NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Aggregate Sustainability—Production

May 15, 2023

1:00 – 2:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

Purpose Statement

This webinar will provide an overview of the impact of aggregate sources on sustainability and share examples of how aggregates are currently being evaluated.

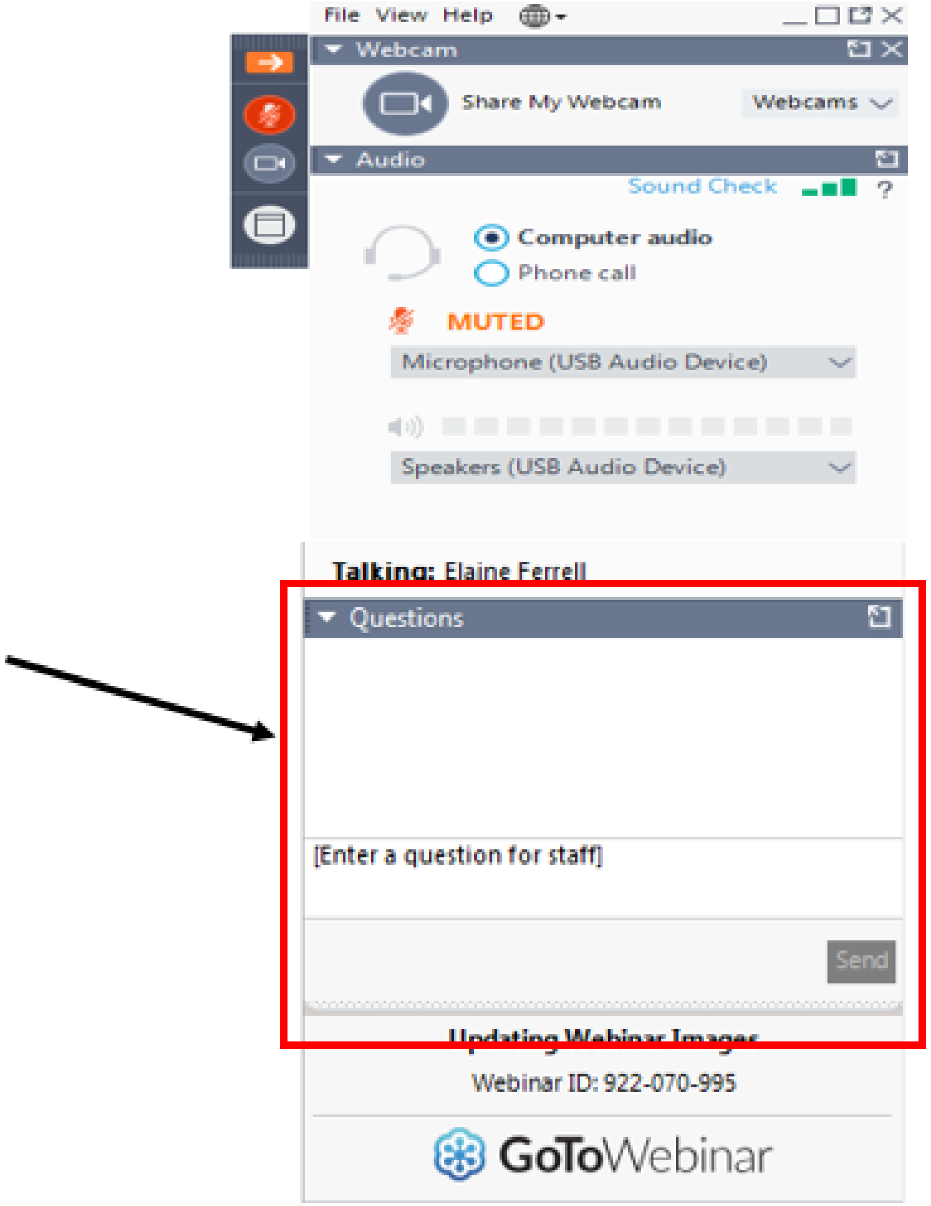
Learning Objectives

At the end of this webinar, you will be able to:

- Identify the importance of using locally available aggregate materials
- Identify the impact of zoning laws and policies on aggregate material availability
- Use quarry by-products in pavement applications

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



● Computer audio
○ Phone call

Microphone (USB Audio Device)

Speakers (USB Audio Device)

Talking: Elaine Ferrell

[Enter a question for staff]

Updating Webinar Images

Webinar ID: 922-070-995

Today's presenters

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NSSGA

NATIONAL STONE, SAND
& GRAVEL ASSOCIATION

Latest Developments and Industry Perspective on Aggregate Sustainability

Kyle Brashear, PE

Biography

- Kyle T. Brashear, PE
  - Graduated with a Bachelor’s and Master’s degrees in Mining and Minerals Engineering from Virginia Tech, with secondary focus areas in Geosciences and Green Engineering. Nine years of aggregates industry experience in materials testing, sustainability, quality assurance/control, technical services, and operational support. Licensed Professional Engineer in the state of North Carolina.

This presentation is intended for educational purposes only. The opinions expressed in this presentation and on the following slides are solely those of the presenter and are not intended to represent individual organizations, companies, or trade associations associated with the presenter.

Aggregates Industry

- Responsible for 100,000 jobs in the United States
- 2.8 Billion tons of aggregate (crushed stone and sand & gravel) produced annually
- 38,000 tons of aggregates are in every mile of highway
- Every American will use 680 tons of aggregate during their lifetime

Sustainability

SOCIAL

ECONOMIC

ENVIRONMENTAL

Social

- Participate in social license to operate
  - Participate and host community events
  - Donate materials, reclaimed mine sites, and pit reservoirs to local communities
  - Mining and geological tours and classes offered to local educators
- Evolving workforce needs

New Bern Earth Day Celebration coming to Martin Marietta Park

By The Sun Journal Apr 11, 2023 Updated Apr 13, 2023

Martin Marietta Park is the newest and largest park in the City of New Bern Park System. This park is located on the site of a former quarry previously owned by the Martin Marietta Corporation.

Environmental

- Concurrent reclamation projects part of initial and final mine plans
- Investments in renewable energy for on-site power
- Water monitoring and improvements
- Overall efficiencies

Economics

- Efficient operations and equipment have less down time and less energy demand on the grid
- Finding engineered uses for byproducts created by production process
- Increased reserves and mine life

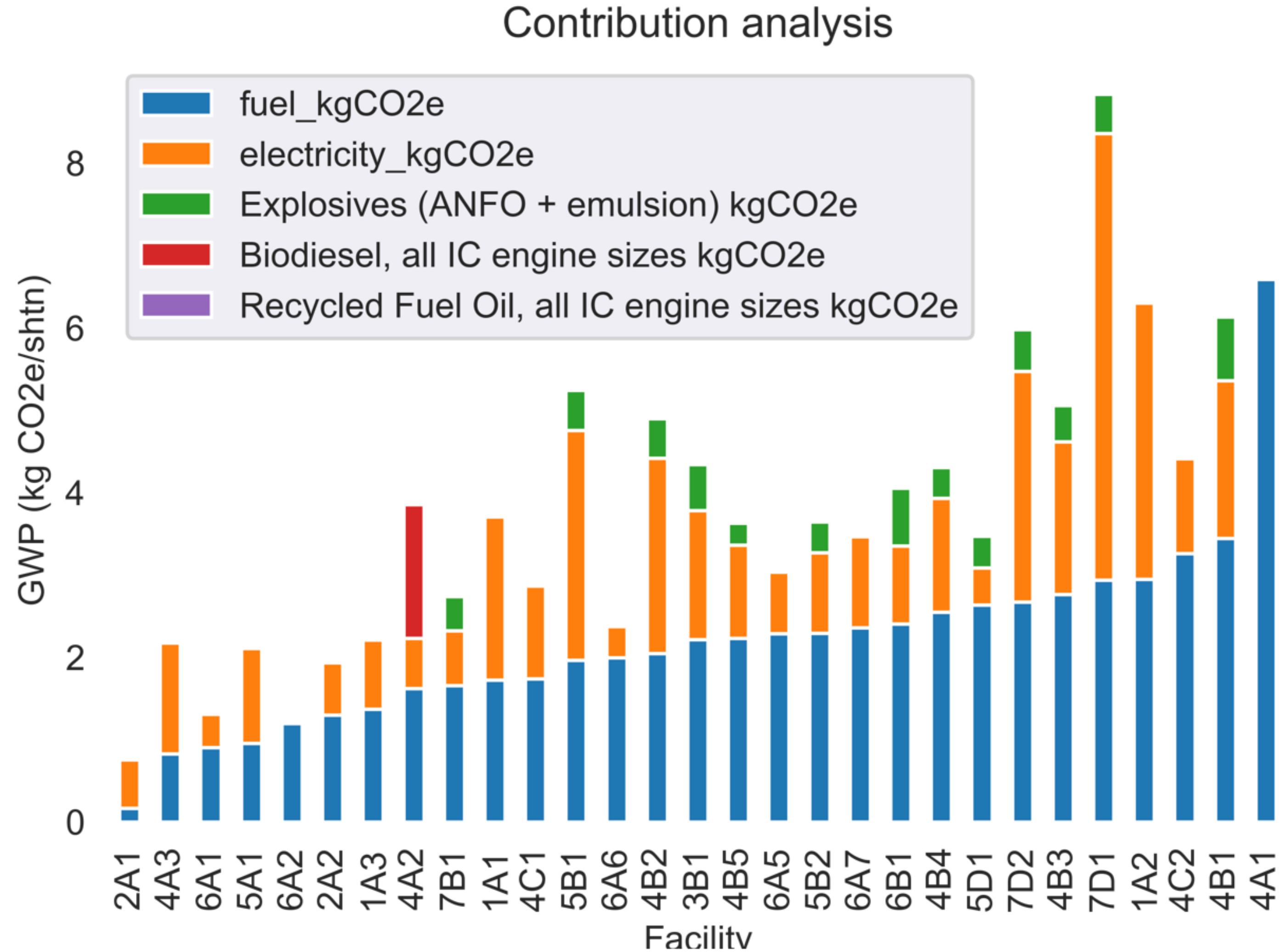
Connecting Sustainability

- All three sectors (social, environmental, and economics) are not exclusive of one another
- As an aggregate operation increases efficiency and decreases downtime
  - Less operating hours needed
    - Less energy demand
      - Both economical and environmental
    - Less hours for employees

PCR Update

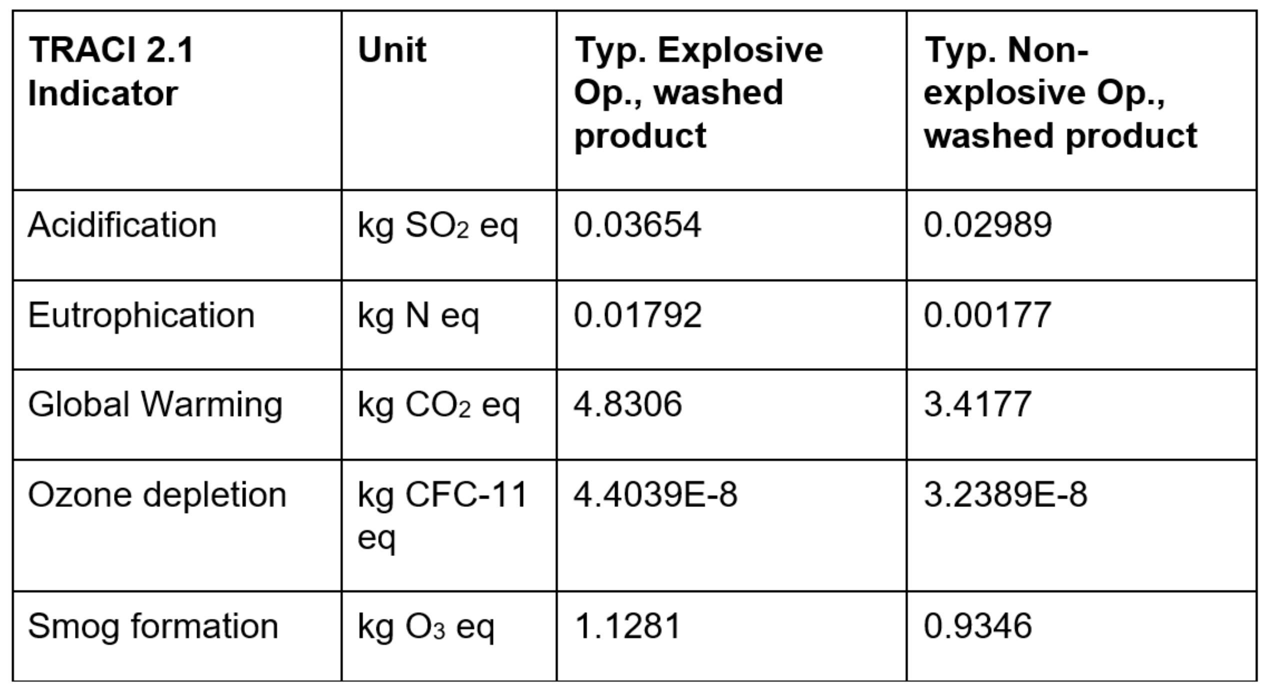
- Product Category Rule (PCR) for Construction Aggregates
    - Needed update to generate Environmental Product Declarations (EPDs) in accordance to ISO 21930
    - Public review period in May 2023
    - First constructions materials PCR to follow American Center for Life Cycle Assessment (ACLCA) Guidance
    - First Construction Aggregates PCR to include underlying life-cycle assessment (LCA) and prescriptive datasets

Using EPDs in the Aggregates Indus



- Fueling plants and mobile equipment with traditional fuels
- Blasting hardrock sources
- Electrical used of crushing and processing equipment

Using EPDs in the Aggregates Indus



TRACI 2.1 Indicator	**Unit**	**Typ. Explosive Op., washed product**	**Typ. Non-explosive Op., washed product**
Acidification	kg SO_2 eq	0.03654	0.02989
Eutrophication	kg N eq	0.01792	0.00177
Global Warming	kg CO_2 eq	4.8306	3.4177
Ozone depletion	kg CFC-11 eq	4.4039E-8	3.2389E-8
Smog formation	kg O_3 eq	1.1281	0.9346

- Improvements made by:
  - Efficient blast designs
  - Efficient plant and mobile equipment
  - Local sourcing of supplies
  - Utilizing lower emission fuels
  - Incentivizing nonrenewable grid developments

Product Balance and Permitting

- Sustainable aggregates production is best when product production (coarse, base, and fine products) is even with sales. This avoids:
  - Stockpiling byproducts
  - Sterilization of reserves
  - Additional permitting/mitigation needs
  - Inefficient production operations

Inverted Pavement at FHWA

- Thin, flexible pavement overtop cement-treated and unbounded aggregate bases
- Uses less “high energy” aggregates
- Generally more economic
- Utilizes natural product balance
- Test section planned at Turner-Fairbank

Source: FHWA.

Evolving Technologies

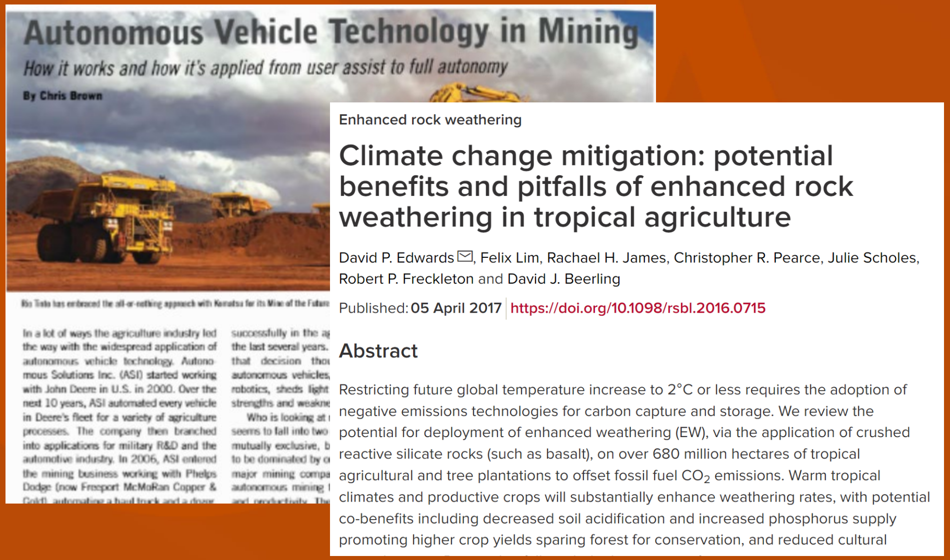
- Renewable on-site energy
- Biofuels for mobile equipment
- Autonomous and intelligently engineered mobile and plant equipment

Quarry Byproducts

- Estimated nearly 500 million tons of fine aggregates have been “landfilled”
- Typically less than 3/8” and includes wash plant fines from cleaning construction aggregates and sand
- Dust of fracture

Areas of Research

- Enhanced rock weathering
  - Carbon “mineralization” and agricultural benefits
- Innovative uses of byproducts
  - Quarry fines in 3-D printed concrete
  - Harden concrete filler material
  - Subbase improvement
- Equipment automation
- Marginal, local products



Autonomous Vehicle Technology in Mining

How it works and how it's applied from user assist to full autonomy

By Chris Brown

Rio Tinto has embraced the all-or-nothing approach with Komatsu for its Mine of the Futur

In a lot of ways the agriculture industry led the way with the widespread application of autonomous vehicle technology. Autonomous Solutions Inc. (ASI) started working with John Deere in U.S. in 2000. Over the next 10 years, ASI automated every vehicle in Deere's fleet for a variety of agriculture processes. The company then branched into applications for military R&D and the automotive industry. In 2006, ASI entered the mining business working with Phelps Dodge (now Freeport McMoRan Copper & Gold), automating a haul truck and a dozer

successfully in the a
the last several years.
that decision thou
autonomous vehicles,
robotics, sheds light
strengths and weakne

Who is looking at
seems to fall into two
mutually exclusive, b
to be dominated by o
major mining compa
autonomous mining
and productivity. The

Enhanced rock weathering

Climate change mitigation: potential benefits and pitfalls of enhanced rock weathering in tropical agriculture

David P. Edwards, Felix Lim, Rachael H. James, Christopher R. Pearce, Julie Scholes, Robert P. Freckleton and David J. Beerling

Published: 05 April 2017 https://doi.org/10.1098/rsbl.2016.0715

Abstract

Restricting future global temperature increase to 2°C or less requires the adoption of negative emissions technologies for carbon capture and storage. We review the potential for deployment of enhanced weathering (EW), via the application of crushed reactive silicate rocks (such as basalt), on over 680 million hectares of tropical agricultural and tree plantations to offset fossil fuel CO_2 emissions. Warm tropical climates and productive crops will substantially enhance weathering rates, with potential co-benefits including decreased soil acidification and increased phosphorus supply promoting higher crop yields sparing forest for conservation, and reduced cultural

Industry Perspective

- EPD web-based tool for aggregate sources to be deployed
- Continuing to invest in areas of aggregates research
- Partnership with concrete and asphalt industries to reduce emissions from grid and find uses for local, low transport materials

Conclusions

- Aggregates are essential to transportation sector
- Sustainability has been an industry focus
- Research and tools are becoming available to allow the industry to play a bigger role in emissions reduction
- While the overall impact of a ton of aggregate is low, industry still has a role in carbon reduction

Quarry by-products and their sustainable pavement applications

Issam Qamhia, PhD

University of Illinois Urbana Champaign

Project Team:

Erol Tutumluer (1),Hasan Ozer (2), Issam Qamhia (1)

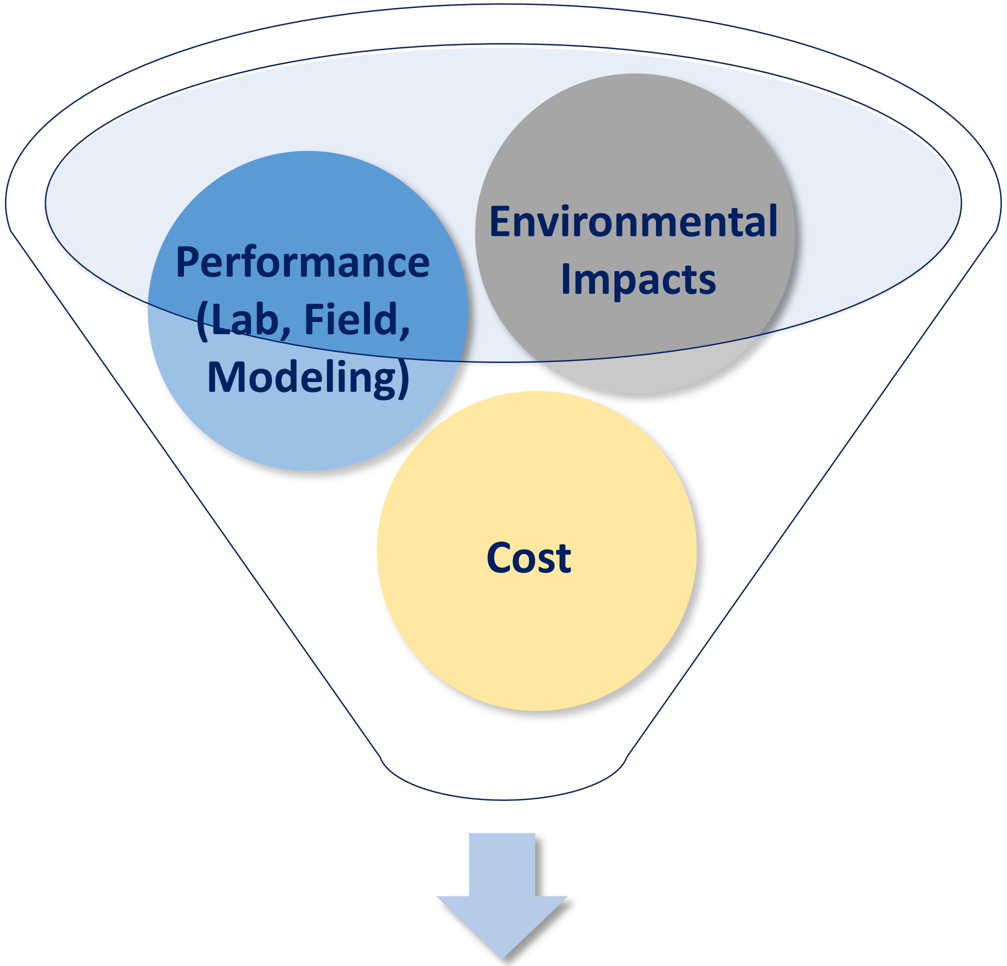
(1) University of Illinois Urbana – Champaign
(2) Arizona State University

Courtesy of Brian Rice

♦ Monday May 15, 2023 ♦ TRB Webinar: Aggregate Sustainability—Production ♦

Objective

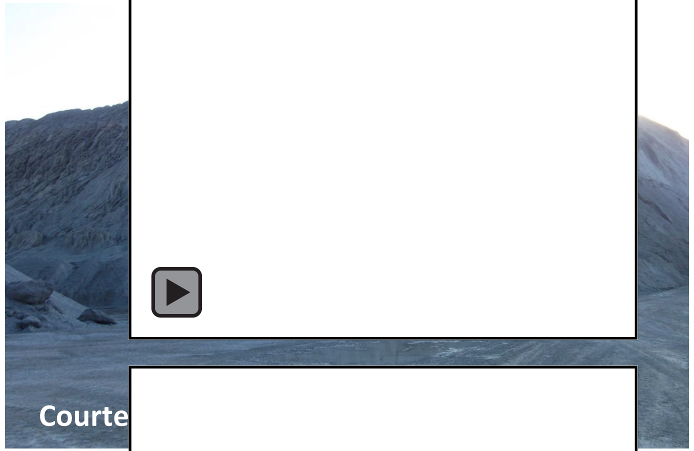
Evaluate **sustainable** pavement applications for using **quarry by-products** in pavement subsurface layers



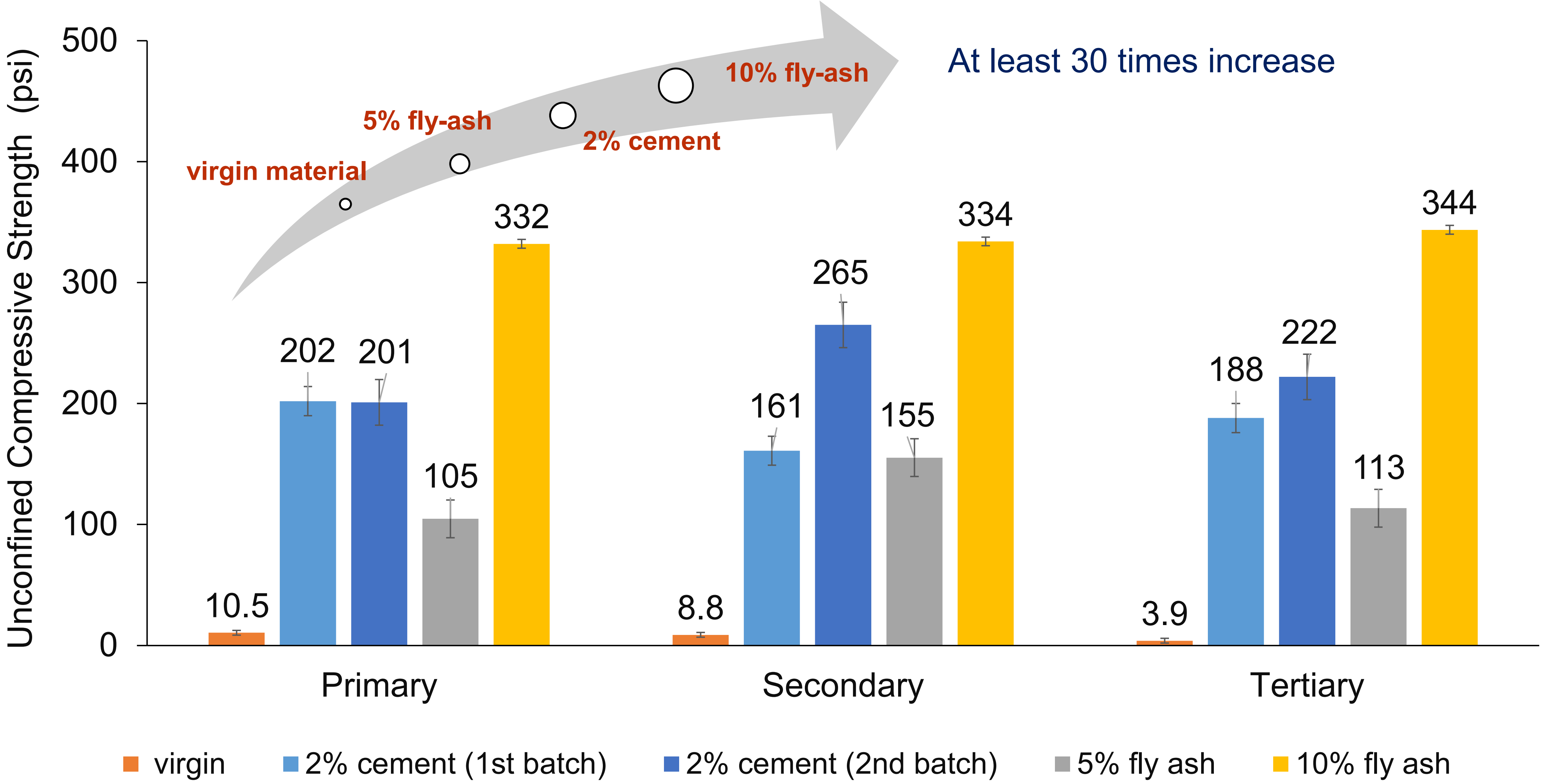
Sustainable QB Applications

Motivation

- In 2021, 1.5 billion metric tons of crushed stone were produced from 3,440 operating quarries in 50 States (USGS, 2022)
- 175 million metric tons of quarry by-products (QB) are generated in over 3000 quarries in the United States each year (NCHRP Synthesis 435, Volume 4)
- Produced in quarry processes
  - Blasting, crushing, and screening
- Typically less than ¼ in. (6 mm) in size
  - Coarse, medium and fine sand particles and a clay/silt fraction
- Stockpiling and disposal of QB is a **major problem** facing the aggregate industry



Unconfined Compressive Strength Results



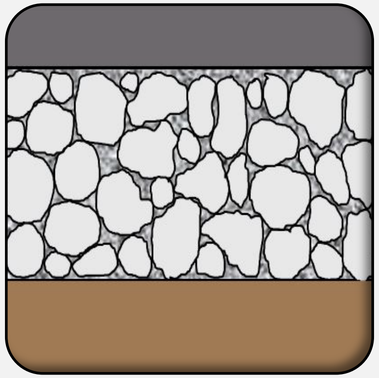
Tutumluer et al., 2015

Evaluated Applications

Unbound Applications

High Fine (QB) Aggregate for Subgrade Remediation

- Fines content (Passing No, 200) up to 15% (Plastic vs nonplastic fines)



Aggregate Subgrade + QB

- Aggregate subgrade on very weak (CBR = 1) subgrades blended with QB
- Fill gaps/voids between large stones

Bound Applications

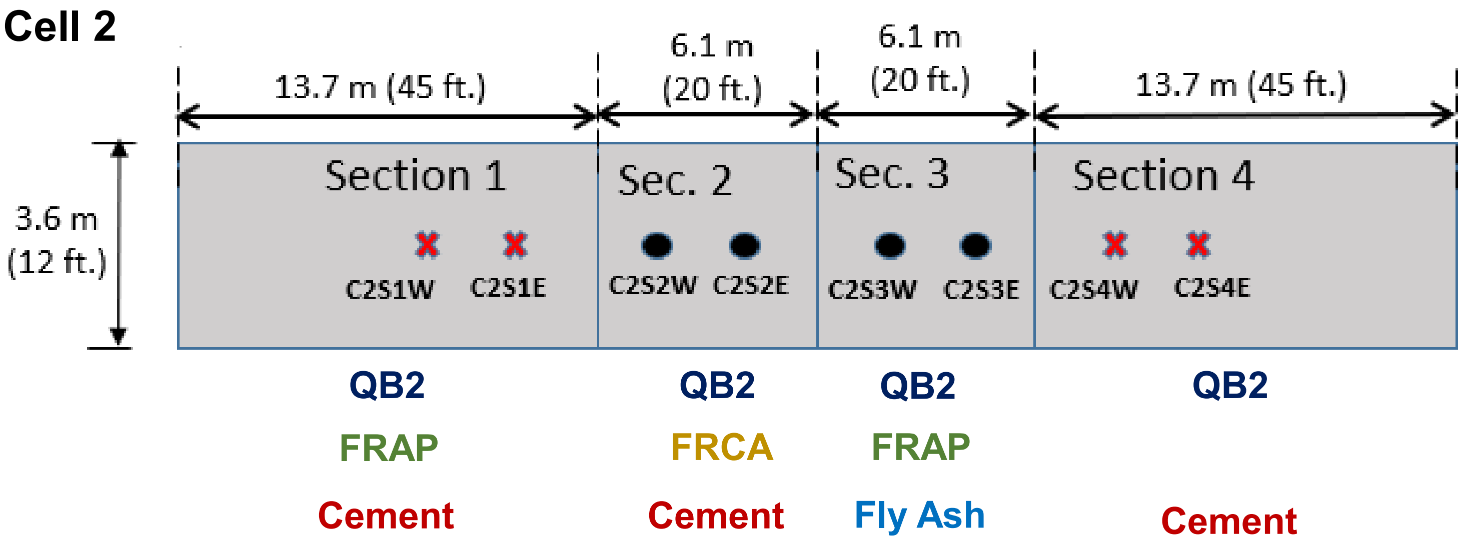
Stabilized QB Subbase

- **Inverted Pavements**
- Stabilized with 3% cement or 10% Type C Fly ash
- Better compaction of aggregate base

Stabilized Base with QB

- Stabilized with 3% cement or 10% Fly ash
- 100% QB Bases
- 70% QB and 30% Recycled asphalt or concrete bases

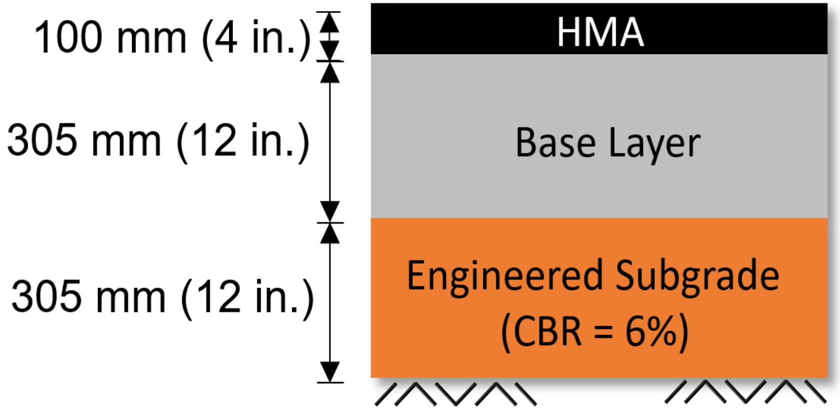
Test Sections Layout



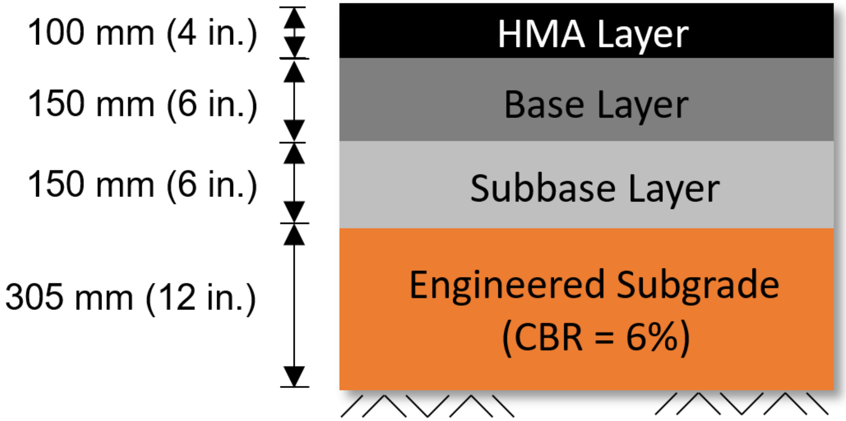
Cell 2

13.7 m (45 ft.)
6.1 m (20 ft.)
6.1 m (20 ft.)
13.7 m (45 ft.)
3.6 m (12 ft.)

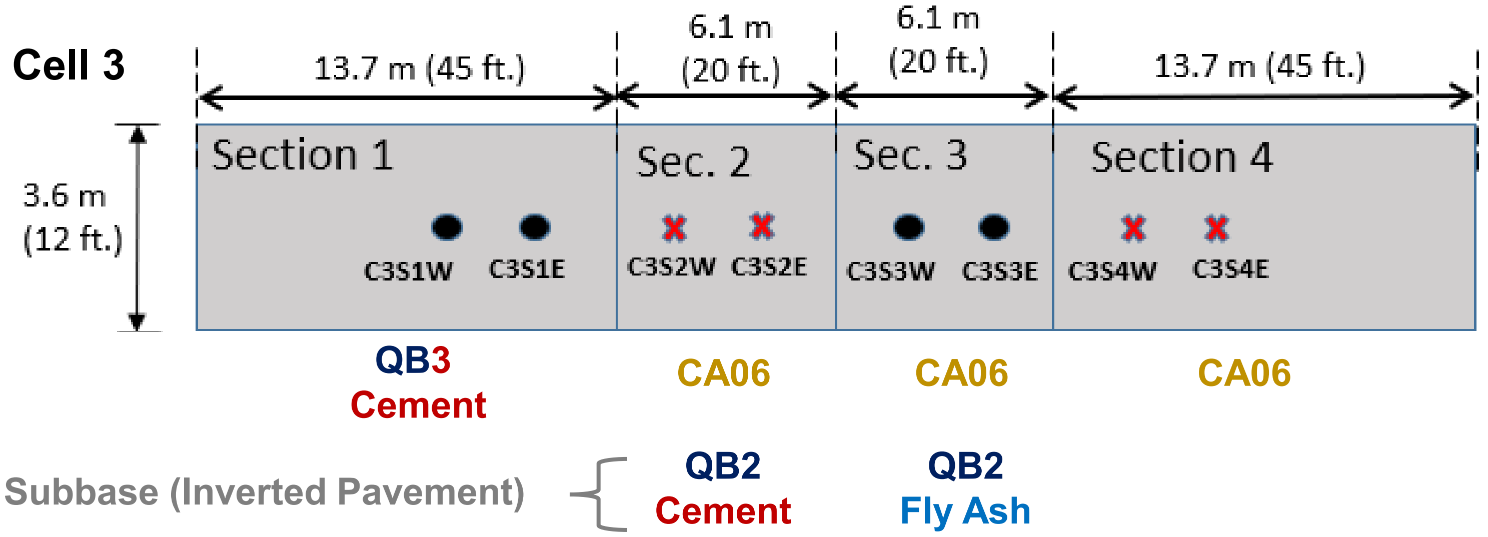
Section 1	Sec. 2	Sec. 3	Section 4
C2S1W ✗ C2S1E ✗	C2S2W ● C2S2E ●	C2S3W ● C2S3E ●	C2S4W ✗ C2S4E ✗
QB2	**QB2**	**QB2**	**QB2**
FRAP	**FRCA**	**FRAP**	
Cement	**Cement**	**Fly Ash**	**Cement**



100 mm (4 in.) HMA
305 mm (12 in.) Base Layer
305 mm (12 in.) Engineered Subgrade (CBR = 6%)



100 mm (4 in.) HMA Layer
150 mm (6 in.) Base Layer
150 mm (6 in.) Subbase Layer
305 mm (12 in.) Engineered Subgrade (CBR = 6%)

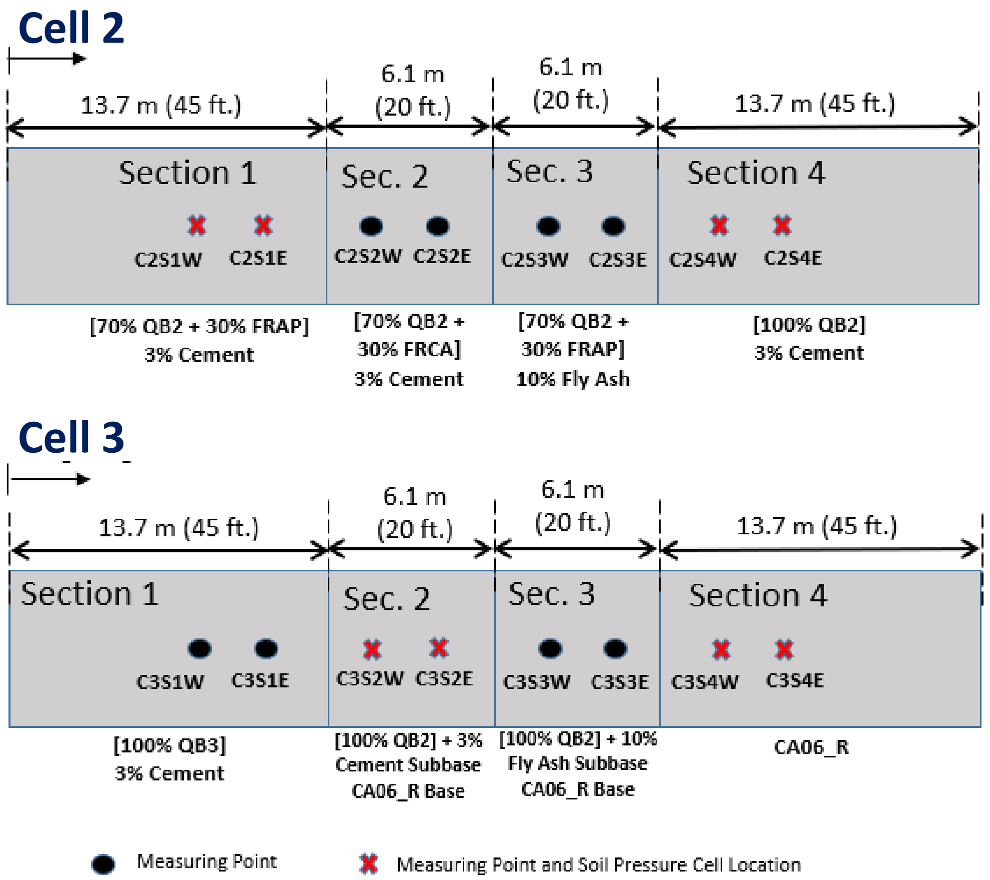


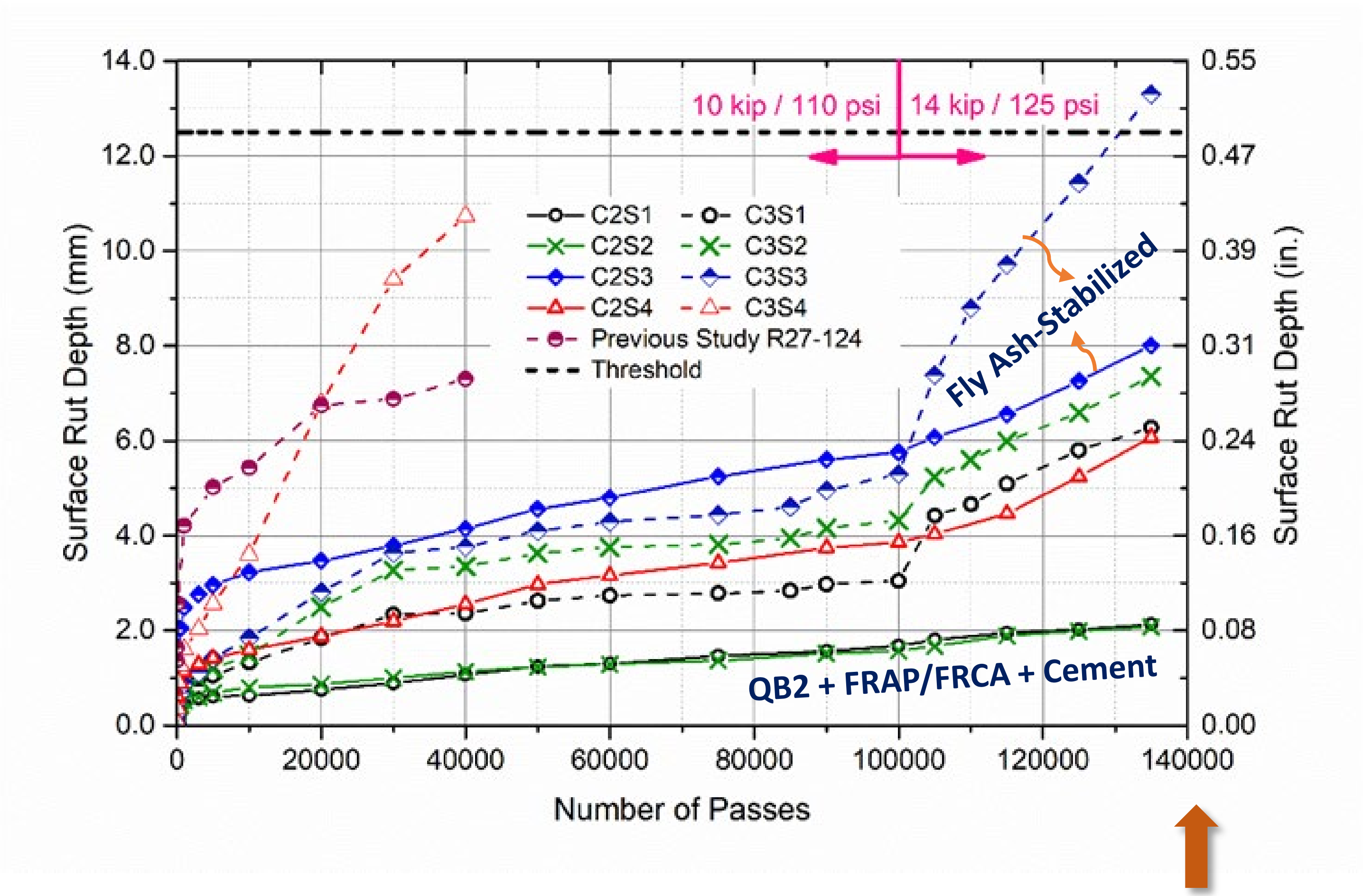
Cell 3

13.7 m (45 ft.)
6.1 m (20 ft.)
6.1 m (20 ft.)
13.7 m (45 ft.)
3.6 m (12 ft.)

Section 1	Sec. 2	Sec. 3	Section 4
C3S1W ● C3S1E ●	C3S2W ✗ C3S2E ✗	C3S3W ● C3S3E ●	C3S4W ✗ C3S4E ✗
QB3 **Cement**	**CA06**	**CA06**	**CA06**
Subbase (Inverted Pavement)	**QB2** **Cement**	**QB2** **Fly Ash**	

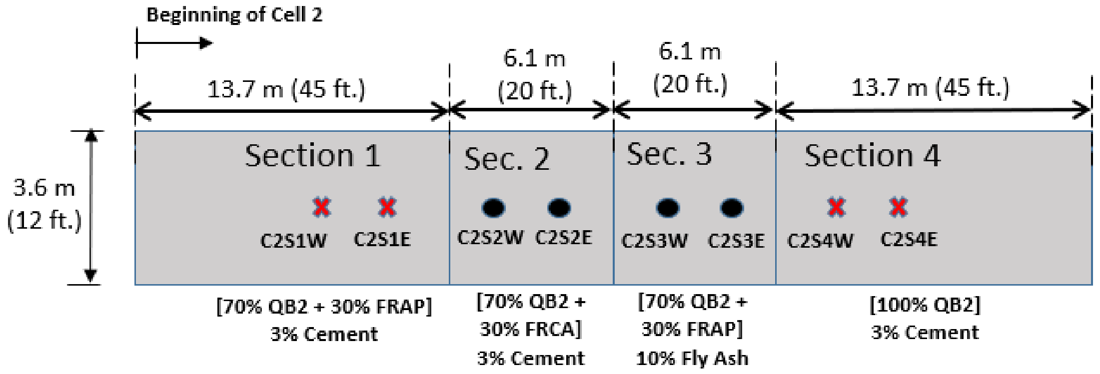
Performance Monitoring

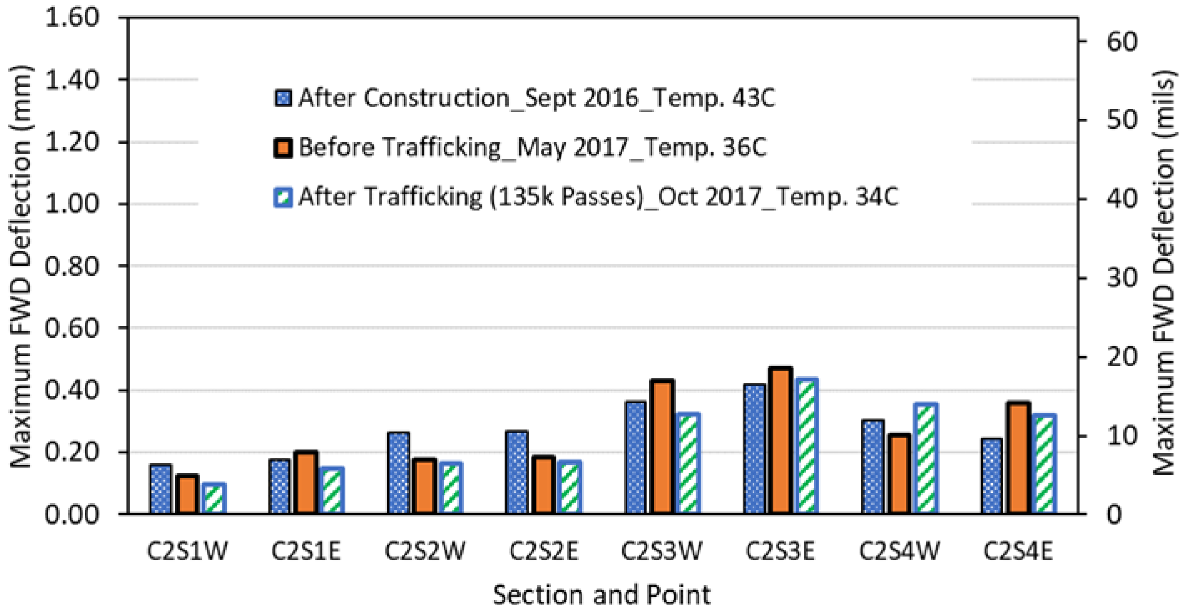




Sections with QB blended with FRAP / FRCA performed best

FWD Center Deflections





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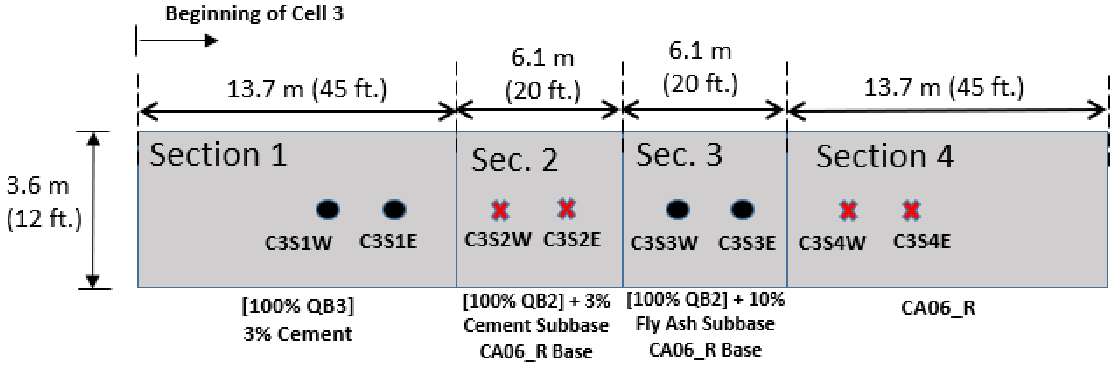
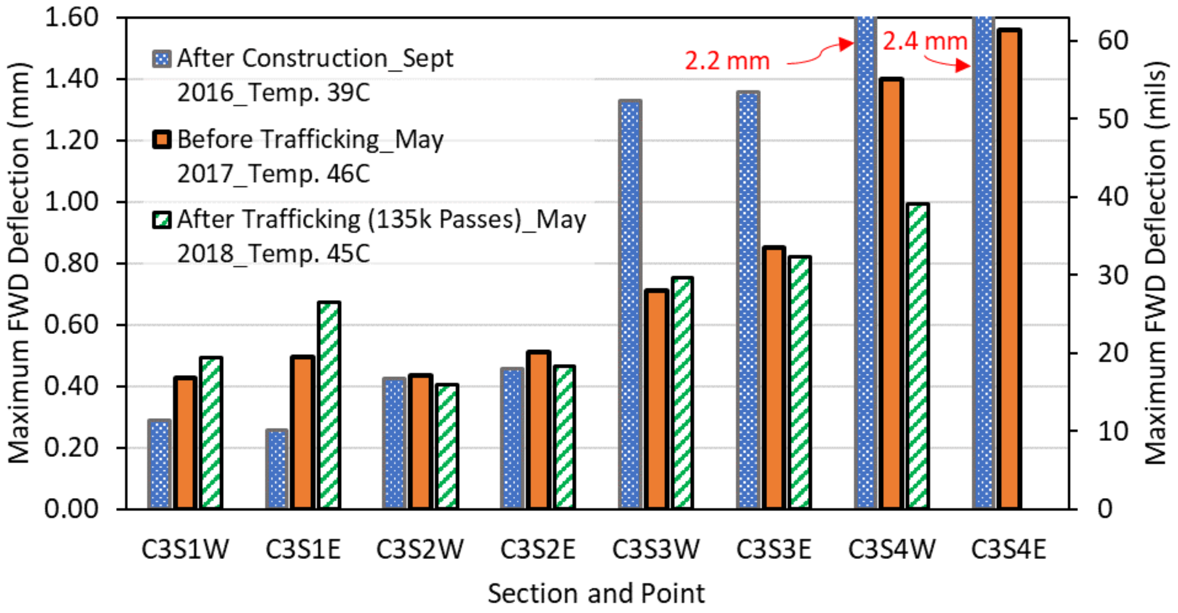




Cell 3

Life Cycle Assessment (LCA)

☐ Three scenarios

- **No. 1:** As-Constructed Test Sections in Cells 2 and 3
- **No. 2:** As-Designed Test Sections (Design Thicknesses)
- **No. 3:** Proposed Pavement Test Sections
  - 3 in. HMA and 8 in. base
  - Low to medium levels of traffic (e.g. local roads)

Pavement LCA Symposium, 2017

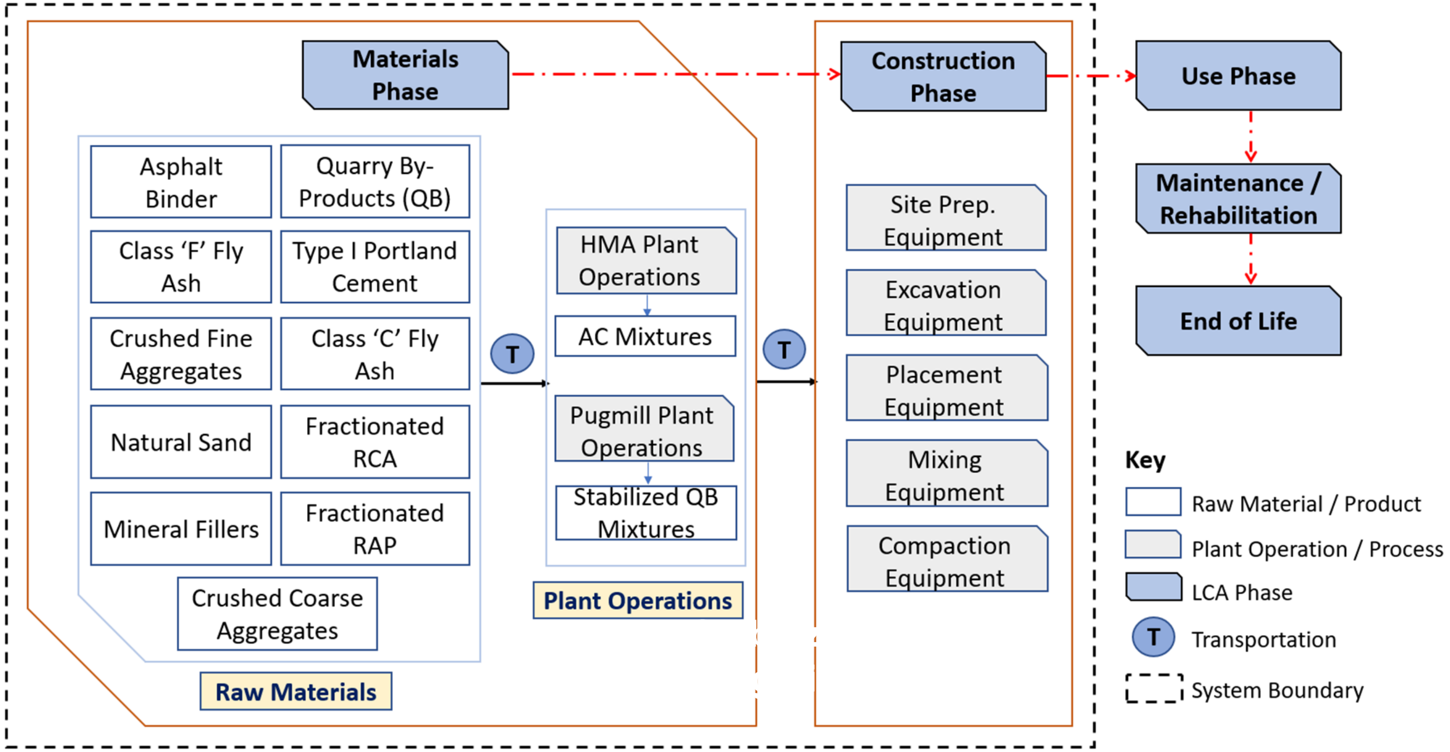
☐ Life stages

- **Considered:** Materials acquisition, plant operations, transportation, construction
- **Not Considered:** Use phase, maintenance and rehabilitation, end-of-life

→ Require knowledge of long-term performance and durability (Not readily available)

LCA for Studied QB Applications

Boundary Conditions



Functional Unit

One-Lane Mile (12 ft. width)

Impact Categories

- ❑ Global Warming Potential
- ❑ Total Energy Demand

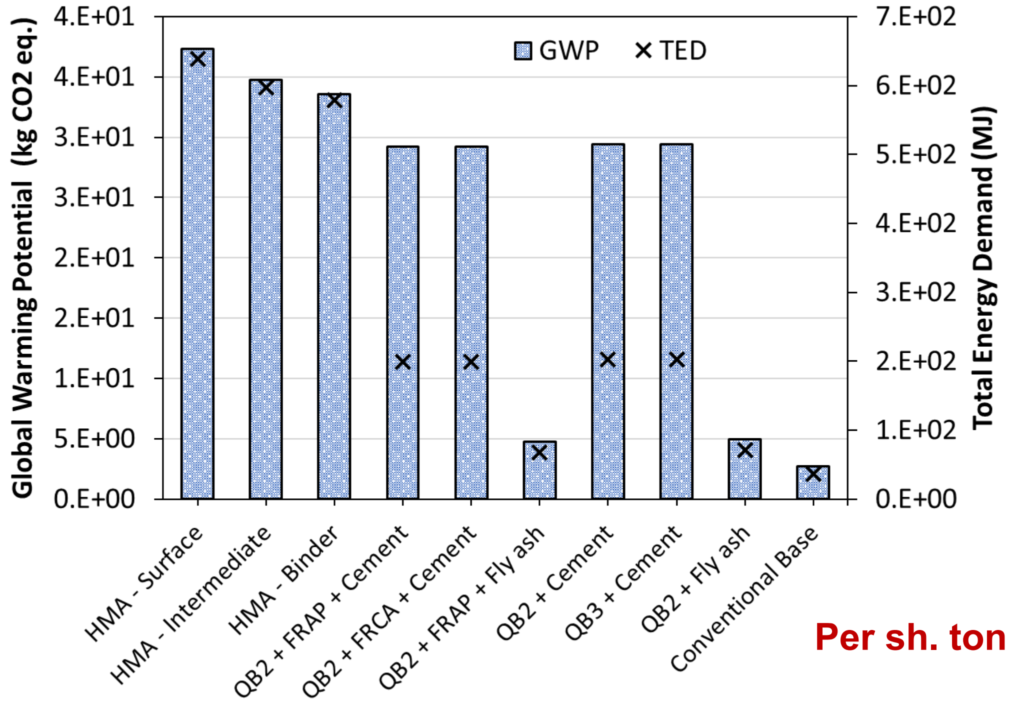
Data Sources

- ❑ ICT Tollway Database

  (Ozer et al., 2017; Kang et al., 2014)
- ❑ eGRID
- ❑ U.S. LCI
- ❑ SimaPro (U.S. Ecoinvent)

LCA for Studied QB Applications

Materials and Plant Operations



Per sh. ton

Transportation (Kang et al., 2018)

$$\text{Impact}_k\ (\text{per truck}\cdot\text{mi}) = \frac{\alpha_1 W + \alpha_2 G + \alpha_3 T + \alpha_4 RH + \alpha_5 v^2}{1 + \exp\ (\beta_1 + \beta_2 v^{\beta_3} + \beta_4 G + \beta_5 t^{\beta_6})}$$

W= truck payload; G = grade (%); T = temperature (°F);

RH = relative humidity (%); v = speed (mph); t = year of hauling

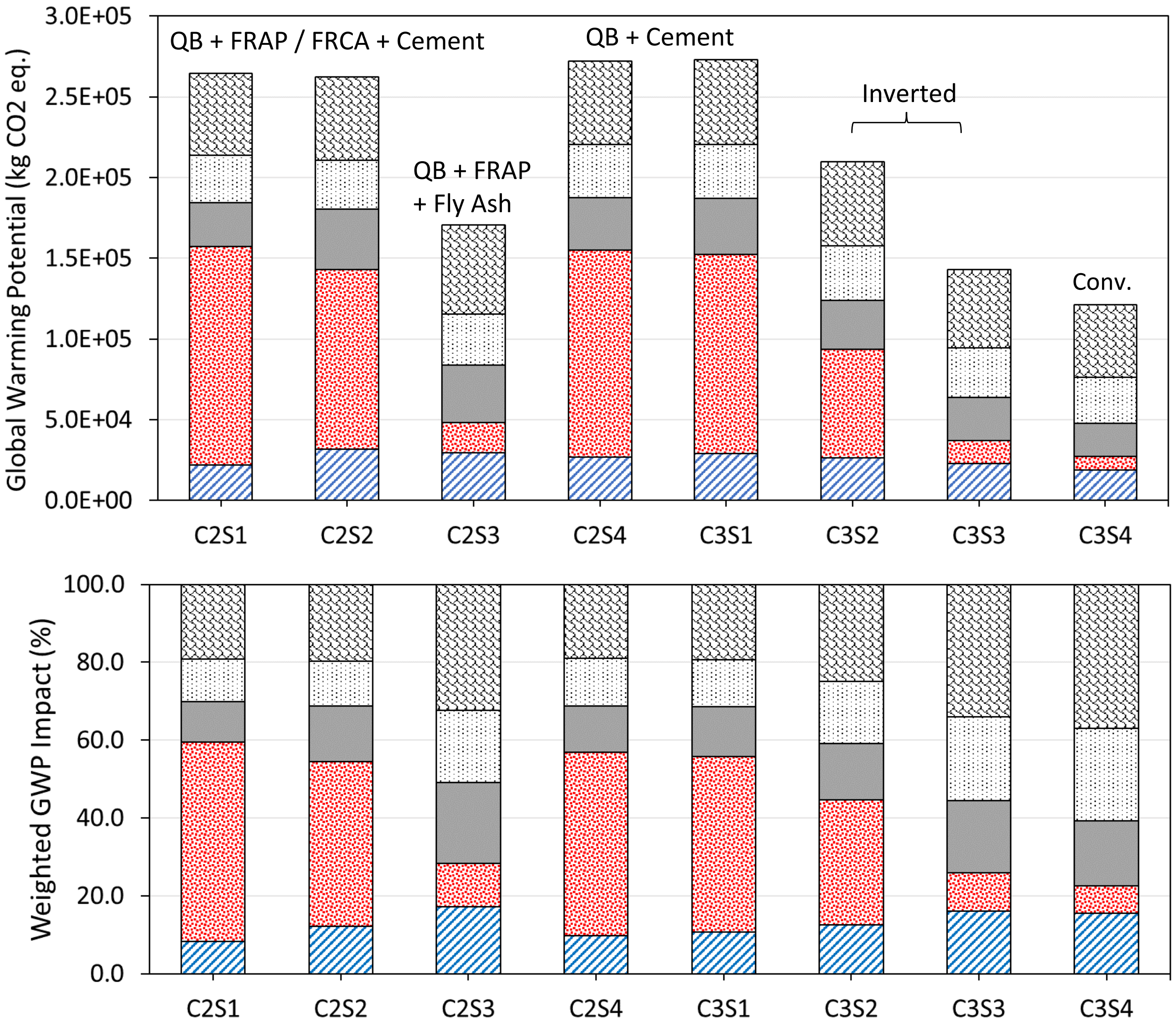
Construction

Activities	Production Rate	Fuel Usage
Site Preparation Clearing - Medium	0.175 acre/hr.	171 Gallons/Acre
Subgrade Preparation Grading - Dirt - Off Road	215 C.Y./hr.	0.26 Gallons/C.Y.
Subgrade Preparation Strip Topsoil	120 C.Y./hr.	0.17 Gallons/C.Y.
Base Stone Stabilized QB	217 sh. ton/hr.	0.41 Gallons/sh. ton
Structural (Binder) Course	200 ton/hr.	0.58 Gallons/sh. ton
Surface Course	150 ton/hr.	0.77 Gallons/sh. ton
Leveling Course	130 ton/hr.	0.89 Gallons/sh. ton

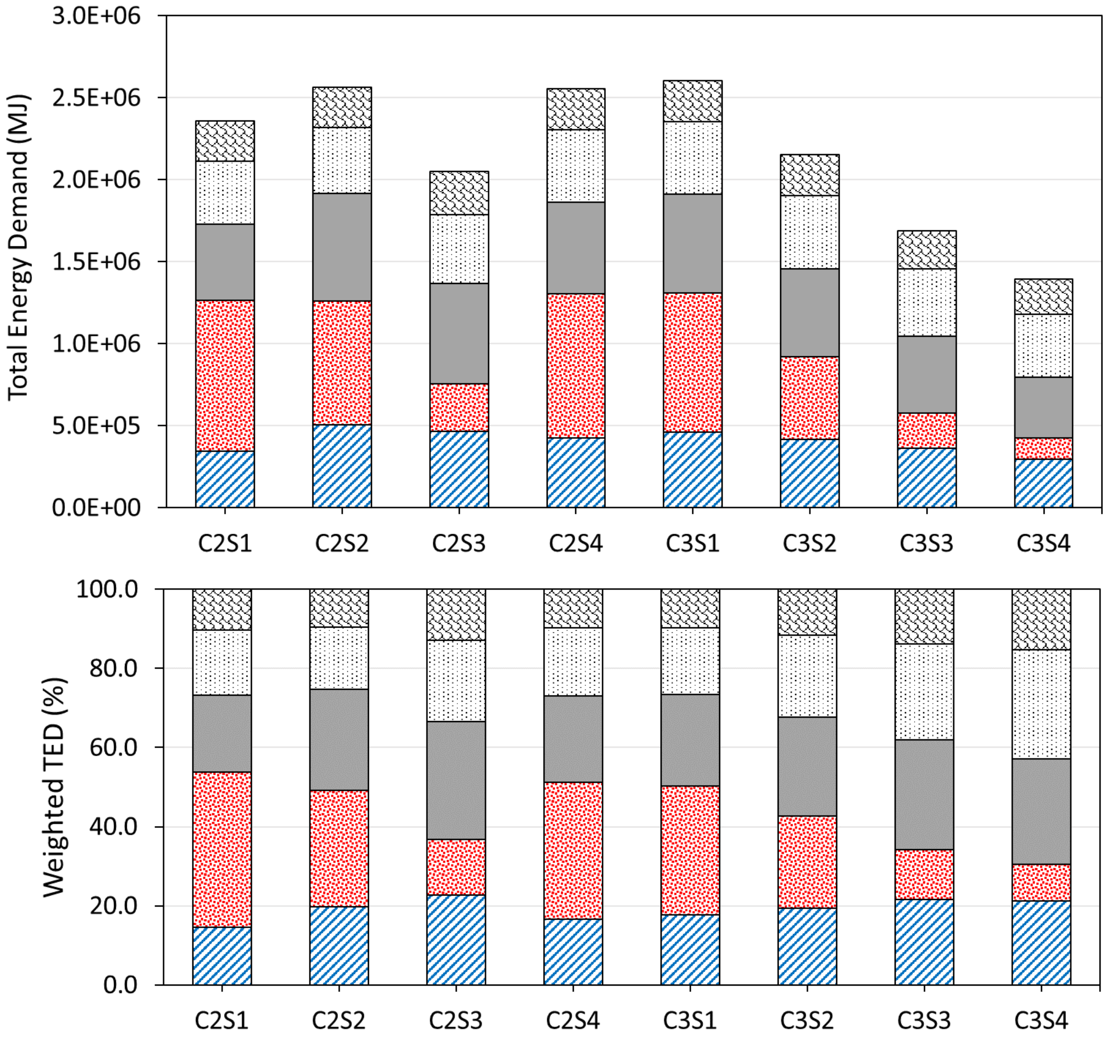
Skolnik et al., 2013 (adapted)

LCA – Results for Scenario #1

Global Warming Potential (GWP)



Total Energy Demand

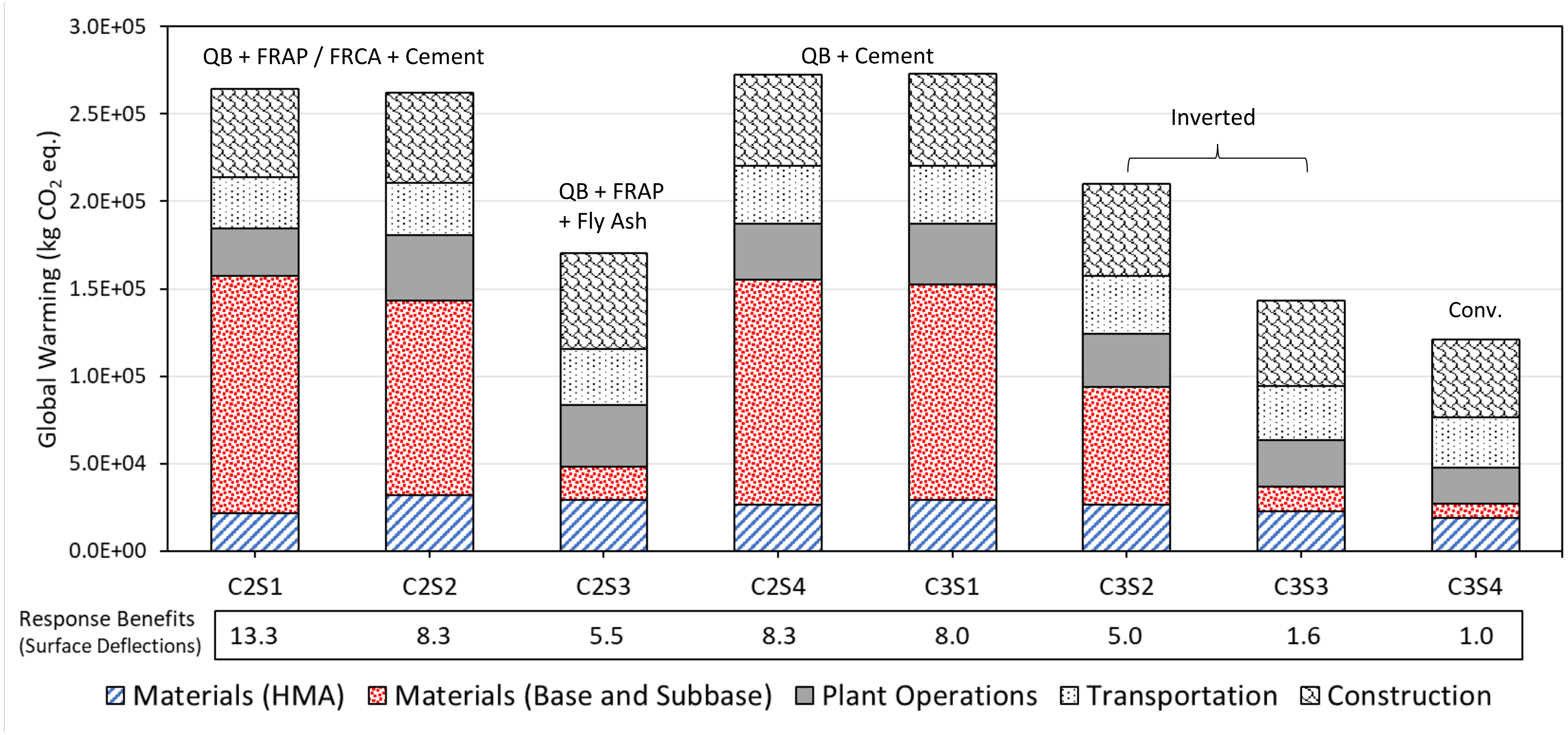


▨ Materials (HMA) ▨ Materials (Base and Subbase) ■ Plant Operations ▨ Transportation ▨ Construction

LCA – Results for Scenario #1

- ☐ Response benefit was defined for Resilient FWD deflections

$$Response\ Benefit = \left(\frac{D_{0\,(i)}}{D_{0\,(conv.)}}\right)^{-1}$$

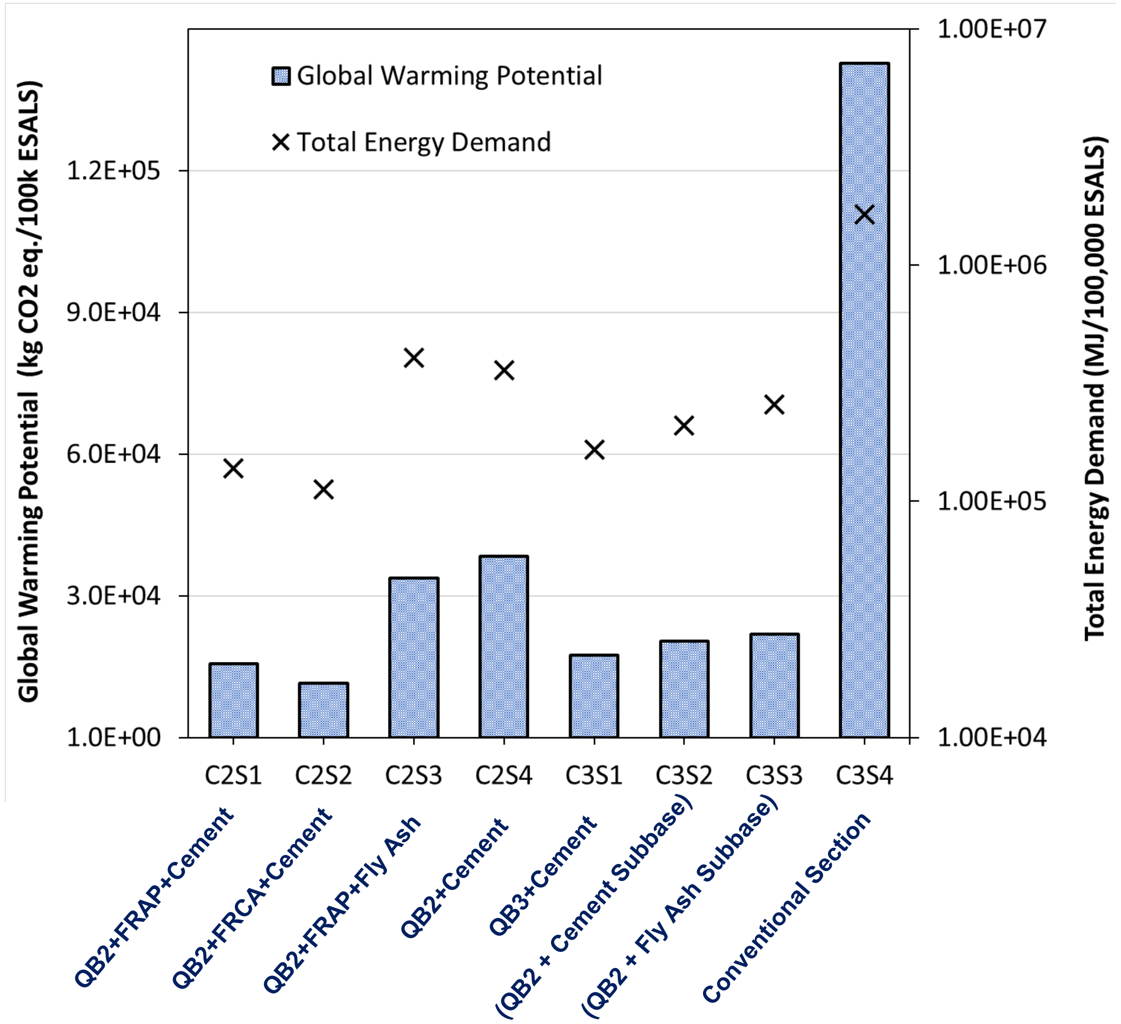


	C2S1	C2S2	C2S3	C2S4	C3S1	C3S2	C3S3	C3S4
Response Benefits (Surface Deflections)	13.3	8.3	5.5	8.3	8.0	5.0	1.6	1.0

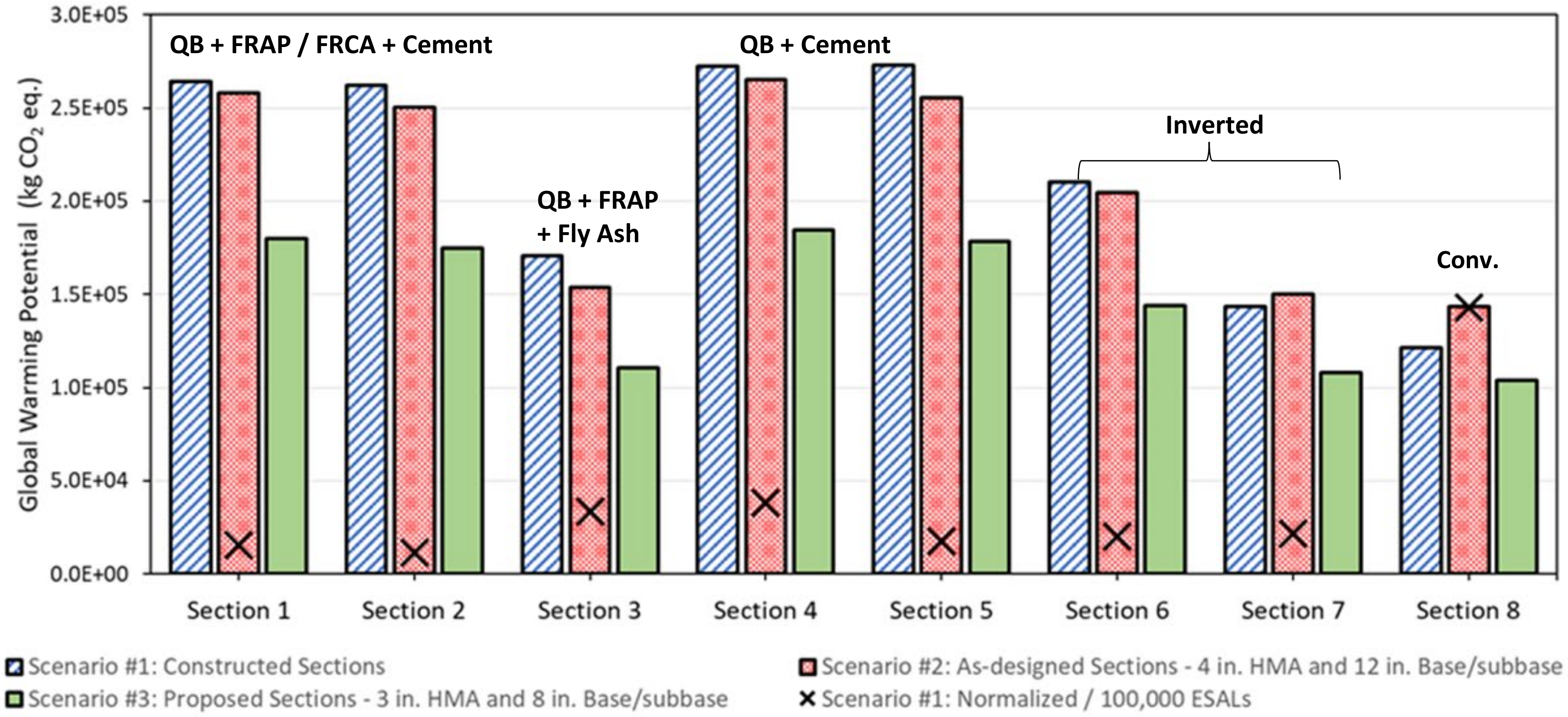
LCA – Results for Scenario #1

Normalized Impacts (per 100,000 ESAL)

Section	No. of ATLAS Passes for 0.5 in rutting	Equivalent No. of ESALs
C2S1	1,127,772	1,702,935
C2S2	1,515,486	2,288,386
C2S3	335,179	506,120
C2S4	469,694	709,238
C3S1	1,040,277	1,570,819
C3S2	682,032	1,029,868
C3S3	434,896	656,693
C3S4	56,219	84,891



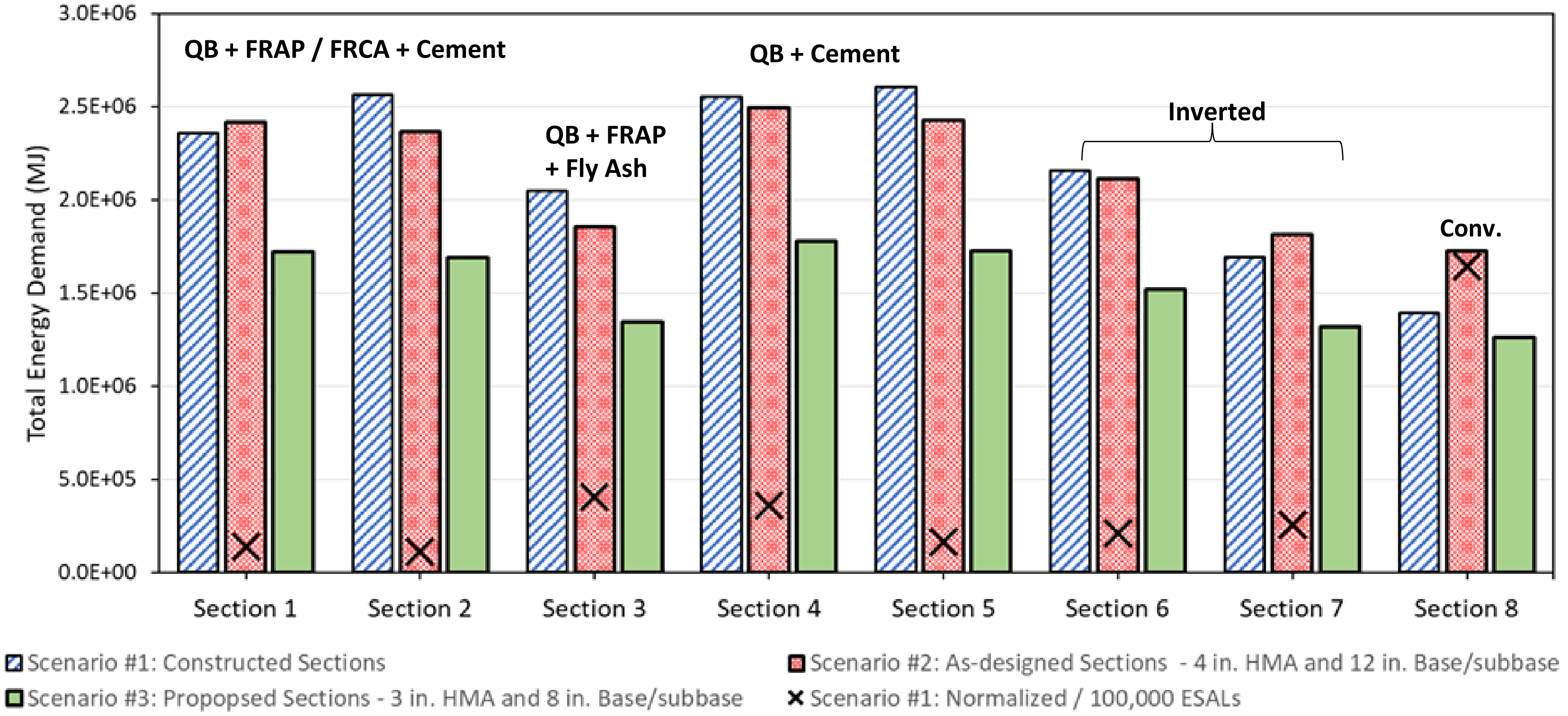
Global Warming Potential Results



Environmental impact savings when **normalized impacts** are considered

- Higher savings and better performance for cement (vs. fly ash)
- Higher savings when QB is blended with FRAP or FRCA

Total Energy Demand Results



Environmental impact savings when **normalized impacts** are considered

- Higher savings and better performance for cement (vs. fly ash)
- Higher savings when QB is blended with FRAP or FRCA

Concluding Remarks

- **Life cycle assessment revealed that stabilized QB layers may reduce environmental impacts while maintaining structural integrity**
  - Clearly seen when response benefits/normalized APT data are considered
  - Higher savings (with improved performance) with cement
  - More savings when QB is blended with FRAP or FRCA
- **More savings in environmental impacts can be anticipated when the use stage is accounted for**
  - The higher stiffness of stabilized layers, which can deflect less and sustain more load repetitions; lead to environmental and economical savings

ILLINOIS

ILLINOIS CENTER FOR TRANSPORTATION

Illinois Department of Transportation

Thank You!
Questions?

Ohio: Estimation of Aggregate Reserves and Depletion

Ala R. Abbas, The University of Akron
Munir Nazzal, The University of Cincinnati
Michael Eriksen, Purdue University
Kirk Beach, Terracon Consultants

This presentation summarizes the results of a recently completed research project sponsored by the Ohio Department of Transportation (ODOT):

Abbas, A., R., Mahmoud, K., Quasem, T., Eriksen, M., Nazzal, M., and Beach, K. (2021). *Analysis of Ohio's Fine and Coarse Aggregate Reserve Balances*, Ohio Department of Transportation (ODOT), Report No. FHWA/OH-2021-37.

Acknowledgements

- Ohio Department of Transportation (ODOT)
    - Mickey Cronin (Aggregate Section)
    - Timothy Pritchard (Office of Contract Sales and Estimating)
    - Jill Martindale (Research Section)
- Ohio Department of Natural Resources (ODNR)
    - Kelly Barrett and Chris Freidhof (Mineral Resources Management)
    - J. D. Stucker and Christopher Wright (Geological Survey)
- Aggregate Industry
    - Ohio Aggregates & Industrial Minerals Association (OAIMA)
    - Several aggregate producers who participated in the study

Outline

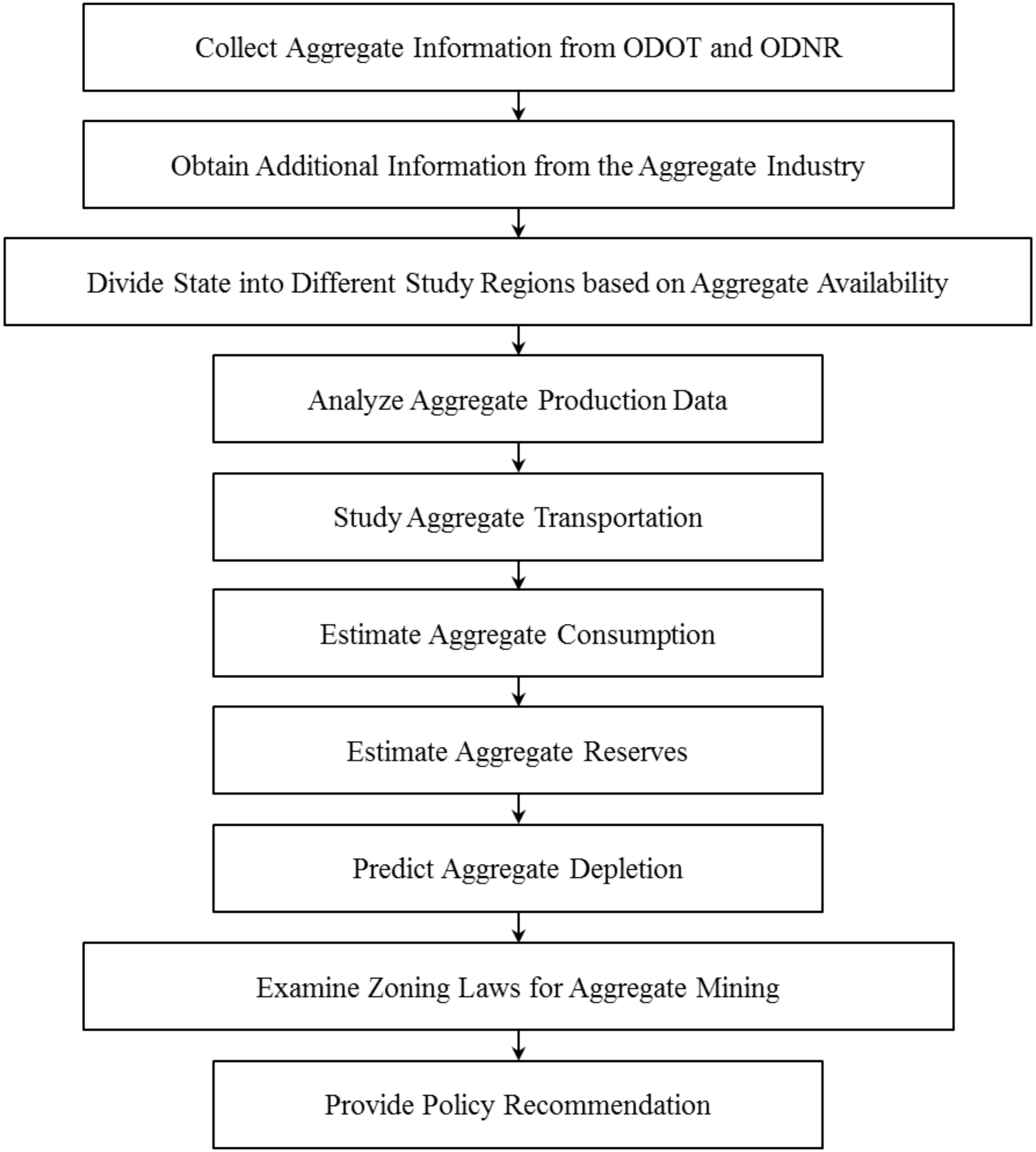
- Background
- Problem Statement
- Research Approach
- Aggregate Data and Analysis Results
- Research Findings and Conclusions

Problem Statement

Problem Statement

- Aggregates are used by ODOT in a wide variety of applications.
- While the distribution of aggregate sources in Ohio may appear to be adequate to meet ODOT’s current needs, the supply of aggregates may not continue indefinitely.
- Research is needed to provide ODOT with a better understanding of the supply and demand for aggregates in different regions within the state and estimate the economic impact on future ODOT construction projects in regions with low supply balances.

Research Approach



Collect Aggregate Information from ODOT and ODNR

Obtain Additional Information from the Aggregate Industry

Divide State into Different Study Regions based on Aggregate Availability

Analyze Aggregate Production Data

Study Aggregate Transportation

Estimate Aggregate Consumption

Estimate Aggregate Reserves

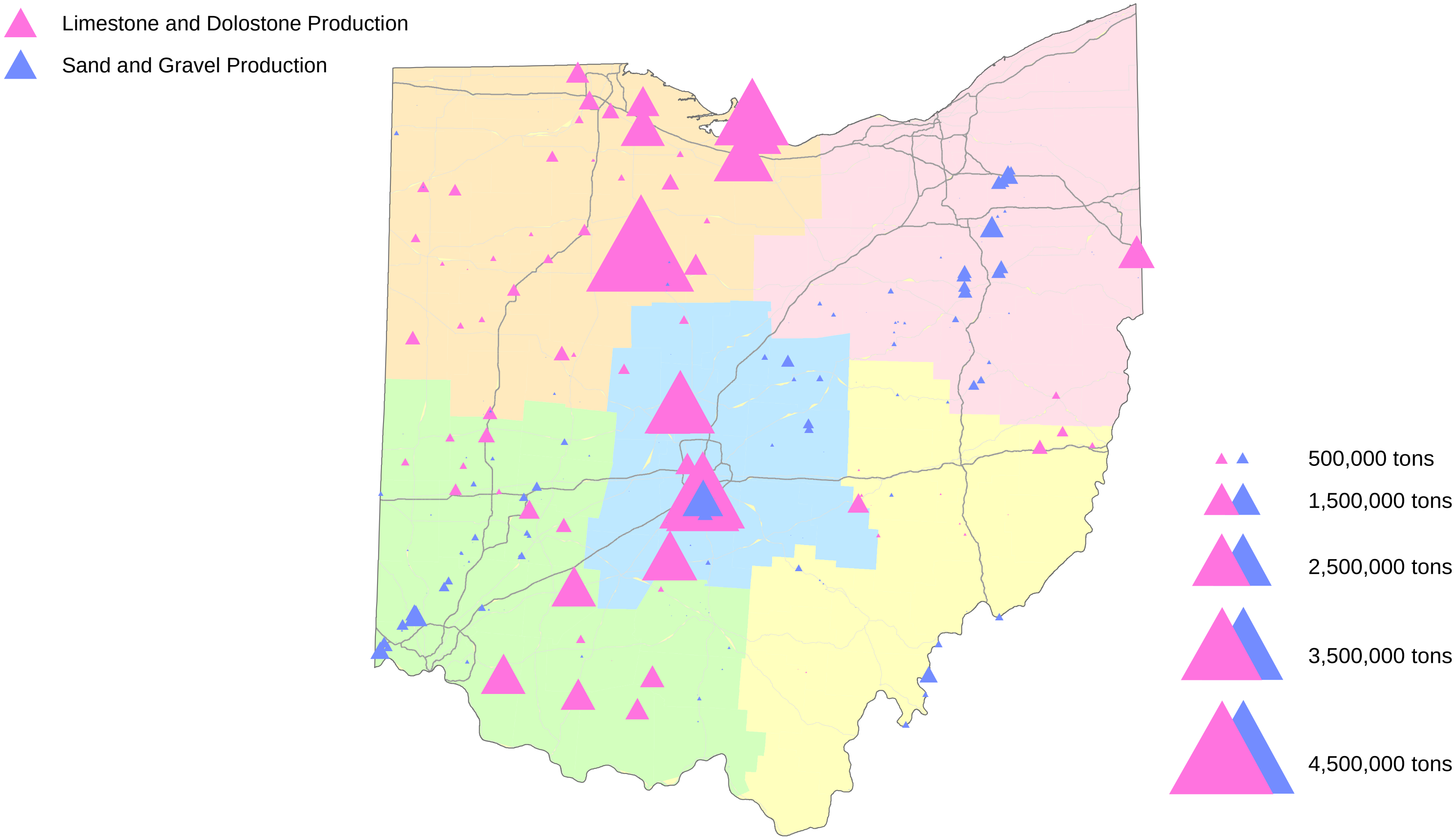
Predict Aggregate Depletion

Examine Zoning Laws for Aggregate Mining

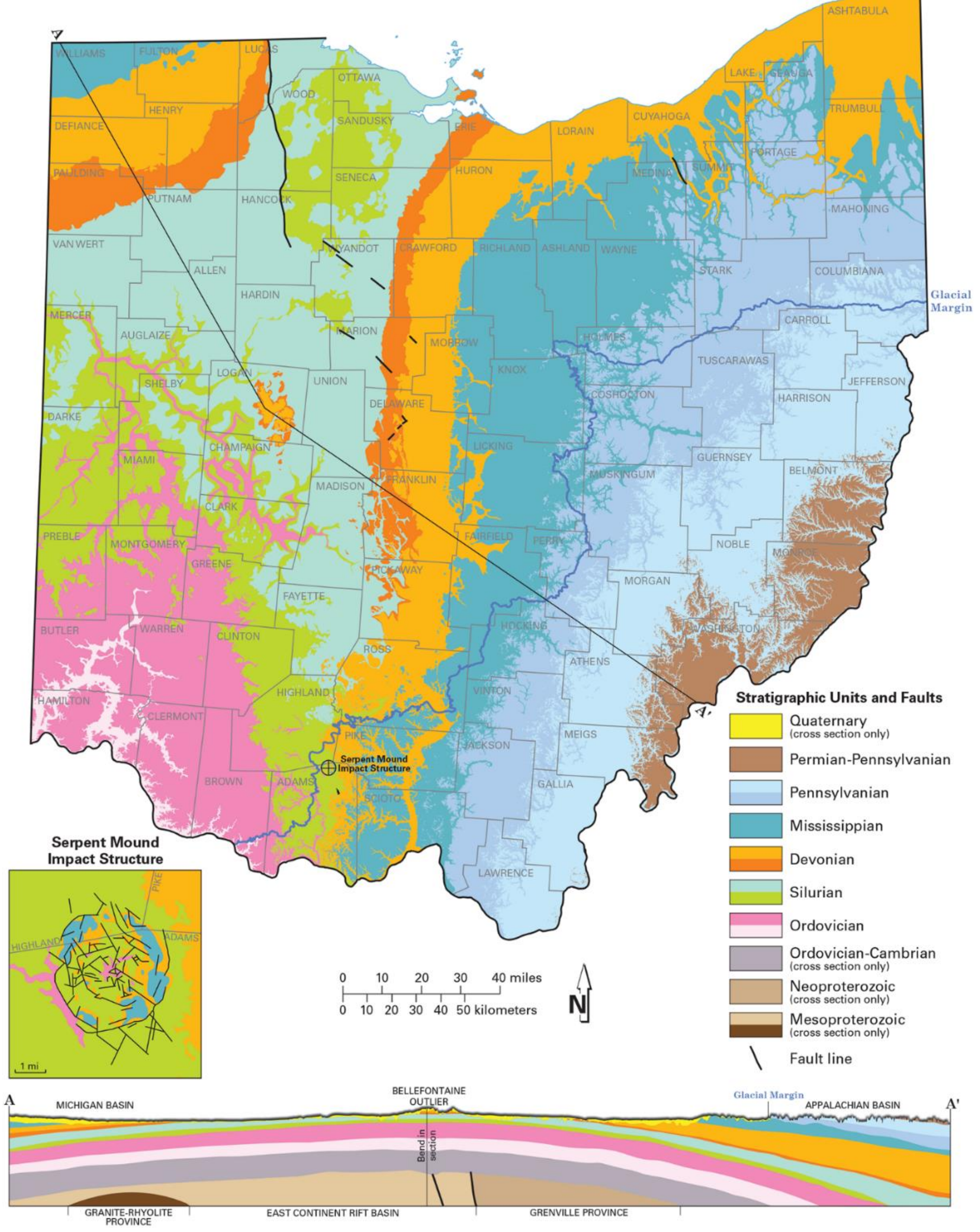
Provide Policy Recommendation

Aggregate Production

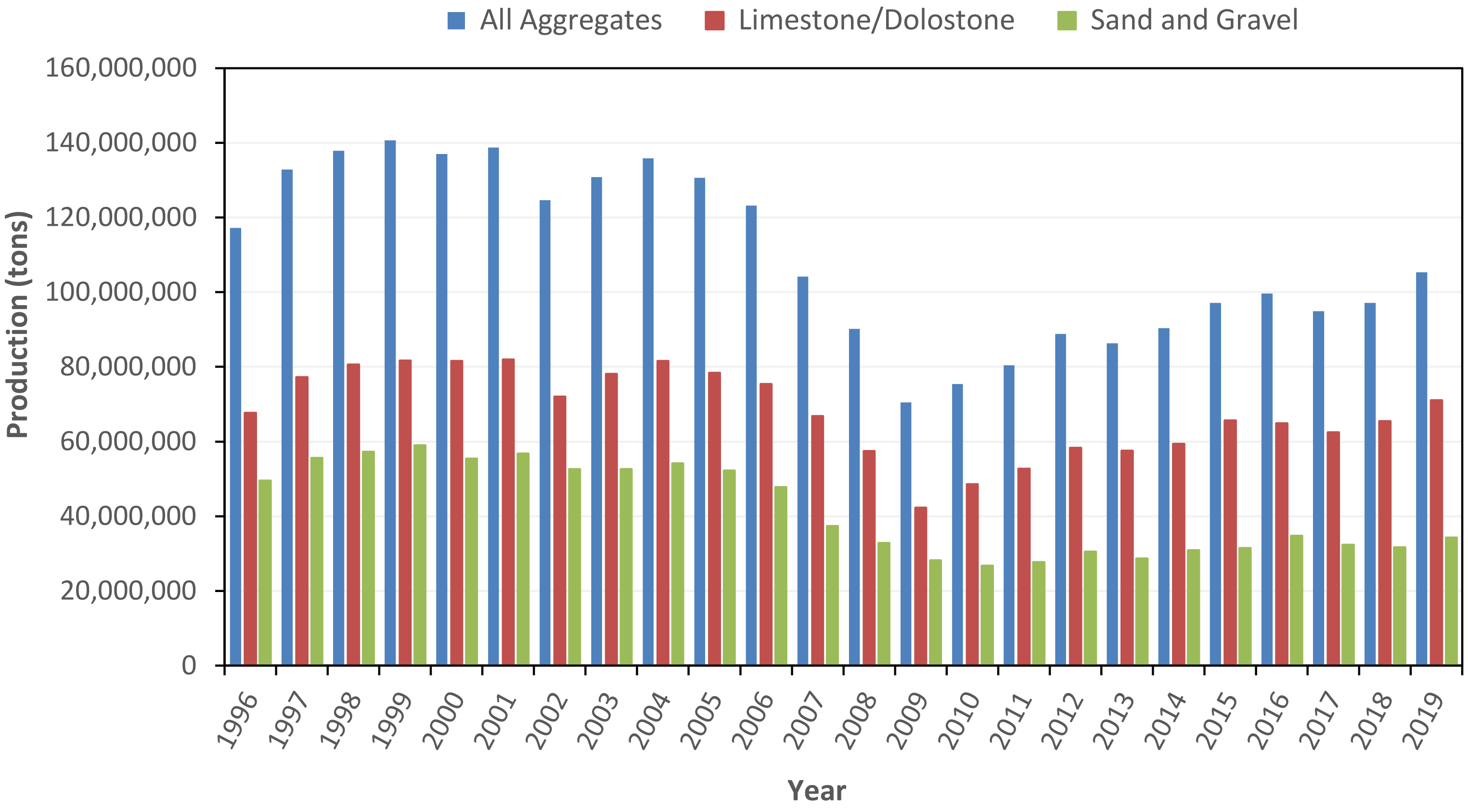
Aggregate Production in 2019



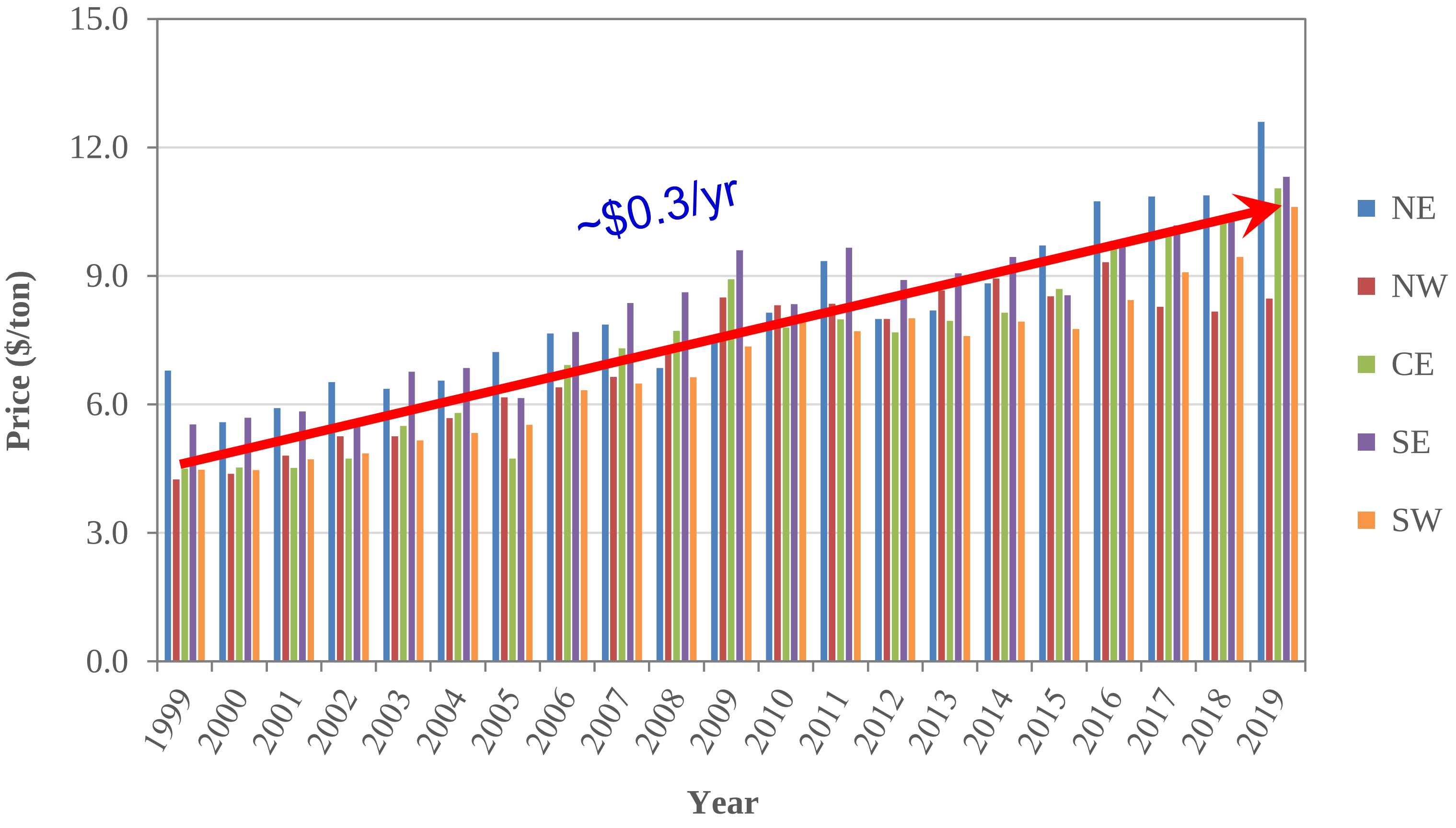
BEDROCK GEOLOGIC MAP OF OHIO



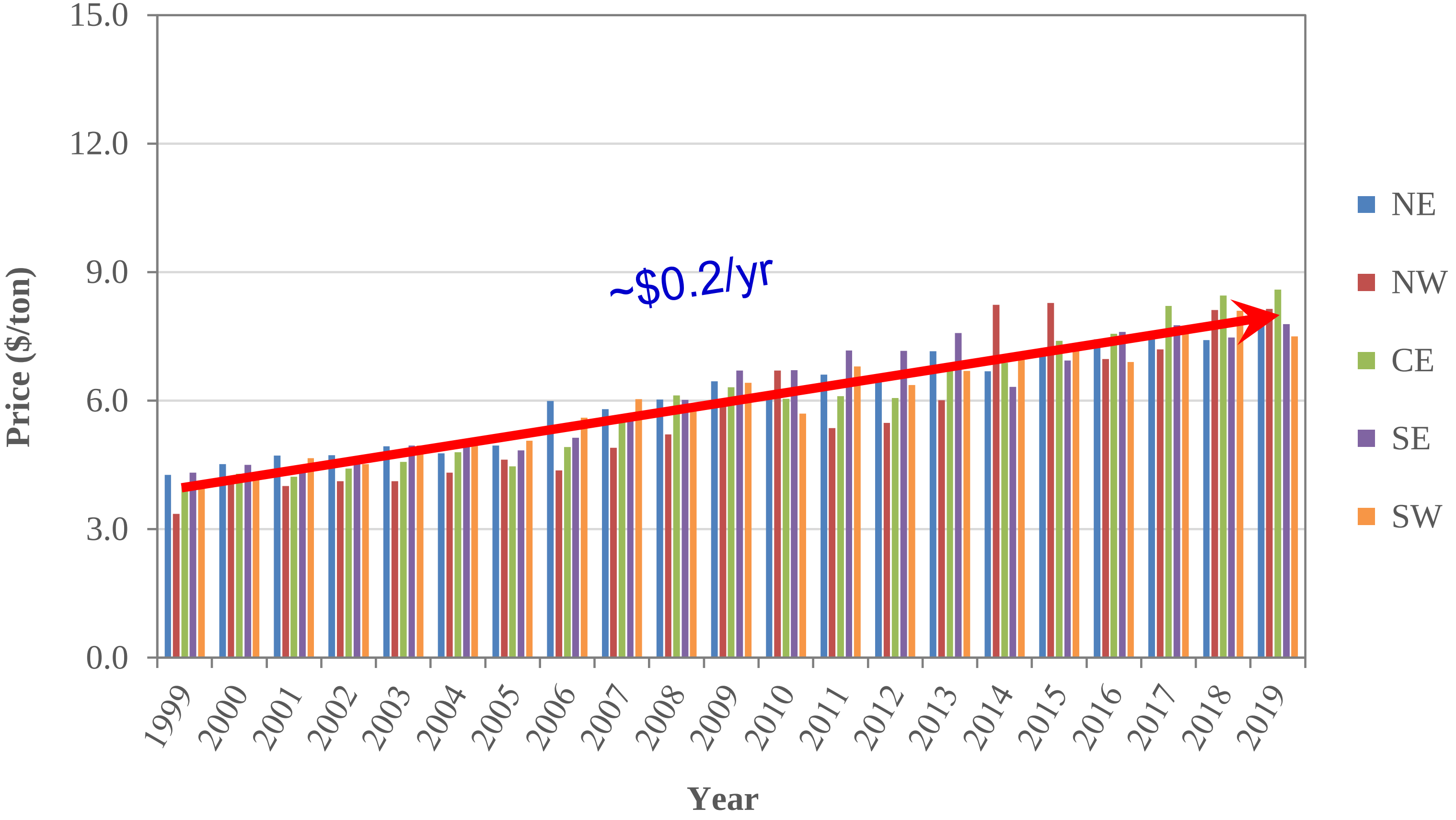
Aggregate Production



Aggregate Cost (LS/DS)

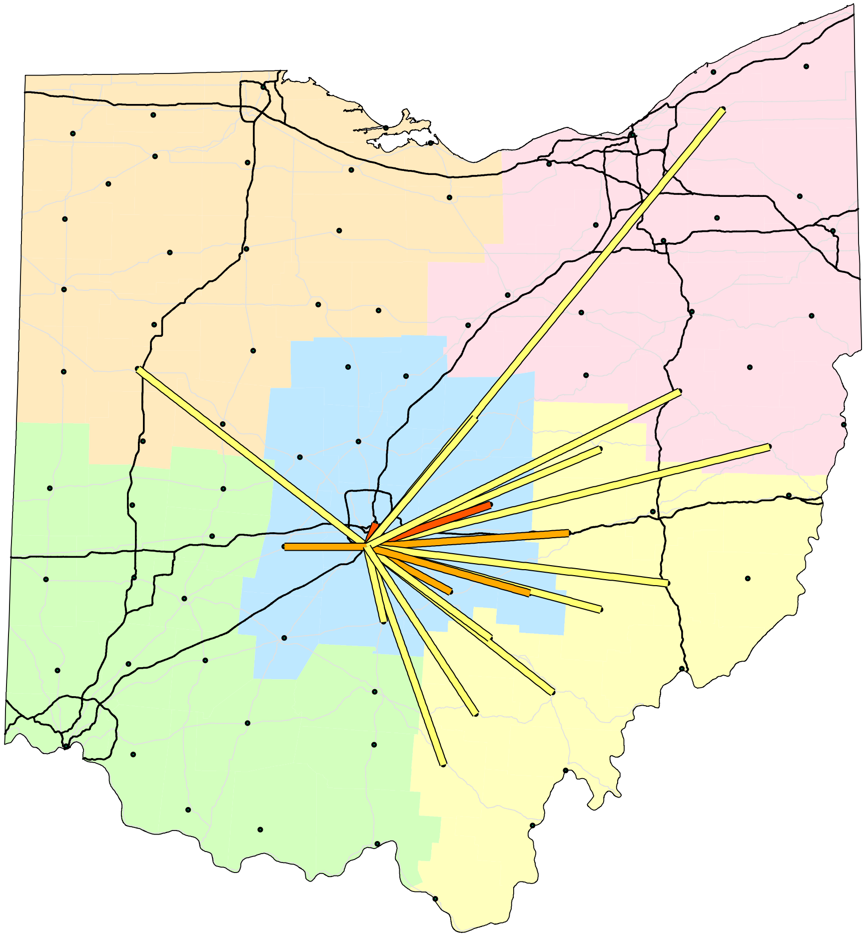


Aggregate Cost (SG)



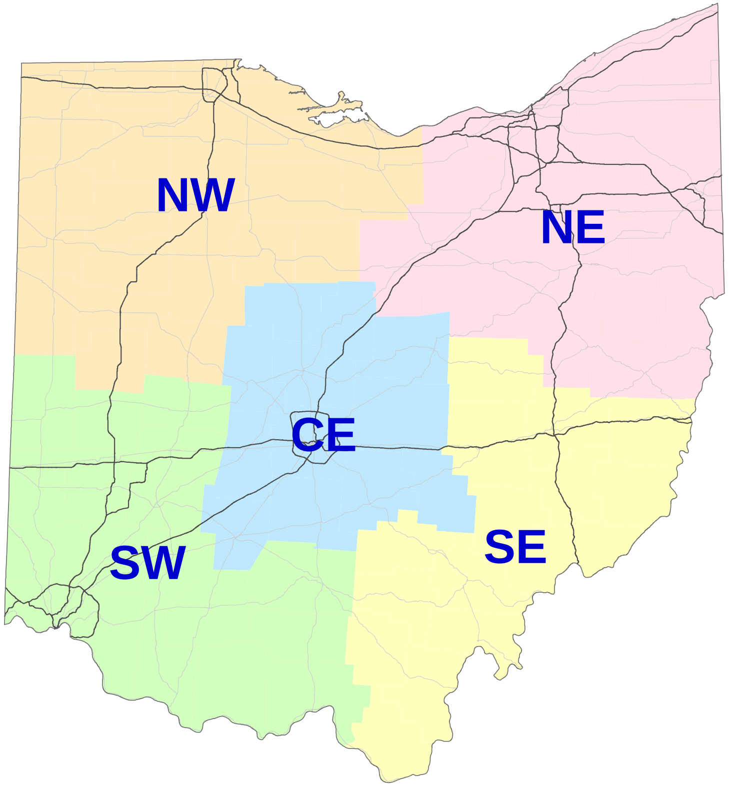
Aggregate Consumption

Origin-Destination



Yellow < 5,000 tons
Orange between 5,000 and 50,000 tons
and Red > 50,000 tons

Origin-Destination

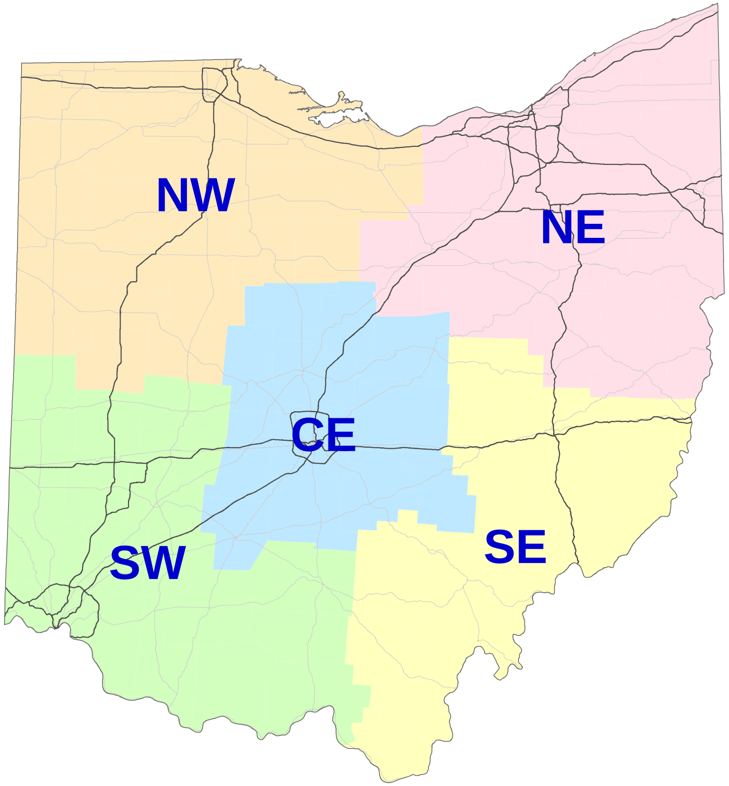


Limestone and Dolostone

Destination Region

Origin Region	NE	NW	CE	SE	SW
NE	96.7%	0.0%	0.0%	3.3%	0.0%
NW	42.3%	52.4%	0.9%	3.1%	1.3%
CE	0.1%	0.3%	98.4%	1.2%	0.0%
SE	5.0%	0.0%	15.0%	78.0%	2.0%
SW	0.0%	0.0%	2.3%	8.0%	89.7%

Origin-Destination

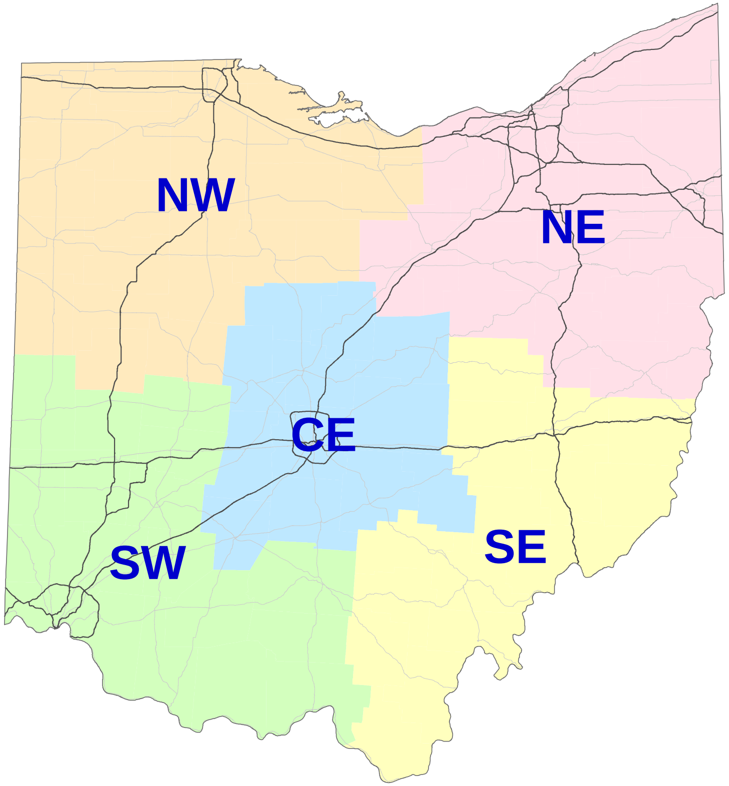


Sand and Gravel

Destination Region

Origin Region	NE	NW	CE	SE	SW
NE	83.2%	3.3%	1.6%	11.6%	0.3%
NW	0.0%	67.5%	4.7%	0.0%	27.8%
CE	13.9%	3.9%	81.4%	0.3%	0.5%
SE	2.2%	0.0%	34.9%	62.9%	0.0%
SW	0.0%	1.5%	1.0%	5.8%	91.7%

Aggregate Consumption in 2019

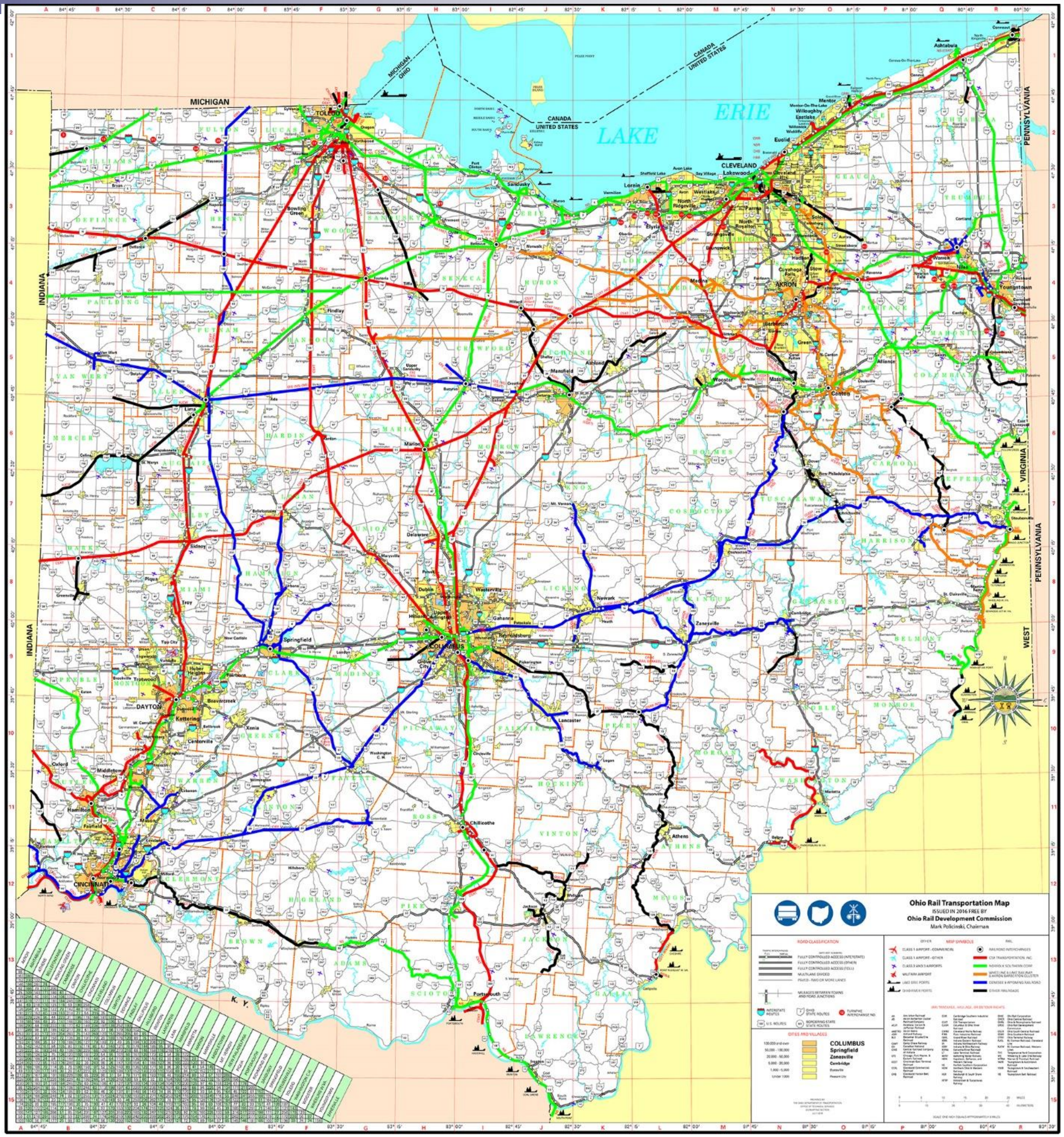


All Aggregates

Region	Production in 2019 (thousand tons)	Consumption in 2019 (thousand tons)
NE	15,145	29,034
NW	36,351	20,089
CE	22,703	23,975
SE	6,730	9,257
SW	24,372	22,947
Total	**105,301**	**105,301**

Aggregate Flow Between Regions

Active Rail Routes and Ports in Ohio



Transportation Methods

Trucks

Rail

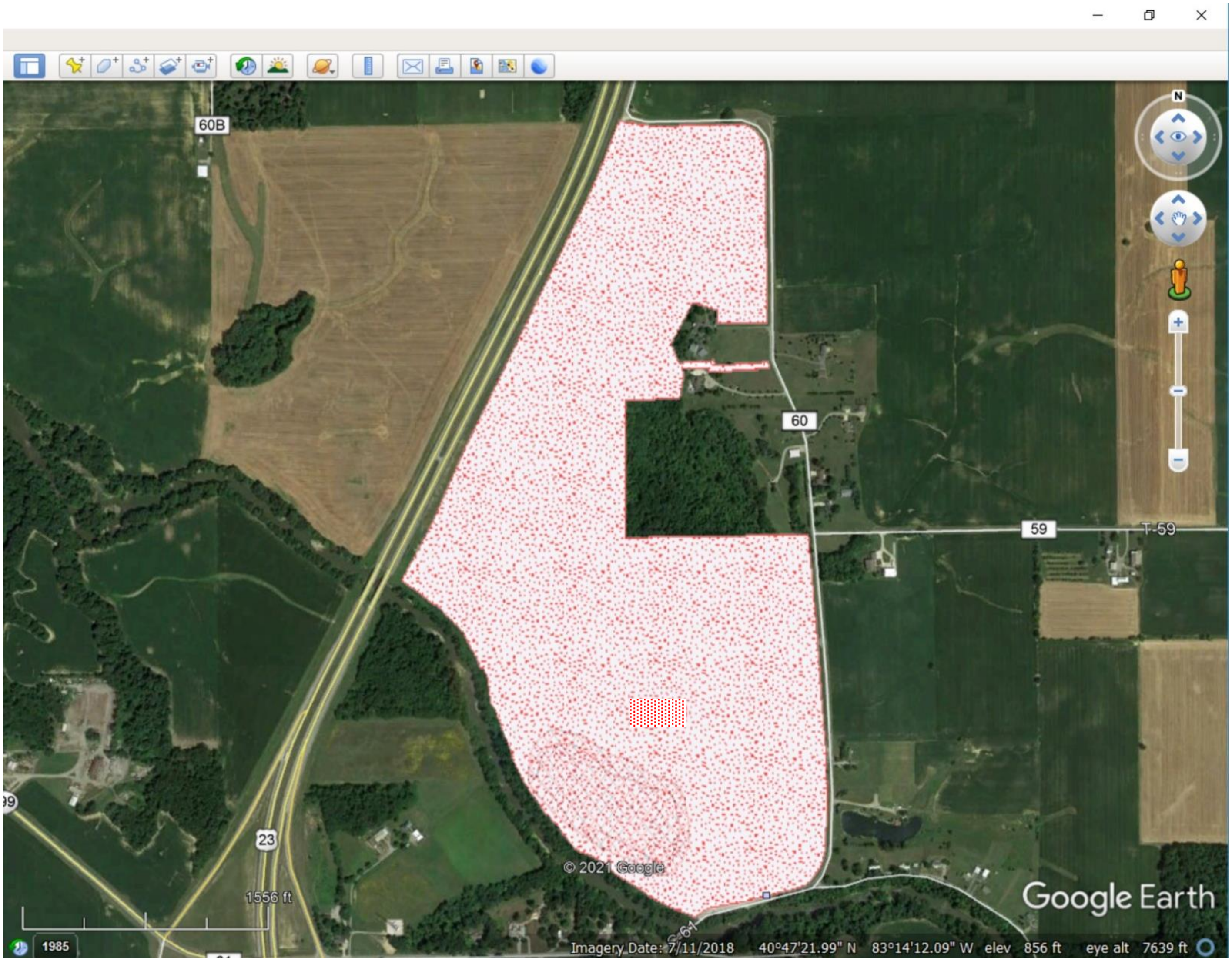
Lake Freighters

Barges

Aggregate Reserves

Aggregate Reserves

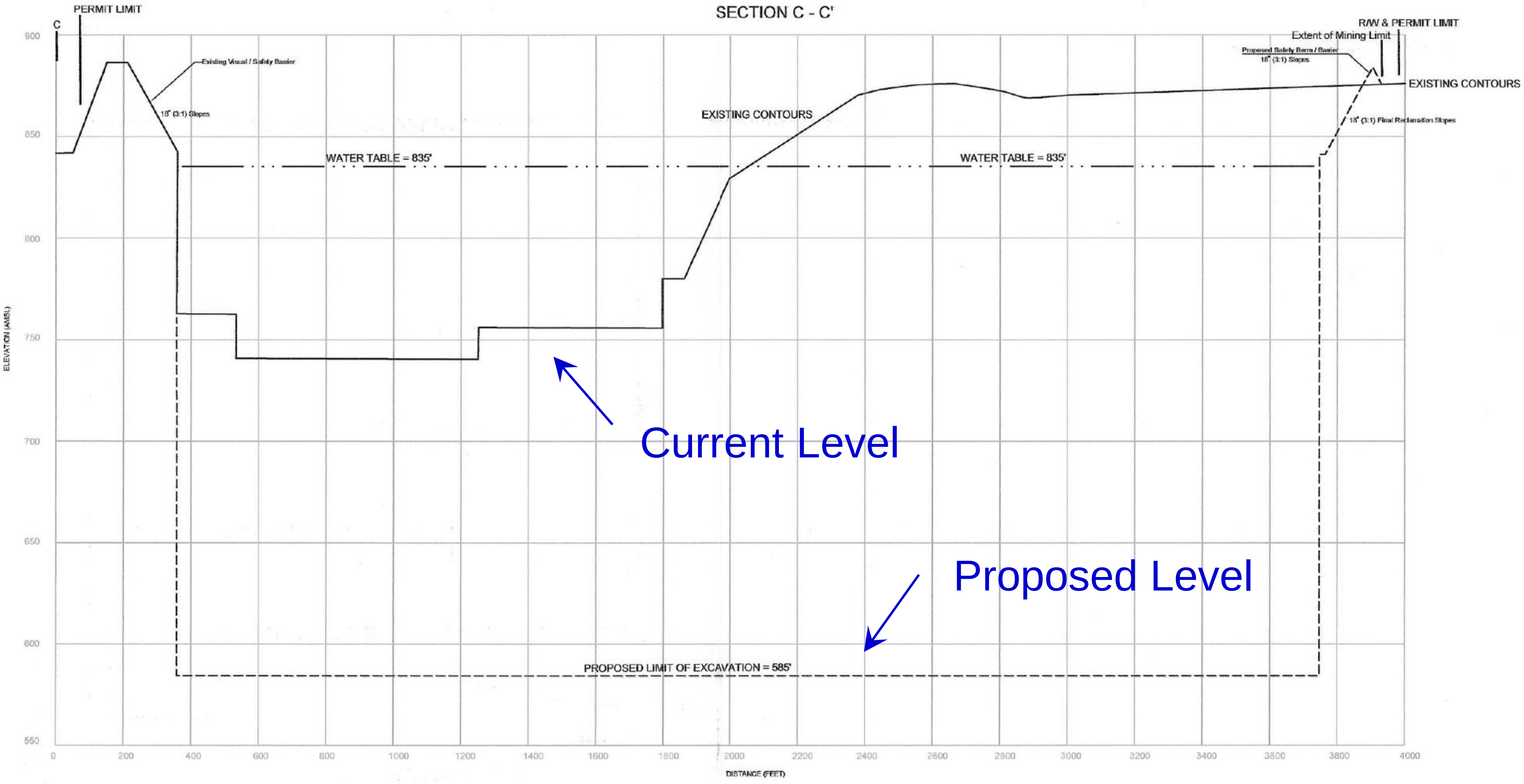
- Mines with production information: ~850 mines
- Active mines: ~600 mines
- Mines used for estimation of aggregate reserves: ~325 mines
  - Sand and gravel: ~200 mines
  - Limestone and dolostone: ~85 mines
  - Dual (sand and gravel as well as limestone and dolostone): ~40 mines



Google Earth – Limestone Mine

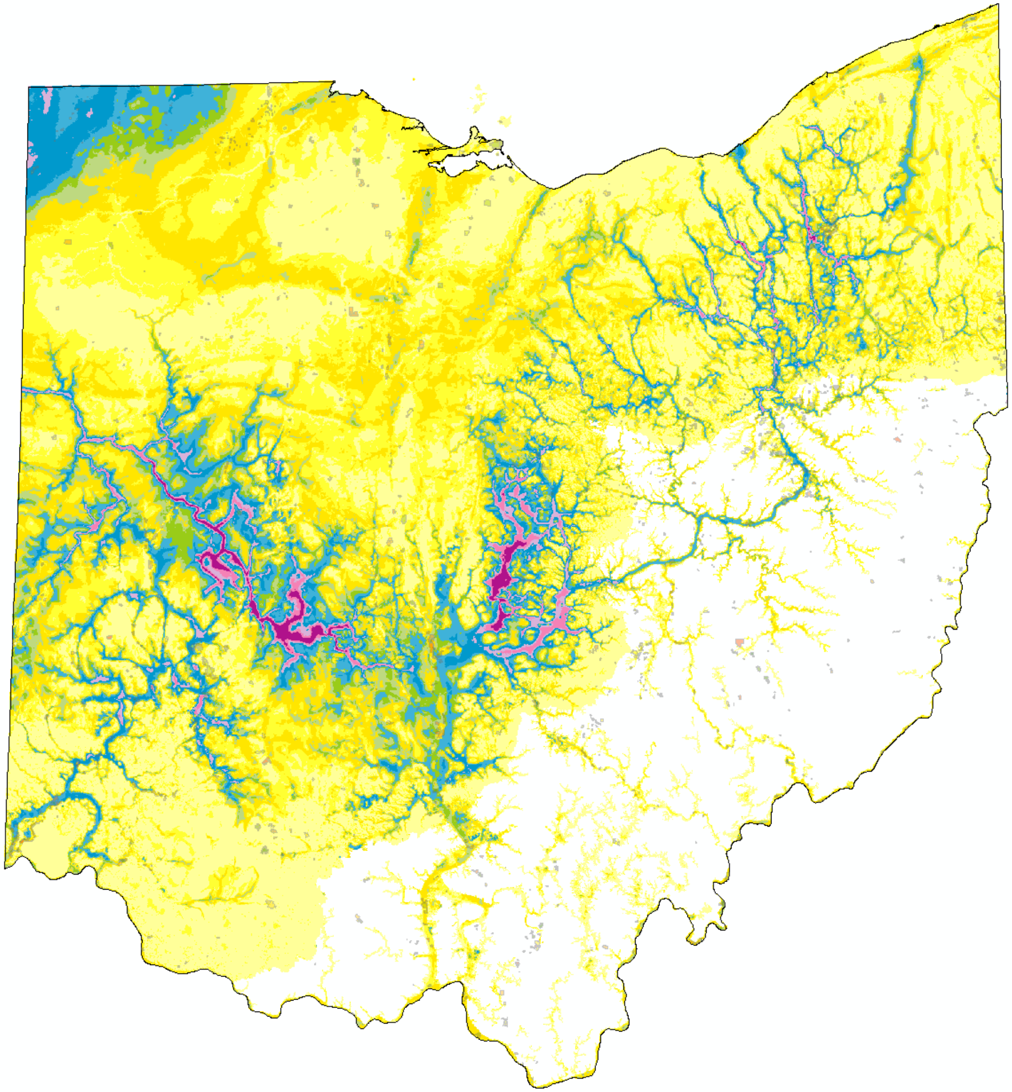
Google Earth

Limestone Mine

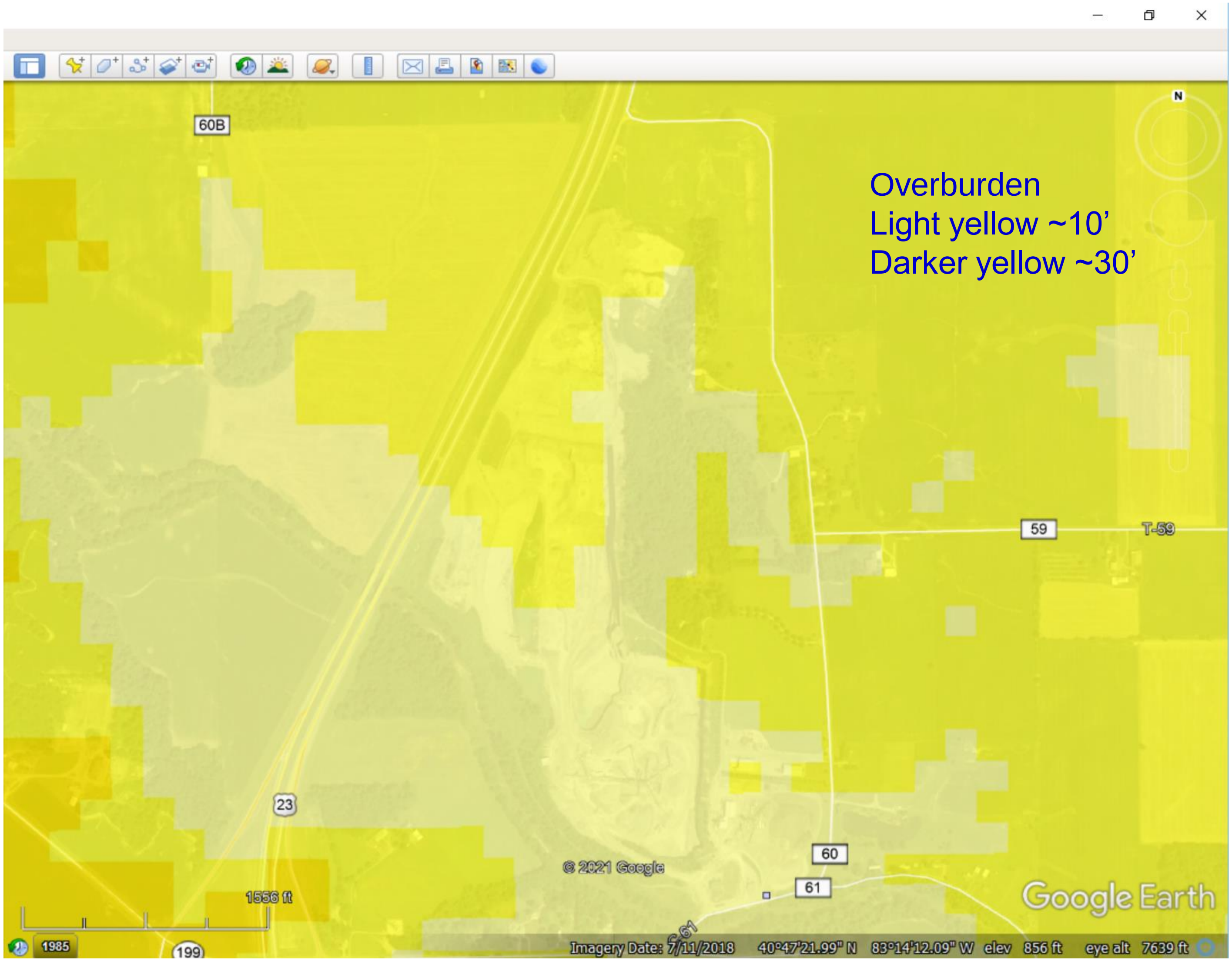


Current Level

Proposed Level

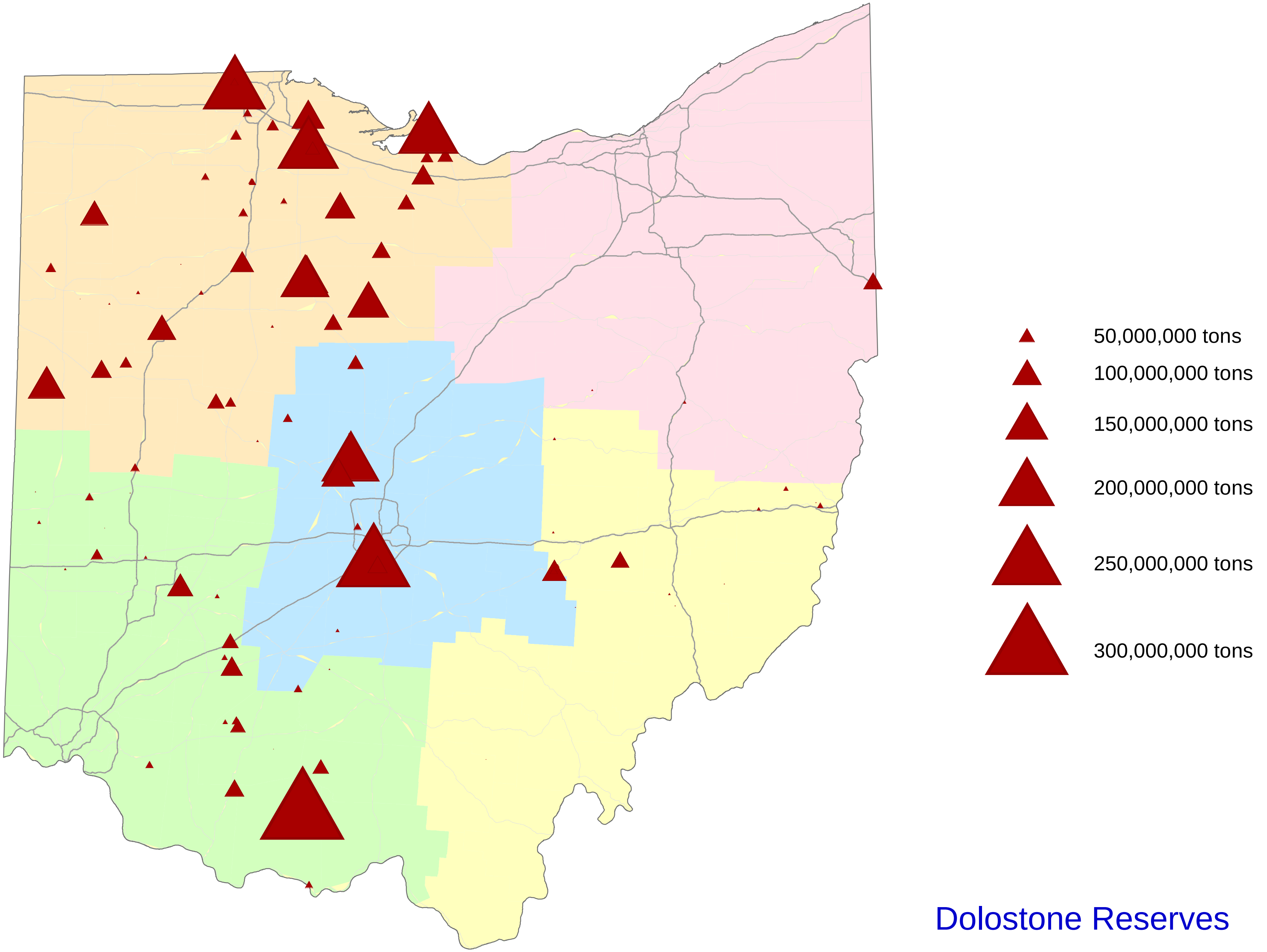


Drift Thickness

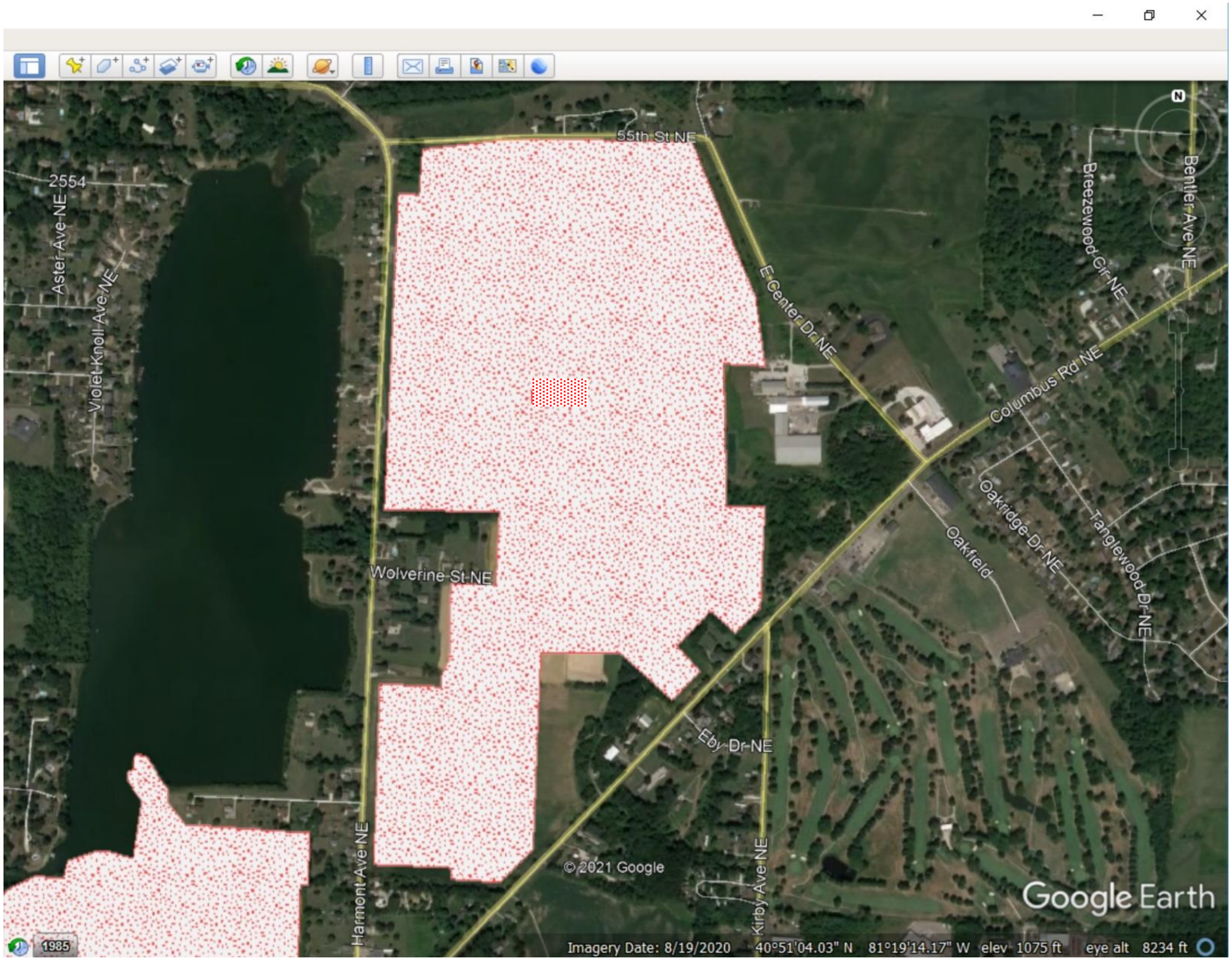


Overburden
Light yellow ~10’
Darker yellow ~30’

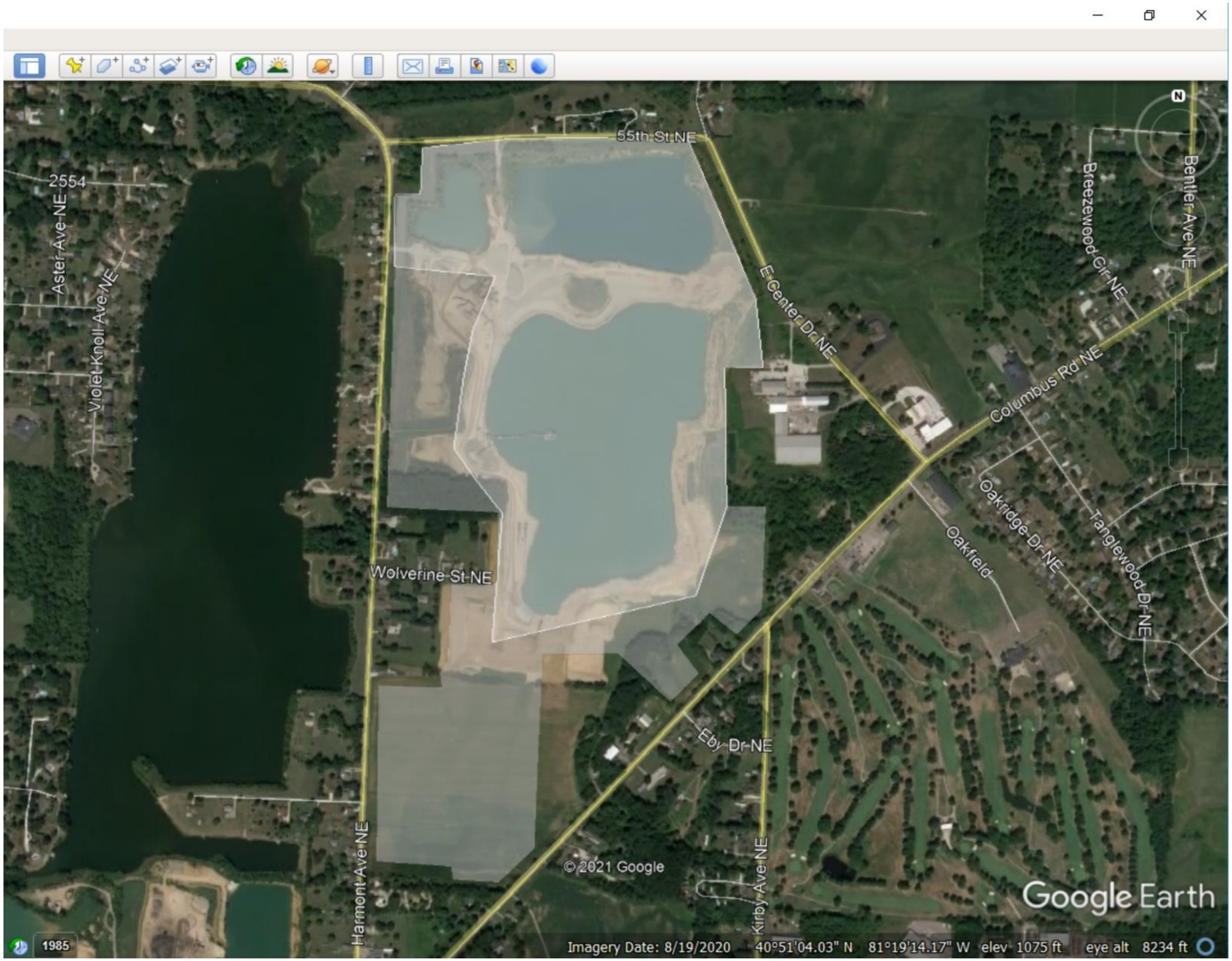
Google Earth – Limestone Mine



Dolostone Reserves

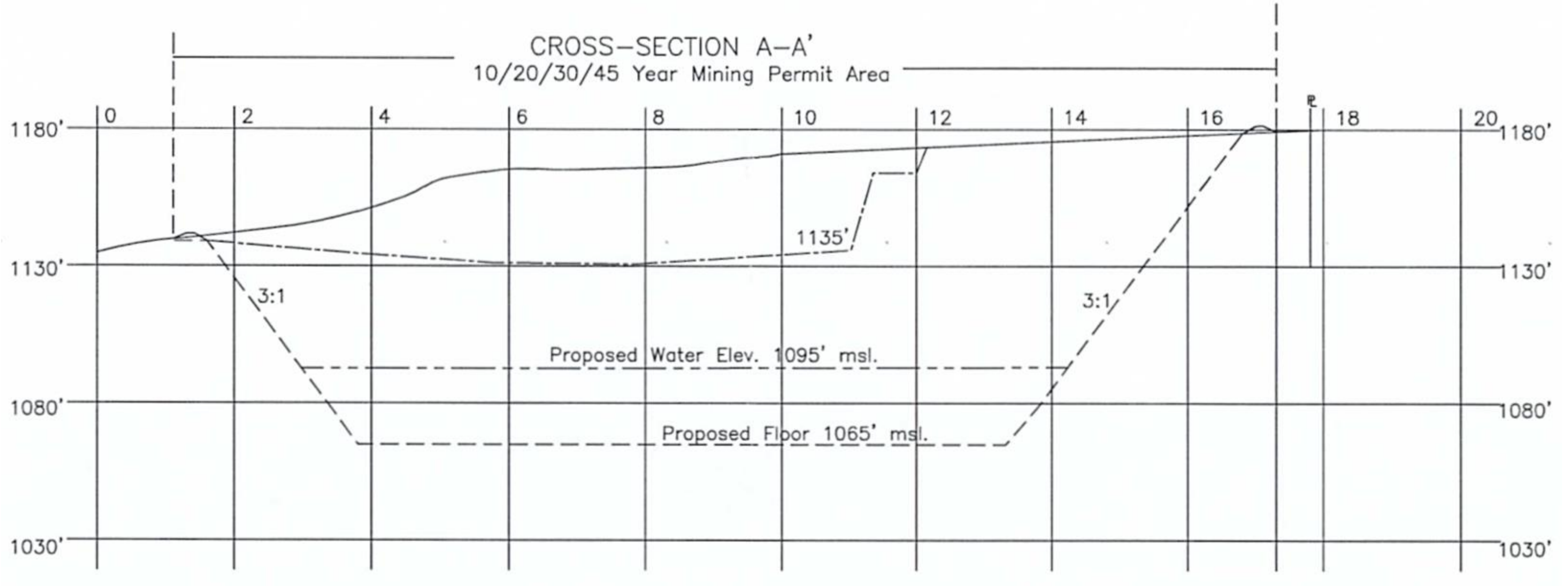


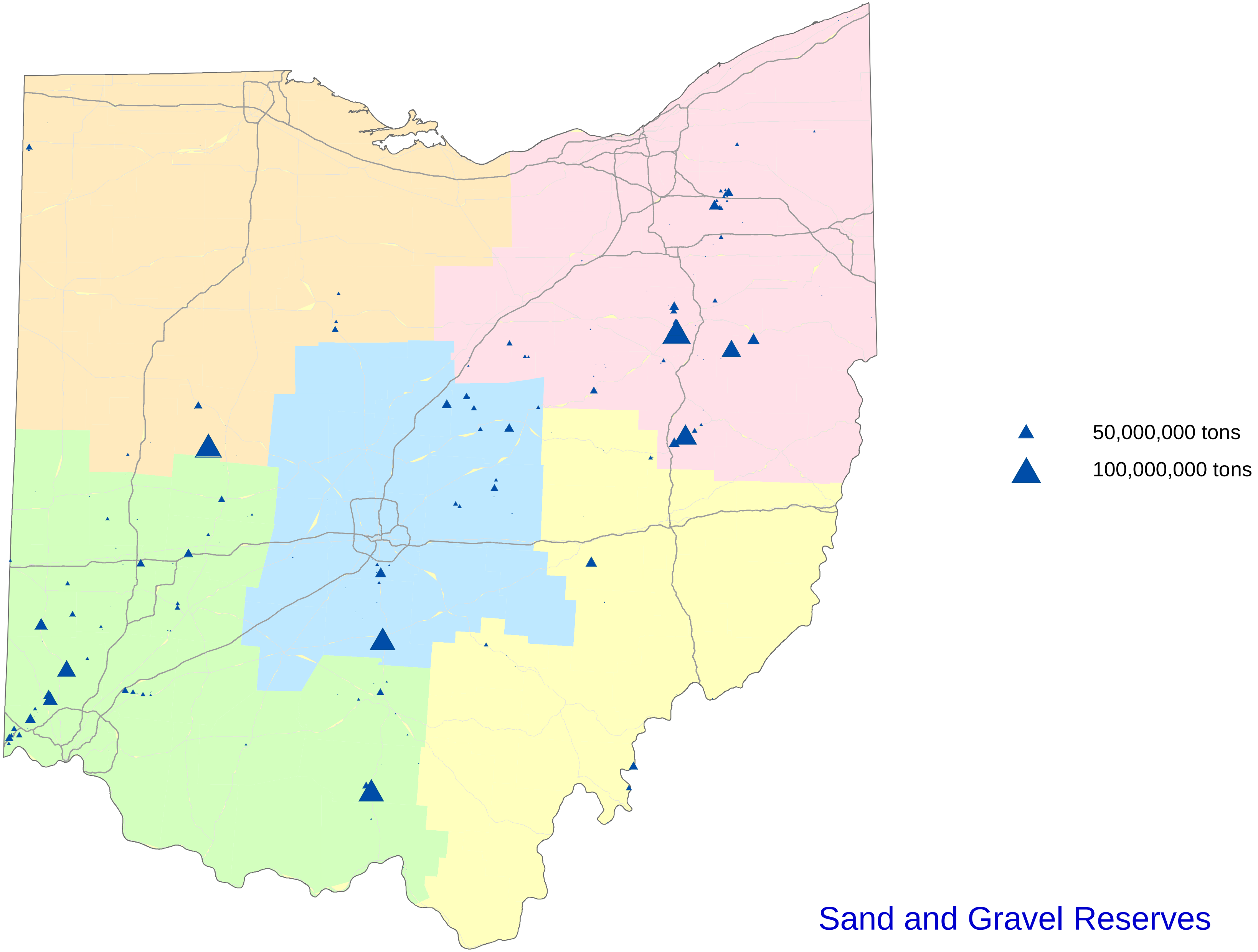
Google Earth – Sand and Gravel



Google Earth – Sand and Gravel

Sand and Gravel Mine





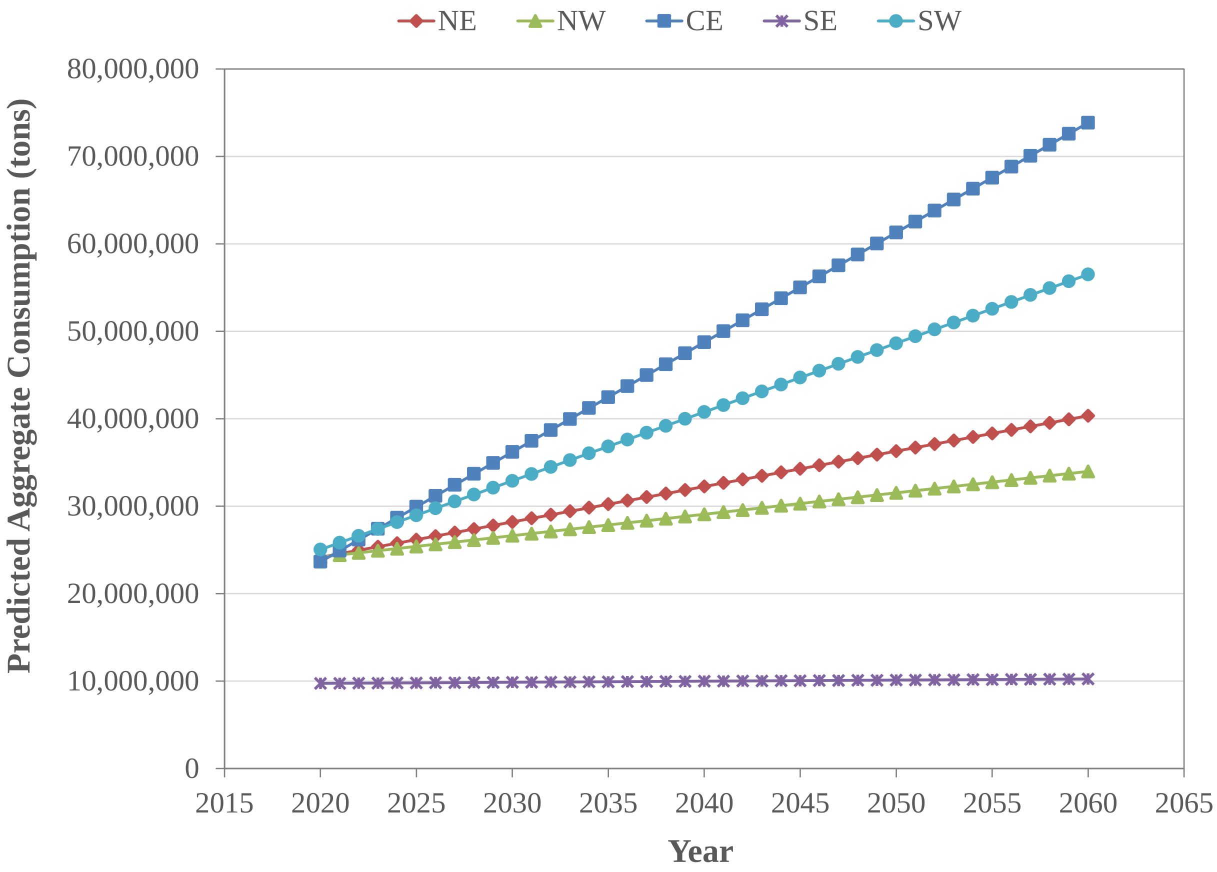
Sand and Gravel Reserves

Aggregate Reserves

- Checking the results:
  - Mining depth consistent with other mines in region.
  - Production rate consistent with mining depth.
  - Reasonable aggregate reserves for remaining area to be mined.

Aggregate Depletion

Future Aggregate Consumption



Fixed Effects Regression Model (with Different Intercepts for Each Region)

Model Variables:

- Future Population
- Annual Change in Population
- Housing Permits
- Number of Construction Workers

Permitting History (Acres)

Year	NE	NW	CE	SE	SW	Total
2011	190.4	477.7	-16.2	131.9	10.5	794.3
2012	255.9	77.4	-9.6	549.8	201.2	1074.7
2013	243.9	-7	440.5	152	511.5	1340.9
2014	493.3	-24.4	70.8	27.2	88.6	655.5
2015	142.1	99.4	20.9	156.6	81.3	500.3
2016	113.6	8.3	50	162.9	-19.3	315.5
2017	-301.7	43.6	-148.9	254.1	458.3	305.4
2018	403.6	67.5	-181.3	160.5	530.6	980.9
2019	217.6	96.2	53.7	391.4	-15.5	743.4
2020	309.5	24.1	86	153.4	10.2	583.2
2021	457.3	77.5	-148	56.8	8.6	452.2
Total	2525.5	940.3	217.9	2196.6	1866.0	7746.3
Total/Year	230.0	85.5	19.8	199.7	169.6	704.2

Aggregate Depletion

Region	Aggregate Type	Reserves (Tons)	Depletion (Years)
NE	Limestone/Dolostone	161,840,283	11
	Sand and Gravel	994,569,341	> 40
NW	Limestone/Dolostone	3,182,953,318	> 40
	Sand and Gravel	136,500,274	> 40
CE	Limestone/Dolostone	875,636,055	30
	Sand and Gravel	449,589,381	37
SE	Limestone/Dolostone	326,114,084	> 40
	Sand and Gravel	174,488,686	38
SW	Limestone/Dolostone	1,057,208,108	> 40
	Sand and Gravel	1,098,483,970	> 40
Statewide	Limestone/Dolostone	5,603,751,847	> 40
	Sand and Gravel	2,853,631,652	> 40

Research Findings and Conclusions

Research Findings

- Aggregate availability:
  - Limestone/dolostone and sand and gravel aggregates are the most common types of aggregates produced and consumed in Ohio. This study revealed that the supplies of these aggregates are sufficient to meet the needs of the state for more than forty years. However, the geologic deposits of these aggregates are not uniformly distributed across the state.
  - The eastern half of the state has limited amounts of limestone reserves, while the southern and northwest regions of the state have limited amounts of sand and gravel reserves, making it necessary to import aggregates from other regions to meet local needs or use locally available aggregates that may be lower in quality.

Research Findings

- Aggregate depletion:
  - At the current time, the central region of the state has moderate amounts of reserves of limestone/dolostone as well as sand and gravel. However, these aggregates are being rapidly depleted, especially from mines that are located in the Columbus area.

Research Findings

- Zoning laws:
    - At the present time, there has been more effort to expanding existing operations than opening a new mine due to challenges in obtaining the required zoning approval.
    - In recent years, the majority of zoning change applications for aggregate mining were submitted to townships that treat aggregate mining as a conditional use. Ohio Revised Code Section 519.141 (Conditional Zoning Certificates for Surface Mining Activities) that went into effect in 2007 provided guidance regarding this process.
    - Despite having a more clear process for requesting modifications to zoning permits to expand or open an aggregate mine in these townships, the aggregate industry maintains that it is time-consuming and expensive to obtain the zoning changes.

Questions?

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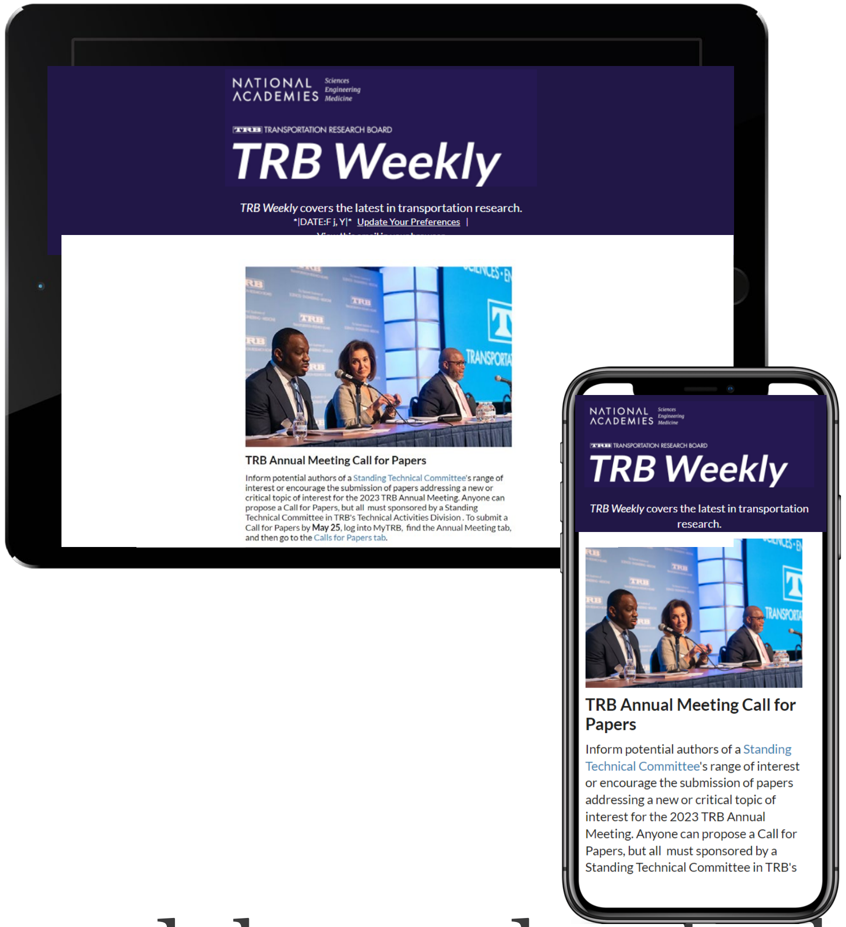

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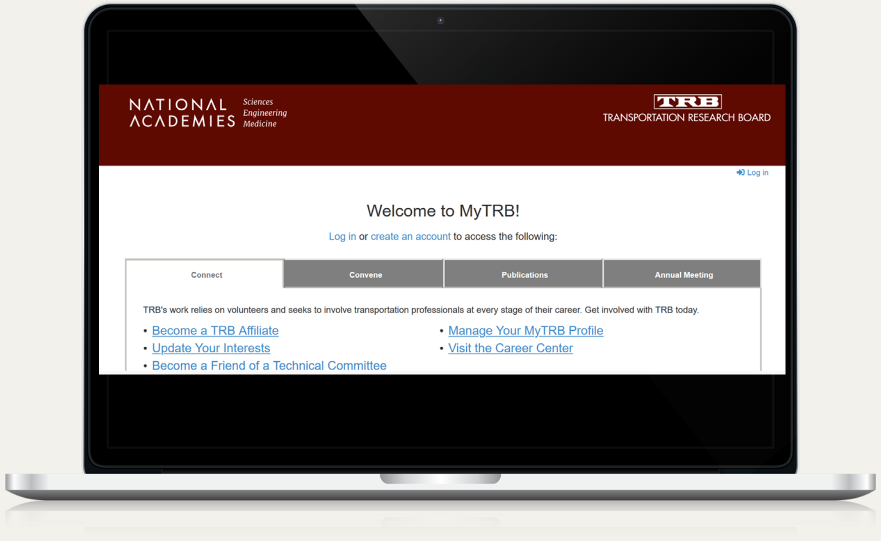

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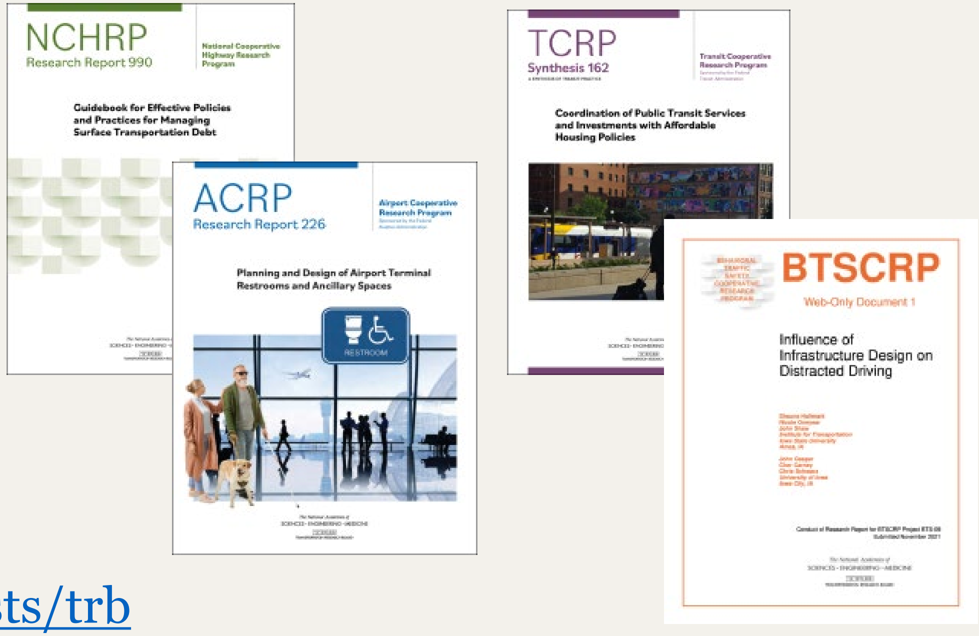

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