Pima Association of Governments

Request for Proposal (RFP)

Land-use Model Development and Enhancement

Pima Association of Governments, hereinafter referred to as PAG, is soliciting proposals from qualified firms to provide land use model development and enhancement services as outlined in Appendix A, Scope of Work.

This Request for Proposal (RFP) follows previous consulting work completed for PAG that evaluated the current AZ-SMART UrbanSim land use model and provided recommendations for enhancement. The selected consultant will build upon these recommendations to develop and enhance PAG's land use modeling capabilities to better support long-range transportation and land use planning efforts.

PAG invites interested firms to submit written technical proposals relating to this project. A selection committee will evaluate the proposals based on qualifications, technical approach, and price. Scope of Work and additional information, including the Mandatory Terms & Conditions and/or answers to questions may be found at https://pagregion.com/info-center/rfp-rfqs/

Questions shall be addressed as identified under Item 3 of "Instructions to Proposers." Questions may be submitted to Roy Cuaron, Procurement Officer, at info@PAGregion.com.

SUBMITTAL PROCESS

Sealed proposals shall be received by PAG's Procurement Officer, by 10:00 a.m., Mountain Standard Time (MST) on February 27, 2026.

Proposals shall be submitted to:

Pima Association of Governments
Attention: Procurement Officer
1 E. Broadway, Suite 401
Tucson, AZ 85701

Proposals must be delivered to PAG's office by U.S. Postal Service mail, private, paid messenger service (such as FedEx, DHL, UPS, etc.), or by hand-carried delivery.

Proposals delivered by facsimile or electronic mail or in any format other than paper copies will not be considered.

Submittals must be in the actual possession of PAG's Procurement Officer at the location indicated, on or prior to the exact time and date indicated above. Late submittals shall not be considered. The prevailing clock shall be PAG's clock.

Submittals must be submitted in a sealed envelope with the Request for Proposal Title and the firm's name and address clearly indicated on the envelope. All submittals must be completed in ink or typewritten.

One original shall be bound and single-sided and formatted as described in Appendix A. The original must be bound in a single volume and constitute the proposal in its entirety and clearly marked "ORIGINAL". A digital copy, saved on a secure (virus-free), read-only USB portable drive (e.g., flash drive, etc.) of the proposal must be included in the sealed envelope or box. Additional requirements are described herein under INSTRUCTIONS TO PROPOSERS.

All sealed proposals received by the deadline will be opened at the PAG offices by the Procurement Officer. Only the names of the Proposers will be read aloud when the proposals are opened. Proposers are welcome to attend the bid opening.

Publish date: February 6, 2026
Daily Territorial

SCOPE OF WORK

All work performed on this project must comply with federal requirements associated with the fund source(s) being used for this project. PAG will serve to coordinate this with the selected consultant. The Scope of Work is listed in Appendix A.

INSTRUCTIONS TO PROPOSERS

1. **DEFINITION OF KEY WORDS USED IN THE SOLICITATION:**

   For purposes of this solicitation and subsequent contract, the following definitions shall apply:

   Contract: The legal agreement executed between PAG and the Consultant. The Contract shall include this RFQ document incorporated herein by reference, all terms, conditions, specifications, scope of work, amendments, the Consultant's offer and negotiated items as accepted by PAG.

   Consultant: The individual, partnership, or other entity who, as a result of the RFP process, is awarded a contract by PAG.

   PAG Representative(s): PAG employee or employees who have specifically been designated to act as a contact person or persons to the Consultant and is responsible for monitoring and overseeing the Consultant's performance under this Contract.

   Executive Director: The contracting authority for PAG, authorized to sign contracts and amendments thereto on behalf of PAG.

   May: Indicates something that is not mandatory but permissible.

   Proposer: The individual, partnership, or corporation who submits a proposal in response to a solicitation.

   Shall, Will, Must: Indicates a mandatory requirement. Failure to meet these mandatory requirements, if they constitute a substantive requirement, may, at PAG's sole discretion, result in the rejection of a submittal as non-responsive.

   Should: Indicates something that is recommended but not mandatory. If the Proposer fails to provide recommended information, PAG may, at its sole option, ask the Proposer to provide the information or evaluate the submittal without the information.

   Solicitation: Indicates this Request for Proposal.

2. **PRE-SUBMITTAL CONFERENCE (If Applicable):** If scheduled, the date and time of a Pre-Submittal conference is indicated on the cover page of this document. Attendance at this conference is not mandatory. Written minutes and/or notes will not be available, therefore attendance is encouraged.

3. **INQUIRIES:** Proposers shall not contact or ask questions of any PAG employee regarding this Solicitation. Proposers are required to submit all questions related to this Solicitation via email to the PAG Project Manager, Eric Kramer at EKramer@pagregion.com no less than

three (3) business days prior to the submittal due date. Questions received after this date will not be answered. Questions related to this Solicitation should refer to the appropriate service, page and paragraph number. Only questions answered by this process will be binding. Failure to follow these instructions may result in Proposer's disqualification from further consideration under this Solicitation.

PAG staff will endeavor to answer all questions within two (2) business days following receipt of each question.

4. **AMENDMENTS TO SOLICITATION:** The Proposer shall acknowledge any and all amendments to this Solicitation by signing and returning Appendix B bound into their Proposal.

5. **FAMILIARIZATION OF SCOPE OF WORK:** Before submitting their Proposal, each Proposer shall familiarize itself with the Scope of Work (Appendix A), laws, regulations and other factors affecting contract performance. The Proposer shall be responsible for fully understanding the requirements of the subsequent Contract (refer to Contract boilerplate in Appendix E) and otherwise satisfy itself as to the expense and difficulties accompanying the fulfillment of contract requirements. The submission of a proposal will constitute a representation of compliance by the Proposer. There will be no subsequent financial adjustment, other than that provided by the subsequent Contract, for lack of such familiarization.

6. **TAXES:** PAG is exempt from federal excise tax, including the federal transportation tax.

7. **SUBMITTAL/SUBMITTAL FORMAT:** Proposals are to be submitted as described above along with the forms in Appendices B, C and D and in the format specified in this Solicitation. The material must be in sequence and related to this Solicitation. The sections of the submittal should be tabbed, clearly identifiable and should include a minimum of the following sections: sections described in Appendix A, the completed forms, acknowledgment of all amendments, and a copy of this Solicitation document. Failure to include the requested information may result in disqualification.

8. **PUBLIC RECORD:** All submittals submitted in response to this Request for Submittal shall become the property of PAG and shall become a matter of public record available for review subsequent to the award notification, notwithstanding Item 9 below.

9. **CONFIDENTIAL INFORMATION:** PAG is obligated to abide by all public information laws. If a Proposer believes that any portion of an offer contains information that should be withheld, a written statement advising the Procurement Officer of this fact should accompany the submission and the information shall be so identified wherever it appears. PAG shall review all requests for confidentiality and may provide a written determination to designate specified documents confidential, or the request may be denied. Proposed budget is not confidential and will not be withheld. If the confidential request is denied, such information shall be disclosed as public information, unless the Proposers submits a formal written objection. If the Proposer objects to this process they shall submit a written letter on company letterhead requesting, they be withdrawn from further consideration of the Solicitation.

10. **CERTIFICATION:** By signature on the Offer page, solicitation Amendment(s), or cover letter accompanying the submittal documents, Proposer certifies:
    A. The submission of the offer did not involve collusion or other anti-competitive practices.
    B. The Proposer shall not discriminate against any employee or applicant for employment in violation of Federal Executive Order 11246, or A.R.S. 41-1461 et seq.
    C. The Proposer has not given, offered to give, nor intends to give at any time hereafter, any economic opportunity, future employment, gift, loan, gratuity, special discount, trip, favor, meal or service to a public servant in connection with the submitted offer.
    D. The Proposer hereby certifies that the individual signing the submittal is an authorized agent for the Proposer and has the authority to bind the Proposer to the Contract.

11. **LATE SUBMITTALS:** Late submittals will be rejected.

12. **OFFER PERIOD:** In order to allow for an adequate evaluation, PAG requires a proposal in response to this solicitation to be valid and irrevocable for ninety (90) days after the submittal due date and time.

12. **WITHDRAWAL OF SUBMITTAL:** At any time prior to the specified solicitation due date and time, a Proposer may formally withdraw the submittal by a written letter, facsimile or electronic mail from the Proposer's designated Representative(s). Telephonic or oral withdrawals shall not be considered.

13. **DISCUSSIONS:** PAG reserves the right to conduct discussions with Proposer for the purpose of eliminating minor irregularities, informalities, or apparent clerical mistakes in the submittal in order to clarify a Proposal and assure full understanding of, and responsiveness to, solicitation requirements. However, it is PAG's prerogative to disqualify incomplete Proposals.

14. **UPON NOTICE OF INTENT TO AWARD:** The apparent successful Proposer shall sign and file with PAG, within ten (10) business days after Notice of Intent to Award, all documents necessary to the successful execution of the Contract.

    AWARD OF CONTRACT: Notwithstanding any other provision of the Solicitation, PAG reserves the right to:

    (1) waive any immaterial defect or informality; or

    (2) reject any or all proposals, or portions thereof; or

    (3) reissue the Request for Proposals.

15. **SUBMITTAL RESULTS:** The name of the successful Proposer will be available for review following contract award in PAG's office upon issuance of a Notice of Intent to Award or upon final contract execution.

16. **KEY PERSONNEL:** It is essential that the Consultant provide adequate experienced personnel and equipment, capable of and devoted to the successful accomplishment of work to be performed under this contract. PAG encourages the Consultant to hire or subcontract, if necessary, in order to provide the best personnel and equipment, providing that the Consultant performs a minimum of 51-percent of the contracted work. The Consultant must agree to assign specific individuals to the key positions as designated in their Proposal.

    The Consultant agrees that, once assigned to work under this contract, key personnel shall not be removed or replaced without written notice to PAG and PAG's written acceptance of said replacement(s).

    If key personnel are not available for work under this contract as expected, or to devote substantially less effort to the work than initially anticipated, the Consultant shall immediately notify PAG, and shall, subject to the concurrence of PAG, replace such personnel with personnel of substantially equal or greater ability and qualifications. If PAG does not accept said replacements and/or substitutions, PAG may unilaterally begin termination under the Contract provisions.

17. **CONTRACT INFORMATION:** The initial terms of this contract shall be three (3) years, with an option to extend the contract for an additional two (2) years at PAG's sole discretion.

18. **MANDATORY TERMS AND CONDITIONS FOR SUBRECIPIENT PROCUREMENT**: The attached document entitled Mandatory Terms and Conditions for Subrecipient Procurement is hereby incorporated into the Requests for Proposals. Proposers acknowledge they will abide by all applicable terms and conditions noted in the document.

19. **DISADVANTAGED BUSINESS ENTERPRISE (DBE):** There is no DBE goal for this project.

ATTACHMENTS

APPENDIX A – SCOPE OF WORK AND SUBMITTAL REQUIREMENTS

APPENDIX B – ADDENDA ACKNOWLEDGEMENT

APPENDIX C – PROPOSERS INFORMATION SHEET

APPENDIX D – PROPOSED BUDGET ESTIMATION

APPENDIX E – PAG LAND USE MODEL EVALUATION AND RECOMMENDATION

APPENDIX A

SCOPE OF WORK AND SUBMITTAL REQUIREMENTS

1. Statement of Need

PAG maintains a land use model as part of its integrated transportation and land use planning framework. The current model, AZ-SMART UrbanSim, provides parcel-level socioeconomic forecasts that serve as inputs to PAG's activity-based travel demand model. PAG recently completed a comprehensive evaluation of the UrbanSim / AZ-SMART land use model (see Appendix E), which included:

- Assessment of the model's data architecture and analytical components
- Evaluation of data compatibility with PAG's travel demand model
- Interviews with peer MPOs regarding their land use modeling practices
- Recommendations for model enhancement and development

Building upon the evaluation findings and recommendations, PAG seeks to enhance and further develop its land use modeling capabilities. The enhanced model, based on the UrbanSim modeling platform will need to:

- Support PAG's long-range transportation planning and scenario analysis needs
- Maintain compatibility with PAG's activity-based travel demand model
- Incorporate current and projected demographic and employment trends
- Provide parcel-level or block-level resolution for land use forecasting
- Support analysis of land use policies and development scenarios
- Be maintainable by PAG staff with appropriate training and documentation

2. Objectives

The primary objectives of this project are to:

1) Develop and implement enhancements to PAG's land use model based on previous evaluation recommendations in Appendix E
2) Improve model calibration and validation to better reflect regional development patterns.
3) Enhance data integration and model workflows to support efficient scenario analysis
4) Update model inputs with current baseline data.
5) Develop comprehensive documentation and provide training to PAG staff
6) Ensure compatibility with PAG's travel demand modeling framework

3. Minimum Qualifications and Requirements

Proposals will be evaluated based on the following criteria and weights:

3.1. Consultant Team Qualifications and Experience – ***maximum score: 20 points***

3.1.1. The key team must have one senior level member with more than five (5) years of experience (senior) and one mid-level member with greater than three (3) years of experience.

3.1.2. Background of key team members must demonstrate the firm's capacity to meet the objectives of this project.

3.1.3. The firm must identify three (3) relevant projects completed within the last ten (10) years, including references for at least two (2) of these projects.

3.1.4. The firm must indicate a project-relevant support team to demonstrate management and organizational capacity.

3.2. Project Understanding and Technical Approach ***- maximum score: 30 points***

3.2.1. Proposal must demonstrate understanding of project objectives and provide a suggested / recommended approach to meet PAG's requirements for the development and implementation of the land use model (LUM). These include:

- Synthetic population development including demographic sub-models and control totals
- Updated spatial and socio-economic data development and review
- AZ-SMART/UrbanSim model specification and calibration/validation
- Integration of PAG's activity-based travel demand model with the AZ-SMART/UrbanSim land use model
- Enhancements to the LUM such as a redevelopment and infill model
- Other QA/QC procedures

3.3. Project Schedule and Management - ***maximum score: 20 points***

3.3.1. Provide project milestones for timely completion of tasks, by month

3.3.2. Provide work schedule by personnel, task, and project timeline

3.3.3. Provide mechanisms to ensure timely responses to PAG requests

3.4. Project Budget Estimation – ***maximum score: 30 points***

3.4.1. Provide the best budget (Appendix D) to fulfill the objectives and the criteria addressed above.

MAXIMUM POSSIBLE SCORE FOR COMBINED ELEMENTS IN SECTION 3: 100 POINTS

APPENDIX B

ADDENDA ACKNOWLEDGMENT FORM

ALL OTHER PROVISIONS OF THE INVITATION FOR PROPOSAL SHALL REMAIN IN THEIR ENTIRETY.

TO PAG:

The Undersigned hereby acknowledge receipt of the following list of Addendums:

Addendum No.	Date of Issuance	Date Received

_____ Phone: _____

Company Name

_____ Fax: _____

Signature of Person Authorized to Sign

_____

Title

APPENDIX C

PROPOSERS INFORMATION SHEET

Please complete this form and return it with your response.

If you have any questions about this form, please contact:

Roy Cuaron, Director of Finance, (520) 495-1470.

All firms proposing as prime consultants or subconsultants on Pima Association of Governments' (PAG) projects are required to submit this form.

1. GENERAL INFORMATION

Name of Firm: _____

Street Address:

City, State, ZIP Code

_____

Mailing Address:

City, State, ZIP Code

_____

Telephone Number: _____

Fax Number: _____

Email address: _____

Web Address: _____

Year Firm was established: _____

Check all that apply:

Is this firm a prime consultant? _____

Is this firm a subconsultant? _____ Identify specialty: _____

Is this firm a certified DBE? _____ If so, by whom? _____

Is this firm currently debarred? _____

Is this firm currently the subject of debarment proceedings? _____

FINANCIAL INFORMATION

The undersigned swears that the above information is correct. Any material misrepresentation may be grounds for terminating any Contract which may be awarded. By signing below, the authorized representative of the consultant firm affirms that the firm has the financial capacity to perform the proposed work.

_____

Name, Title Date

APPENDIX D

PROPOSED BUDGET ESTIMATION

Tasks	Items	Project Manager	Team 1	Team 2	Team 3	...	Total Amount
		(Rate)	(Rate)	(Rate)	(Rate)	...	
Task 1							
Task 2							
Task 3							
Task 4							
...							
Total Amount							

TOTAL:_____

OFFER

TO PAG:

The Undersigned hereby offers and shall furnish the service in compliance with all terms, scope of work, conditions, specifications, and amendments in the Request for Submittal which is incorporated by reference as if fully set forth herein.

For clarification of this offer, contact:

_____ Name: _____

Company Name

_____ Title: _____

Address

_____ Phone: _____

Town State ZIP Code

_____ Fax: _____

Signature of Person Authorized to Sign

_____ Email: _____

Printed Name

_____

Title

APPENDIX E

PAG LAND USE MODEL EVALUATION AND RECOMMENDATION

CAMBRIDGE SYSTEMATICS

PAG AZ-SMART UrbanSim Land Use Model Evaluation and Recommendations

for

Pima Association of Governments

prepared by

Cambridge Systematics, Inc.

June 30, 2025

www.camsys.com

report

PAG AZ-SMART UrbanSim Land Use Model Evaluation and Recommendations

prepared for

Pima Association of Governments

prepared by

Cambridge Systematics, Inc.
200 River's Edge Drive
Suite 420
Medford, MA 02155

date

June 30, 2025

Executive Summary

For the Pima Association of Governments (PAG), Cambridge Systematics (CS) evaluated AZ-SMART as a platform for land use forecasting for the PAG region. AZ-SMART is a Python-based socio-economic modeling suite developed by the Maricopa Association of Governments (MAG) and built in part upon UrbanSim's open-source Urban Data Science Toolkit (UDST). The review included a comprehensive review of AZ-SMART's existing components – code structure, input data, and model components – to determine the feasibility of adaptation to PAG's planning priorities, customization requirements, available input data, and staffing requirements. In parallel, the potential alternative of developing a cloud-based UrbanSim model, based on a software-as-a-service (SaaS) business model, was explored, providing a comparative basis for long-term system recommendations.

CS conducted structured interviews with AZ-SMART and UrbanSim Users – MAG and the Chicago Metropolitan Agency for Planning (CMAP), the Metropolitan Area Planning Council (MAPC), and the Denver Regional Council of Governments (DRCOG), respectively. Objectives of the interviews included gaining insight into model development, user experience, and current practices, highlighting trade-offs between the rapid development and turnkey nature of UrbanSim's cloud-based service, and the transparency, control, and flexibility afforded by open-source, in-house implementations developed by MAG and DRCOG. Several key takeaways arose:

- Agencies reported significant effort (30-50% of total modeling program time) is devoted to preparing and updating base-year inputs – zoning, building inventories, development pipelines, and synthesizer targets.
- Agencies under strict timelines (i.e., imminent Long-Range Transportation Plan (LRTP) deadlines) adopted UrbanSim's cloud-based, block-level service for rapid deployment and vendor support;
- Growth in internal capacity prompted and allowed DRCOG to transition from a SaaS arrangement with UrbanSim to an in-house-developed open-source land use model implementation;
- Parcel-level models support the finest-grain policy levers but incur higher maintenance burdens and stochastic variability, whereas block-level models achieve a practical balance between spatial detail, maintenance effort, and automated calibration; and
- Success with either approach correlates strongly with in-house Python or data-science expertise and dedicated land use modelers capable of validating external setups, developing custom modules, and interpreting results.

A discussion of PAG's current parcel-level model demonstrated its strength in producing fine-grained forecasts of housing units and six employment sectors and leveraging a custom multinomial logit redevelopment sub-model to allocate residual growth. County-level control totals ensure compatibility with the activity-based model (ABM), but the use of separate synthesizers for population and household generation extends runtimes, sometimes up to 24 hours per full scenario, and creates opportunities for inconsistency. While Jupyter notebook automation streamlines batch processing, this process obscures intermediate results and limits opportunities for inspection. Furthermore, the model lacks built-in modules for K-12 enrollment and group-quarters population forecasting, two critical demographic segments. Integrating a unified Micro Analysis Zone (MAZ)-level population synthesizer, introducing modular workflow checkpoints, and embedding demographic sub-models would simplify the process, accelerate execution, and provide needed transparency.

CS conducted an evaluation of MAG's AZ-SMART model, a Python-based, parcel-level microsimulation socio-economic modeling suite built in part upon UrbanSim's open-source UDST with custom modules to produce: households by income and size, including permanent residents, group quarters (GQ), seasonal, and transient populations; employment by two-digit North American Industrial Classification System (NAICS), with distinctions among site-based, non-site-based, work-at-home (WAH), and construction jobs; and school enrollments for K-12 and post-secondary institutions. A deterministic developer model phases known projects using a heuristic scoring and tiering system, yielding reproducible allocation of residential and non-residential growth based on the likelihood of development over time. Robust data integration – including assessor parcel data, CoStar, AirDNA, and standardized zoning feeds – populates a comprehensive GIS database. Meanwhile, annual advisory workshops and statutory calibration schedules ensure methodological rigor. Travel demand model feedback is orchestrated via Jupyter notebooks, with highway skims updated only upon network changes. Tighter automation with the ABM is achievable through a unified scripting framework.

With regard to PAG's data compatibility with AZ-SMART's requirements, AZ-SMART outputs map directly to PAG's ABM requirements at Micro Analysis Zone (MAZ)- and Traffic Analysis Zone (TAZ)-levels. Resident households, GQ residents, seasonal and transient population, households by income quintile, and employment by NAICS and job class require no manual post-processing. School enrollment outputs support K-12 and post-secondary demand modules. Base-year parcels, buildings, and control totals (derived from the Census, Public Use Microdata Sample (PUMS), and Quarterly Census of Employment and Wages (QCEW)) would be supplied by PAG. Minor scripting will be needed to reconcile field names and spatial geographies. The principal data-preparation effort centers on a one-time effort to translate PAG's land use, general plan, and municipal planning area (MPA) definitions into AZ-SMART's Future Land Use (FLU) space and building factor tables. PAG has begun creating a translation between PAG parcel/land use types and building definitions into the MAG land use and building types, which appears to support equivalent building type and land use type definitions as well as working definitions for translating general plans into future land uses. To support model operations, PAG will need to recalibrate AZ-SMART's econometric models for real estate prices and household employment location choices, which are segmented by building type definitions (and household income for households), which will require developing calibration targets datasets.

Lastly, CS provided a roadmap for recommended implementation to guide the adoption of AZ-SMART or an alternative UrbanSim framework to meet PAG's needs. Determining the better path forward for PAG's land use modeling requires careful consideration of several strategic questions which illuminate the essential tradeoffs between AZ-SMART and the UrbanSim cloud-based solution:

- The necessity of parcel-level detail versus block- or MAZ-level aggregates must be determined, considering the balance between planning sensitivity and data maintenance burden.
- The desired level of end-to-end automation, particularly the coupling of land use forecasts and activity-based travel runs within a single orchestration framework, should be established.
- Acceptable reliance on external vendor or consultant support must be defined, weighing the benefits of turnkey assistance against the desire for in-house troubleshooting and rapid iteration.
- The degree of code and data transparency required for internal experimentation and customization should be clarified.

- The timeline for delivering a production-ready model should align with the next Regional Mobility and Accessibility Plan (RMAP).

- PAG staffing capacity for ongoing maintenance - encompassing annual data updates, calibration cycles, and incremental code enhancements - must be assessed, including potential supplementation by consulting resources during periods of peak workload.

Should PAG elect to pursue an in-house land use modeling solution, a preliminary work plan is recommended as an essential “gut check” to validate feasibility and resource requirements. The plan’s scope should consider all foundation aspects: inputs, processing, and conditioning of spatial and socioeconomic data for calibration and validation; design and organization of geodatabases for parcels, buildings, and control totals; deployment of the AZ-SMART (or alternative UrbanSim) application stack; and execution of initial calibration, validation, and sensitivity analyses. A phased timeline could be structured around the RMAP update cycle. Lastly, budget planning must address both near-term development and long-term maintenance. The development budget should cover staff effort, estimated at two full-time equivalents (FTE) with Python/GIS expertise, as well as potential consulting support for code adaptation, calibration, and policy module design. A separate strategic budget should be allocated for ongoing maintenance, including annual data reviews and updates, incremental code improvements, recalibration exercises, and the addition of new scenario drivers to support evolving planning needs over multiple RMAPs.

1.0 PAG Land Use Model Recommendations

In this section, we recommend a land use model development path for PAG. We begin with a comparison of the essential features of two alternative systems, UrbanSim's SaaS product and the AZ-SMART system developed by the MAG, which would be adapted by PAG and customized as an in-house model development project.

1.1 Comparison of UrbanSim SaaS with AZ-SMART

In this section, we make comparisons between alternative land use model strategies - adapting the AZ-SMART system as an in-house solution or contracting with UrbanSim, Inc. to develop a cloud-based platform that would be developed and supported primarily by UrbanSim staff. We will discuss three main themes:

- PAG Planning Needs and Priorities;
- PAG Resources; and
- Long-Term Land Use Model System Maintenance Objectives.

1.1.1 PAG Planning Needs and Priorities

PAG's primary need for an updated land use model is to support long-range transportation planning needs, namely the Regional Mobility and Accessibility Plan (RMAP). In particular, PAG needs a systematic, replicable process for generating households by size and income distributions and employment by 2-digit NAICS codes. Additionally, PAG envisions potential use of the model for scenario analyses, such as high-density and corridor infill scenarios. Embedding policy-sensitive modules, similar to UrbanSim's redevelopment and scenario runners, would also be desirable. Parcel-level resolution and the ability to automate feedback with the activity-based travel demand model are strongly preferred.

Socioeconomic Modeling

Both AZ-SMART and UrbanSim would meet PAG's fundamental needs for more consistent methods of socioeconomic modeling. The AZ-SMART population synthesizer generates a base-year population for resident households and for GQ, then simulates annual changes to match control totals. This approach has certain advantages over running a full population synthesis with control totals for each year, which would each generate a new population from scratch. In addition, AZ-SMART includes special modules for handling GQ, seasonal, and transient populations, requirements for PAG that would need to be added, as these populations are not readily handled by the commonly available population synthesizers. AZ-SMART also includes modules for forecasting K-12 enrollment and school building needs, as well as post-secondary school enrollment. These should be desirable for PAG, but they will require some local customization and are not included in a standard UrbanSim package. The processes for forecasting future-year employment based on NAICS codes are similar for AZ-SMART and for UrbanSim, as they both involve generating new jobs to satisfy control totals.

Scenario Analysis

One feature of the AZ-SMART design is that the real estate development model is deterministic - a set of potential projects are developed for the first simulation year. From there, a complex set of heuristics involving

scoring and tiering determine which projects will be built each year, which also considers residential and non-residential demand and assumed structural vacancy rates. That the development models are deterministic can be an advantage, as anecdotal evidence from other agencies has indicated that some of the stochastic effects of UrbanSim's developer model can lead to variation in the forecasted locations of large developments that can be difficult to explain.

Recent UrbanSim models, such as UrbanCanvas, would typically use a proforma analysis approach, which mimics developer return-on-investment calculations. This approach influences the probability of land being developed or redeveloped in various ways, subject to zoning and other constraints. The advantage of the proforma approach, in theory, is that it more realistically represents the real estate market; however, the proforma approach is only available in the parcel-level version of UrbanSim. The block-level version of UrbanSim, which is currently offered in the cloud-based service, does not use the proforma approach, but does offer other tools to construct policy levers for applications like affordable housing studies and transportation accessibility. The value of these tools depends on how well the model has been specified (policy sensitive variables and good quality input data) and how well it has been calibrated and tested.

In our view, AZ-SMART can be used for more complex scenario analysis; however, it would require making assumptions and manual changes to key inputs, such as to municipal planning area (MPA) density or land use factors and possible changes to some of the scoring rules and parameters embedded in the code base, such as structural vacancy rates and velocity functions. Although, AZ-SMART lacks a proforma approach to assessing the financial feasibility of projects, it fundamentally accounts for regional market supply and demand. Redevelopment is encouraged using general plans or MPA lookup tables that would be used to generate these projects. In addition, AZ-SMART includes policy-sensitive variables related to transportation features, such as distance to highways and transit facilities, which should make it suitable for most long-range plan analyses.

Parcel-Level Resolution

AZ-SMART is a parcel-based model, which requires work to maintain and update, although PAG is already accustomed to working with parcel-level data for its current land use forecasting process. To date, UrbanSim's cloud-based service has not supported parcel-level analysis, but rather more aggregate Census Tract, Block Group, or Block-level analysis. The advantages to UrbanSim's more aggregate treatment (say Block-level) is that this level of resolution is satisfactory for many agencies' travel demand model inputs; it lends itself well to UrbanSim's machine-learning automated calibration methods (which would be very difficult to implement at the parcel-level); and has the potential to save agency staff maintenance time because it can use Census and some other commercially available data sets more readily without having to assign attributes to parcels. One caveat: The agency staff to whom we spoke reported they still needed to carry out a substantial amount of data development-related work. While it may be possible for UrbanSim to construct a post-processing tool that would allocate block-level forecasts to parcels, this would be an extra cost, and we are unaware of any agencies who have this.

Feedback with the Travel Model

The UrbanSim cloud service runs remotely on UrbanSim servers. In addition, agencies are not able to run their travel demand models on UrbanSim servers. This means that, under current business models, using the UrbanSim cloud-based service would require manual downloading and uploading of data. AZ-SMART runs using Jupyter Notebooks. Kicking off the PAG travel demand model from a Jupyter Notebook would facilitate a more automated integration between the two.

Overall Needs and Priorities Considerations for PAG

Table 1-1 below summarizes the discussed tradeoffs above with respect to adopting an UrbanSim cloud-based service or AZ-SMART as an in-house tool.

Table 1-1. Planning Needs Comparison

Planning Need	UrbanSim Cloud Service	In-House/Open-Source Implementation
Socioeconomic Modeling	Supports population synthesis and employment modeling.	Supports population synthesis and employment modeling. Also includes modules for GQ, seasonal, and transient pops. Includes modules for school enrollment and facilities.
Scenario Analysis	More sophisticated modules for redevelopment and policy levers. Stochastic methods used.	Deterministic approach to developer model (heuristics and scoring). Sensitive to transportation features.
Parcel-Level Resolution	Limited to Block-Level.	Parcel-Level.
Travel Model Feedback and Integration	UrbanSim cloud servers are restricted to running UrbanSim and do not allow for integrated data transfer with other systems.	It is possible to use a master Jupyter Notebook to integrate land use and travel model runs across the PAG local area network or using a general-purpose cloud-based service such as GitHub Codespaces, AWS, or Azure.
Overall Considerations for PAG	Supports policy analysis well, but limits on spatial resolution and travel model integration in the cloud-based version. Stochastic developer model outcomes have advantages and disadvantages.	Supports desired parcel-level resolution and travel model integration. Deterministic approach. Lacks policy behavioral sensitivity requiring creative, manual solutions.

1.1.2 PAG Resources

This section outlines the resource implications for PAG in pursuing alternative approaches to land use modeling. Drawing on interviews with peer agencies, the following section summarizes expected staff costs, subscription and licensing fees, time requirements for development and deployment, and computing needs. Two broad approaches are considered: Adopting UrbanSim's cloud-based subscription service, and developing or maintaining an in-house, open-source implementation, such as AZ-SMART.

Staff Resource Requirements

Adopting UrbanSim's cloud-based service typically requires a leaner internal staffing commitment. Agencies using this approach reported needing one to two FTE staff dedicated primarily to data preparation, scenario design, vendor coordination, and quality control. Technical skills are moderate: Staff must maintain GIS

datasets, manage zoning and development pipeline updates, and validate outputs, but do not have to maintain or develop the modeling software itself. Peer agencies emphasized that while vendor support significantly reduces the maintenance burden, effective use of the system still depends on the agency's capacity to prepare high-quality input data and interpret outputs.

By contrast, agencies that chose to develop or maintain their own open-source or in-house UrbanSim implementations reported a need for higher internal capacity. Typically, this approach requires two to three FTEs with strong data science or software development skills, including proficiency in Python, GIS data engineering, and model calibration. While this represents a greater staffing commitment, it affords greater flexibility and control over the model's behavior, integration with other systems (such as ActivitySim), and customization of scenario design. Agencies pursuing this route highlighted the importance of sustained, dedicated modeling staff to maintain institutional knowledge and ensure continuity as the system evolves.

In both approaches, interviewees underscored that preparing and updating base-year inputs - especially zoning harmonization, building inventories, and development pipeline data - remains one of the most labor-intensive aspects of land use modeling, often consuming 30 to 50 percent of the overall modeling effort. This data-preparation workload is invariant to platform choice and must be planned regardless of approach.

Subscription and Licensing Costs

UrbanSim's cloud-based subscription service represents a significant recurring cost. Agencies reported annual subscription fees ranging from $100,000 to over $200,000, depending on the region's size, the level of vendor support required, and the degree of customization. These costs are typically incurred on an ongoing basis, even during periods when the land use model is not being used intensively (for example, between long-range planning cycles). Agencies also noted that custom vendor support - such as scenario design assistance, calibration services, or post-processing automation - can generate additional costs beyond the base subscription fee.

By comparison, in-house or open-source implementations avoid these subscription costs entirely for the modeling software itself. Agencies using this approach rely on open-source code bases and shared community resources, sometimes even adopting peer agencies' existing code repositories to reduce start-up effort. However, while software licensing costs may be effectively zero, such approaches require investment in internal staffing capacity, training, and potentially consultant support to adapt and operationalize the code. These onboarding costs are often one-time but can be substantial.

Time Requirements

Agencies adopting UrbanSim's cloud service reported onboarding periods ranging from six months to 18 months, driven primarily by the effort required to compile, clean, and harmonize zoning, development pipeline, and building inventory data. Once deployed, scenario run times are typically very fast - ranging from about 15 minutes to three hours depending on region size and model resolution. This enables rapid scenario iteration, which can be particularly valuable.

For AZ-SMART, the development of the baseline target tables, particularly the parcels and building tables, as well as supporting tables would seem to be the most time consuming. While MAG staff handled this through a nine-step set of Python scripts, it is likely that PAG would need to modify these approaches to work better with PAG data and definitions for developments, land use entitlements, and building types.

In-house or open-source implementations typically involve longer initial development timelines. DRCOG reported one to two years to achieve a fully production-ready workflow, depending on existing internal expertise and the availability of code-sharing opportunities. Scenario run times for these systems are longer - typically four to eight hours per run - but can be reduced or parallelized using local computing resources or cloud instances. Importantly, DRCOG emphasized that while development timelines are longer, in-house systems allow continuous adaptation and integration with local travel modeling workflows without external dependencies.

Computing Resources

Computing resources are not a limiting factor in choosing between these alternatives. UrbanSim's cloud-based service removes the need for any substantial local computing infrastructure, with all scenario execution and storage handled by the vendor.

For in-house or open-source implementations, agencies reported successfully running models on modern desktop workstations or using cloud-based virtual machines. Scenario run times of four to eight hours can be further reduced through parallelization or cloud processing (i.e., GitHub Codespaces), but do not require high-performance computing facilities.

Overall Resource Considerations for PAG

Based on peer agency experience, PAG should anticipate the following broad resource implications when evaluating between the two alternatives as shown in Table 1-2.

Table 1-2. Resource Requirements Comparison

Resource Type	UrbanSim Cloud Service	In-House/Open-Source Implementation
Staff Resource Requirements	~1-2 FTE (Analysts, GIS)	~2-3 FTE (Data Scientists, Modelers)
Subscription and Licensing Costs	~$100K-$200K+ Annually	~$0 Software Cost, but Onboarding Costs
Time Requirements	~6-18 Months Onboarding	~12-24 Months Development
Computing Resources	~15 min-3 hours (Cloud)	~4-8 hours (Local/Cloud, Parallelizable)
Overall Considerations for PAG	Vendor-provided cloud; Minimal MPO need	Moderate local/cloud; Manageable with modern PCs

1.1.3 Long-Term Land Use Model System Objectives

Important considerations are the long-term prospects for land use modeling agency funding support and staff growth and development in their land use modeling expertise. In the short term, the three interviewed agencies chose to develop a new land use model through UrbanSim, Inc.'s cloud-based service model to meet immediate needs to develop a new land use model which could be quickly implemented and support

their long-range planning efforts. Two of the three agencies continue to use the cloud-based service and found it valuable for improving their productivity. However, both agencies were comfortable relying on UrbanSim support staff for their workflow, block-level spatial resolution, and infrequent, manual feedback with their respective travel models. A third agency, DRCOG, chose to forego the UrbanSim cloud-based service, preferring to have more local control over the workflow, calibration, and deeper knowledge of the inner workings of their model. Similarly to MAG, DRCOG chose to develop their own in-house implementation using various components of the open-source UDST.

The question remains: What direction does PAG envision for its use of the land use modeling tool? Based on conversations with PAG land use modeling staff, there exists a desire and level of technical ability to support the in-house development of a new land use model, with the primary concerns being limited staff resources (2 FTE, compared with 4 FTE for MAG or 3 FTE for DRCOG). PAG staff are comfortable and have proficiency with Python programming, which is required for developing and maintaining a model like AZ-SMART. The primary risk lies with engaging in a protracted land use model development or update effort which jeopardizes a long-range plan effort. This, of course, can be mitigated by outsourcing consultant support, as needed.

With UrbanSim SaaS, there would be a certain level of dependency on UrbanSim's technical staff to provide timely support. Risks include possible technical changes in the SaaS architecture which may affect future performance or require upgrades. PAG will benefit from feature enhancements that UrbanSim will undoubtedly make over time; however, PAG may also have to wait for requested feature enhancements to coincide with UrbanSim's software development plans. Moreover, as the model will reside on UrbanSim's cloud-based server, PAG staff will not have the ability to easily test different model parameters, investigate unexpected results, or make changes to algorithms and market segmentation assumptions without involving UrbanSim staff.

1.2 Land Use Model Development Roadmap

Synthesizing from the above discussion, Table 1-3 lists the key differentiating factors that represent the essential tradeoffs for PAG, based on staff's expressed needs and preferences for model features and workflow. Pros are indicated in the table using a "+" symbol in green. Cons are indicated in the table with a "-" symbol in red. Notably, we have omitted the UrbanSim dollar costs from the list of tradeoffs. Development and subscription costs are negotiable and are designed to be competitive with the cost of employing a staff member (FTE) to perform the work. Similarly, computing resources do not seem to be a limiting factor in the decision-making process, nor do programming or software skills as PAG staff have reported solid aptitude with Python and statistical computing.

Table 1-3. Summary of Essential Tradeoffs

UrbanSim Cloud Service	In-House/Open-Source Implementation
+ Faster to startup, possible in less than 1 year	- Startup time to become productive will likely take more than 1 year
+ Expertise in land use model specification, estimation, calibration	- In-house staff responsible for model estimation and calibration, unless contracted to consultants

+ Staff support for model calibration, automated	- Substantial staff time required for model updates
+ Software policy analysis levers	- Home-made software may lack sophisticated policy sensitivity, may need to develop special modules
- Block-level resolution limitation	+ Parcel-level resolution permits detailed analysis
- Travel model integration difficult to automate	+ Travel model integration easily automated
- Dependency on UrbanSim staff for workflow and software updates	+ PAG controls ownership, independent workflow, and software updates
- Model code, parameters not readily accessible	+ Accessible model code and parameters

1.2.1 Questions to Answer

We believe that PAG's best interests are served by a land use modeling solution that will provide long-term benefits in staff productivity and value to internal customers/stakeholders (e.g., RMAP). Given these tradeoffs, the answer to the following risk-based questions will be important to make a final decision:

- ***Can PAG get by with a block-level resolution land use model?*** **If the answer to this question is "no," then the current UrbanSim cloud-based service would not meet agency needs** because it does not support parcel-level resolution according to current users. The PAG travel model requires MAZ inputs, which should be generally compatible with Census blocks; however, a parcel-level analysis may be needed for other types of analyses as identified by staff. Although it may be possible to post-process the results to a parcel-level allocation, this would add another step to the workflow, require custom programming, and the results may not provide the desired level of accuracy or planning sensitivity for certain use cases.

- **Is automating the feedback between the land use model and the travel model important to PAG staff productivity? If the answer to this question is "yes," then the current UrbanSim cloud-based service would not meet agency needs** because it does not provide the ability to run the land use model and the travel model on the same network, much less the same machine. Currently, PAG does not have an automated process for passing land use model results to the travel model and travel model skims to the land use model, but staff have expressed a desire to do so. An in-home operated model would provide the opportunity for travel model integration.

- **Are PAG staff comfortable with a workflow that involves some level of dependency on an outside firm to maintain and update their land use modeling system and provide timely assistance in defining and running scenarios? If the answer to this question is "no," then the current UrbanSim cloud-based service would not meet agency needs.** Current and former users of the UrbanSim cloud-based subscription service have provided mixed reviews of the UrbanSim level of customer service and have reported periods of system outage. It should be noted that more recent users seem to be more positive. Even with excellent customer response time, PAG staff should be comfortable with needing to interact with UrbanSim staff on a routine basis to set up scenarios, update data, and trouble-shoot results.

- **Is it important for the PAG land use modeling staff to be able to access land use model code, data, and parameters and perform their own troubleshooting and test modifications? If the answer to this question is "yes," then the current UrbanSim cloud-based service would not meet agency needs** because program code, data, parameter lookups, etc., will be stored on the UrbanSim cloud server, and UrbanSim staff assistance will be required to perform troubleshooting and experiment with modifications to programs and parameter settings. Many agency modelers like to be more "hands on" with their code and prefer to be directly involved in diagnosing and fixing problems or investigating why certain forecasts provide unexpected outcomes.

- **Does PAG need a new land use model ready for production within one year's time? If the answer to this question is "yes," then adapting AZ-SMART or a similar in-house developed program may not meet agency short-term needs.** All interviewed users, including MAG, warned of long model development time windows that would likely take more than a year without outside support, such as that from a consultant. The UrbanSim cloud-based service has been able to get new users up and running in as little as six months. Alternatively, PAG may hire other consulting support to accelerate their in-house model development.

- **Does PAG's land use modeling staff feel they have the expertise to adapt land use modeling components, such as from AZ-SMART, to customize a solution for their region, such as potentially respecifying variables, model estimation, and calibration? If the answer to this question is "no," then adapting AZ-SMART or a similar in-house developed program may not meet agency short-term needs** as these types of model development activities will certainly be required. Data compatibility issues are most likely to be centered around how to represent developments from general plans, MPA plans, and building types. PAG will need to invest a modest amount of time to carry out this effort. The AZ-SMART code base appears to be flexible enough to handle small differences in building types, our assumption being that most of the building types would be compatible with PAG definitions. For example, employment location choice models are currently specified to filter available building types based on a short list of alternatives for employment industry groups. There would seem to be no issue with specifying different building type choice sets for different industry groups; however, this will require recalibration of these models and sensitivity testing. The UrbanSim cloud-based service has experts who can develop land use models from scratch and provide model design, estimation, and calibration services. Alternatively, PAG could hire other consulting support to assist with adapting AZ-SMART or other open-source components to better meet agency needs.

- **Does PAG feel they have the staff resources for the long-term maintenance of the land use modeling system, beyond its initial development, such as annual input data updates and occasional code and parameter modifications? If the answer to this question is "no," then then adapting AZ-SMART or a similar in-house developed program may not meet agency long-term needs**. Although the Greater Tucson region served by PAG is much smaller in population than other agencies with whom we spoke (Phoenix, Chicago, Boston, Denver), it is not clear that the effort to maintain and update a complex land use modeling system would scale linearly with region size. PAG has reported 2 FTE as the expected staff resource level, compared with MAG 4 FTE and Denver 3 FTE. It is also important to note that the Portland Metro MPO (not interviewed here) maintained an in-house land use modeling system for many years with about 2 FTE. Contracting with UrbanSim, Inc.'s cloud-based service could provide the extra support needed, particularly during periods leading up to an RMAP delivery. Although, current users of the UrbanSim cloud service report paying an annual fee regardless of workload. Alternatively, PAG could supplement land use modeling staff with interns or other consultants as needed.

- **Does PAG feel the technical features of AZ-SMART, and similar open-source modeling templates, provide an adequate level of policy sensitivity for anticipated use cases? If the answer to this question is "no," then adapting AZ-SMART or a similar in-house developed program may not meet agency short-term needs**. AZ-SMART model components were profiled in the AZ-SMART review report. In our view, AZ-SMART is technically sound as a whole. It has particular strengths in its representation of different population market segments and job types, which support robust household and employment location choice models. The deterministic, heuristic structure of AZ-SMART's real estate development model has its pros and cons. A deterministic development model is generally preferred by most practitioners because it enables them to program known developments and exert more control over where large developments occur. In scenario analyses, a deterministic developer model provides reassurance that forecasts change in response to changes in inputs, not just simulation noise. In contrast, the AZ-SMART suite of real estate development models is not set up to provide rapid testing of policies, such as corridor infill and densification, or developer incentives to provide affordable housing. While the model represents the balance between regional supply and demand and has a general sensitivity to development potential around highway and transit infrastructure, it lacks sensitivity to developer investment considerations which may be of interest for certain locally focused policies. PAG would need to construct special modules to create these types of policy levers and identify the sets of inputs which would need to be changed for these types of scenarios. In contrast, UrbanSim specializes in developing customized policy levers for their land use modeling clients.

1.2.2 Develop a Workplan

In the event that the PAG staff's answers to the above questions result in a decision to develop an in-house land use model, we strongly recommend the development of a preliminary program work plan as a "gut check." The work plan should include the following elements:

- **Scope**: Include data processing and conditioning for use in model calibration and validation; database design/organization; standing up application software; and initial calibration, validation, and sensitivity testing. Re-estimating models from scratch may not be necessary, initially, but may be a second-phase activity, which will be informed by staff experience with the initial model validation and testing.

- **Timeline**: Choose a realistic date at which the land use model system would be operational (i.e., plan around RMAP cycles). A phased approach may be worth considering. For example, in the first phase, begin with AZ-SMART code and make as direct a transfer to PAG data as possible. In the second phase, respecify certain model components to better represent the PAG region.

- **Development Budget**: To support the scope for model development, including staff time and consulting support, if anticipated.

- **Long-Term Budget**: This is more of a strategic budget to cover long-term PAG land use model maintenance and updates. Include annual reviews and updates of key input data sources. Expect modest improvements to the program code and specifications will be desirable to support future scenario analysis needs and provide an annual budget for this purpose.