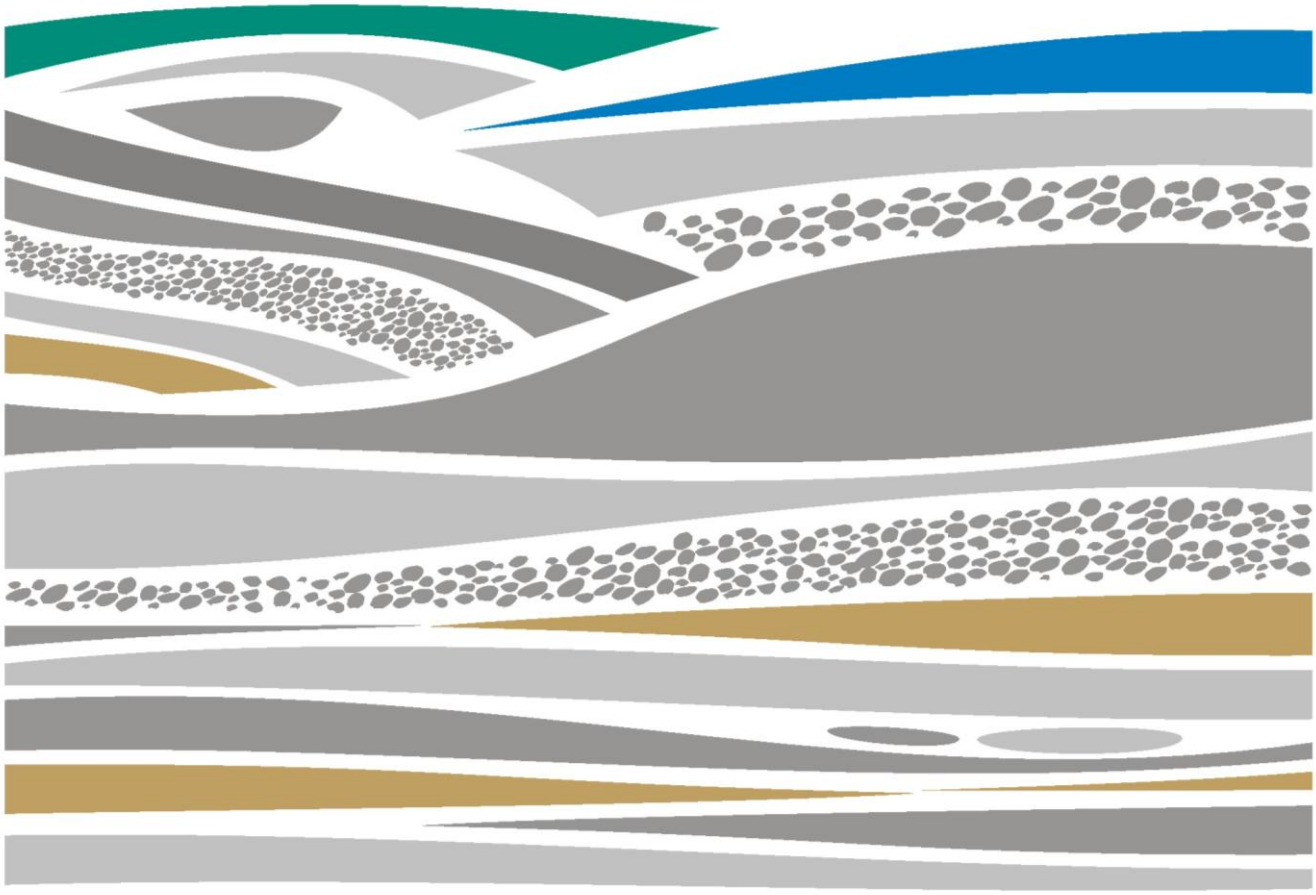
Proposed Official Plan Bedrock Mineral Aggregate Resource Designations

How the recommended mapping of bedrock mineral aggregate resources in Ottawa was prepared for the 2013 Official Plan Review and a review of alternative designation mapping that was considered.



2013

We encourage comments on this document. Please communicate your comments to:

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Introduction

Lands designated for mineral aggregate extractions in the long term are illustrated on Schedule A and B of the Official Plan. The function of this designation as stated in the Official Plan is to "Protect non-renewable mineral aggregate resources, located close to markets, for future use" and "Minimize community and environmental disruptions from aggregate extraction activities".

The City of Ottawa is relatively rich compared to many Ontario municipalities in bedrock mineral aggregate resources. In particular the city has pronounced deposits of bedrock for crushed stone manufacture of aggregate products such that there is already many decades of potential supply for the City. In contrast sand and gravel resources in the City are scarcer. In particular the City seems to have a scarcity of sands suitable for concrete manufacture.

From time to time the former Region and now the City have studied the geological resources of the city with the goal of updating the designations so that they reflect an up to date knowledge of the landscape and also land uses in the rural area. The preparation of the mapping for the Official Plan in 2013 has closely followed the process and method that was completed in the 1995 Ottawa-Carleton Mineral Aggregate Resource Study. Where ever possible the most accurate spatial information has been used.

The subject of this report is bedrock sources for mineral aggregate. Bedrock is composed of layers of rock formed over millions of years. It is not to be confused with surficial sand and gravels which were deposited in glacial times and are found atop bedrock in many areas of the city. They are a different but no less important source of aggregate materials. No sand and gravel resource areas have been recommended for addition at this time. An explanation as to why no additional sand and gravel resources have been recommended is provided in Appendix A.

The goal of this report is to document the various steps and decisions in the analysis that have led to the recommended mapping of additional bedrock areas in the Official Plan Review of 2013.

Background: the 1979 and 1995 Ottawa-Carleton Mineral Aggregate Studies

Mineral aggregate resources have been the subject of two previous studies by the former Region of Ottawa-Carleton. The first study was completed in 1979 and the second in 1995. Each study resulted in the municipality having a better knowledge of resources and issues surrounding aggregate location, quality and supply. Nevertheless mineral aggregate studies need to be updated from time to time as developments, the market place and science change.

When completing the current study staff preparing maps for consideration revisited the past studies and, where possible, followed the methods used in previous studies. The following subsections describe the previous studies and how they were completed.

The 1979 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton

Although over 30 years old and produced at a time before computing was widespread, the 1979 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton assessment is notable for bringing together a remarkable amount of information regarding quality, quantity and geological background to the study. The key components of the 1979 study were resource maps and resource calculations for each municipality. Information was separated into quaternary (glacial and post glacial) sand and gravel deposits and bedrock resources.

Bedrock Resources and Recommendations in the 1979 Study

The 1979 report described that the Region has a substantial bedrock resource (as much as 58 billion tonnes) that can be processed into crushed stone or other products. Much of the bedrock however, was noted as not available or "sterilized" because of restrictions such as existing development, environmental impact and other constraints that limited the ability of the area to be mined. To help identify lands to be protected for future extraction the 1979 report prepared mapping of selected bedrock resources. The mapping took into consideration a number of factors including:

- quality of bedrock;
- depth of overburden or drift thickness of 1.5 metres (5 feet);
- land area requirements;
- market demand;
- social and environmental impact of extraction and distribution activities and;
- provision for quarries in close proximity to the future urban area (transportation factors).

The Region of Ottawa – Carleton ultimately included bedrock resource mapping in it's Official Plan along with policies to protect from potential sterilization of resources so that mineral aggregate would be available in the long term.

The 1995 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton

The 1995 Ottawa-Carleton Mineral aggregate resource study consisted of a major report commissioned by the Region. The report was prepared by MacNaughton Hermsen Britton Clarkson Planning Limited (MHBC) in association with Gorrell Resource Investigations, A. J. Robinson and Associates and Smith Consultants. Gorrell was the firm that prepared geological mapping.

The Gorrell report on geology updated previous mapping and classified the various deposits and formations in the Region. Formations in the region were classed as either usable or not useable and resources were assigned a degree of usability. Of the many formations, six were identified as having aggregate potential and these were divided into five classes based on their suitability for the production of aggregate products such as asphalt and concrete. The following table reiterates the useable formations and classes from the report.

Table 2.2.2.1a Useable Bedrock Classes

Class	Bedrock Type	Notes
1	Oxford	The Oxford is generally considered the most usable of the bedrock formations in Ottawa. Crushed stone from the Oxford Formation can be used in all types of aggregate products including concrete and asphalt.
1b	March	The March is a sandy dolostone formation of somewhat unique characteristics – it contains a high degree of silicate sand. Because of this sandy component the March Formation can be used to create asphalts which are uniquely suited for skid resistant pavement such as 400 series highways. This specialty use has elevated the importance of the March formation. The March can also be used in products similar to the Oxford formation.
2	Gull River	The Gull River can be used for crushed stone and asphalt products. There are some chemical limitations to the formation which may limit it's use in concrete. This formation is mined throughout Ottawa.
3	Bobcaygeon	Bobcaygeon can be used for crushed stone and asphalt products. There are some chemical limitations to the formation which may limit its use in concrete. This formation is mined throughout Ottawa.
4	Lindsay	Due to quality limitations the Lindsay has only potential for use as crushed stone and it is not used for concrete.
5	Verulam	Due to quality limitations the Verulam has only potential for use as crushed stone and it is not used for concrete.

The conclusion of Gorrell was that only the Oxford, March, Gull River, Bobcaygeon and Lindsay formations should receive further consideration for protection for future use. The report also defined a general figure for consideration of overburden depth for future use of 1.5 metres. What this meant is that if a resource was greater than 1.5 metres below surface it was not generally included in the proposed resource mapping.

Using the mapping prepared by Gorrell the 1995 team completed an evaluation to determine recommended bedrock resource mapping for the Official Plan. The study used evaluation criteria to screen out areas of potential constraint, incompatibility, inadequate quality or size and other factors. Two levels of screening criteria were defined.

The first level criteria identified lands to be excluded prior to further review. This was prepared by GIS analysis and consultation with agencies such as the Ministry of Natural Resources and Conservation Authorities. The following is a list of the first level criteria

- Agricultural Constraints
    - prime agricultural lands
- Proximity to Developed Area Constraints
    - existing, registered or approved development
    - existing villages and urban area
- Natural Environment Areas
    - Provincially signficant wetlands
    - Endangered Species Habitat
    - ANSI (Life Science)
    - Sars Esker ANSI
    - River Corridors
- Geological Criteria
    - Verulam Bedrock
    - Class 4 sand and gravel
    - Depth of overburden >1.5 metres
- Other Factors
    - Marginal resource areas
    - Lands already sterilized

The second level of screening in the study added additional, criteria for subsequent review. The criteria were identified in consultation with government agencies and the aggregate industry. The secondary level criteria included factors to include as well as exclude lands from proposed mapping. They included:

- *Existing Aggregate Resources Act licenses.*
- *Size of deposit area (most sand and gravel deposits of less than 25 acres and bedrock deposits of less than 50 acres were excluded).*
- *Proximity to registered and draft approved subdivisions.*
- *Relative importance of aggregate deposit.*
- *Proximity to market.*
- *Density of non-subdivision rural development (based on information provided by local municipalities which varied in availability and level of detail by municipality).*
- *Agricultural resources and soil capability (based on previously developed decision making framework.*
- *Project team, MNR staff and local knowledge of deposit areas and surrounding land use.*
- *Corrections to reflect intended First Level Assessment Criteria including removal of additional river corridor designations and*
- *Deposits under pending subdivision applications.*

Based on the evaluation criteria and the consultation a map was prepared and recommended for further review and consultation. This map was circulated to the public, the aggregate industry and agencies for input. After consultation the maps received final amendments and were recommended to be included in the Official Plan as lands to

conserve for future extraction. One of the key points described in the final planning report answered the question “how much aggregate should be designated”. The report concluded that three planning horizons (60 years) was reasonable and appropriate to use for the long term time to plan for mineral aggregate resources.

For the current mineral aggregate study it was determined that the method of analysis used in 1995, with some updates, is still relevant and should be used again. This includes the screening process.

What is a planning horizon?

A planning horizon relates to the length of time for which an Official Plan is planned for. The Ottawa Official Plan update being currently made will plan for the city through to the year 2032. Three planning horizons therefore would be to the year 2072.

The 2013 Approach to Propose Lands for Inclusion in the City Official Plan.

The preparation of recommended bedrock mineral resource designations for the Official Plan followed a similar process and method to that completed in the 1995 Mineral aggregate resource study.

In this study the City was fortunate to have the Ministry of Northern Development and Mines prepare an update of mineral aggregate resources to use as a starting point for evaluation of mineral aggregate resource areas into the Official Plan. Using this base mapping from the Province the City completed a screening process to isolate areas with the least constraints and highest potential for resource exploitation. The following subsections define what was done by both the Province and the City that results in a recommended mapping of bedrock mineral aggregate resources.

The 2013 Ottawa Aggregate Resources Inventory Paper (# 191)

In 2011 and 2012 the Ministry of Northern Development and Mines deployed geologists to prepare an Aggregate Resources Inventory Paper for the City of Ottawa. This was the first Aggregate Resources Inventory Paper for Ottawa and it was published in February 2013 (see www.bit.ly/aripottawa).

The Aggregate Resources Inventory Paper identified sand and gravel deposits and potential bedrock areas within the city. It also gave documentation on the geological history of the area and insight into the aggregate potential of various bedrock formations. The information and mapping from this Aggregate Resources Inventory Paper therefore is considered a key reference in the current study.

Screening of factors to establish recommended bedrock mineral aggregate resource areas

The mapping in the Aggregate Resources Inventory Paper represents the starting point for preparing mapping for recommended inclusion in the Official Plan. Based on the mapping various factors in a screening out process were used to determine potential resource areas for consideration.

The screening out process used is nearly identical to that used in 1995; various constraints have been overlain on the base mapping to define lands that can appropriately be added to the Official Plan schedule as mineral aggregate resource areas.

The table below provides a listing of the constraints used to screen and evaluate potential mineral aggregate resource lands from the base mapping prepared by the Ministry of Northern Development and Mines. Additional screening criteria from the approach used in 1995 are coloured orange and with an asterisk*.

Detailed Screen Factors for Bedrock Mineral Aggregate Resource Mapping							
Factor	**Constraint** * = updated from 1995						
Agricultural Lands	Prime agricultural lands						
Proximity to Developed Area	existing villages, residential clusters and urban area		existing, registered or approved development		*Wellhead protection areas		
Natural Environment Areas	Provincially Significant Wetlands (PSW)	Areas of Natural and Scientific Interest (ANSI)	River Corridors and Water Bodies	Sars Esker ANSI	Rare, Threatened or Endangered Species	*Candidate Life Science ANSI's	*Earth Science ANSIs
Geological Criteria	Verulam Bedrock	Class 3 Sand and Gravel	Gull, Bobcaygeon, Oxford and Lindsay Bedrock > 2 metres overburden as an initial criteria, with consideration of depths > 2m adjacent to existing licenses and potential locations			*March Formation > 8 metres over-burden	
Additional Factors	distance to market variables - haul route	lands already sterilized	deposit size less than 20 ha (sand and gravel)			deposit size less than 20 ha (bedrock)	

Agricultural Lands

As with the 1995 Mineral Aggregate Resource Study, this study provides for the protection and conservation of Agricultural Lands as a constraint to mineral aggregate resource definition under the Official Plan. Provincial policy requires municipalities to protect and designate prime agricultural areas in their Official Plans through a land evaluation system. Ottawa is currently updating its Land Evaluation and Area Review (LEAR) for changes to the agricultural designations.

The screening criteria used for agricultural lands are those lands identified as being part of Agricultural Resource Area designation in the Official Plan Schedule A. The currently designated Agricultural Resource Lands from the Official Plan were excluded from consideration as potential mineral aggregate resources areas in this study.

Developed Area Factors

Areas that are developed or slated to be developed through approved plans cannot be readily utilized for aggregate extraction and are considered sterilized. Through the assessment these areas have been screened out of further consideration.

Lands screened from further consideration also include lands in the defined urban area and those within any of the 26 designated village settlements in the Official Plan. Also included are draft approved, registered or approved country lot subdivisions and rural residential clusters greater than 10 Ha in size (for example the small hamlet of Edwards).

Deposits of aggregate within 500 metres of developed or developing areas were reviewed carefully. Consideration during this review was given to adjacent land uses, prevailing wind direction (westerly), elevation, servicing (municipal or private) presence of buffering vegetation and elevation. Generally, if a bedrock deposit was within 500 metres of a settlement area, rural hamlet or country lot subdivision it was not included. Individual residences and vacant lots (where a single residence may be permitted as-of-right) less than 500 metres away from a potential resource were not considered to sterilize aggregate resources.

The long term supply of clean water to municipal wells is of vital public importance and, based on the Provincial Policy Statement and the Official Plan, these lands were determined to be a screening factor to protect the long term municipal water supply. To this end, this study added a factor protecting some of the lands in Municipal Wellhead Protection Areas (WHPAs). A municipal wellhead is a defined area of surface capture that supplies water to a municipal well. Generally, the WHPA around a well is mapped as the two year, five year or 25 year capture zone around the well. In this case WHPA A and B areas which encompass up to a five year time of travel have been excluded from consideration in resource mapping.

It should be stated that a pit or quarry within a WHPA is not necessarily a significant threat to drinking water as defined by Source Protection Plans in the City. Nevertheless a pit or quarry operation in a WHPA represents an opportunity for exposure of the aquifer to potential contamination or diversion, thus representing a potential risk to drinking water quality or quantity through what is called a preferential pathway. For this reason the lands within the five year time of travel (WHPA's A and B) around each municipal well have been screened from further consideration as resource areas in the Official Plan.

Natural Environment Factors

Under provincial and City policy many kinds of natural environment features are protected from negative impacts of development. The following is a list of features that were screened from further consideration as aggregate resource areas in the proposed Official Plan mapping:

- Provincially Significant Wetlands (PSW)
- Areas of Natural and Scientific Interest (ANSI)
- Provincially Significant Earth Science ANSIs
- Candidate Life Science ANSIs
- Water bodies and River Corridors
- Natural Heritage System as defined in Schedules L of the Official Plan (excluding significant woodlands)

The screening of candidate ANSIs was included as a constraint because these lands are included in the Rural Natural Features for long term protection.

Habitat of rare, threatened and endangered species were included in the 1995 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton as a screening criterion however the factor proved to be useful in text only. Because there were no rare species habitats actually defined at the time, no area was omitted from consideration. The factor

has been carried over to this assessment however because now, under the new Species at Risk Act the habitat of these species is regulated. Nevertheless, the information available and the widespread distribution of some species such as Butternut and Bobolink mean that it is not easily possible to screen out this area. It is noted that through the rezoning and provincial licensing processes these issues would be studied and potentially protected. In the future, should rare, threatened or endangered species habitats be better defined, the City may consider refining potential resource mapping.

Based on the methodology employed in the 1995 study water bodies and river corridors were used as a screening factor. It should be noted however that the designation of river corridor is not to be confused with the floodplain of a watercourse. Historically, floodplains have been used for extraction. Nevertheless given associated constraints of natural heritage, fish habitat, water diversion, water discharge and other factors intrinsic to river corridors they were excluded from the consideration in the mapping of resource areas.

Adjacent lands to natural heritage constraints were determined to be a reasonable consideration during the rezoning process in accordance with the PPS and the Natural Heritage Reference Manual to establish a new pit or quarry so these lands were not screened from the potential resource mapping.

Geological Factors

Not all bedrock and surface deposits are suitable for aggregates. There are for instance six different bedrock formations that are used for aggregate within the City. The best quality bedrock is the Oxford Formation. The least quality bedrock is called the Verulam formation. Consistent with the screening done in 1995 Verulam deposits have been screened out of resource mapping.

Depth of Overburden, Working Depth and Bedrock Supply

Depth of overburden can be a limiting factor in development of aggregate resources. The depth of overburden that is feasible to remove is related to the relative availability of the underlying resource and the value of the product in the market place. Sufficient resource areas of aggregate resources were identified in the 1995 review based on a 1.5 m of overburden with a design/supply horizon of 60 years. The Province's 2013 Aggregate Resources Inventory Paper based the resource potential for areas with up to eight metres of overburden; a depth broadly used elsewhere in the province where perhaps resources are more constrained or less abundant.

In this study depth of overburden has also been used as an initial factor for the Gull, Bobcaygeon, Oxford and Lindsay bedrock formations. As in earlier studies, areas with limited overburden were identified (less than two metres). However, adjacent areas with up to 8.0 m, of overburden were considered in addition to the areas of shallow overburden, recognizing that depth of overburden is less of a limitation when an operation is established in an area. The specialty aggregate formation, the March has been included for extraction at a depth of up to eight metres due to its limited availability near the surface. In summary then, this study selected for lands where at least part of the area has less then 2 metres of overburden and mapped lands nearby up to 8 metres.

A special note on depth of overburden

Previous studies used a maximum depth of overburden for excluding bedrock from consideration for resource mapping of 1.5 metres. The figure of 1.5 metres comes from historic imperial mapping that showed depth at 10 foot intervals – 1.5 metres is roughly 5 feet. The figure of 5 feet or 1.5 metres in previous studies therefore is an extrapolation of the 10 foot intervals in historic mapping. The current mapping estimates use rounded metric values. The value of 2 metres was chosen because this is closest to 1.5 metres (5 feet) and would require the least extrapolation of mapping intervals to derive. The estimates of depth of overburden used are developed by Ontario Geological Survey and the Geological Survey of Canada and were compared against other available information.

Consideration of areas with less than two metres of overburden identifies a very large area of 8,500 ha of land with an associated resource estimate ranging from 2,875 to 4,730 million tonnes. The depth or level of overburden then yields as still substantial supply for the city of greater than 150 years (which is 7.5 design horizons based on a 20 year Official Plan). Such an estimate confirms that there is no need then to extend generally beyond the two metre depth of overburden in identifying resource areas in the Official Plan.

It is important to note however, that once a quarry is established adjacent bedrock deposits having an overburden of greater than two metres becomes more attractive economically for exploitation. This is particularly the case when a quarry is being used up and an extension can be sought on adjacent lands. Therefore the criteria have been refined in these instances to include areas with overburden cover greater than two metres and up to 8.0 m areas where it is adjacent to a deposit greater than 20 Ha with less than 2.0 m overburden.

Additional Factors

Aside from the factors in previous subsections, the 1995 Mineral Aggregate Resource Study also included other considerations. These were used to fine-tune the mapping after the consideration of other primary screening factors. First used was the criteria of deposit size. Afterward other factors were used. In the consideration of distance to market and haul route criteria these factors were used in a complex way to qualitatively define key resource areas in the recommended mapping alternative.

Size

The size of an operation is a key consideration in determining supply availability. The 1995 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton proposed 10 ha as the minimum resource area for a sand or gravel deposit and 20 ha for a bedrock deposit. These area factors are considered to be still relevant and have been used in this review.

Distance to Market

Distance to market is a factor that, on its own, was not used to limit individual deposits from consideration. It is recognized however that the cost of aggregates rises substantially with each additional kilometre of travel and, assuming labour and extraction costs are essentially the same from operation to operation the more distant a deposit is from the central area of Ottawa, the more expensive this resource will be. The 1995 Aggregate Assessment of the Regional Municipality of Ottawa – Carleton noted a shift in demand to outside the Greenbelt; this demand may be shifting back to some extent due to intensification including

condos and other taller buildings but by and large the more distant the resource the less likely it is to be used in the trade area.

Nevertheless the impact of distance to market is difficult to quantify. For this reason potential aggregate resource areas in Ottawa have not been excluded solely on the basis of distance from market. Rather, distance to market was used as an additional qualifier in conjunction with other factors.

Haul Route Factors

Related to factor of distance to are haul route considerations. Since 1995 issues have arisen elsewhere in Ontario dealing with the haul routes to new pits and quarries. Historically rural roads have carried very little traffic, had few residential properties, were unpaved and had essentially no cycling or foot traffic. Over the last 25 years the nature of the rural area has changed. There are many more rural residential properties as a result of severances and country lot subdivisions and the vast majority of rural roads are paved. Pedestrian and cycling traffic is much more common. The increase in use of the roads has led to conflict because a pit or quarry can generate substantial traffic of very large, heavy trucks where previously there was none or very few. This causes concern with safety of rural residents especially near villages and hamlets where cyclists and pedestrians are relatively common but road shoulders are not present.

The introduction of a quarry haul route can also result in a substantial increase in noise impacts on sensitive uses. In some instances trucks will queue and idle on the roadside near a quarry before it opens and this can give rise to noise and air quality concerns. More heavy trucks also mean that paved roads must be maintained more often and to a relatively high standard to accommodate the weight of these vehicles. It makes sense then to try to concentrate resource extraction to areas where haul routes direct to the market are the shortest, have a full road profile (with level paved or gravel shoulders), are designated truck routes and have fewer potential conflicts with developed or developing areas.

Where improvements to existing roads are needed to enable their use as a haul route, processes under the Environmental Assessment Act such as the Class Environmental Assessment for Provincial Transportation Facilities or the Municipal Class Environmental Assessment and/or development agreements under the *Planning Act* to cover the implementation of improvements may be required.

Complex Factors Considered

In addition to the above descriptions there has been consideration of complex or multiple factors used in further consideration of bedrock resource lands to propose for mapping.

Proximity to market, resource type and haul route were used as a complex factor to screen out lands for consideration in resource mapping. For instance, a resource that is somewhat distant to the urban market, of lesser quality (i.e. Bobcaygeon or Gull River) and would require transport through developed neighbourhoods or an upgrade of a road to a rural truck route may not be advantageous to include in mapping at this time. As a result of this complex factor some areas were left out from further consideration in mapping. In summary, complex factors were used to fine-tune the mapping of bedrock resource areas.

Special Cases

Greenbelt Resources

The first special case deals with aggregate resources in the Greenbelt. While the 1995 study took the approach to include these resources, this study has not. The reason for this is that the lands are not regulated by the City or the Province. The National Capital Commission does have its own plan for the greenbelt (currently under review) and the Airport Land Authority has their own long term plan as well. These plans may well include aggregate extraction but it is not realistic to suggest that the City should rely on these resources for aggregate when the lands are in federal management and ownership.

Overlapping Resources

The second special case deals with overlapping resources. In very few cases a sand and gravel resource may exist as overburden to a bedrock resource. When the sand and gravel resource is extracted the opportunity exists then to continue operations on the bedrock formations. To take advantage of this situation overlapping resources have been included in the mapping where they are known to exist.

Estimates of Potential Supply by the Ministry of Northern Development and Mines

Estimates of the total potential supply are found in the Province's 2013 Aggregate Resources Inventory of the City of Ottawa. The Aggregate Resources Inventory Paper report provides a gross estimate that the supply of bedrock in the city is 36 billion tonnes. Following a linear trend of increasing aggregate consumption Ottawa would have more than 700 years of potential aggregate supply based on the Aggregate Resources Inventory Paper. Such a vast supply and the area that it covers is quite unrealistic for protection under the Official Plan because it would preclude productive and desirable use of very large areas of countryside for hundreds of years. It is necessary then to define the ideal resources for protection based on established factors as has been completed in this study.

The ARIP also provides an estimated working depth for each formation which has been used to calculate potential supply. City staff has developed alternative estimates based on more information. These alternative estimates more closely reflect of actual depth of various deposits and current operations and were prepared in discussion with the Ministry of Northern Development and Mines. For clarity both the ARIP and City working depths are shown in estimates in the subsections below.

Supply and Reserve Estimates from Recommended, Considered and Existing Bedrock Resource Areas

There are five bedrock formations of importance to Ottawa and adjacent markets. The most important resource is the Oxford formation, with the crushed aggregate being of value for granular and concrete products. The depth of the Oxford Formation can be up to 100 m and is found across the southern portion of Ottawa. The assumed working depth for this analysis was 25 m based on a review of bedrock geology and discussions with the Ministry of Northern Development and Mines. With the importance of this formation greater depths of overburden could be considered. The Oxford formation is under laid by the March formation.

Outcroppings of the March formation are found in areas of western Ottawa. The March formation is also found underlying surface deposits including sand and gravel and is relatively accessible when underlying shallow layers of the Oxford formation. A portion of the aggregates from the March formation meets the specification for a specific premier price market of skid resistant asphalt. Due to the characteristics of the formation there is a high wear factor on quarry equipment. Depths of the March formation are estimated up to 20 m. The assumed working depth for this analysis was 12m.

The Bobcaygeon and Gull River Formations are used for similar aggregate products, largely granular, with limited use for concrete. Found in north western and western Ottawa, the Bobcaygeon overlies the Gull River Formation with depth of the respective formations ranging up to 75 and 50 m. The assumed working depth for this analysis for both formations were 25 m.

The Lindsey formation is found in eastern Ottawa, with outcroppings in the larger matrix of sand and clay plains. They are of local significance for use in granular products, but are not appropriate for concrete products. Estimates of the depth of the Lindsay formation are in the order of 25 m. The assumed working depth for this analysis was 15 m.

From the above, it is recommended that areas with accessible Oxford formation should be protected with greater priority. The following table provides a description of each formation and its general order of priority in mapping of resources.

Table a Summary of Bedrock Formations by Order of Interest

Formation	Products	Underlying formation	Maximum Depth (m)	Depth of Overburden (m)	Assumed Working Depth (ARIP, Ottawa) (m)	Location
Oxford	Granulars and concrete	March	100+	2,3	15,25	Across southern extents
March	Skid resistant asphalt	Nepean	20	8	12,12	west – localized
Bobcaygeon	Granular, limited supply suitable for concrete	Gull River	70+	2,3	15,25	west and north west
Gull River	Granular, limited supply for suitable for concrete	Shadow Lake	70+	2,3	15,25	west and north west
Lindsey	Local supply granular	Verulam	30+	2,3	15,15	eastern - localized

Review and Proposal of Bedrock Areas for Potential Designation

Based on current trends and assuming 80% of the aggregate supply continues to be supplied from bedrock sources the estimated required supply for 100 and 200 year planning horizons is 1,360 and 3,640 million tonnes respectively.

Reviewing licensed sites as well as active and undeveloped areas, the estimated remaining licensed resource is 861 million tonnes. Resource potential in the designated bedrock resource area but still unlicensed is estimated between 600 and 947 million tonnes. The potential bedrock resources in both licensed and designated-unlicensed area is estimated between 1,461 and 1,808 million tonnes.

Alternatives for Proposed Mapping of Bedrock Resources

The abundant supply of bedrock resources means that the City can contemplate a range of options under the Official Plan for realistically meeting the requirements of the Provincial Policy Statement for protection of mineral aggregate resources for the long term. Based on the mapping analysis three alternatives were considered.

Alternative 1 – Maintain the Existing Mapping with No Changes

The 1995 mineral aggregate study proposed that the City ensure that sufficient lands be designated in the Official Plan to meet a target of three planning horizons (60 years). The target was considered reasonable and realistic so it is interesting that many years later the estimated supply of bedrock in designated and licensed bedrock resource areas still widely exceeds this proposed target.

Alternative 1 recognizes that the City already has sufficient resources designated in its plan to meet three planning horizons. This alternative is considered valid however there is concern that over the next 15 to 20 years some potentially important future resource areas that will be close to market and are of excellent quality may be sterilized if not designated

now. As a result, it was recommended that, where possible, additional areas in the plan be added.

The table below gives a summary of the bedrock resources available in alternative 1.

Designated and or Licensed Bedrock Resources – Map 2

Source	**Gross Area** (Ha)	**Working Area** (Ha)	**Potential Resource** (million tonnes)	
			Estimate 1 (ARIP #191)	Estimate 2 (assumed working depth)
Designated - Unlicensed	1,784	1,516	600	947
Licensed - Estimated Remaining	1,540	1,309	861	861
Totals	3,324	2,825	1,461	1,808
Estimated Years of Supply			105	123

Alternative 2 – Addition of All Relatively Unconstrained Bedrock Resource Areas in the Official Plan

The spatial analysis has yielded a map showing the mostly unconstrained bedrock resource areas within the city. If brought forward it is estimated that this supply is adequate to meet demand for more than 300 or 400 years. Map 3 (Alternative 2) illustrates the potential area that could be designated based on this scenario.

Alternative 2 has not been proposed to be used in the Official Plan because the alternative would sterilize a very large spatial area in the rural countryside. In addition, the potential supply is so great (more than 15 planning horizons – 300 years) that it is not considered at all to be realistic or reasonable.

The table below gives a summary of the bedrock resources available in alternative 2.

Designated, Licensed, and Unconstrained Resources – Map 3

Source	**Gross Area** (Ha)	**Working Area** (Ha)	**Potential Resource** (million tonnes)	
			Estimate 1 (ARIP #191)	Estimate 2 (assumed working depth)
Designated – Unlicensed	1,784	1,516	600	947
Licensed - Estimated Remaining	1,540	1,309	861	861
Added by Alternative 2	19,914	16,927	6,704	10,888
Totals	23,238	19,752	8,165	12,696
Estimated Years Supply			335	400+

Recommended Alternative 3 – Addition of Selected Resources

The substantial quality of mapping and resource quality estimates in the Aggregate Resources Inventory Paper, combined with the abundant supply of bedrock resources allows the City to choose selected additional areas for bedrock resource mapping.

Alternative 3 has been recommended because it provides an opportunity to make additions to the bedrock resource area in the city that are relatively unconstrained and still available. The alternative selects the resources of the high estimated quality, within substantial parcel areas, that are relatively unconstrained, easily accessible to truck routes and close to the market. The alternative if applied without modification is estimated to add approximately 60 to 90 years (three to more than four planning horizons) of potential supply to the already adequate bedrock supply in the City. The addition of some or all of these considered desirable because it provides an opportunity to replace some of the resources that have been exhausted in the past and gives the opportunity to protect some good, relatively unconstrained, resource areas to service the city and other markets in the long term.

Because the bedrock supply in the city is already much greater than the goal of three planning horizons (60 years) it is recommended that the City present the option of designation rather than apply the designation above potential objections of landowners. It is understood that a mineral aggregate designation and zoning on a property is a potentially significant encumbrance to future land uses. For this reason some landowners and neighbours may object to the designation of their lands from General Rural to Bedrock Resources Area. Others however may consider the designation a positive opportunity. Where there is an objection by a landowner affected properties will not be added to the Official Plan but consideration could be made in future aggregate reviews to include these lands.

The table below gives a summary of the bedrock resources available in alternative 3.

Designated, Licensed and Selected Resource Additions – Map 4

Source	**Gross Area** (Ha)	**Working Area** (Ha)	**Potential Resource** (million tonnes)	
			Estimate 1 (ARIP #191)	Estimate 2 (assumed working depth)
Designated - Unlicensed	1,784	1,516	600	947
Licensed - Estimated Remaining	1,540	1,309	861	861
Added by Alternative 3	3,482	2,960	1,170	1,901
Totals	6,806	5,785	2,631	3,710
Estimated Years Supply			166	211

Appendix A: Sand and Gravel Resources

The total estimated current potential sand and gravel resources supply in the city is 193 million tonnes. This volume includes lands currently licensed or designated for sand and gravel resources but does not include resources below the estimated water table. 193 million tonnes represents approximately a 64 year supply based on current consumption rates . Given the goal of establishing a reasonable supply of aggregate resources at about three planning horizons (60 years) there is therefore no pressing need to designate additional sand and gravel resources at this time. Although an adequate supply of sand and gravel resources exists the Province's study identified other sand and gravel resource locations. As discussed below, staff recommends that the City not add additional locations of sand and gravel resources at this time as there could be significant impacts on the hydrologic and ecological function of adjacent streams.

Sand and gravel deposits may play an important role in maintaining quantity and temperature of water in the streams. Once sand and gravel is removed this function is lost and streams may become warmer with less base flow. The result is a less healthy aquatic system, less resistant to impact and less able to support fish and other wildlife. The city estimates that 70% of the primary and secondary sand and gravel resources are currently designated and only 30% remains undesignated, (not including the resources extracted to date). If we consider the total resources historically extracted and currently designated there is actually comparatively little of the original accessible supply of sand and gravel left undesignated or un-extracted in the city, perhaps less than 10%.