



# San Francisco International Airport GBAS Procedure Review

SFO Roundtable Technical Working Group

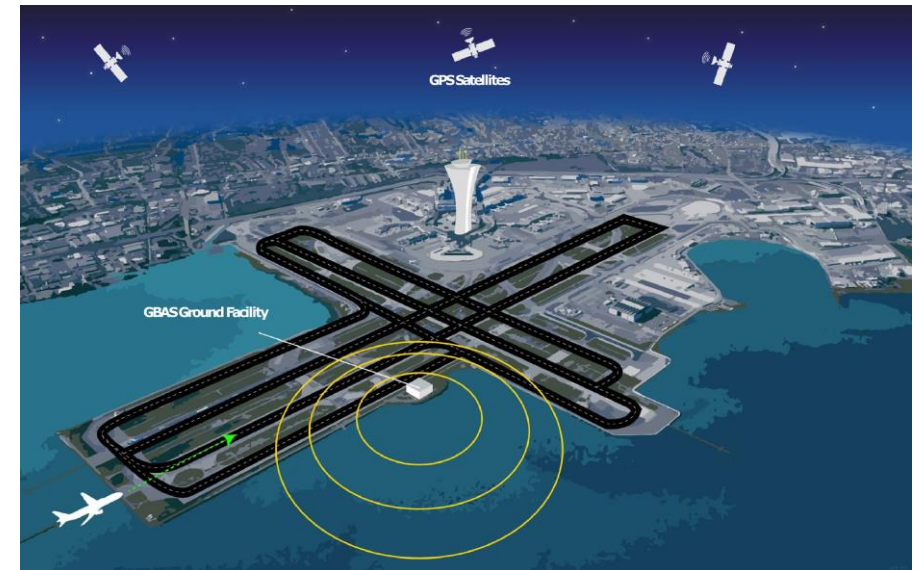
November 19, 2020





# Ground Based Augmentation System (GBAS) at SFO

1. GBAS support up to 48 unique GBAS Landing System (GLS) approach procedures to SFO runways
2. SFO GBAS receives information from Global Positioning System (GPS), and Wide Area Augmentation System (WAAS), to create precision approach paths for aircraft to follow
3. Equipped aircraft, and trained flight crews, request GLS approach and tune into the GBAS data broadcast specific to the runway and procedures
4. The GLS precision approach path is currently limited to the final approach segment, which is approximately 5 – 10 Nautical Miles from the end of the runway



<https://www.flysfo.com/community/noise/making-sfo-quieter/sfos-initiatives-tackle-noise>



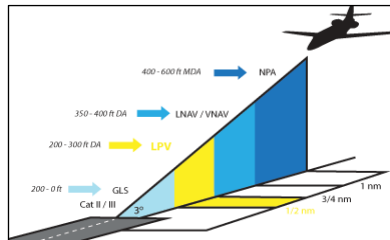
## 1. Reduce Noise Impact to the Community

- GLS, and RNP to GLS, allows innovative procedure design resulting in unique flight tracks and increased operational altitudes.



## 2. Create Redundant ILS Capabilities

- Allows continued ILS like operations during runway/taxiway rehabilitation and equipment outages.



## 3. Enhance Efficiency

- Single GBAS can support multiple runway ends steeper approaches and reduced track miles via RNP to GLS leading to reduced fuel burn and GHG



## 4. Reduce Delays

- Closely Spaced Parallel Runway Operations (CSPR) and CAT I/II/III Capabilities to runways that do not currently have ILS.

## **SFO Commitment**

### *Purchase, Commission and Operation of GBAS*

- Commissioning and Operations are performed in accordance with FAA Non-Federal NAVAID Program

### *Review GLS Procedures with Community*

- Evaluate and communicate any proposed GBAS procedures thoroughly, with active and ongoing input from the Round Table and our communities.
- If a proposed GBAS procedure appears to have a negative community impact, that procedure will not be pursued.

# GBAS Overlay Approach Status

## SFO Requested Overlay Approaches for 28L, 28R, 19L and 19R

- Approaches were requested in Q2 of 2018
- All overlay approaches are being developed from RNAV (GPS) approaches using LPV profiles and waypoints
- Existing waypoints, altitudes and speed restrictions (no changes from current procedures)
- FAA Environmental Screening resulted in a CATEX for these four overlay approaches in Q3 2019
- Procedures are “hard dated” for publication to coincide with commissioning of the SFO GBAS on 07OCT21

**Aeronautical Information Services**

- Alerts/Notices
- NOTAMs
- Catalog of Products
- Digital Products
- Order FAA Products
- Aeronautical Data
- Obstacle Data
- Critical DME List
- Instrument Flight Procedures Information Gateway
  - IFP Request Form
  - IFP Announcements & Reports
  - PBN Implementation Plan
  - IFP Initiation
  - IFP Inventory Summary
- Aeronautical Charting Meeting
- Air Transportation Information Exchange Conference (ATIEC)
- FAQs
- Chart Discrepancies

### SFO SAN FRANCISCO/SAN FRANCISCO INTL

Notify me of changes to SFO

Charts (58) IFP Production Plan (12) IFP Coordination (0) IFP Documents (NDBR) (53)

IFP Production Plan - Current IFPs under Development or Amendments with Tentative Publication Date and Status.

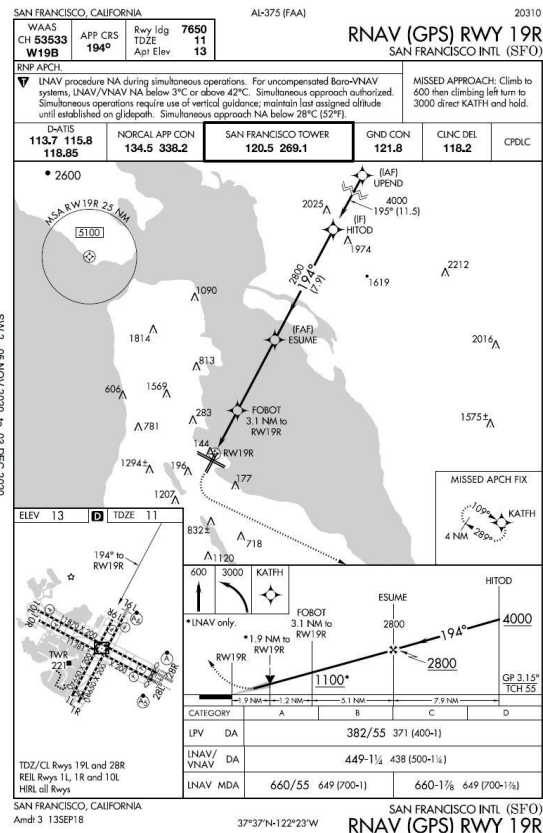
Filter Options

Showing results 1 - 12 of 12

Procedure	Airport Name	Airport ID	City/State	Scheduled Pub Date	Status	Actual Pub Date	
TIPP TOE VISUAL RWY 28L/R, AMDT 3	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	12/2/2021	Pending		Email FAA
GLS OVERLAY RNAV (GPS) RWY 19L, AMDT 3	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	10/7/2021	Pending		Email FAA
GLS OVERLAY RNAV (GPS) RWY 19R, AMDT 2	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	10/7/2021	Pending		Email FAA
GLS OVERLAY RNAV (GPS) RWY 28L, AMDT 6	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	10/7/2021	Pending		Email FAA
GLS OVERLAY RNAV (GPS) Z RWY 28R, AMDT 6	SAN FRANCISCO INTL	SFO (KSFO)	SAN FRANCISCO, CA	10/7/2021	Pending		Email FAA

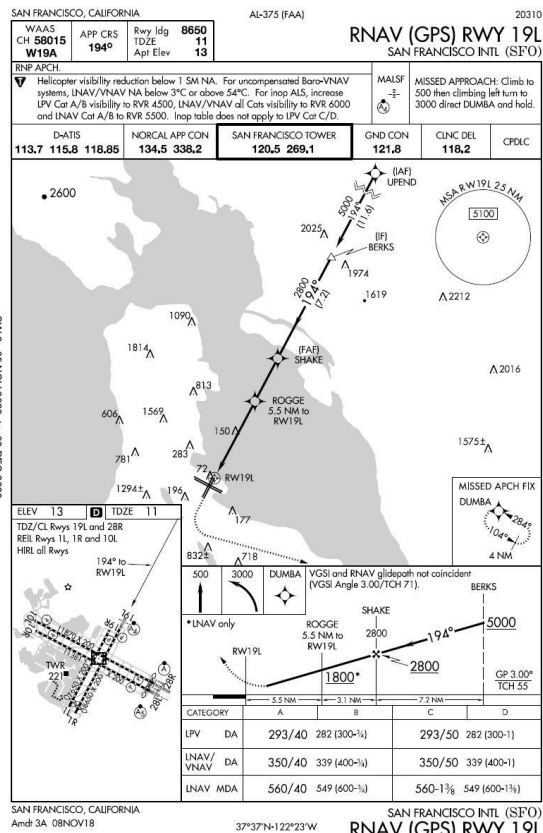
[https://www.faa.gov/air\\_traffic/flight\\_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrl=d=SFO#searchResultsTop](https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/application/?event=procedure.results&tab=productionPlan&nasrl=d=SFO#searchResultsTop)

# SFO GLS Overlay Approaches



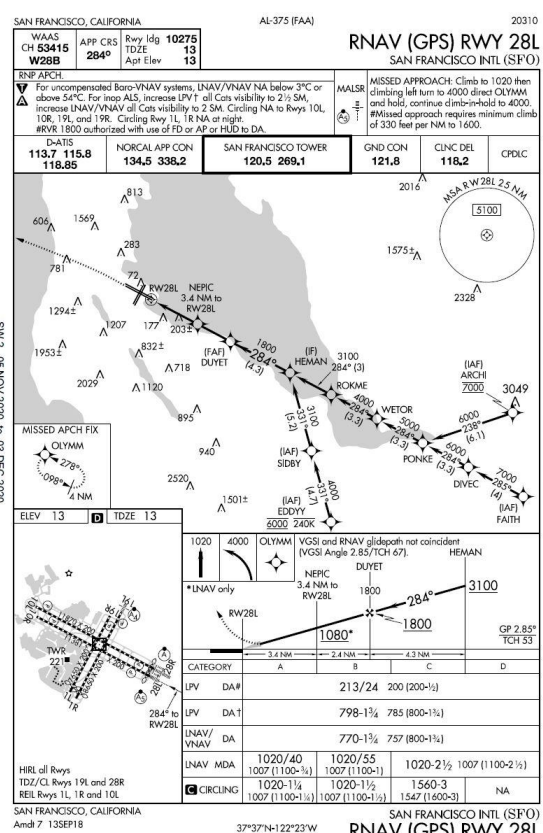
## RNAV (GPS) RWY 19R

- GPA: 3.15°
- Opportunity: 5%
- CSPR: TBD



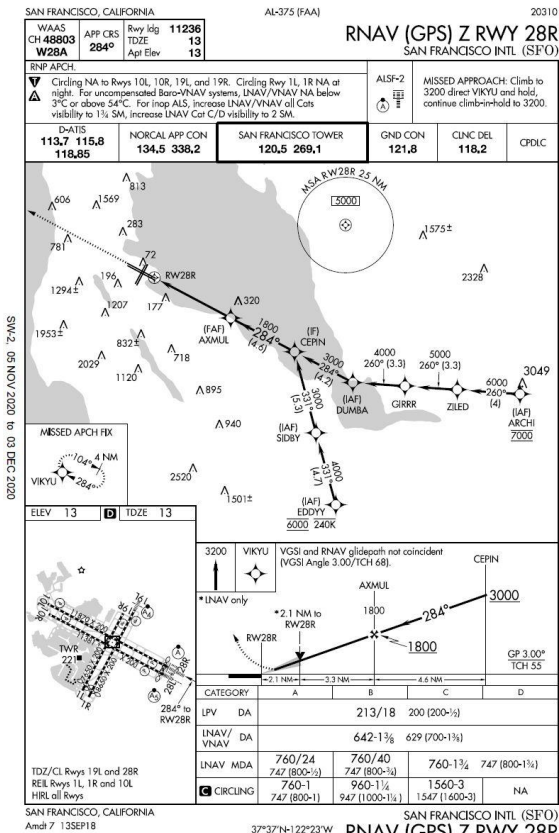
## RNAV (GPS) RWY 19L

- GPA: 3.00°
- Opportunity: 5%
- CSPR: TBD



## RNAV (GPS) RWY 28L

- GPA: 2.85°
- Opportunity: 95%
- CSPR: Yes



## RNAV (GPS) Z RWY 28R

- GPA: 3.00°
- Opportunity: 95%
- CSPR: Yes

## Additional Overlay Changes Since 2018

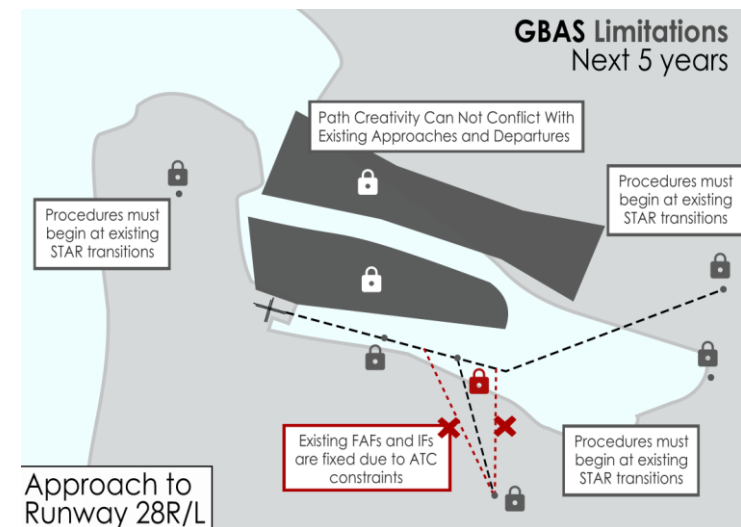
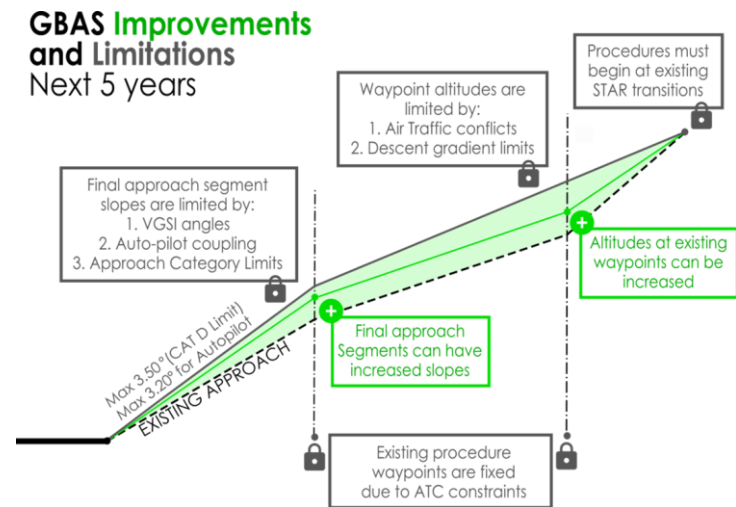
- GBAS Project Team is tracking possible changes to SERFR
  - Currently using the existing EDDYY location
  - All GLS outreach materials that use EDDYY will be updated if/when SERFR 5 reaches the IFP Gateway
- GLS version of LDA approaches to 28R are no longer being pursued
  - No current FAA criteria for “offset” GLS approaches that terminate in a long visual segment
  - LDA approach is being decommissioned
- Potential change to missed approaches to 19L and 19R are being studied to enhance safety during CSPR in southeast flow



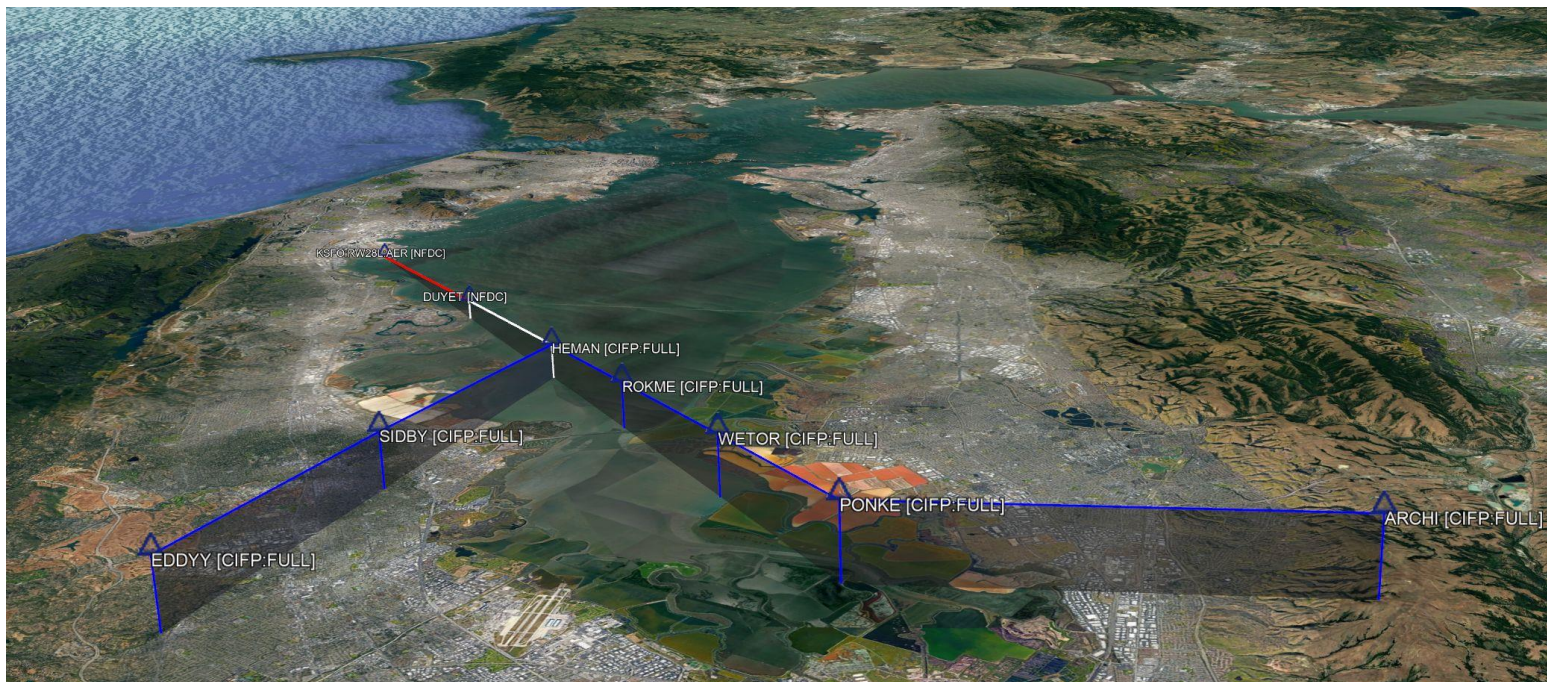
# GBAS Innovative Approach Evaluation Status

## SFO GBAS Project Team Has 8 Innovative GLS Concepts For Evaluation

- Developed through a flight procedures subcommittee to identify criteria, ATC and flyability challenges
- 23 initial concepts were reduced to 8
- Resulted in two “groups” of concept approaches to pursue
- Group 1 focusses on what can be published and flown within the next 5 years
  - 28R – 4 Concepts
  - 28L – 1 Concept
  - 10R – 1 Concept
  - 10L – 1 Concept



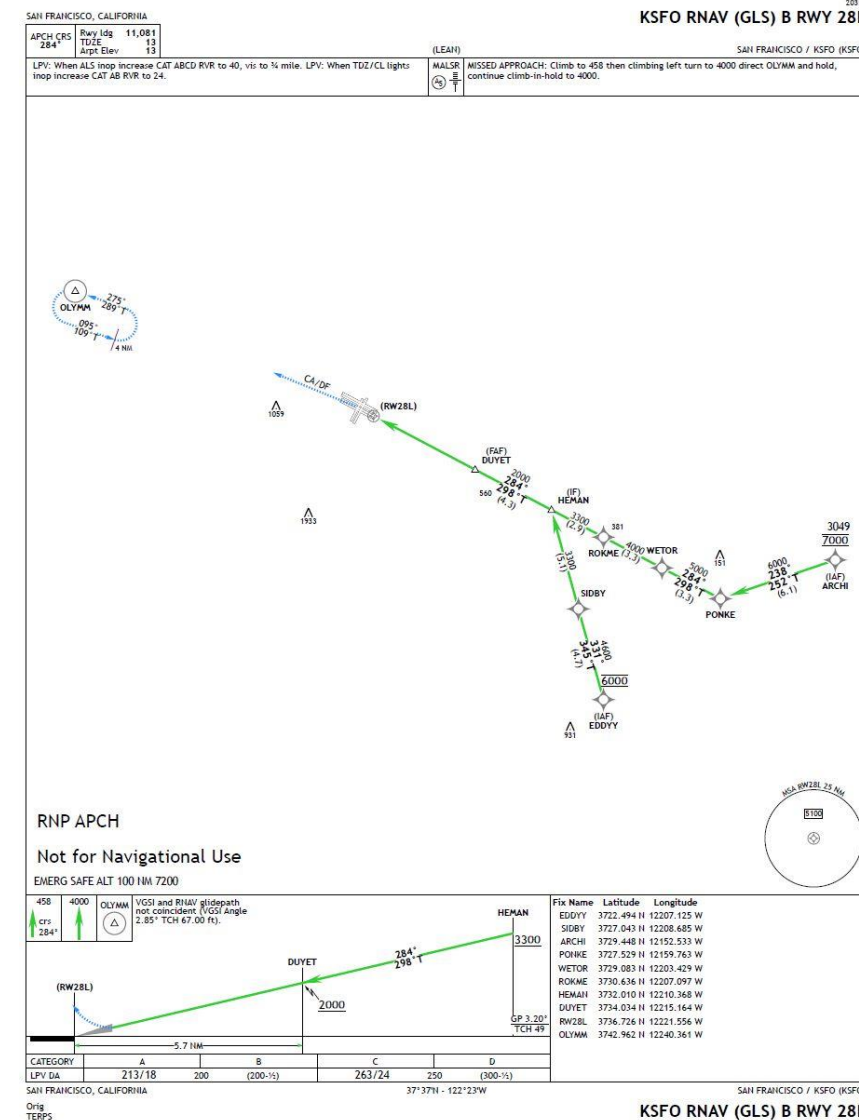
# SFO GLS Concept: 28L



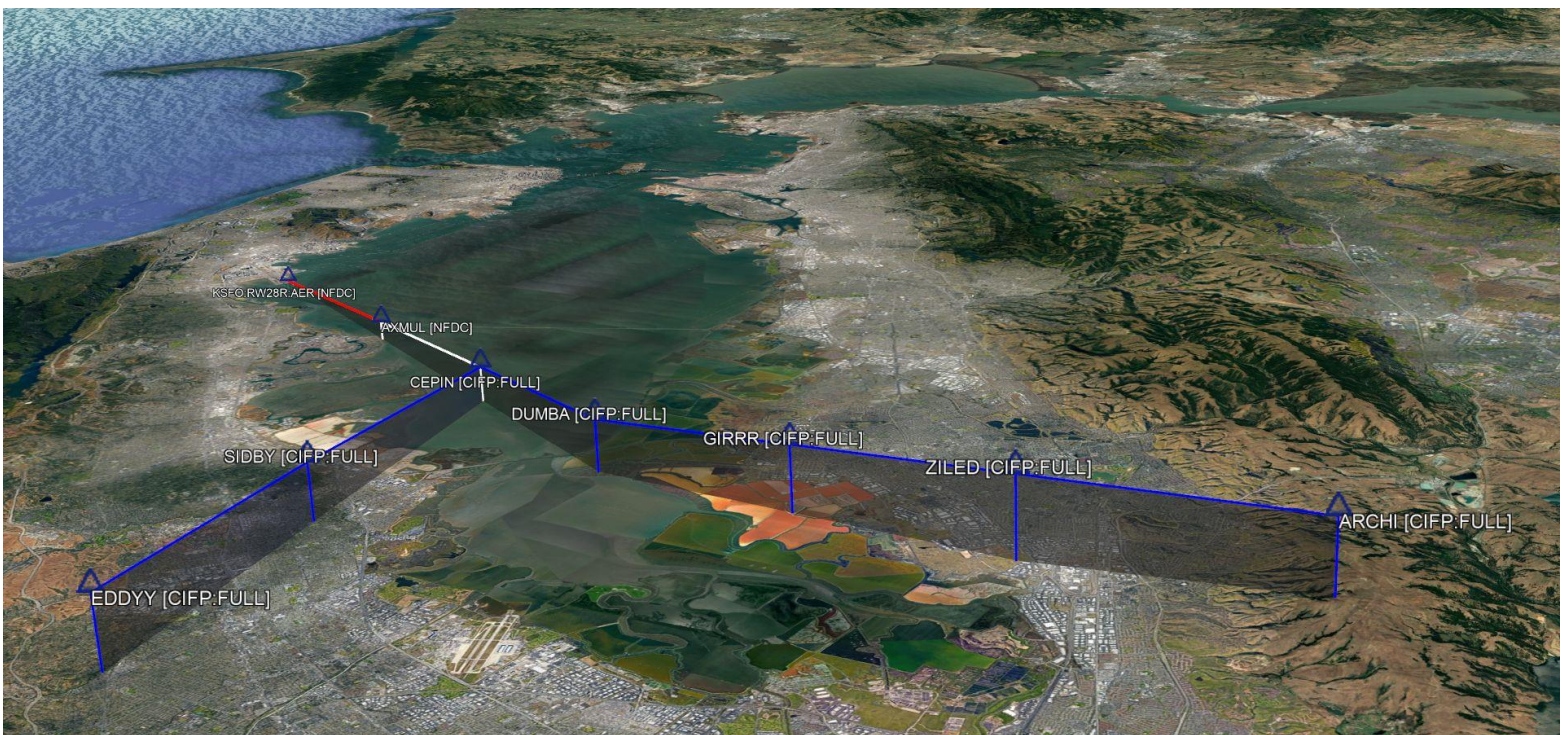
28L GLS Procedure Image TARGETS, Background Image Google Earth

## GLS B RWY 28L

- GPA: 3.20°
- Opportunity: 95%
- CSPR: TBD
- Final approach, and preceding altitudes are increased
- Can not change location or altitude at EDDYY or ARCHI
- Can not change location of any other waypoints



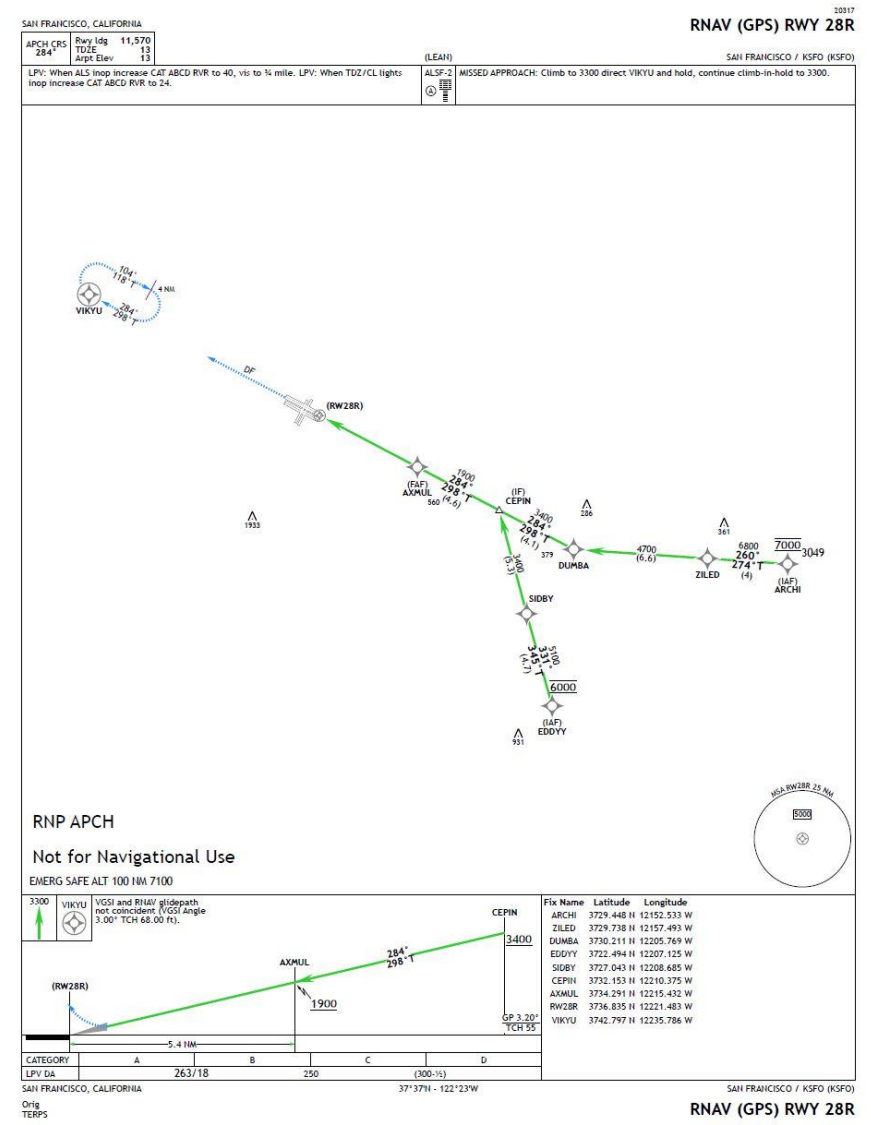
# SFO GLS Concept: 28R



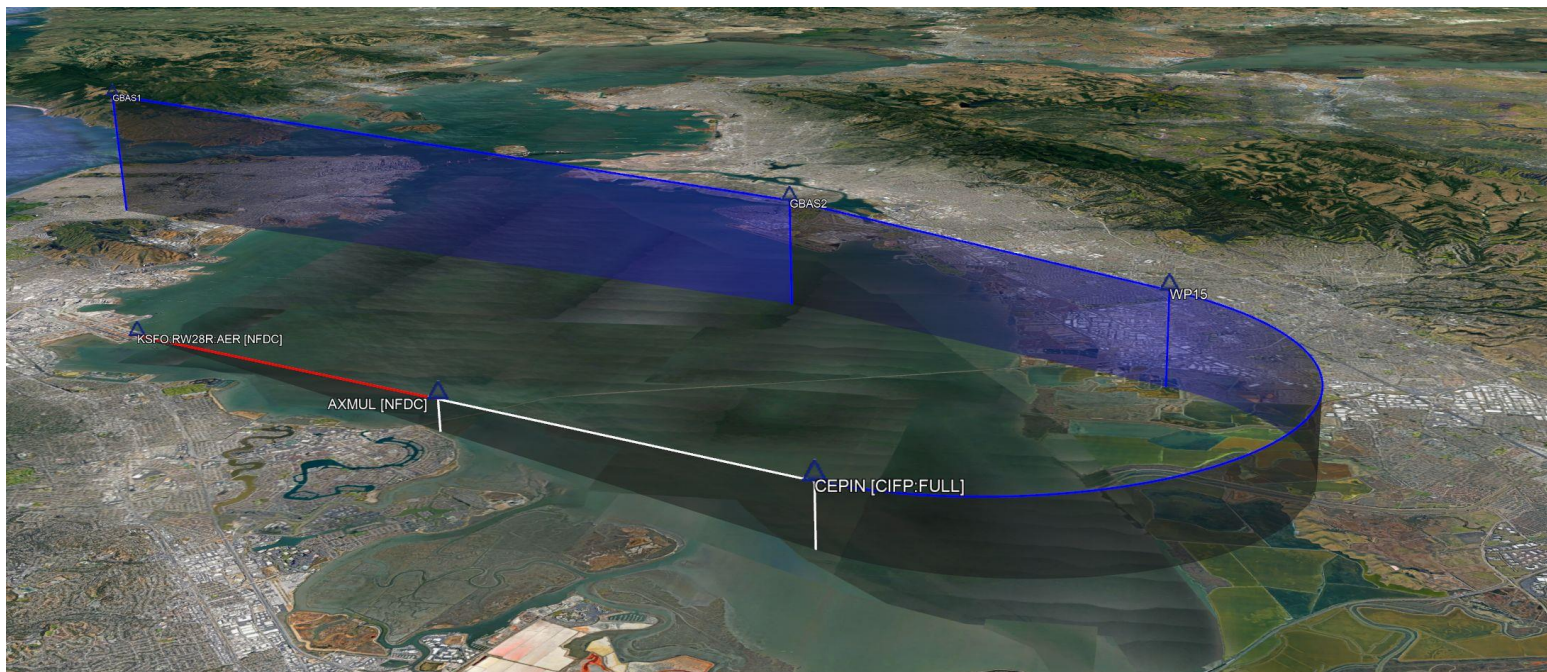
28R GLS Procedure Image TARGETS, Background Image Google Earth

## GLS B RWY 28R

- GPA: 3.20°
- Opportunity: 95%
- CSPR: TBD
- Final approach, and preceding altitudes are increased
- Can not change location or altitude at EDDYY or ARCHI
- Can not change location of any other waypoints



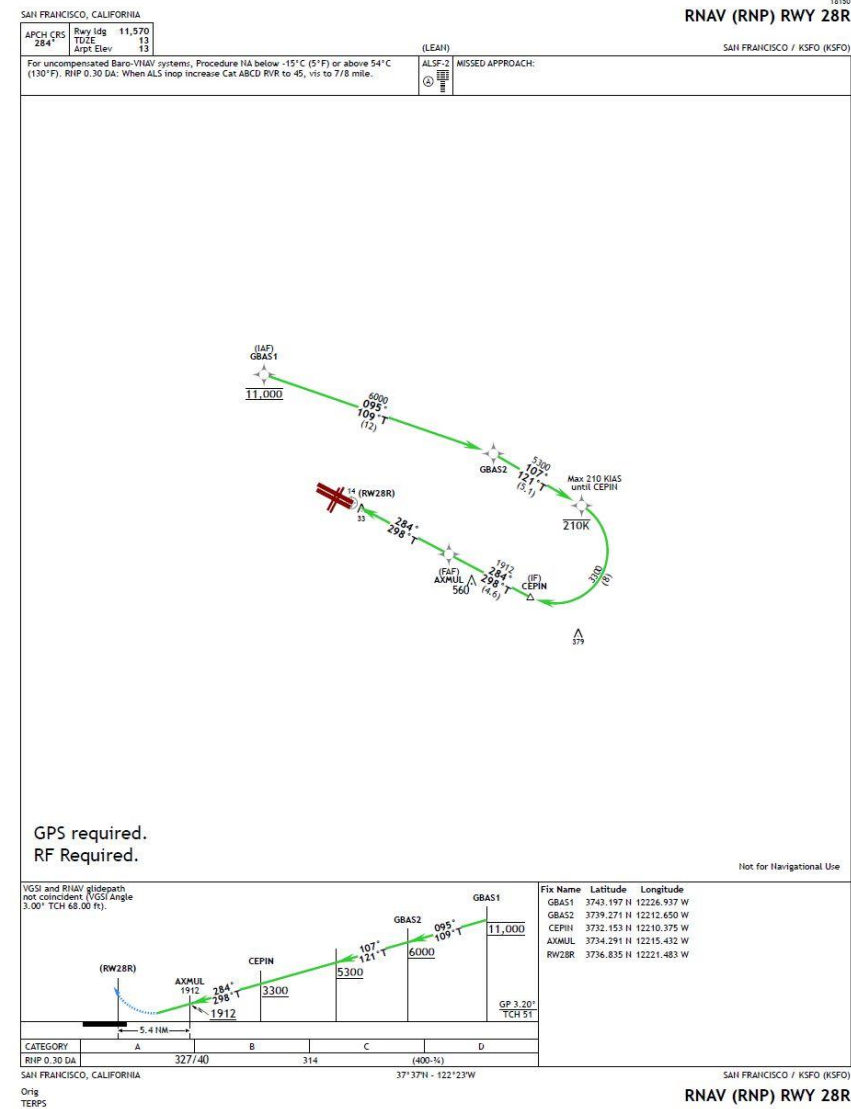
# SFO GLS Concept: 28R "Down the Bay"



28R GLS Procedure Image TARGETS, Background Image Google Earth

## GLS B RWY 28R "Down the Bay"

- GPA: 3.20°
- Opportunity: 95%
- CSPR: No
- Intended to mirror existing vectors from BDEGA Arrival to 28R at CEPIN
- Can not start the approach at CORKK (New Waypoint – GBAS 1)
- Can not change location of CEPIN or AXMUL



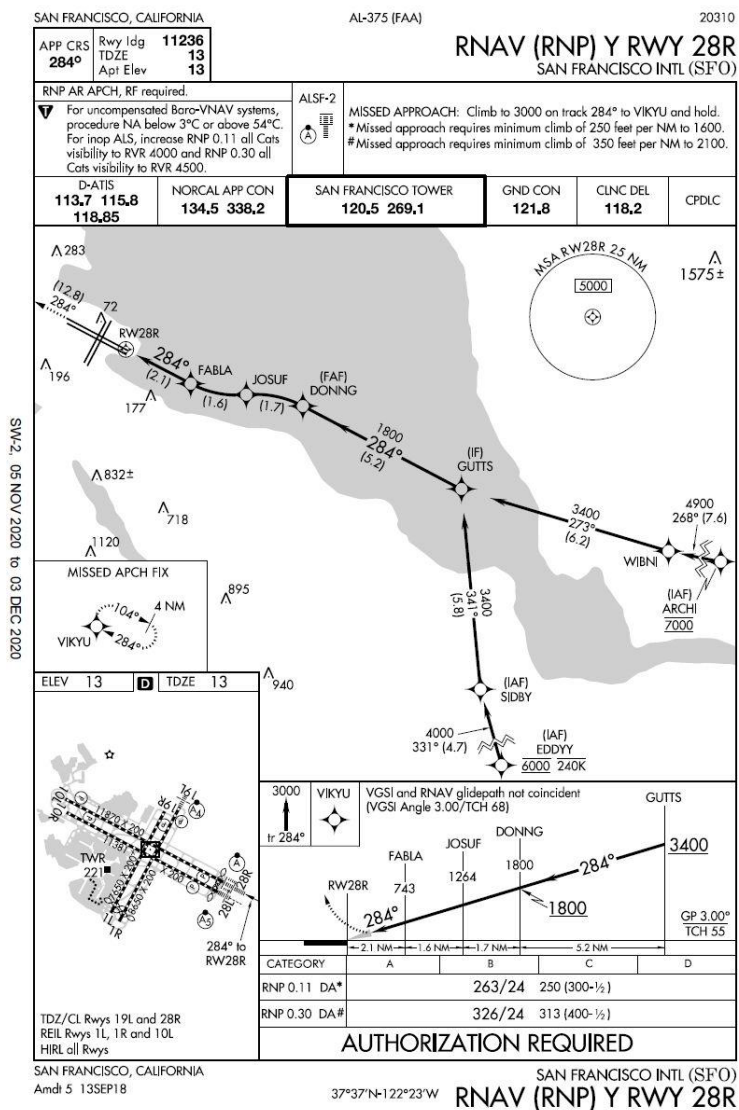
# SFO GLS Concept: 28R "RNP-Y to GLS"



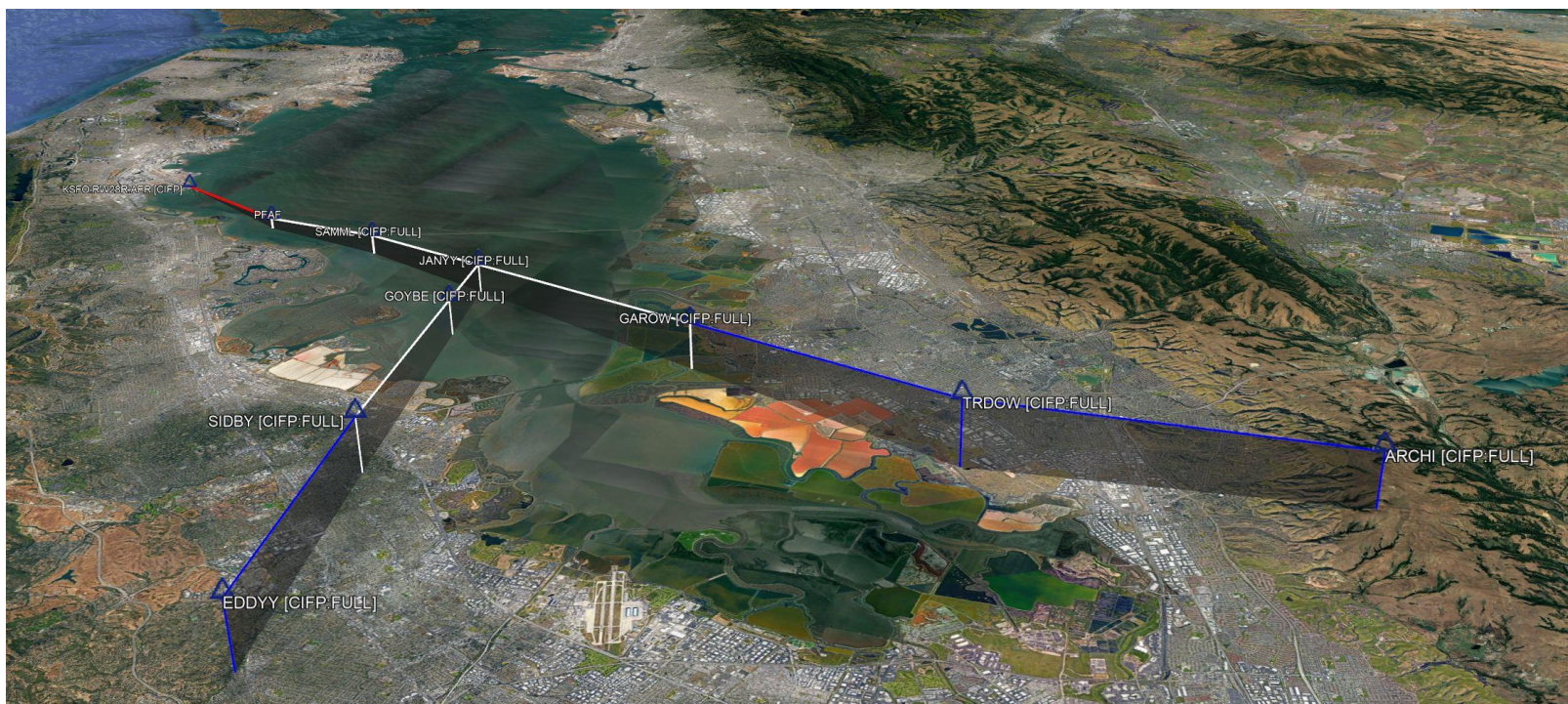
28R GLS Procedure Image TARGETS, Background Image Google Earth

## GLS B RWY 28R "RNP-Y to GLS"

- GPA: 3.00°
- Opportunity: 95%
- CSPR: No
- GLS Conversion of RNAV (RNP) Y RWY 28R
- Short FROP will prevent increase in GPA
- FAA Criteria for this is in development



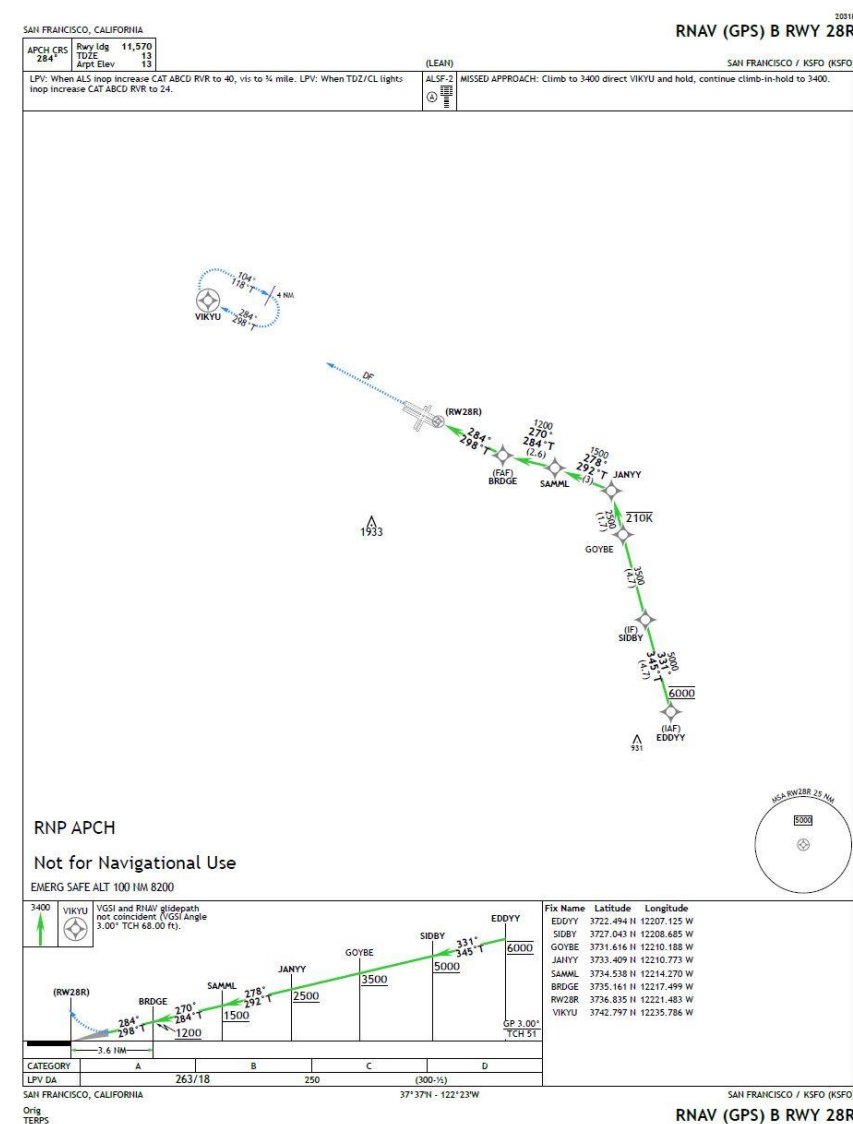
# SFO GLS Concept: 28R "Bridge Visual" EDDYY



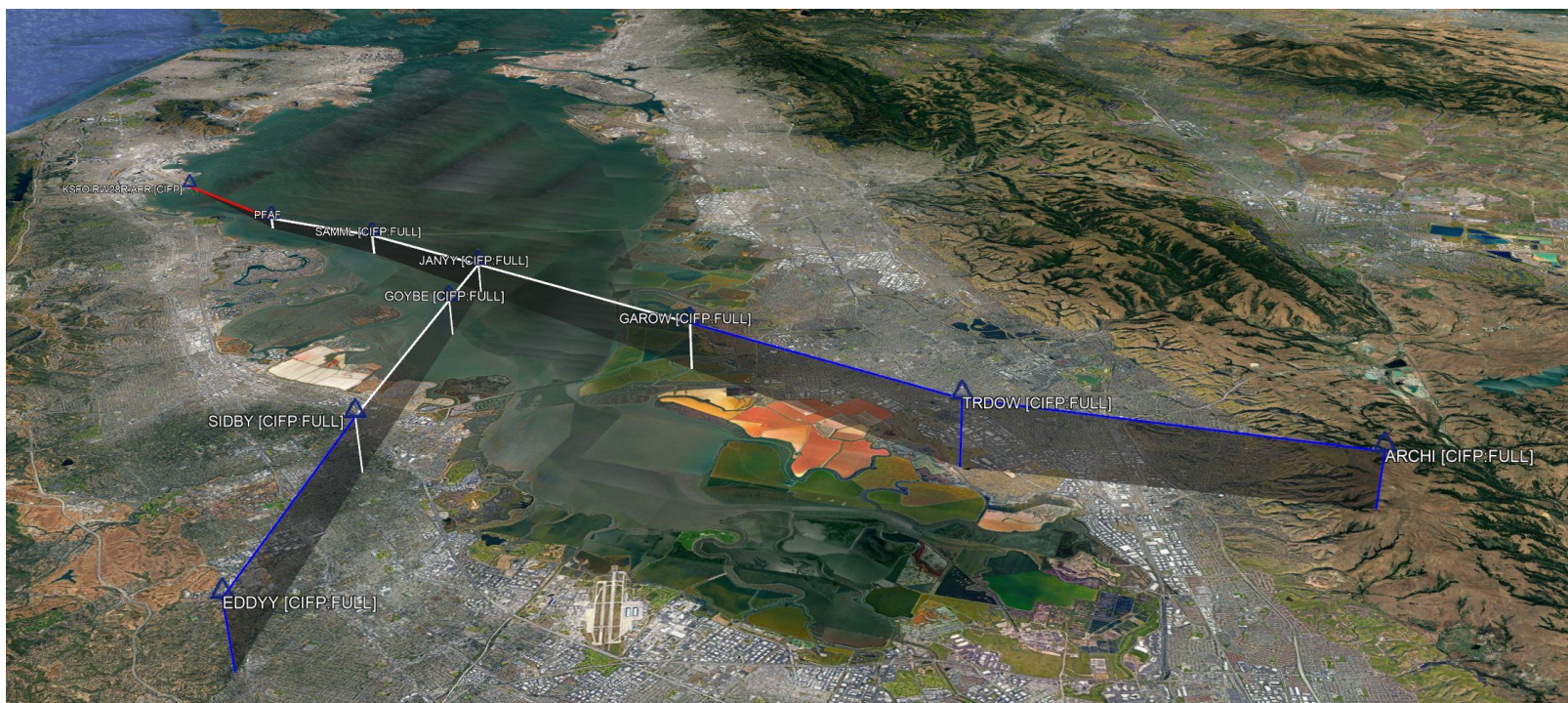
## GLS B RWY 28R "Bridge Visual" EDDYY

- GPA: 3.00°
- Opportunity: 95%
- CSPR: No
- GLS Conversion of FMS Bridge Visual
- Use of GOYBE Waypoint considered to reduce "early turns" from SIDBY
- Charts are divided into two for review with community, but will be combined into a single procedure if FAA were to develop

28R GLS Procedure Image TARGETS, Background Image Google Earth



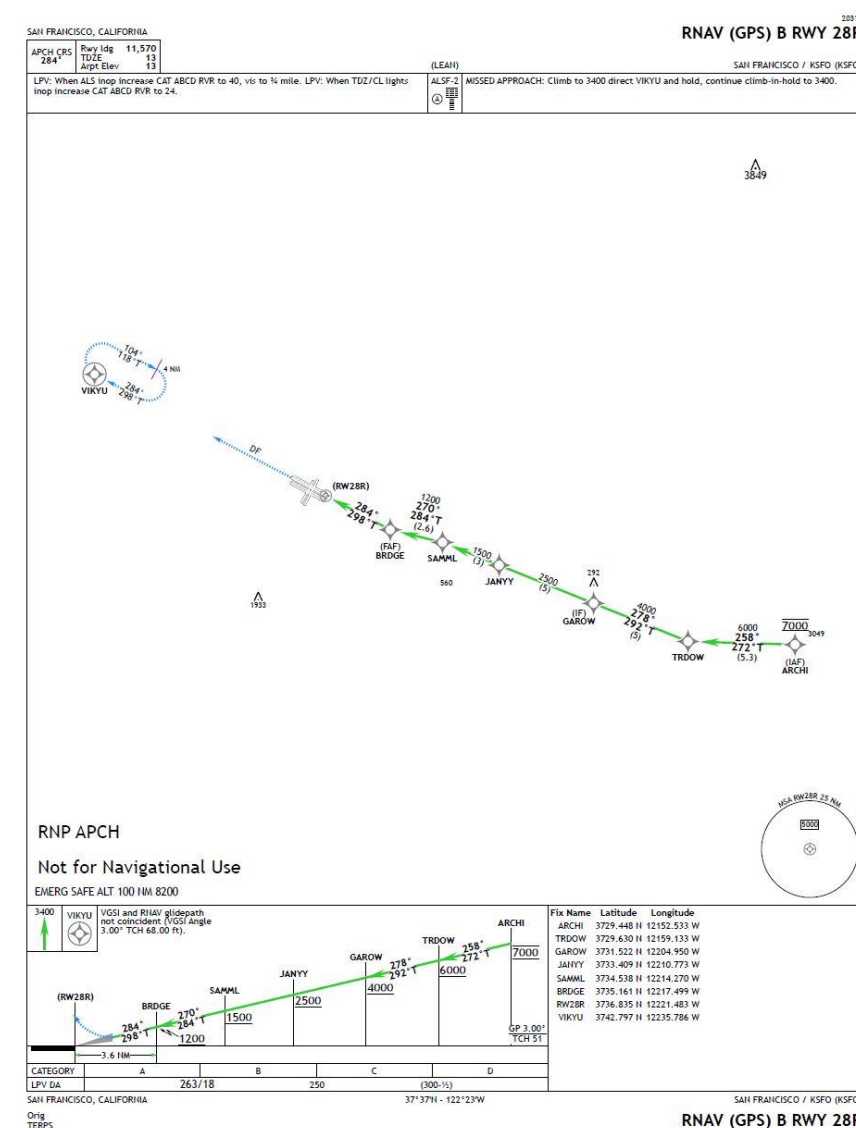
# SFO GLS Concept: 28R "Bridge Visual" ARCHI



## GLS B RWY 28R "Bridge Visual" ARCHI

28R GLS Procedure Image TARGETS, Background Image Google Earth

- GPA: 3.00°
- Opportunity: 95%
- CSPR: No
- GLS Conversion of FMS Bridge Visual
- Charts are divided into two for review with community, but will be combined into a single procedure if FAA were to develop

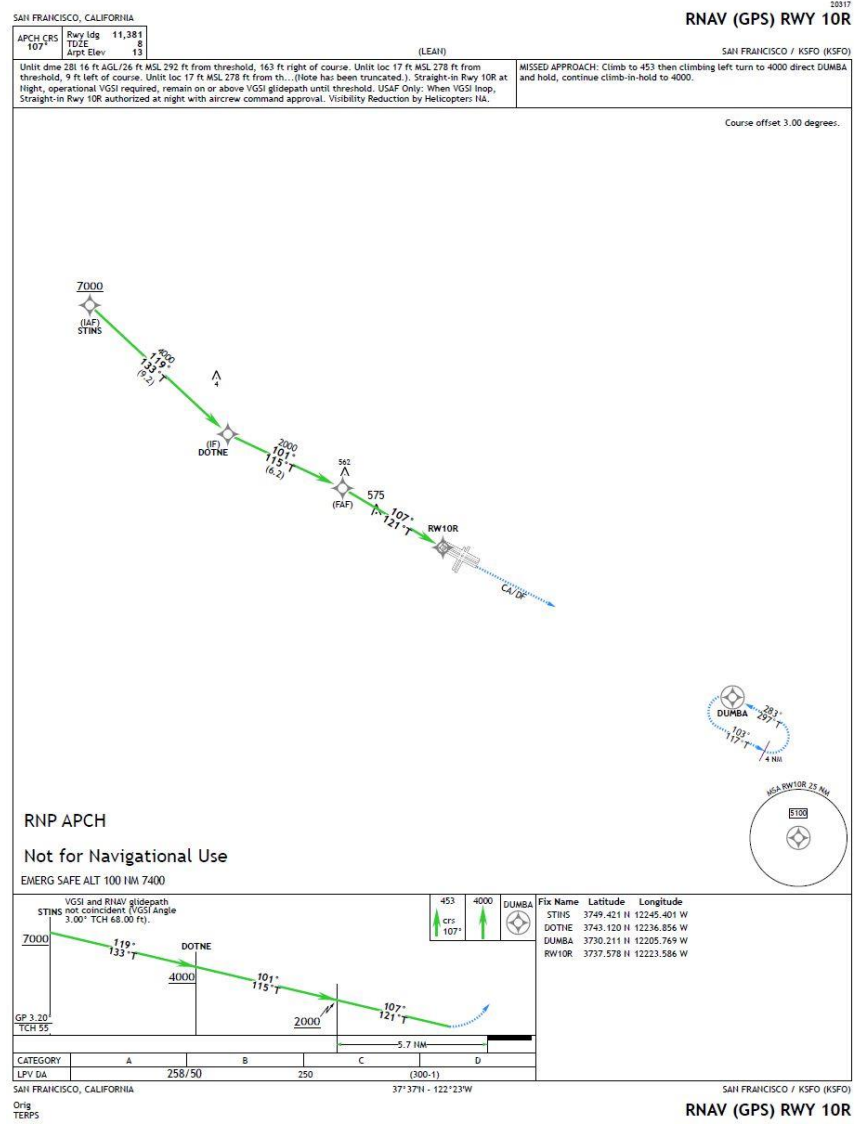




## GLS B RWY 10R

- GPA: 3.20°
- Opportunity: 0%
- CSPR: No
- Final approach course is offset 3.00 degrees north of the centerline to achieve lowest possible minimums
- This procedure is not considered to reduce noise impact

10R GLS Procedure Image TARGETS, Background Image Google Earth





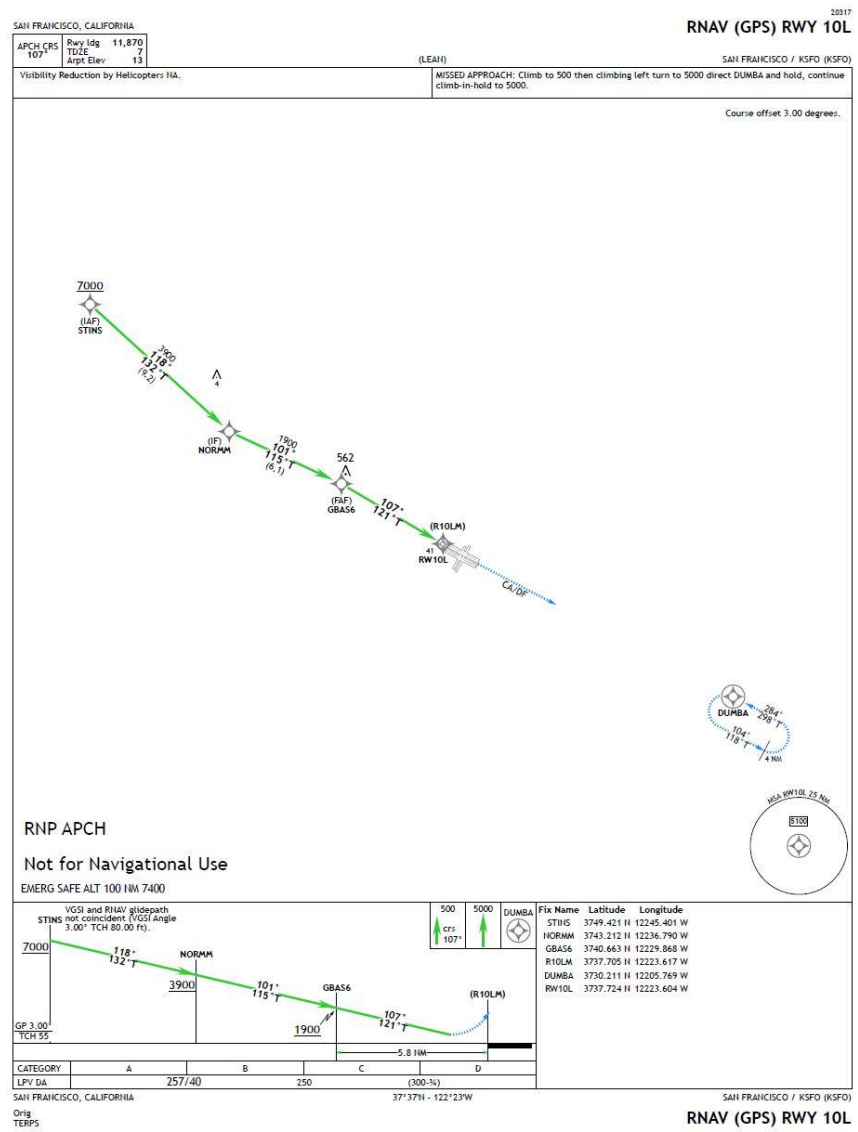
# SFO GLS Concept: 10L



10L GLS Procedure Image TARGETS, Background Image Google Earth

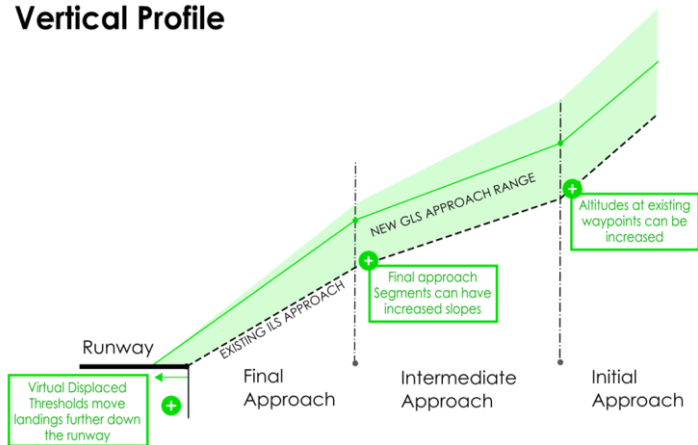
## GLS RWY 10L

- GPA: 3.00°
- Opportunity: 0%
- CSPR: No
- Final approach course is offset 3.00 degrees north of the centerline to achieve lowest possible minimums
- This procedure is not considered to reduce noise impact



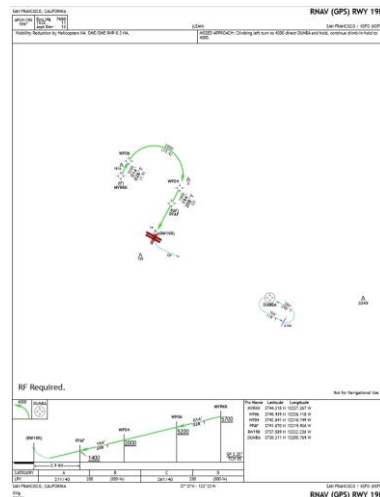
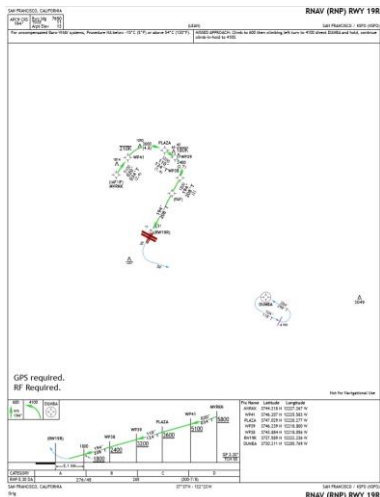
# GBAS Innovative Approach Evaluation Status

## GBAS Approach Vertical Profile



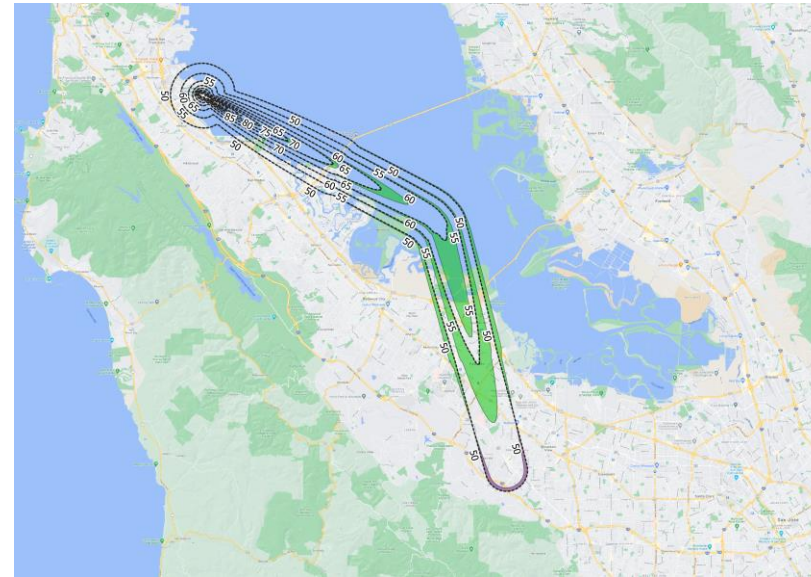
## Group 2 Innovative Approach Concepts (Beyond 5 Years)

- GLS CAT II with a 3.00<sup>0</sup> or 3.10<sup>0</sup> GPA
- 19R RNP to GLS
- Virtually Displaced Threshold
- Short final RNP to GLS
- Additional concepts that emerge from exploration with residents, airlines and air traffic

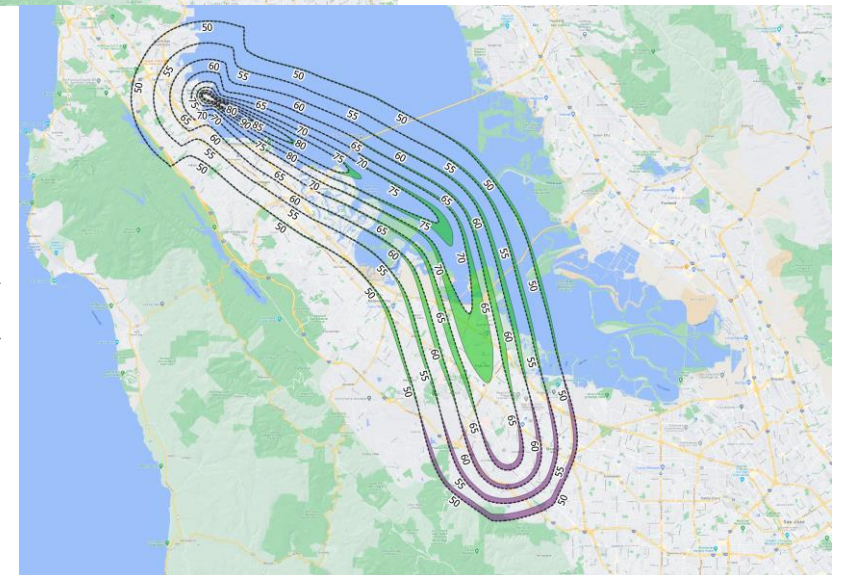


## Single Event Noise Analysis

- FAA AEDT v3C with Eurocontrol BADA 4
- LAMAX
- SEL (1 Second)
- Noise sensors utilized both 0.1 Nmi Grid Spacing and existing SFO Noise Monitor Locations
- Noise analysis is presented as areas where single event noise could be expected to change
  - Green areas indicate potential reductions in noise over an area
  - Purple areas indicate potential expansions in noise over an area



28R GLS LAMAX Noise Analysis from AEDT v3C (BADA 4), Background Image Google Maps XYZ Layer

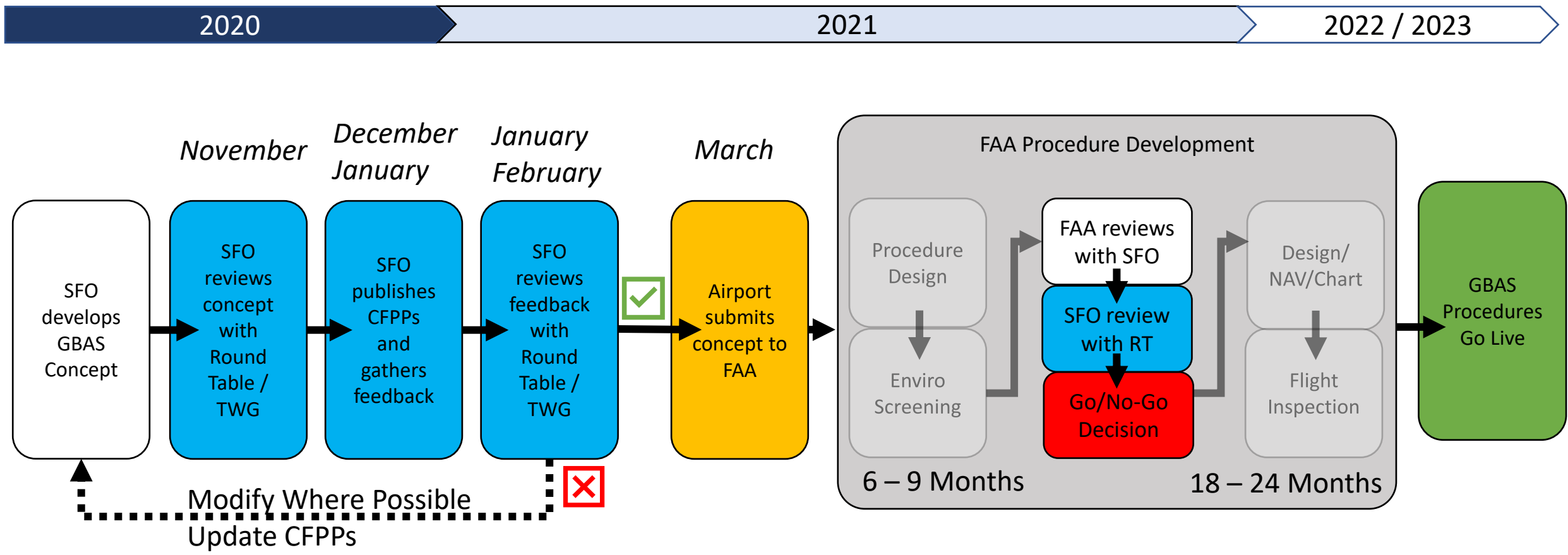


28R GLS SEL Noise Analysis from AEDT v3C (BADA 4), Background Image Google Maps XYZ Layer

# Screenshare from GIS



# SFO GLS Procedure Development and Community Evaluation



Timeline to FAA Procedure development will depend on outreach

## GBAS Project Team is Seeking Feedback from the TWG

- Initial thoughts on innovative GLS concepts?
- Are there additional formats or materials that should be generated?
  - Google Earth files
  - GIS capable materials
  - Additional flight procedure information (ARINC 424)
- Which of these should be included in the Community Flight Procedure Packages?
  - Flight Inspection Graphics
  - Maps
  - Tables
- Best ways to gather feedback from residents?

## Next Steps Between SFO Roundtable TWG and SFO GBAS Project Team

NOV/DEC20 - Update the FlySFO website, GBAS section, with additional materials reviewed today

NOV/DEC20 - Gather feedback from TWG via email (Please contact Bert Ganoung)

DEC20 – Participate in SFO Roundtable

DEC20 - Explore opportunity to engage with TWG specifically for GBAS Project in December

DEC20 – Upload CFPPs to FlySFO website

# Questions



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GBAS PM

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<https://www.flysfo.com/community/noise/making-sfo-quieter/sfos-initiatives-tackle-noise>



# Backup Material



## Approach Profiles

- Generic narrowbody aircraft (multiple types), approaching SFO at near maximum structural landing weight
- Aircraft approaches are modeled to decelerate throughout the approach using reduced thrust applications, flap deployment and gear deployment
- Current analysis does not consider
  - Bank angle
  - Aerodynamic deceleration devices
  - Terrain

## Approaches Evaluated

- Evaluating Innovative GLS Approach Concepts that are not replicas/overlays of existing procedures (10L, 10R, 28L GLS-B, 28R GLS-B)
- GBAS Project Team is working with NCT to determine an “equivalent” to the 28R Down the Bay procedure for single event modeling
- 28R GLS Bridge Visual is considered an overlay of the existing approach