



MEMORANDUM

TO: Mayor and Council Members

FROM: Michael L. Personett, Acting Director
Watershed Protection Department *MLP*

DATE: October 30, 2017

SUBJECT: Update on the Onion Creek Floodplain and Flood Hazard Mitigation Feasibility Study

This memorandum provides an update on the Watershed Protection Department's (WPD) progress on the Onion Creek Flood Hazard Mitigation Feasibility Study and the implementation of a flood risk reduction project in the Upper Onion Creek neighborhood, referred to as the Pinehurst and Wild Dunes areas in the report.

There are 138 houses at risk of interior flooding during a 100-year flood event in this neighborhood. During the flood on October 30, 2013, approximately 129 homes flooded with as much as 4.6 feet of flood water inside them. During the flood on October 31, 2015, approximately 58 homes flooded with as much as 4 feet of water inside them. Because of the risk of flooding, this area is ranked 4th on WPD's priority list for city-wide flood risk reduction projects.

In response to the 2013 Halloween Flood and at the direction of City Council (Resolution 20140515-028), WPD initiated a comprehensive Onion Creek floodplain study to evaluate flood risk reduction options within this neighborhood. The study, performed by Halff Associates, included field surveys of home elevations and high water marks from the 2013 Halloween flood; the creation of new floodplain maps for Onion Creek and several tributaries for City of Austin regulatory purposes and for FEMA flood insurance purposes; and the evaluation of flood risk reduction alternatives for the Pinehurst and Wild Dunes neighborhood.

WPD shared preliminary results of the study with Council via a memo dated March 2, 2016. We presented the preliminary results to a joint meeting of the Council Public Utilities Committee and Open Space, Environment, and Sustainability Committee on May 26, 2016. WPD also presented preliminary results to stakeholders in the Pinehurst and Wild Dunes neighborhood on November 15, 2016. Input from these stakeholders was used to help refine the list of flood risk reduction alternatives that were carried forward for final evaluation. WPD held another public meeting with the neighborhood on May 16, 2017, to update them on the study's progress and to share information about the final flood risk reduction

alternatives that WPD evaluated. Alternatives considered included detention ponds upstream of the project area, floodwalls within the impacted area, channel modifications and clearing, and buyouts of at-risk houses.

The project team evaluated each alternative based on several criteria, which included: the ability to cost-effectively reduce the risk of flooding to homes; the amount of time a project would require to implement; stakeholder preferences; the complexity of regulatory approvals; and environmental impacts. Due to the size of the watershed and the amount of water that needs to be conveyed through the watershed's creek system, options to effectively reduce the risk of flooding of houses in this neighborhood are limited. Furthermore, even the most effective options in terms of flood risk reduction are very costly and some would likely take several more years of additional engineering design before construction could begin, assuming funding is available.

The conclusion of the study is that a voluntary buyout option is the most effective flood risk reduction alternative for this area. WPD concurs with this conclusion and intends to proceed with a phased implementation of the buyout project. Assuming 100 percent participation of property owners, the preliminary cost estimate is \$77.5 million. Based on our recent experience with similar voluntary buyout projects, it can be expected that participation, and therefore costs, will be lower.

As full funding for the project is not immediately available, WPD will prioritize voluntary buyout offers based on the degree of 100-year flood risk at each house, which is consistent with our implementation of the buyouts in the Lower Onion Creek area. At the direction of City Council (Resolution 20140515-028), WPD has already offered recovery buyouts to 10 properties at high risk of flooding in the Pinehurst neighborhood. WPD currently has funding available to acquire an additional 50 properties at the highest risk of flooding. Buyouts of the remaining homes (78 properties at risk of flooding) will proceed as additional funding becomes available in the future.

WPD and the Office of Real Estate Services will host a neighborhood meeting this fall to present the final results, conclusions, and recommendations of the study, and to share detailed information about the project and the process for voluntary buyouts. WPD will also be actively working with the Parks & Recreation Department, the neighborhood, and other stakeholders to begin development of conceptual plans for how the acquired properties may be used in the future.

The Executive Summary of the Onion Creek Floodplain and Flood Hazard Mitigation Feasibility Study is attached and the full text of the report will soon be uploaded to the WPD project website at www.austintexas.gov/department/onion-creek-floodplain-and-flood-mitigation-study. Should you have questions or need additional information, please feel free to contact me at 512-974-2652.

Cc: Elaine Hart, Interim City Manager
Joseph G. Pantalion, P.E., Interim Assistant City Manager



City of Austin, Texas

Onion Creek Floodplain Modeling and Mapping Phase 2 – Risk Identification and Mitigation

Flood Mitigation Analyses

Executive Summary & Technical Report

October 20, 2017



Prepared by:

Halff Associates, Inc.

9500 Amberglen Blvd., Bldg. F, Suite 125
Austin, TX 78729-1102



SMARTER SOLUTIONS

DRAFT Document is intended for
review purposes only.

ENGINEER: Cindy Engelhardt, PE
P.E. LICENSE NO.: 103496
DATE: 10/20/2017
TBPE FIRM: 312

EXECUTIVE SUMMARY



Executive Summary

The Onion Creek watershed encompasses approximately 344 square miles. Onion Creek generally flows easterly, from the headwaters in Blanco County, through Hays County, to the confluence with the Colorado River in Travis County. In response to the October 2013 flood along Onion Creek, the City of Austin initiated a multi-phase study of the Onion Creek Watershed. The initial phase of this study included hydrologic and hydraulic analyses redefining flows, water surface elevations, and the floodplain along the Onion Creek and tributaries in Travis County. The flood mitigation concepts discussed in this report are the results of the second phase of this study, Risk Identification and Mitigation. In October 2015, Onion Creek once again experienced a significant flooding event which further demonstrated the importance of this evaluation. **This Onion Creek Flood Mitigation Analysis is a feasibility study. Any results from this study, including post-project flood risk, will be refined should any of the projects mentioned in this analysis be recommended for further evaluation.** This area of Onion Creek was first studied and mapped by FEMA in 1978. Since that time, several studies have been performed in this area. Flood mitigation alternatives were analyzed in this area by Loomis and Moore in 1997. The United States Army Corps of Engineers (USACE) studied Onion Creek in 2006 and again in 2013. The previous studies were reviewed and the alternatives with the best potential were further evaluated in this study.

To validate the updated hydrologic and hydraulic analyses, the study team simulated three historical events (October 2013, May 2015, and October 2015) using gage-adjusted radar rainfall and gage records provided by the City of Austin. Once validated, the updated analysis was used to redefine computed peak flows, water surface elevations, and floodplains along Onion Creek within Travis County. Based on this study, the City was able to re-evaluate flood risk within the Pinehurst and Wild Dunes neighborhoods and evaluate potential flood mitigation alternatives.

Flood Mitigation Study Area

This study focuses on flood mitigation along the portion of Onion Creek between Interstate Highway 35 (IH-35) to East Slaughter Lane. For a location map of the study area in relation to the watershed, please see Figure 1. Because of the topography of the creek and locations of the homes at risk of flooding, the flood mitigation alternatives have varying effects throughout the study area. The flood mitigation benefits vary based on location along Onion Creek for each of the flood mitigation alternatives. For this reason, the study area is often referred to as two separate locations: the Pinehurst and Wild Dunes neighborhoods. The nomenclature refers to the homes in the general areas near Pinehurst Drive and Wild Dunes Drive including homes on all streets and not only those specific streets.

Existing Conditions Flood Risk

Once the hydrologic and hydraulic analyses were updated, the potential existing condition flood risk in the Pinehurst and Wild Dunes neighborhoods was established. Flood risk in the study area was evaluated for several flood events with varying frequency (probability of occurring). No homes within the study area are estimated to be flooded during the 50-year or 2% Annual Chance

Event (ACE) or any flood events with higher frequencies. Therefore, the evaluation of flood risk in the study area focused on mitigating the 100-year or 1% ACE.

Finished floor elevations were defined based on survey for over 90% of the homes in the study area. Where survey was not available, LIDAR elevation data was utilized. The number of at risk homes and expected depth of flooding in those homes were defined by subtracting the finished floor elevation from the 1% ACE water surface elevation. When the 1% ACE water surface elevation exceeds the finish floor elevation, interior or structural flooding is likely to occur. The estimated 1% ACE depths in homes can be seen in Figure 1. There are 115 homes in the Pinehurst neighborhood and 23 in the Wild Dunes neighborhood that are estimated to experience structural flooding during the 1% ACE, for a total of 138 homes.

As you can see in Figure 1, there are more than 138 homes located within the floodplain. This means that, even though the 1% ACE floodplain surrounds the home, the flood waters are not estimated to reach above the finished floor elevation and enter into the home. There are 174 homes located within the 1% ACE floodplain in the Pinehurst neighborhood, 45 homes in the Wild Dunes neighborhood, and 7 homes in other locations within the study area, for a total of 226 homes. This total includes the 138 homes that are expected to experience interior flooding.

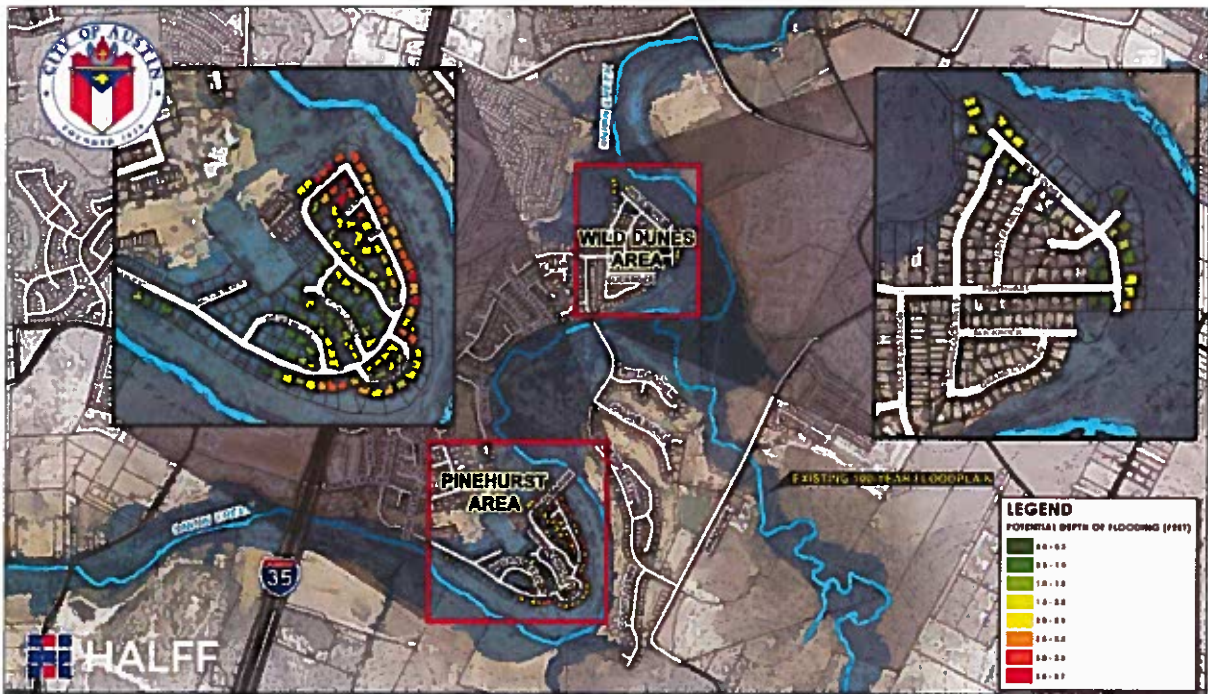


Figure 2: 1% (100-year) ACE Existing Conditions Risk of Flooding in Homes



Mitigation Goals

The overall flood mitigation objective is to eliminate the risk of interior flooding of homes along the reach of Onion Creek between IH-35 and East Slaughter Lane during the 1% ACE. In order to significantly reduce structural flooding between IH-35 and East Slaughter Lane, the flood elevations from the 1% ACE need to be reduced to levels similar to the 2% (50-year) ACE or at risk homes can be relocated out of the floodplain through the use of voluntary buyouts. A water surface elevation reduction can be accomplished using hydrologic alternatives (detention/retention ponds), hydraulic alternatives (diversions, floodwalls, channel improvements, etc.), or a combination of these alternatives. An analysis of possible flood mitigation improvements was conducted to potentially convey floodwaters within existing or proposed channel easements and roadway right-of-ways. The goal of this feasibility analysis was to identify alternatives that would either reduce the 1% ACE peak flows by approximately 30% or produce equivalent water surface elevation reductions ranging from 2 to 6 feet through the study area. When water surface elevation reduction is not feasible through the use of hydrologic or hydraulic alternatives, buyouts can be utilized to completely remove people and homes from the floodplain. When people and homes are removed from the floodplain, risk is eliminated indefinitely.

Final Flood Mitigation Alternatives

The flood mitigation analysis consisted of the development and evaluation of a variety of potential alternatives, both structural and non-structural, with the goal of protecting people and property from flooding and possibly reducing flood levels along Onion Creek between IH-35 and East Slaughter Lane within the Pinehurst and Wild Dunes neighborhoods. An extensive set of potential flood mitigation alternatives were evaluated based upon expected flood mitigation benefits, high-level engineering feasibility, and cost effectiveness of each individual alternative.

Based on the analysis, 3 stand-alone alternatives and 3 combined alternatives were selected for further engineering analysis. These six alternatives are listed below:

Stand-Alone Alternatives:

- Centex West Regional Detention Pond
- Channel Clearing
- Voluntary Buyouts

Combined Alternatives:

- Centex West Regional Detention Pond with Channel Modifications
- Pinehurst Flood Protection Wall with Voluntary Buyouts
- Pinehurst Flood Protection Wall with Channel Modifications

These selected alternatives were chosen considering their technical feasibility, cost, and input from project stakeholders. The continued engineering analysis of these alternatives included refinement of design to maximize effectiveness. The effectiveness of each of these alternatives was evaluated based on the benefits provided relative to the updated existing condition 1% ACE



flooding conditions. Highlights of these alternatives are displayed in the alternative fact sheets located in Appendix A. After the finalization of the engineering analysis for the selected flood mitigation alternatives, each were evaluated using a project scoring criteria. Project scoring allows for all flood mitigation alternatives to be evaluated equally to ultimately identify the most favorable flood mitigation project for the Onion Creek study area.

Stand-Alone Alternatives

Centex West Regional Detention Pond – Hydrologic detention is used to temporarily impound flood waters for later release in order to reduce peak flows or to alter the timing and prevent the additive impact of tributary peak flows within a watershed. Therefore, the location of the rainfall within the watershed can have a significant impact on the true effectiveness of any regional detention alternative. This conceptual-level analysis included the identification of several potential regional detention pond locations upstream of IH-35 along Onion Creek. Compared to other regional detention alternatives that were analyzed, the Centex West pond is located relatively close to the study area, has fewer permitting challenges than other alternatives, and has significant flood mitigation benefits. Therefore this alternative was further evaluated in the final flood mitigation alternatives. The Buda/IH-35 Pond is located closer to the study area and did provide more flood mitigation benefits than the Centex West alternative, however due to exorbitant estimated project cost, significant permitting, and property acquisition this detention alternative was not selected for further analysis.

The Centex West Regional Detention Pond would utilize a portion of the active Centex quarry as an offline detention pond. The pond would be offline (flow diverted from the creek into the pond) and would, therefore, not require construction of an inline dam across Onion Creek. The diversion channel would be excavated from Onion Creek to the quarry. It would be designed to allow smaller or more frequent flood events to continue down Onion Creek while diverting and detaining only the larger or less frequent flood events. The flood waters will only be temporarily stored within the pond. The quarry would remain dry except for a period of time after significant flood events. Since this is currently an active quarry, in order to utilize it for detention, negotiations with the property owner and quarry operator would be required to allow for disruptions to mining operations during and after flood events that utilize the pond. Also agreements would need to be established regarding the property once mining operations are complete. When utilizing regional detention as a flood mitigation alternative there is a risk that if the rain falls primarily downstream of the detention pond, the pond will not be able to store a sufficient quantity of flood waters, and the study area will not see the full anticipated flood mitigation benefits.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$50,700,000** and **\$40,000** respectively. The estimated time required to design and construct the pond (once funding is available) is **more than 10 years**. This flood mitigation alternative could be utilized to produce about an **11% flow reduction** of the computed 1% ACE peak flow at the Pinehurst and Wild Dunes neighborhoods. This 11% reduction in peak flow eliminates structural flooding for approximately **78 out of 138 homes** from the 1% ACE.



Channel Clearing – This alternative includes channel clearing for 126 acres of the densest areas of vegetation within the Onion Creek floodplain adjacent to the Pinehurst and Wild Dunes neighborhoods. In order to provide a flood mitigation benefit within the study area, channel clearing would require more than simply removing debris and fallen trees along Onion Creek. Although channel clearing is somewhat effective, it does not have the impact necessary to provide relief to a majority of the homes at risk in the 1% ACE floodplain compared to other flood mitigation alternatives analyzed. Since the City of Austin does not currently own easement or property along this reach of Onion Creek, easements would need to be acquired in the areas where channel clearing is proposed. Once the channel clearing is complete, great efforts would be required to maintain the "cleared" channel. The initial channel clearing and the perpetual maintenance would significantly impact the riparian corridor along Onion Creek including negative effects on water quality, creek stability, wildlife, and trees. This channel clearing alternative would remove all underbrush and more than 50% of existing trees within the dense vegetation areas, and would negatively impact heritage trees. Because of the environmental impacts, utilizing channel clearing as a flood mitigation alternative runs contrary to both the national trend in floodplain management and the City of Austin's goal of natural channel preservation.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$35,300,000** and **\$448,000** respectively. The estimated time required to design and construct this alternative (once funding is available) is **2 to 5 years**. This flood mitigation alternative eliminates structural flooding for approximately **51 out of 138 homes** from the 1% ACE.

Voluntary Buyouts – Property acquisition is often the most effective means of improving public safety and reducing flood damages in previously developed floodplain areas. When people and homes are removed from the floodplain, risk is eliminated permanently. The voluntary buyout option considered in this study is based on the offer of flood mitigation buyouts to homes within the study area that experience structural flooding during the 1% ACE. Such buyouts could be prioritized based on the depth of flooding and would proceed from the highest risk homes to the lowest risk as funding becomes available. The estimated cost of buyouts or property acquisition includes real estate services, appraisals, acquisition costs, relocation/moving expenses, asbestos testing/abatement, demolition, and property management. In order to avoid isolating homes, the cost estimate for this project includes estimates to offer voluntary buyouts to a handful of homes that are not at risk of structural flooding in the 1% ACE, but are located between at risk homes.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$77,500,000** and **\$105,000** respectively. The estimated time required for implementation (once funding is available) is **2 years**. This flood mitigation alternative eliminates structural flooding for approximately **138 out of 138 homes** at risk within the Pinehurst and Wild Dunes neighborhoods from the 1% ACE.



Combined Alternatives

The voluntary buyout alternative presented above is the only stand-alone alternative that would potentially mitigate the full risk of flooding in the study area during the 1% ACE flood. In order to provide this level of mitigation without relying solely on buyouts, a combination of alternatives is required.

Centex West Regional Detention Pond with Channel Modifications – This alternative includes a combination of the Centex West Regional Detention Pond, River Plantation Drive bridge improvements, as well as channel modifications downstream of River Plantation Drive near the Wild Dunes neighborhood. Since the City of Austin does not currently own easement or property along this reach of Onion Creek, property acquisition would be required in the areas where channel modifications are proposed. In the areas of the proposed channel modifications, significant efforts to maintain the "cleared" channel once the project is complete will be required. Cutting into the channel would significantly impact the riparian corridor along Onion Creek negatively impacting water quality, creek stability, wildlife, and trees.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$70,200,000** and **\$88,000** respectively. The estimated time required to design and construct this combined alternative (once funding is available) is **more than 10 years**. This flood mitigation alternative could be utilized to produce about an **11% flow reduction** of the computed 1% ACE peak flow at the Pinehurst and Wild Dunes neighborhoods. This combined alternative eliminates structural flooding for approximately **110 out of 138 homes** from the 1% ACE.

Pinehurst Flood Protection Wall with Voluntary Buyouts – This alternative includes a flood protection wall in the Pinehurst neighborhood in combination with voluntary buyouts for the homes at risk of flooding in the 1% ACE in the Wild Dunes neighborhood. Because the flood protection wall would only provide limited flood reduction benefits to the Wild Dunes neighborhood, buyouts could be used to help meet the flood mitigation goals in this area. The purchase of 48 properties along the southeast side of Pinehurst Drive would also be required for construction of the wall. The height of the proposed wall is on average 5.5 feet, similar to the height of a standard privacy fence, with a max height of 14 feet. These dimensions include the FEMA requirements of freeboard (height above the 1% ACE water surface elevation) of at least 3 feet for the entire length of the wall, and 3.5 feet of freeboard at the upstream and downstream ends of the wall. The facade of the wall could be constructed to match current architecture in the neighborhood. The flood protection wall's alignment would also allow for the full function of the golf course as it is today. In addition, an internal drainage system would be required to drain approximately 77 acres of neighborhood drainage located behind the wall.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$59,400,000** and **\$68,000** respectively. The estimated time required to design and construct this alternative (once funding is available) is **5 to 7 years**. This flood mitigation alternative eliminates structural flooding for approximately **138 out of 138 homes** at risk within the Pinehurst and Wild Dunes neighborhoods from the 1% ACE.



Pinehurst Flood Protection Wall with Channel Modifications – This alternative includes the combination of the Pinehurst flood protection wall, River Plantation Drive bridge improvements, as well as channel modifications downstream of River Plantation Drive. The Pinehurst flood protection wall is the same as the wall proposed in the combined alternative Pinehurst Flood Protection Wall with Voluntary Buyouts. The River Plantation bridge improvements are the same as those included in the combined alternative with the Centex West Pond and channel modifications. The channel modifications in combination with the flood protection wall would require more conveyance and excavation than the channel modifications in combination with the Centex West Pond, because it does not experience the flow reduction benefits that the Centex West Pond would provide.

Since the City of Austin does not currently own easement or property along this reach of Onion Creek, property acquisition would be required in areas where channel modifications are proposed. In the areas of the proposed channel modifications the channel will require significant efforts to maintain the "cleared" channel once the project is complete. Cutting into the channel would significantly impact the riparian corridor along Onion Creek negatively impacting water quality, creek stability, wildlife, and trees.

The estimated project cost and annual O&M cost for this flood mitigation alternative are **\$88,900,000** and **\$159,000** respectively. The estimated time required to design and construct this alternative (once funding is available) is **7 to 10 years**. This flood mitigation alternative eliminates structural flooding for approximately **138 out of 138 homes** at risk within the Pinehurst and Wild Dunes neighborhoods from the 1% ACE.

Project Scoring

Each of the flood mitigation alternatives were compared based on a set project scoring criteria. The scoring criteria cover a wide range of issues and were established based on a review of prioritization approaches used previously by the City of Austin and methods used by other municipalities and agencies. The selected criteria balance a broad range of considerations. There are seven different criteria:

- **Cost Effectiveness** – A Benefit-Cost Analysis was performed for the six flood mitigation alternatives.
- **Environmental Impacts** – The estimate of environmental impact is generally based on whether the environmental impact would be moderate or significant, and if the impact would be short-term or long-term.
- **Funding Constraints** – This criteria is based on what could be the project's funding source, the estimated time required to obtain funding, and the ability of the project to be implemented in phases.
- **Time of Implementation** – This criteria is based on what would be the time it takes to design, permit, and construct for each project. This criteria does not include the time to obtain funding.



- **Land & Easement Acquisition Required** – This criteria is based on the land or easement acquisition required for the flood mitigation alternative to be implemented.
- **Neighborhood Input** – This criteria is based on the neighborhood survey results from the Onion Creek public meeting on November 15, 2016.
- **Complexity of Permitting** – This criteria considers what permits would be required for the proposed flood mitigation projects and what is the difficulty in obtaining those permits due to other entities' involvement.

In Table 1, the results of the project scoring are summarized. The alternative that received the highest score, Voluntary Buyouts, is highlighted in green. The alternative that received the lowest score, the combination of the Centex West Pond with channel modifications, is highlighted in red. The table illustrates where each alternative fell for each project scoring criteria.

Table 1. Project Scoring Results Summary

Criteria			
Cost Effectiveness (Benefit-Cost Index)	• Wall with Buyouts	• Voluntary Buyouts • Wall with Chl. Mods.	• Centex West Pond • Channel Clearing • Pond with Chl. Mods.
Environmental Impact	• Voluntary Buyouts	• Centex West Pond • Wall with Buyouts	• Channel Clearing • Pond with Chl. Mods. • Wall with Chl. Mods.
Funding Constraints	• Voluntary Buyouts	• Channel Clearing • Pond with Chl. Mods. • Wall with Buyouts • Wall with Chl. Mods.	• Centex West Pond
Time of Implementation	• Voluntary Buyouts	• Channel Clearing • Wall with Buyouts	• Centex West Pond • Pond with Chl. Mods. • Wall with Chl. Mods.
Land & Easement Acquisition	• Voluntary Buyouts	• Channel Clearing • Wall with Buyouts • Wall with Chl. Mods.	• Centex West Pond • Pond with Chl. Mods.
Neighborhood Input	• Centex West Pond • Channel Clearing • Pond with Chl. Mods.	• Voluntary Buyouts • Wall with Chl. Mods.	• Wall with Buyouts
Complexity of Permitting	• Voluntary Buyouts	• Channel Clearing • Wall with Buyouts • Wall with Chl. Mods.	• Centex West Pond • Pond with Chl. Mods.



Conclusion & Recommendations

The Onion Creek Flood Mitigation Analysis allowed the City to re-evaluate flood risk within the Pinehurst and Wild Dunes neighborhoods in light of the October 2013 and 2015 floods and evaluate potential flood mitigation alternatives. There are 115 homes in the Pinehurst neighborhood and 23 in the Wild Dunes neighborhood where the estimated 1% ACE water surface elevation exceeds the finished floor elevations. The overall flood mitigation objective is to eliminate the interior flooding risk of homes during the 1% ACE within the Pinehurst and Wild Dunes neighborhoods.

Voluntary Buyouts are less expensive than regional detention and have the flexibility of being implemented as funding becomes available. A Voluntary Buyout program offers the shortest time of implementation and allows for prioritization of the most at risk homes. In addition to these benefits, this alternative has the least environmental impact to the Pinehurst and Wild Dunes neighborhoods. Based on the results of the analysis and the project scoring criteria, Halff recommends **Voluntary Buyouts** as the preferred flood mitigation alternative.

Regional Detention could also be considered as a flood mitigation alternative for long-term and comprehensive planning. However high project cost, lack of funding, complex permitting, property acquisition, and environmental impact will all be obstacles that would need to be overcome if regional detention was ever implemented. Regional detention would also require regional partnerships between multiple jurisdictions, including coordination between Travis and Hays Counties through their recent Interlocal Agreement (ILA).

This Onion Creek Flood Mitigation Analysis is a feasibility study. Any results from this study, including post-project flood risk, will be refined should any of the projects mentioned in this analysis be recommended for further evaluation. For a more in-depth narrative of the flood mitigation analyses please refer to the *Onion Creek Flood Mitigation Analyses Technical Report*.