Manchester Re-Imagined | Redevelopment Masterplan

Emma Brodie, Travis Dickie, Michael Ge
EVDS616 - Urban Infrastructure & Land Use
Noel Keough

PRESENT CONDITION

HOMOGENOUS LAND USES · BUILT FOR SPEED · TRANSIT ORIENTED DEVELOPMENT · BISECTED BY RAILWAYS · HEAVY INDUSTRY · PARKING FRIENDLY · LAND USE PATCHES

Calgary's Manchester Industrial Park is one of many examples of how historic inner city industrial areas have become **inefficient, under-populated neighbourhoods** as they enter the 21st century.

Designed in an era when land use separation was the norm and personal vehicles were ubiquitous, the **large block-sizes and absence of pedestrian infrastructure has limited Manchester's ability to evolve with the rest of the city.**

FUTURE OPPORTUNITIES

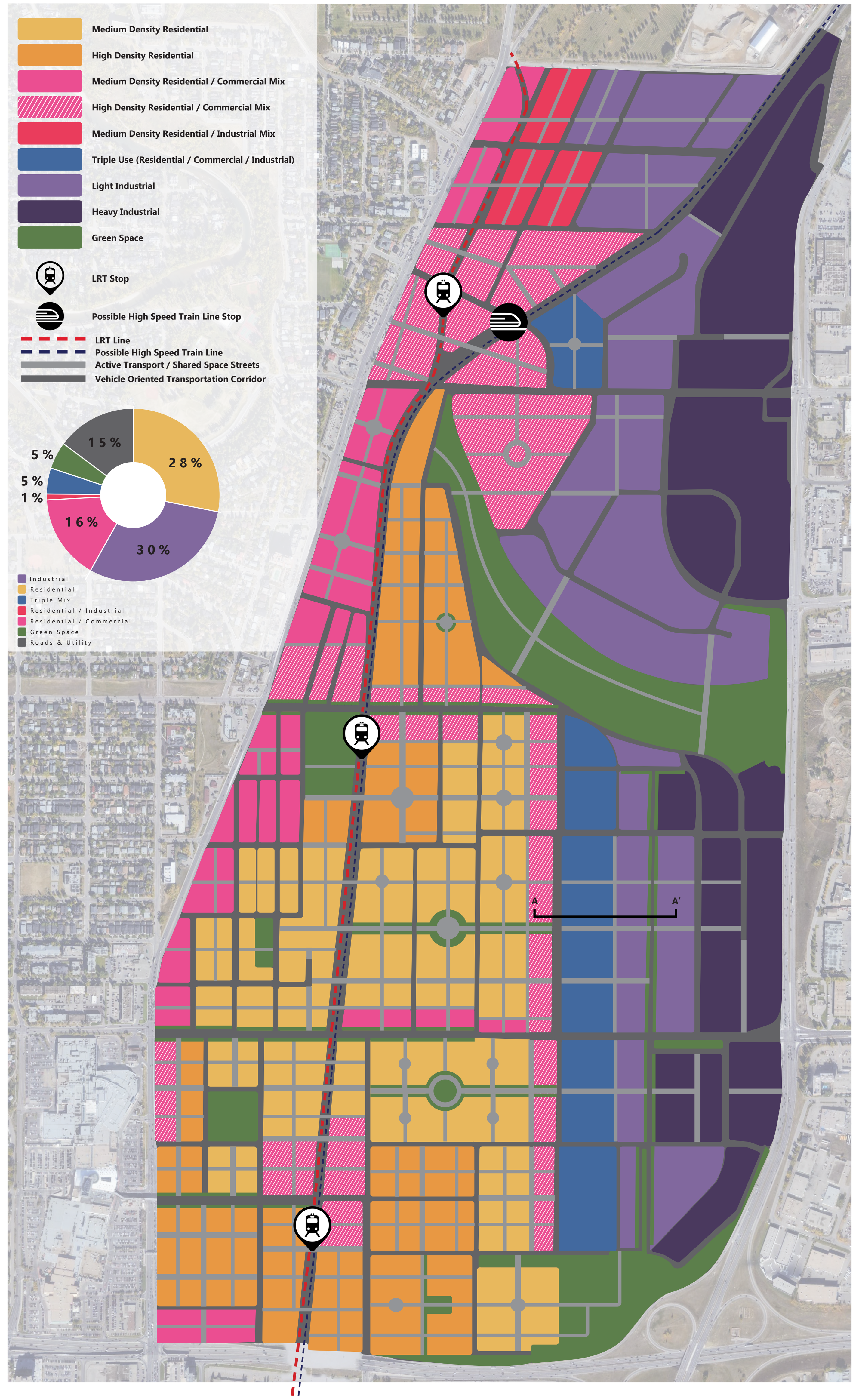
HETEROGENEOUS LAND USES · ELECTRIC VEHICLE INFRASTRUCTURE · ACTIVE TRANSPORT OPPORTUNITIES · PEDESTRIAN FIRST · INCREASED LRT INFRASTRUCTURE · POSSIBILITY FOR HIGH SPEED RAIL · WIND POWER GENERATION · WASTEWATER HEAT RECOVERY

RAINWATER COLLECTION & TREATMENT · MAXIMIZING REUSE PRINCIPLES · SOLAR POWER INTEGRATION · GEOTHERMAL INFRASTRUCTURE · LOCALLY PRODUCED FOOD · VERTICAL FARMING TECHNIQUES · COMPOSTING FACILITIES · BIOMASS COLLECTION

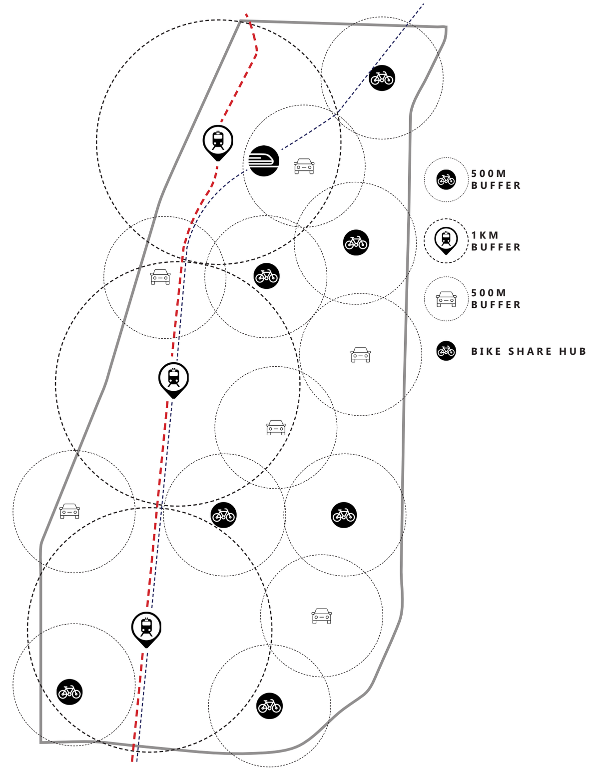
PRECEDENT STUDIES

Vauban Germany	**Olympic Village** Vancouver
Deepwater Farms Calgary	**Havana Community Gardens** Cuba
BedZed UK	**Copenhagen Bike Share** Denmark
Bullit Building Seattle	**City of Westminster** UK

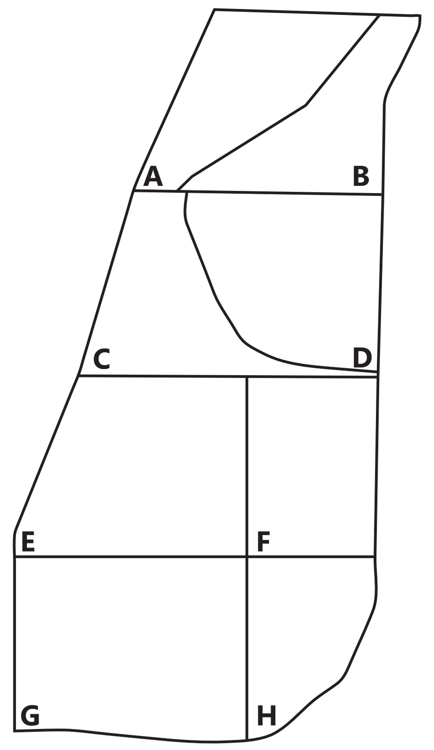
PROPOSED LAND USE DIAGRAM



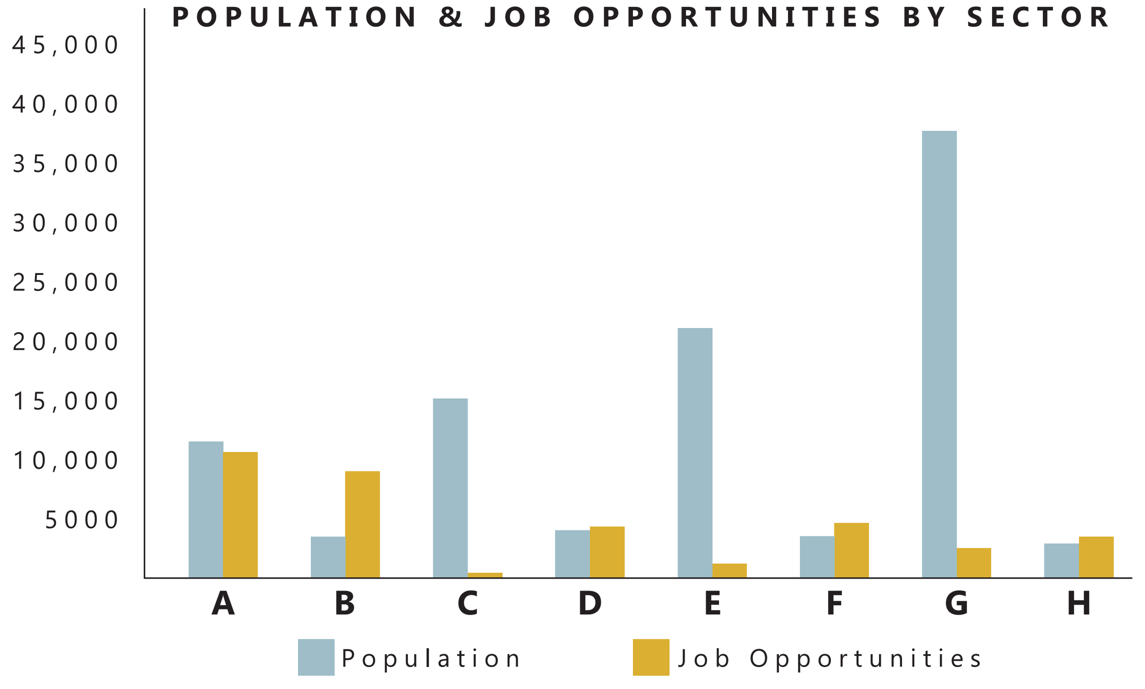
TRANSPORTATION BUFFER DIAGRAM



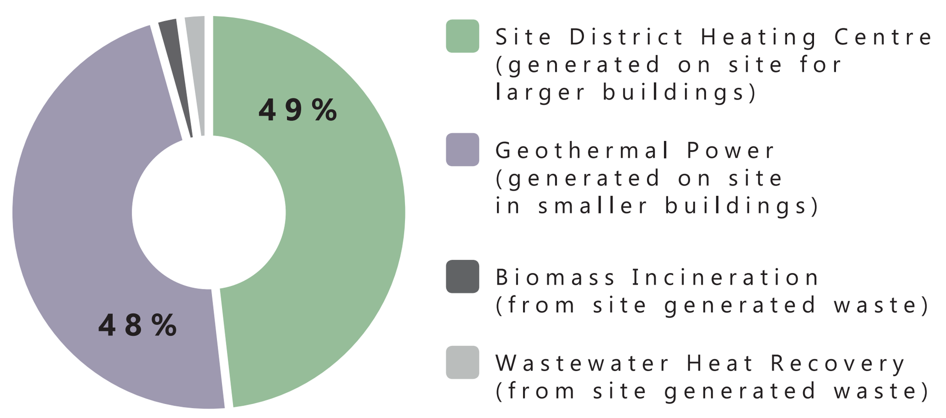
SECTOR DIAGRAM



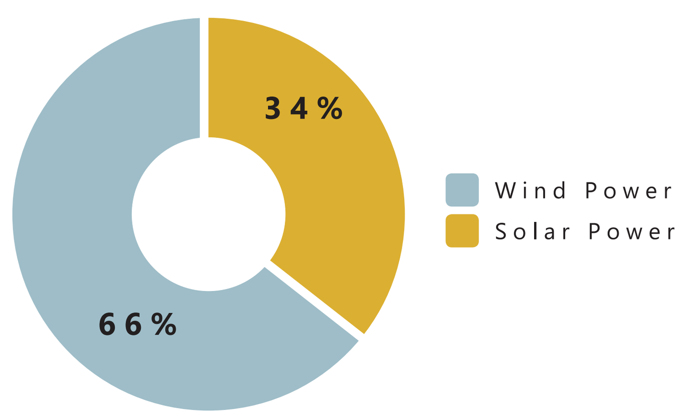
POPULATION & JOB OPPORTUNITIES BY SECTOR



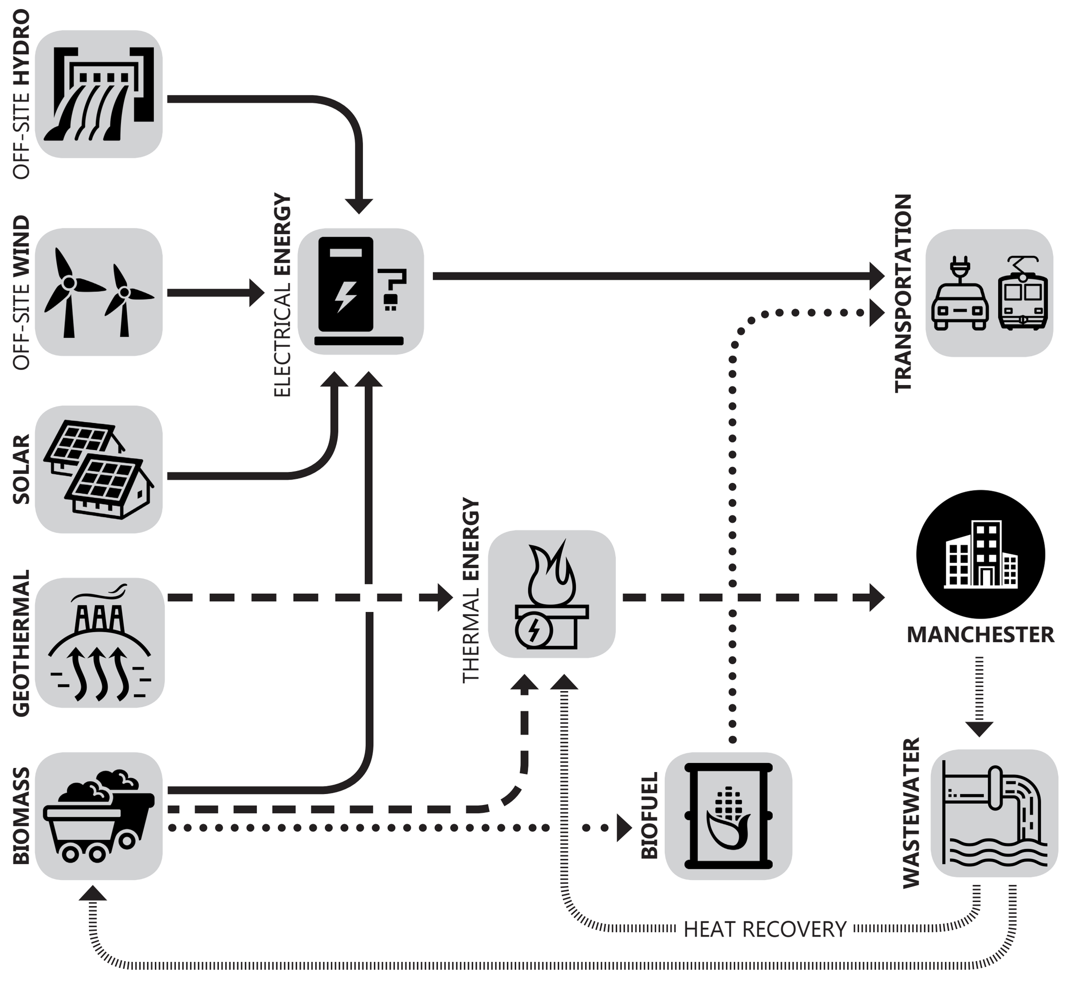
THERMAL ENERGY GENERATED FOR MANCHESTER



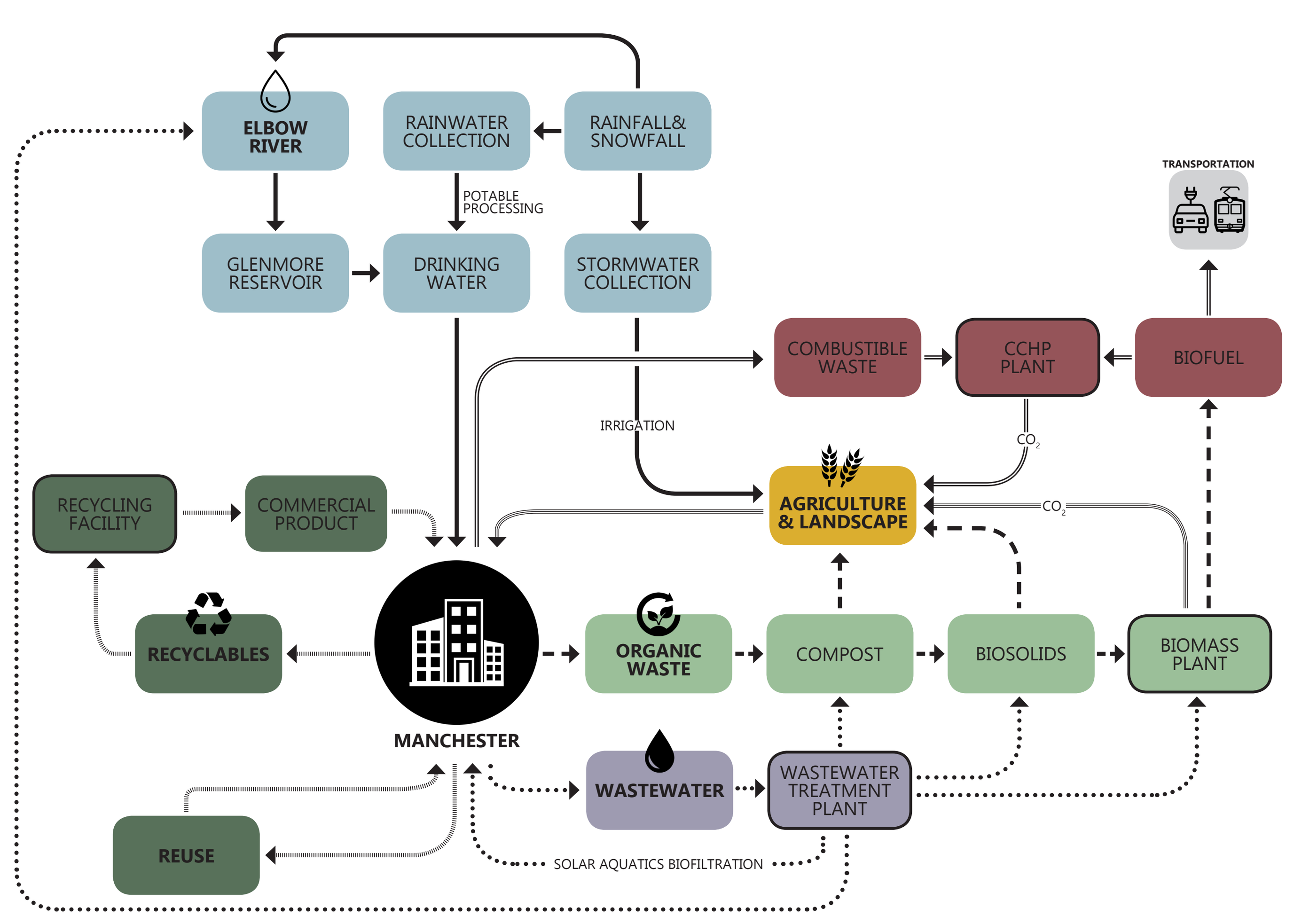
ELECTRICITY GENERATED FOR MANCHESTER



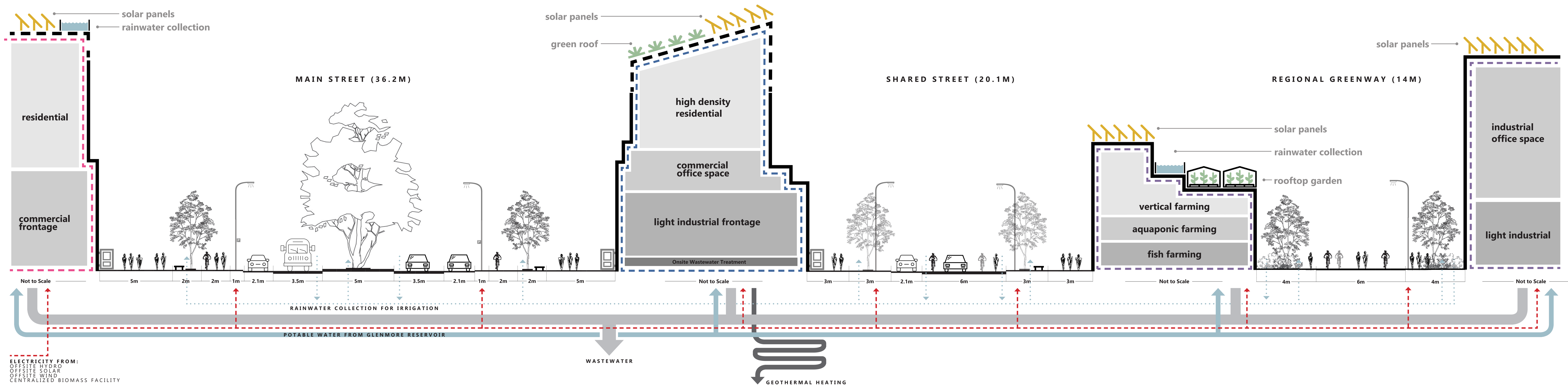
ENERGY FLOW DIAGRAM



MATERIALS FLOW DIAGRAM



SECTION A-A'



Manchester Re-Imagined

Emma Brodie, Michael Ge, Travis Dickie

EVDS 616

04/07/2019

Calgary's Manchester Industrial Park is one of many examples of how historic inner-city industrial areas have become inefficient, under-populated neighborhoods as they enter the 21st century. Deigned in an era when land use separation was the norm and personal vehicles were ubiquitous, the large block-sizes and absence of pedestrian infrastructure has limited Manchester's ability to evolve with the rest of the city.

Today, a renewed interest in walkability, advances in brownfield reclamation, and the growing interest in sustainable development make re-imaging both viable and lucrative. Bordered by major transport channels, located close to downtown, and boasting residents that are pro-development, Manchester is a developer's dream – a return on investment for a conventional neighborhood development would be all but guaranteed. Following critical warnings by the Intergovernmental Panel on Climate Change however, *conventional development* in Manchester would squander a chance to create a high-profile sustainable infrastructure hub in a recognizable part of the city. Initiatives that embed food production, renewable energy and transport alternatives into the neighborhood's master plan are becoming best practices for urban growth worldwide. A sustainable Manchester would be a pivotal step for Calgary and would demonstrate to other North American cities how to retrofit old industrial districts, and in turn, reduce GHG emissions.

To reach this goal by 2060, the Manchester District master development plan should integrate the following three infrastructure innovations to help it reach net-zero energy use and waste: ***become a robust shipping and transport node*** *for the region,* ***a year-round indoor food producer****, and an* ***energy generator on a neighborhood scale.***

The built form would consist of a low-impact mix of high density, modular living and mixed-use commercial spaces, and will offer residents and business owners a variety of unique building configurations. Built with active transport in mind, a multi-modal green transportation network that prioritizes pedestrian and cycle traffic over cars – an innovation that encourages activity and an active streetscape.

The Manchester re-design not only suggests that public utilities, resource production and economic activity can all exist harmoniously in one neighborhood, but that by building everything in-close proximity, but that the diversity of form and function, increased work opportunities and densification of space benefit residents of the neighborhood most of all.

Transport Hub: Vauban's 'perimeter parking garages', the public/private purchase of a fleet of electrical cars in Vermont and California, and the centrally managed car sharing business model that originated in San Francisco all helped to inform the vehicle parking and ownership plans for Manchester. Like in Vauban, personal or fleet vehicles would all live in centralized parking garages located close commercial or mixed-use nodes across the site. To promote exercise as well as an attractive and uncongested streetscape, residents and visitors will walk only 5 minutes (500m) from most places on the site to secure a vehicle. Personal bikes would be kept at residences, but similar to Vancouver or Copenhagen's bike share initiatives, fleet owned bikes would be parked at centralized hubs after use as a means to combat vandalism and misuse. These stations would live within reasonable distance from transit and vehicle share hubs. With the addition of a third LRT station and a pervasive bus service, a transit pricing program would provide discounted passes for residents of co-operative housing in the southern most triple-mix area. The pricing shortfall would be off-set by community residents whose need for a personal vehicle would be paid for by their ongoing rental of a parking space. Regular vehicular transport through the site would be restricted to the existing roadways of 42 Avenue, 50 Avenue, and 58 Avenue. The increased emphasis on modes of active transport within, and to locations outside of the site would directly offset car congestion caused by the increase in population and would maintain an operating capacity for these three roads of 84% at peak periods.

<u>Energy Hub:</u> Developing a net-zero neighborhood that produces much of its electricity and thermal power on-site cannot be achieved using one technology alone. To power the entirety of Manchester at its maximum capacity of 100,000 residents, a combination of solar energy (BedZed in the UK) and bio-mass (Bullit building) on-site and the purchase of wind (Southern AB) and hydro (Site C Dam) generated off-site would diversify the energy mix, and help to balance the demand load. For thermal heating, a combination of district heating plant(s) (Enmax), thermal heat recovery from wastewater (Olympic Village in Vancouver) and building-level geothermal (City of Westminster) would be more than meet the needs of the neighborhood population. District energy potential for the site would be limited to the immediate area of the physical plants, but could practically cover all heating needs for 100,000 conventional users on its own (96% of site). Even with only one district plant, a robust building-appropriate geothermal portfolio would bring site demand to 1/3 of what was required by conventional gas customers, and by leveraging passiv haus design and construction (Bullit), energy loss would be reduced by an additional 90% over conventionally built structures.

In terms of water use, the 248mm seen in annual rainfall on the site would be collected, and purified for use in site agriculture and district energy (boiler heating/steam generation) practices. According to the City of Calgary, 30% of all potable water used is is returned as wastewater. In keeping with a zero-waste goal in Manchester, black water produced on site would be exploited for its thermal heat producing potential (Vancouver Olympic Village), and purified for re-use or converted into biomass for further use.

<u>Food Production:</u> Permaculture inspired vertical farming techniques would be employed at a factory scale in the southeastern portion of the site, with community sized gardening operations (Havana, Cuba) taking place throughout. Like Deepwater Farms' circular, closed-system operation, animal and plant waste products would circulate into the aquaponics gardens for use as fertilizer, then once harvested, would be converted from compost to bio-solids.

The potential for a re-imaged Manchester district to influence neighborhood planning practices in both Calgary and across the country cannot be understated. By identifying opportunities where utility, food production and shared transportation can contribute to one another, Manchester can become a net-zero neighborhood whose circular local economy is both self-sustaining and a great place to live.

JOB/POPULATION DENSITY, FOOD, TRANSPORTATION

For the site area, the average densities for high-density and medium-density housing are assumed. The persons per unit reference the persons per unit information from Beltline and East Village communities, where the majority of housing types are high-density and medium-density.

Housing Type	Average Density, upa	Persons per Unit	Land, acre	Units	People	Share
High Density	180	1.8	175	31,550	56,791	54%
Medium Density	100	2.3	208	20,762	47,753	46%
Total	137	2.0	383	52,312	104,543	100%

Job density assumptions are listed below for retail, office and industrial sectors.

Sector	Density, sqm per employee
Retail	20
Office	19
Industrial	36

Based on the assumptions above, population and employment are calculated for each development cell.

Development Cell	Population	Share	Jobs	Share
A	11,605	11%	10,683	29%
B	3,629	3%	9,165	25%
C	15,240	15%	625	2%
D	4,536	4%	4,685	13%
E	23,717	23%	1,382	4%
F	4,347	4%	4,769	13%
G	38,893	37%	2,004	6%
H	2,576	2%	3,049	8%
Total	104,543	100%	36,360	100%

The detailed job breakdown by sector for each development cell is listed below.

Jobs by Sector	Commercial	Office	Industrial	Total
A	640	7,515	2,528	10,683
B	178	6,012	2,975	9,165
C	625	0	0	625
D	74	0	4,611	4,685
E	818	564	0	1,382
F	208	0	4,561	4,769
G	595	1,409	0	2,004
H	74	0	2,975	3,049
Total	3,213	15,499	17,649	36,360
Share	9%	43%	49%	100%

The land use area for the site area is calculated below.

Land Use	Area, acre	Share
Residential	289	28%
Industrial	303	30%
Res & Com Mix	162	16%
Res & Ind Mix	15	1%
Triple Mix	47	5%
Park	46	5%
Roads & Utility	152	15%
Total	1,014	100%

Based on food consumption per capita, the total food demand is calculated.

Food	Volume, lbs
Consumption / day / person	3.8
Population	104,543
Annual Consumption	145,002,000

Using Deepwater farms and Lufa farm precedents, the land requirements for each precedent is calculated.

Precedent	Production per sqft	Volume, lbs	Size, acres
Deepwater Farm	13	121,750,200	215
Lufa Farm	5	23,587,049	108

Using the land use information, the vehicular traffic in the PM peak is calculated and converted to daily traffic. As the site area is 100% covered by transit, good walking and cycling facilities, a 90% mode share of sustainable transportation is applied.

Land Use	Size	Per Unit	PM Trip Rate	PM Traffic Volumes	Mode Share	PM Vehicular Volumes	Daily Volumes	Share
Multi-Family	52,312	Units	0.45	23,541	10%	2,354	23,541	39%
Office	3,522	1,000 sqft	1.57	5,529	10%	553	5,529	9%
Retail	4,610	1,000 sqft	6.00	27,662	10%	2,766	27,662	46%
Industrial	7,599	1,000 sqft	0.49	3,723	10%	372	3,723	6%
Total	-	-	-	60,456	-	6,046	60,456	100%

As the site area has three primary entrance routes (42 Avenue, 50 Avenue, and 58 Avenue), the daily roadway capacity into / out of the site is calculated and it is estimated that the roadway operates at 84% of its capacity, confirming the roadway design could accommodate the expected traffic demand.

Number of Primary Entrance Routes	3
Hourly Capacity (2 Lanes)	2,400
Total Hourly Capacity	7,200
Total Daily Capacity	72,000
Volume / Capacity Ratio	84%

MANCHESTER ENERGY PROVISIONS AND REQUIREMENTS

Electricity Required for Manchester	**Total energy required**
Total percentage of electricity created from solar on site	34%
Additional electricity required from off-site hydro and wind	66%
Heat required for Manchester	
Total heat generated from district heating centre on site	49%
Potential thermal heat recovery from wastewater	1.34%
Total required heat generated from Biomass	1.3%
Total required heat generated from Geo-thermal (Ground Source Heat Pumps in all buildings)	48%
Site water re-use	
Total annual stormwater available for recirculation (mm)	248.25
Potential for wastewater re-allocation for thermal heating	100%

SOLAR ENERGY IN MANCHESTER

Solar energy requirements were calculated using the D2L calculations guide. Final calculations approximate percentages of rooftop space available for panels, optimal sunlight and a demand of 100,000 residents.

Electricity required for 100,000 total residents in Manchester *per year*	**Energy (kWh)**
Total daily Res& Ind. consumption in Manchester per capita *(kWh)*	6,208
Manchester total usage *(kWh/y * 100,000 residents)*	620,800,000
Solar energy potential for Manchester District *per year*	
Total solar insolation in Manchester *p.year (1.38 MWh/m2/yr)(4,000,000m2)*	5,520,000
Total solar capture in Manchester per year at 100% coverage *(4000000m2)/(11.4m2/351000)*	453,000,000

SOLAR CONTRIBUTIONS BY LAND USE AREA

Land use coverage	**Area coverage (m2)**	**Land-use totals**	**Solar coverage**	**Energy output (kWh)**
Residential *(50% usable for solar)*	1,109,500	27.74%	14%	62,825,438
Industrial *(75% usable for solar)*	1,201,005	30.03%	23%	102,010,362
Res & Com Mix *(50% usable for solar)*	655,591	16.39%	8%	37,122,857
Res & Ind Mix *(75% usable for solar)*	60,703	1.52%	1%	5,155,953
Triple Mix *(25% usable for solar)*	190,202	4.76%	1%	5,385,105
Park	186,156	4.65%	0%	0
Roads & Utility	615,123	15.38%	0%	0
Totals	4,000,000	100%	47%	212,499,715

Total solar (kWh)	408,300,285
Total percentage of energy created from solar on site (%)	34%

HEATING IN MANCHESTER

Calculations for district heating determine that district plants would fulfill demand almost entirely, but that pervasive ground source heat pump Geothermal across the site would complement district heating output by 70% of traditional natural gas demand (@ 650sq ft./resident). Lastly, site waste reduction initiatives that generate heat from biomass, wastewater thermal heat reduction and biofuel would add to the overall portfolio, but would contribute negligibly.

District Energy System Provisions *(Enmax District Energy website)*	**Heat energy (kWh)**
Total heat energy produced annually *(55 mW*8766 [hours in a year]) = (kWh)*	482130000
Annual per capita heat energy used *(41.8m2 or 450ft2 = 1820kWh/month*)*12	21840
Annual heat required per m2 in Calgary *(21840kWh/41.8m2)*	522

Manchester site heating requirements *per year*	**Total coverage (m2)**	**Total heatable area (m2)**	**Heat required per m2 (kWh)**
Residential *(Built form - 75% of total area)*	1,109,500	832,125	434,775,359
Industrial - *(Built form - 50% of total area)*	1,201,005	600,503	313,755,373
Res & Com Mix *(Built form - 50% of total area)*	655,591	327,796	171,269,306
Res & Ind Mix *(Built form - 50% of total area)*	60,703	30,351	15,858,270
Triple Mix *(Built form - 50% of total area)*	190,202	95,101	49,689,239
Totals	4,000,000	1,885,876	985,347,547
Site Heat sourced from Single District Energy Centre	49%		
Site Heat sourced from Two District Energy Centres	98%		

BIO-MASS/BIO-LIQUID ENERGY IN MANCHESTER

Per Capita waste production in 2017 *(2014 study of family waste breakdown), (EPA)*	**Waste (kg)**	**Usable waste (kg)**
Annual landfill waste per capita *(10% to biomass)*	74	7
Annual compost waste per capita *(44% to biomass)*	239	105
Annual recycling waste per capita	55	Not used
Total annual per capita landfill waste in Calgary	368	112
Total annual compost waste in Manchester *(Calgary total*100000 residents)*	23,920,000	11,260,800
Usable Biomass extracted from site waste (tonnes)	11,261	
Litres of Biofuel Produced Annually *(Enerkem - 100k tonne = 33million L)*	3,716,064	
Tonnes of Biomass (combustion) converted to heat *(626mW = 4.5m tons/ 1t=7.18kWh)*	80,853	
Percentage of total required electricity generated from Biomass	1.30%	%

GEOTHERMAL & HEAT RECOVERY THERMAL ENERGY IN MANCHESTER

Geothermal System Provisions	**Gas used per capita (kWh)**	**Geothermal equiv. (kWh)**	
Ground source heat pump (~350% more efficient than gas [3.25* less)	16.25	5	
(.63 GJ/ft2 or 16.25kWh/m2)(16.25kWh) - Alberta energy*			
Manchester site heating requirements *per year*	**Total coverage (m2)**	**Gas required (kWh)**	**Geothermal required (kWh)**
Residential *(Built form - 75% of total area)*	1,109,500	18029375	5151250
Industrial - *(Built form - 50% of total area)*	1,201,005	19516331.25	5576094.643
Res & Com Mix *(Built form - 50% of total area)*	655,591	10653358.63	3043816.75
Res & Ind Mix *(Built form - 50% of total area)*	60,703	986422.125	281834.8929
Triple Mix *(Built form - 50% of total area)*	190,202	3090789	883082.5714
Total	3,217,002	52,276,276	14,936,079
Geothermal efficiency over natural gas with GSHP used in all units	29%		
Thermal heat recovery provisions *(Vancouver Olympic Village)*	**Total Wastewater (L)**	**Heat produced (kWh)**	
Wastewater to recoverable heat per year using DES *(100k res = 300k GJ)*	14,052,500,000	83333.33	
Percentage of total required electricity generated from heat recovery	**1.34%**		

WATER FLOWS IN MANCHESTER

Lastly, site rainfall and runoff has been measured and combined for the area to determine the annual volume of water that can be reintroduced into the site for irrigation, use in the district heating system and for drinking after being purified. In addition, the assumption that 30% of the total potable water used becomes wastewater provides a useful variable for determining thermal heat recover percentages (in the geothermal section).

Water type *City of Calgary/Bonnybrook stats*	**Total water used/return (L)**
Treated/Delivered water *(200,750L per capita/year * 100,000 Manchester Res.)*	20,075,000,000
Wastewater *(30% of outgoing treated water)*	14,052,500,000
Stormwater volumes in Manchester	
Total area of site	3.8 km2/ 835.186 acres
Estimate 1 - Average rainfall (Calgary weather data)	438.12
Estimate 2 - Average rainfall – site level (12 acres) (EPA geolocating tool)	475.49
EPA Tool Average runoff (mm)	222.5
Loss due to evaporation (30%)	201.75
Total annual stormwater available for recirculation (mm) (average of two estimates)	470.75

REFERENCES:

WATER USE/RAINFALL IN MANCHESTER

<u>Per capita demand for water</u>
City of Calgary: http://www.calgary.ca/UEP/Water/Documents/Water-Documents/water_efficiency_plan.pdf?noredirect=1

<u>30% of tap water becomes wastewater in Calgary</u>
Wikipedia: https://en.wikipedia.org/wiki/Alyth/Bonnybrook/Manchester,_Calgary

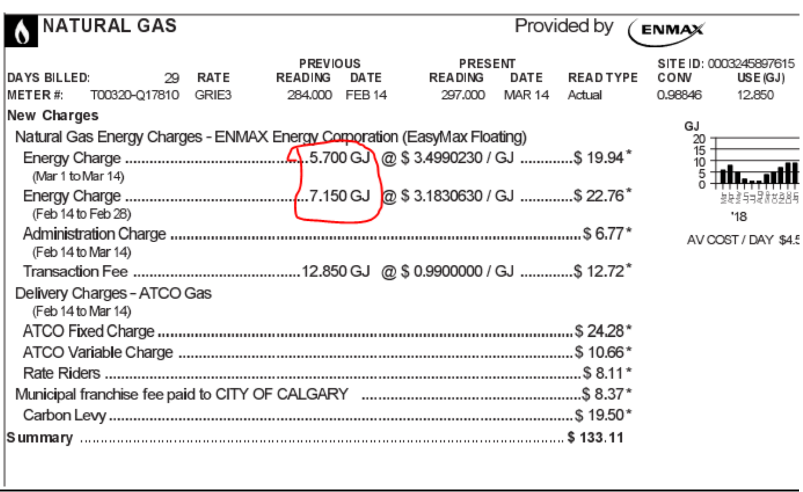
<u>Rainfall estimates</u>
USA EPA Stormwater calculator: https://www.epa.gov/water-research/national-stormwater-calculator
Annual precipitation data for Calgary: https://calgary.weatherstats.ca/charts/precipitation-yearly.html

Customer water pricing: Heating a house with electicity - http://energyusecalculator.com/electricity_furnace.htm

HEATING

<u>Measuring Geothermal production (@350% more efficient than Natural Gas)</u>
Alberta Natural gas website: https://www.efficiencyalberta.ca/average-alberta-energy-consumption/

<u>District Heating – measuring personal natual gas use as benchmark</u>



NATURAL GAS Provided by ENMAX

			PREVIOUS		PRESENT			SITE ID: 0003245897615	
DAYS BILLED:	29	RATE	READING	DATE	READING	DATE	READ TYPE	CONV	USE (GJ)
METER #:	T00320-Q17810	GRIE3	284.000	FEB 14	297.000	MAR 14	Actual	0.98846	12.850

New Charges
Natural Gas Energy Charges - ENMAX Energy Corporation (EasyMax Floating)
Energy Charge ....5.700 GJ @ $ 3.4990230 / GJ ....$ 19.94*
(Mar 1 to Mar 14)
Energy Charge ....7.150 GJ @ $ 3.1830630 / GJ ....$ 22.76*
(Feb 14 to Feb 28)
Administration Charge ....$ 6.77*
(Feb 14 to Mar 14)
Transaction Fee ....12.850 GJ @ $ 0.9900000 / GJ ....$ 12.72*
Delivery Charges - ATCO Gas
(Feb 14 to Mar 14)
ATCO Fixed Charge ....$ 24.28*
ATCO Variable Charge ....$ 10.66*
Rate Riders ....$ 8.11*
Municipal franchise fee paid to CITY OF CALGARY ....$ 8.37*
Carbon Levy ....$ 19.50*
Summary .... **$ 133.11**

GJ
20
15
10
5
0
'18
AV COST / DAY $4.5

<u>Passivhaus – 90% more efficient than traditional house</u>
Brookfield single family house: https://alberta.brookfieldresidential.com/calgary-homes/brookfield-stories/detail/Brookfield-Residential-builds-its-first-Passive-House-in-Canada

Skeena mid-rise: http://www.greenenergyfutures.ca/episode/skeena-passive-house

ELECTRICITY – D2L Calculations sheet and estimates

BIOMASS/FUEL - Enerkem to understand how much of waste, and what kind of waste can become biomass and biofuel - https://enerkem.com/facilities/enerkem-alberta-biofuels/