Innovative Construction Stormwater Management

IN A TRANSPORTATION ENVIRONMENT

Barry Fagan, PE/PLS, ENV SP, CPMSM, CPESC, CESSWI

VOLKERT | Environment & Infrastructure

ALDOT'S MISSION

To provide a transportation system…

MAKING THE CONNECTION

mission → activities → *potential* impacts → *environmental* responsibilities

ALDOT ENVIRONMENTAL

an evolution of thinking, focus, and application

EVOLUTION - THE FIVE PILLARS OF CONSTRUCTION STORMWATER MANAGEMENT

Effectiveness → **COMMUNICATION**

Implementation → **WORK**

Cause → **WATER**

Source → **EROSION**

Symptom → **SEDIMENT**

THE FIVE PILLARS OF CONSTRUCTION STORMWATER MANAGEMENT

Decreasing effectiveness

Increasing cost of implementation

Putting first things first…

A = ~~R K LS C P~~

A = AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

A CASE STUDY

MISSION – ACTIVITIES – IMPACTS - RESPONSIBILITIES

- Add two lanes to a section of I20/59 in Tuscaloosa, Alabama
- Widen to inside
- 9 miles
- 50,000 ADT
- 45% trucks

A CASE STUDY

MISSION – ACTIVITIES – IMPACTS - RESPONSIBILITIES

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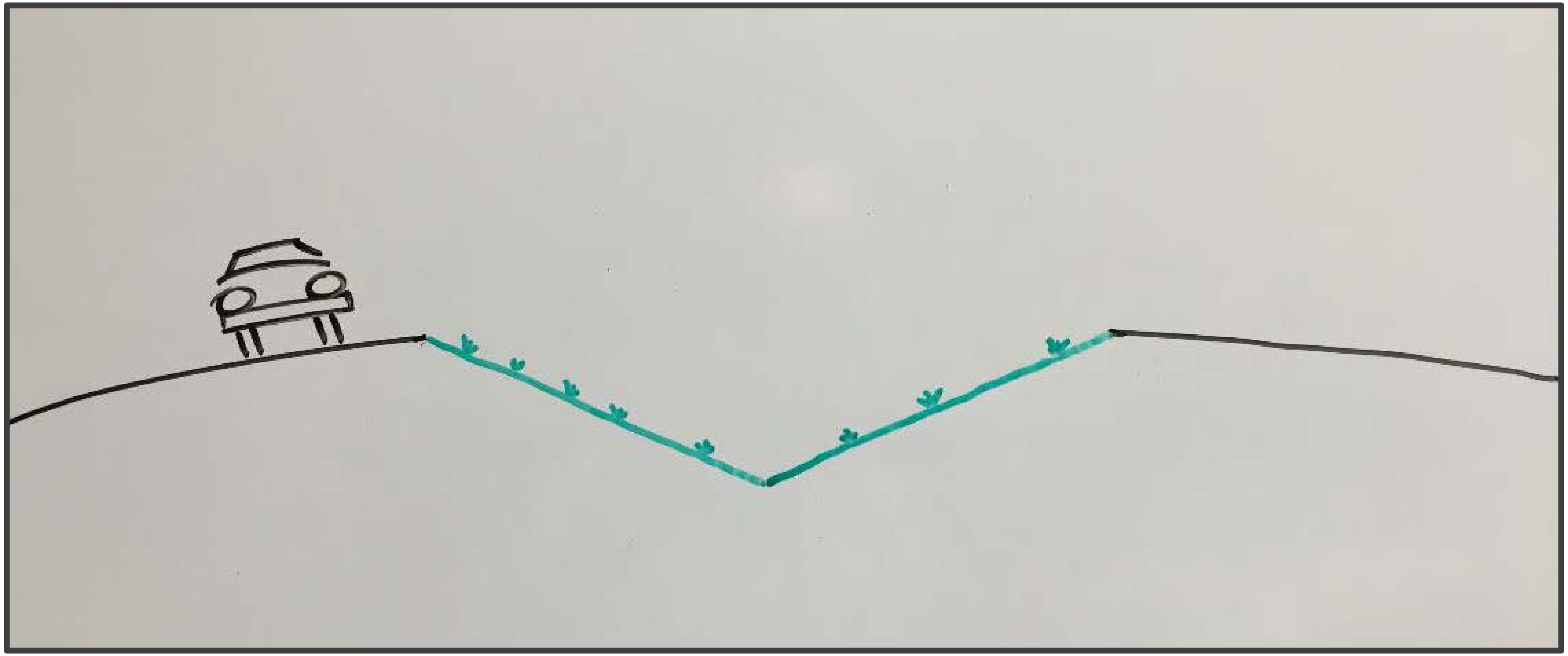

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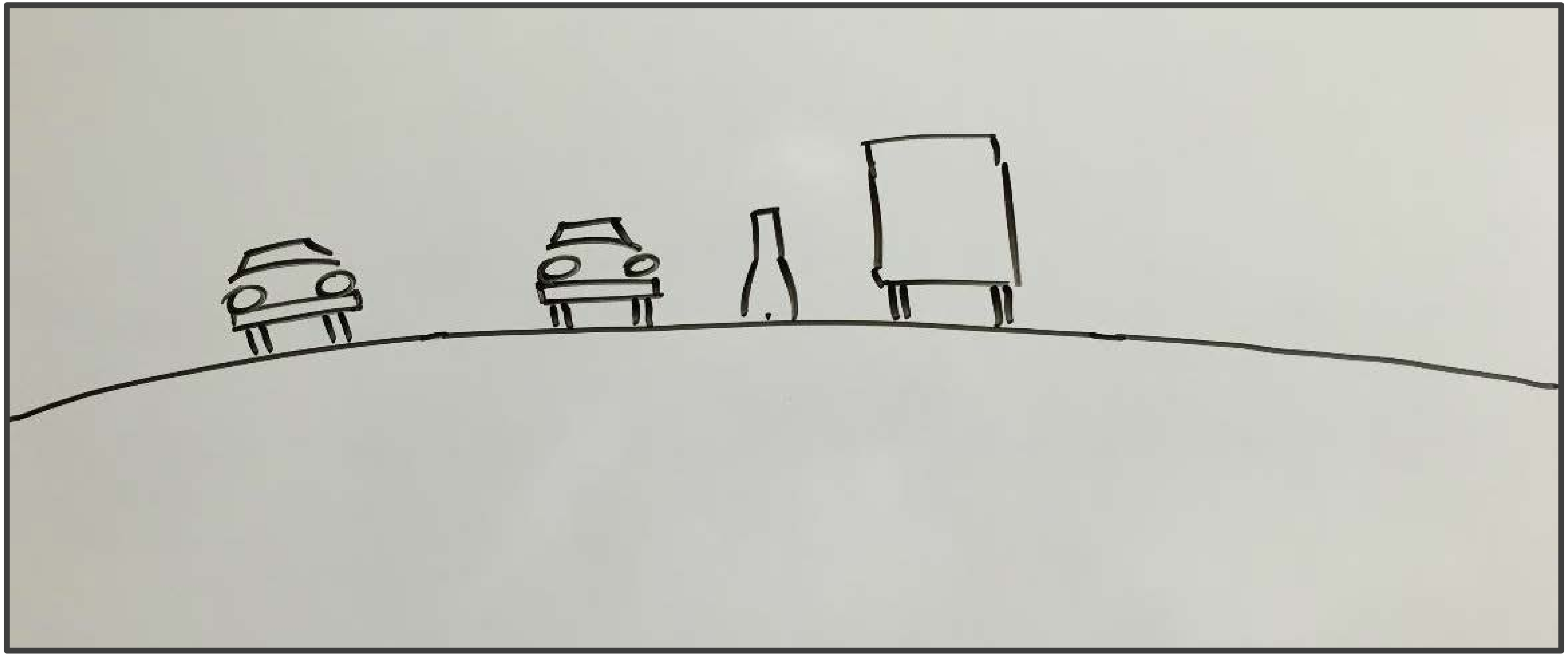

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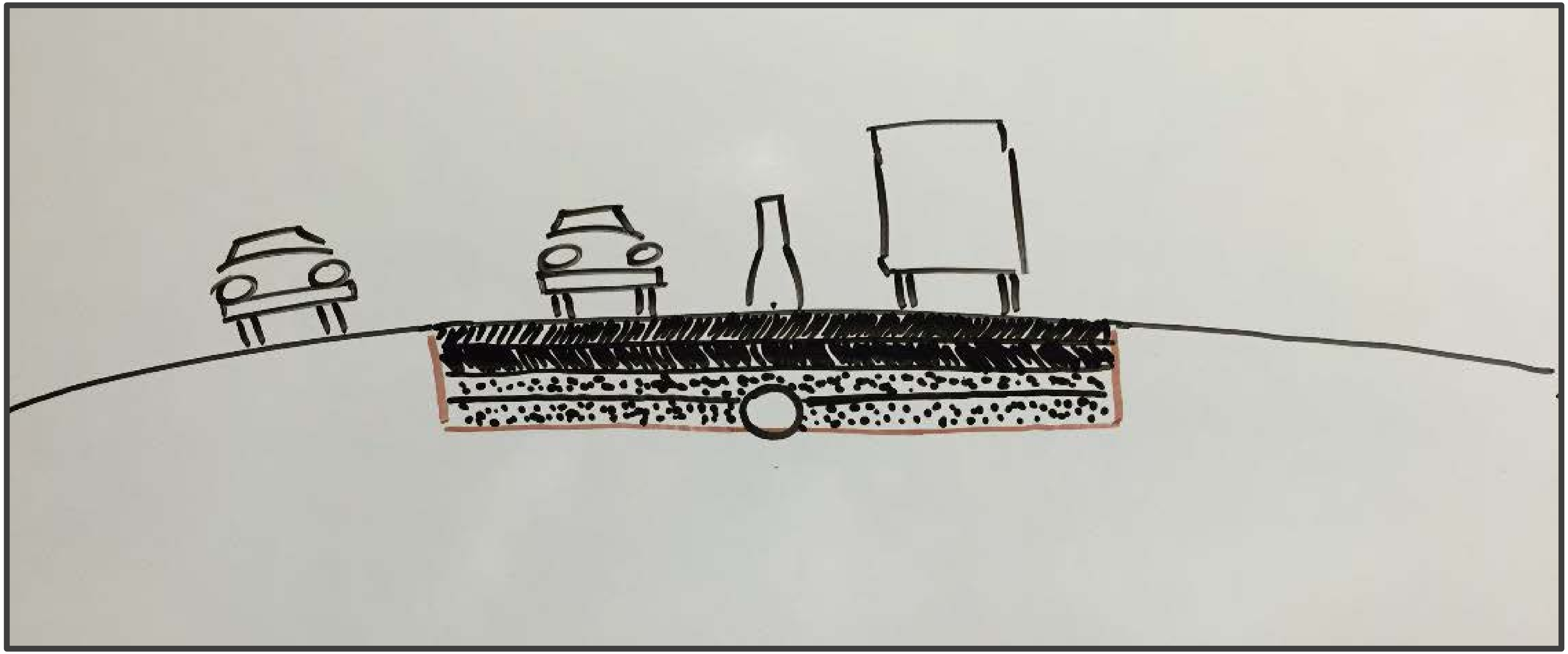

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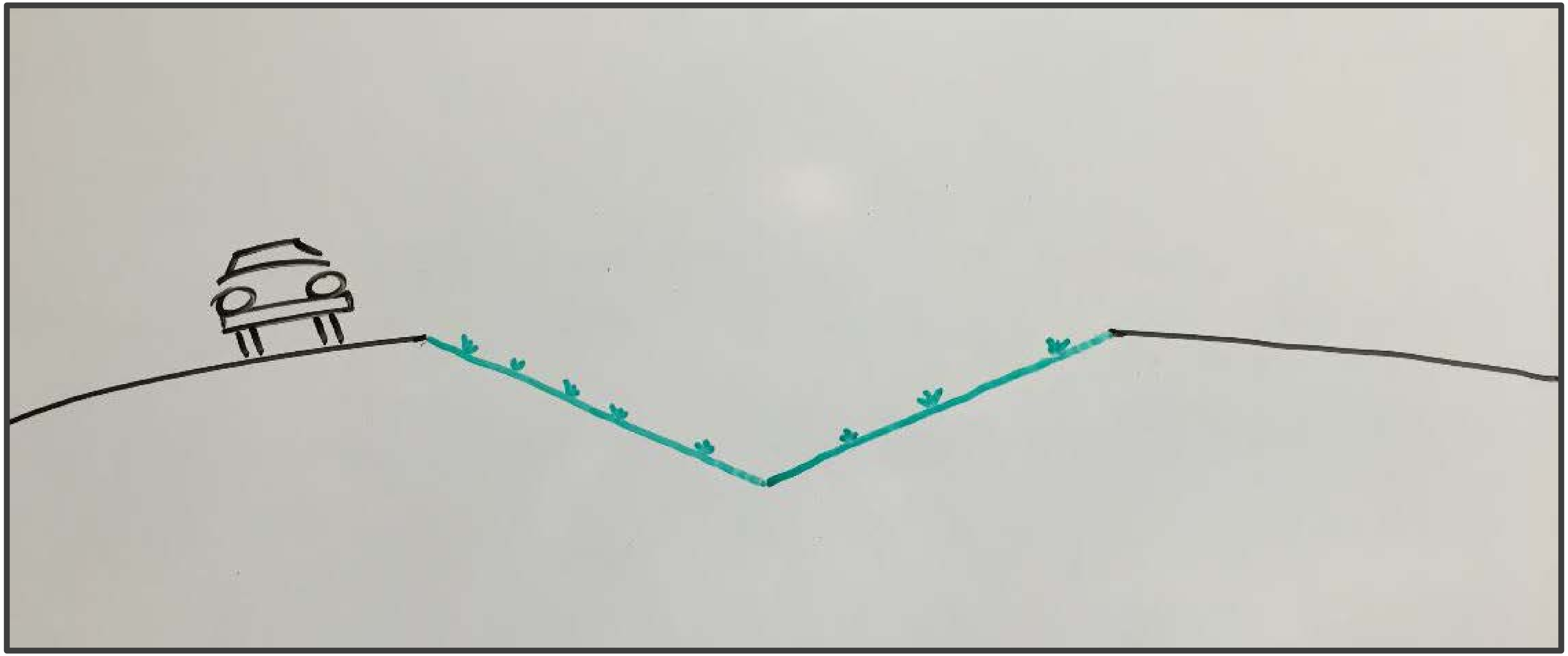

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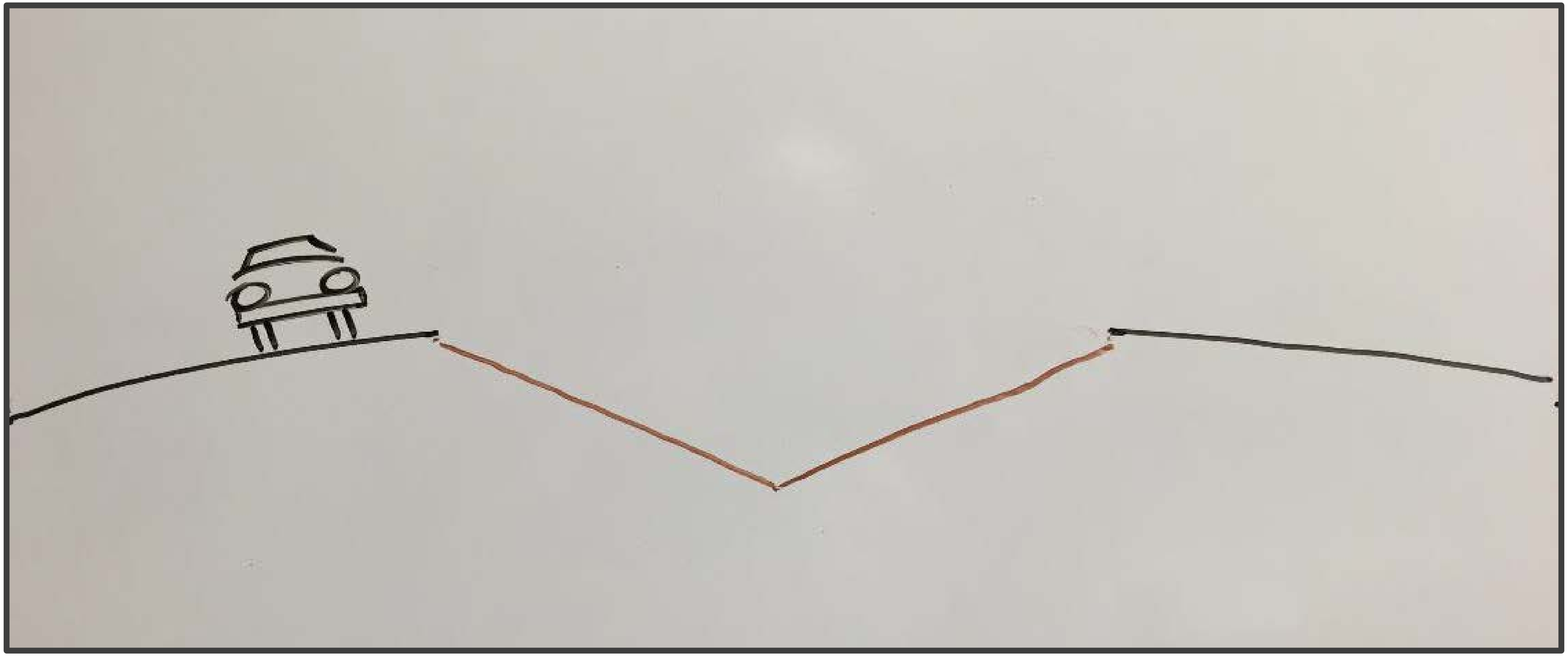

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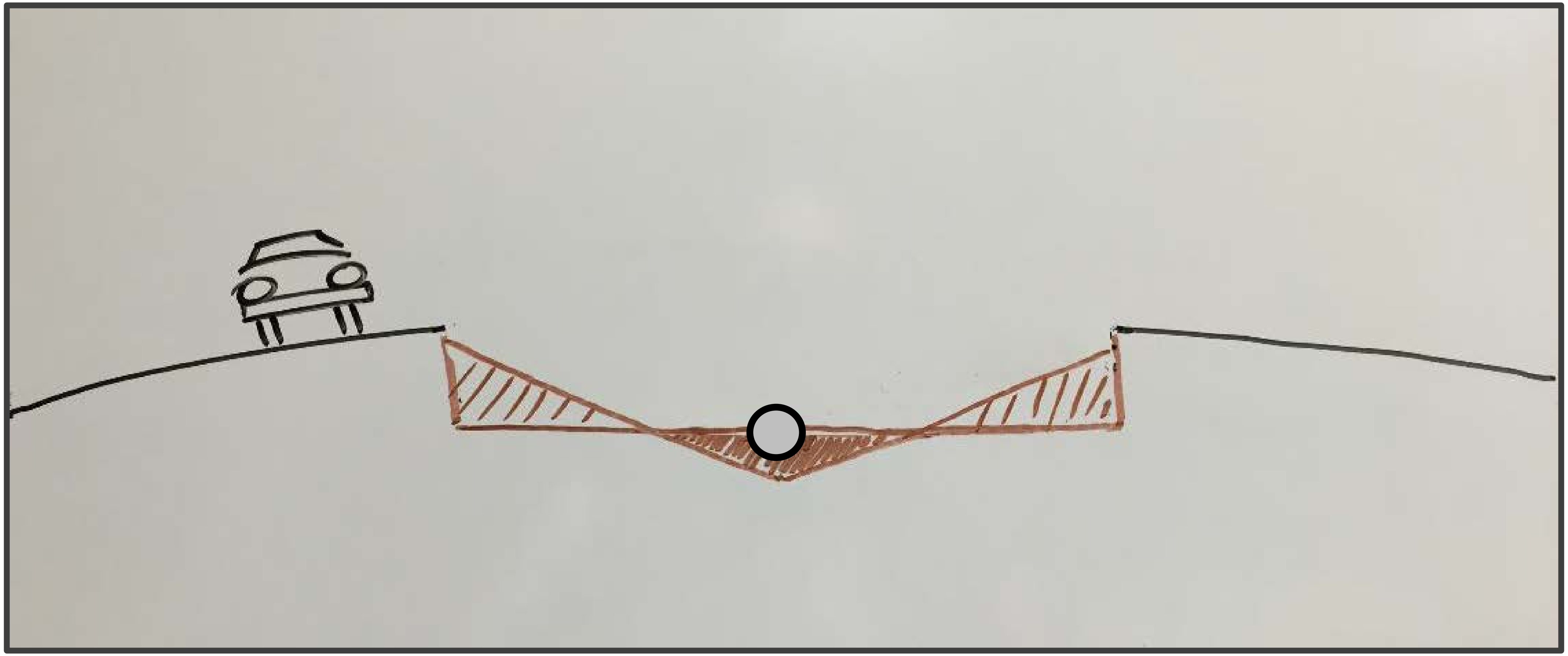

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MISSION – ACTIVITIES – IMPACTS - RESPONSIBILITIES

POTENTIAL IMPACTS:

- Impacts to water quality
- Impacts to habitat
- Impacts to private property
- Regulatory actions
- Civil actions
- Embarrassment
- Loss of trust and grace

A CASE STUDY

MISSION – ACTIVITIES – IMPACTS - RESPONSIBILITIES

RESPONSIBILITIES:

Regulatory Requirements

- General permit
- TMDL –
  - 32% turbidity reduction
  - 60.8 NTU limitation

Social Expectations

- Hurricane Creekkeeper
- Friends of Hurricane Creek
- Black Warrior Riverkeeper
- ALDOT commitment to the environment

MAKING THE CONNECTION

potential *environmental*

mission → activities → impacts → responsibilities

HOW?

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HOW?

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THE FIVE PILLARS OF CONSTRUCTION STORMWATER MANAGEMENT

Communication - *the* best management practice.

Work - Contractors can do just about anything.

~~Water~~ - Clean water in, clean water out.

~~Erosion~~ - Green is good.

~~Sediment~~ - Sediment control alone is ineffective.

A CASE STUDY

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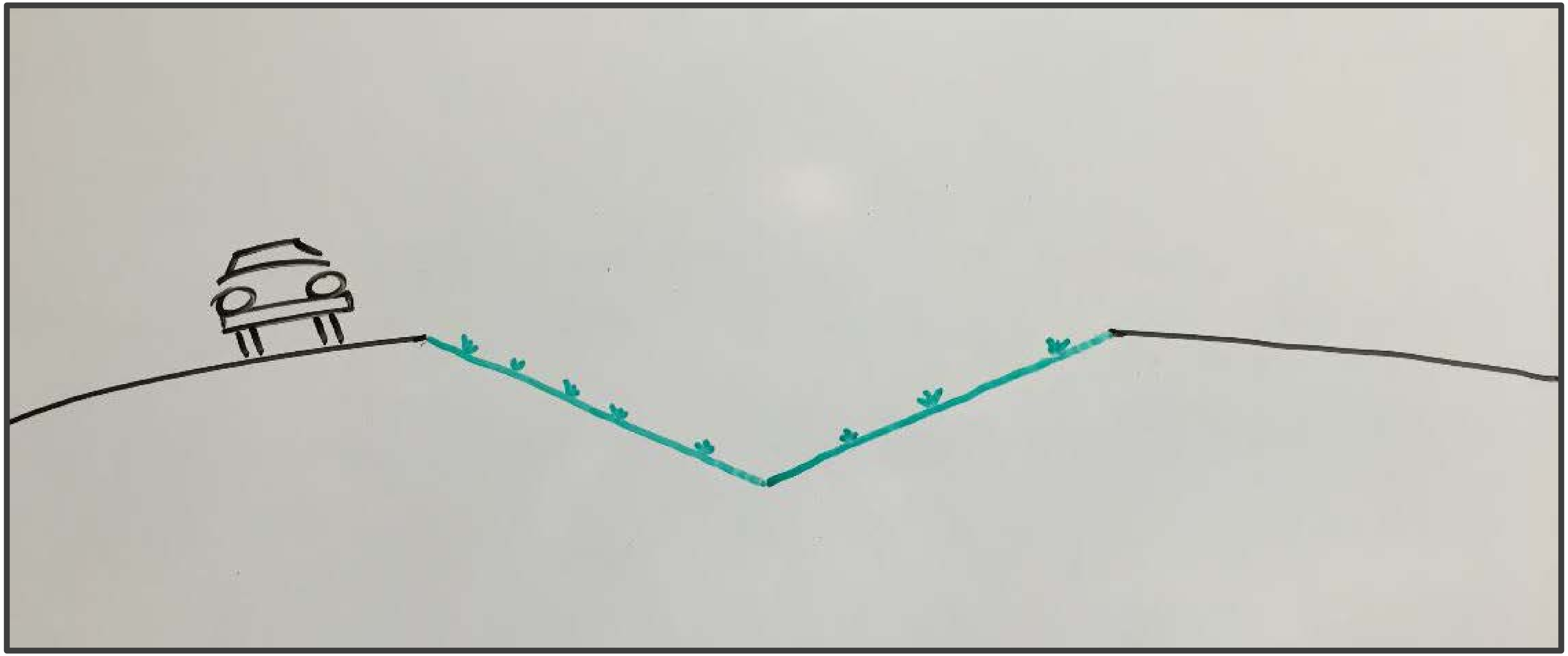

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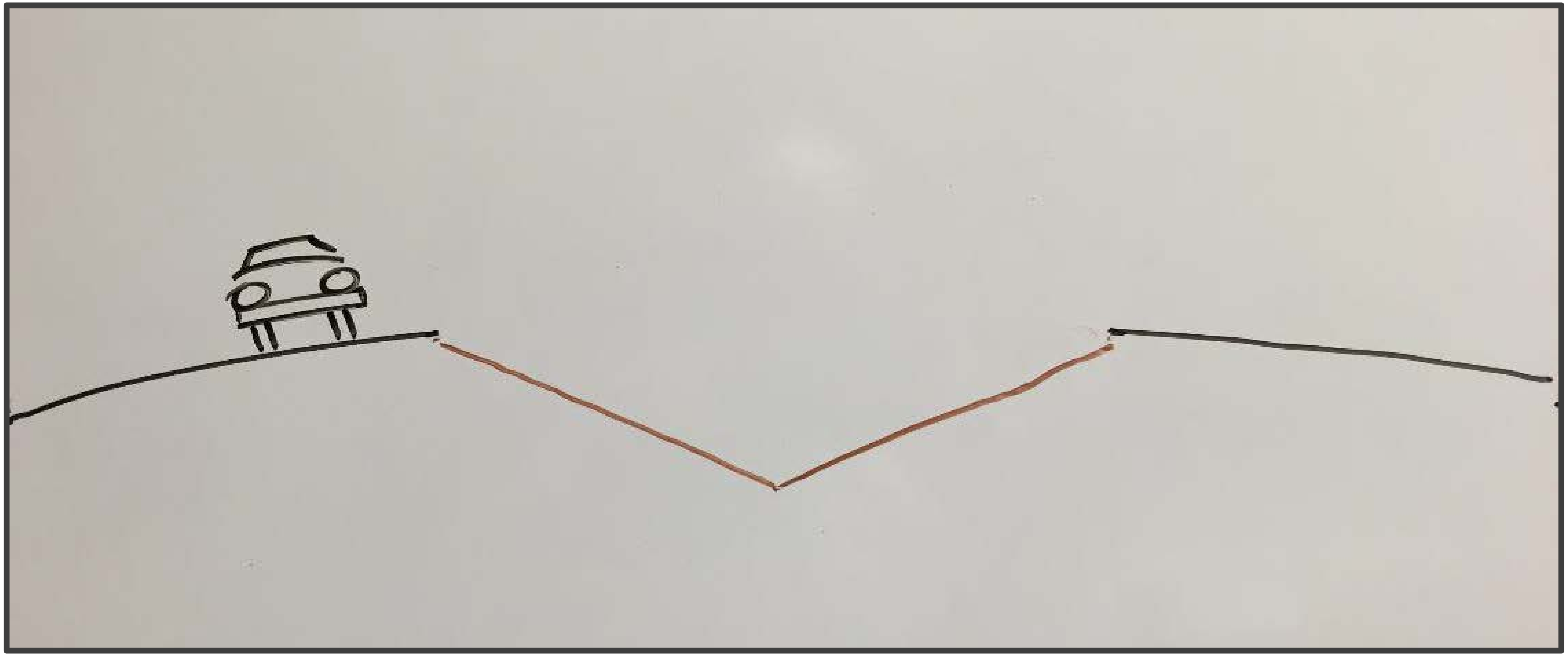

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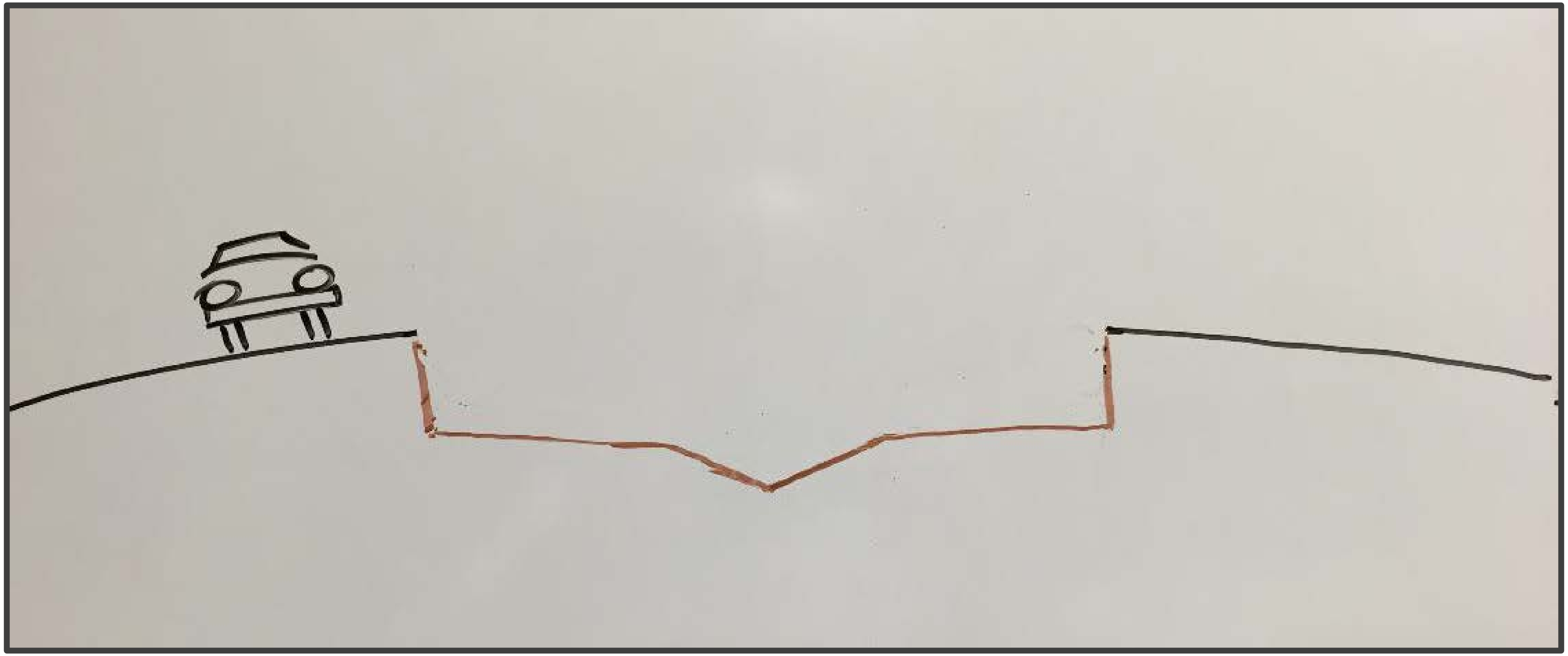

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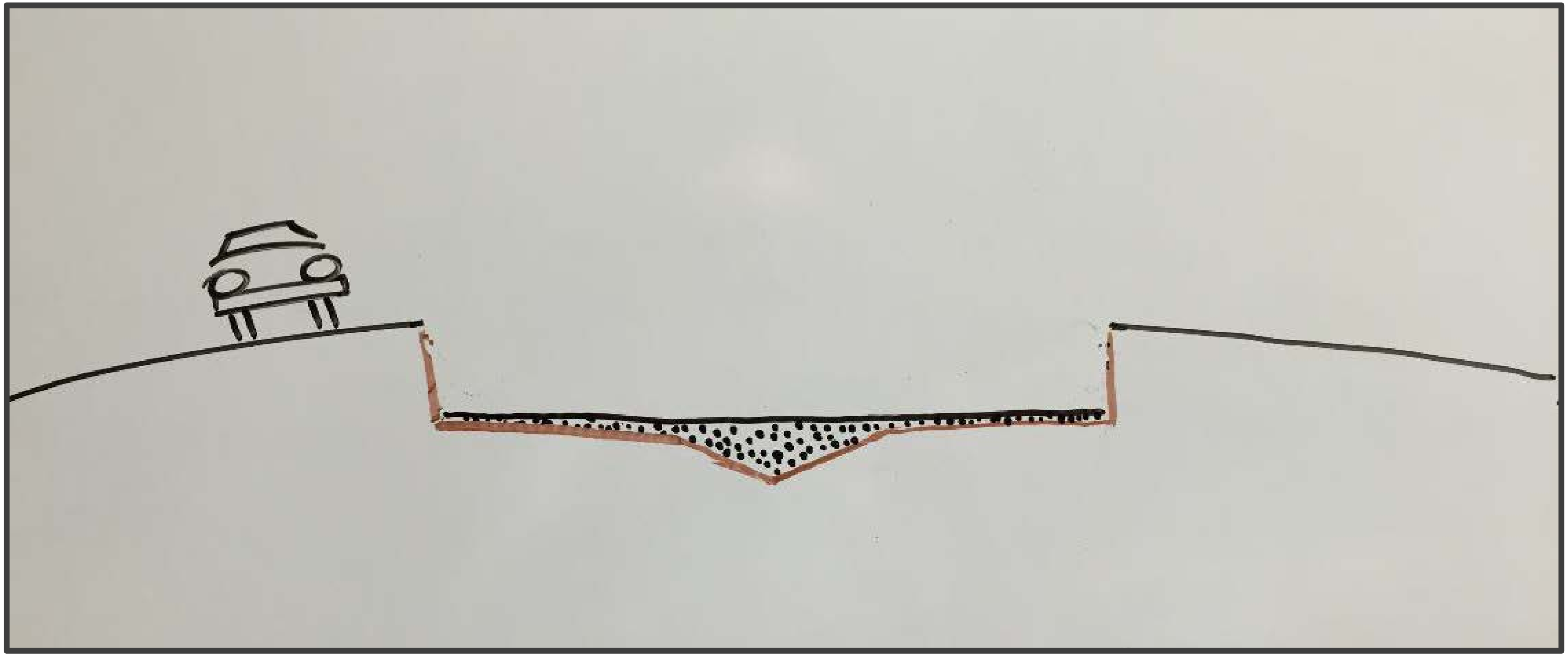

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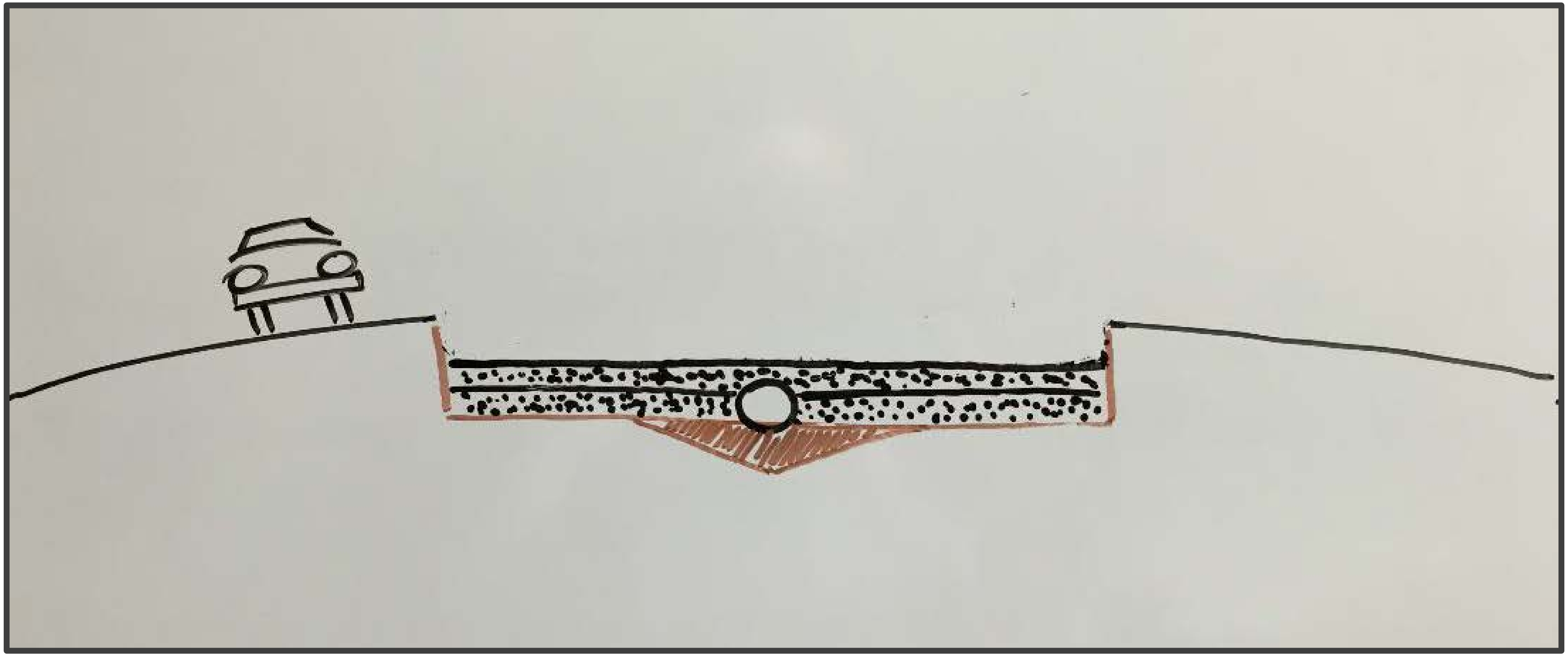

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TRADITIONAL

ALTERNATIVE

A CASE STUDY

A CASE STUDY

POTENTIAL Q&A

“We can’t dictate the contractor’s means and methods… can we?”

- Why not?
- The contractor works for us, right?
- We have different interests.
- We have expertise where they don’t.

“Didn’t that slow production?”

Contractor:

- “We may have been shut down for a day after a rain, not a week.”
- “Unless the rain was falling, we were working.”

“Didn’t that slow production?”

Contractor:

- “We would have waited until April to start rather than last November… and we would not have been shifting traffic today.”
- “Production was increased by at least 35%.”

“If you don’t mind me askin’, how much did she set you back?”

Significant direct contract cost increases

Not considering savings due to improvements in -

- Safety
- Reduction in traffic delays
- Production
- Headache

Do you realize what we just did?

- Environmental protection, with benefits in…
  - Quality
  - Safety
  - Traffic
  - Production
  - Cost

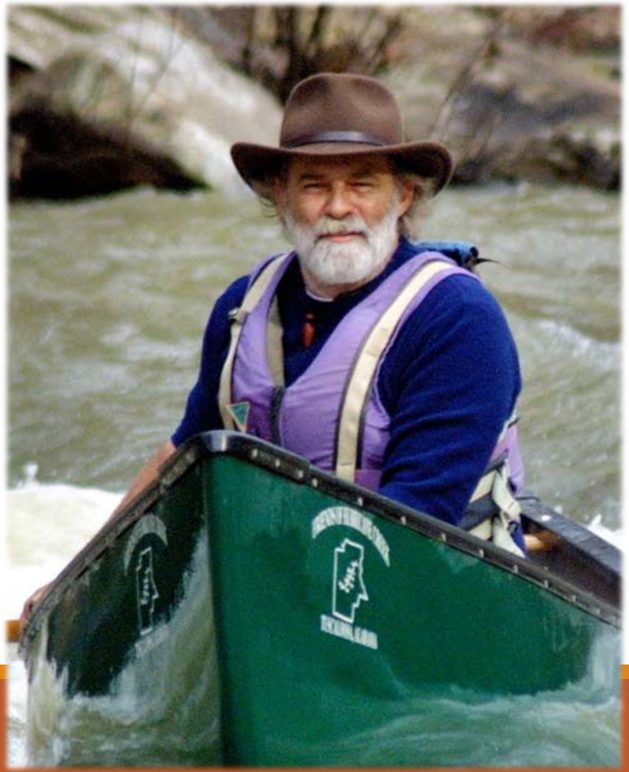
Also, we changed the way we've always done it.

We changed the way we've always done it.

We changed the way we've always done it.

“I have never seen a better run road project by ALDOT.”

“That doesn't mean I believe they can build the eastern (boondogle expressway) bypass with the same control. We'll see.”



- John Wathen
  Hurricane Creekkeeper Blog
  June, 2015

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The Five Pillars of Construction Stormwater Management

Managing Communication includes all efforts to convey information among project stakeholders to increase effectiveness in project planning, design, and implementation. Measures and Practices may incorporate written or verbal interaction and operational systems and behaviors to effectively convey necessary information.

Managing Work includes all operational efforts to ensure that work proceeds in a manner that is protective of the owner's interests and environmental responsibilities. Measures and Practices incorporate prescribed operational practices and selected work methods, sequencing, and scheduling for enhanced water quality protection.

Managing Water includes all efforts that address the flow of waters through the project to protect the work area and minimize the work of managing erosion and sediment. Measures and Practices address construction-related surface waters such as runoff, run-on, flow-through, and dewatering effluent.

Managing Erosion includes all efforts to minimize the displacement of soil particles by splash, sheet, rill, and channel erosion to minimize negative project impacts and reduce the work of managing sediment. Measures and Practices primarily include those that promote vegetation establishment or reduce runoff velocities.

Managing Sediment includes all efforts to influence the transport and deposition of suspended soil particles displaced by erosion. Measures and Practices primarily include barriers and impoundments that cause the slowing or temporary ponding of construction site runoff.

Five Pillars of Construction Stormwater Management

Photo: Barry Fagan

BARRY FAGAN

The author is Vice President, Green Infrastructure, Volkert, Inc., Prattville, Alabama.

Above: Contractor crews manage water, erosion, and sediment as work progresses—parts three through five of the five pillars approach.

The unique character of the transportation environment often presents challenges associated with managing construction stormwater runoff and protecting receiving waters. Traditional guidance and regulation do not always distinguish between residential, commercial, and linear development. If inappropriate and ineffective practices are implemented or expected by regulators, it can create inefficiencies for the transportation stormwater professional.

Transportation projects typically cross multiple watersheds and have many outfalls. The topography eliminates the possibility of utilizing the regional or single projectwide treatment approaches that sometimes are possible with nonlinear development. Available right-of-way and treatment areas typically are also more limited in a transportation setting.

Slope lengths and steepness, the types of soils encountered, seasons of construction, and proximity to surface waters usually are not all chosen at the discretion of the roadway designer and contractor. Many of these variables are beyond the control of the transportation stormwater professional and are not accounted for by a traditional approach to managing construction stormwater.

To fulfill its mission of providing for the movement of people and goods, a transportation agency must engage in activities that can negatively affect the environment. This potential for impact triggers environmental responsibilities in the form of regulatory requirements and social expectations (Figure 1). These responsibilities, if left unfulfilled, can lead to costly delays in project delivery and can affect the fulfillment of the agency's mission.

Traditional Erosion Control

Historically, construction stormwater management has focused primarily on the symptom of stormwater-related issues—sediment in the receiving water, sediment in the wetland, and sediment deposited on adjacent property. Sediment is still largely a primary target of management efforts, even though the phrase "erosion control" is often used to describe this focus.

As stormwater management efforts evolved, practices from agricultural advancements in soil conservation were implemented for transportation-related development. An approach of supplementing sediment management with minimizing the detachment of soil particles became accepted as the basis for best management practices plans. The addition of erosion management and targeting the source of suspended sediments caused management efforts to become more effective.

Although this approach of simultaneously managing erosion and sediment is logical and more effective than managing sediment alone, transportation agencies still struggle to maintain regulatory compliance and to protect receiving waters during construction.

Different Approach

Faced with ever-increasing regulatory scrutiny and a realization that traditional stormwater management approaches largely were ineffective in a transportation setting, stormwater professionals at the Alabama Department of Transportation (DOT) began to explore approaches that were outside of those prescribed by regulation and existing guidance materials. In the 2000s, Alabama DOT engineers recognized the risk of combining the uncontrollable variables previously described with goals and standards intended to merely achieve regulatory compliance. This check-the-box approach led to several high-profile, expensive stormwater-related calamities on Alabama DOT projects.

As Alabama DOT realized that managing the source of suspended soil particles was more achievable than total capture and control of the particles in transport, the agency also began to recognize the role the runoff itself plays in the actions of erosion and sediment transport and deposition. Both erosive energy of stormwater and its sediment-carrying capacity can be significantly reduced by simply slowing the runoff.

Alabama DOT also began to see water entering its projects as worthy of protection and developed a mantra: "clean water in, clean water out."

Water is a common factor in erosion and sediment transport. Applying the knowledge of the benefits of slowed water, stormwater professionals began shifting from the unachievable goal of capturing all projects' waters to the more attainable goal of simply slowing down the waters as they ran over and across a construction site.

Alabama DOT also began to see water entering its projects as worthy of protection and developed a mantra: "clean water in, clean water out." The agency worked hard to develop ways to keep run-on and flow-through waters separated from runoff from areas where required soil-disturbing activities were taking place. Temporary open and enclosed diversions were employed to convey water across, under, and around areas where sediment-laden waters could cause these clean waters to become dirty and trigger a need for sediment control.

Soon, *managing water* became as important and critical to managing construction stormwater runoff as *managing erosion* and *managing sediment*.

But Alabama DOT didn't stop there. Construction stormwater professionals studied the Revised Universal Soil Loss Equation (RUSLE) to better understand the mechanics of soil loss and see how they could further improve Alabama DOT's program.

RUSLE is an erosion model developed principally by the U.S. Department of Agriculture's Agricultural Research Service. The model predicts the average annual soil loss resulting from raindrop splash and runoff from slopes, given rainfall, slope, soils characteristics, land cover types, and management practices (Figure 2). The units of the product of the model were particularly intriguing: tons per acre per year; in other words, the mass of transported soil per area of disturbance per duration of disturbance.

Alabama DOT questioned whether it could reduce the area of disturbance and the duration of disturbance in order to reduce the soil loss from its project. The agency decided that through *managing the work* of the contractor, it could.

Alabama DOT saw that its contractors were smart, capable, innovative, and ready to do just about anything the agency needed—if the work and the method of payment was fully described before bid submittal. Effectiveness lies more in how the contractor performs the work rather than what the contractor installs. Effectively managing the work of the contractor requires the acknowledgement and acceptance of a few basic points:

- The contractor works for the owner–agency, not the other way around;
- The interests of the owner are different from the interests of the contractor and should be considered and protected; and

FIGURE 1 Environmental responsibilities are directly connected to a transportation agency's mission.

$$A=RKLSCP$$

FIGURE 2 Revised Universal Soil Loss Equation. (A = average annual soil loss in tons per acre per year.)

Photo: Barry Fagan

Soil disturbance is limited and delayed as a contractor completes one section of roadway before advancing its clearing operations. The project demonstrates the second of the five pillars: managing the work to minimize the area and duration of erodible materials.

- The means and methods employed to construct the project can be directed by the owner to ensure favorable project outcomes.

The understanding that an agency must first tell the contractor up front revealed a practice that perhaps should have been the first to be implemented during the evolution of Alabama DOT's construction stormwater program. After some thought toward practical application, Alabama DOT declared *managing communication* to be the best management practice for managing construction stormwater.

Effectively communicating the priorities and expectations of leadership to the contractor can be more effective than any sediment barrier. Contractually directing the delay and limitation of soil disturbance is much more effective than any brand of erosion control blanket. Promoting the required continuous pursuit of permanent stabilization in specifications and mandatory pre-bid meetings can save money, minimize project conflicts, and promote environmental protection and regulatory compliance.

Photo: Barry Fagan

An Alabama DOT work truck serves as a reliable impromptu display for construction plans during a mandatory preconstruction onsite stormwater meeting. The gathering represents the first of the five pillars in action: managing communication.

Based on these experiences, Alabama DOT developed and implemented a new, fundamental approach for managing construction stormwater. This approach prioritized effectiveness over compliance and economy over prescription. It made sense to designers, inspectors, and contractors as Alabama DOT implemented the concepts into its training, processes, and specifications. The approach was coined "The Five Pillars of Construction Stormwater Management."

Photo: Barry Fagan

A contractor provides permanent stabilization as the work progresses. Alabama DOT requires continuous pursuit of final stabilization, including application of topsoil and permanent ground cover in vertical increments of 20 feet in excavation areas.

Five Pillars

The five pillars of construction stormwater management are to be implemented in order of effectiveness and economy. They include the following actions, in order:

1. Manage communication,
2. Manage work,
3. Manage water,
4. Manage erosion, and
5. Manage sediment.

A state DOT can choose to focus solely on *managing sediment*, but it runs the risk of soon communicating with regulators, neighbors, attorneys, and reporters about the lack of management in the other areas.

The five pillars have been implemented in planning and design, during construction, and while troubleshooting issues on ongoing projects and have been applied to many types of development projects, including transportation, residential, commercial, and even utility-scale solar facilities.

Over the past decade and a half, Alabama DOT has more fully fleshed out the five pillars approach and has added to it, as better practices have supplanted best management practices of yesterday. The approach has been shared with and adopted by transportation and other agencies and organizations across the United States.

Two state DOTs are currently working on new applications of the five pillars. Ohio DOT is using the concept to categorize its practices in a new construction stormwater manual developing and implementing stormwater pollution prevention plans. The agency has also drafted an update to its construction stormwater management specifications that will incorporate the five pillars. Hans Gucker, Ohio DOT's construction hydraulic engineer, has observed that the new framework is a means of strategically bringing and clarifying meaningful and effective change to the Ohio DOT construction stormwater program.

Nebraska DOT is currently incorporating the five pillars into a construction stormwater management chapter of its drainage design manual. Nebraska DOT highway environmental program manager Ronald Poe has encouraged adoption of the five pillars as a way to update Nebraska DOT's design standards to reflect the state of practice for managing construction stormwater in a transportation environment.

Conclusion

The five pillars of construction stormwater management represent a holistic and fundamental approach to managing construction stormwater in a transportation environment. The approach has been successfully implemented by transportation agencies and deployed on construction projects in linear and nonlinear settings. The five pillars may be applied at any stage of project development and delivery to enhance effectiveness, reduce risk, and promote regulatory compliance.

Photo: Michael Perez, Auburn University

Linear (*left*) and nonlinear (*right*) construction sites vary greatly in appearance and in stormwater management needs. A one-size-fits-all approach to regulation, implementation, or both may not be completely appropriate or effective.