Title:	**Transport to Vertical Schools**
Author:	Rebecca Lehman, Director, Transport Planning, Frank Turquoise Group
Subject:	Urban Infrastructure/Transport
Keywords:	Education Infrastructure Schools Transportation
Publication Date:	2019
Original Publication:	2019 Chicago 10th World Congress Proceedings - 50 Forward | 50 Back
Paper Type:	1. Book chapter/Part chapter 2. Journal paper 3. **Conference proceeding** 4. Unpublished conference paper 5. Magazine article 6. Unpublished

Transport to Vertical Schools

Rebecca Lehman
Director, Transport Planning

Frank Turquoise Group
Brisbane, Autralia

Rebecca Lehman is a practicing transport planner. She identified a niche for place-based transport initiatives to help Sydney developers and workplaces manage travel demand and reduce traffic and parking congestion. She helps clients understand complex transport issues, and liaises with transport providers to support more walking, bicycle riding, carpooling and public transport use to campus. Initially from Indiana and now based in Sydney and Brisbane, Australia, Lehman is passionate about multi-modal transport, seeing that each mode has a time and a place in our communities. She walks, rides and scoots herself to work and personal activities.

Abstract

New South Wales (NSW), Australia is experiencing population growth and rising property values. To meet the community's educational needs, this means vertical public schools—intensifying school development at existing inner Sydney Metropolitan school sites. Amplifying schools in this way will lead to higher travel demand. As daily car travel already places pressure on road networks—existing active and public transport networks must work harder just to accommodate the current mode share to school. To reduce local impacts, vertical schools must achieve a higher rate of travel by "traditional" transport modes: walking, bicycle riding, carpooling and public transport. This paper outlines school travel demand, transport infrastructure and operational considerations, and the sustainable transport calculator tested with five NSW schools. The calculator assesses the potential mode share to school and guides the selection of site-specific policies, programs, internal infrastructure and external infrastructure to implement. The catchment mapping process identifies the "low-hanging fruit" transport which can be readily promoted, and shows missing infrastructure links in a legible graphic, for rectification through partnerships with government agencies.

Keywords: Education, Infrastructure, Transport, Transportation Demand Management Vertical Schools

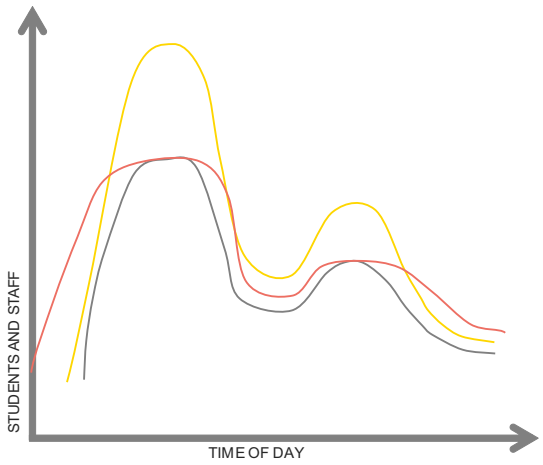
Introduction

Population growth in New South Wales (NSW) requires more intensive use of existing (and new) school sites. Rising property values also increase the cost to assemble land on which to expand school sites outward, making it cost-effective to build upward. Although the land use does not change, a vertical school accommodates more students and requires more staff, increasing travel demand. Public schools are a community asset, drawing from a predominantly local residential catchment. Daily school travel demand already impacts the regional and local transport networks. This theoretical demand is shown in Figure 1. Upwards of 70 percent of 5 to 9-year olds and 46 percent of 10 to 14-year olds are driven to school in Greater Sydney (NSW Government 2013). This car travel congests the road network, and dangerous driver behavior at student kiss-and-drop locations creates a serious road safety risk. Parents and caregivers, having already driven a student to school in a car, usually continue to drive a car the rest of the way to work.

With more travel demand, the existing active and public transport networks must work harder just to accommodate the current mode share to school. To reduce traffic and parking congestion, students and staff at vertical schools must achieve a higher rate of travel by "traditional" transport modes, including walking, bicycle riding, carpooling and public transport for the journey to school.

This paper outlines:

- A desktop review of Travel to School rating schemes
- The transport assessment process, to establish travel demand and assess nearby transport opportunities and deficiencies
- Catchment mapping as a graphic tool, to demonstrate transport modes that can be readily promoted, and to identify missing infrastructure to rectify



Daily car travel to school already places pressure on road network operations.

Amplifying school precincts will effect travel demand:

- Existing staff and student car travel demand
- More students and more staff increases the number of car trips
- Before and after school care / sport and tutoring spreads car travel demand earlier and later

To reduce impacts to local communities, more travel to school must be accommodated by walking, bicycle riding, carpooling and public transport.

Figure 1. Daily car travel to school places pressure on road networks, and fluctuates across the day. © Frank Turquoise Group

- The pilot of the Sustainable Transport Calculator tool, to assess the potential mode share to school and guide the selection of site-specific policies, programs and infrastructure investment
- The pilot travel plan process, used to determine the site-specific policies, programs and internal and external infrastructure investment needed to increase active and public transport use for the journey to school

For the five test sites, the process assisted delivery teams in setting a realistic, sustainable travel goal, understanding policy settings and programs required to help meet the goal, as well as the internal and nearby infrastructure required.

Further testing is underway. The concept has potential to foster collaboration across departmental and jurisdictional boundaries. The potential benefits include improved transport, public health and road-safety outcomes. There is potential to apply this approach across all 2,200 public schools in NSW, with interest in applying the concept to independent and religious schools.

Background

Driving a car is one of multiple transport access modes available for reaching schools. However, compared to other transport modes, traffic management and car parking receives more scrutiny during the planning process. Parking consumes space that could otherwise be allocated for student play areas and the capital budget for education infrastructure.

Many Local Government Areas (LGAs) in NSW prescribe school parking requirements in their Development Control Plans (DCPs). Parking rates vary substantially between LGAs (Lehman 2018). Meeting parking requirements is costly, space-intensive and unproductive. Cost estimates to install off-street car parking in NSW range between AU$30,000 (US$20,358) per space (surface) and AU$50,000 (US$33,931) per space (structured). The online travel-to-school questionnaire identified that all available off-street car parking is provided for free, and typically occupied by staff during school hours only.

Discussions with the NSW Department of Planning and Environment (DPE) established that it is impractical to set blanket, prescriptive parking requirements for new school (re) development. It is also impractical to establish and apply a single sustainable transport target mode share to all schools, particularly where some may not have feasible transport options, nor a dense, local residential catchment. Robust data must support decision-making, with each project receiving a merit-based assessment.

The transport assessment, travel plan and calculator processes were developed to assess the specific needs of school projects, whilst accounting for the local variance in transport networks and operations between school sites in five metropolitan or regional settings. These provide a frank assessment of the transport potential for each site, and identify supporting infrastructure and programs required to meet the potential.

Planning context

Existing Australian and international, voluntary or mandatory travel plan programs targeting travel to school (Lehman and Tan 2018) include:

- STARS (Sustainable Travel Accreditation and Recognition for Schools) – London, United Kingdom
- Green Schools Programme – Ireland
- Development Control Plan – North Sydney Council
- Way2Go – South Australia
- RTA Guide to Traffic Generating Developments – NSW Government

The desktop review documented typical components:

- **Methodology:** How to document and analyze transport, how to select encouragement programs.

- **Content:** Sample policies, encouragement programs and initiatives.
- **Reporting:** Tools to communicate with staff, parents and students, transport providers.
- **Governance:** How to adopt and implement a travel plan, with state and local transport providers.
- **Data collection:** How data is collected and stored.
- **Evaluation:** How to use data to set objectives and mode-share targets, to demonstrate success, to revise programs.
- **Funding:** Arrangements to deliver one-off infrastructure, funding for recurring programs.

Four common directions are shown in Figure 2: collecting data, reviewing and analyzing transport networks and operations, and selecting initiatives and programs to increase active and public transport use. The process is cyclical. Data collection establishes the baseline, and subsequent data collection demonstrates progress on the baseline, informs future gap analyses and guides decision-making about programs to promote, revise or discontinue in future years. With more participating schools, data enables benchmarking between schools.

The Transport Assessment

A school site is served by a variety of transport networks and operators. However, students, parents and staff may not be aware of the complex accountabilities for these modes between state and local government decision-makers, transport plans and budgets.

A vertical school at an existing site requires new or amplified transport networks and operations. The Transport Assessment informs a consistent approach to assess travel demand, guiding data collection and analyses to scan existing transport options and opportunities. This helps set a mode-share target, guides the selection of transport programs and documents missing links to rectify with the LGA or Transport for New South Wales (TfNSW).

The three components of the transport assessment are: data collection, transport options and transport use.

Data Collection

Data informs the transport assessment and travel plan. It is essential to use data to request state and local authorities rectify deficiencies. Data demonstrates the performance of the travel plan.

Sample data includes:

- Depersonalized residential data
- Transport mode-share data for residents and workers in the school suburb (Census Journey to Work / annual questionnaires)
- Pedestrian, bicycle and vehicle traffic counts
- Public transport patronage at nearby stops / stations for am alighting, pm boardings (extracted from electronic ticketing)
- Transport networks including footpaths, shared-user paths and cycleways, public transport network stops / stations / wharves
- Public transport timetables

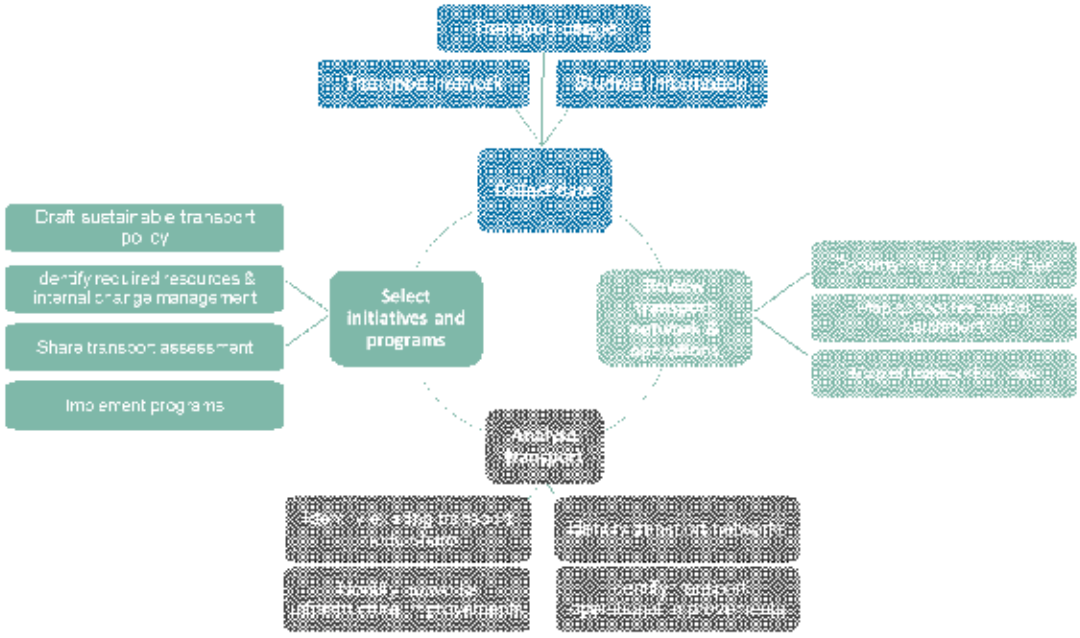


Figure 2. The transport assessment cycle determines the best strategy for selecting a transport mix for journeys to schools. © GHD

- The following data is requested from existing schools in an interview or self-guided checklist:
- Existing school transport infrastructure, documented on a plan or checklist
- School policies, procedures and practices
- Existing transport program information and participation data

Documenting the Potential Transport Use

Mapping transport networks and depersonalized residential data is the cornerstone of the Transport Assessment. Using query tools in Geographic Information System (GIS), three maps analyze the walk, bicycle and public transport catchments. Figure 3 shows the "crow flies" catchment, the straight-line distance notionally traveled without barriers, shown as concentric circles based on distance. The actual catchment is the "on-network" trip using existing infrastructure; this is smaller than the "crow flies" catchment, constrained by barriers including busy roads, rail lines, waterways and large impermeable development (e.g. residences, businesses, parks and reserves without through-paths). Figure 3 also shows the depersonalized residential data, the "crow flies" and actual catchments.

For inner urban areas where footpaths are usually provided on both sides of the road and students under 16 years old are permitted to ride a bicycle on the footpath, the road network

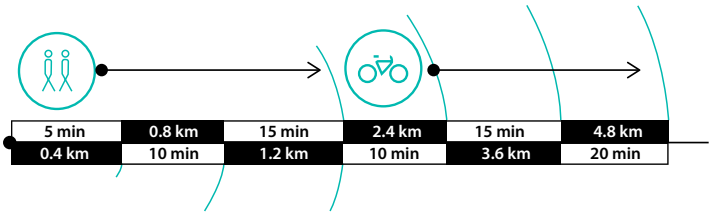


Figure 3. A notional catchment diagram shows the straight-line distance notionally traveled without barriers, shown as concentric circles based on distance. © Frank Turquoise Group

	Notional network km coverage	Actual network km coverage	No of students in actual network (cumulative)	No of teachers in actual network
5 minute walk (400m)	12.4	4.1	2	0
10 minute (800m)	36.3	16.6	18	1
15 minute (1200m)	73.4	39.5	65	3
HS Opal Card (2900m)	206		232	16
10 minute bike ride (2.4 km)	223.5	139.1	172	14
15 minute bike ride (3.6 km)	497.2	295.1	315	5
20 minute bike ride (4.8 km)	903.1	530.6	519	0
Bus network	876.6	633.4	359	24
Rail network	240.6	123.8	45	1
Ferry routes	45.2	18.3	2	1

Table 1. Catchment analysis comparing notional and actual network coverage, and the number of students and teachers in the actual network. © GHD

is a proxy for mapping the walking and bicycle catchment in GIS. This expedites the mapping process, as the actual footpaths do not form a network unless joined with all the pedestrian crossings of the road network. Footpaths and shared-user paths through parks and reserves must be added prior to running the catchment assessment.

Walking

For inner urban areas in Greater Sydney and regional New South Wales, footpaths are usually provided on at least one side of the road. In testing the pedestrian catchment for regional schools where footpaths may not be provided, the footpath network was verified through site visits or Google StreetView.

For walking, the notional catchment is shown as concentric circles of 400-, 800-, and 1,200-meter walks (or 5-, 10-, and 15-minute walks at roughly 1.4 m/s). The actual walking catchment is the on-path 400-, 800-, and 1,200-meter barrier-free walks from the un-controlled entries to the school site.

Riding a bicycle

The New South Wales bicycle network is opportunistically delivered. There are often gaps in the network. As students are allowed to ride on the footpath until 16 years of age, the footpath network also serves bicycle riders.

For riding a bicycle, the notional catchment is shown as concentric circles of 1,200, 2,400, and 3,600 meters (5-, 10-, and 15-minute bicycle rides at 15 km/h). The actual bicycle catchment is the on-path 1,200-, 2,400-, and 3,600-meter barrier-free bicycle ride from un-controlled school entries where bicycle parking is provided.

Taking public transport

The public transport network includes heavy rail, light rail, ferries, public and private buses. The network assessment is accompanied by a timetable assessment for "destination" stations, stops or wharves near the school—documenting the span of services and frequency for the hour before school. The notional catchments are shown as concentric circles of a 400-meter walk (five-minute walk at roughly 1.4 m/s) for each stop, station or wharf. The actual catchment is shown as the on-path 400-meter barrier-free walk.

The public transport was initially tested with a walking catchment for each station, stop or wharf of 400, 800, or 1,200 meters, but was refined to 400 meters based on practical journey times to walk to, use public transport near to school, and walk from public transport to school. It also did not differentiate between students living within the "destination" stations, stops and wharves—subsequent assessments removed these students, as they are unable to use these modes to travel closer to school and are in the walk catchment. The analysis was expanded to identify the number of students within 2,300 meters (primary) and 2,900 meters (high school) who are ineligible for free

public transport travel on the School Student Transport Scheme (SSTS).

The catchment-analysis outputs are shown in Table 1; graphic comparisons are in Figure 4.

Documenting Actual Transport Use
Understanding how existing residents and workers choose to travel to work shows how students and staff may travel to school. This is established through the five-yearly Census or a questionnaire.

Census
Conducted every five years, the Census is a 100 percent sample of Australians with two "Journey to Work" questions offering insight into how students and staff are likely to travel. The Census identifies the origin suburb, where residents begin their trip and the destination suburb where workers are employed. The Census is a proxy for how parents may choose for their children to travel to school, and how staff would travel to the school.

Questionnaires
A travel questionnaire, conducted during a typical week without any public or school holidays, sets a baseline and gauges progress. The responses establish trip origin, mode share (staff / students / parents), time of travel, travel behavior characteristics, and any before- or after-school activities. A free-form question allows respondents to report barriers. Conducted annually, the data demonstrates progress on a benchmark and indicates areas requiring additional infrastructure, programs or funding.

In the pilot:

- To test potential student travel demand to school, the Census mode share data for residents accessed online for the Statistical Area 2 (SA2) is used to estimate potential student mode share for travel to school. This assumes students' travel mode share will reflect that of area residents, including their parents. "Car, as driver" is assumed to be the ratio of parents driving students to "kiss-and-drop" before continuing to work.
- To test potential staff travel demand to school, the mode-share data for workers traveling to the Census Statistical Area 2 (SA2) is used to estimate potential staff mode share for travel to school. It is likely the staff would have the same travel behavior as area workers.

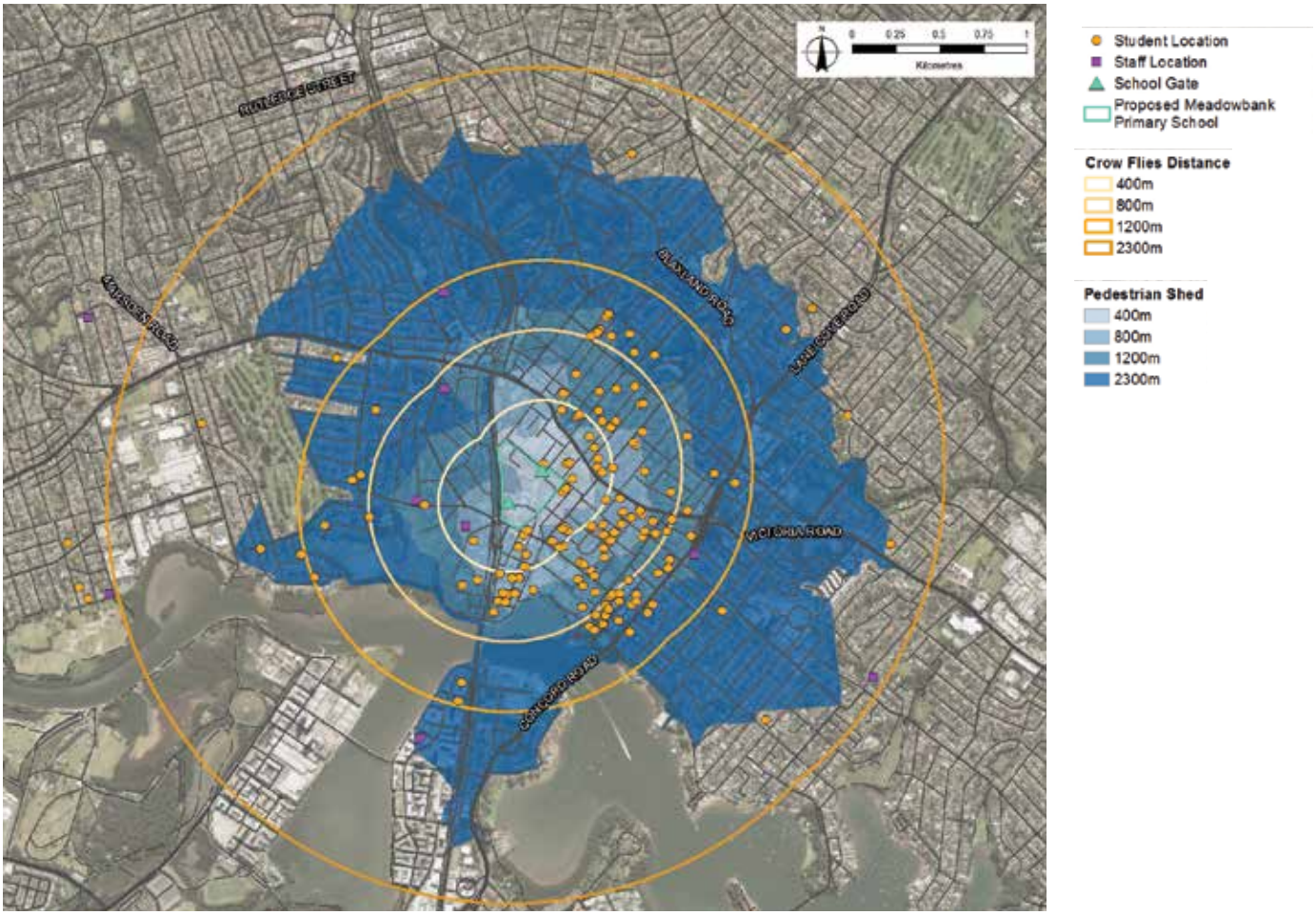


Figure 4. The GIS analysis uses blue shading for the catchment's actual on-path access and yellow concentric circles for the "crow flies" catchment. © GHD

Assessment
The template Transport Assessment helps select a realistic sustainable transport target and identifies feasible transport modes to promote right away. The existing mode-share data confirms the modes existing residents and employees already use. The legible graphic of the catchment and depersonalized residential maps shows transport options to promote right away, and indicates areas with high travel demand, but also with deficiencies to resolve.

The Department of Planning and Environment may require the school project implement this infrastructure to commit to the transport target, or that the school project may voluntarily collaborate with the LGA or state transport agencies to rectify the gaps prior to promoting the scheme to students and staff.

The Sustainable Transport Calculator

The Sustainable Transport Calculator uses inputs from the transport assessment to assess the potential mode share to school and guide the selection of site-specific policies, programs, internal and external infrastructure to implement.

Calculator Inputs
The calculator inputs include data from the catchment maps and the questionnaires / Census transport usage data.

In Figure 5, the catchment and usage data in the calculator are input into the yellow boxes.

Setting a Sustainable Transport Target
In Figure 6, the gap between the potential catchment travel

Catchment Parameters

Meadowbank		Meadowbank	
Number of Students:		Number of Staff:	
376		144	
Student Catchment		**Staff Catchment**	
% within 15 min walk		% within 15 min walk	
73.0%	✓	4.80%	✓
% between 5 - 20 minute bicycle ride		% between 5 - 20 minute bicycle ride	
233	62.0% ✓	95	65.97% ✓
% excl from SSTS		% within PT, 1 seat ride	
91.0%	✓	9.00%	✓
% within PT, 1 seat ride			
90.0%	✓		

Figure 5. Sustainable transport calculator inputs: catchments. © GHD

Mode Parameters

Origin: Meadowbank — Destination: Meadowbank

Number of Students:		Number of Staff:	
376	✓	144	✓

Student Mode		Staff Mode	
Train	30.90% ✓	Train	9% ✓
Bus	3.63% ✓	Bus	3% ✓
Car, as driver	49.21% ✓	Car, as driver	71% ✓
Motorbike/scooter	1.00% ✓	Motorbike/scooter	5% ✓
Motorbike/scooter	0.60% ✓	Motorbike/scooter	1% ✓
Bicycle	0.53% ✓	Bicycle	0.3% ✓
Other	0.99% ✓	Other	1% ✓
Walked only	3.23% ✓	Walked only	6% ✓
Two modes	6.50% ✓	Two modes	4% ✓
Three modes	0.65% ✓	Three modes	1% ✓
**likely student mode share*		**likely teacher mode share*	

Figure 6. Sustainable transport calculator inputs: transport use. © GHD

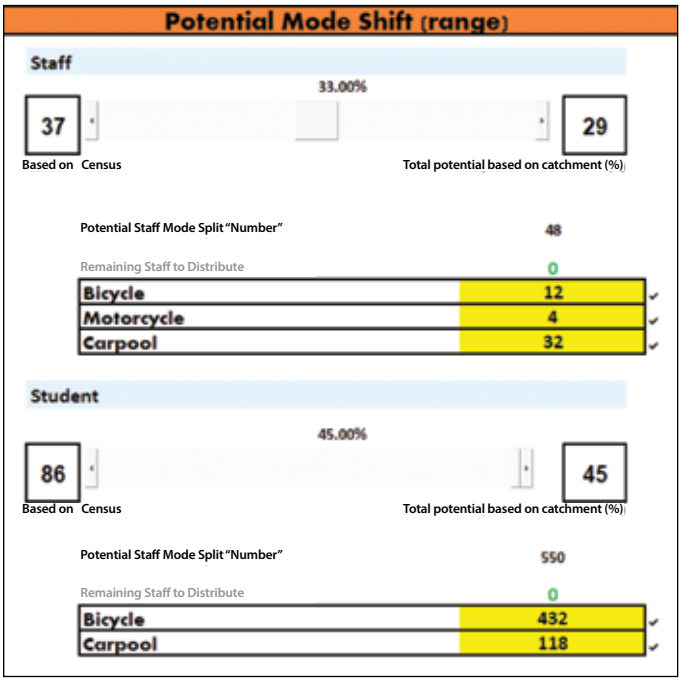


Figure 7. Sustainable transport calculator inputs: calculator with sliders. © GHD

	Students	Staff	Visitors
new walkers	338	4	
Scooter parking (Pods)	40	6	
new bicycle riders	432	12	
bicycle parking u-rails	216	6	68
new motorcycle riders		4	
Motorcycle parking		4	
total end of trip facilities		20	
potential student drop-off demand	174		
kiss-n-drop	756m		
kiss-n-drop DDA compliment wheelchair acce	1		
total parking requirements		116	4
GoGet		2	
EV parking		2	
general car parking		96	
new carpool users		32	
carpool parking		16	

Figure 8. Sustainable transport calculator output: infrastructure requirements. © GHD

demand and existing transport usage data is the range to consider in setting realistic sustainable transport targets.

For example, a school site where 68 percent of the employees use sustainable transport to work and 35 percent of staff living in the sustainable transport catchment have a target range between 35 and 68 percent.

In Figure 7, sliders allow school leadership and project teams to test the catchment potential and usage targets.

Using the Calculator to Identify Required Site Transport Infrastructure

With mode-share targets set for each transport mode, the school leadership and project team must identify infrastructure to implement in support of the target. This responds to criticism of the voluntary travel planning process in NSW: a travel plan may propose to reduce driving alone, without identifying funding, infrastructure, policies or programs that would provide a reasonable alternative.

For example, a 60 percent walking target requires corresponding investment in footpaths and programs. Walking School Buses, Walking Buddies, Safe Routes to School and independent walking training programs are required to meet a higher walking target. A school proposing to reach a 60 percent target without delivering additional footpaths, nor transport encouragement programs promoting walking, would be met by skepticism during the development application. The calculator links targets with meaningful infrastructure investment.

School transport infrastructure identified in the calculator includes:

- Bicycle parking for staff and students;
- Ped scooter parking and helmet storage for students;
- End-of-trip facilities or showers, lockers, changerooms and a drying room for staff that run, walk, bicycle and motorcycle;
- Staff parking for motorcycles and carpools;
- Car parking for a pod of car-share vehicles.

Figure 8 shows the supporting infrastructure required to meet the sustainable transport target.

Sample outputs include:

- U-rail bicycle parking racks accommodate two bicycles. A school of 1,000 students seeking a bicycle target of 20 percent requires 100 u-rails to park 200 bicycles.
- As walking encouragement programs also increase pedestrian scooter use, the calculator estimates pedestrian scooter parking is required to manage the "clutter" of helmets and pedestrian scooters. A school of 1,000 students seeking a walking mode share of 65 percent requires storage for 19 scooters and helmets—one storage place for one scooter.
- Carpool and motorcycle parking must accommodate the target for these modes. A school of 100 employees and a carpooling target of 30 percent would mean 15 carpool parking spaces are required.

The Pilot Travel Plan

A travel plan is informed by the opportunities identified in the transport assessment and the Sustainable Transport Calculator. The travel plan must be prepared with the project team and the school leadership in order to implement meaningful, realistic site-specific policies and programs to meet the target and proposed uses of the internal transport infrastructure, with

the aim of increasing active and public transport use for the journey to school.

The travel plan process:

- Formalizes a governance structure to adopt and deliver the travel plan
- Selects transport initiatives and encouragement programs
- Sets the sustainable transport policy with SMART (Specific, Measurable, Attainable, Relevant and Timely) objectives to achieve the results
- Identifies required resources and internal change-management process
- Agrees funding to implement the encouragement programs
- Sets communication structures to consult with staff, parents and students,
- Proposes governance structures to collaborate with the LGA and TfNSW to rectify issues identified
- Adopts a regular data collection and monitoring regime to
  - Gauge success
  - Rectify underperforming issues (i.e. bicycle parking is full, more is required)
  - Evaluate annual progress against targets
  - Revise programs based on annual changes to the staff and student catchment

Two school sites have prepared a travel plan to supplement a development application.

For the test sites, this process assisted delivery teams to understand the ramifications of policy settings, infrastructure and program implementation—setting a baseline to track individual performance, benchmark comparable schools and, ultimately, develop a minimum standard for school access infrastructure and operations based on catchment characteristics. Further testing of the school transport plan process described above is underway.

Conclusion

Whilst aligning infrastructure investment with population growth is essential for successful communities—there are often many stakeholders with varying degrees of responsibility and different timeframes for delivery.

For schools in NSW, with the increasing transport demands placed upon them by population and property price constraints, transport assessment and the development of transport plans will provide a useful tool for decision-makers in determining likely transport impacts and the credibility of transport options to meet travel demand.

The concepts described in this paper have the potential to foster collaboration across departmental and jurisdictional boundaries, and to engage school and local communities in the design of transport solutions essential to minimize the impact of vertical schools and intensified school sites, and to achieve broad planning objectives such as improving health, access to services and road safety. There is clear potential to apply this approach across all 2,200 public schools in NSW.

References:

Australian Bureau of Statistics (ABS). (2018). **Census.** Accessed 08 February 2018. https://www.abs.gov.au/census.

Department of Planning, Transport and Infrastructure (DPTI). (2018). Way2Go. Accessed 19 March 2018. https://www.dpti.sa.gov.au/Way2Go/home.

Green Schools Ireland. (2019). "Working Together For A Sustainable Future." Accessed 15 August 2019. https://greenschoolsireland.org/.

Lehman, R. (2019). **The Meadowbank Travel Plan, Sustainable Transport Calculator and Transport Assessment.** Sydney: Frank Turquoise Group.

Lehman, R. (2018). **Technical Note: Review of NSW School Parking Requirements.** Sydney: Frank Turquoise Group.

Lehman, R. & Tan, J. (2018). **The School Infrastructure Sustainable Transport Calculator and Transport Assessment.** Melbourne: GHD.

NSW Government. (2013). "Sydney's Walking Future." **Transport for NSW.** Accessed 12 June 2019. https://www.transport.nsw.gov.au/newsroom-and-events/reports-and-publications/sydney%E2%80%99s-walking-future site.

NSW Government. (2004). **Planning Guidelines for Walking and Cycling, Department of Infrastructure, Planning and Natural Resources.** Sydney: Department of Infrastructure, Planning and Natural Resource (DIPNR). Accessed 9 August 2007. http://www.pcal.nsw.gov.au/__data/assets/pdf_file/0006/164742/planning-guidelines-for-walking-and-cycling.pdf.

Sustainable Travel: Active, Responsible, Safe (STARS). (2019). "About STARS." Accessed 15 August 2019. https://stars.tfl.gov.uk/About/About.