



# Conflation: Edgematching Tools and Workflows

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# Agenda

**Conflation Overview and Edgematching Tools**

**Edgematching Workflow**

➤ **Demo: edgematching roads**

**Conclusions and Future Work**

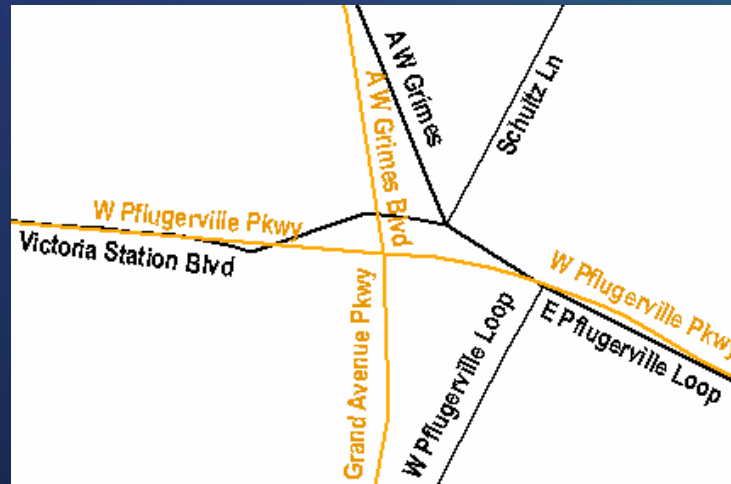
# Conflation Overview and Edgematching Tools

# When using multi-source spatial data **together**

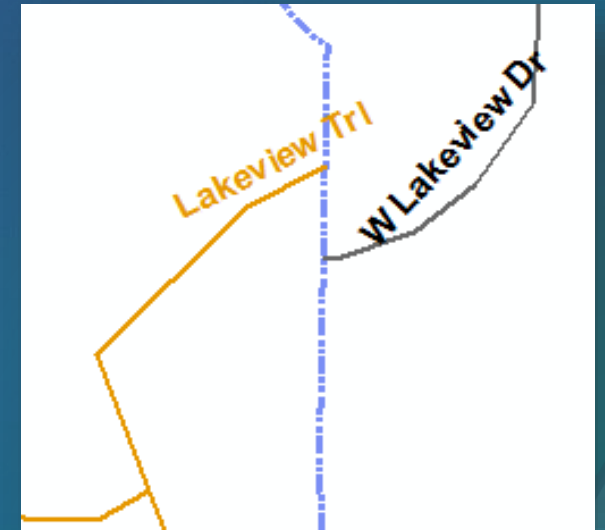
## Common obstacles in analysis and mapping:

- **Spatial and attribute inconsistency caused by differences in data collection and modeling**
- **High cost to fix the problems**

**Overlapping datasets**



**Adjacent datasets**



# Conflation reconciles multi-source datasets and optimizes data quality and usability

## Between overlapping datasets :

- Detect feature changes (differences) through feature matching
- Make spatial adjustment and attribute transfer

## Between adjacent datasets :

- Detect and resolve feature conflicts and disconnections through edge matching and alignment

## Ultimately:

- Maintain an unified and seamless dataset – enriched and up-to-date
- No longer live with various imperfect datasets
- Rely on the data to perform analysis and quality mapping with confidence

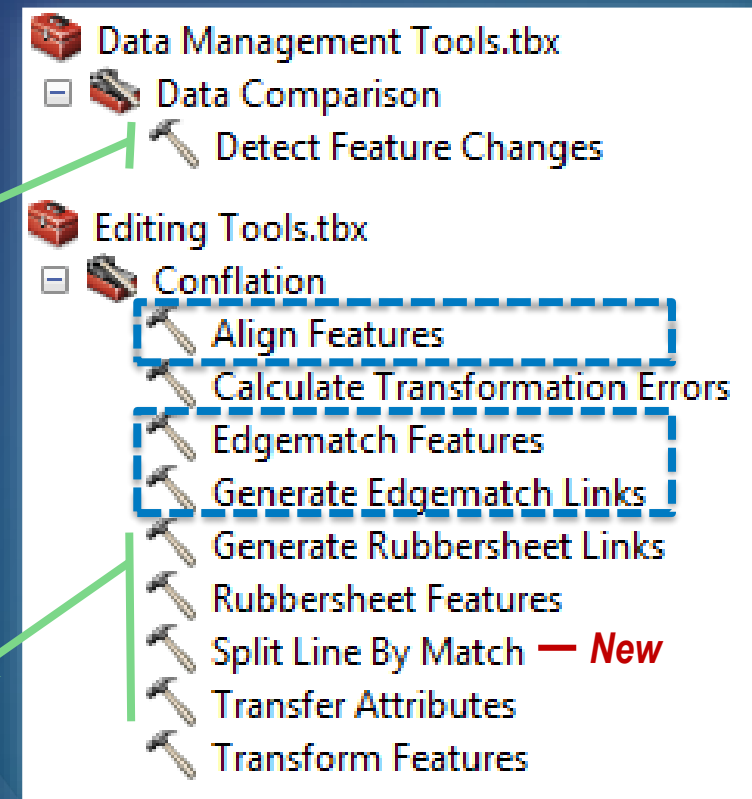
# Highly automated geoprocessing tools

## New and enhanced system tools

- **Focusing more on linear features (roads, parcel lines, etc.)**
- **Aiming at high accuracy (not promising 100%)**
- **Providing information to facilitate post-processing**

## Improved workflows

**In ArcGIS 10.6.1 and Pro 2.2**



### **Conflation Tools and Workflows: An Introduction**

1:00pm – 2:00pm, Tuesday, Room 30D

2:30pm – 3:30pm, Wednesday, Room 29C

# Edge matching (**EM**) tools for adjacent datasets

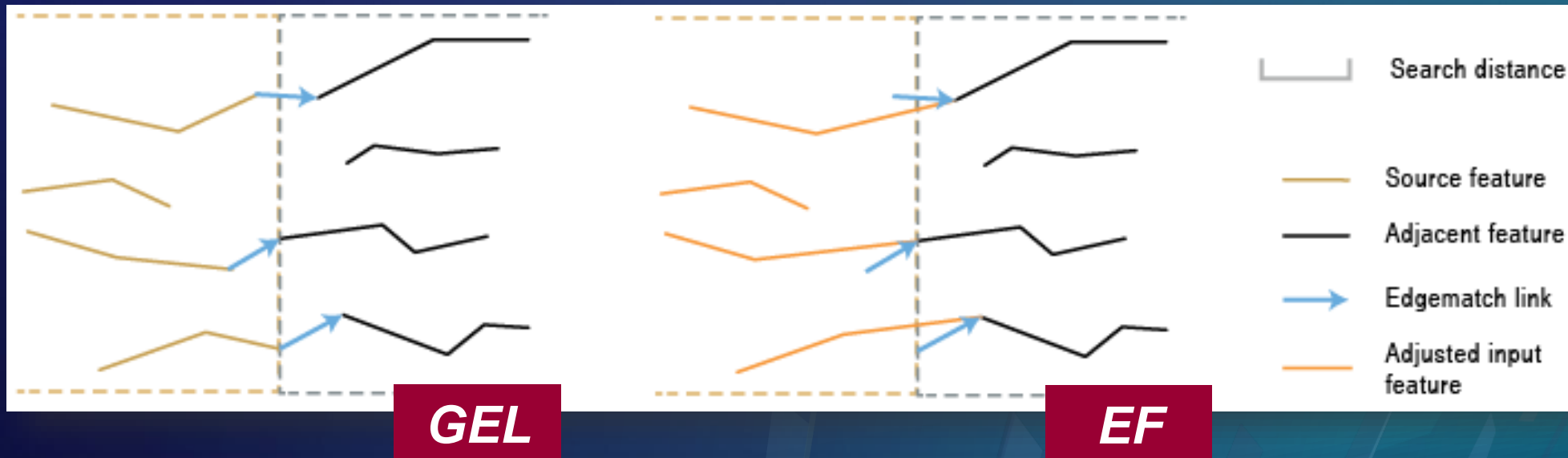
Based on proximity, topology, and continuity analysis, as well as attributes

## Generate Edgematch Links (**GEL**)

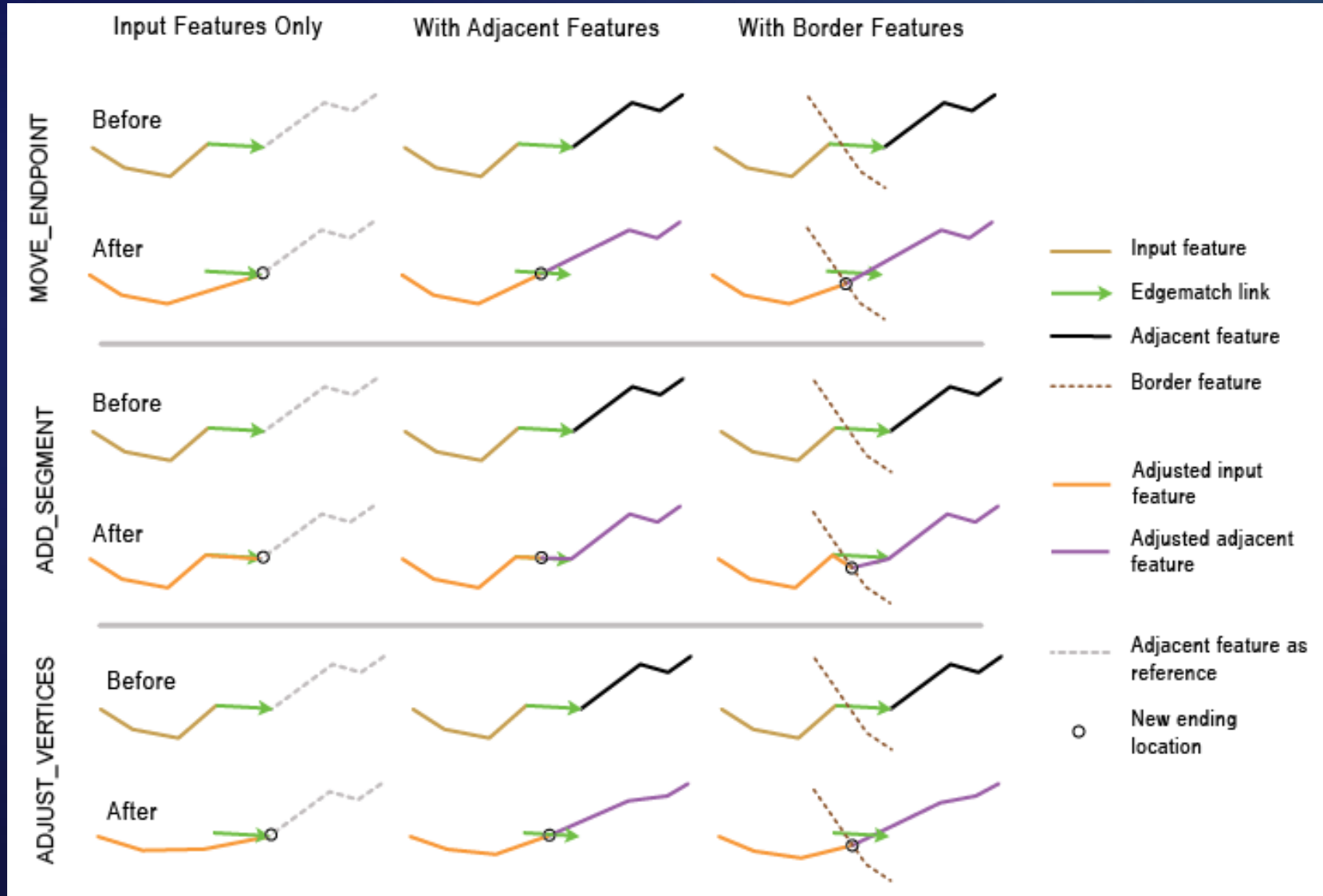
- From input features to adjacent features

## Followed by Edgematch Features (**EF**)

- Connects features guided by the established links



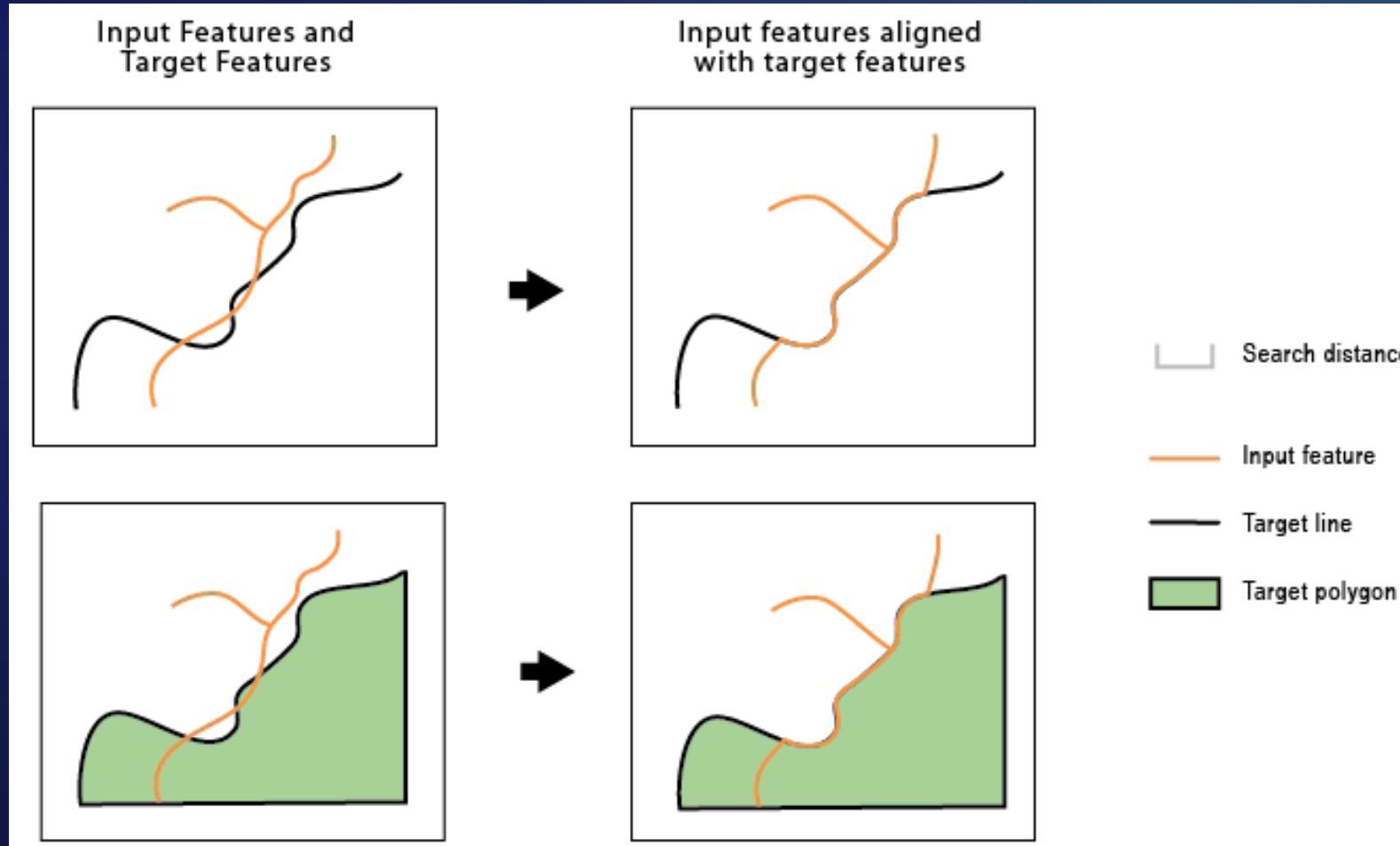
# Options for connecting features





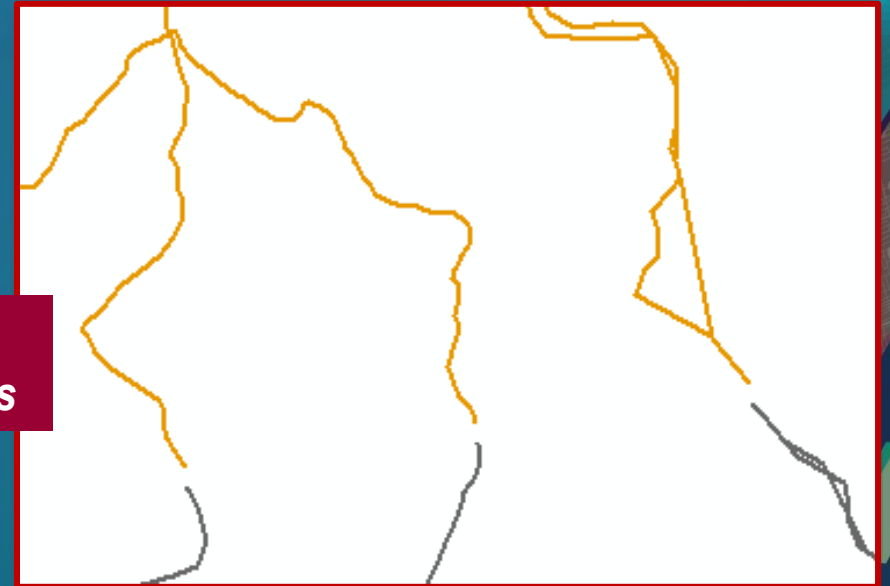
# Align Features

Based on proximity, topology, and similarity analysis, as well as attributes information



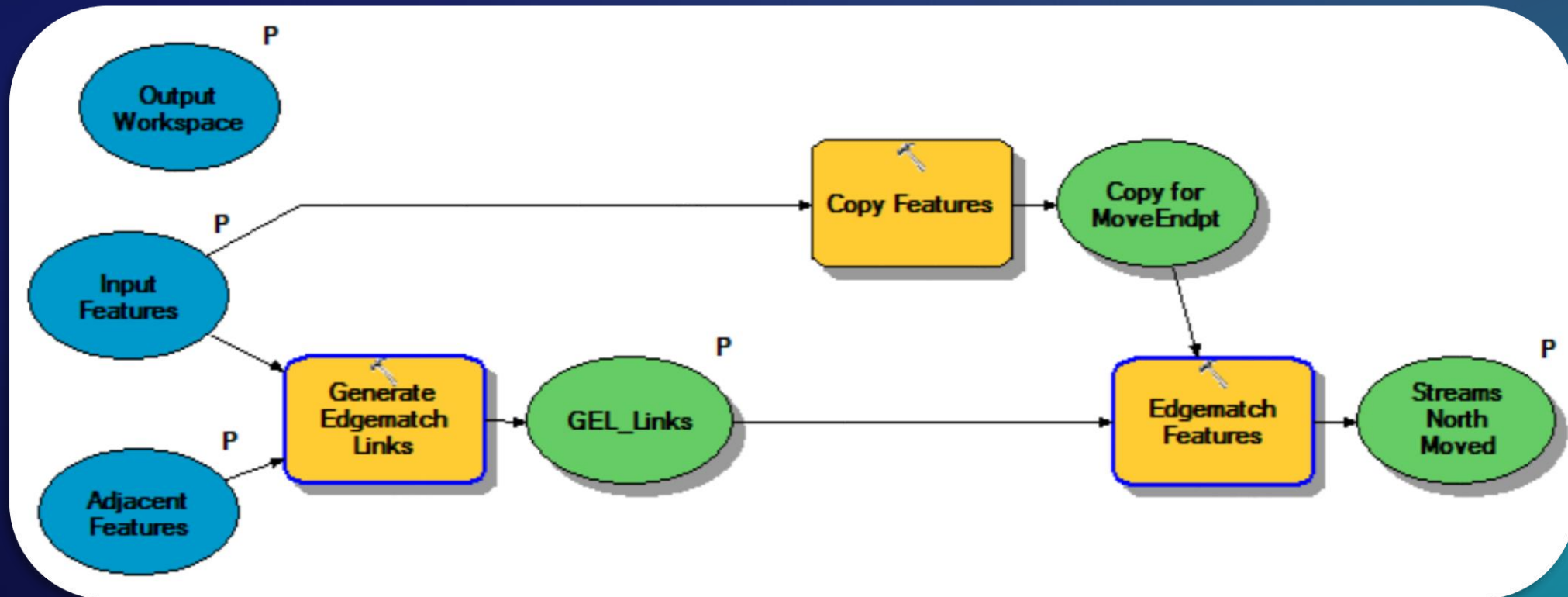
# Edge Matching Workflows

*Two adjacent,  
disconnected datasets*



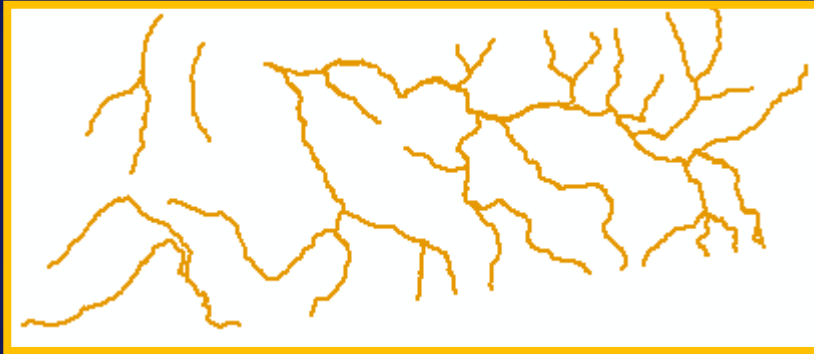
# Conceptual, ideal workflow

Goal - make two adjacent line datasets properly connect

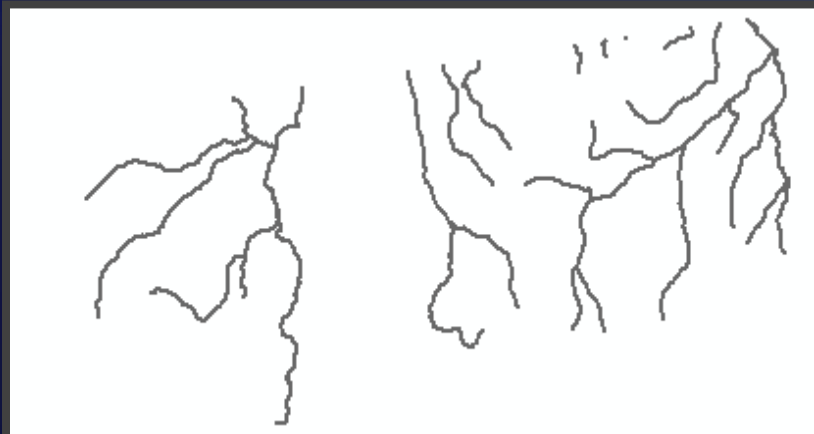


# Example edgematching of adjacent datasets

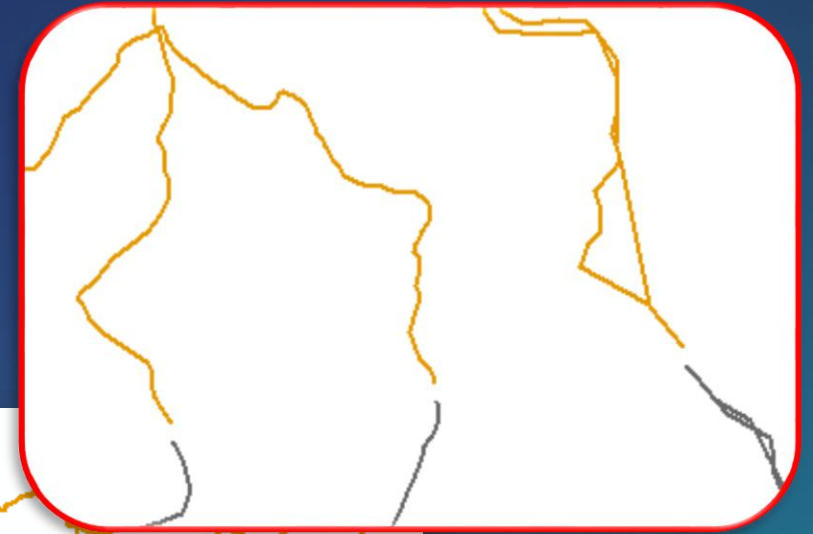
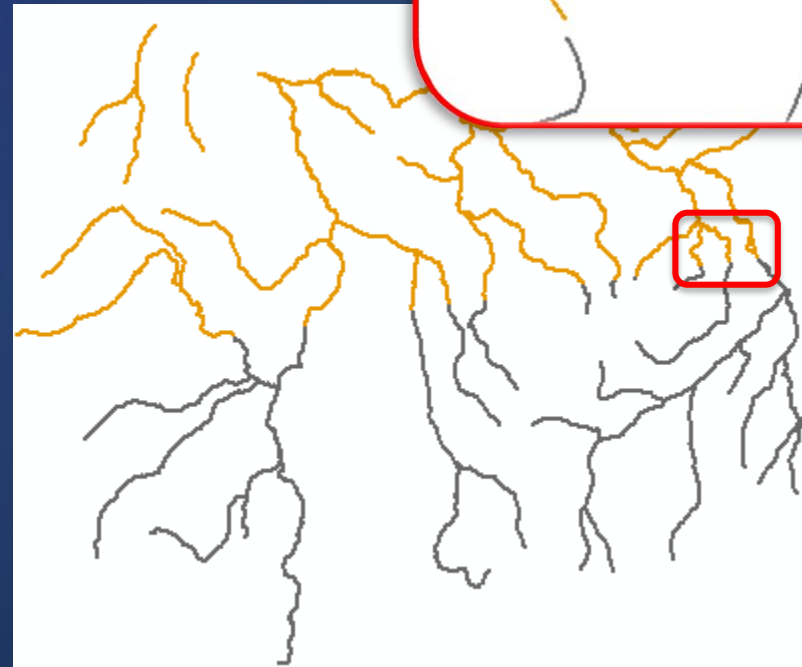
Source features



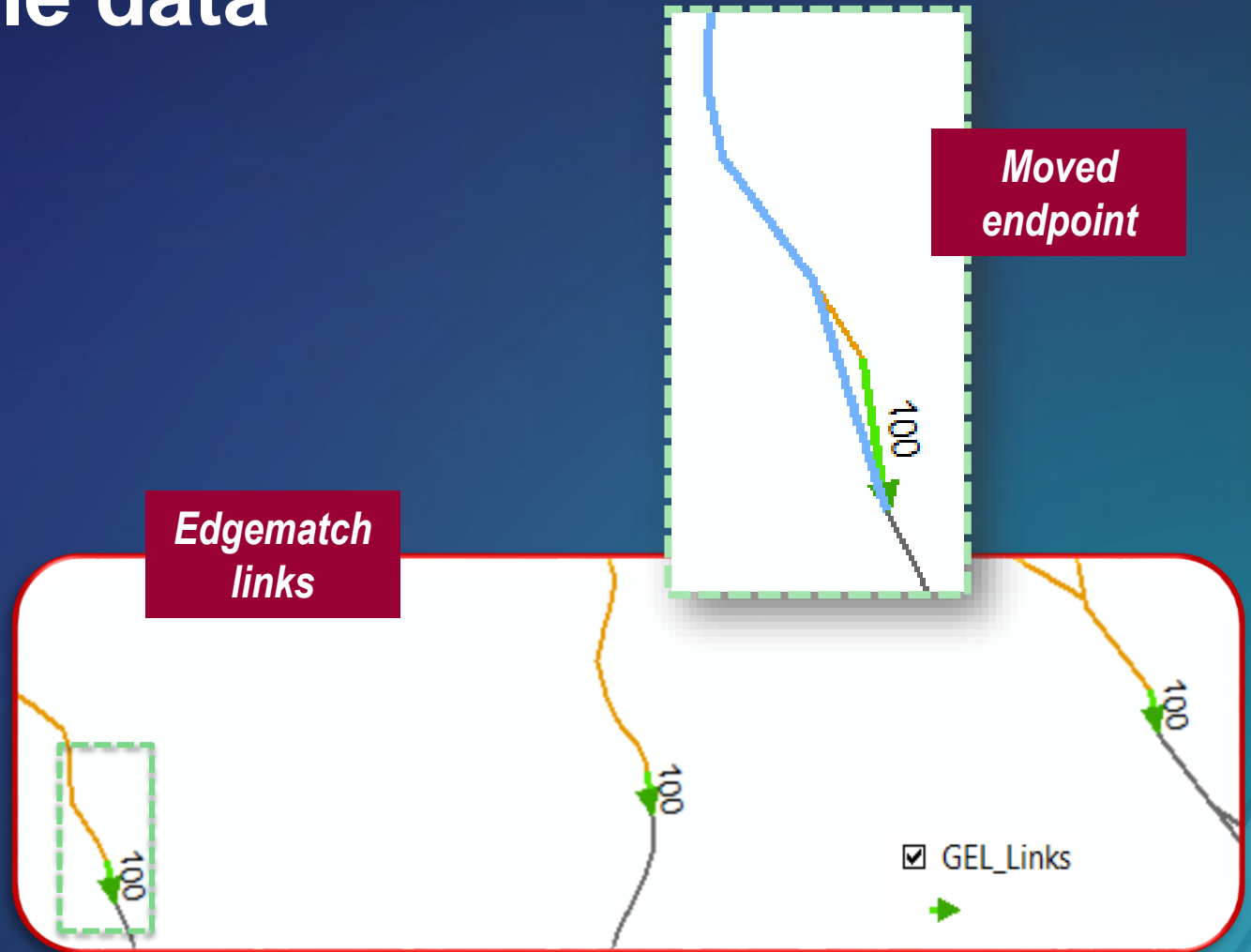
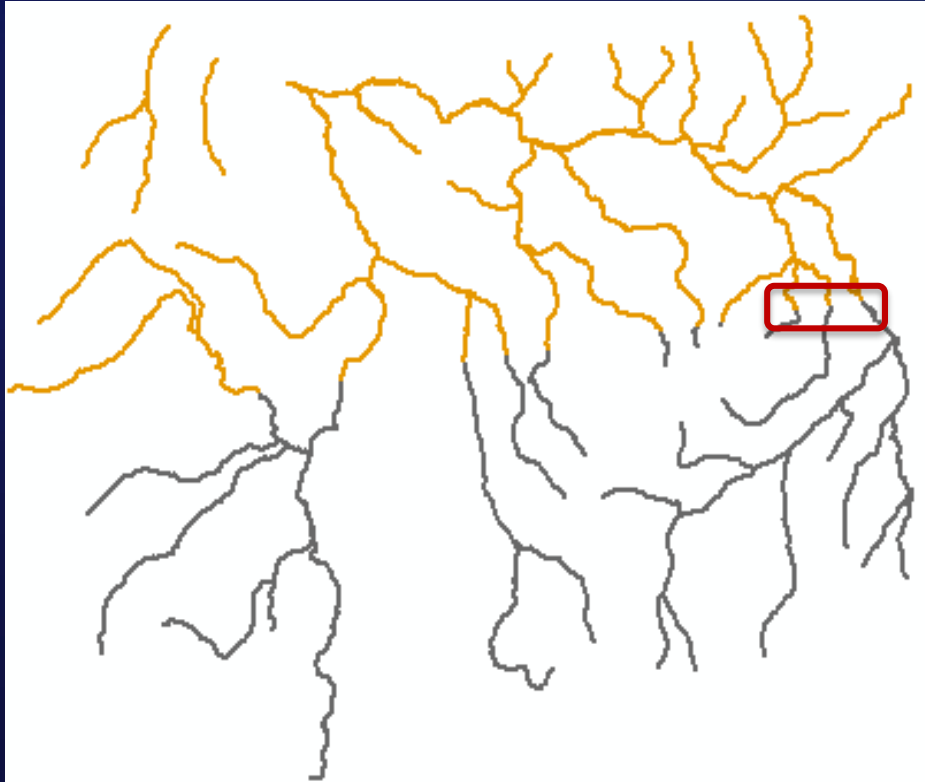
Adjacent features



Together

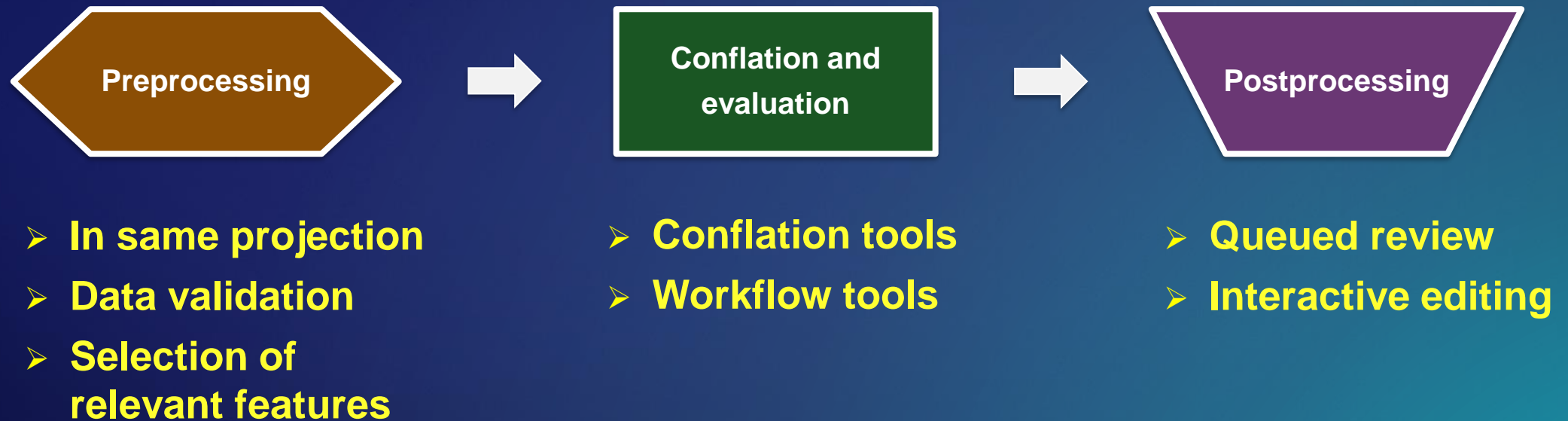


# Perfect results of simple data



*The reality is more complicated ...*

# Conflation workflow in real world scenarios



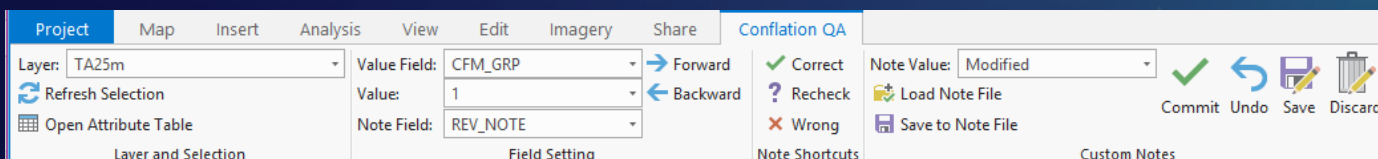
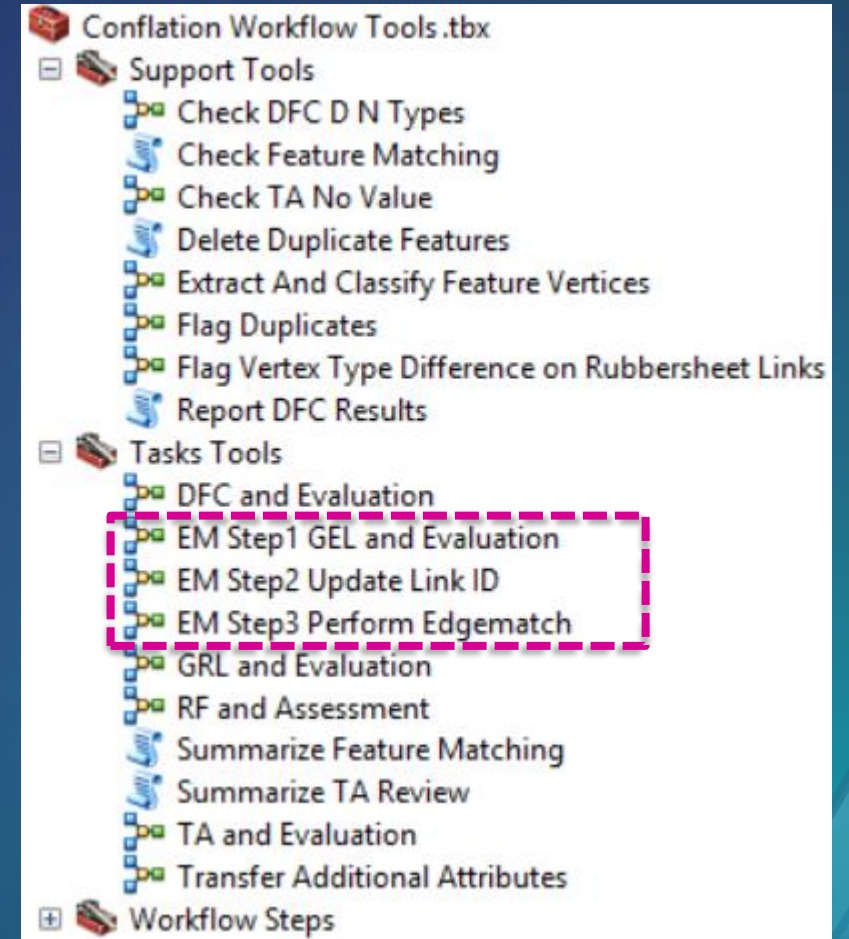
# Supplemental Conflation Workflow Tools

## Popular tasks:

- **Transfer attributes**
- **Spatial adjustment**
- **Detect feature changes**
- **Edge matching**

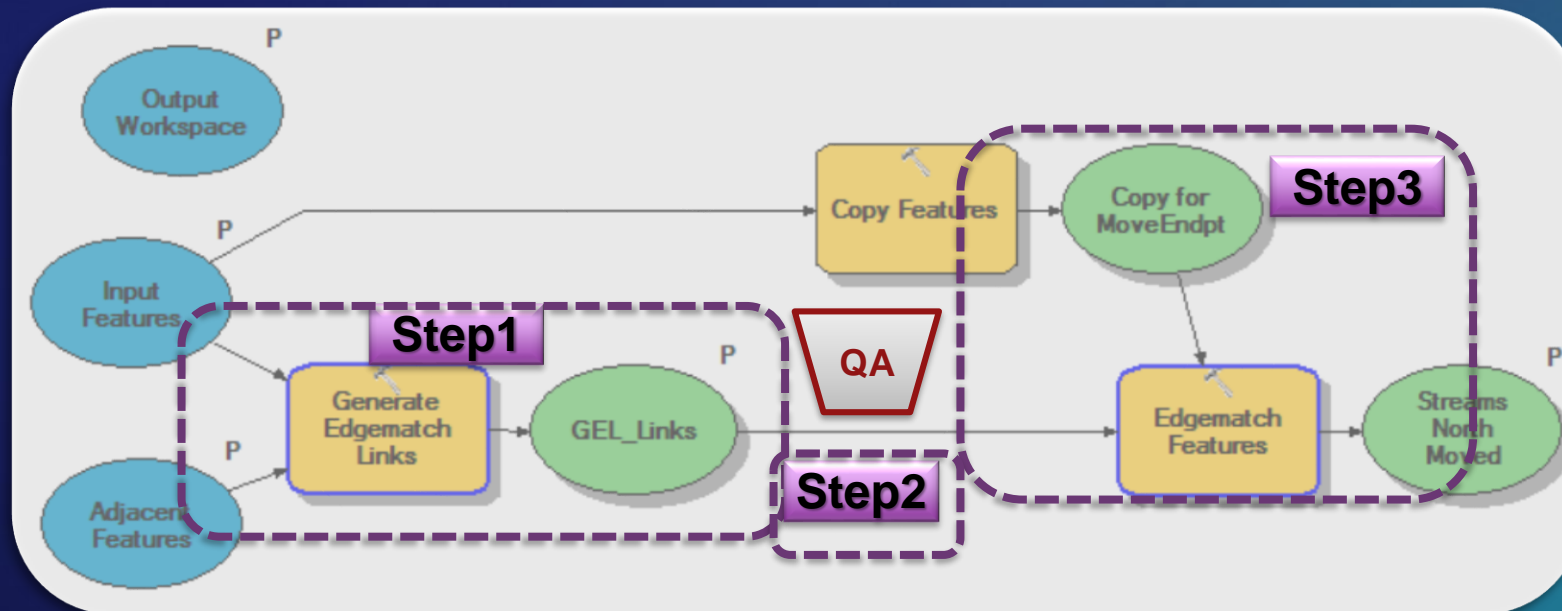
## Focusing on tasks:

- **Task specific tool set**
- **Enriched results to facilitate inspections**
- **Enhanced interactive tools (python add-in for ArcMap; SDK add-in for Pro)**



*This demo shows TA workflow in Pro 2.2 ...*

# Breakdown of the ideal workflow into sub-steps





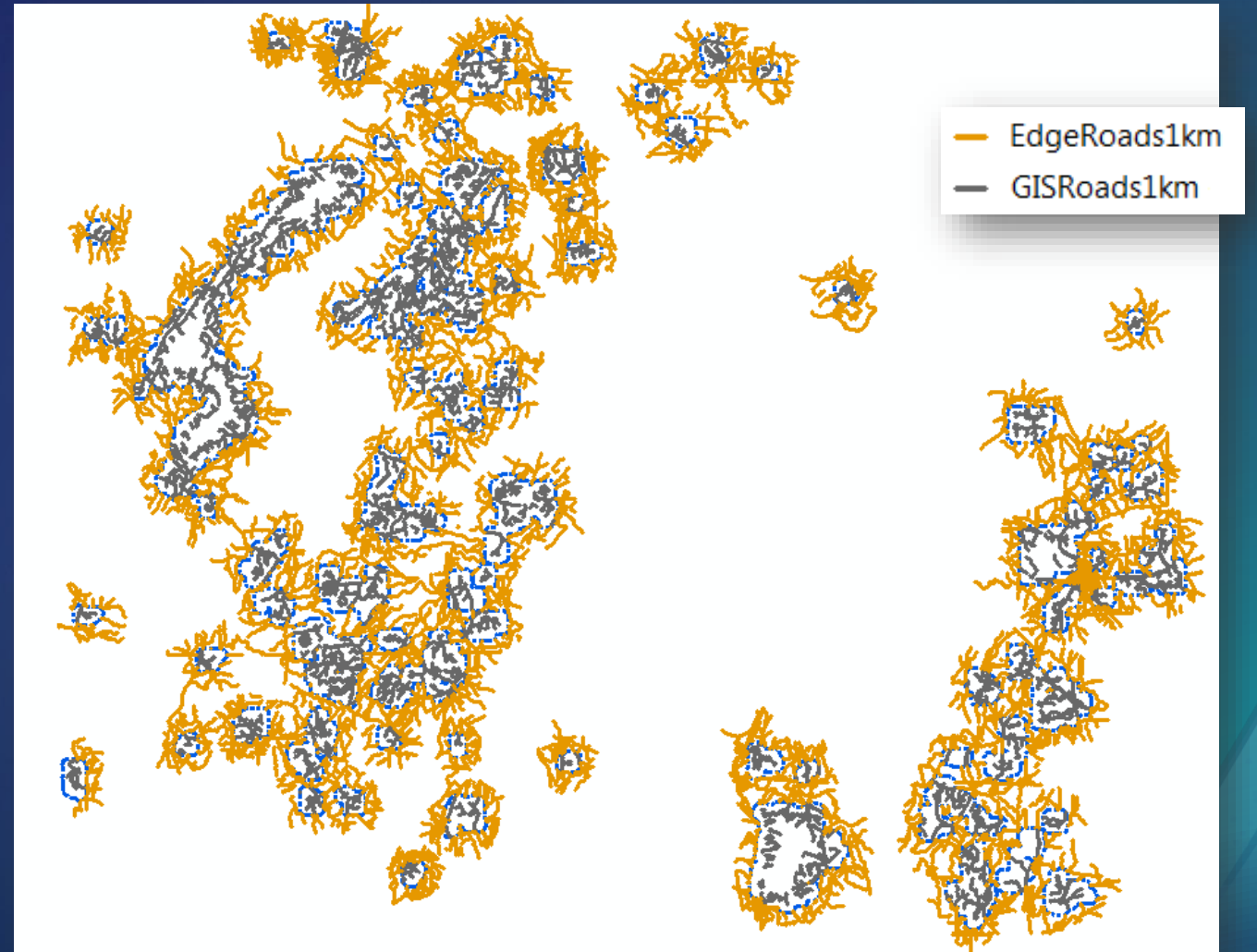
# Demo: edgematching roads

Two road datasets (an area in Alabama):

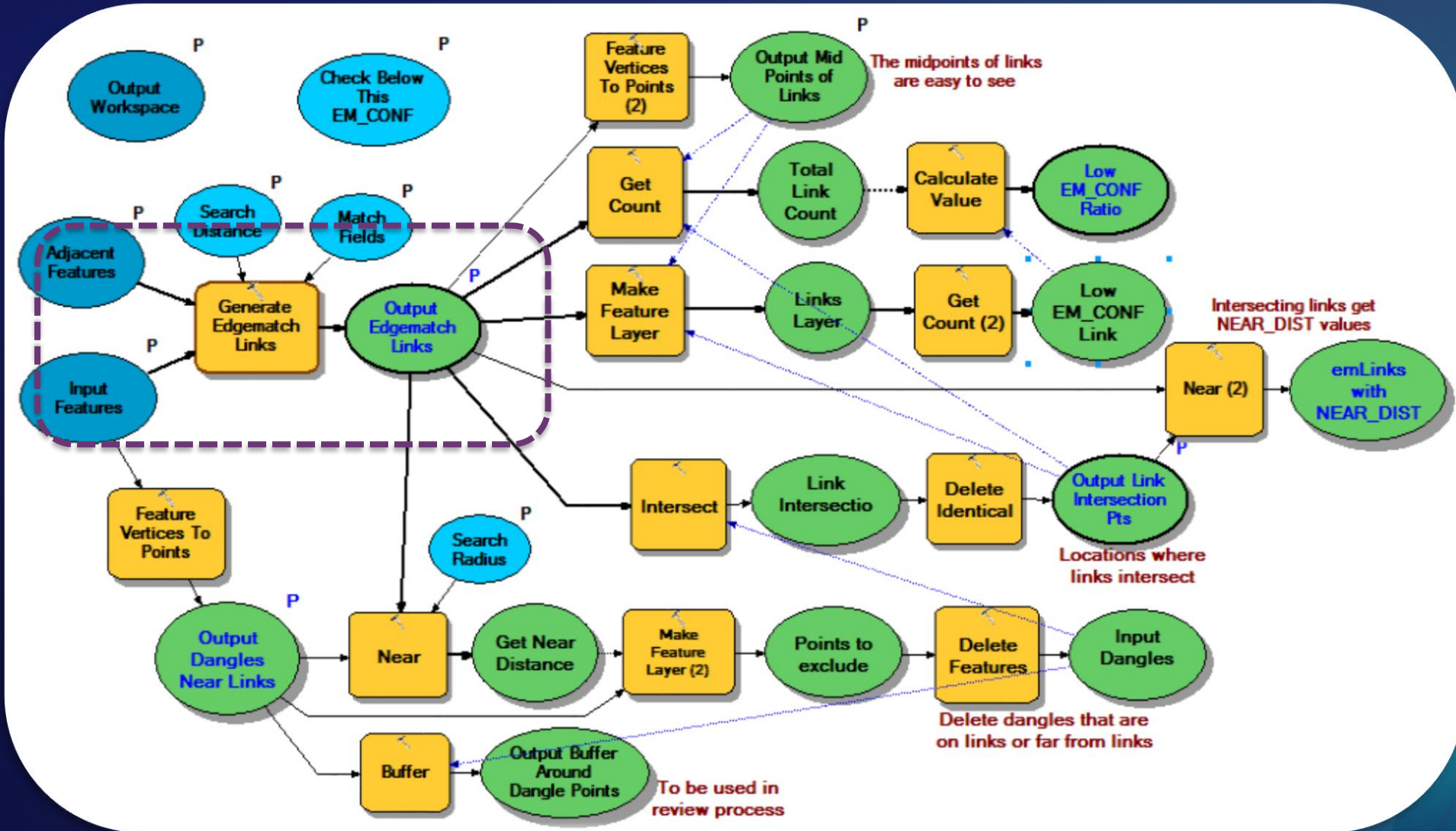
- **EdgeRoads** – 7576 features
- **GISRoads** – 3634 features

Both datasets:

- **Contain roads that are within 1 km to borders**
- **Have inconsistent road names**

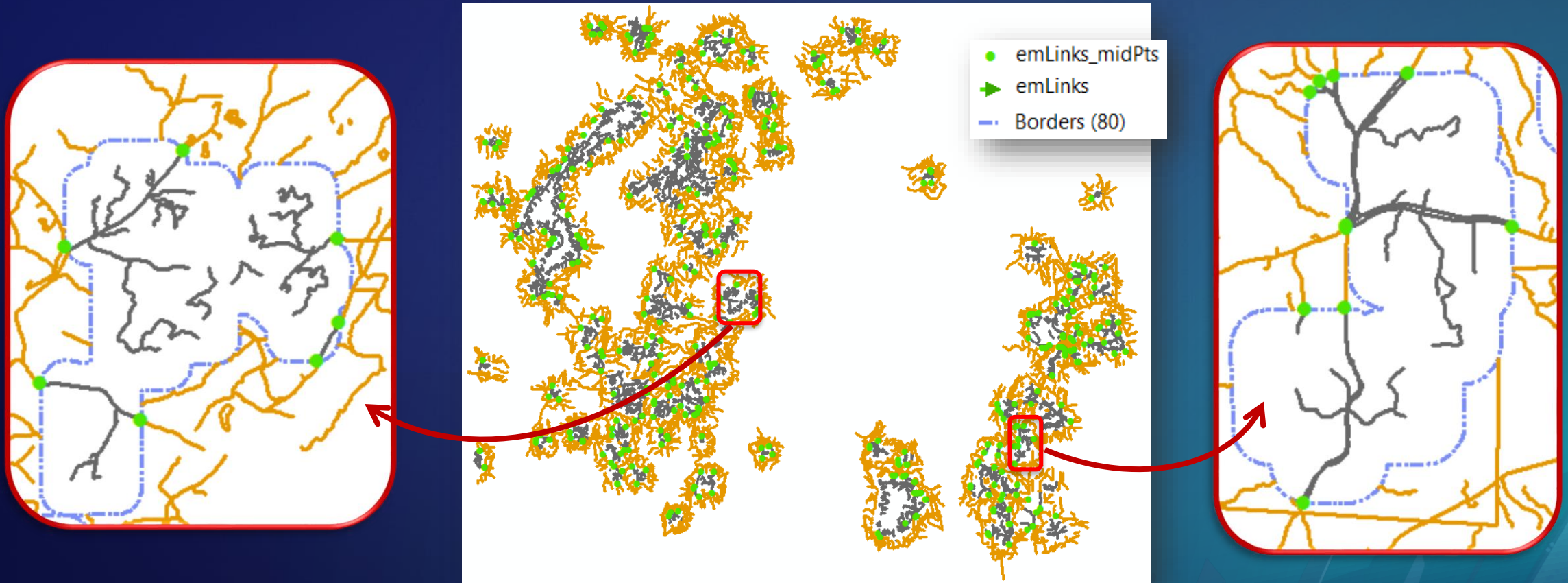


# EM Step1 GEL and Evaluation



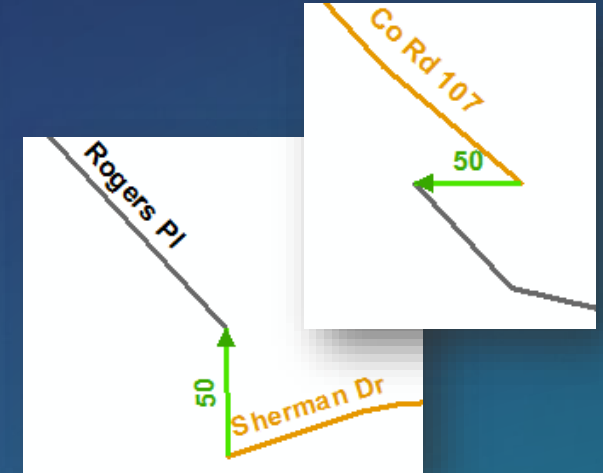
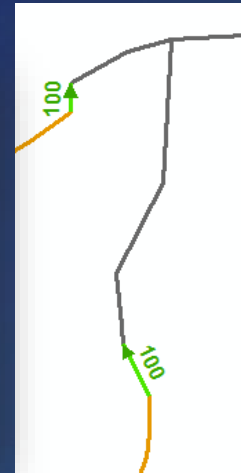
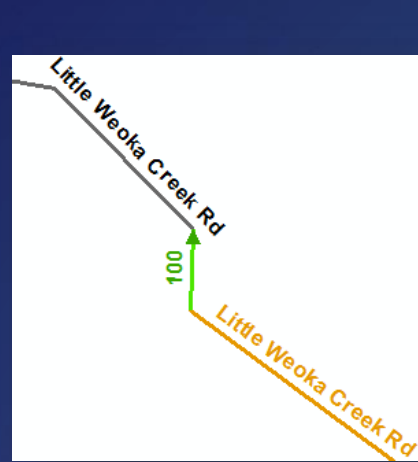
# GEL result

Generated 454 links; midpoints of links were created for visualization purpose.  
Borders were not in the process, but displayed for reference.

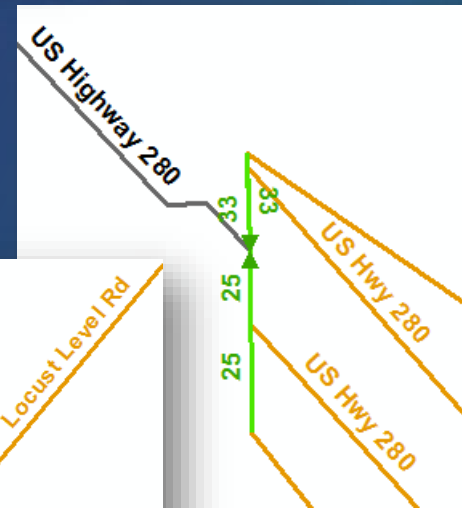
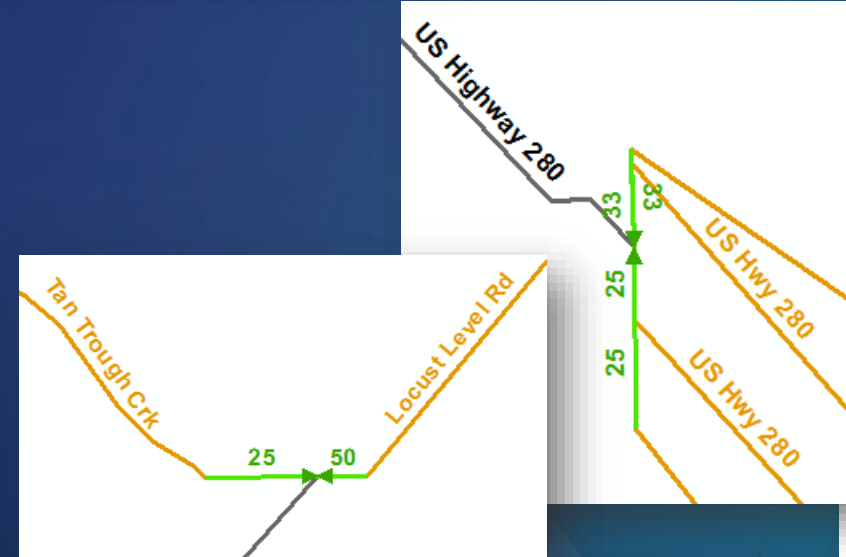


## EM\_CONF in output

- 100 (matched with no ambiguity)
- 50 (spatially matched with unmatched attributes)
- < 50 (spatially matched with some ambiguity and weak continuity)



OBJECTID *	SHAPE *	SRC_FID	TGT_FID	EM_CONF
402	Polyline	6763	346	100
403	Polyline	6768	607	100
409	Polyline	6854	3047	100
418	Polyline	6946	2898	100
421	Polyline	7019	2053	100
425	Polyline	7148	3343	100
442	Polyline	7420	2240	100
450	Polyline	7532	1390	100
2	Polyline	51	46	50
3	Polyline	51	42	50
5	Polyline	207	21	50
6	Polyline	227	51	50
7	Polyline	359	1618	50
10	Polyline	397	890	50
12	Polyline	404	1366	50

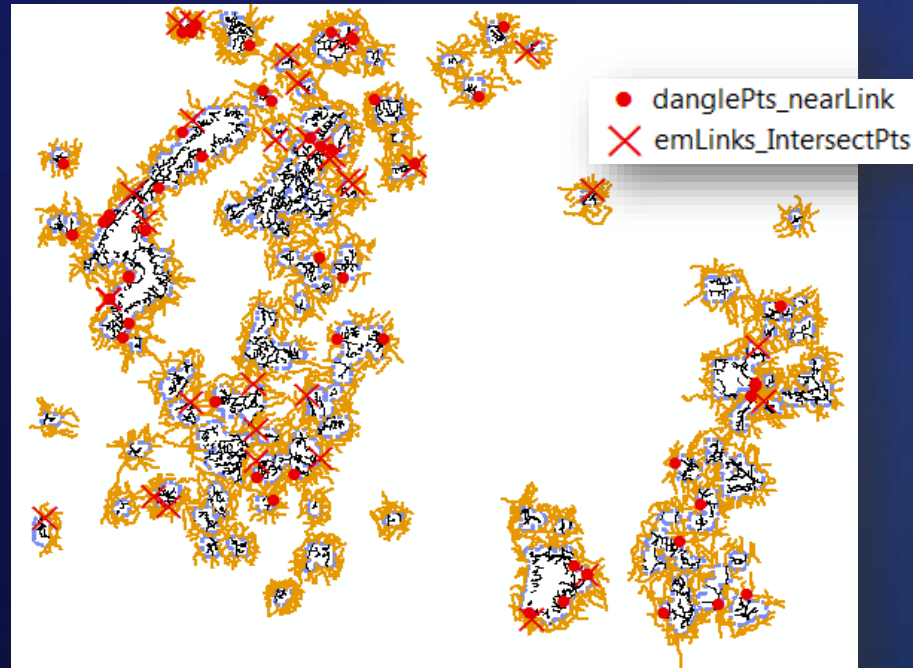


# GEL evaluation results

EM\_CONF < 33: 134 links

Intersecting links: 33 locations

Potential missing links: 62 source dangle locations



Table

emLinks

OBJECTID *	SHAPE *	SRC_FID	TGT_FID	EM_CONF	SHAPE_Length	NEAR_FID	NEAR_DIST
107	Polyline	2093	1444	4	40.738594	19	0.000043
326	Polyline	5493	1439	6	23.537258	19	0.00002
1	Polyline	20	21	33	7.172191	1	0
5	Polyline	207	21	50	6.374133	1	0
8	Polyline	364	3041	20	37.807129	3	0
14	Polyline	442	3041	50	11.227967	3	0
23	Polyline	754	3139	25	32.194831	5	0
26	Polyline	828	3598	10	53.134568	7	0
36	Polyline	986	3071	100	0.625383	9	0
37	Polyline	987	3117	11	41.232301	59	0
44	Polyline	1068	2613	33	46.451843	11	0
54	Polyline	1326	2870	20	7.738393	62	0
57	Polyline	1350	3386	100	48.961098	13	0
63	Polyline	1407	2000	25	33.527426	15	0
65	Polyline	1414	1113	25	59.985441	17	0
67	Polyline	1458	2870	17	21.200973	62	0
73	Polyline	1581	3117	50	0.0806	50	0

*It's time for inspection ...*

# Inspection and editing of edgematch links

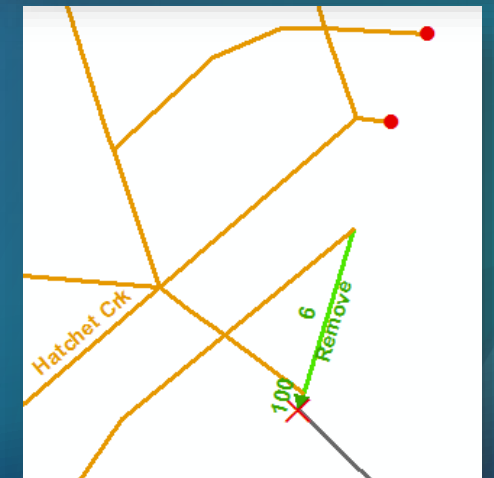
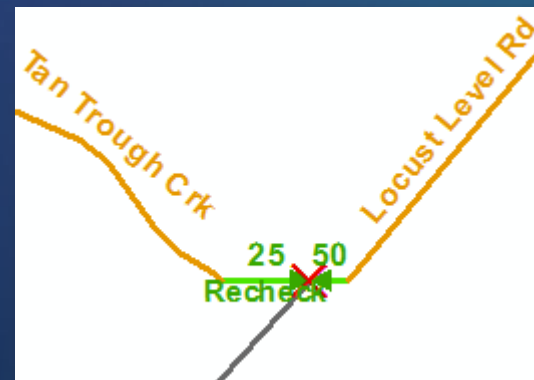
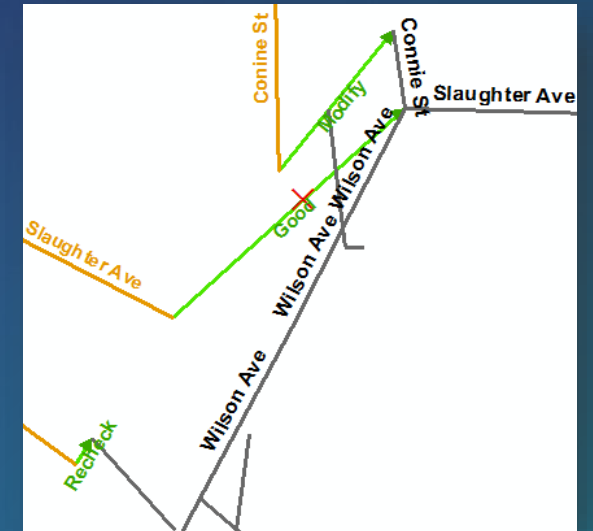
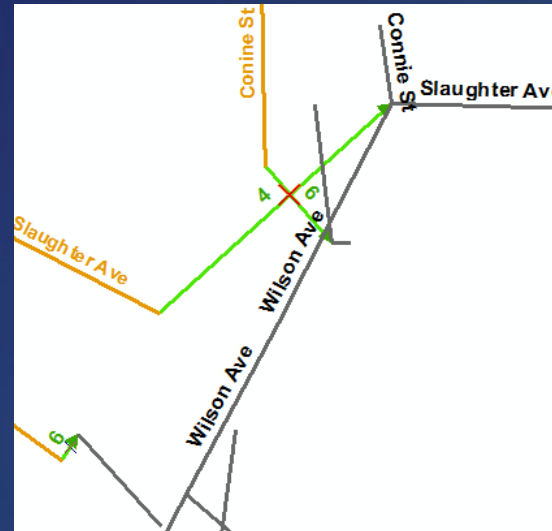
## Reviewed:

- 33 locations of intersecting links  
NEAR\_DIST >= 0
- 98 low EM\_CONF links  
(EM\_CONF < 33) AND (REV\_FLAG IS NULL)
- 62 source dangle locations (near links)

## Summary:

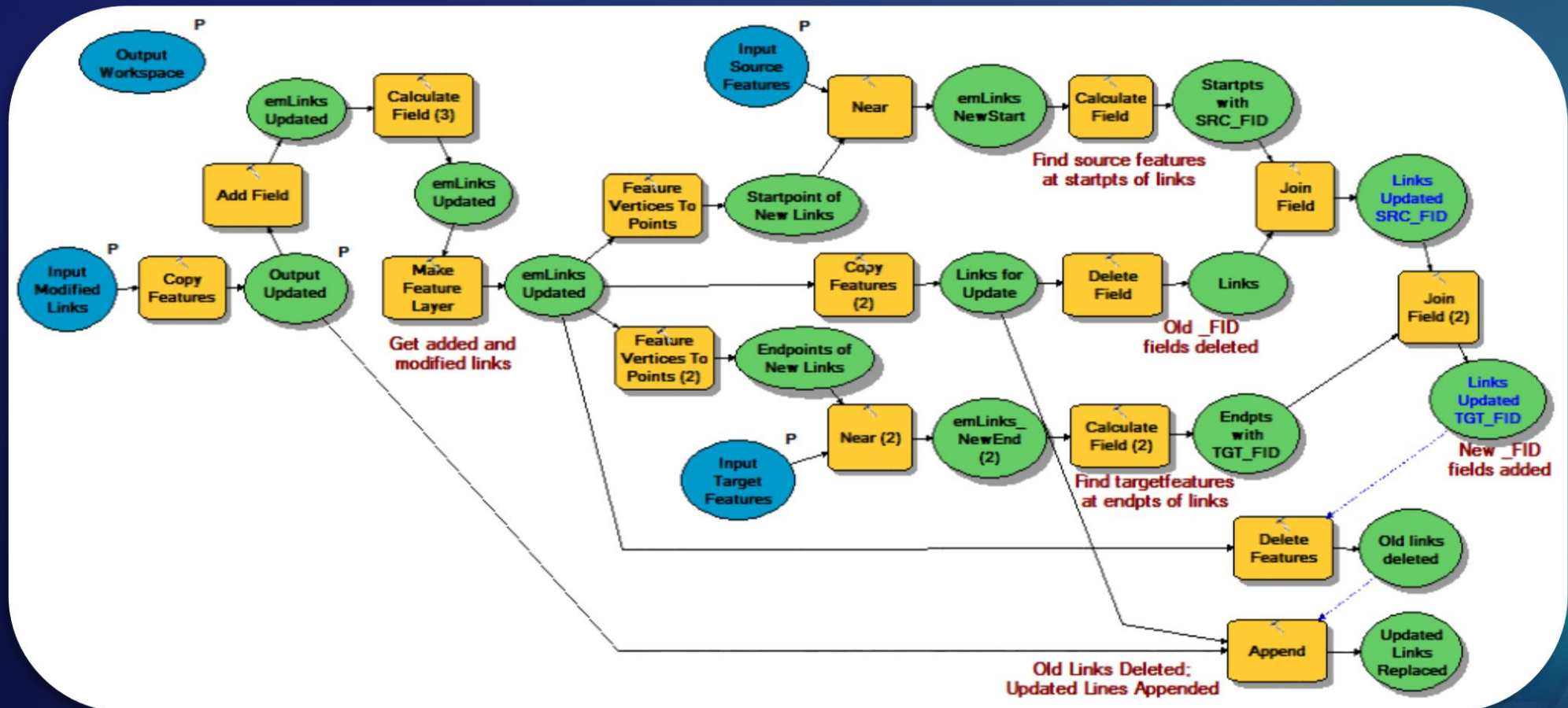
- 388 (~85%) of total 459 links were good (54 were flagged for recheck)
- 71 (~15%) of total links were modified, removed, or added

emLinks_freqREVFLAG			
OBJECTID *	FREQUENCY	REV_FLAG	
1	267	<Null>	
2	5	Added	
3	66	Good	
4	46	Modify	
5	55	Recheck	
6	20	Remove	



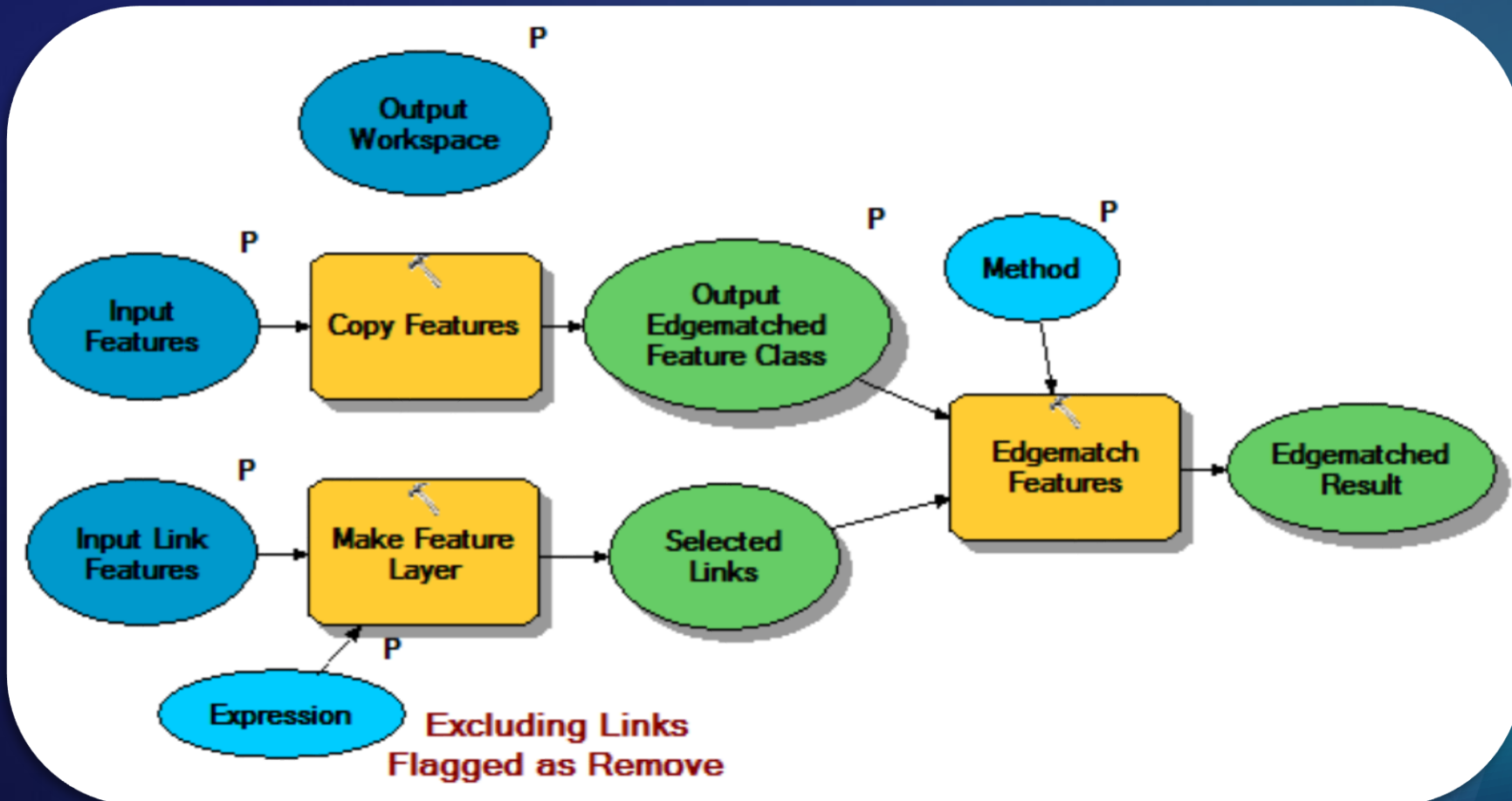
# What happened to the SRC\_FID and TGT\_FID of the added or modified links?

## EM Step2 Update Link ID



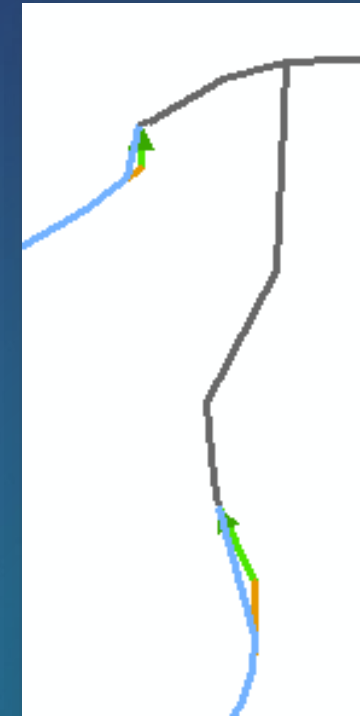
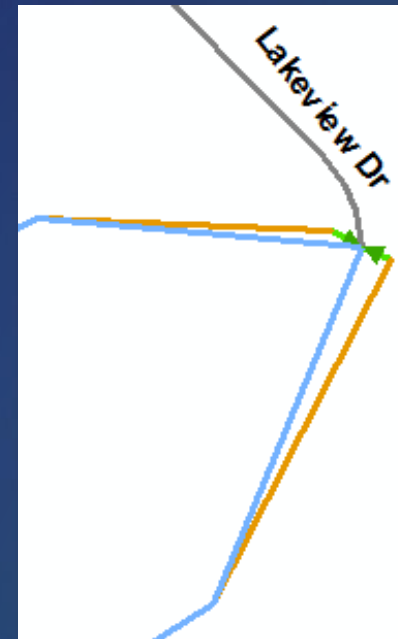
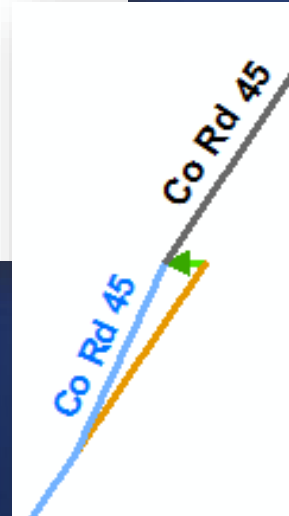
# Edgematch Features

## EM Step3 Perform Edgematch





# Edgematch result



**Review flagged locations ...**

# Edgematching of adjacent datasets workflow completed!

**Automated  
processing**

	Processing Time
Step1	6.52 sec
Step2	4.09 sec
Step3	2.15 sec
Total	12.76 sec

**Interactive  
processing  
(not counting  
final review)**

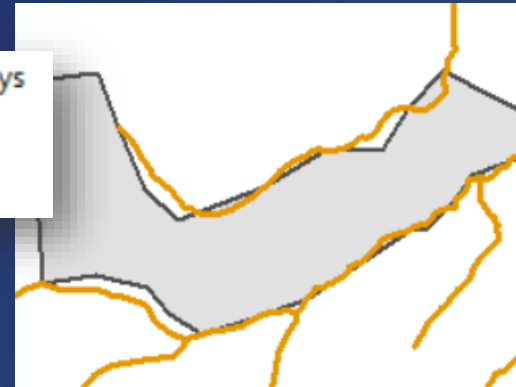
	QA Links	Time (2-3 review counts per minute)
Review Count (locations or feature groups)	~ 193	~ 1 - 1.6 hrs.
Edit Count (field values)	192	

# Examples of Align Features

## Inconsistent bordering features

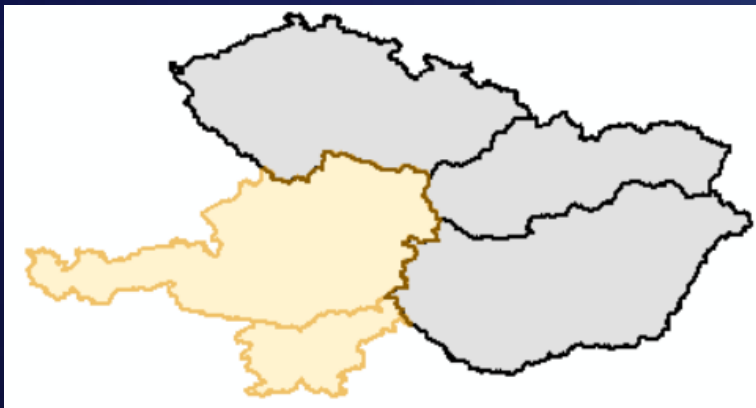
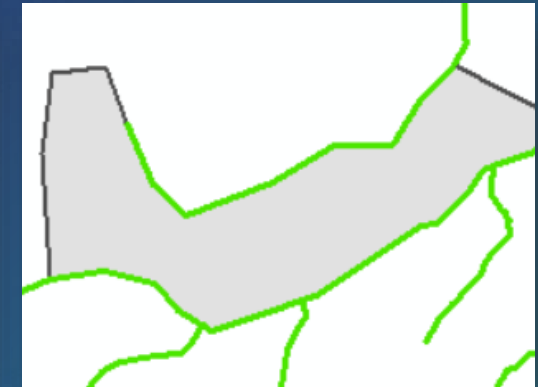


## Before

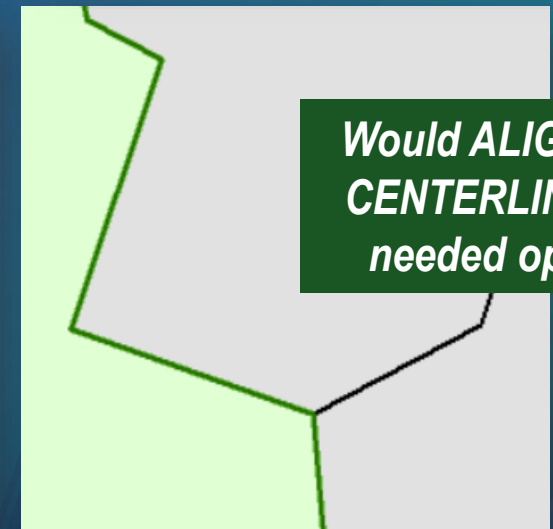
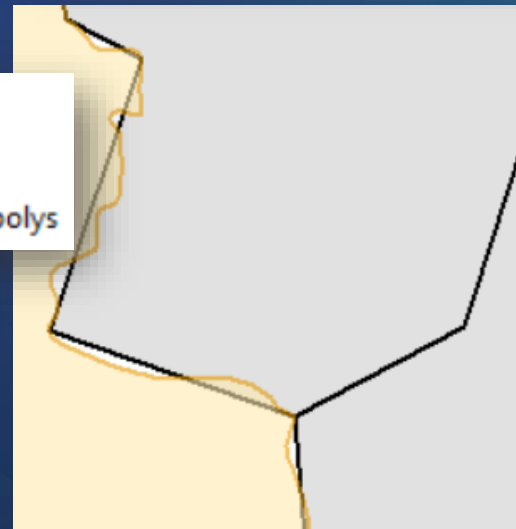


- AF\_LinesToPolys
- Lines
- Polys

## After



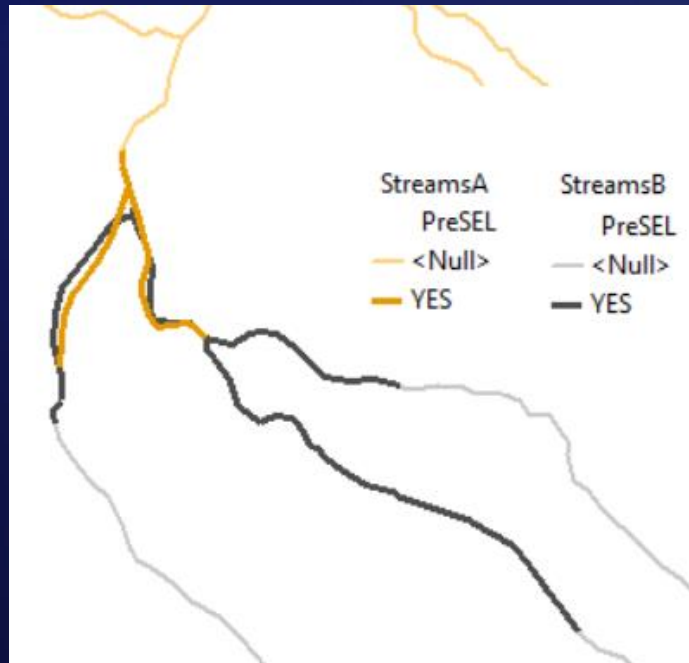
- 2polys
- 3polys
- AF 2polys -> 3polys



Would **ALIGN\_TO\_CENTERLINE** be a needed option?

# Aligning stream features between map sheets

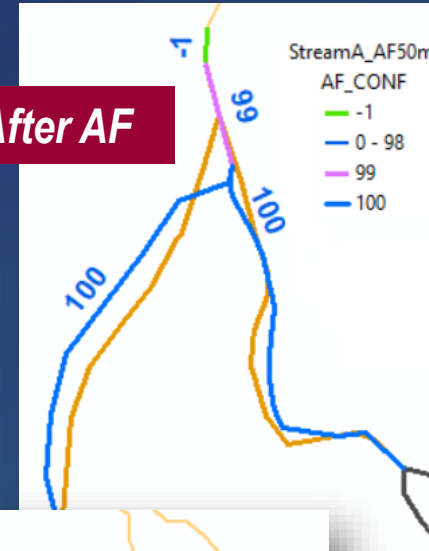
**Pre-selection**



**Before AF**



**After AF**



**Identical parts to be removed**

**Remaining affected features replaced**

**Would ALIGN\_TO\_CENTERLINE be a needed option?**

# Conclusions and Future Work

## Thanks to:

- Department of Public Works (DPW), Los Angeles County, USA.
- Resource Management Service, LLC, Birmingham, AL, USA.
- SwissTopo, Switzerland
- All others who supported us along the way.

# Edge matching can be done more efficiently now

## It takes a workflow:

- **Automated tools produce highly accurate results and evaluate the information.**
- **Minimal interactive review and editing are likely necessary. The time is worth-investing.**

## It brings new life and value to your data

- **Improved data quality and usability**
- **Seamless analysis and mapping**
- **Extended data sharing and collaboration**

*Please send us your feedbacks and share your stories ... 😊*

# Future work

## New tools and enhancements

- **Continue improving feature matching**
- **Further enrich output to facilitate post processing**
- **Develop new tools or options for other feature types and scenarios**

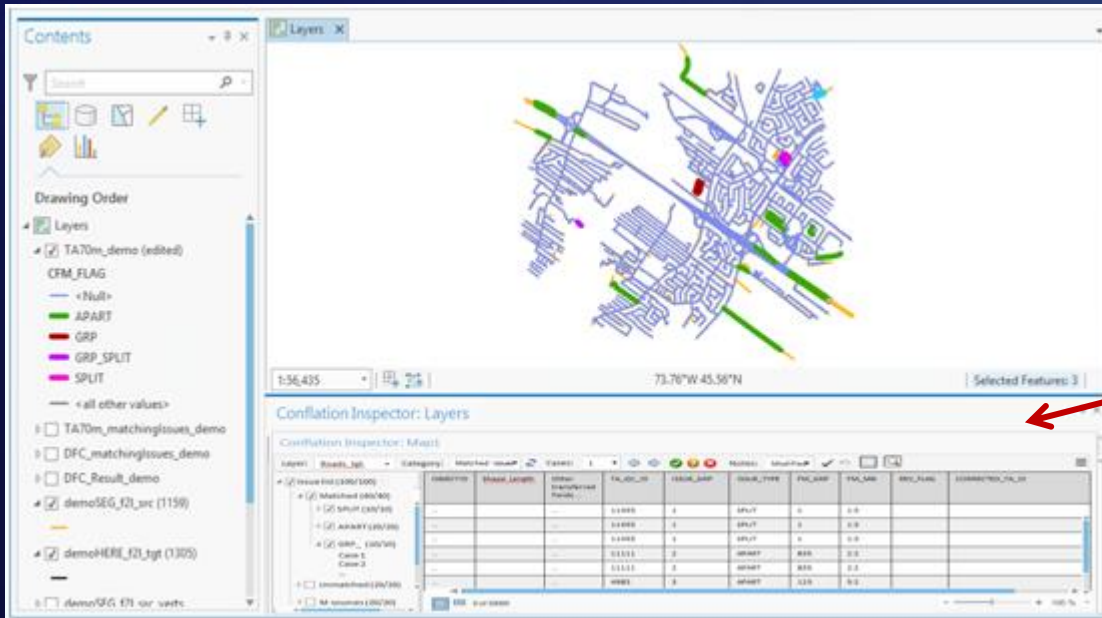
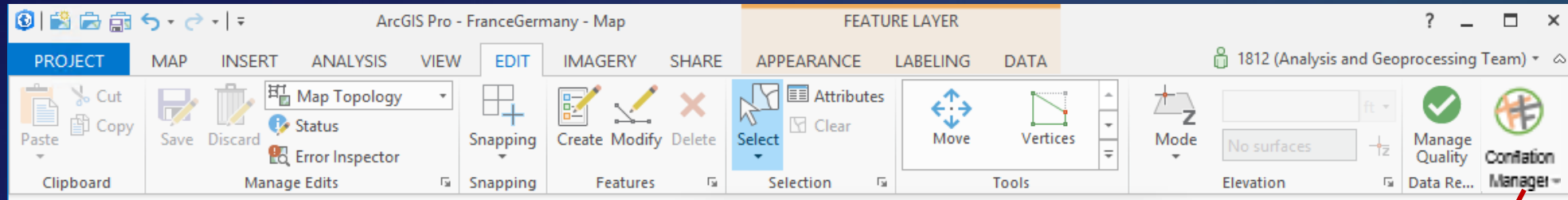
## Integrated processing and inspection system

- **Design of Conflation Manager for ArcGIS Pro is underway**

## Formalization of workflows

- **Common scenarios (e.g. multi-scale data updating, linking features of different scales)**
- **Incorporation of other data sources (imagery, lidar, GPS)**
- **Contextual conflation (spatially related features)**

# Conflation Manager (ConfMgr)



### Tasks

Transfer Attributes

Tasks | Messages

- Preparation (optional)
  - Clarify topology
  - Split lines by match (if the tool is created...)
- Automatic processing
  - Run TA and Evaluation process
- Review
  - Open the Conflation Inspector**
  - Review potential match issues
  - Review potentially missed matches
  - Review multiple source transfers (optional)
- Completion
  - Finalize the transfer
  - Generate a report about the process (optional)

### Conflation Scenarios

#### Single Tasks

- Detect spatial and attribute changes between two datasets.
- Perform rubbersheeting adjustment to bring source features closer to target features.
- Transfer user specified attributes from source to target features
- Perform edgematching adjustment to connect input features with adjacent features.
- Align input features with target features.

#### Comprehensive Tasks

- Unify two datasets**  
Reconcile spatial and attribute differences.



# Recent papers

- Baella B, Lee D, Lleopart A, Pla M (2014) *ICGC MRDB for topographic data: first steps in the implementation*, The 17<sup>th</sup> ICA Generalization Workshop, 2014, Vienna, Austria. [https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2014/genemr2014\\_submission\\_8.pdf](https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2014/genemr2014_submission_8.pdf)
- Lee D, Ahmed N, Chowdhury, I (2018), *Incorporating Changes in Multi-scale Databases*, poster presentation, AutoCarto/UCGIS Conference, 2018, Madison, Wisconsin, USA. <http://www.ucgis.org/assets/docs/AutoCarto-UCGIS%202018%20Proceedings.pdf> (page 95)
- Lee D, Yang W, Ahmed N (2017), *Road data conflation – the key step to geospatial data enhancement*, The 28th International Cartographic Conference, 2017, Washington DC, USA.
- Lee D (2015), *Using Conflation for Keeping Data Harmonized and Up-to-date*, ICA-ISPRS Workshop on Generalisation and Multiple Representation, 2015, Rio de Janeiro, Brazil. [https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2015/genemr2015\\_submission\\_8.pdf](https://kartographie.geo.tu-dresden.de/downloads/ica-gen/workshop2015/genemr2015_submission_8.pdf)
- Lee D, Yang W, Ahmed N (2015) *Improving Cross-border Data Reliability Through Edgematching*, The 27th International Cartographic Conference, 2015, Rio de Janeiro, Brazil. <http://www.icc2015.org/abstract,670.html>
- Lee D, Yang W, Ahmed N (2014) *Conflation in Geoprocessing Framework - Case Studies*, GEOProcessing, 2014, Barcelona, Spain. <http://goo.gl/iOoSGV>
- Yang W, Lee D, and Ahmed N (2014), “Pattern Based Feature Matching for Geospatial Data Conflation”, GEOProcessing, 2014, Barcelona, Spain. <http://goo.gl/JKGJbo>

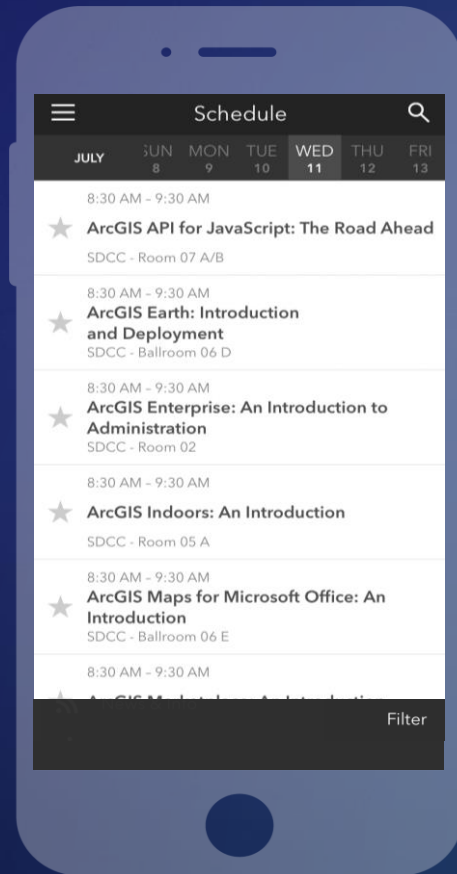
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Your feedback allows us to help maintain high standards and to help presenters

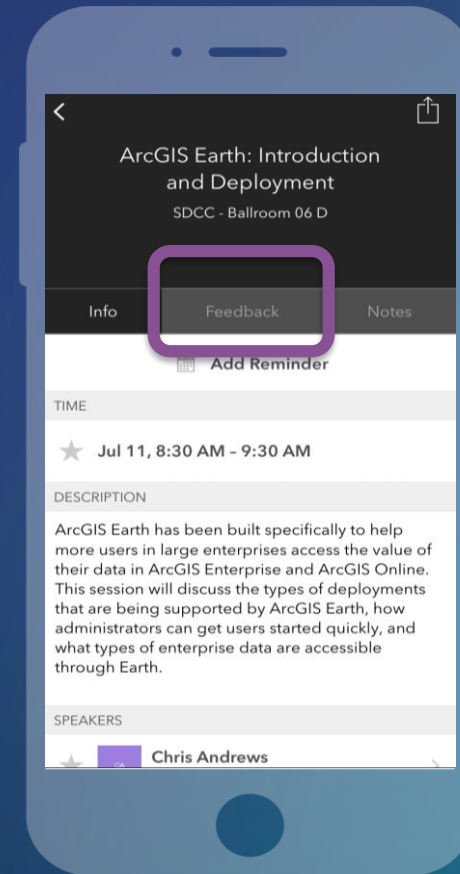
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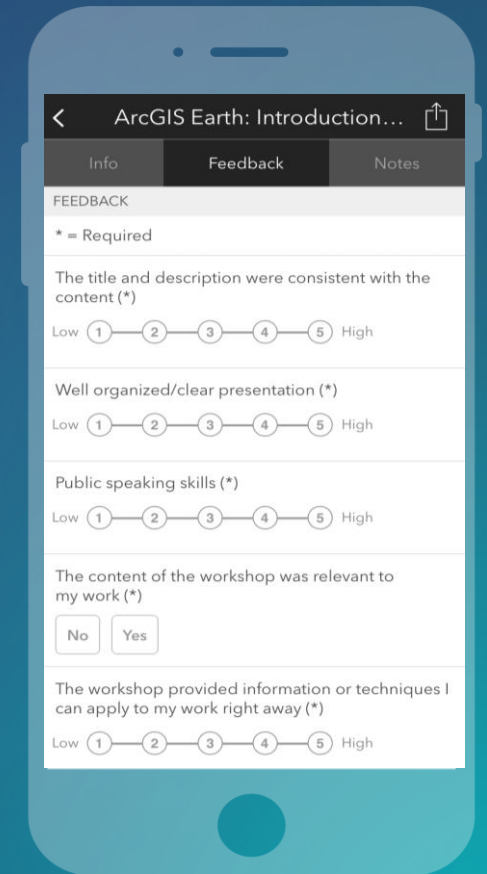
Select the session you attended



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Complete Answers and Select "Submit"



**Thank you for attending!**

# Questions & Answers



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