Real Estate Sales Analysis (2001-2022)

Objective: This notebook analyzes real estate sales data from 2001 to 2022, including data cleaning, exploratory data analysis (EDA), and predictive modeling.

In [9]:
```
# Import necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [11]:
```
# Load dataset
file_path = r"C:\Users\fc\Downloads\Projects\Real_Estate_Sales_2001-2022_GL.csv"
data = pd.read_csv(file_path,low_memory=False )
```

In [12]:
```
data.head()
```

Out[12]:

	Serial Number	List Year	Date Recorded	Town	Address	Assessed Value	Sale Amount	Sales Ratio	Property Type	Resid
0	220008	2022	01/30/2023	Andover	618 ROUTE 6	139020.0	232000.0	0.5992	Residential	
1	2020348	2020	09/13/2021	Ansonia	230 WAKELEE AVE	150500.0	325000.0	0.4630	Commercial	
2	20002	2020	10/02/2020	Ashford	390 TURNPIKE RD	253000.0	430000.0	0.5883	Residential	
3	210317	2021	07/05/2022	Avon	53 COTSWOLD WAY	329730.0	805000.0	0.4096	Residential	
4	200212	2020	03/09/2021	Avon	5 CHESTNUT DRIVE	130400.0	179900.0	0.7248	Residential	

Data Cleaning

1. Drop unnecessary columns
2. Handle missing values
3. Convert data types

In [15]:
```
data.shape
```

Out[15]:
```
(1097629, 14)
```

In [16]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1097629 entries, 0 to 1097628
Data columns (total 14 columns):
 #   Column            Non-Null Count    Dtype  
---  ------            --------------    -----  
 0   Serial Number     1097629 non-null  int64  
 1   List Year         1097629 non-null  int64  
 2   Date Recorded     1097627 non-null  object 
 3   Town              1097629 non-null  object 
 4   Address           1097578 non-null  object 
 5   Assessed Value    1097629 non-null  float64
 6   Sale Amount       1097629 non-null  float64
 7   Sales Ratio       1097629 non-null  float64
 8   Property Type     715183 non-null   object 
 9   Residential Type  699240 non-null   object 
 10  Non Use Code      313451 non-null   object 
 11  Assessor Remarks  171228 non-null   object 
 12  OPM remarks       13031 non-null    object 
 13  Location          298111 non-null   object 
dtypes: float64(3), int64(2), object(9)
memory usage: 117.2+ MB
```

In [17]:
```
data.nunique()
```

Out[17]:
```
Serial Number        96220
List Year               22
Date Recorded         6958
Town                   170
Address             771931
Assessed Value       99306
Sale Amount          61075
Sales Ratio         552974
Property Type           11
Residential Type         5
Non Use Code            74
Assessor Remarks     75286
OPM remarks           6490
Location            216556
dtype: int64
```

In [18]:
```
data_cleaned=data.drop(columns=['Non Use Code','Assessor Remarks' , 'OPM remarks',
```

In [19]:
```
data_cleaned['Date Recorded'] = pd.to_datetime(data_cleaned['Date Recorded'], error
```

In [20]:
```
data_cleaned = data_cleaned.dropna(subset=['Sale Amount', 'Assessed Value'])
```

In [21]:
```
data_cleaned['Property Type'] = data_cleaned['Property Type'].fillna('Unknown')
data_cleaned['Residential Type'] = data_cleaned['Residential Type'].fillna('Unknown
```

In [22]:
```
data_cleaned.shape
```

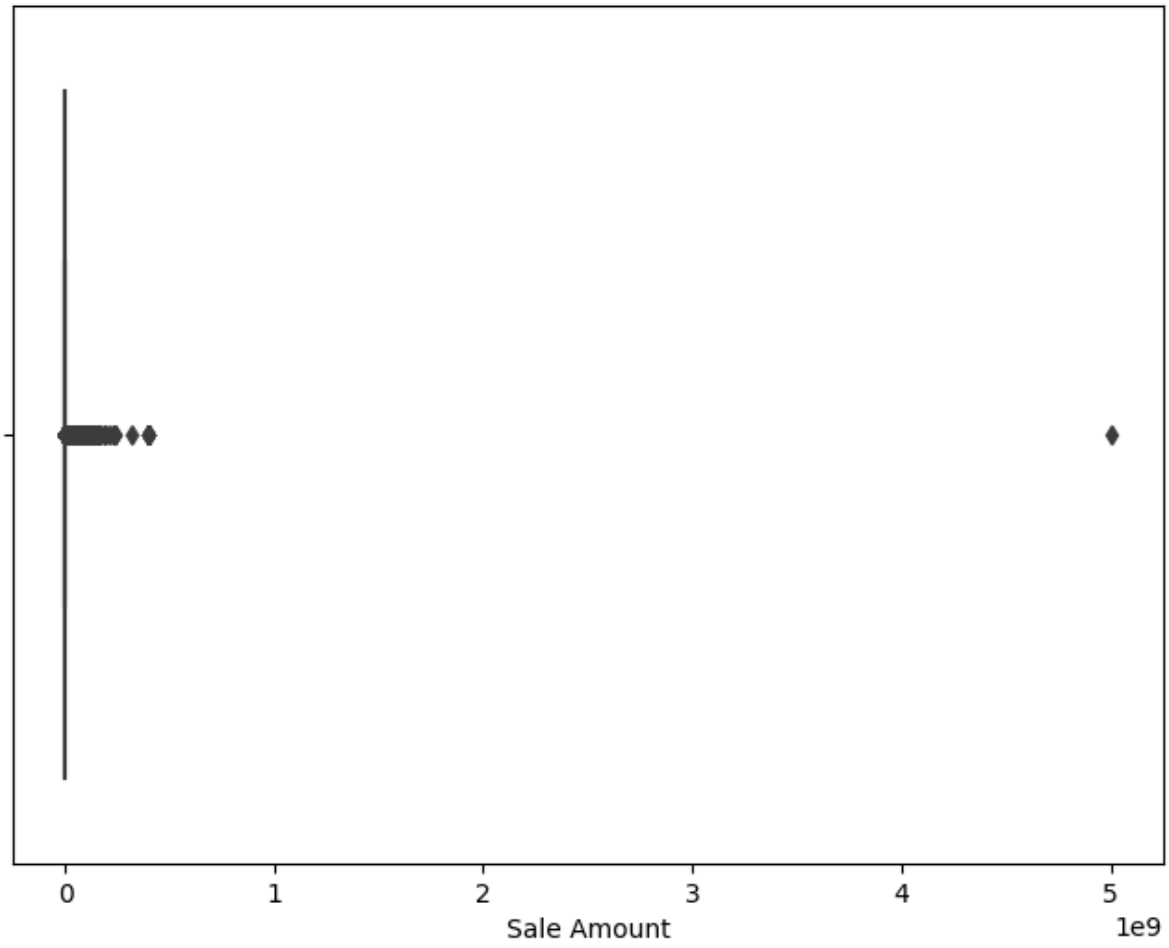
Out[22]:
```
(1097629, 10)
```

In [24]:
```
data_cleaned.isnull().sum()
```

Out[24]:
```
Serial Number        0
List Year            0
Date Recorded        2
Town                 0
Address             51
Assessed Value       0
Sale Amount          0
Sales Ratio          0
Property Type        0
Residential Type     0
dtype: int64
```

In [25]:
```
data_cleaned = data_cleaned.dropna(subset=['Date Recorded', 'Address'])
```

In [29]:
```
# Box plot for a specific column, e.g., 'Sale Amount'
plt.figure(figsize=(8, 6))
sns.boxplot(x=data_cleaned['Sale Amount'])
plt.show()
```



In [31]:
```
from IPython.display import display, HTML
# Filter rows where 'Sale Amount' is greater than 5 million
high_sales = data_cleaned[data_cleaned['Sale Amount'] > 500000000]

# Display the DataFrame in a scrollable format
display(HTML(high_sales.to_html(classes='table table-bordered table-hover table-con
```

	Serial Number	List Year	Date Recorded	Town	Address	Assessed Value	Sale Amount	Sales Ratio	Prope T
75719	20200091	2020	2021-08-19	Willington	456 TOLLAND TPKE	2238530.00	5000000000.00	0.00	Apartm

In [33]:
```
# Remove outliers from the 'Sale Amount' column
Q1 = data_cleaned['Sale Amount'].quantile(0.25)
Q3 = data_cleaned['Sale Amount'].quantile(0.75)
IQR = Q3 - Q1

lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

data_cleaned = data_cleaned[(data_cleaned['Sale Amount'] >= lower_bound) & (data_cl

data_cleaned.shape
```

Out[33]:
```
(1004209, 10)
```

In [ ]:
```

```

Exploratory Data Analysis (EDA)

1. Summary statistics
2. Visualizations (histograms, boxplots, sales trends)

In [26]:
```
# Summary statistics
print(data_cleaned.describe())
```

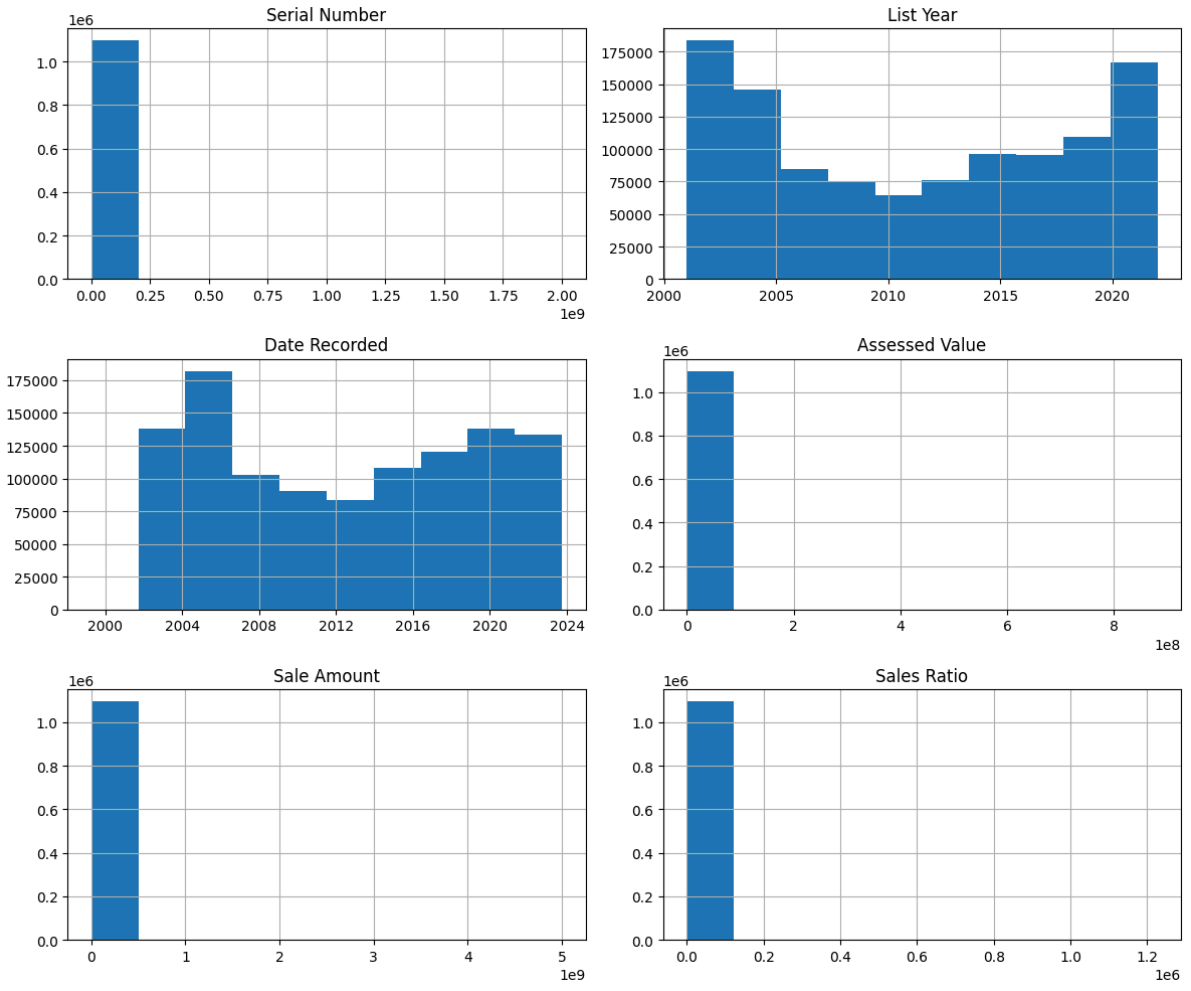
```
       Serial Number     List Year  Assessed Value   Sale Amount   Sales Ratio
count   1.097578e+06  1.097578e+06    1.097578e+06  1.097578e+06  1.097578e+06
mean    5.370584e+05  2.011219e+03    2.818110e+05  4.053209e+05  9.604324e+00
std     7.526248e+06  6.773461e+00    1.657927e+06  5.143607e+06  1.801706e+03
min     2.100000e+01  2.001000e+03    0.000000e+00  0.000000e+00  0.000000e+00
25%     3.071200e+04  2.005000e+03    8.910000e+04  1.450000e+05  4.778919e-01
50%     8.070850e+04  2.011000e+03    1.405900e+05  2.330000e+05  6.105882e-01
75%     1.703420e+05  2.018000e+03    2.282700e+05  3.750000e+05  7.707259e-01
max     2.000500e+09  2.022000e+03    8.815100e+08  5.000000e+09  1.226420e+06
```

In [27]:
```
pd.set_option('display.float_format', '{:.2f}'.format)

data_cleaned.describe()
```

Out[27]:

	Serial Number	List Year	Assessed Value	Sale Amount	Sales Ratio
count	1097578.00	1097578.00	1097578.00	1097578.00	1097578.00
mean	537058.38	2011.22	281810.97	405320.89	9.60
std	7526247.64	6.77	1657926.78	5143607.38	1801.71
min	21.00	2001.00	0.00	0.00	0.00
25%	30712.00	2005.00	89100.00	145000.00	0.48
50%	80708.50	2011.00	140590.00	233000.00	0.61
75%	170342.00	2018.00	228270.00	375000.00	0.77
max	2000500023.00	2022.00	881510000.00	5000000000.00	1226420.00

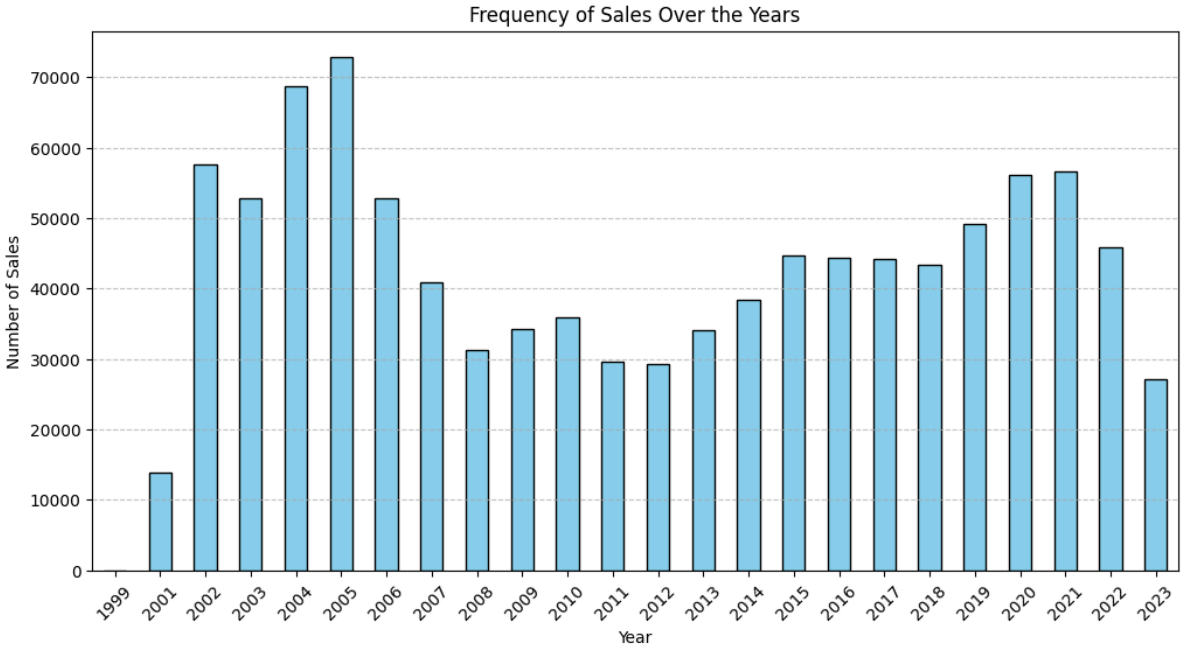
In [28]:
```
# Histogram of numerical features
data_cleaned.hist(figsize=(12, 10))
plt.tight_layout()
plt.show()
```



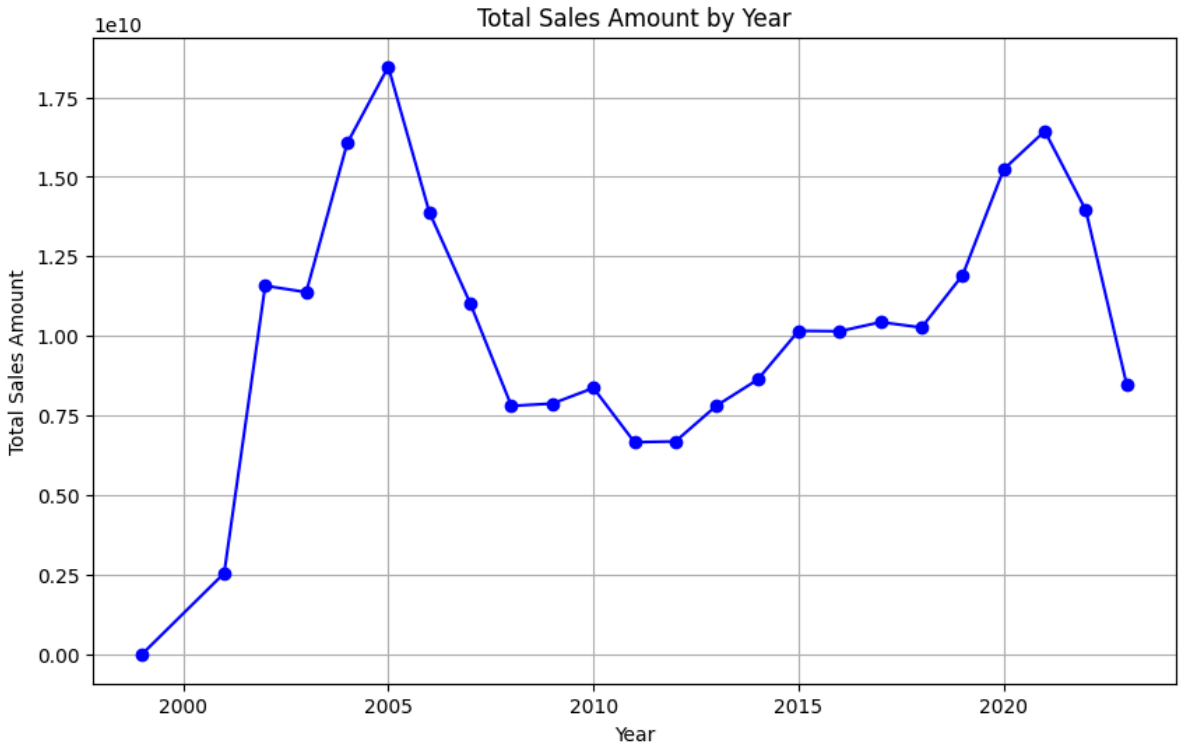
In [57]:
```
yearly_data = pd.DataFrame({
    'Frequency': data_cleaned.groupby('Year')['Serial Number'].count(),
    'SalesAmount': data_cleaned.groupby('Year')['Sale Amount'].sum()
})

correlation = yearly_data['Frequency'].corr(yearly_data['SalesAmount'])
print(f"Correlation: {correlation:.2f}")
```

```
Correlation: 0.96
```

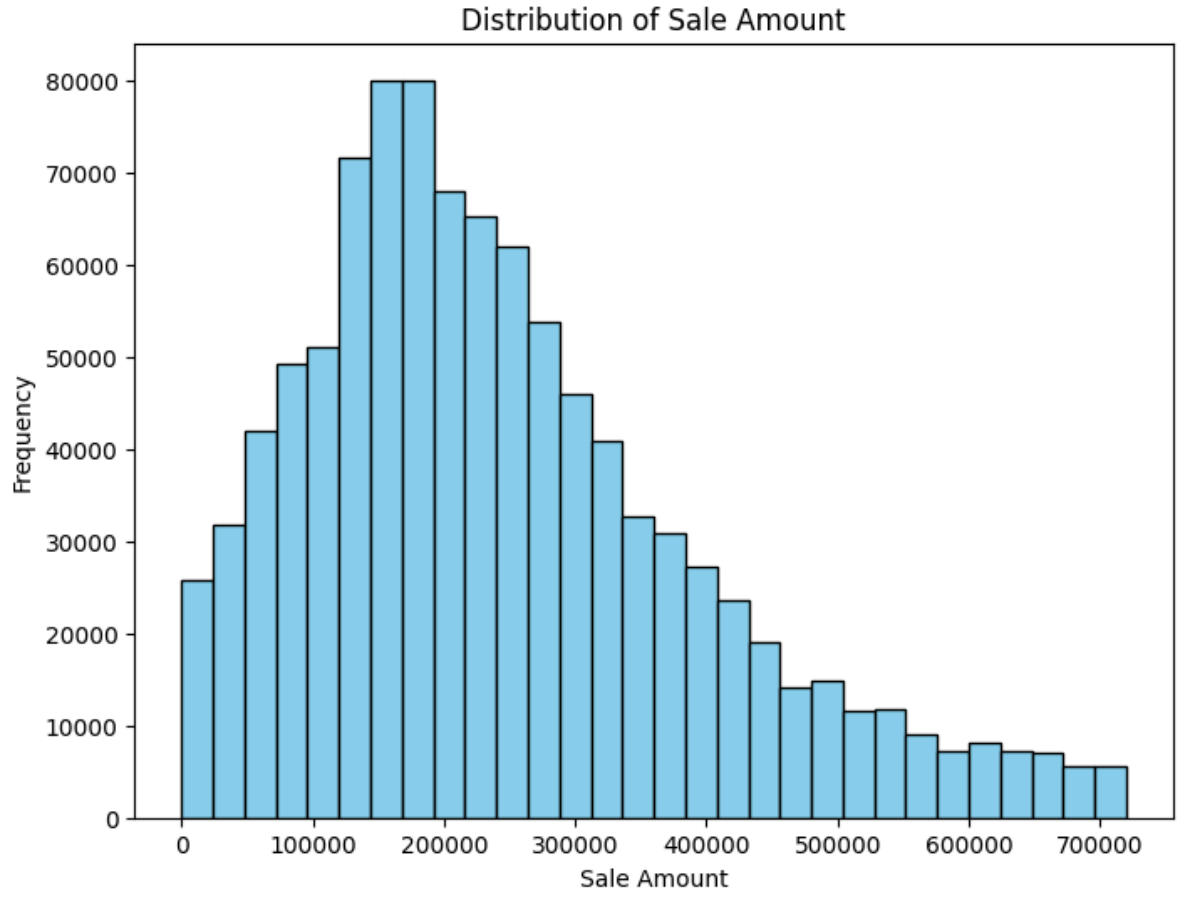
In [41]:
```
# Plot sales frequency over the years

sales_frequency = data_cleaned['Year'].value_counts().sort_index()
plt.figure(figsize=(12, 6))
sales_frequency.plot(kind='bar', color='skyblue', edgecolor='black')
plt.title('Frequency of Sales Over the Years')
plt.xlabel('Year')
plt.ylabel('Number of Sales')
plt.xticks(rotation=45)
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```



In [36]:
```
# Sales trends over years
data_cleaned['Year'] = data_cleaned['Date Recorded'].dt.year
sales_by_year = data_cleaned.groupby('Year')['Sale Amount'].sum()

plt.figure(figsize=(10, 6))
plt.plot(sales_by_year.index, sales_by_year.values, marker='o', color='blue')
plt.title('Total Sales Amount by Year')
plt.xlabel('Year')
plt.ylabel('Total Sales Amount')
plt.grid(True)
plt.show()
```

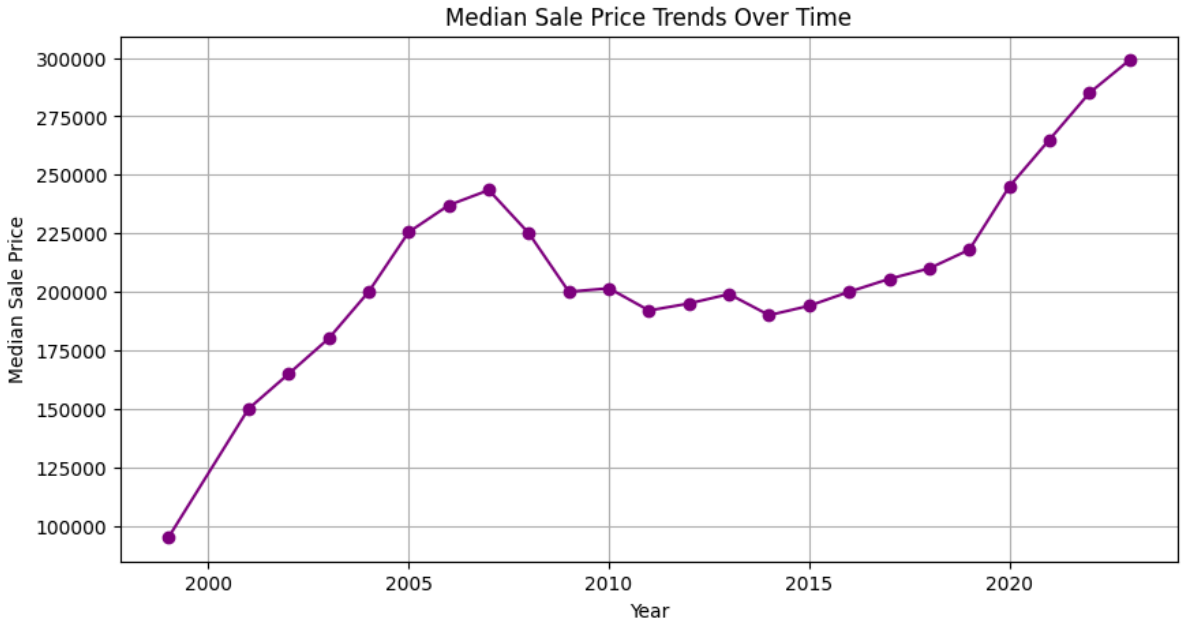


In [39]:
```
plt.figure(figsize=(8,6))
plt.hist(data_cleaned['Sale Amount'], bins=30, color='skyblue', edgecolor='black')
plt.title('Distribution of Sale Amount')
plt.xlabel('Sale Amount')
plt.ylabel('Frequency')
plt.show()
```



In [58]:
```
#  Median Sale Price Trends Analysis
median_price_by_year = data_cleaned.groupby('Year')['Sale Amount'].median()
plt.figure(figsize=(10, 5))
```

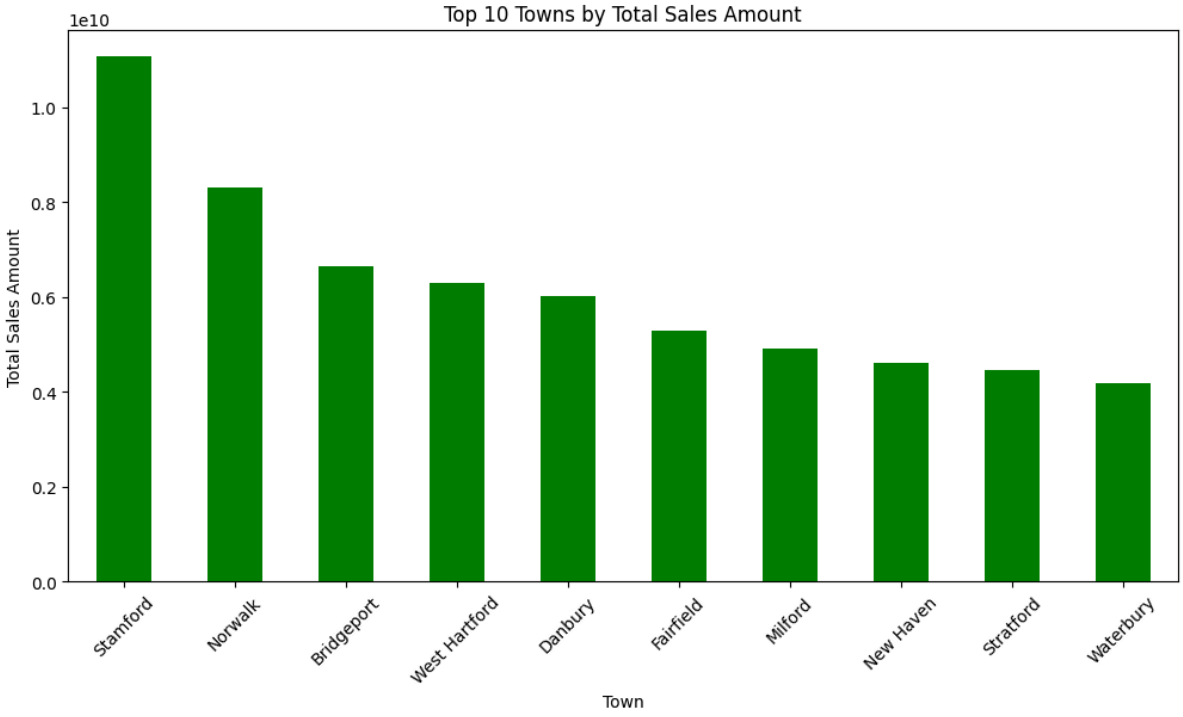
```
plt.plot(median_price_by_year.index, median_price_by_year.values, marker='o', lines
plt.xlabel('Year')
plt.ylabel('Median Sale Price')
plt.title('Median Sale Price Trends Over Time')
plt.grid(True)
plt.show()
```



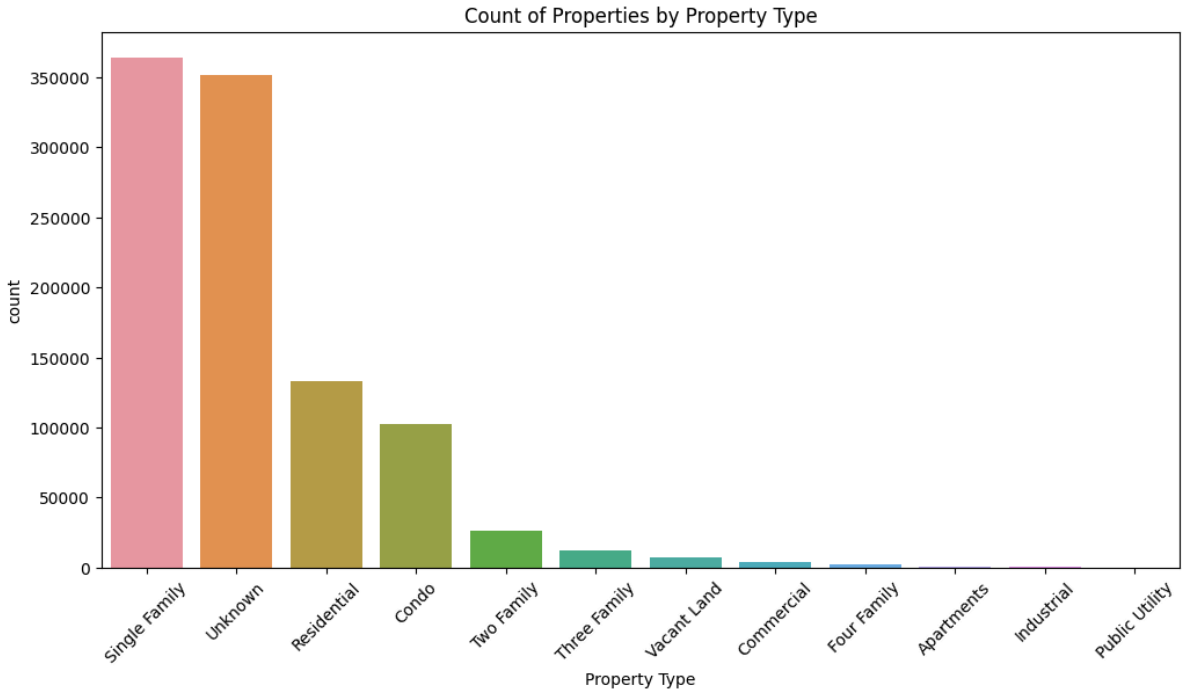
In [37]:
```
# Town-wise Sales Analysis
sales_by_town = data_cleaned.groupby('Town')['Sale Amount'].sum().sort_values(ascen
print("Town with Highest Sales:", sales_by_town.idxmax())
```

```
Town with Highest Sales: Stamford
```

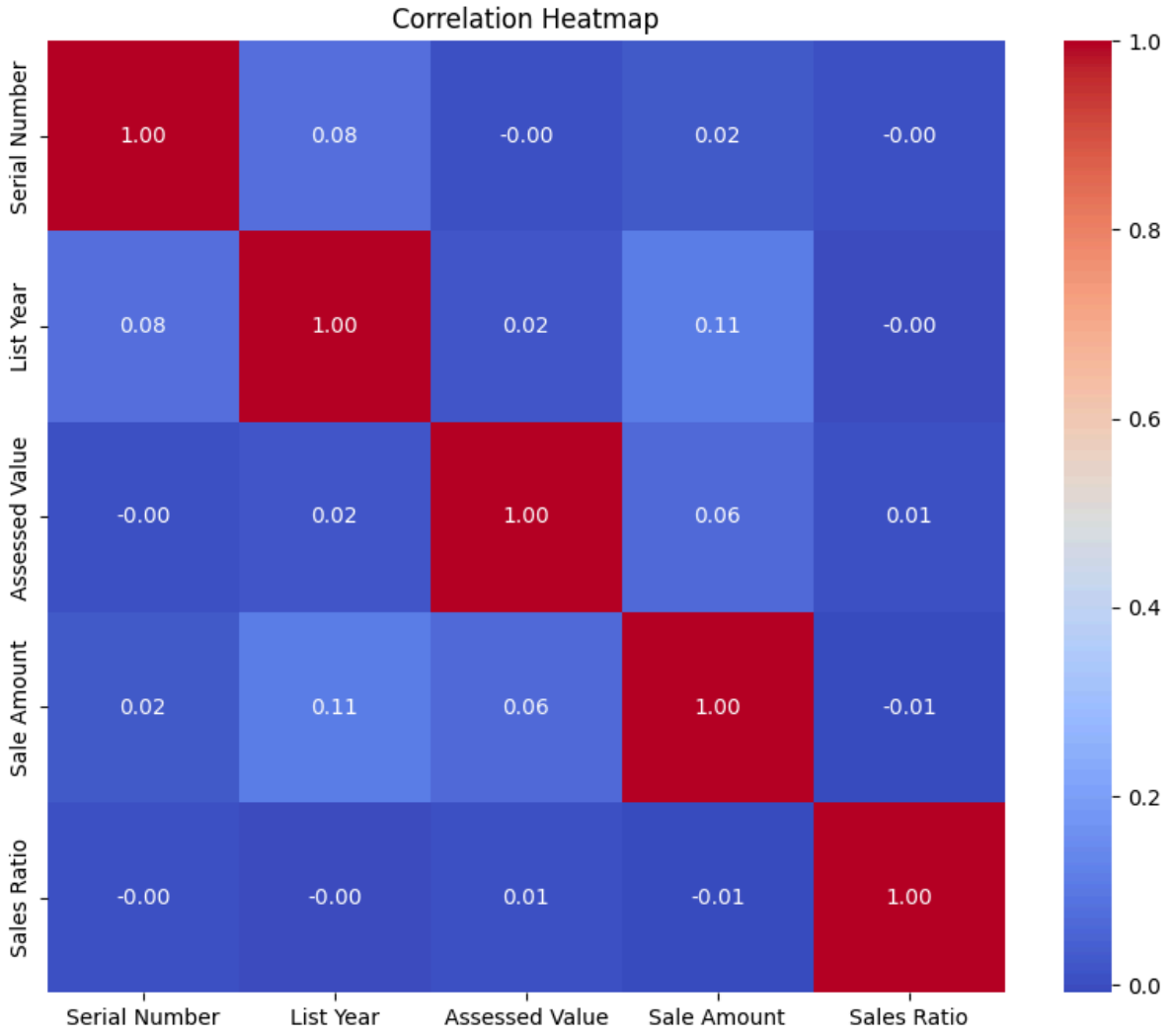
In [38]:
```
# Top 10 towns by sales
plt.figure(figsize=(12, 6))
sales_by_town[:10].plot(kind='bar', color='green')
plt.title('Top 10 Towns by Total Sales Amount')
plt.ylabel('Total Sales Amount')
plt.xlabel('Town')
plt.xticks(rotation=45)
plt.show()
```



In [42]:
```
# Count of Properties by Property Type
plt.figure(figsize=(12,6))
sns.countplot(data=data_cleaned_no_outliers,x='Property Type',order=data_cleaned_nc
plt.title('Count of Properties by Property Type')
plt.xticks(rotation=45)
plt.show()
```

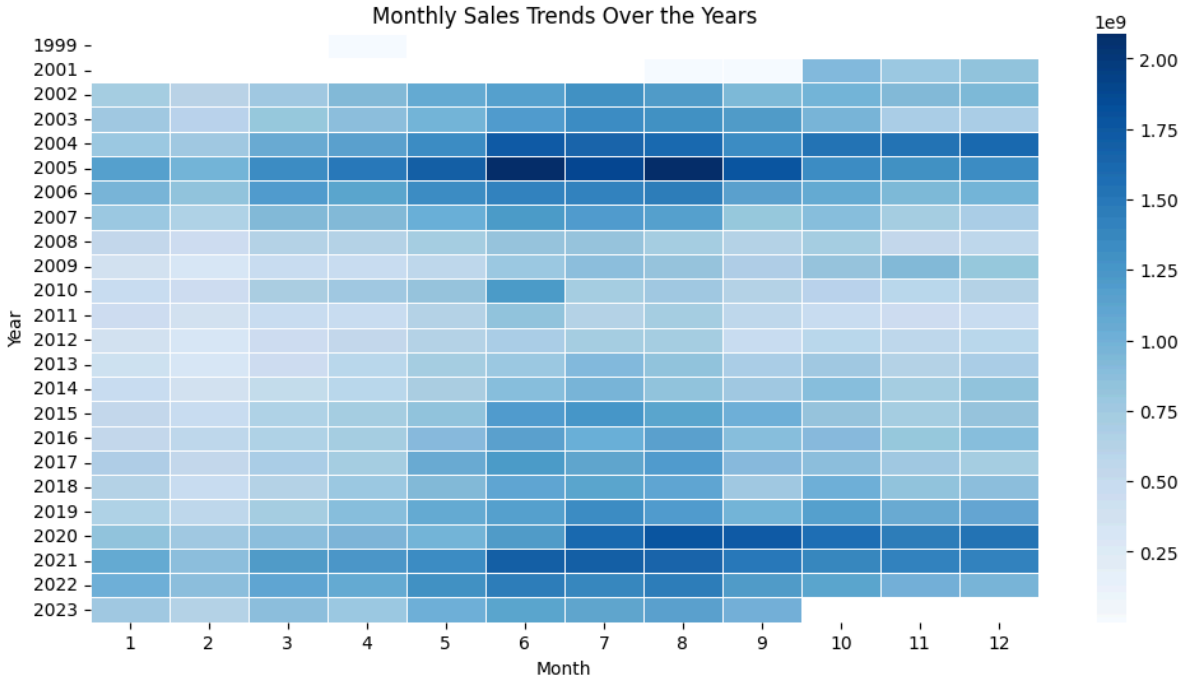


In [43]:
```
# Correlation Heatmap
plt.figure(figsize=(10,8))
correlation_matrix = data_cleaned_no_outliers.corr()
sns.heatmap(correlation_matrix, cmap='coolwarm', annot=True, fmt ='.2f')
plt.title('Correlation Heatmap')
plt.show()
```

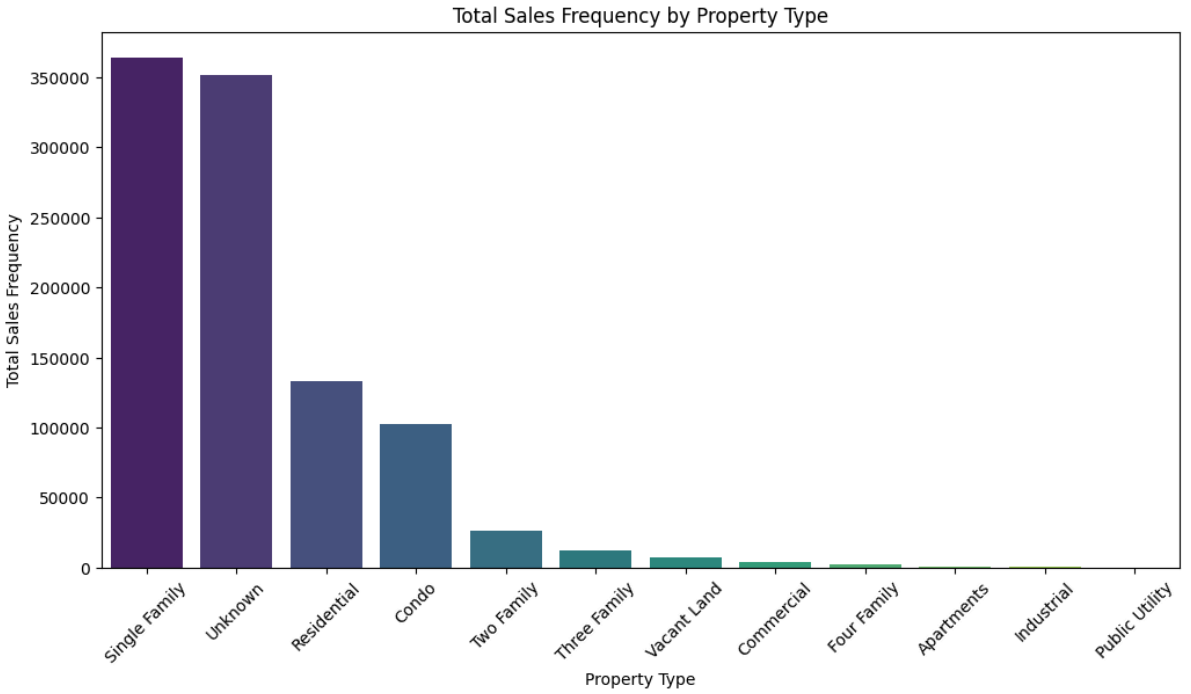


In [46]:

```
# Monthly Sales Trends Over the Years
data_cleaned['Month'] = data_cleaned['Date Recorded'].dt.month

sales_trends = data_cleaned.groupby(['Year', 'Month'])['Sale Amount'].sum().unstack

plt.figure(figsize=(12, 6))
sns.heatmap(sales_trends, cmap='Blues', annot=False, cbar=True, linewidths=0.5)
plt.title('Monthly Sales Trends Over the Years')
plt.xlabel('Month')
plt.ylabel('Year')
plt.show()
```

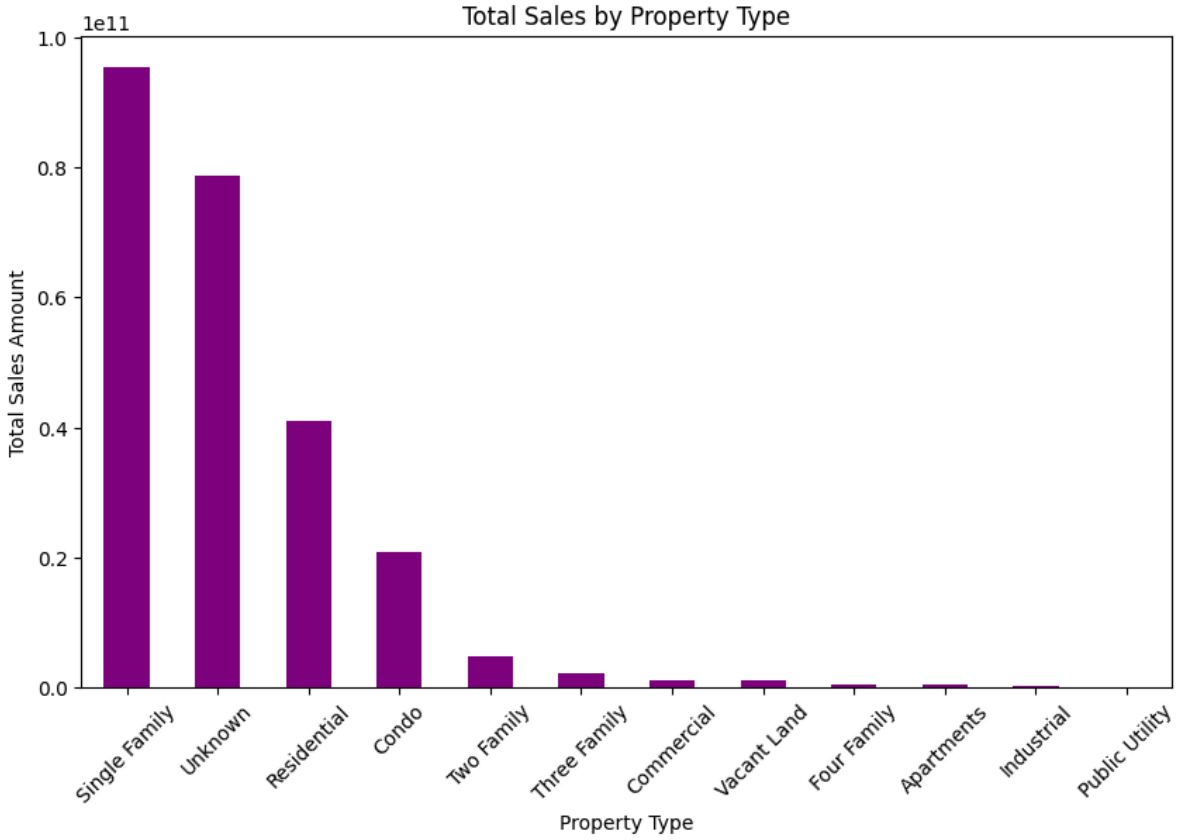


In [51]:
```
# Total sales frequency by property type
sales_freq_by_property = data_cleaned['Property Type'].value_counts()
plt.figure(figsize=(12, 6))
sns.barplot(x=sales_freq_by_property.index, y=sales_freq_by_property.values, palett
plt.xlabel('Property Type')
plt.ylabel('Total Sales Frequency')
plt.title('Total Sales Frequency by Property Type')
plt.xticks(rotation=45)
plt.show()
```



In [50]:
```
# Total sales by property type
sales_by_property_type = data_cleaned.groupby('Property Type')['Sale Amount'].sum()

plt.figure(figsize=(10, 6))
sales_by_property_type.plot(kind='bar', color='purple')
plt.title('Total Sales by Property Type')
plt.ylabel('Total Sales Amount')
plt.xlabel('Property Type')
```

```
plt.xticks(rotation=45)
plt.show()
```

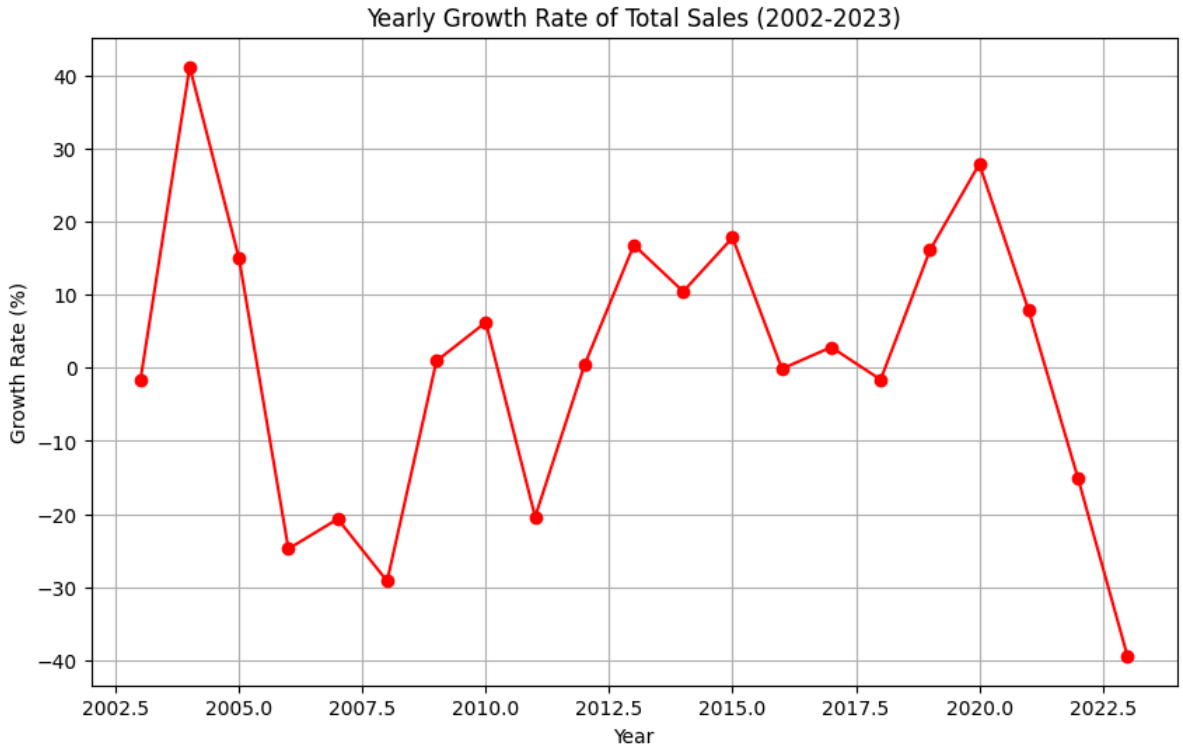


In [53]:
```
# Top towns by sum of sales amount by year
sales_by_town_year = data_cleaned.groupby(['Year', 'Town'])['Sale Amount'].sum()

top_towns_per_year = sales_by_town_year.groupby('Year').idxmax()

for year, town in top_towns_per_year.items():
    print(f"In {year}, the top town was {town[1]} with sales of {sales_by_town_year
```

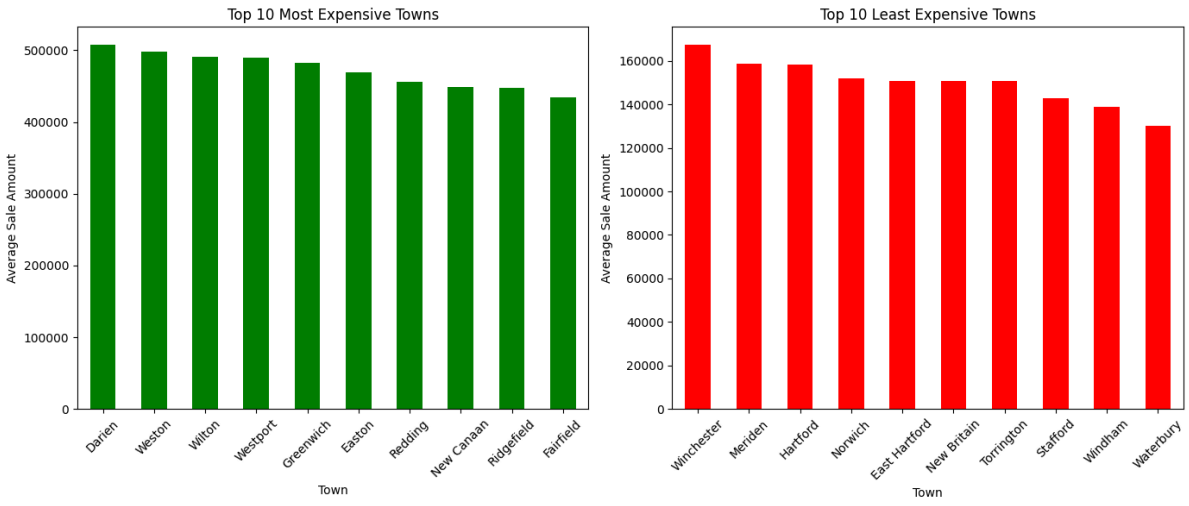
```
In 1999, the top town was New London with sales of 95000.0
In 2001, the top town was Stamford with sales of 159320574.0
In 2002, the top town was Stamford with sales of 758919774.0
In 2003, the top town was Stamford with sales of 787136323.0
In 2004, the top town was Stamford with sales of 958794444.0
In 2005, the top town was Stamford with sales of 914520150.0
In 2006, the top town was Bridgeport with sales of 706403518.0
In 2007, the top town was Norwalk with sales of 535892373.0
In 2008, the top town was West Hartford with sales of 298266829.0
In 2009, the top town was Stamford with sales of 361965975.0
In 2010, the top town was Stamford with sales of 394661870.0
In 2011, the top town was Stamford with sales of 360238446.0
In 2012, the top town was Norwalk with sales of 269766238.0
In 2013, the top town was Fairfield with sales of 315224127.0
In 2014, the top town was Stamford with sales of 482007915.0
In 2015, the top town was Stamford with sales of 553983146.0
In 2016, the top town was Stamford with sales of 613957904.0
In 2017, the top town was Stamford with sales of 451937142.0
In 2018, the top town was Norwalk with sales of 356334567.0
In 2019, the top town was Stamford with sales of 617051073.0
In 2020, the top town was Stamford with sales of 673011610.0
In 2021, the top town was Stamford with sales of 794659978.0
In 2022, the top town was Stamford with sales of 624241017.67
In 2023, the top town was Bridgeport with sales of 328024672.0
```

In [55]:
```
# Yearly growth rate for sales
yearly_sales = data_cleaned.groupby('Year')['Sale Amount'].sum()

yearly_sales_filtered = yearly_sales[yearly_sales.index >2001]

yearly_growth_rate = yearly_sales_filtered.pct_change() * 100

print("Yearly Growth Rate (2002-2023):")
print(yearly_growth_rate)

# Plot yearly growth rate (2002-2023)
plt.figure(figsize=(10, 6))
yearly_growth_rate.plot(marker='o', color='red')
plt.title('Yearly Growth Rate of Total Sales (2002-2023)')
plt.xlabel('Year')
plt.ylabel('Growth Rate (%)')
plt.grid(True)
plt.show()
```

```
Yearly Growth Rate (2002-2023):
Year
2002      NaN
2003    -1.74
2004    41.17
2005    14.96
2006   -24.76
2007   -20.68
2008   -29.19
2009     0.93
2010     6.23
2011   -20.38
2012     0.38
2013    16.81
2014    10.44
2015    17.81
2016    -0.13
2017     2.83
2018    -1.62
2019    16.09
2020    27.89
2021     7.85
2022   -15.11
2023   -39.40
Name: Sale Amount, dtype: float64
```



In [56]:
```
# Average sale price per town
avg_sale_by_town = data_cleaned_no_outliers.groupby('Town')['Sale Amount'].mean().s

plt.figure(figsize=(14, 6))

plt.subplot(1, 2, 1)
avg_sale_by_town[:10].plot(kind='bar', color='green')
plt.title('Top 10 Most Expensive Towns')
plt.ylabel('Average Sale Amount')
plt.xticks(rotation=45)

plt.subplot(1, 2, 2)
avg_sale_by_town[-10:].plot(kind='bar', color='red')
plt.title('Top 10 Least Expensive Towns')
plt.ylabel('Average Sale Amount')
plt.xticks(rotation=45)

plt.tight_layout()
plt.show()
```



In [ ]: