of Nevada, and the Board of Regents, Nevada System of Higher Education, obo the University of Nevada, Reno, an institution of higher education of the State of Nevada (University).

RECITALS

WHEREAS, County and University are public agencies of the State of Nevada and are authorized to enter into this Agreement pursuant to NRS 277.180; and

WHEREAS, County wishes to have certain services performed in accordance with the scope of work outlined in this Agreement; and

WHEREAS, the performance of such services are consistent, compatible and beneficial to the academic role and mission of University as an institution of higher education; and

WHEREAS, University is qualified to provide such services.

AGREEMENT

NOW, THEREFORE, for and in consideration of the mutual covenants, conditions and undertakings herein set forth, the parties agree as follows:

1. Scope of Work. University agrees to perform for County certain services ("Services") described in the Scope of Work set forth in Appendix A, which is attached hereto and incorporated herein by this reference.

2. Period of Performance. The Project period under this Agreement is intended to commence on August 9, 2016 and continue until February 9, 2021. The Budget Period shall commence on August 9, 2016 and continue until March 9, 2021 (Initial Term). This Agreement may be extended for additional periods of performance beyond the Initial Term, upon written approval by County and University.

3. Compensation and Payment.

3.1 Compensation. County shall pay to University a total of One Million Seven-Hundred and Fourteen Thousand Seven Hundred and Four Dollars ($1,714,704.00) ("Compensation") for performance of the Services under this Agreement. A budget itemizing the costs for providing the Services is set forth in Appendix B, which is attached hereto and incorporated

herein by this reference.

3.2 Payment. Quarterly progress payments shall be made by County to University based upon quarterly invoices submitted by University. Invoices submitted to County shall be paid by County within thirty (30) days of receipt according to the rules outlined in Appendix B (Billing Schedule Section). Final payment shall be made upon completion of the Services.

Invoices shall be delivered to:

Clark County Department of
Building and Fire Prevention
Werner K. Hellmer
4701 W. Russell Rd.
Las Vegas, NV 89118

Compensation checks shall reference the appropriate UNR account number and be payable to "BOR, NSHE obo UNR" and shall be delivered to:

University of Nevada Reno
Controller's office
Mail Stop 124
Reno, NV 89557-0025

4. Technical Supervision

4.1 Supervision by County. The person with primary responsibility for supervision of the performance of the Services on behalf of County shall be Werner K. Hellmer, or such other person as may be designated by County, who shall have primary responsibility for technical supervision of the Project.

4.2 Supervision by University. The person with primary responsibility for supervision of the performance of the Services on behalf of University shall be Dr. Craig dePolo. No other person shall replace or substitute for him/her in the supervisory responsibilities hereunder for the term of the project without the mutual consent of County's and University's respective supervisors as described in Section 4 herein.

5. Reporting Requirements. University shall provide written reports to County on the progress of the performance of Services as outlined or required in the Scope of Work.

6. Equipment. All equipment, instruments and materials purchased or used by University and/or its subcontractors in connection with performance of the Services shall at all times remain under the sole control and ownership of University and/or its subcontractors.

7. Publication and Confidentiality.

7.1 Publication. In furtherance of University's role as a public institution of higher education, it is necessary that significant results of services activities be reasonably available for publication by the University, and County acknowledges that University may publish the

results of services conducted in connection with this Agreement. Such publication will be mutually agreed upon between the County and the University.

7.2 Confidentiality. County and University are governmental entities and thus subject to the Nevada Open Records Act, NRS Code 239.005 to 239.011. Pursuant to the Act, this Agreement, and confidential information provided pursuant hereto, may be subject to public disclosure. Any person who provides University with records that such person believes should be protected from disclosure for business reasons must indicate the confidentiality of such records upon disclosure.

8. Disclaimer of Liability and Reliability

This study is intended to show an analysis of earthquake faults and characterize the seismic hazards within the Las Vegas Valley. The University will make every reasonable effort to offer the most current, correct, and clearly expressed information possible. However, while it is understood that inadvertent errors in information may occur, the County will assume no liability as to the accuracy of the data provided by the University. If misleading, inaccurate or otherwise inappropriate information is brought to University's attention, a reasonable effort will be made to fix or remove it.

9. Compliance With Laws. In performance of the Services, County and University shall comply with all applicable federal, state and local laws, codes, regulations, rules and orders.

10. Patents and Inventions. County shall own all right, title and interest in all inventions and improvements conceived or reduced to practice by County and/or County's employees and may, at its election, file all patent applications relating thereto. The University does not claim any interest in County's prior conceived intellectual property. County shall allow University access to County's intellectual property only as far as is necessary to allow University to successfully conduct the scope of work identified as Attachment A.

The University shall own all right, title and interest in all inventions and improvements conceived or reduced to practice by University or University personnel in the performance of the Services (hereinafter collectively "Invention") and may, at its election, file all patent applications relating thereto.

11. Relationship of Parties. In assuming and performing the obligations of this Agreement, University and County are each acting as independent parties and neither shall be considered or represent itself as a joint venturer, partner, agent or employee of the other. Neither party shall use the name or any trademark of the other party in any advertising, sales promotion or other publicity matter without the prior written approval of the other party.

12. Termination. This Agreement may be terminated by either party at any time, by giving written notice thereof to the other party. Such termination shall be effective thirty (30) days after receipt of such notice. Termination shall not relieve either party of any obligation or liability accrued hereunder prior to such termination, or rescind or give rise to any right to rescind any payments made prior to the time of such termination.

13. Uncontrollable Forces. Neither County nor University shall be considered to be in default of this Agreement if delays in or failure of performance shall be due to uncontrollable forces the effect of which, by the exercise of reasonable diligence, the nonperforming party could not avoid. The term "uncontrollable forces" shall mean any event which results in the prevention or delay of performance by a party of its obligations under this Agreement and which is beyond the control of the nonperforming party. It includes, but is not limited to, fire, flood, earthquakes, storms, lightning, epidemic, war, riot, civil disturbance, sabotage, inability to procure permits, trespass issues, licenses, or authorizations from any state, local, or federal agency or person for any of the supplies, materials, accesses, or services required to be provided by either County or University under this Agreement, strikes, work slowdowns or other labor disturbances, and judicial restraint.

14. Miscellaneous.

14.1 Assignment. Neither party shall assign or transfer any interest in this Agreement, nor assign any claims for money due or to become due under this Agreement, without the prior written consent of the other party.

14.2 Entire Agreement. This Agreement, with its attachments, constitutes the entire agreement between the parties regarding the subject matter hereof and supersedes any other written or oral understanding of the parties. This Agreement may be amended by approval of a signed amendment by the parties. Unless otherwise expressly authorized by the terms of this Agreement, no modification or amendment to this Agreement shall be binding upon the parties unless the same is in writing and signed by the respective parties hereto.

14.3 Successors and Assigns. This Agreement shall be binding upon and inure to the benefit of the parties, their successors and permitted assigns.

14.4 Notices. Except as provided in Section 3 hereof regarding payment of invoices, any notice or other communication required or permitted to be given to either party hereto shall be in writing and shall be deemed to have been properly given and effective: (a) on the date of delivery if delivered in person during recipient's normal business hours; or (b) on the date of delivery if delivered by courier, express mail service or first-class mail, registered or certified, return receipt requested. Such notice shall be sent or delivered to the respective addresses given below, or to such other address as either party shall designate by written notice given to the other party as follows:

In the case of University

Technical

Dr. Craig dePolo

Nevada Bureau of Mines and Geology
University of Nevada, Reno/MS 178
Reno, NV 89557
(775) 682-8770
eq_dude@sbcglobal.net

Contractual

OFFICE OF SPONSORED PROJECTS
Attn: Director
UNIVERSITY OF NEVADA, RENO

204 Ross Hall MS 325
Reno, NV 89557

In the case of County:

Technical

Werner K. Hellmer
4701 W. Russell Rd.
Las Vegas, NV 89118
702-455-8095
wkh@co.clark.nv.us

Contractual

Werner K. Hellmer
4701 W. Russell Rd.
Las Vegas, NV 89118
702-455-8095
wkh@co.clark.nv.us

14.5 Order of Precedence. In the event of any conflict, inconsistency or discrepancy amount, the Agreement and any other documents listed below shall be resolved by giving precedence in the following order.

(a) This Agreement including the Exhibits hereto

(b) Purchase Order issued by County. In the event a purchase order is issued under this Agreement and such purchase order contains standardized terms and conditions, the terms and conditions of this Agreement shall supersede and replace all such purchase order standardized terms and conditions.

14.6 Governing Law and Disputes. This Agreement shall be interpreted and construed in accordance with the laws of the State of Nevada, without application of any principles of choice of laws. Disputes that cannot be resolved by County and University shall be determined by a court of competent jurisdiction in the State of Nevada.

14.7 Nonwaiver. A waiver by either party of any breach of this Agreement shall not be binding upon the waiving party unless such waiver is in writing. In the event of a written waiver, such a waiver shall not affect the waiving party's rights with respect to any other or further breach.

14.8 Attorney Fees. The prevailing Party in any action or suit to enforce the terms or conditions of this Agreement shall be entitled to recover its costs of court and reasonable attorneys' fees incurred in enforcing the terms or conditions of this Agreement.

15. Ratification. This Interlocal Contract must be ratified by appropriate official action of the governing body of each party to the contract as a condition precedent to its entry into force.

16. Signatures.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by their duly authorized representatives effective as of the day and year first written above.

Steve Sisolak
Chair of the BCC

County Clerk LYNN MARIE GOYA

By: _____
Signature

Name: Steve Sisolak
(Please print)

Title: Chairman, Board of County Commissioners

Date: August 2, 2016

BOARD OF REGENTS, NSHE OBO UNIVERSITY OF NEVADA, RENO

By: _____
Signature

Name: Thomas Landis

Title: Grants and Contracts Manager

Date: 7/19/2016

Agreement NO._____

APPENDIX A

Scope of Work statement ("Appendix A") for Research Agreement NO. _____, "Earthquake Fault Analysis of Las Vegas Valley "

This Proposal is submitted to Clark County

Proposal Submitted By

Board of Regents, Nevada System of Higher Education, obo the University of Nevada, Reno, an institution of higher education of the State of Nevada ("University")

1.0 Proposed Scope of Work

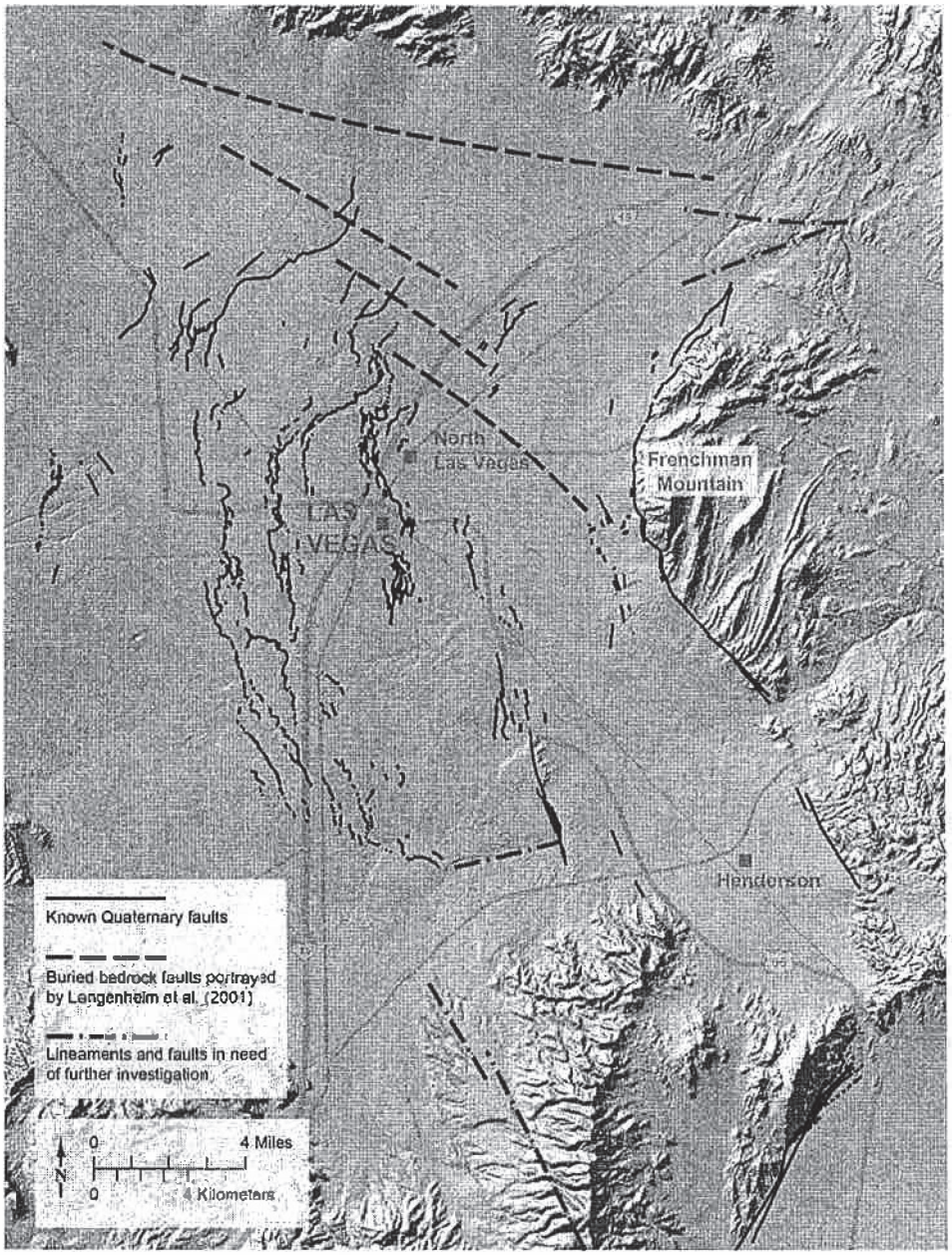
Earthquake faults within Las Vegas Valley are under-characterized with regard to their seismic hazard, particularly considering their proximity to the densely populated areas of Clark County. An important consequence of the under-characterization is that nearly all the known Quaternary faults in Las Vegas Valley are classified as "Class B faults" meaning that too little information about the faults is known for them to be considered in the analysis for the National Seismic Hazard Map. Consequently, the National Seismic Hazard Map, which is a basis for building codes, does not include these faults in the seismic hazard calculation despite the fact that we know they are present. To address the issue of under-characterization of earthquake faults within the Las Vegas area and the resultant inaccuracy in the seismic hazard calculation and analysis, we propose an accelerated data collection and analysis program that will provide the needed data, fault parameters, and analysis for more accurate calculation of the seismic hazard. The proposed project will bring the understanding of the earthquake hazard potentially posed by faults in Las Vegas Valley up to the level of other seismically active areas in the U.S. and stabilize the calculated size of the hazard. The stabilization is central to avoiding frequent changes in the seismic aspects of the building code. A combination of scientists from the Nevada Bureau of Mines and Geology (University of Nevada, Reno), the University of Nevada, Las Vegas, and the U.S. Geological Survey will work together to develop characterization within a four-and-a-half-year timeframe. The proposed work is divided into tasks that culminate with the earthquake source characterization of the faults. This characterization will include the locations of earthquake faults, the potential magnitudes of earthquakes along these faults, and how often earthquakes can occur. The results can be used for (1) building codes in Clark County, (2) input to the National Seismic Hazard Map, (3) site-specific engineering studies in the county, (4) emergency response planning scenarios, and (5) other seismically related purposes.

The University will perform all necessary tasks for completion of the work, including field data acquisition, data processing and reports, working with County personnel to make the products of the work (hereafter referred to as the "deliverables") available in a format to be mutually agreed upon during the term of this contract. Maps produced under this agreement will be integrated with Clark County's present internet based public information system in order to make the project findings available to the general public, government and private institutions.

2.0 Significance of the Project

Quaternary faults in Las Vegas Valley (Fig. 1) are under-characterized with regard to their seismic hazard, particularly considering their proximity to the densely populated areas of Clark County. Most of the known faults in the Las Vegas Valley are classified by the U.S. Geological Survey as "Class B faults" meaning that too little information is known to accurately assign the age of most recent earthquake activity. Class B faults are not considered in the National Seismic Hazard Map, which forms a basis for the Clark County building codes. Modern studies and funding for research on these faults has been lacking over the past decades primarily due to an early interpretation suggesting that they resulted from hydro-compaction of sediments in the valley. Hydro-compaction faults typically do not generate earthquakes of a significant or damaging magnitude. However, results from recent investigations including excavations across fault scarps, seismicity data, Quaternary sedimentation, GPS geodetic measurements, and regional fault studies indicate a tectonic or earthquake origin to these fault scarps suggesting an under-characterized earthquake hazard within the valley.

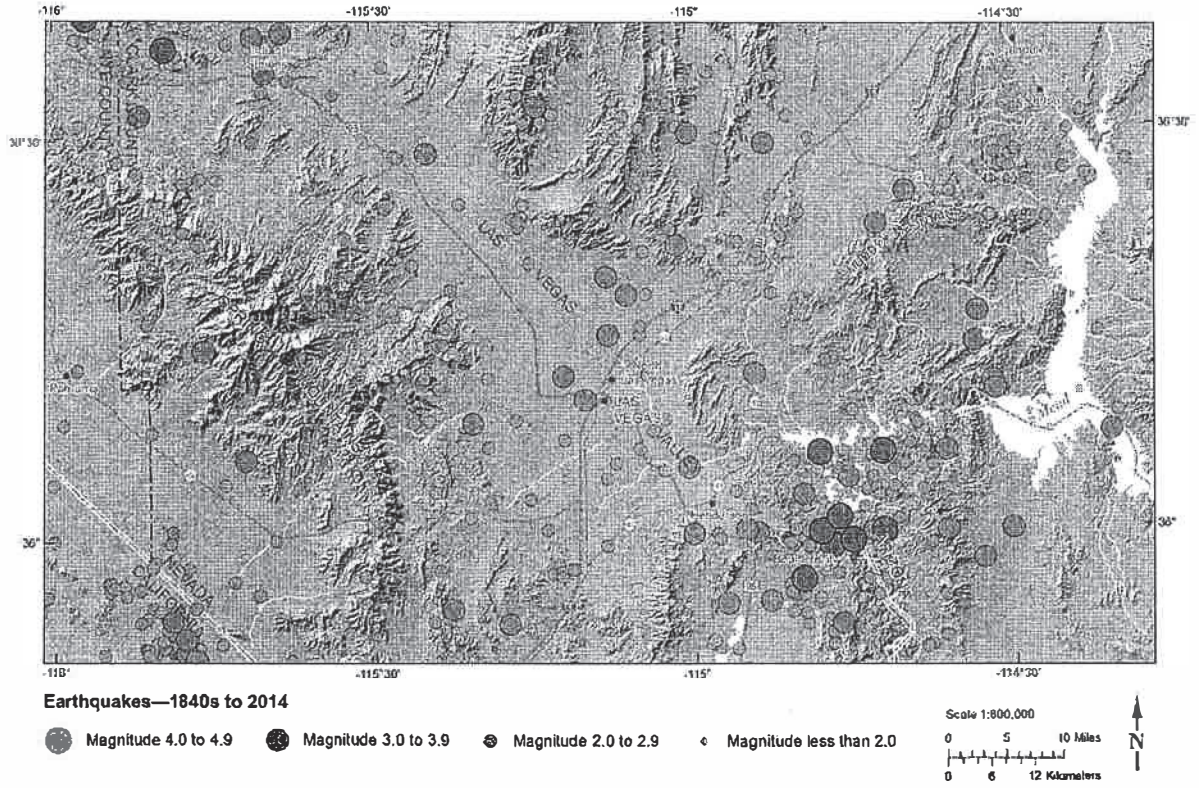
Figure 1.



Quaternary faults, inferred buried faults from Langenheim et al. (2001), and lineaments that are possible faults in the Las Vegas area.

Recent studies and the presence of small recorded earthquakes (Fig. 2) suggest that the faults may pose an earthquake hazard and need to be evaluated. DePolo et al. (2006) documented two paleoearthquakes along the Valley View fault in Las Vegas Valley that offset the ground surface about 6 to 9 feet each. DePolo et al. (2013) also reported on a high rate of activity along the Eglington fault in the northern part of Las Vegas Valley and evidence for one of the youngest paleoearthquakes (~2000 years ago) in the valley. Lamichhane et al. (2014) modeled seismic hazards in Las Vegas Valley, including local faults, and reported that the earthquake hazard is substantially

higher if the faults are considered. Lamichhane et al. (2014) concluded, "the study provides a



rationale for the urgency to intensify investigations of faults in and around the Las Vegas Valley."

Figure 2. Earthquake activity in the Las Vegas Valley region between the late 1800s and 2014.

Lacking an earthquake hazard analysis of the faults and well-founded input parameters, the seismic hazard design levels for Las Vegas Valley have fluctuated through time (Fig. 3), a situation that is untenable for developers, builders, and building officials. The proposed study will stabilize these values at appropriate and scientifically based levels. Due to the rapid urban expansion in the valley, there is an urgent need to gain an understanding of the earthquake potential.

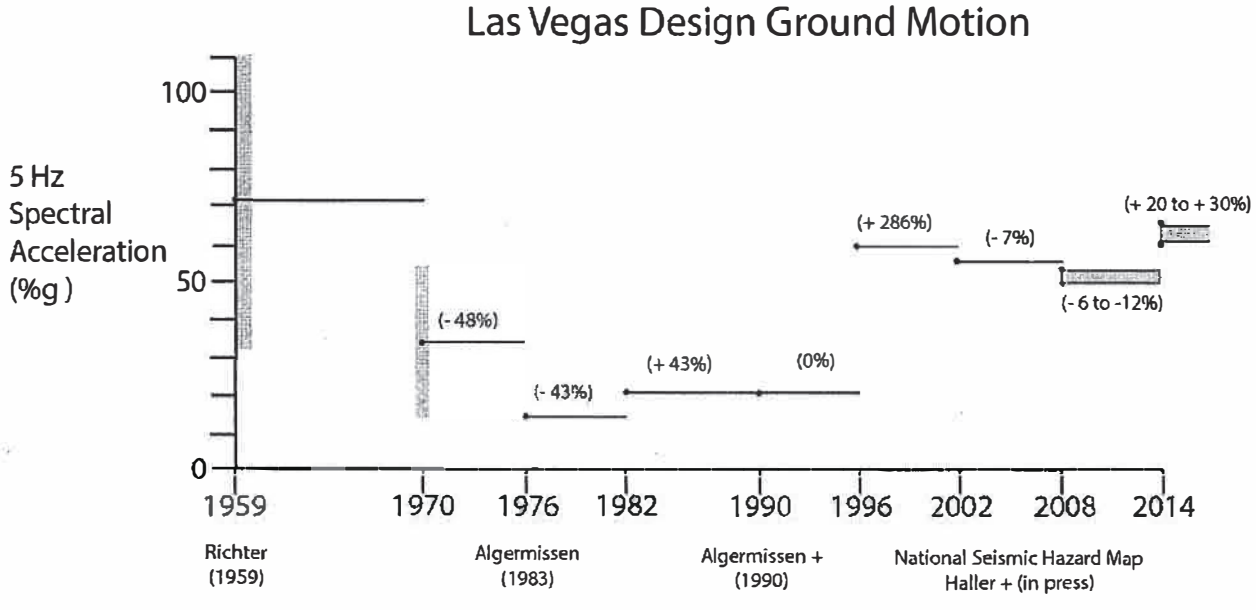


Figure 3. The design ground motion or derived design ground motion for Las Vegas Valley showing how values have fluctuated through time. The percentages above each line are the percent change from the previous value. Ranges in values shown after 2008 represent the variation across the Las Vegas Valley from north (higher) to south (lower). This fluctuation in ground motion values is partly due to poorly constrained fault parameters and partly to changes in the seismic hazard model calculations. The proposed study will help stabilize these values at appropriate levels.

Fault-earthquake-hazard studies have been conducted Salt Lake City since the 1970s (e.g., Swan et al., 1980 and Crone et al., 1984), including 1:50,000-scale surficial geologic mapping (e.g., Personius, 1990 and Personius et al., 1992), fault analyses (e.g., Machette et al., 1992 and McCalpin and Nishenko, 1996), and detailed trenching investigations (e.g., McCalpin, 2002 and Olig et al., 2004). These studies have culminated in a well-founded seismic hazard characterization of the local faults in the Salt Lake City area that is used in the National Seismic Hazard Map, site-specific engineering studies, and earthquake response planning scenarios.

An accelerated program of data collection and analysis of fault characteristics is needed to make up for the lack of basic earthquake hazard research in Las Vegas Valley. Evaluation of the offsets of geologic units across faults and the age of the offset units is needed to ascertain the frequency of earthquakes. This involves developing and producing a uniform up-to-date geologic map, dating geologic units, and establishing fault scarp profiles to understand offsets. In some areas, we will reconstruct the land surface prior to development, using historical aerial photography. An accurate, detailed fault map will be made for surface rupture hazard and to develop parameters such as earthquake rupture lengths, which relate to the size of potential earthquakes (the longer the fault – the larger the potential earthquake). Subsurface fault geometry is another important parameter that affects earthquake potential and must be constrained. The information and natural uncertainties of these parameters will be formally handled in a final statistical analysis of the earthquake hazard of each fault. All the information gained will be readily available to Clark County inspectors, engineers, and geologists so it can be utilized.

Scientists from the Nevada Bureau of Mines and Geology (University of Nevada, Reno), the University of Nevada, Las Vegas, and the U.S. Geological Survey will work together to develop this earthquake characterization within a four-and-a-half-year timeframe. The work is divided into six tasks which culminate in the earthquake source characterization of the faults. The source characterization will include potential earthquake magnitudes and earthquake recurrence values that will be used for building codes in Clark County, input to the National Seismic Hazard Map, site-specific engineering studies in the county, emergency response planning scenarios, and other seismic hazard applications. This research will bring a long overdue understanding of the earthquake hazard in Las Vegas.

2.1 Technical Proposal Summary

We propose a series of tasks designed to bring the understanding of the seismic hazard posed by faults in Las Vegas Valley to a modern, state-of-the-art level and stabilize the calculated size of the hazard. The focus in the first years of the project is on collecting data, such as geologic mapping, and determining the precise ages of geologic units. These data will provide the needed parameters and constraints used in the later years of the project to carry out the earthquake potential analysis. The six main tasks are: (1) generating new geologic and fault maps of the Las Vegas Valley area; (2) investigations of earthquake sources; (3) evaluation of fault source geometry, segmentation, and maximum magnitude potential; (4) investigations of earthquake recurrence times; (5) analysis of fault earthquake potential; and (6) project management, reporting, and communication. Over the course of this project we will systematically develop supporting data, analyze and develop seismic

hazard values, and report the results for utilization locally and in the National Seismic Hazard Map. Most tasks involve detailed investigations and span multiple years.
This project will lead to the characterization of the earthquake hazard for faults in the Las Vegas Valley. This characterization will include the locations of earthquake faults, the potential magnitudes of earthquakes along those faults, and how often we can expect to have these earthquakes. This information will be published and submitted to the U.S. Geological Survey for use in the National Seismic Hazard Map. The earthquake hazards from faults are used along with background seismicity and ground motion modeling to generate the final ground-motion hazard maps (e.g., the National Seismic Hazard Map).

3.0 Proposed Work

Task 1 – Developing New Surficial Geologic and Fault Maps

A fundamental basis for understanding the surface expression, earthquake potential, and earthquake occurrence along faults is a state-of-the-art, uniform surficial geologic map. This map will be used to identify earthquake faults, measure the length of fault traces for magnitude estimates, evaluate structural relationships between faults to understand if they fail together during earthquakes, identify the age of offset geologic units along faults for estimating how often earthquakes occur, and to identify areas with deposits that could be susceptible to liquefaction.

Developing a high-quality geologic map includes compiling all previous mapping; combining and/or splitting out geologic units into a consistent mapping paradigm; conducting age dating of key geologic units; new field mapping where needed; field checking of existing mapping; and building a digital Geographic Information System (GIS) database of all map data. The map will include the entire Las Vegas drainage basin (Fig. 4). This will be a surficial geologic map focused on distinguishing variously aged Tertiary through Quaternary sediments, including basin fill deposits, alluvial fans, and spring discharge deposits. The bedrock exposed in the study area will not be analyzed in this study unless there is evidence of Quaternary faults cutting through the bedrock.

A difficulty in assigning detailed geologic units in Las Vegas Valley, where several different aged units have similar appearances, is a lack of dates from these deposits. This project will develop over 100 dates from across the valley to fill this data gap. Optical luminescence and accelerator radiocarbon dating will be conducted on the geologic units. The luminescence dates will be principally collected by scientists from the U.S. Geological Survey and processed at their laboratories. Radiocarbon dates are limited to the younger deposits, but can be important for the most-recent paleoseismic history of faults and will be collected when opportunities for strategic dates are discovered. The dates will be strategically collected to support the geologic mapping and fault characterization investigations.

Task 1 has five subtasks:
Task 1.1 – Compiling Existing Mapping,
Task 1.2 – Age Determination Studies,
Task 1.3 – New Geologic Mapping,
Task 1.4 – Compilation and Drafting of a New 1:50,000 Geologic Map,
Task 1.5 – Final Map and Report.
The main effort for geologic mapping will be within the first two years, but follow up studies, such

as resolving dating of key units needed to constrain age and frequency of earthquakes, may continue through the duration of the project. The final product will be a 1:50,000-scale surficial geologic map, detailed descriptions of geologic units, and an overall discussion of the surficial geology of the Las Vegas area. The map will be a peer-reviewed product with input from geologists that are knowledgeable about the area. The final map will be available in digital and hard copy formats.

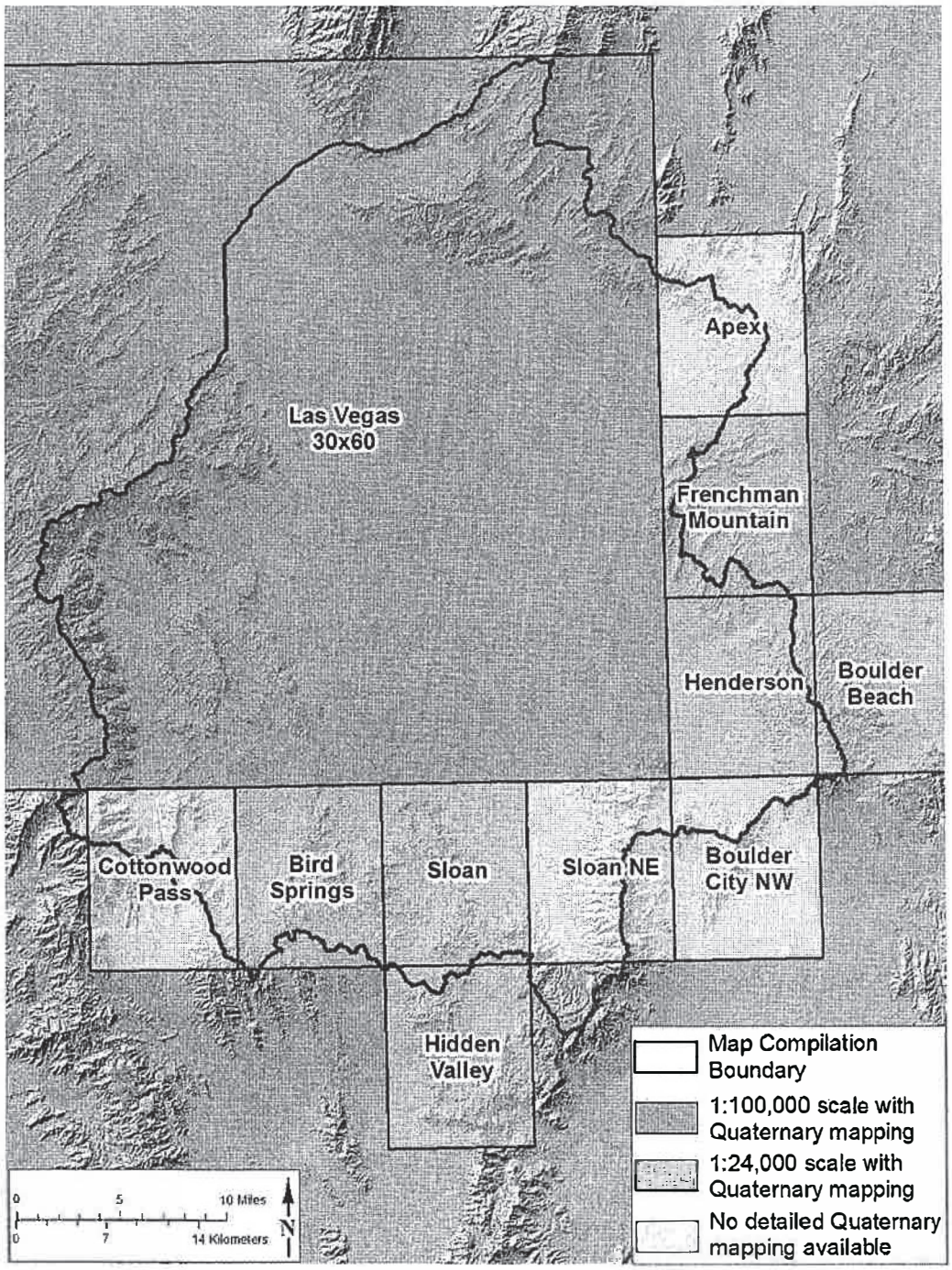


Figure 4. Area to be included in the 1:50,000-scale surficial geologic map of the Las Vegas Valley. The drainage basin shown with the blue line is the area that will be included in the map. The status of geologic mapping in this area is also shown.

Agreement NO._____

Task 2 – Earthquake Source Investigations

Earthquake source investigations are required to identify and characterize all potential earthquake faults in the Las Vegas Valley. Although several major faults have been recognized for decades, such as the "known" Quaternary faults in Figure 1, other faults have yet to be considered as seismic sources. These other potential sources include uncharacterized lineaments, suspected active faults, and buried or blind faults (blind faults usually do not break the surface when they rupture but can cause strong ground shaking). A comprehensive study of the valley using state-of-the-art techniques is needed to identify faults that have not been previously recognized or that were not fully considered as potential earthquake sources. The proposed investigation will conduct a comprehensive examination of available aerial photography and other imagery (e.g., LiDAR), consider subsurface geology using the borehole data previously compiled at UNLV, review gravity studies that define the shape of the bottom of the basin, and possibly use new seismic reflection surveys to identify and determine the length of faults and other parameters of potential earthquake sources.

Digital elevation models (DEMs) have many uses in earthquake characterization, including the delineation of faults, the estimation of offsets along a fault, and delineation of the extent of surficial geologic units. Along some faults, urban development obscures the natural topography. In these areas historical photographs will be used to make pre-development DEMs using "structure from motion" software, a program that uses photogrammetric triangulation from overlapping photographs to produce a 3-D elevation model. A resultant DEM will be used to map faults and make offset measurements.

The hydro-compaction hypothesis has been the most prevalent aseismic hypothesis cited for the Las Vegas Valley faults. This hypothesis is predicated on the capacity for subsurface sediments to compact with differential subsidence across lateral contrasts in material types, sediment thickness, or variable groundwater conditions. In the hypothesis, this differential subsidence then generates the observed faults. The capacity for differential hydro-compaction will be evaluated using geologic drill hole logs that have been compiled at the University of Nevada, Las Vegas and testing of drill hole samples stored at the Great Basin Science Sample and Records Library at the Nevada Bureau of Mines and Geology. In our current understanding, subsurface information indicates that the hydro-compaction process fails to account for displacement across several of the major faults. However, if a significant differential hydro-compaction component is found to be possible across a fault, the contribution of compaction will be incorporated into slip rate and hazard estimates.

A regional fault study is proposed to develop and test tectonic models for faults in Las Vegas Valley. A tectonic model incorporates other data into our understanding of deformation, or strain, in the Las Vegas Valley, such as the long term geologic history of regional faults, paleogeographic reconstructions, and geodetic information from precise GPS measurements. Because a balance of deformation is sought, this model can indicate areas where unaccounted strain and therefore undiscovered faults might exist. This task will guide reconnaissance field work of known and suspected regional Quaternary faults (Fig. 5). The locations, extent, sense of displacement, paleoseismic activity, and/or slip rate activity of regional faults are needed for an accurate understanding of faults in the Las Vegas Valley. Regional faults can also have earthquakes that can cause damaging ground motion in Las Vegas basin and are worth investigating on that basis alone. There are currently about a dozen regional faults that would be included in this task (Fig. 5).

Task 2 has seven subtasks:

Task 2.1 - Unrecognized Fault Investigation,

Task 2.2 – Predevelopment Digital Elevation Model along Faults,

Task 2.3 – Evaluation of Potential Buried/Blind Faults within Las Vegas Basin,

Task 2.4 – Evaluation of Hydro-Compaction as a Source of Deformation,

Task 2.5 – Regional Faults Investigation,
Task 2.6 – Development of a Tectonic and Deformation Model,
Task 2.7 - Fault Map and Reporting.

These tasks will be conducted within the first three years of the project so that the seismic sources are developed for the final analysis of earthquake hazard.

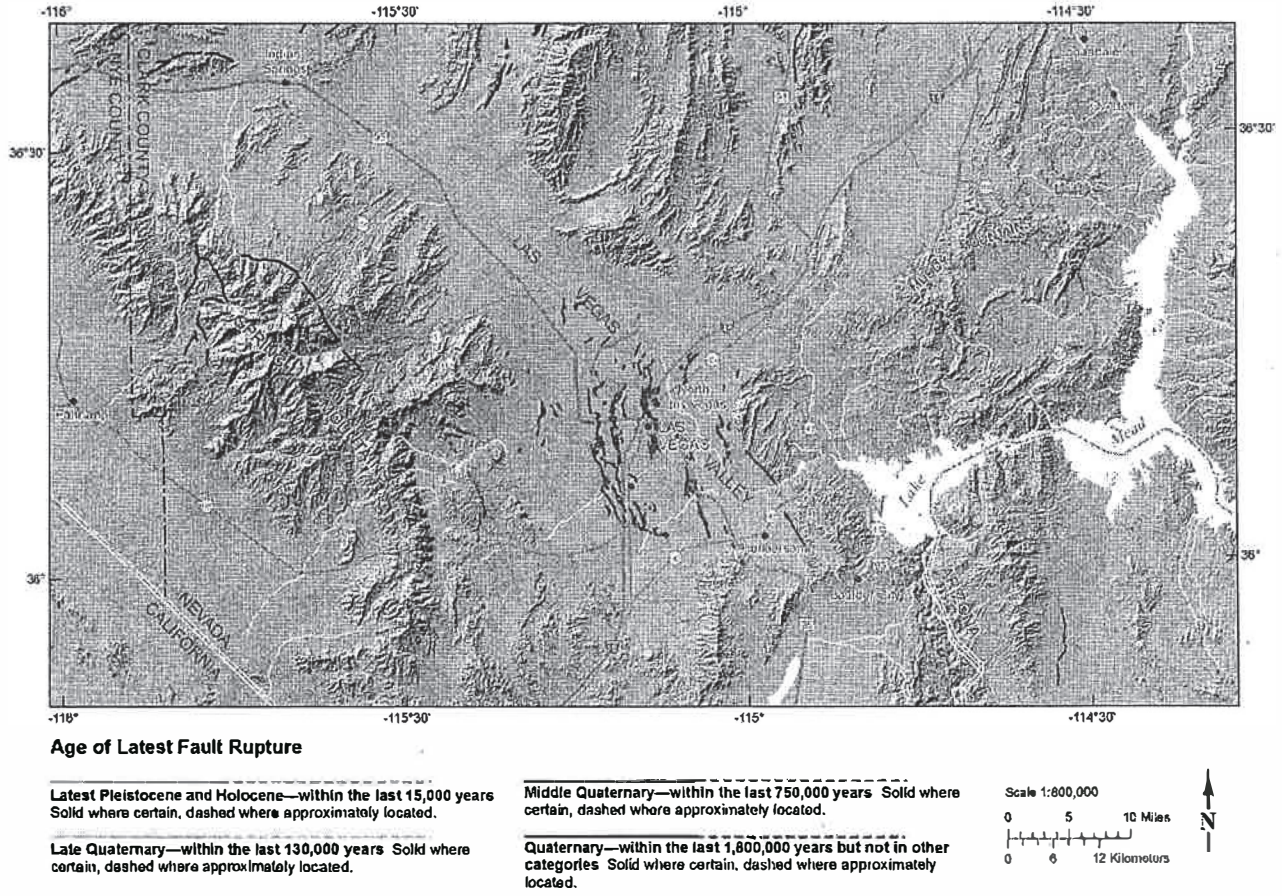


Figure 5. Quaternary faults within the Las Vegas Valley region. The age of the known most recent activity of the faults is indicated by the line colors. Many of the faults are assigned older ages due to a lack of age data constraining the most recent earthquake activity.

Task 3 – Evaluation of Fault Geometry, Rupture Segmentation, and Maximum Magnitude
Critical to understanding earthquake size potential in Las Vegas Valley is the determination of the dimensions of a potential earthquake source, establishing the connectivity and/or segmentation of earthquake faults, and establishing a methodology for incorporating these data into a maximum magnitude estimate. The total lengths of faults will be determined using the new geologic map and will include estimates of potential uncertainties (e.g., a possible extension to an isolated fault trace). The subsurface geometry of faults will be estimated using gravity models, existing seismic reflection data, and a small number of deep boreholes. These data will help determine whether faults project to the base of the seismogenic zone or are truncated by a master fault at shallower levels, such as the

westward-dipping Frenchman Mountain fault that lies along the western base of Frenchman Mountain.

Many of the known faults in Las Vegas Valley intersect each other at the surface. Better documentation and understanding of this connectivity is needed, including whether it means that simultaneous failure along multiple faults during a single earthquake is either more or less likely. If connectivity is small, individual earthquakes may only rupture a single fault trace. This assessment will be made using available paleoseismic information, structural and kinematic relations between faults, and displacement profiles along faults. Displacement profiles along the faults will be made using pre-developmental elevation data, existing topographic maps, and field measurements of present-day topography.

Earthquake rupture models for the faults will be developed based on structural, geometric, and available paleoseismic information. For example, a fault may fail as a single entity during an earthquake or it may fail along with an adjacent fault; these would be two different earthquake rupture models. In some cases, faults may have substantial discontinuities along them that would be considered as possible rupture ends. In this case, an earthquake model that is smaller than the total fault length would be considered. Parameters associated with the earthquake rupture models will be used in the earthquake hazard analysis.

A contemporary strategy will be developed for the scaling of earthquake size that uses multiple fault parameters, such as fault length and co-seismic displacement. The strategy will incorporate direct magnitude calculations by using earthquake moment estimates based on rupture model dimensions and co-seismic offset. It will also incorporate the estimation of magnitude values using fault parameters and regressions developed from documented historical earthquakes. Regressions used in national analyses, such as by Wells and Coppersmith (1994), will be considered, as well as research from the University of Nevada, Reno and the University of Nevada, Las Vegas, such as Wesnousky (2008). Using the developed strategy, potential earthquake magnitudes will be estimated for the faults in the valley.

Task 3 contains six subtasks:

Task 3.1 – Determination of Fault Parameters,
Task 3.2 – Measuring Fault Scarp Offsets,
Task 3.3 – Developing Earthquake Rupture Models,
Task 3.4 – Developing a Magnitude Estimation Strategy,
Task 3.5 – Earthquake Size Analysis,
Task 3.6 – Synthesis and Reporting.

The work in Task 3 will primarily be conducted in the third year of the project, use information developed in the previous years, and will be available for the final hazard analyses.

Task 4 – Earthquake Recurrence Investigations

A fundamental earthquake hazard parameter is earthquake recurrence, or how often earthquakes occur along each fault/earthquake source. Few paleoearthquakes have been documented and dated in Las Vegas Valley that can be used to view earthquake recurrence directly. We will compile and evaluate what constraints on earthquake recurrence paleoseismic information provides, and incorporate any additional new data that may become available with fault trenching (to be proposed to the U.S. Geological Survey Earthquake Hazard Program). In some cases, we will be able to get better constraints on existing recurrence estimates through the new dating. We will monitor pipeline and other excavations occurring in Las Vegas Valley during the project and will attempt to use any new exposures across faults to gain additional local paleoseismic data.

An approach that will be used for estimating how often earthquakes occur will be determining fault slip rates (how fast faults are moving) and considering the time it takes with these rates for earthquake displacement to accumulate. This is a standard approach used in the National Seismic Hazard Map where a detailed paleoearthquake record is not available. The dates collected in Task 1 will be critical in making slip rate estimates for local faults (calculated by dividing the offset measurement by the age of the offset). The displacement of the ground during a single earthquake (co-seismic displacement) is determined by direct measurements made in trenches or through correlation with estimated earthquake magnitudes (the larger the earthquake magnitude, the larger the average offset). The co-seismic displacement is divided by the fault slip rate to get the average time between earthquakes.
The earthquake recurrence analysis will synthesize all available data into determining how often earthquakes occur along individual and connected faults. This will include using insights gained from tectonic and deformation models developed in Task 2. Average earthquake recurrence intervals will be determined along with uncertainties in those estimations.

Task 4 is divided into four subtasks:
Task 4.1 – Estimating Fault Slip Rates,
Task 4.2 – Paleoseismic Studies and Inferences,
Task 4.3 – Earthquake Recurrence Analysis,
Task 4.4 – Final Report.

Most of Task 4 will be conducted in the third year of the project.

Task 5 – Earthquake Potential of Late Quaternary Faults
The earthquake potential analysis will formally combine the different earthquake sizes and recurrence intervals to come up with preferred estimates for each potential earthquake source. The synthesis is complicated because of the potential for multi-fault earthquake ruptures, as well as ruptures along individual faults. A formal analysis is required to avoid errors such as double counting earthquakes (counting too many earthquakes for a fault that is not capable of such activity). Uncertainties in fault parameters will also be incorporated into analysis.
A state-of-the-art strategy for the earthquake potential analysis will include a logic tree tool for combining multiple sources of data and uncertainties. This analysis uses a relative weighting of different parameters and formally combines them into resultant values. The logic tree technique offers a transparent, statistically consistent way of analyzing earthquake data. The final results will be the earthquake potential of individual faults and collectively of all earthquake faults in Las Vegas Valley.
The fault map produced in Task 2 and the earthquake magnitude estimations for the faults (Task 3) will be combined to generate potential surface rupture hazard maps for Las Vegas Valley. These maps will indicate the locations of fault traces, the activity of those faults, and the size of their potential offset during an earthquake. This information can be used so buildings and facilities can be carefully placed to avoid surface rupture during an earthquake and so facilities or infrastructure that must cross faults, such as pipelines, can be designed for the potential offset that might occur during an earthquake. This mitigation opportunity will help minimize disruption and economic loss from a surface-rupturing earthquake.

Task 5 consists of five subtasks:
Task 5.1 – Develop Earthquake Potential Estimation Strategy,
Task 5.2 – Logic Tree Analysis,
Task 5.3 – Develop Earthquake Magnitude and Recurrence Values,
Task 5.4 – Develop Earthquake Surface Rupture Hazard,
Task 5.5 – Surface Rupture Map and Report.

Task 5 will be conducted during the fourth year of the project and will use all the data collected in the earlier years.

Task 6 – Project Management, Reporting, and Communication
This large, integrated project will achieve many goals that would take decades to complete without such a focused effort. The goals, data, and analyses needed for this project have to be coordinated and completed in a systematic fashion to achieve the efficiency required for this accelerated program. As such, coordinating oversight and management is essential. The results must be, reported to a number of entities in a format that allows next steps to be taken. In addition, communication must be facilitated between the different tasks; the participating institutions; and the geologists, engineers, and officials of the Clark County Building Department, so that newfound results, information, and hazard values can be used as soon as they are reviewed and vetted. Part of this reporting will be making the results available online through web-based applications. Management will include oversight, conducting project meetings and other communications with project staff, and conducting progress meetings in Clark County. The support for the UNLV Ph.D. student is also placed in Task 6, because that individual will be working on tasks throughout the project. The student will be supervised primarily by Dr. Taylor, but Dr. dePolo will supervise some aspects of the student's work. Dr. Taylor, Dr. dePolo, and the student will be in close communication throughout the project. The study is designed to inform and engage Clark County professionals of the results during and after the project. We will do this by communicating with public entities (e.g., the Clark County Building Department) and professional organizations (e.g., Association of Engineering Geologists, Southern Nevada Chapter) and through a well-publicized final workshop for professionals. We would be happy to work with the Clark County Office of Emergency Management on a public informational event as well. The results of this project will be peer-reviewed and published in internationally recognized journals, through the Nevada Bureau of Mines and Geology, and in a web page devoted to the study.
Task 6 has five subtasks:
Task 6.1 – Project Management and Support,
Task 6.2 – Annual Reports and Meetings,
Task 6.3 – Web Page Development,
Task 6.4 – Final Workshop
Task 6.5 – Project Research by Ph.D. Student, which includes Tuition and Stipend.

The project management will be conducted throughout the project and the task funds the last half year of reports, web products, and the final workshop in Las Vegas Valley.

4.0 Timetable of Planned Studies

A tentative timeline of the main tasks is presented in Table 1. Many of these studies are scientific investigations, and the pace of research is not always predictable. Some flexibility may be needed within the project to achieve these goals with the quality required.

Table 1. Timeline for Proposed Tasks and Projects

Task	Year 1	Year 2	Year 3	Year 4	Year 5	Products
Develop Surficial Geologic Map of Las Vegas Valley	----------					**Surficial Geologic Map and Unit Descriptions**
Radiocarbon and Luminescence Dating of Surficial Deposits	----------					**Age Dating Results and Reports**
Quaternary Fault Investigations	----------					**Fault Rupture Potential Map and Local Faults Report**
Rupture Segmentation, Fault Geometry, Max. Magnitude		----------				**Earthquake Size Potential Report**
Earthquake Recurrence Analysis			----------			**Earthquake Recurrence Report**
Hydro-Compaction Analysis	----------					**Hydro-Compaction Report**
Tectonic/Deformational Model		----------				**Tectonic Model and Regional Fault Map**
Earthquake Hazard Analysis Logic Tree Probability Calculations			----------			**Final Fault Seismic Hazard Analysis Report**
Annual Progress Reports	--	--	--			**Annual Project Reports**
Final Report and Workshop				----------		**Final Report and Workshop**

The anticipated timeframe for study extends from August, 2016 to February, 2021.

5.0 Funding, Products, and Final Report

Each subtask is a significant contribution to characterizing earthquake hazard posed by faults in the Las Vegas area and, importantly, the results will be compiled into products that can be broadly used by engineers, scientists, and others in Clark County. The produced maps and papers will also be peer-reviewed, vetted, and adopted by other agencies, such as the U.S. Geological Survey, which produces the National Seismic Hazard Map. The major products are shown in Table 1. Products will be delivered within 90 days of the end of the annual time period. Table 2 shows the total annual cost of the project, including university overhead costs.

Table 2. Annual Project Costs

Project Year	Project Cost	University of Nevada, Las Vegas	Nevada Bureau of Mines and Geology
Year 1	$472,560	$202,771	$269,789
Year 2	$493,578	$224,277	$269,301
Year 3	$442,166	$147,488	$294,678
Year 4	$259,457	$91,379	$168,078
Year 5 (half year)	$46,943	$3,596	$43,347
Total Project	$1,714,704	$669,511	$1,045,193

APPENDIX B

Itemized Budget and Schedule of Deliverables ("Appendix B") for Research Agreement NO. _____, "Earthquake Fault Analysis of Las Vegas Valley"

This Proposal Submitted to Clark County

Proposal Submitted By

Board of Regents, Nevada System of Higher Education, obo the University of Nevada, Reno, an institution of higher education of the State of Nevada ("University")

Agreement NO._____

Schedule of Tasks for the Las Vegas Valley Earthquake Fault Project [University Overhead is Included (UNLV 48%; UNR 43.5%) UNR will issue UNLV a subcontract for their portion of the scope of work and for their portion of the overall project budget]

Year 1 Tasks	Estimated Total Cost	UNLV Split	UNR Split
T1.1 existing geologic mapping	48,091	0	48,091
T1.2 ½ age determination	114,238	88,704	25,534
T1.4 ¾ map compilation	39,024	0	39,024
T2.1 unrecognized faults	82,871	34,839	48,032
T2.2 pre-developmental topography	32,719	1,184	31,535
T2.3 ½ buried faults	21,573	7,415	14,158
T2.4 ½ hydrocompaction	19,941	11,411	8,530
T6.1 ¼ support/manage	61,844	17,390	44,454
T6.2 ¼ annual report	11,171	740	10,431
T6.5 ¼ Ph.D. funding	41,088	41,088	0
Total	***472,560***	***202,771***	***269,789***

Year 2 Tasks	Estimated Total Cost	UNLV Split	UNR Split
T1.3 new geologic mapping	101,037	21,934	79,103
T1.2 ½ age determination	114,237	88,704	25,533
T1.4 ¼ map compilation	39,024	0	39,024
T2.3 ½ buried/blind faults	21,573	7,415	14,158
T2.4 ½ hydrocompaction	19,941	11,411	8,530
T2.5 regional faults	33,173	16,014	17,159
T2.6 ½ tectonic model	10,671	7,267	3,404
T2.7 local faults report	38,771	12,314	26,457
T6.1 ¼ support/manage	62,892	17,390	45,502
T6.2 ¼ annual report	11,171	740	10,431
T6.5 ¼ Ph.D. funding	41,088	41,088	0
Total	***493,578***	***224,277***	***269,301***

Year 3 Tasks	Estimated Total Cost	UNLV Split	UNR Split
T1.5 final reviewed map/descriptions	45,720	12,314	33,406
T2.6 ½ tectonic model	10,671	7,267	3,404
T3.1 fault parameters	39,235	11,574	27,661
T3.2 scarp offsets/event displacement	25,250	9,339	15,911
T3.3 rupture models	18,185	5,787	12,398

Agreement NO._____

T3.4 magnitude estimation strategy	6,951	0	6,951
T3.5 fault magnitude analysis	21,124	5,787	15,337
T3.6 fault magnitude report	37,409	12,314	25,095
T4.1 fault slip rates	30,557	5,787	24,770
T4.2 paleoseismic data	33,911	5,787	28,124
T4.3 earthquake recurrence	22,484	5,787	16,697
T4.4 fault activity report	34,417	6,527	27,890
T6.1 ¼ support/manage	63,993	17,390	46,603
T6.2 ¼ annual report	11,171	740	10,431
T6.5 ¼ Ph.D. funding	41,088	41,088	0
Total	***442,166***	***147,488***	***294,678***

Year 4 Tasks	**Estimated Total Cost**	**UNLV Split**	**UNR Split**
T5.1 develop EHA strategy	12,881	5,787	7,094
T5.2 logic tree analysis	28,271	11,574	16,697
T5.3 develop EHA values	25,354	5,787	19,567
T5.4 surface rupture hazard	32,328	0	32,328
T5.5 ¾ EHA report	37,349	9,013	28,336
T6.1 ¼ support/manage	71,015	17,390	53,625
T6.2 ¼ annual report	11,171	740	10,431
T6.5 ¼ Ph.D. funding	41,088	41,088	0
Total	***259,457***	***91,379***	***168,078***

Year 5 (1/2 year) Tasks	**Estimated Total Cost**	**UNLV Split**	**UNR Split**
T5.5 ¼ reviewed EHA report	12,449	3,004	9,445
T6.3 online posting	12,548	0	12,548
T6.4 final workshop	21,946	592	21,354
Total	***46,943***	***3,596***	***43,347***
Total Project	**$1,714,704**	**$669,511**	**$1,045,193**

The development and progression of research cannot be precisely predicted and to assure success this project will need some flexibility in funding, such as the ability to carryover research and allotted funding into the following year of the project. Unforeseen circumstances, such as delays in obtaining permission to work on a property, can prolong the collection and processing of data.

Should incorporated municipalities within Clark County join the Earthquake Fault Analysis project during the term of the ongoing work, the following budget will be adjusted downward accordingly. The budget can be re-evaluated in consideration of expanding the project at anytime during the course of the work.

The following budget is good for ninety (90) days from 7/19/16. If the project does not start Agreement NO._____

within this time frame, the costs of the project will have to be re-evaluated.

Schedule of Deliverables for the Las Vegas Valley Seismic Hazard Project

Year	Deliverable
Year 1	Age Dating Report 1
	Annual Progress Report
Year 2	Preliminary Geologic Map
	Age Dating Report 2
	Compaction Report
	Local Faults Report
	Regional Fault Map
	Annual Progress Report
Year 3	Local Fault Map
	Fault/Earthquake Size Potential Report
	Fault/Earthquake Activity/Frequency Report
	Annual Progress Report
Year 4	Surface Rupture Hazard Map and Report
	Fault Seismic Hazard Analysis Report
	Final Surficial Geologic Map
	Annual Progress Report
Year 5	Final Peer-Reviewed Project Report
	Presentation of Results to National Seismic Hazard Map
	Online Posting of Results
	Las Vegas Workshop

EXHIBIT 2

EXHIBIT 2

AMENDMENT NO. 1
TO THE AGREEMENT BY AND BETWEEN
CLARK COUNTY, NEVADA
AND
THE BOARD OF REGENTS OF THE NEVADA SYSTEM OF HIGHER EDUCATION
OBO UNIVERSITY OF NEVADA, RENO

An amendment to the Interlocal Contract (Agreement) is entered into and effective as of August 2, 2016, by and between Clark County (County), a political subdivision of the State of Nevada, and the Board of Regents, Nevada System of Higher Education, obo the University of Nevada, Reno, an institution of higher education of the State of Nevada (University).

RECITALS

WHEREAS, County and University are public agencies of the State of Nevada and are authorized to enter into this Agreement pursuant to NRS 277.180; and

WHEREAS, County wishes to have certain services performed in accordance with the scope of work outlined in this Agreement; and

WHEREAS, the performance of such services are consistent, compatible, and beneficial to the academic role and mission of University as an institution of higher education; and

WHEREAS, University is qualified to provide such services; and

WHEREAS, the Board of County Commissioners approved the Agreement at their August 2, 2016, meeting; and

WHEREAS, the Governor Steve Sisolak declared a state of emergency over concerns of the COVID-19 pandemic on March 12, 2020.

AGREEMENT

NOW, THEREFORE, for and in consideration of the mutual covenants, conditions and undertakings herein set forth, the parties agree to amend the Agreement as follows:

2. Period of Performance. The Project period under this agreement is intended to commence on August 9, 2016 and continue until December 31, 2021. The Budget Period shall commence on August 9, 2016 and continue until January 31, 2022 (Initial Term). This Agreement may be extended for additional periods of performance beyond the Initial Term, upon written approval by County and University.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by their duly authorized representatives effective as of the day and year first written above.

Chair of the BCC

BOARD OF REGENTS, NSHE OBO UNIVERSITY OF NEVADA, RENO

County Clerk

By: _____
Signature

By: _____
Signature

Name: _____
(Please print)

Name: Thomas Landis
(Please print)

Title: _____
(Please print)

Title: Grants and Contracts Manager
(Please print)

Date: _____

Date: 5/31/2021

CLARK COUNTY BOARD OF COMMISSIONERS
AGENDA ITEM

Petitioner: Jerome A. Stueve, Director/Building and Fire Official

Recommendation:

Approve and authorize the Chair to sign Amendment No. 1 to the Agreement between Clark County and the Nevada System of Higher Education (NSHE) for the seismic fault study throughout Clark County; or take other action as appropriate. (For possible action)

FISCAL IMPACT:

Fund #:	5340	Fund Name:	Building Enterprise Fund
Fund Center:	113053000	Funded PGM/Grant:	N/A
Amount:	N/A		
Description:	N/A		
Additional Comments:	N/A		

BACKGROUND:

On March 2, 2016, the Board of County Commissioners approved an agreement with the Nevada System of Higher Education (NSHE) to perform a seismic study of seismic faults throughout Clark County. The COVID-19 pandemic temporarily delayed completion of certain tasks, including conducting workshops and performance of the peer review. These delays have been beyond the reasonable control of either contracting party. NSHE is requesting a no cost time extension to extend the term of the agreement to January 31, 2022 (respectively).

The District Attorney's Office has reviewed and approved the amendatory agreement as to form.

Cleared for Agenda

04/20/2021

File ID#

21-491