City of Phoenix

Agenda
City Council Policy Session

Meeting Location:
City Council Chambers
200 W. Jefferson St.
Phoenix, Arizona 85003

Tuesday, June 13, 2023 **2:30 PM** **phoenix.gov**

OPTIONS TO ACCESS THIS MEETING

Virtual Request to speak at a meeting:

- Register online *by visiting the City Council Meetings page on phoenix.gov* ***at least 2 hours prior to the start of this meeting****. Then, click on this link at the time of the meeting and join the Webex to speak:* https://phoenixcitycouncil.webex.com/phoenixcitycouncil/onstage/g.php?MTID=e27817988e2b2bf816e7e2ff83461982e

- Register via telephone at 602-262-6001 **at least 2 hours prior to the start of this meeting,** noting the item number. Then, use the Call-in phone number and Meeting ID listed below at the time of the meeting to call-in and speak.

In-Person Requests to speak at a meeting:

- Register in person at a kiosk located at the City Council Chambers, 200 W. Jefferson St., Phoenix, Arizona, 85003. Arrive **1 hour prior to the start of this meeting**. Depending on seating availability, residents will attend and speak from the Upper Chambers, Lower Chambers or City Hall location.

- Individuals should arrive early, 1 hour prior to the start of the meeting to submit an in-person request to speak before the item is called. After the item is called, requests to speak for that item will not be accepted.

At the time of the meeting:

- Watch the meeting live streamed on phoenix.gov or Phoenix Channel 11 on Cox Cable, or using the Webex link provided above.

- Call-in to listen to the meeting. Dial 602-666-0783 and Enter Meeting ID 2550 861 4961# (for English) or 2558 520 5398# (for Spanish). Press # again when prompted for attendee ID.

- Watch the meeting in-person from the Upper Chambers, Lower Chambers or City Hall depending on seating availability.

Para nuestros residentes de habla hispana:

- Para registrarse para hablar en español, llame al 602-262-6001 **al menos 2 horas antes del inicio de esta reunión** e indique el número del tema. El día de la reunión, llame al 602-666-0783 e ingrese el número de identificación de la reunión 2558 520 5398#. El intérprete le indicará cuando sea su turno de hablar.

- Para solamente escuchar la reunión en español, llame a este mismo número el día de la reunión (602-666-0783; ingrese el número de identificación de la reunión 2558 520 5398#). Se proporciona interpretación simultánea para nuestros residentes durante todas las reuniones.

- Para asistir a la reunión en persona, vaya a las Cámaras del Concejo Municipal de Phoenix ubicadas en 200 W. Jefferson Street, Phoenix, AZ 85003. Llegue 1 hora antes del comienzo de la reunión. Si desea hablar, regístrese electrónicamente en uno de los quioscos, antes de que comience el tema. Una vez que se comience a discutir el tema, no se aceptarán nuevas solicitudes para hablar. Dependiendo de cuantos asientos haya disponibles, usted podría ser sentado en la parte superior de las cámaras, en el piso de abajo de las cámaras, o en el edificio municipal.

CALL TO ORDER

COUNCIL INFORMATION AND FOLLOW-UP REQUESTS

This item is scheduled to give City Council members an opportunity to publicly request information or follow up on issues of interest to the community. If the information is available, staff will immediately provide it to the City Council member. No decisions will be made or action taken.

CONSENT ACTION

This item is scheduled to allow the City Council to act on the Mayor's recommendations on the Consent Agenda. There is no Consent Agenda for this meeting.

CALL FOR AN EXECUTIVE SESSION

A vote may be held to call an Executive Session for a future date.

REPORTS AND BUDGET UPDATES BY THE CITY MANAGER

This item is scheduled to allow the City Manager to provide brief informational reports on topics of interest to the City Council. The City Council may discuss these reports but no action will be taken.

INFORMATION AND DISCUSSION (ITEM 1)

1 **Update on Availability of Colorado River Water 2024-26 and Water Strategy** Page 5

This report provides an update to the City Council on the following three subjects: 1) Conditions on the Colorado River, 2) the recently proposed regional plan to use Colorado River during 2024 through 2026, and 3), the City's strategy to stabilize and address water resource portfolio challenges.

THIS ITEM IS FOR INFORMATION AND DISCUSSION.

Responsible Department

This item is submitted by Deputy City Manager Ginger Spencer and the Water Services Department.

Roll Call and City Clerk Reads 24-Hour Paragraph

ORDINANCES, RESOLUTIONS, AND FORMAL ACTION (ITEM 2)

2 **Resolution Adoption - The Sustainable Desert City Development Policy-Water (Resolution 22129)** Page 7

Request City Council approval of a resolution to address water consumption of new development.

THIS ITEM IS FOR DISCUSSION AND POSSIBLE ACTION.

Responsible Department
This item is submitted by Deputy City Managers Alan Stephenson and Ginger Spencer along with the Planning and Development and Water Services departments.

DISCUSSION AND POSSIBLE ACTION (ITEM 3)

3 **Results on Yellow Light Timing Field Study** Page 14

This report provides the field study results on the Street Transportation Department's efforts to investigate and evaluate the "before" and "after" impacts of a focused implementation of the new Institute of Transportation Engineers' guidelines on yellow change intervals at signalized intersections in comparison with Phoenix's current practices. The report further requests Council approval of staff's recommendation on the implementation of new yellow change interval timing based on the results of the field study.

THIS ITEM IS FOR DISCUSSION AND POSSIBLE ACTION.

Responsible Department
This item is submitted by Deputy City Manager Alan Stephenson and the Street Transportation Department.

ADJOURN

Agenda Date: 6/13/2023, **Item No.** 1

Update on Availability of Colorado River Water 2024-26 and Water Strategy

This report provides an update to the City Council on the following three subjects: 1) Conditions on the Colorado River, 2) the recently proposed regional plan to use Colorado River during 2024 through 2026, and 3), the City's strategy to stabilize and address water resource portfolio challenges.

THIS ITEM IS FOR INFORMATION AND DISCUSSION.

Summary

The Colorado River Basin has been in decline for over a decade, with reservoir levels dropping to historic low elevations, due to reduced flows in the river, and over allocation among the 40 million people throughout the Western United States that rely upon the river for drinking water and agricultural uses. Beginning in 2020 through 2022, the declines were particularly precipitous, resulting in a call from the United States Bureau of Reclamation (Reclamation) in June of 2022, to Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California (the Basin States) to take action. Specifically, Reclamation called for the Basin States to develop a plan to reduce demand on the Colorado River by two to four million acre-feet (af) by 2024 to save the reservoir system from collapse. For context, the entire State of Arizona receives a 2.8 million af allocation from the Colorado River. The announcement was particularly concerning to Phoenix, which receives its Colorado River allocation from the Central Arizona Project (CAP). The CAP is the most junior priority on the Colorado River, and the proposed reductions could end deliveries of Colorado River Water to Central Arizona under many legal interpretations of the cases, and agreements that comprise the Law of the River.

For over six months in 2022, the Basin States were unable to reach agreement on reductions to Colorado River deliveries. Last fall, Reclamation announced it would consider taking unilateral federal action to reduce deliveries, issuing a Supplemental Environmental Impact Statement (SEIS) with two alternative plans to reduce deliveries. Neither alternative was acceptable to Arizona water users. On May 2023, the Lower Basin states of Arizona, California, and Nevada announced a new plan to reduce Colorado River demand in those states by 1 million af, each year, from 2024 through 2026. The reductions would be largely compensated with federal funding in the form of

system conservation agreements such as the one approved by the Phoenix City Council on May 31, 2023. The plan also relies on run off from the extraordinary winter snowpack and rainfall from 2022-23. While this plan is likely not sustainable beyond 2026, it does provide the Basin States time to negotiate more permanent operating rules for the Colorado River that must address sustainable water allocations in a declining river system.

While the proposal may resolve delivery disputes between 2024 and 2026, the long-term outlook for Colorado River supplies for Phoenix is still not stable. Staff has developed a water strategy to strengthen Phoenix's long-term outlook and resilience. This includes (1) utilizing available alternative water resources; (2) increasing water efficiency through demand management; (3) promoting sustainable desert development; and (4) augmenting the Phoenix water resource portfolio.

Responsible Department
This item is submitted by Deputy City Manager Ginger Spencer and the Water Services Department.

City of Phoenix

Report

Agenda Date: 6/13/2023, **Item No.** 2

Resolution Adoption - The Sustainable Desert City Development Policy-Water (Resolution 22129)

Request City Council approval of a resolution to address water consumption of new development.

THIS ITEM IS FOR DISCUSSION AND POSSIBLE ACTION.

Summary

The history of the City of Phoenix is built on water management and conservation. From the canals of ancient Hohokam societies through the Salt River Project to the construction of the Central Arizona Project, human's ability to thrive in the desert has always depended first and foremost on our ability to use the limited water resources available with care. For this reason, the City, and Central Arizona more broadly, have elected to develop on a backbone of renewable surface water resources rather than a finite resource of groundwater, unlike many other communities in the American West.

Because it is not sustainable to revert to groundwater supplies, the City has taken great care to protect surface water in the region. In 2014, the Council authorized the Colorado River Resiliency fund, improving local watershed resiliency and providing for underground water storage. Water supply is only one side of the equation. Due to the foresight of current and previous civic leaders, the City has made significant progress in demand management and conservation. In 1980, the State of Arizona passed the Groundwater Management Act, becoming the first US state to regulate groundwater and mandate water conservation measures at that scale. Because of these measures and other efforts, per-person water use has fallen by more than 30 percent over the last 30 years. However, hydrologic conditions in the Colorado River, which currently comprise approximately 40 percent of the water delivered to residents, are currently experiencing significant reductions in flow. Therefore, the City can no longer depend on receiving its full allocation from the Colorado River. For this reason, in June 2022, the Water Services Director declared a "Stage 1 Water Alert" as part of the City's Drought Management Plan, which means a supply insufficiency is likely in the future.

To adapt to a challenge of this magnitude, the City will have to embrace its heritage of water-problem solving. Only by adopting institutional water conservation policies will

the City be able to maintain a pattern of sustainable growth and efficient water use. The resolution requested (**Attachment A**) includes the sections highlighted below:

- Section 1: Conservation Measures for New Development.
- Section 2: Conservation and Restrictions on New Large Water Users.
- Section 3: Annexations outside the current Water Department Service Area.
- Section 4: Applicability and Implementation.

Financial Impact

There is no financial impact from this resolution.

Concurrence/Previous Council Action

- The Transportation, Infrastructure and Planning Subcommittee received an Update on Supply Shortages in the Colorado River on June 15, 2022.
- The Transportation, Infrastructure and Planning Subcommittee received an Update on Proposed Water Conservation Measures for New Development on Nov. 16, 2022.
- The Transportation, Infrastructure and Planning Subcommittee received an Update on Proposed Water Conservation Measures for New Development on Jan. 18, 2023.

Responsible Department

This item is submitted by Deputy City Managers Alan Stephenson and Ginger Spencer along with the Planning and Development and Water Services departments.

ATTACHMENT A

DRAFT

THIS IS A DRAFT COPY ONLY AND IS NOT AN OFFICIAL COPY OF THE FINAL, ADOPTED RESOLUTION

RESOLUTION #

A RESOLUTION ADDRESSING THE FUTURE WATER CONSUMPTION OF NEW DEVELOPMENT

WHEREAS, The Council of the City of Phoenix seeks to maintain the City's position as the most sustainable desert city in the world.

WHEREAS, The Council of the City of Phoenix recognizes that water security is the cornerstone of sustainability in desert cities.

WHEREAS, The City identifies that water serves many purposes in a desert city, providing environmental services such as shade and heat mitigation in addition to being a critical component in many economic processes.

WHEREAS, The Council of the City of Phoenix has taken significant action to prepare the City for drought, including supporting construction of Gatewater and New Conservation Space resources on the Salt and Verde rivers, authorizing the Colorado River Resiliency Fund, funding "system conservation" to stabilize Lake Mead, participating in the "500+ Plan," and constructing the "Drought Pipeline."

WHEREAS, The Council of the City of Phoenix recognizes that any use of the City's precious water resources should consider the economic and community benefits of that use.

WHEREAS, It is important to protect water resources serving existing customers in a time of drought.

WHEREAS, A large water user can create significant strain on water resource and infrastructure planning.

WHEREAS, The Council of the City of Phoenix understands that the City cannot thrive if it does not use its water resources efficiently.

WHEREAS, The Council of the City of Phoenix wishes to expand upon the water conservation practices identified by the Ad Hoc Water Conservation Committee.

WHEREAS, The Council of the City of Phoenix understands that the use of the latest water conservation technologies and practices is key to being the most sustainable desert city in the world.

Background:

The history of the City of Phoenix is a history of water management and conservation. From the canals of ancient Hohokam societies through the Salt River Project to the construction of the Central Arizona Project, human's ability to thrive in the desert has

always depended first and foremost on our ability to use the limited water resources available with care. For this reason, the City, and Central Arizona more broadly, have elected to develop on a backbone of renewable surface water resources rather than a finite resource of groundwater, unlike many other communities in the American West.

Because it is not sustainable to revert to groundwater supplies, the City has taken great care to protect surface water in the region. In 2014, the Council authorized the Colorado River Resiliency fund, improving local watershed resiliency and providing for underground water storage. In 2017, the City partnered with the Gila River Indian Community, State of Arizona, Bureau of Reclamation, and Walton Family Foundation to fund "system conservation," which permanently left water in Lake Mead to delay shortages. In 2022, the City chose to voluntarily forgo 30,000 acre-feet of Colorado River water use as one of the leading participants in the "500+ Plan." Perhaps most importantly, construction of the "Drought Pipeline" is nearing completion, which will allow the more efficient transport of drought supplies to areas of the City that rely upon Colorado River supplies.

Water supply is only one side of the equation. Due to the foresight of current and previous civic leaders, the City has made significant progress in demand management and conservation. In 1980, the State of Arizona passed the Groundwater Management Act, becoming the first US state to regulate groundwater and mandate water conservation measures at scale. Because of these measures and other social forces, per person water use has fallen by more than 30% over the last 30 years. Since 2000, the Water Services Department has seen demands fall by more than 19,000 acre-feet, despite the service population growing by more than 305,000 residents and a thriving economy. With more yet to accomplish, in 2019 the City adopted the recommendations of the Ad Hoc Water Conservation Committee for new and enhanced water conservation programs. These recommendations radically increased the scope and staffing of the City's water conservation work, adopting 12 new or expanded conservation programs and a new Citywide water efficiency goal of 155 gallons of water delivered per person per day by 2030. If this goal is attained per person water use in the City will have fallen by more than 35% in the last 30 years.

However, hydrologic conditions in the Colorado River, which currently comprises approximately 40% of the water delivered to residents, are currently the worst they have been in over a millennium. As of August 2022, Lakes Mead and Powell were at 26% and 27% of capacity, respectively. Over the summer of 2022, the Bureau of Reclamation, who serves as the water master on the Colorado River, stated that it would be necessary for water users in the Colorado River Basin to radically reduce water demands on the river and threatened to unilaterally institute water cuts if users cannot collaboratively agree on a framework to protect hydropower generation and water deliveries. Therefore, the City can no longer depend on receiving its full allocation from the Colorado River. For this reason, in June 2022, the Water Services Director

declared a “Stage 1 Water Alert” as part of the City’s Drought Management Plan, which means a supply insufficiency is likely in the future.

To adapt to a challenge of this magnitude, the City will have to embrace its heritage of water-problem solving. Only by adopting institutional water conservation policies will the City be able to maintain a pattern of sustainable growth and efficient water use. The policy document below describes these policies in detail.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF PHOENIX as follows:

Section 1: Conservation Measures for New Development

1. Development of a list of standards for consideration as stipulations for all rezoning cases that will address best practices related to water usage. Stipulations will be evaluated for appropriateness on a case-by-case basis and may address the following best practices:

a. Third-party water efficiency certifications such as EPA WaterSense or an equivalent.

b. Utilization of drought tolerant and / or native landscaping.

c. Restrictions on the utilization of turf.

d. Outdoor irrigation efficiency standards.

e. Green infrastructure / low-impact development provisions for surface parking areas, streets and sidewalks.

f. Participation in the City’s Efficiency Checkup program.

g. Enhanced standards for swimming pools.

h. Design standards for wet-cooling systems.

i. Preservation of natural open space.

2. Staff will propose updates to the following ordinances and processes to codify the water usage best practices that will be implemented initially via rezoning stipulations.

a. Zoning Ordinance

i. Landscaping standards

ii. Open space preservation

iii. Outdoor irrigation efficiency standards

iv. Green infrastructure / low-impact development provisions

b. Building Code

i. Water efficiency standards

ii. Participation in third-party water efficiency certification

iii. Design standards for wet-cooling systems

c. Drainage Design Manual

i. Green infrastructure / low-impact development provisions

3. Staff will also explore the following:

a. Requirements for separate water meters for indoor and outdoor areas.

b. Framework for the issuance of swimming pool permits that could address the size and location of pools.

Section 2: Restrictions on New Large Water Users

1. A large water user is defined as a user that is projected to use an average of 250,000 gallons or more of water per day.

2. Proposed large water users would be required to submit a Water Conservation Plan. The plan shall:

a. Describe the measures the user will take to create water efficiencies specific to its use, including technologies or best practices that will be implemented to conserve water, and an estimate of water savings attributable to the technologies or best practices.

b. For a large water user proposing to use >500,000 gallons per day, the Water Conservation Plan must include a specific plan that demonstrates that at least 30% of the large water user's consumptive use is from a recycled or conserved water source.

3. Staff will evaluate and approve of the plan of the Water Conservation Plan. This evaluation will include an assessment of following plan aspects:

a. Adequacy

b. Innovation

c. Feasibility

4. The City will evaluate the proposed large water use based on multiple factors, including water resource availability in the proposed location; consistency with the City's planning documents (including General Plan, Water Services' master plan, infrastructure plans and Water Resource Plan); the economic value of the proposed water use to the City and economic impact to the City; consistency with the City's

Designation of Assured Water Supply; impact to City water rates based on infrastructure and resource needs of the project; and whether the project is a key industry identified by the City as significantly beneficial to the City's economy.

5. Based on these evaluations, the City may determine the project is incompatible with available water resources, consistency with planning documents or an insufficient economic benefit to warrant the large water use.

Section 3: Annexations

1. When the City of Phoenix Drought Management Plan is active, the City of Phoenix should employ increased level of scrutiny regarding request for annexations.

2. Request for annexation from properties outside of the current Water Services Department service area should be discouraged to ensure that water resources are focused on areas within the current service area. County islands located within the Water Services Department service area will not be affected by this policy.

Section 4: Applicability and Implementation

The policies will be implemented after City Council adoption. Any updates to codes or ordinances will include specific standards and will be vetted through the public hearing process and brought forward for City Council consideration and approval.

City of Phoenix

Report

Agenda Date: 6/13/2023, **Item No.** 3

Results on Yellow Light Timing Field Study

This report provides the field study results on the Street Transportation Department's efforts to investigate and evaluate the "before" and "after" impacts of a focused implementation of the new Institute of Transportation Engineers' guidelines on yellow change intervals at signalized intersections in comparison with Phoenix's current practices. The report further requests Council approval of staff's recommendation on the implementation of new yellow change interval timing based on the results of the field study.

THIS ITEM IS FOR DISCUSSION AND POSSIBLE ACTION.

Summary

The Street Transportation Department (Streets) conducted a field study in partnership with the University of Arizona to examine whether implementing Institute of Transportation Engineers' (ITE) 2020 guidelines on yellow change intervals can enhance safety at signalized intersections. This report addresses relevant background information, how the field study was designed and implemented, the field study results and recommendations.

Background

Red-light running (RLR) is one of the riskiest behaviors at signalized intersections. According to a report published by the American Automobile Association (AAA) Foundation for Traffic Safety, more than two people were killed every day across the U.S. due to noncompliance with red signal indications (AAA Foundation for Traffic Safety, 2020). According to a report published by the Insurance Institute for Highway Safety (IIHS), RLR violations caused 928 fatalities in 2020 in the United States. In addition, an estimated 116,000 people suffered injuries in RLR collisions (IIHS, 2022). Similar to cities across the nation, RLR-related violations in the Phoenix metropolitan area have become one of the most severe causes of fatal crashes, with 144 fatalities and 10,685 injuries reported from 2014 to 2021.

The basic purpose for the yellow change interval is to inform the driver that the green phase has ended. The yellow change interval provides time for the driver to either stop before entering the intersection or to proceed and clear the intersection. The basic

purpose of the red clearance interval is to provide the driver who decides to enter the intersection during the yellow change interval adequate time to clear the intersection prior to a conflicting (or opposing) green phase beginning at the intersection. The red clearance interval is typically called the “all-red” time.

Streets' Current Signal Timing Practices

Streets has a standard operating procedure (SOP) for determining the duration of traffic signal intervals. The SOP utilizes the pre-2020 ITE kinematic equation and calculates yellow change intervals based on posted speed limits. The current City of Phoenix equations for calculating the yellow change and red clearance intervals are included in **Attachment A**.

ITE 2020 Guidelines

The updated ITE guidelines for calculating traffic signal timing were released in March 2020. Since 1965, ITE has developed a variety of methods for calculating yellow change and red clearance intervals, all of which are based on the kinematic equation method. According to ITE, the kinematic equation method is the most popular and widely accepted technique for determining yellow change intervals (Noble, 2020). In comparing the new ITE 2020 guidelines to the prior ones, there are three key modifications.

- Change in the speed at which a reasonable driver approaches an intersection. If a speed study is not completed and the 85th percentile speed is not available, the 85th percentile approach speed for through movements may be estimated and substituted by the value of Posted Speed Limit + 7 miles per hour. For the left-turn movements, the Posted Speed Limit can be used as the 85th percentile approach speed.
- Change in the method for yellow change interval calculations for left-turn movements.
- Change in maximum yellow change interval for left-turn movements. ITE advises use of 7.0 seconds as the maximum yellow change interval for left-turn movements.

The current 2020 ITE-recommended equations for calculating the yellow change and red clearance intervals are included in **Attachment A**.

Traffic signal timings have long been an area of study to determine the proper traffic signal timings to ensure intersection safety while maintaining an acceptable level of travel efficiency. However, there is still no broad consensus on the most appropriate method for calculating yellow change and red clearance intervals.

In order to effectively reduce the total number of RLR-related crashes and maintain a safe journey for all road users, it was crucial for Streets to perform a field study to explore RLR behavior at local intersections, understand the impact of different signal timing parameters (e.g., yellow change and red clearance intervals) on RLR frequency, and ultimately develop appropriate countermeasures.

Signal Timing Field Study

Objectives

Streets' purpose in performing this field study was to examine the ITE 2020 guidelines for yellow change intervals and identify the relationship between signal timing parameters and RLR violations. Initially, based on several criteria, including the frequency and severity of RLR-related crashes as well as infrastructure feasibility, 12 intersections were selected to be part of the field study. Then, at each study intersection, smart sensor equipment was installed. Finally, to determine the relationship between signal timing parameters and RLR violations, an experimental design for before-and after analysis was conducted and implemented.

Baseline Condition Data - Intersection Through Movements

At each of the 12 intersection study locations, baseline data was collected on weekdays between Sept. 1 and Nov. 21, 2022. Over this 12-week period, a total of 144,795 RLR incidents were observed. Among the study sites, two intersections experienced the most RLR incidents at more than 300 per day, eight of the intersections experienced between 200 and 300 RLR incidents per day, and the remaining two intersections had less than 200 RLR incidents per day.

It was found that the majority of RLR violations (88.5 percent or 128,164 events) occurred during the red clearance interval, while the remaining (11.5 percent or 16,631 events) RLR violations occurred after the red clearance time elapsed when opposing green phase movement began. The figure in **Attachment B** shows the percentage of RLR incidents that passed through the intersection on a red light both during and after the red clearance time.

Study Design to Implement and Analyze ITE 2020 Guidelines

The "before-and-after" aspects of this study were intended to statistically determine whether the ITE 2020 guidelines for yellow change and red clearance intervals can improve intersection safety by reducing the number of RLR violations. Moreover, the potential relationship between different signal timing parameters and the potential impact of signal timing parameters on RLR frequency will be identified. Finally, a statistical method was developed to identify the appropriate amount of yellow change and red clearance intervals that will result in reduction in RLR frequency.

With respect to the 12 study intersections, for the through and left-turn movements, some intersections were used as the control sites, and the yellow change and red clearance intervals for these control intersections was not changed from their current timing. The control sites were used to eliminate the effects of traffic volume and pattern variation during the holiday seasons in our statistical analysis.

The remaining intersections were then considered as treatment sites, and the yellow change intervals were changed for all the treatment sites. The new ITE 2020 guidelines were used to calculate the yellow change intervals for through and left-turn movements for the experimental design at the treatment sites. To make the study conclusions statistically sound, the study timeline included twelve weeks to collect sufficient data, which occurred over six, two-week time periods as outlined below.

- Period 1: Nov. 21, 2022 - Dec. 5, 2022;
- Period 2: Dec. 5, 2022 - Dec. 19, 2022;
- Period 3: Dec. 19, 2022 - Jan. 2, 2023;
- Period 4: Jan. 2, 2023 - Jan. 16, 2023;
- Period 5: Jan. 16, 2023 - Jan. 30, 2023; and
- Period 6: Jan. 20, 2023 - Feb. 13, 2023.

Through Movements - Treatment Site Changes
In accordance with the ITE 2020 guidelines, due to the absence of approach speed at the intersections, for this study, the Posted Speed Limit + 7 miles per hour guidance was used in lieu of the through movement's 85th percentile of approach speed. Using the Posted Speed Limit + 7 miles per hour guidance resulted in an increase between 0.4 seconds and 0.6 seconds for the yellow change interval in comparison to the current yellow change interval for through movements.

For evaluation of through movements at the twelve study intersections, three of the intersections were used as the control sites, and the yellow change and red clearance intervals for these three control intersections were not be changed from their current timing. The remaining nine intersections were considered treatment sites. The yellow change intervals for the through movements were changed for all the treatment sites. To better understand driver behaviors and the influence of the yellow change interval over the short-term and long-term, the nine treatment intersections were divided into three equal groups for implementation using the methodology outlined below.

- Incremental Intersections Group: For this group of three intersections, the increase in the yellow change interval was implemented at the selected treatment sites over five two-week periods. Therefore, at each of the three incremental sites, the yellow change interval was increased by 0.1 to 0.2 seconds at the start of each two-week

period, depending on how much the total calculated yellow change interval increased.

- Periodically Intersections Group: For this group of three intersections, the yellow change interval was adjusted at the beginning of each two-week period. That is, the yellow change interval alternated between the new calculated yellow change interval and the baseline (current) yellow change interval every two weeks to study the drivers' compliance behavior over a short period. During the first, third, and fifth two-week periods, the new yellow change intervals were implemented at sites for the entire two-week period. During the second, fourth, and sixth two-week periods, the yellow change interval was returned to the baseline (current) yellow change interval.
- Long-Term Intersections Group: For this group of three intersections, the focus was on studying the impact of increasing the yellow change interval on drivers' compliance behavior in the long term. The new yellow change intervals were implemented at the beginning of the first two-week period and were not modified for the duration of the data collection time frame. These sites were selected to study the long-term impact of ITE 2020 guidelines on driver behavior.

Left-Turn Movements - Treatment Site Changes

In accordance with the ITE 2020 guidelines, due to the absence of approach speed for left turns at the study intersection, the Posted Speed Limit + 7 miles per hour guidance was used in lieu of the left-turn movement's 85th percentile of approach speed. The estimated intersection entry speed for left-turn movements was 20 miles per hour, following the ITE 2020 guidelines, which resulted in an increase between 0.3 seconds and 3.2 seconds for the yellow change interval in comparison to the current yellow change interval for left-turn movements. Since two of the selected intersections for the study did not have protected left -turn phase movements, only ten intersections were used for studying left-turn movements.

Of the ten study intersections for left-turn movements, two of the intersections were used as the control sites, and the remaining eight intersections were used as treatment sites. The significant increases in left-turn yellow change intervals calculated under ITE 2020 guidelines for some intersections represented a change in left-turn yellow change intervals that raised safety concerns. Therefore, four of the eight treatment intersections were implemented as Incremental Intersections Group and four as Long-Term Intersections Group as previously outlined; there were no intersections designated for a Periodically Intersections Group. For the incremental Intersections Group, the yellow change interval was increased by 0.3 to 0.7 seconds at the start of each two-week period, depending on how much the total calculated yellow change interval was increased.

Field Study Results

In order to evaluate the comparative differences between the before and after study groups, a statistical T-test was employed. The T-test is a common method used to assess the significance of differences observed between two sets of data. The statistical T-test has been widely used in previous before-and-after studies. In this study, a 95 percent confidence level is employed to conclude the statistical significance of the difference in RLR rates between the before and after groups. To avoid bias in the analysis and ensure a fair comparison regardless of traffic volumes, the RLR frequency was normalized by dividing the number of RLR violations by the number of vehicles. This calculated the RLR rate, which was measured as the number of RLR violations per 1,000 vehicles per day.

Through Movements - Treatment Site Changes

- Incremental Intersections Group: Table 1 in **Attachment C** shows the statistical T-test results for the RLR rate at the Incremental Intersections Group sites. When comparing Periods 3, 4, 5, and 6 with the Baseline Condition Data, it is evident that the average RLR rate decreased significantly at all treatment sites. However, the results during the initial implementation (Periods 1 and 2) were inconclusive.
- Periodically Intersections Group: Table 2 in **Attachment C** shows the statistical T-test results for the RLR rate at the Periodically Intersections Group sites. These results indicate a significant decrease in the average RLR rate during periods where the new yellow change intervals were implemented (Periods 1, 3, and 5), compared to the periods with the current yellow change intervals (Periods 2, 4, and 6).
- Long-Term Intersections Group: Table 3 in **Attachment C** shows the statistical T-test results for the RLR rate at the Long-Term Intersections Group sites. The results indicate a significant decrease in the average RLR rate during all six periods, particularly in Period 1 when the new yellow change interval was first implemented.

Left-Turn Movements - Treatment Site Changes

- Incremental Intersections Group: Table 4 in **Attachment C** shows the statistical T-test results for the RLR rate at the Incremental Intersections Group sites. It is evident from the comparison of Periods 3, 4, 5, and 6 with the Baseline Condition Data that the average RLR rate decreased at all treatment sites. However, the reduction was not statistically significant for some periods and study sites.
- Long-Term Intersections Group: Table 5 in **Attachment C** shows the statistical T-test results for the RLR rate at the Long-Term Intersections Group sites. The results indicate a significant decrease in the average RLR rate during all six periods, particularly in Period 1 when the new yellow change interval was first implemented.

It should be noted that due to a malfunction of the smart sensors at some of the treatment intersection sites during several of the field study periods, data was not captured for those field study locations or periods.

According to the statistical analysis of the data, the results for both through and left-turn movements are summarized below.

- For the control sites, which were kept at the current yellow change intervals, there was no significant reduction in the average rate of RLR for the through movements and left-turn movements when comparing with the Baseline Condition Data.
- For all the treatment sites for the through and left-turn movements, the average rate of RLR significantly decreased during the periods that used the ITE 2020 yellow change intervals compared to periods with the current yellow change intervals.
- The yellow change intervals for the left-turn movements implemented at the incremental sites did not show a significantly increased benefit beyond Period 3 when additional yellow time was added. Period 3 closely matched the recommended intervals from the National Cooperative Highway Research Program (NCHRP) Report 731 Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections. The NCHRP Report 731 recommends using the Posted Speed Limit - 5 miles per hour as the 85th percentile approach speed for left-turn movements. This results in a shorter yellow change interval for the left-turn movement as compared to the ITE 2020 guidelines. However, the NCHRP yellow change interval is longer than the City's current yellow change intervals for the left-turn movement. The comparison of all three methods is shown in **Attachment D**. The results suggest that using the NCHRP yellow change intervals can be effective, without the need to implement the ITE 2020 guidelines for calculating yellow change intervals for the left-turn movements.

Based on the results of the field study, several recommendations were proposed to improve safety at signalized intersections by better understanding road users' compliance behavior with the yellow change interval. These recommendations include:

- Implementation of the ITE 2020 Guidelines for the yellow change interval for the through movements. For calculating through movement yellow change intervals, the Posted Speed Limit + 7 miles per hour as the 85th percentile approach speed is recommended when field-measured speed data is unavailable.
- Implementation of the NCHRP Report 731 Guidelines for the yellow change interval for the left-turn movements. For left-turn movements, it is recommended to use Posted Speed Limit - 5 miles per hour as an estimation for the 85th percentile left-turn approach speed.
- As the field study recommendations were based on only 12 weeks of data, further

research is necessary to understand the long-term effects of yellow change intervals on driver behavior. Further research is currently being conducted to investigate the impact of red clearance intervals, both individually and in conjunction with yellow change intervals, to gain a more comprehensive understanding of their combined effects on intersection safety.

Attachment E provides a list of references for this report.

Implementation Timeline

In order to implement the field study recommendations with current staff resources in the Traffic Management Center (TMC), it is estimated that it will take approximately six years to implement the new yellow change intervals for the 1,200 traffic signals in Phoenix. Based on the results of this study and the improved safety benefits related to RLR, Streets proposes implementing the field study recommendations on an expedited timeline with a goal to complete the retiming all 1,200 traffic signals within three years.

However, additional staff resources will be needed. Streets is recommending adding five positions to the TMC, which would include one Traffic Engineer I, one Traffic Engineer II, two Signal Systems Specialist I's, and one Signal Systems Specialist II. The new positions would be funded by existing Streets' revenue from the Arizona Highway User Revenue Fund (HURF), at an estimated cost of $445,502 per year.

Update on the MAG Top 100 Locations

At the Jan. 24, 2023, Policy meeting, Council directed staff to install smart sensor equipment at the most dangerous intersections in Phoenix taken from the Maricopa Association of Governments (MAG) Top 100 Intersections by Crash Risk. Staff has evaluated the list and identified 64 Phoenix intersections from that list. Streets is currently working on a procurement to enable the purchase of the necessary smart sensor equipment and anticipates having a contract in place by Fall 2023. Concurrently, staff is evaluating the infrastructure feasibility of all 64 locations in order to develop a prioritized list for implementation.

Recommendation

The Street Transportation Department requests City Council approval of the following actions based on the results of the Yellow Light Timing Field Study:

1. Adoption and implementation of the ITE 2020 Guidelines for calculating the yellow change interval for the through movements for traffic signal timing;
2. Adoption and implementation of the NCHRP Report 731 Guidelines for calculating the yellow change interval for the left-turn movements for traffic signal timing; and
3. Approval of five full-time City staff positions to expedite implementation using existing Department HURF revenues.

Concurrence/Previous Council Action

- An update on the Yellow Light Timing Study was provided to the Transportation, Infrastructure and Planning Subcommittee on Jan. 18, 2023.
- An update on the Yellow Light Timing Study was provided at the Policy meeting on Jan. 24, 2023.

Responsible Department

This item is submitted by Deputy City Manager Alan Stephenson and the Street Transportation Department.

ATTACHMENT A

Current City of Phoenix equations for calculating the yellow change and red clearance intervals:

Yellow Change Calculation

$$Y \geq t + \frac{1.47V}{2a + 64.4g}$$

Where:
Y = minimum yellow change interval (in seconds) with a maximum of 5 seconds (if the calculation exceeds 5 seconds, any excess time from the calculation is added to the red clearance interval);
t = perception-reaction time (in seconds); the time needed for an approaching driver to "perceive" the yellow indication and to "react" by braking to a stop or deciding to pass through the intersection. Default value of 1.0 second.
V = intersection entry speed (mph); the approach speed limit is assumed.
a = deceleration (ft/second^2); the rate at which it is assumed a driver will slow down upon seeing the yellow signal. Default value of 10 ft/second^2.
g = grade of approach (downhill is negative grade)

Red Clearance Calculation

$$R = \left[\frac{W}{1.47V}\right]$$

Where:
R = red clearance interval (seconds);
V= intersection entry speed (mph); the approach speed limit is assumed.
W = distance to traverse the intersection (width), stop line to far side no-conflict point along the vehicle path (ft.);

Current 2020 ITE-recommended equations for calculating the yellow change and red clearance intervals:

Yellow Change Calculation

$$Y \geq t + \frac{1.47(V_{85} - V_E)}{a + 32.2g} + \frac{1.47V_E}{2a + 64.4g}$$

Where:
Y = minimum yellow change interval (in seconds);
t = perception-reaction time (in seconds); the time needed for an approaching driver to "perceive" the yellow indication and to "react" by braking to a stop or deciding to pass through the intersection. Default value of 1.0 second.
V_{85} = 85th percentile approach speed (mph); the speed at which a "reasonable" driver is assumed to approach the intersection.
V_E = intersection entry speed (mph); the speed at which a "reasonable" driver is assumed to cross the stop line of the intersection when they have been slowing down in preparation for making a left turn.
a = deceleration (ft/second^2); the rate at which it is assumed a driver will slow down upon seeing the yellow signal. Default value of 10 ft/second^2.
g = grade of approach (downhill is negative grade)

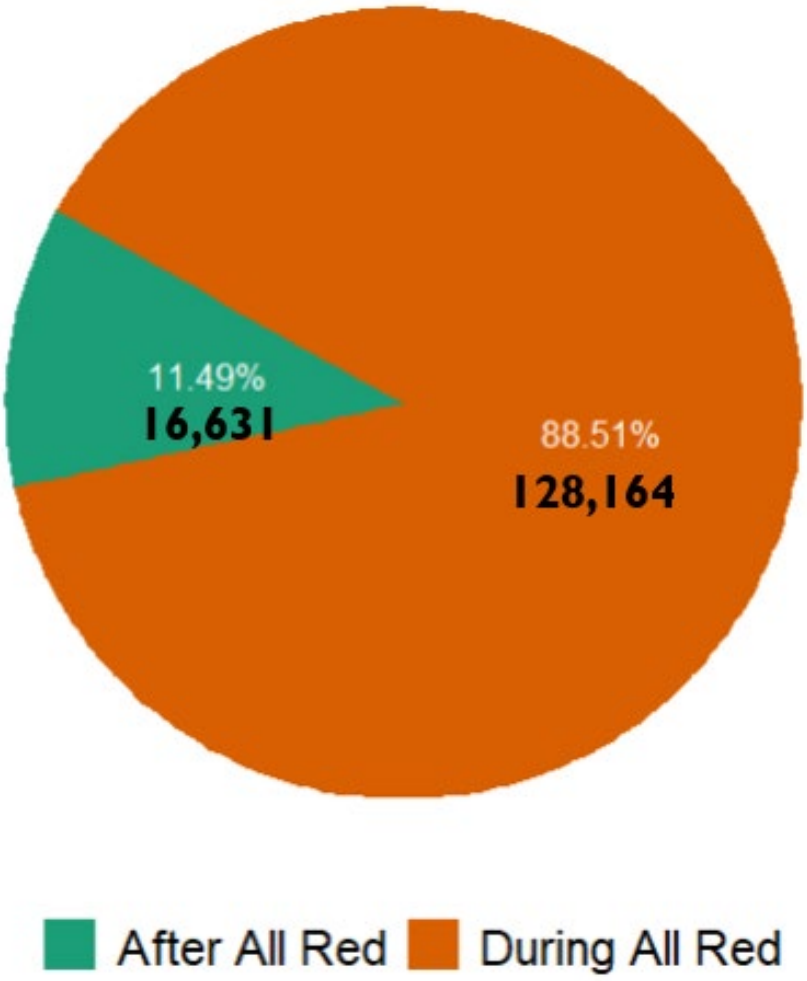
Red Clearance Calculation

$$R = \left[\frac{W + L}{1.47V_E}\right] - t_s$$

Where:
R = red clearance interval (seconds);
W = distance to traverse the intersection (width), stop line to far side no-conflict point along the vehicle path (ft.);
L = length of vehicle (ft.); 20 ft is often used as the representative length for vehicles entering the intersection.
t_s = conflicting vehicular movement start up delay (seconds); an optional parameter with an initial value set at 0.0 seconds, values may be used based on engineering judgment or as supported by an engineering study.

ATTACHMENT B

Percentage of red-light running incidents that passed through the intersection on a red light both during and after the red clearance time



ATTACHMENT C
Results

Through Movements

Table 1: Statistical T-Test Results for RLR Rate (RLR per 1,000 Vehicles) for Through Movements at Incremental Sites

Intersections	Baseline	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Intersection #2	5.49	5.88	6.67	3.64	4.05	3.66	3.99
Intersection #4	9.09	8.49	8.19	7.78	5.67	5.95	5.66
Intersection #9	4.99	3.43	3.47	2.84	1.83	2.45	-

Green-highlighted cells show a statistically significant decrease in the RLR rate compared to baseline at a 95% confidence level.

Table 2: Statistical T-Test Results for RLR Rate (RLR per 1,000 Vehicles) for Through Movements at Periodical Sites

Intersections	Baseline	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Intersection #1	-	-	-	-	-	-	-
Intersection #5	9.94	5.97	11.09	6.10	10.1	6.07	9.25
Intersection #6	8.89	3.95	9.37	3.57	5.67	-	-

Green-highlighted cells show a statistically significant decrease in the RLR rate compared to baseline at a 95% confidence level.

Table 3: Statistical T-Test Results for RLR Rate (RLR per 1,000 Vehicles) for Through Movements at Long-term Sites

Intersections	Baseline	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Intersection #7	5.42	2.64	2.91	2.60	2.51	2.84	2.92
Intersection #10	5.17	2.27	3.27	2.11	2.75	2.3	-
Intersection #11	6.80	3.55	5.13	3.60	4.08	3.33	-

Green-highlighted cells show a statistically significant decrease in the RLR rate compared to baseline at a 95% confidence level.

Left-Turn Movements

Table 4: Statistical T-Test Results for RLR Rate (RLR per 1,000 Vehicles) for Left-Turn Movements at Incremental Sites

Intersections	Baseline	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Intersection #1	-	-	-	-	-	-	-
Intersection #2	5.13	2.36	3.10	2.26	2.15	1.58	2.39
Intersection #4	4.93	3.71	4.17	1.92	3.33	2.65	4.41
Intersection #9	16.13	14.92	17.16	6.97	12.75	5.07	-

Green-highlighted cells show a statistically significant decrease in the RLR rate compared to baseline at a 95% confidence level.

Table 5: Statistical T-Test Results for RLR Rate (RLR per 1,000 Vehicles) for Left-Turn Movements at Long-term Sites

Intersections	Baseline	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Intersection #6	4.00	0.84	2.10	0.97	0.87	-	1.41
Intersection #7	3.87	2.73	3.47	2.30	2.15	2.48	2.21
Intersection #10	4.10	0.76	1.09	0.72	1.18	1.23	-
Intersection #11	17.59	9.14	12.10	9.06	10.69	8.27	-

Green-highlighted cells show a statistically significant decrease in the RLR rate compared to baseline at a 95% confidence level.

ATTACHMENT D

Streets PHX STREET TRANSPORTATION DEPARTMENT	Kinematic Equation (25 MPH)	Kinematic Equation (Speed Limit - 5 MPH)	Extended Kinematic Equation	NCHRP - City of Phoenix	ITE 2020 - City of Phoenix
Posted Speed Limit (MPH)	PHOENIX Left-Turn Yellow Change Interval (sec)	NCHRP Left-Turn Yellow Change Interval (sec)	ITE 2020 Left-Turn Yellow Change Interval (sec)	Yellow Change Interval Difference (sec)	Yellow Change Interval Difference (sec)
25	3.0	3.0	3.3	0.0	+0.3
30	3.0	3.0	4.0	0.0	+1.0
35	3.0	3.3	4.7	+0.3	+1.7
40	3.0	3.6	5.5	+0.6	+2.5
45	3.0	4.0	6.2	+1.0	+3.2
50	3.0	4.4	6.9	+1.4	+3.9
55	3.0	4.7	7.0	+1.7	+4.0

ATTACHMENT E

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