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Department of Real Estate and Construction 房地產及建設系

# A cost-benefit analysis of C&D waste management throughout the waste chain: experiences from Hong Kong SAR of China



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Hong Kong SAR of China – a  
marvelous city





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# HK SAR of China International Airport

Tung Chung New Town







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Tsing Ma Bridge





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New Government HQ





## Public Housing



Currently, housing in Hong Kong SAR of China is mainly supplied through three channels: (1) private housing; (2) public rental housing (PRH), and; (3) subsidized housing under home ownership schemes (HOS). By the end of March 2012, there were 2,599,000 permanent residential flats in stock, of which 1,447,000 (56%) were private flats, 761,000 (29%) were PRH, and 391,000 (15%) were subsidized housing.



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West Kowloon





## Hong Kong SAR of China



Land Area: 1,104 km<sup>2</sup>

Less than 25% of the territory's landmass is developed, and about 40% of the remaining land area is reserved as country parks and nature reserves.

Population: 7.235 million

Labor force: 3.9 million

GDP: HK\$2,022.2 billion (2013)

### GDP by Economic Activity – Percentage contribution to GDP

Economic Activity	2008	2009	2010	2011	2012 <sub>f</sub>
Agriculture, fishing, mining and quarrying	0.1	0.1	0.1	0.0	0.1
Manufacturing	1.9	1.8	1.8	1.6	1.5
Electricity, gas and water supply, and waste management	2.4	2.2	2.0	1.8	1.8
<b>Construction</b>	<b>3.0</b>	<b>3.2</b>	<b>3.3</b>	<b>3.4</b>	<b>3.6</b>
<b>Services</b>	<b>92.6</b>	<b>92.7</b>	<b>93.0</b>	<b>93.1</b>	<b>93.0</b>

Data sources: Hong Kong – the facts, and Hong Kong Census and Statistics Department, Hong Kong SAR of China

### Employment Distribution by Industry Section <sup>Δ</sup>

Industry section	2005	2009	2010 <sup>®</sup>
Agriculture, forestry and fishing	0.3	0.2	0.1
Mining and quarrying	\$	\$	\$
Manufacturing	4.7	3.8	3.5
Electricity and gas supply	0.2	0.2	0.2
Water supply; sewerage, waste management and remediation services	0.2	0.2	0.2
<b>Construction</b>	<b>7.9</b>	<b>7.5</b>	<b>7.7</b>
Import and export trade	16.4	15.0	14.4
Wholesale	2.2	1.9	1.8
Retail	8.3	8.5	8.7

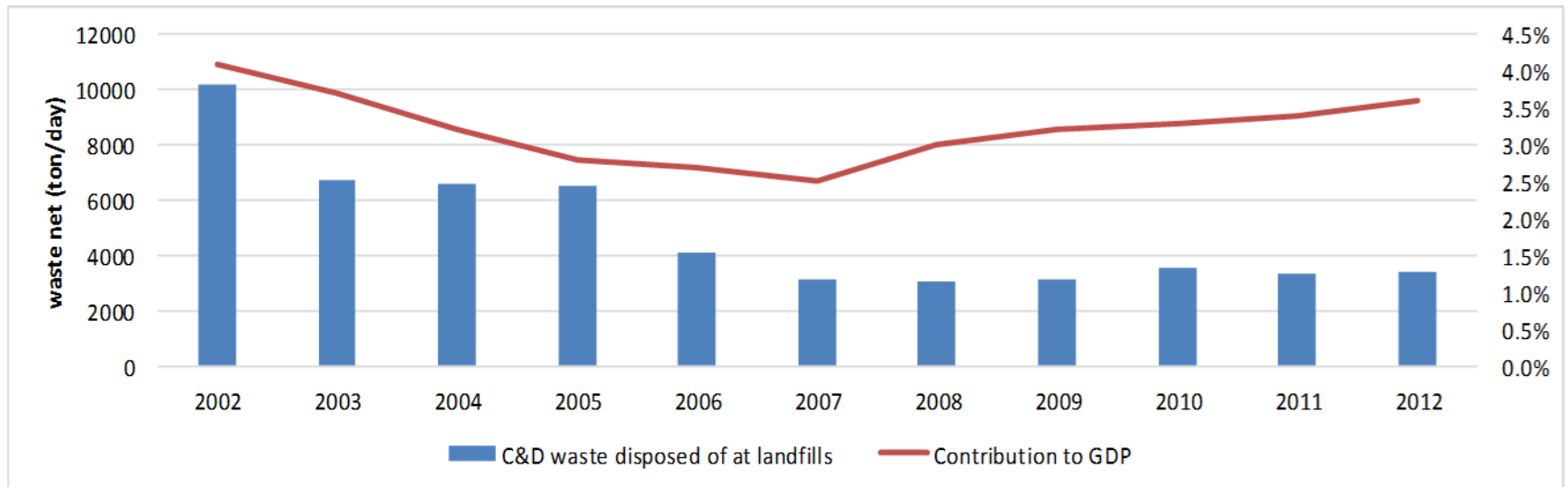




## GDP and waste contributed by construction (year 2002–2012)

Note: GDP related data were at basic prices.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Construction (M HKD) <sup>1</sup>	51850	45237	40797	39010	39227	40643	48403	50264	56531	64527	73445
Contribution to GDP (%) <sup>2</sup>	4.1	3.7	3.2	2.8	2.7	2.5	3	3.2	3.3	3.4	3.6
C&D waste disposed of at landfills (Tonne) <sup>3</sup>	3723730	2455720	2407175	2393305	1505737	1152732	1131527	1139014	1308159	1215940	1259040
C&D waste disposed of at landfills (tpd) <sup>4</sup>	10202	6728	6595	6556	4125	3158	3092	3121	3584	3331	3440

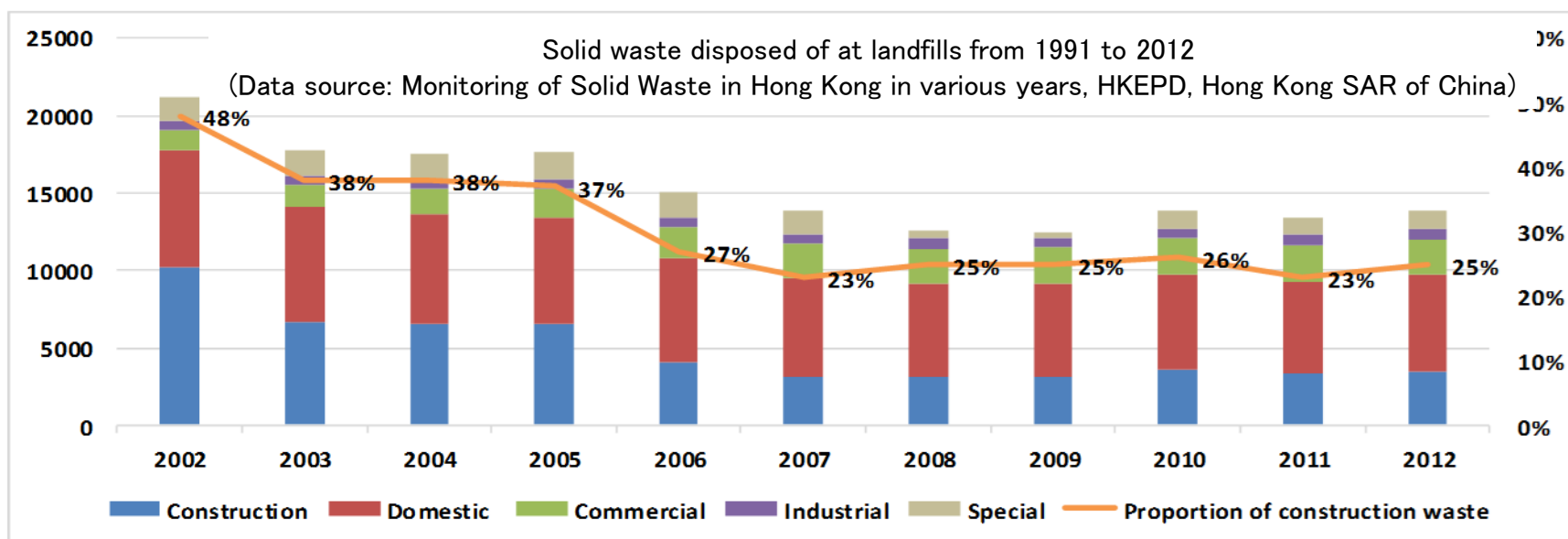




## Comparing C&D waste with other sectors (year 2002–2012)

Note: GDP related data were at basic prices.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Contribution to GDP (%) <sup>1</sup>	4.1	3.7	3.2	2.8	2.7	2.5	3	3.2	3.3	3.4	3.6
C&D waste at landfills (tpd) <sup>2</sup>	10202	6728	6595	6556	4125	3158	3092	3121	3584	3331	3440
Proportion of C&D waste (%)	48	38	38	37	27	23	25	25	26	23	25
Domestic waste at landfills (tpd) <sup>2</sup>	7519	7402	7014	6828	6634	6372	6081	6015	6135	5973	6286
Commercial waste at landfills (tpd) <sup>2</sup>	1342	1428	1673	1895	2062	2190	2280	2319	2352	2360	2260
Industrial waste at landfills (tpd) <sup>2</sup>	561	612	601	654	583	622	660	629	627	663	732
Special waste at landfills (tpd) <sup>2</sup>	1534	1588	1620	1746	1635	1559	443	340	1119	1131	1127







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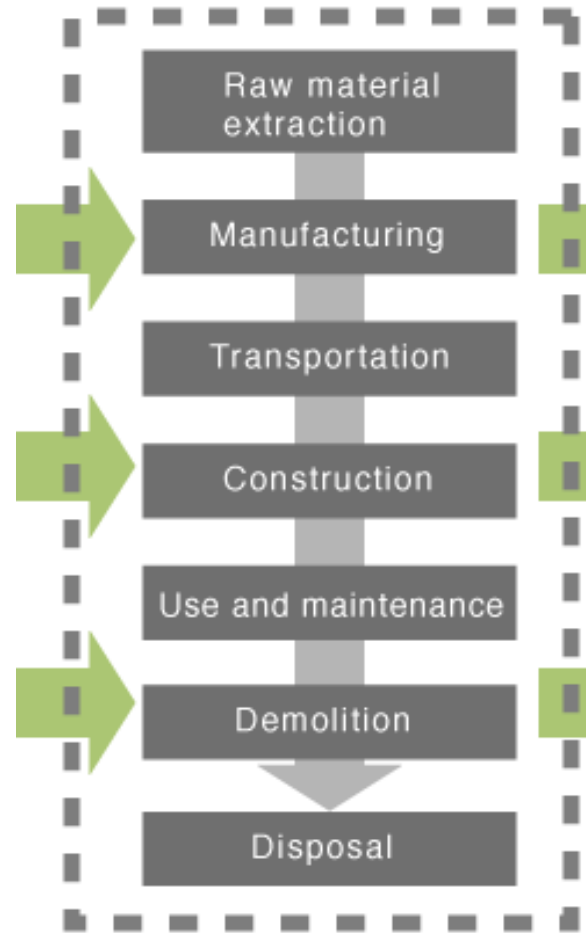
If we don't do anything now ...



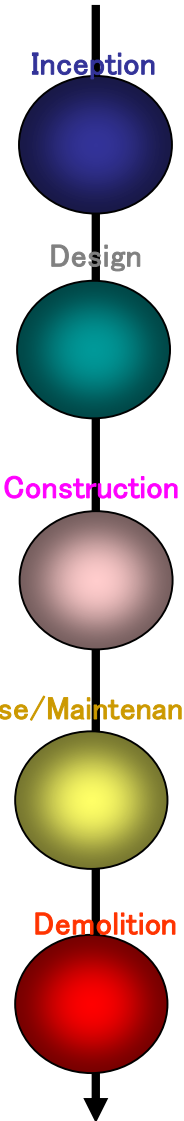




## Managing C&D waste throughout the waste chain



construction materials Lifecycle  
(The waste chain)  
(Adapted from Life Cycle Assessment)

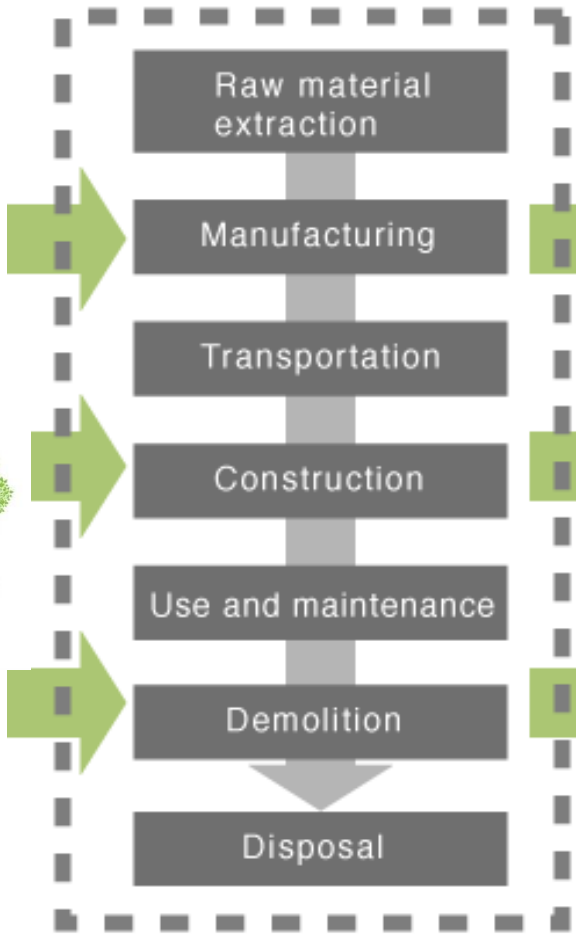
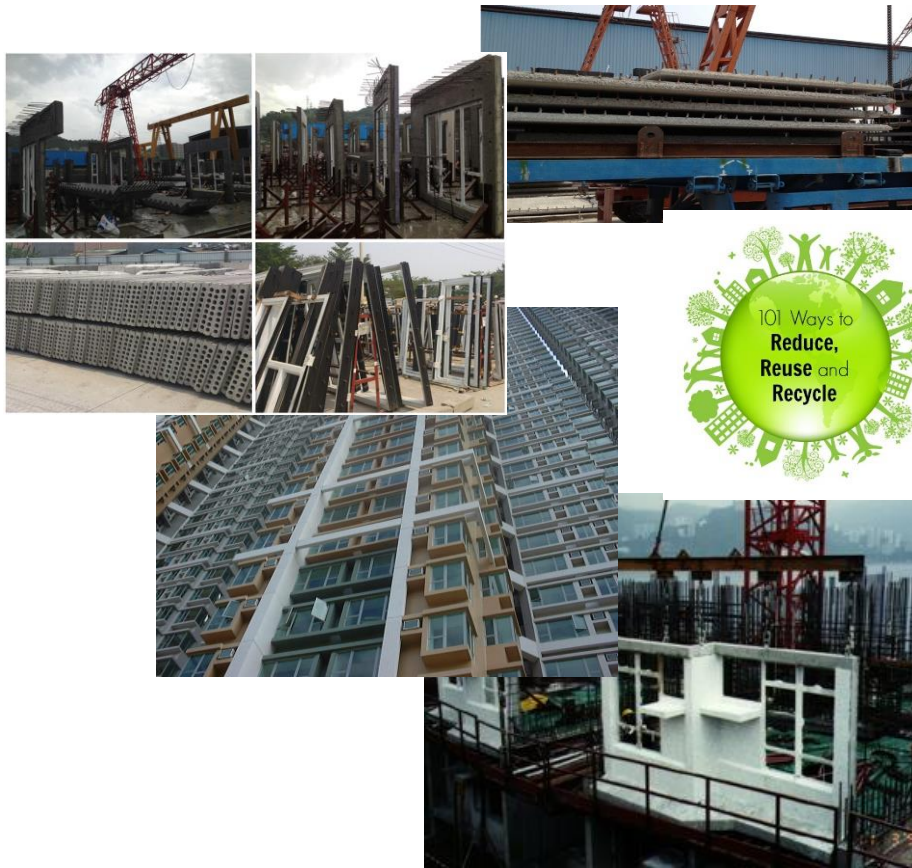


construction project Lifecycle



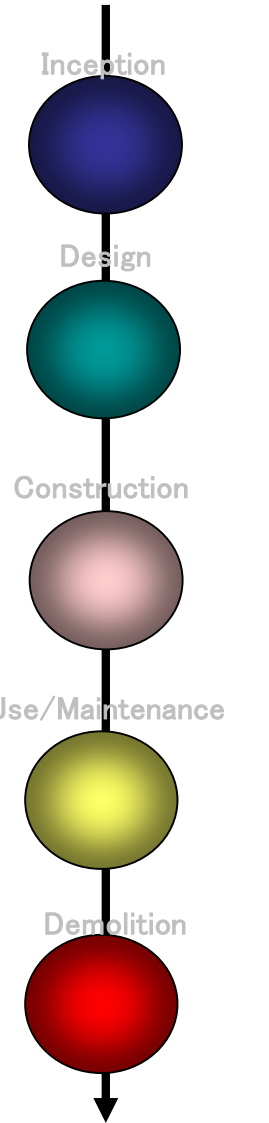
# Managing C&D waste throughout the waste chain

## (1) Prefabrication



construction materials Lifecycle  
(The waste chain)

(Adapted from Life Cycle Assessment)



construction project Lifecycle





## Managing C&D waste throughout the waste chain

### (1) Prefabrication

#### Costs:

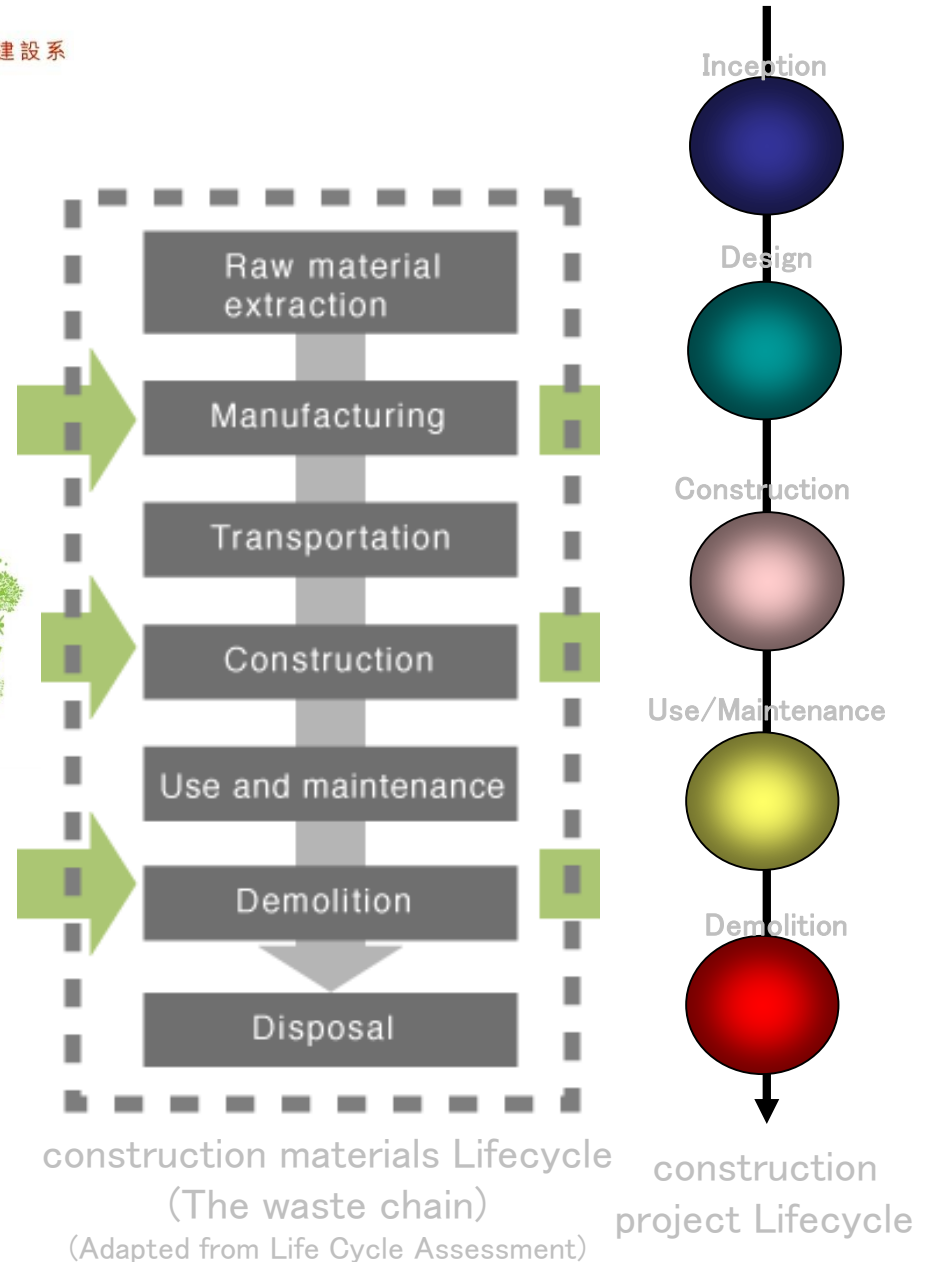
Precast construction is approximately 2% higher than that of conventional cast in-situ construction method (Jaillon and Poon, 2008)

Land for the prefabrication yard

Lack of skills workers

#### Benefits:

- Improved quality control
- Construction waste reduction
- Improved health and safety
- Better onsite
- Environmental conditions (less dust and lower noise)
- Reduction in labour demand
- Construction time (source: Jallon and Poon, 2008)
- waste generation rate is around 2% or lower by weight (Lu and Yuan, 2013)
- construction waste could be minimized up to 84.7% if prefabrication is applied (Tam, 2007)



#### Solutions:

Scale of economy;

Offshore;

Gross Floor Area exemption



## Managing C&D waste throughout the waste chain

### (2) “Designing out” waste

#### Solutions:

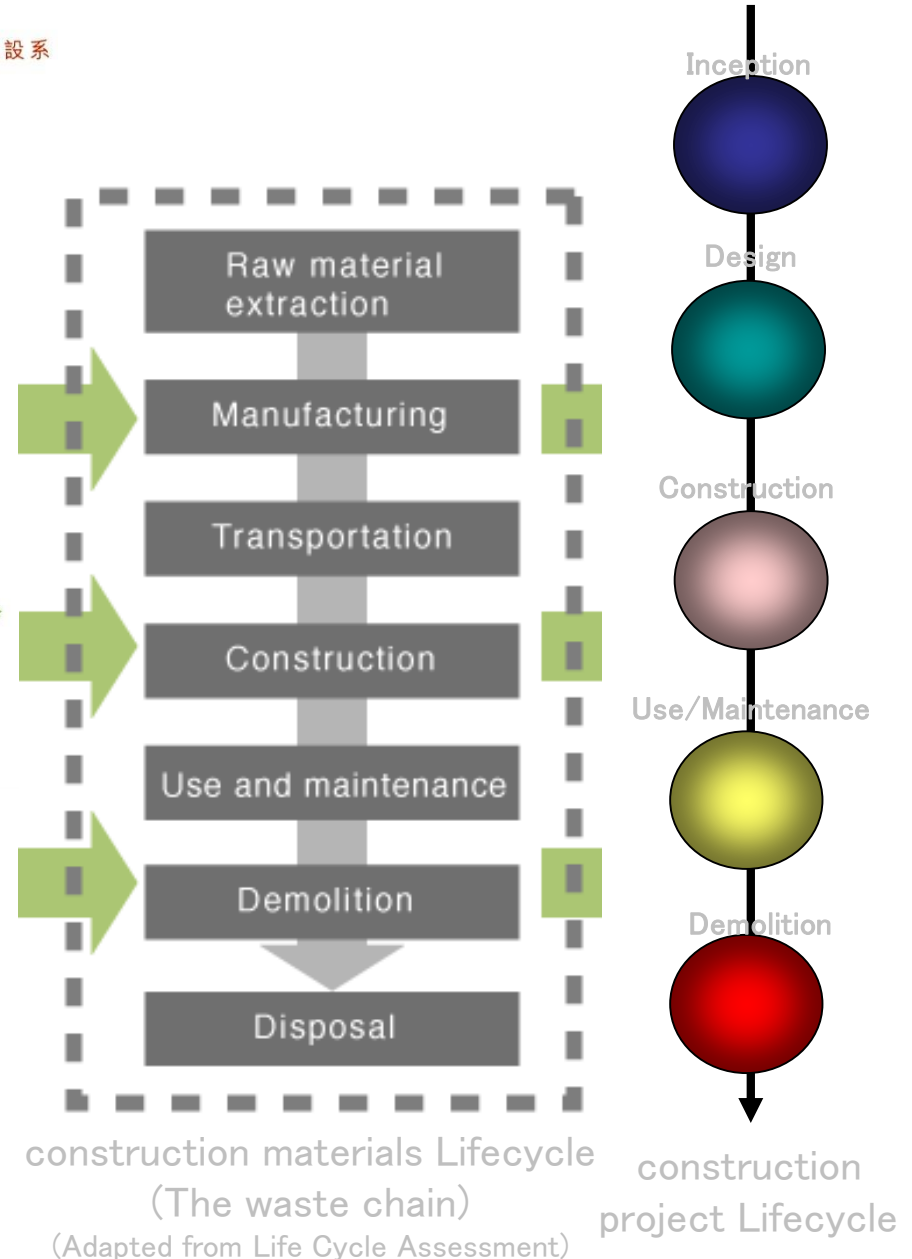
- Using prefabrication;
- Using steel structure;
- Modular design;
- Compatibility and buildability

#### Costs:

- Higher cost;
- Less flexibility

#### Benefits:

- Construction waste reduction
- Better onsite







## Managing C&D waste throughout the waste chain

### (3) Using low waste construction technologies

#### Solutions:

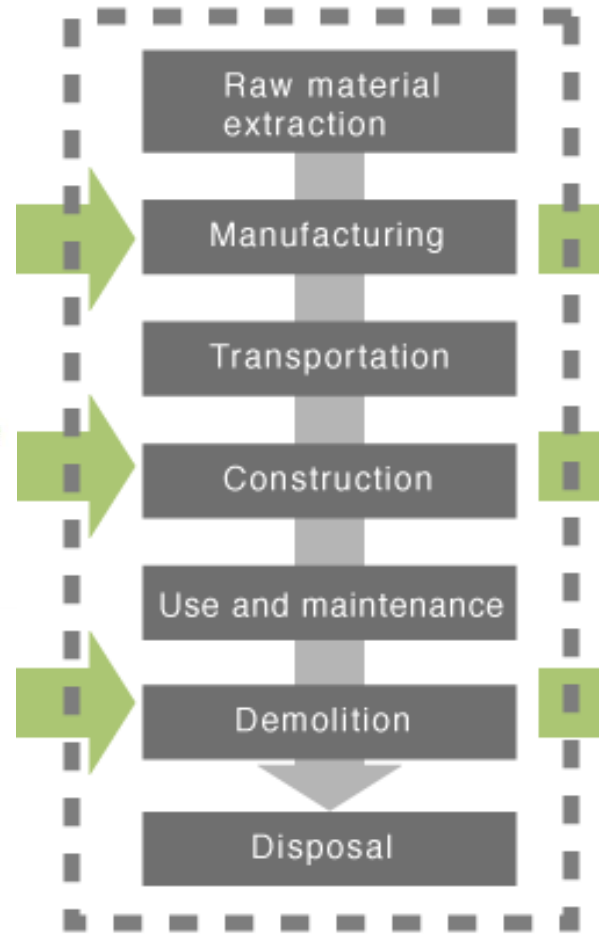
Replacing wood formwork and falsework with metal ones;  
Better housekeeping;

#### Costs:

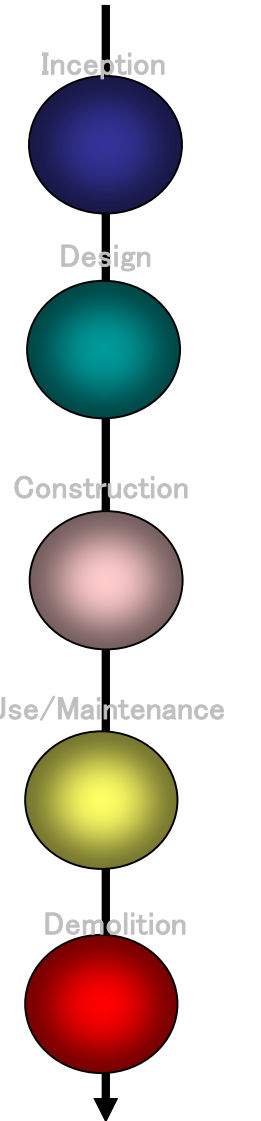
Higher (initial) cost;

#### Benefits:

- Construction waste reduction
- Health and safety improved
- Better onsite
- .....



construction materials Lifecycle  
(The waste chain)  
(Adapted from Life Cycle Assessment)



construction project Lifecycle



## Managing C&D waste throughout the waste chain

### (4) Waste sorting based on the “inert/non-inert dichotomy”

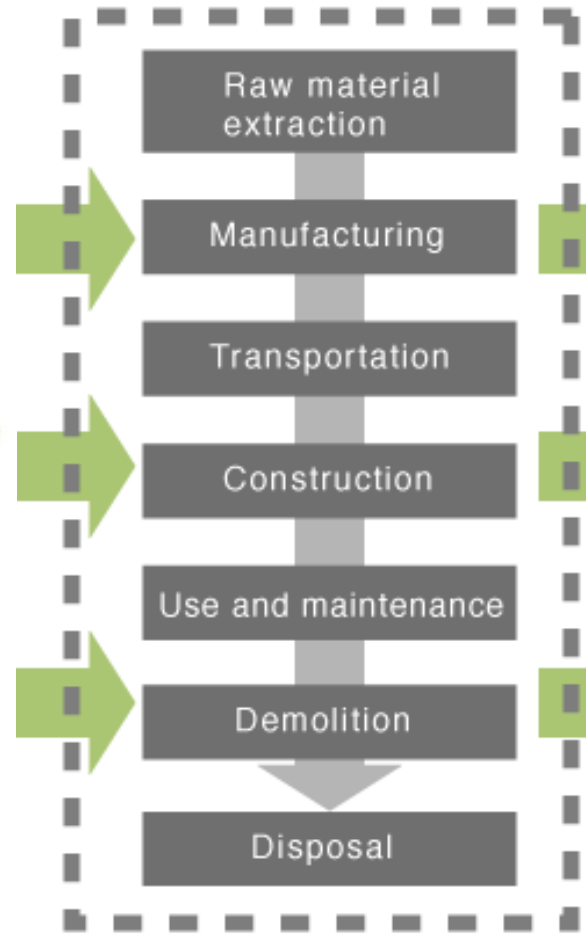
In Hong Kong SAR of China, C&D waste is categorized into inert and non-inert portions;

The inert materials, comprising mainly sand, bricks and concrete, is deposited at public filling areas for land reclamation;

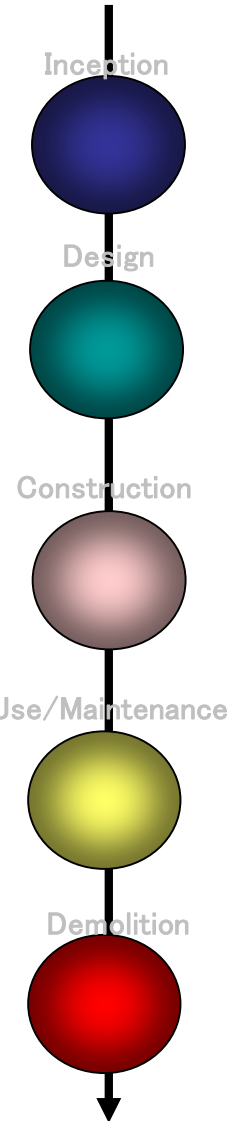


The non-inert portion, consisting of materials such as bamboo, plastics, glass, wood, paper, vegetation and other organic materials, is disposed of at landfills as solid waste; and

C&D waste is usually a mixture of both inert and non-inert materials and therefore segregation of the two types of waste is of paramount importance.



construction materials Lifecycle  
(The waste chain)  
(Adapted from Life Cycle Assessment)



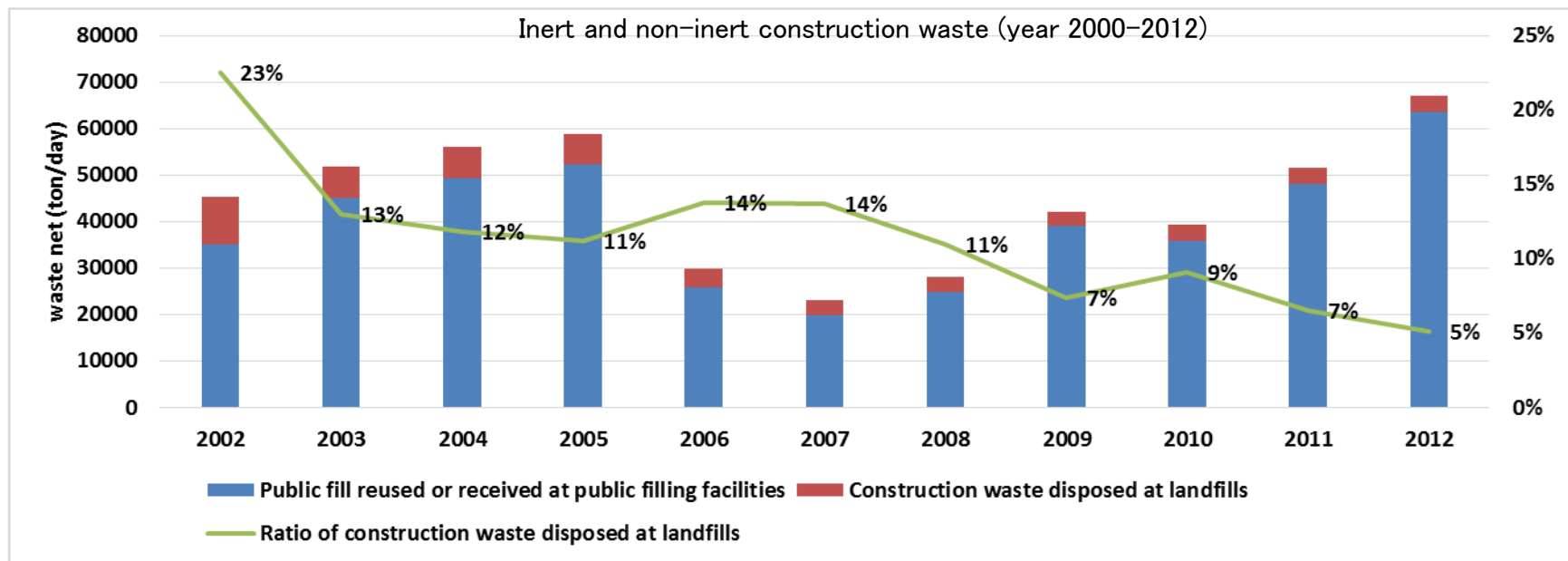
construction project Lifecycle





## An inert and non-inert dichotomy

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
(Inert) C&D waste at PFRF (tpd)	35183	44982	49398	52211	25759	19945	24918	39063	35781	48164	63538
(Non-inert) C&D waste at landfills (tpd) <sup>2</sup>	10202	6728	6595	6556	4125	3158	3092	3121	3584	3331	3440
Total C&D waste at various facilities (tpd)	45385	51710	55993	58767	29884	23103	28010	42184	39365	51495	66978
Proportion of inert C&D waste (%)	77.5	87.0	88.2	88.8	86.2	86.3	89.0	92.6	90.9	93.5	94.9
Proportion of non-inert C&D waste (%)	22.5	13.0	11.8	11.2	13.8	13.7	11.0	7.4	9.1	6.5	5.1
Total (%)	100	100	100	100	100	100	100	100	100	100	100



An iceberg floating in the ocean, with a large portion submerged below the surface, illustrating the concept of hidden waste. The sky is dark and cloudy, and the water is a deep blue. The iceberg's tip is jagged and white, while the submerged part is much larger and darker blue.

Organic/non-inert C&D waste ended in  
landfills – just the tip of the iceberg!





**Tuen Mun Fill Bank**



**TSO Fill Bank**



**Mui Wo PFRF**



Examples of Public Fill Reception Facilities (PFRFs)  
Source: CEDD





**Tuen Mun Construction Waste Sorting Facility**



**Tseung Kwan O Construction Waste Sorting Facility**



Examples of the Offsite Sorting Facilities (OSF) at Tseung Kwan O Area 137 and Tuen Mun Area 38  
Source: CEDD





Examples of the Offsite Sorting  
Facilities (OSF) at Tseung Kwan O  
Area 137 and Tuen Mun Area 38  
Source: CEDD





Examples of Landfills

Source: HKEPD

**North East New Territories Landfill (NENT)**



**West New Territories Landfill (WENT)**



**South East New Territories Landfill (SENT)**

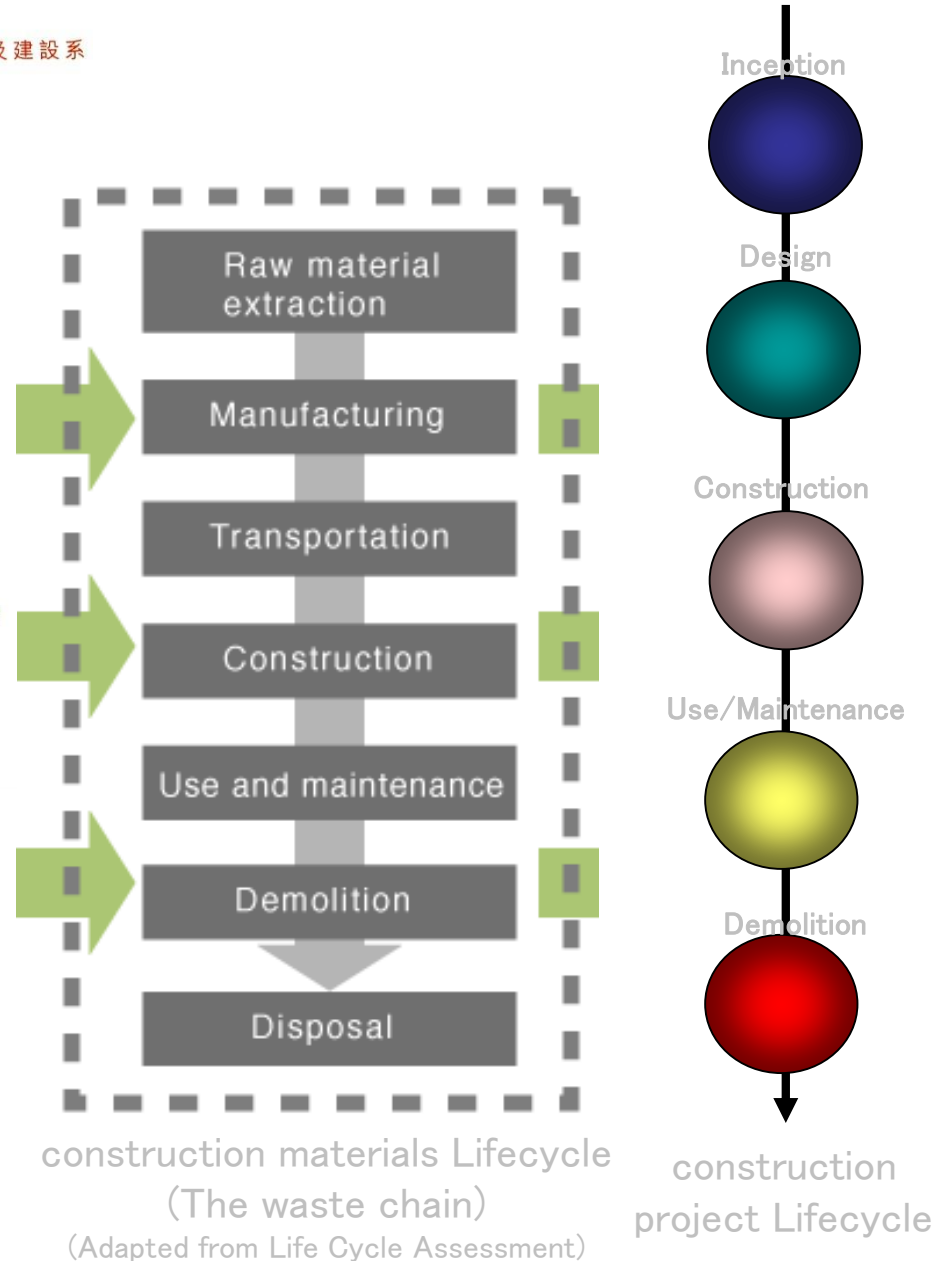






# Managing C&D waste throughout the waste chain

## (5) Reusing/recycling waste



HK Zero carbon building



Eco-blocks/Road pavement



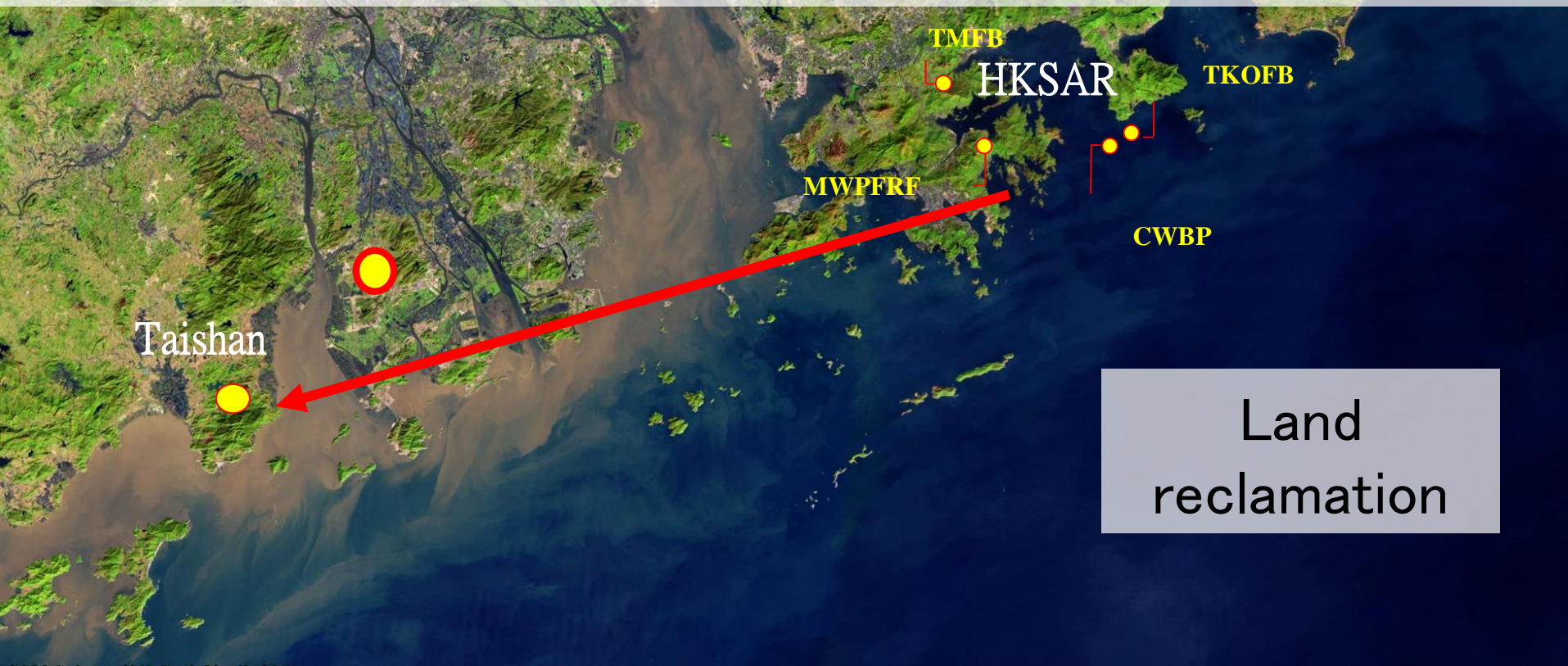
Aggregates





“The surplus public fill materials were transported to Taishan for reclamation, producing more than 500 hectares of reclaimed land there between 2007 and 2013” (Chan, 4-May-2014, my blog).

The recycling industry says its been blocked from selling processed imported waste to the mainland, since PR China tightened regulations (Wong, 2013, SCMP).

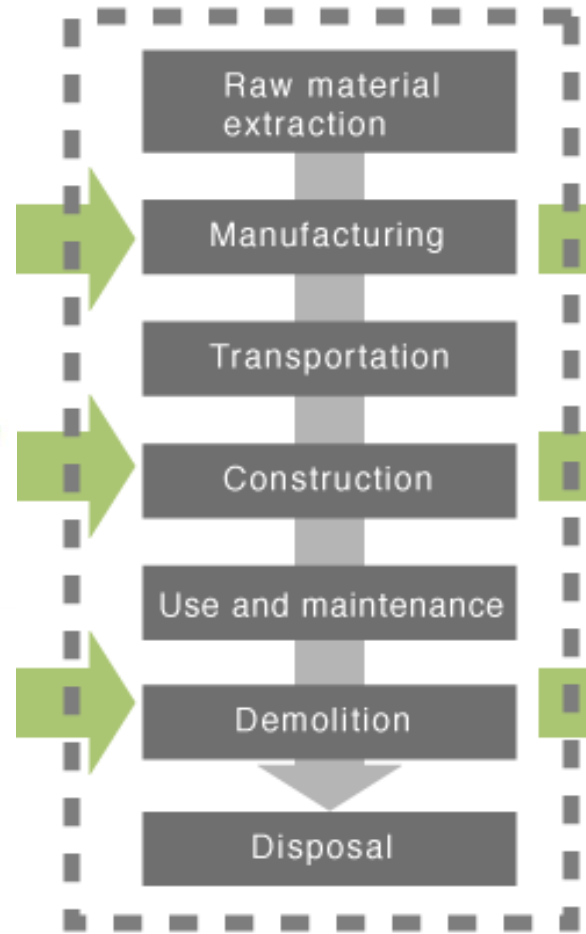




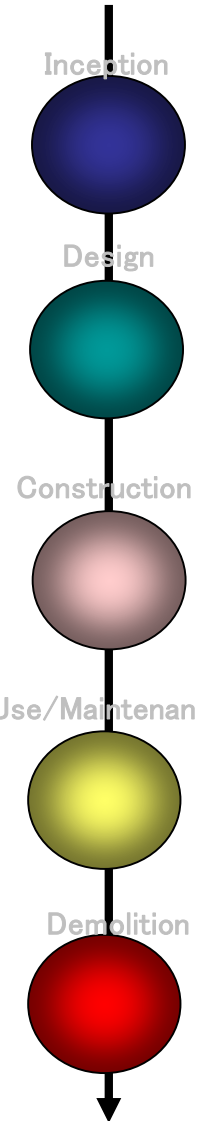


## Managing C&D waste throughout the waste chain

(6) Landfill charging as an incentive/levy



construction materials Lifecycle  
(The waste chain)  
(Adapted from Life Cycle Assessment)



construction project Lifecycle



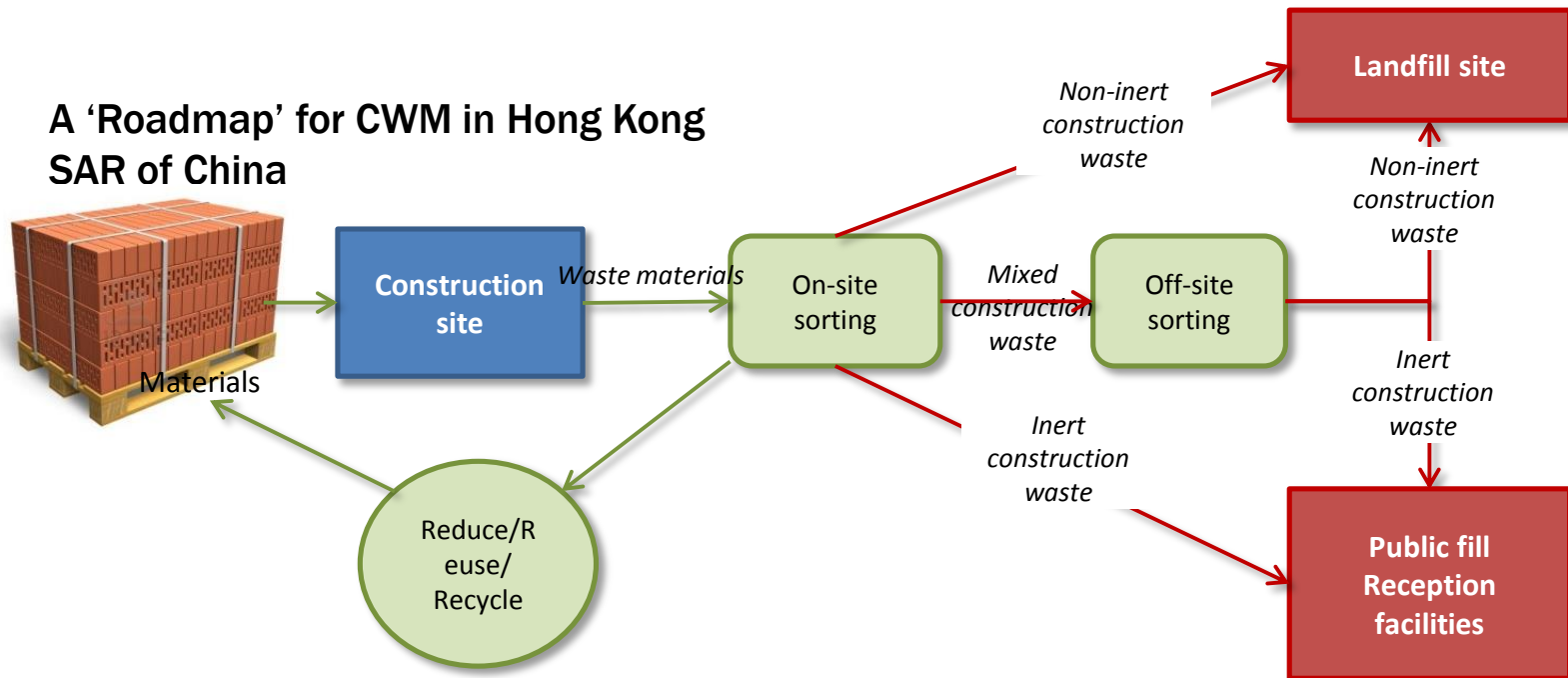
## The CWDCS – Polluter pays principle

Starting from 1 December 2005, main contractor who undertakes construction work under a contract with value of \$1 million or above is required to open a billing account solely for the contract.

For construction work under a contract with value less than \$1 million, any person can open a billing account; the account can also be used for contracts each with value less than \$1 million.

Government waste disposal facilities (Please see location map)	Type of construction waste accepted	Charge per tonne <sup>#</sup>
Public fill reception facilities	Consisting entirely of inert construction waste <sup>++</sup>	\$27
Sorting facilities	Containing more than 50% by weight of inert construction waste <sup>++</sup>	\$100
Landfills <sup>@</sup>	Containing not more than 50% by weight of inert construction waste <sup>++</sup>	\$125
Outlying Islands Transfer Facilities <sup>@</sup>	Containing any percentage of inert construction waste <sup>++</sup>	\$125

## A 'Roadmap' for CWM in Hong Kong SAR of China





## Managing C&D waste throughout the waste chain

### (7) Developing a really sustainable circular economy

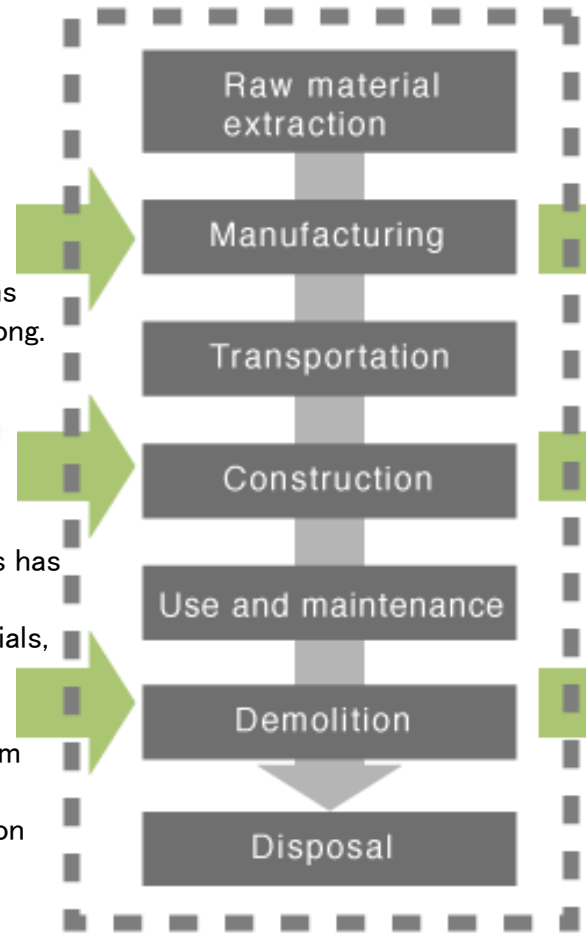
The C&DWM system is increasingly encountering problems with the changing socio-economic background in Hong Kong.

Owing to growing resistance, land reclamation projects have been rare.

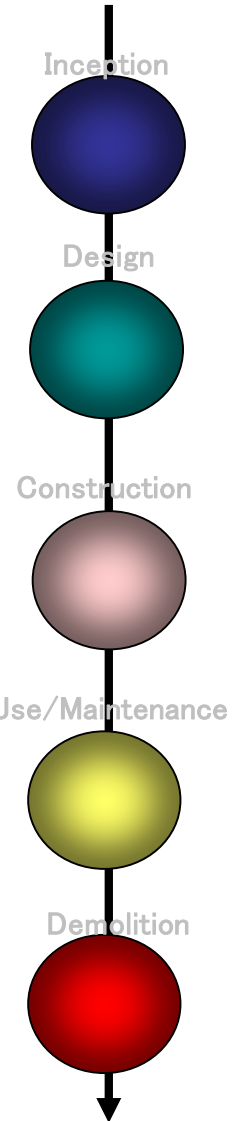
Inert materials were placed in PFRF for later use, but this has yet to be realized. The EcoPark (Chinese: 環保園), an industrial park used for recovering and recycling of materials, can only “consume” very limited inert materials.

The Government is currently using the inert materials from PFRF to produce G200 rocks for public works projects. However, up to the end of April 2013, only about 0.9 million tons of G200 rocks had been produced from the inert materials.

Users are hesitating to fully embrace recycled materials.



construction materials Lifecycle  
(The waste chain)  
(Adapted from Life Cycle Assessment)



construction project Lifecycle





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“The sky is the limit”



Photo from the Internet



## Summary and “food for thought”

- The waste chain is a useful tool for C&D waste cost/benefit analysis (CBA) and turning waste to value;
- 3R as an Economic Industry needs to have a genuine economic foundation on the ground, i.e. costs will be offset by its benefits;
- When will be the tipping point for  $\text{benefits} > \text{costs}$ ?
- The sky is the limit for C&D waste management. The question is “how can we work together to get there?”







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United Nations Centre for Regional Development (UNCRD)

for providing the sharing platform!

Photo from the Internet